には、その装置に応じた装置管理サーバを追加すれば良くなり、動的ネットワーク自動設定サーバ１１の構成を変更する必要が無くなる。これにより、システムの管理が容易となる。

【0061】

〔第３の実施形態〕

図１１に、本発明を好適に実施した第３の実施形態に係る動的ネットワーク自動設定システムの構成を示す。このシステムは、オペレータ用クライアント１００をさらに有する他は、第２の実施形態に係る動的ネットワーク自動設定システムとほぼ同様である。

オペレータ用クライアント１００は、クライアント表示・制御部１０１及び動的自動設定サーバインタフェース１０２を有する。クライアント表示・制御部１０１は、クライアント画面の表示・設定・表示データの制御を司る。動的自動設定サーバインタフェース１０２は、動的自動設定サーバ１１との間でデータを送受信するためのインタフェースである。

【0062】

本実施形態においては、動的ネットワーク自動設定サーバ１１は、クライアントインタフェース１０３をさらに有する。クライアントインタフェース１０３は、オペレータ用クライアント１００経由で任意の装置に割り当てられている通信回線の装置収集データの表示や、設定値変更を実施する場合に設定値プロファイル用データとの比較を行う。

【0063】

本実施形態に係る動的ネットワーク自動設定システムにおいては、動的ネットワークの自動設定とオペレータ用クライアント１００の操作者（すなわち、オペレータ）によるマニュアル設定とを共存させることができる。例えば、動的ネットワーク自動設定サーバ１１のタイマ制御部１８が夜間にのみトリガを生成するように設定しておき、昼間の時間帯にはオペレータよるコールセンタ業務を行うようにすれば、動的ネットワーク自動設定サーバ１１による自動設定と、オペレータによるマニュアル設定とが競合することなく共存させることが可能である。

【0064】

次に、システムの構成例について説明する。本システムを実際に構築する場合には、図１２に示すような拠点分散方式と図１３に示すようなセンタ集中配置方式とが考えられる。

【0065】

拠点分散方式では、カスタマサポートセンタ１１０１にオペレータ用クライアント１１０２を配置し、地域拠点１１０４ａ，１１０４ｂ，・・・に動的ネットワーク自動設定サーバ１１０５及び装置管理サーバ１１０６を配置し、装置管理サーバ１１０６の配下の装置を管理する。

【0066】

本システムを拠点分散方式で構築する場合には、

・各地域拠点の動的ネットワーク自動設定サーバで異なる理論を設定することができるため、地域特性（例えば、ＡＤＳＬの場合には、局舎とエンドユーザとが密接している都市部と、局舎数の少ない郊外とでは、局舎とエンドユーザの間の線路長に差があるため、ネットワーク運用上、最適な設定値は異なる。）に応じた運用が可能。

・動的ネットワーク自動設定サーバと装置管理サーバとの間をＬＡＮで接続できるため、専用の通信回線が不要。

・動的ネットワーク自動設定サーバの負荷を分散可能。

という長所がある。

【0067】

一方、センタ集中配置方式では、カスタマサポートセンタ１２０１にオペレータ用クライアント１２０２、及び動的ネットワーク自動設定サーバ１２０５を配置し、各地域拠点１２０４ａ，１２０４ｂ，・・・には、装置管理サーバ１２０６ａ，１２０６ｂ，・・・を配置し、装置管理サーバ１２０６ａ，１２０６ｂ，・・・の配下の装置を管理する。

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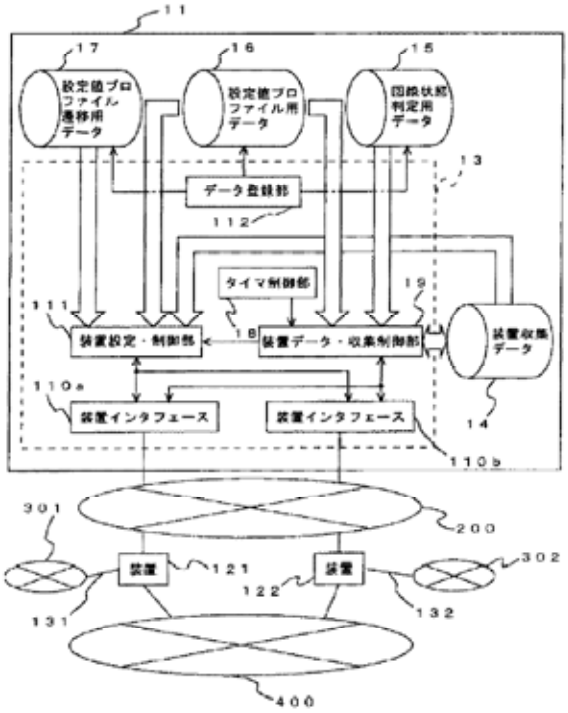
【0068】
本システムをセンタ集中方式で構築する場合には、
・動的ネットワーク自動設定サーバをカスタマサポートセンタに集中配置するため、システムの管理・保守が容易。
・オペレータ用クライアントと動的ネットワーク自動設定サーバとの間をＬＡＮで接続できるため、専用の通信回線が不要。
という長所がある。
【0069】
なお、上記各実施形態は、本発明の好適な実施の一例であり、本発明はこれらに限定されることはない。
例えば、上記各実施形態においては、動的ネットワーク自動設定サーバや装置管理サーバの配下に二種類の装置が存在する場合を例に説明を行ったが、さらに多くの機種を管理下に置くことも可能である。
このように、本発明は様々な変形が可能である。
【図面の簡単な説明】
【0070】
【図1】本発明を好適に実施した第１の実施形態に係る動的ネットワーク自動設定システムの構成を示す図である。
【図2】情報ネットワークの一例を示す図である。
【図3】装置収集データのデータ構造例を示す図である。
【図4】回線状態判定用データのデータ構造例を示す図である。
【図5】設定値プロフィールデータのデータ構造例を示す図である。
【図6】設定値プロフィール遷移用データのデータ構造例を示す図である。
【図7】第１の実施形態にかかる動的ネットワーク自動設定システムの動作の流れを示すフローチャートである。
【図8】装置から収集した装置設定値データ及び状態データに基づいて装置収集データを生成する処理を示す図である。
【図9】装置収集データに基づいて次に設定する設定値群を決定する処理を示す図である。
【図10】本発明を好適に実施した第２の実施形態に係る動的ネットワーク自動設定システムの構成を示す図である。
【図11】本発明を好適に実施した第３の実施形態に係る動的ネットワーク自動設定システムの構成を示す図である。
【図12】第３の実施形態に係る動的ネットワーク自動設定システムを分散拠点方式で構築した状態を示す図である。
【図13】第３の実施形態に係る動的ネットワーク自動設定システムをセンタ集中配置方式で構築した状態を示す図である。
【符号の説明】
【0071】
１１、１１０５ａ、１１０５ｂ、１２０５　　動的ネットワーク自動設定サーバ
１３　　システムプログラム
１４、９２ａ、９２ｂ　　装置収集データ
１５　　回線状態判定用データ
１６　　設定値プロファイル用データ
１７　　設定値プロファイル遷移用データ
１８、９３ａ、９３ｂ　　タイマ制御部
１９　　装置データ・収集制御部
７１　　装置内設定データ・状態データ
７２、７３、８１、８２　　データ
９１ａ、９１ｂ、１１０６ａ、１１０６Ａ、１１０６ｂ、１１０６Ｂ、１２０６ａ、１

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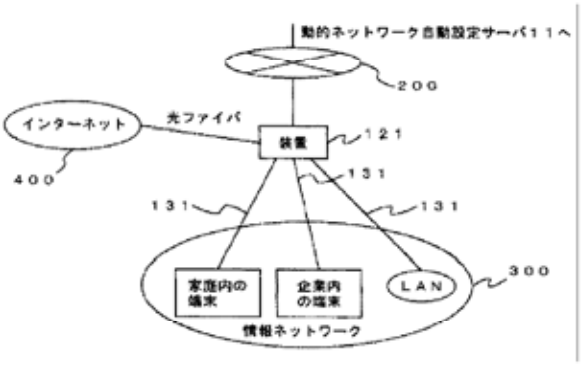
２０６ｂ、１２０６ｃ、１２０６ｄ　装置管理サーバ
９４ａ、９４ｂ　動作制御部
９５ａ、９５ｂ、１１０ａ、１１０ｂ　装置インタフェース
９６ａ、９６ｂ、１０１　動的自動設定サーバインタフェース
９８ａ、９８ｂ　装置管理サーバインタフェース
１００、１１０２、１２０２ａ、１２０２ｂ　オペレータ用クライアント
１０２　クライアント表示制御部
１１１　装置設定・制御部
１１２　データ登録部
１２１、１２２　装置
１３１、１３２　通信回線
１４１　回線識別子
１４２、１６１　設定値プロファイル名
１４３　状態値群
１４４、１７２　回線状態
１５１　回線状態名
１５２ａ　条件指定１
１５２ｂ　条件指定２
１５２ｃ　条件指定３
１５２ｄ　条件指定４
１６２ａ、１６２ｂ、１６２ｃ、１６２ｄ　パラメータ
１７１　遷移元設定値プロファイル名
１７３　遷移先設定値プロファイル名
２００　管理ネットワーク
３０１、３０２　情報ネットワーク
４００　インターネット
１１０１、１２０１　カスタマサポートセンタ
１１０４ａ、１１０４ｂ、１２０４ａ、１２０４ｂ　地域拠点

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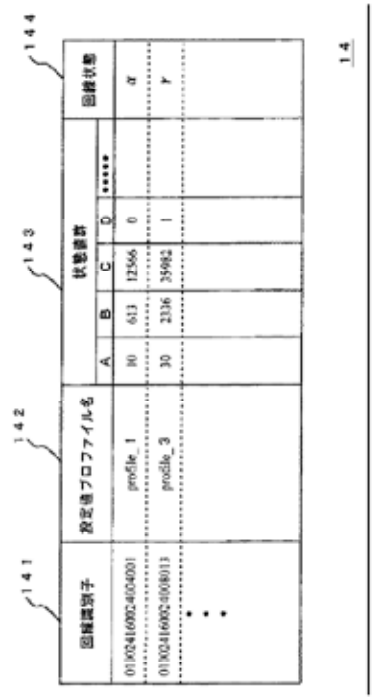
【図1】



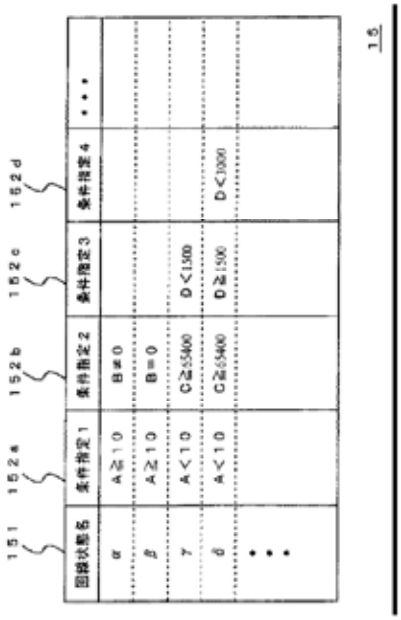
【図2】



【図3】

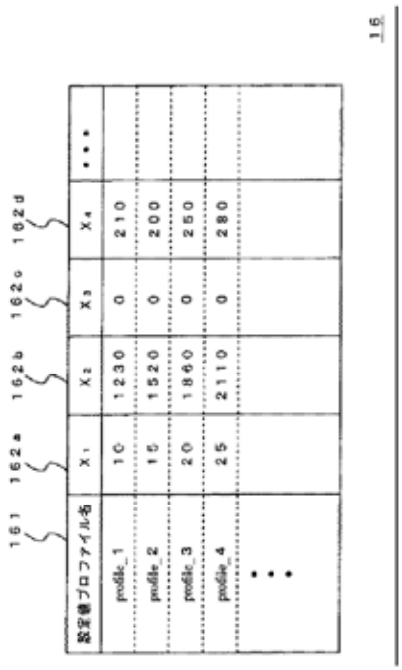


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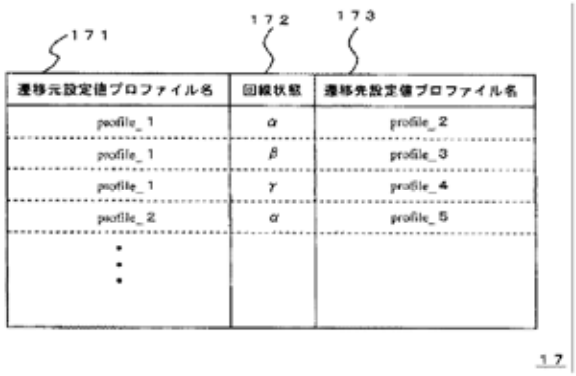


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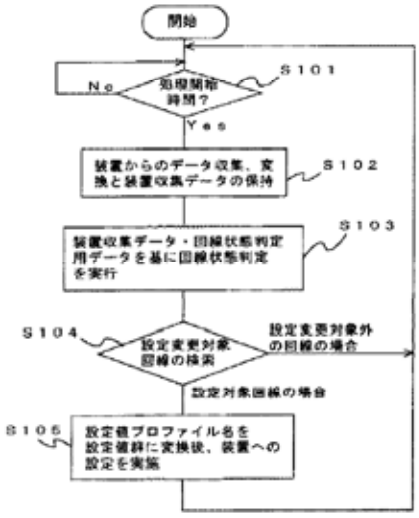
【図5】



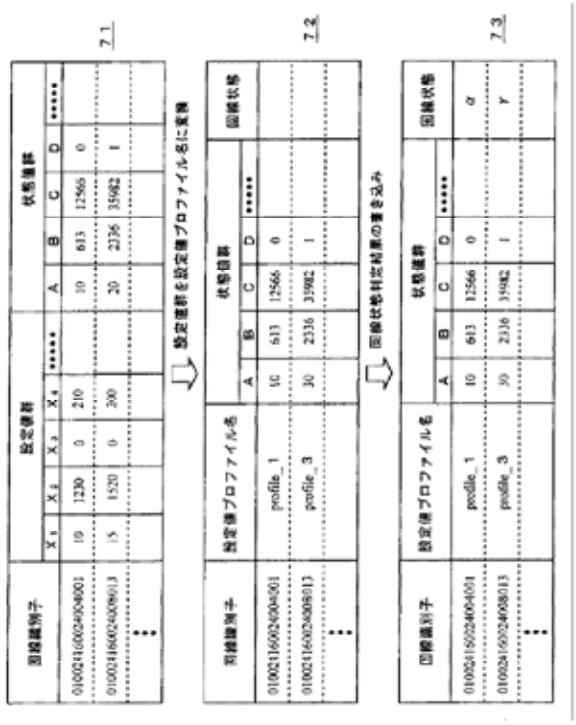
【図6】



【図7】

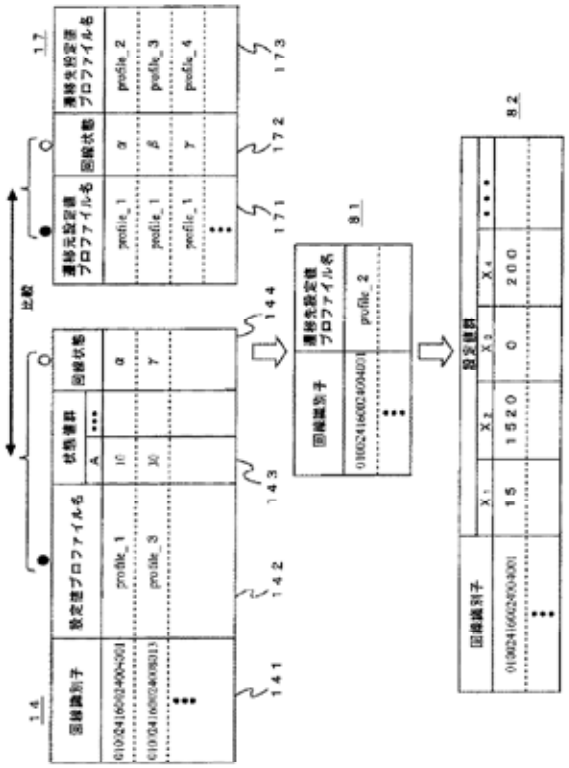


【図8】

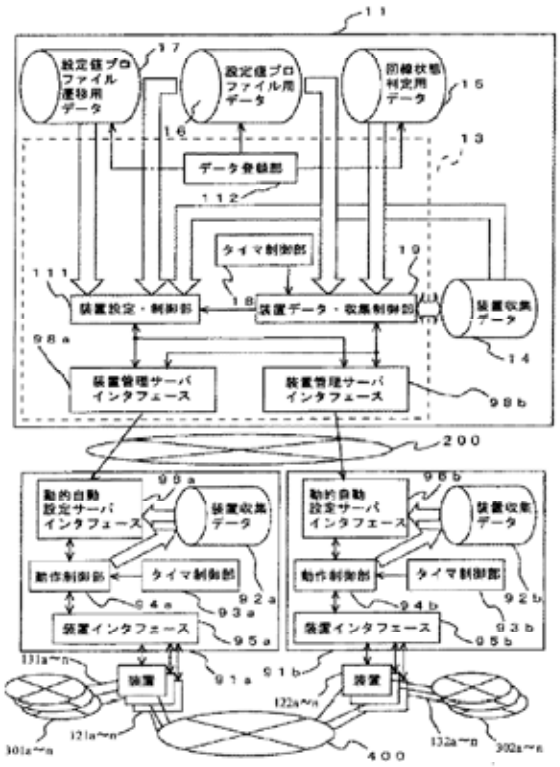


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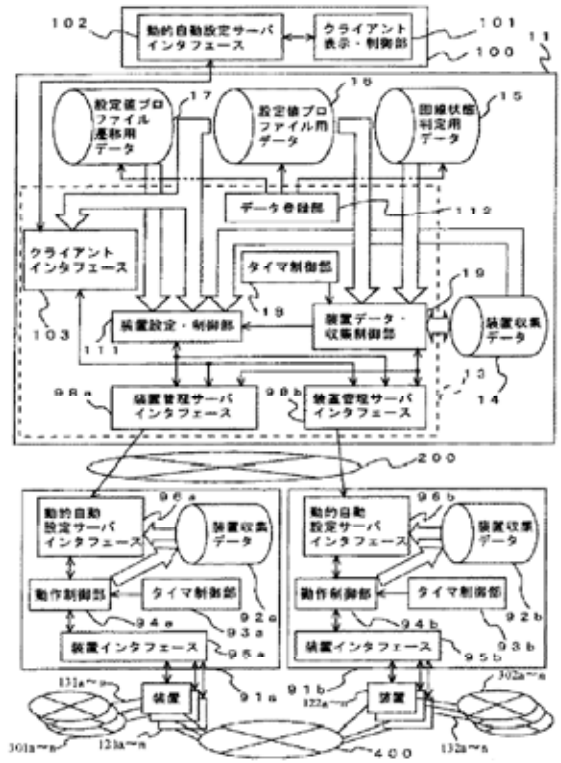
【図9】



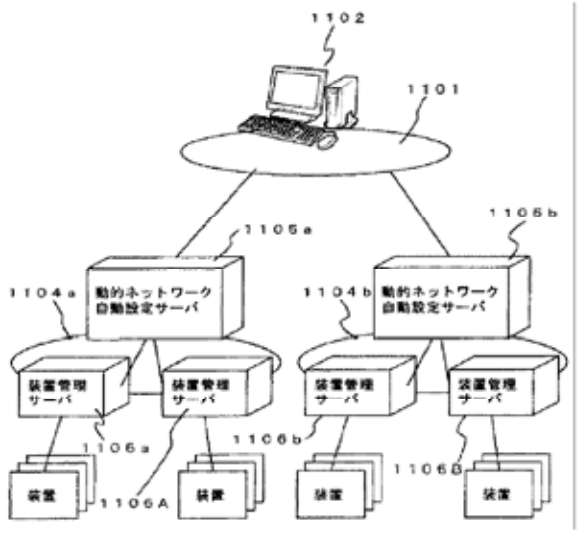
【図10】



【図11】

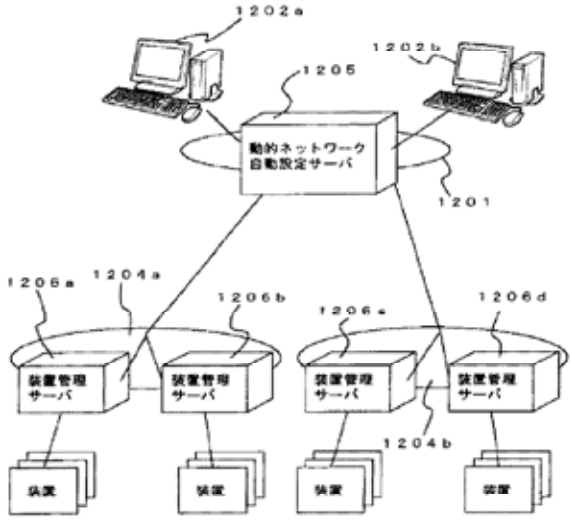


【図12】



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【図13】



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(72) 発明者; および
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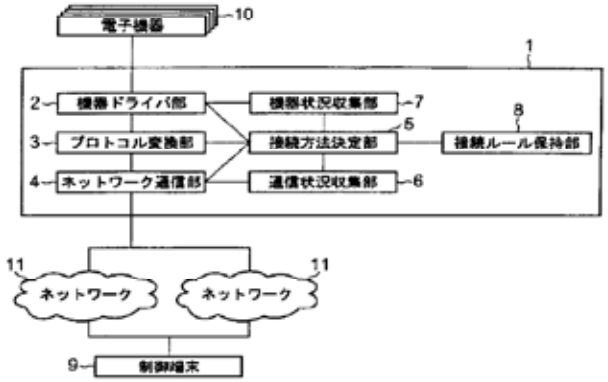
(81) 指定国 (表示のない限り、全ての種類の国内保護が可能): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK,

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(54) Title: REMOTE INSTRUMENT MANAGING SYSTEM, REMOTE INSTRUMENT MANAGING METHOD AND REMOTE INSTRUMENT MANAGING PROGRAM

(54) 発明の名称: 遠隔機器管理システム、遠隔機器管理方法及び遠隔機器管理用プログラム



10... ELECTRONIC INSTRUMENT
2... INSTRUMENT DRIVER UNIT
7... INSTRUMENT STATE COLLECTING UNIT
3... PROTOCOL CONVERTING UNIT
5... CONNECTIN METHOD DECIDING UNIT
8... CONNECTING RULE HOLDING UNIT
4... NETWORK COMMUNICATION UNIT
6... COMMUNICATION STATE COLLECTING UNIT
11... NETWORK
9... CONTROL TERMINAL DEVICE

(57) **Abstract:** In such an environment as the internet which has a great variety of electronic instruments to be subjected to management and a large number of electronic instruments to be subjected to management, connections must be changed smoothly in response to changes in circumstances. An equipment state collecting unit (7) collects an equipment state: a kind, a load, a position and the like of an electronic instrument (10). A communication state collecting unit (6) collects a communication state: a kind, a path, a load and the like of communication. A connecting rule holding unit (8) holds a connecting rule in advance to show a communication connecting method suitable for an equipment state, a communication state and a terminal device state. A connecting method deciding unit (5) extracts a proper connecting method in comparison of the instrument state, the communication state and the terminal device state with the connecting rule. Further, the connecting method deciding unit (5) sets an instrument driver unit (2), a protocol converting unit (3) and a network communication unit (4) to the decided connecting method.

(57) 要約: 管理対象となる電子機器が多種多様であり、かつ管理対象となる電子機器が多数存在するインターネットのような環境において、状況変化に対応して、円滑に接続を変更できるようにしなければならない。 機器状況収集部７は、電子機器１０の種類や負荷、位置

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SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) 指定国 (表示のない限り、全ての種類の広域保護が可能): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), ユーラシア (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), ヨーロッパ (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

添付公開書類:
— 国際調査報告書

等の機器状況を収集する。通信状況収集部６は、通信の種類や経路、負荷等の通信状況を収集する。接続ルール保持部８は、ある機器状況や通信状況、端末状況に適した通信接続方法を示す接続ルールを予め保持する。接続方法決定部５は、機器状況や通信状況、端末状況と、接続ルールとを照合して、適切な接続方法を示す接続ルールを抽出する。そして、接続方法決定部５は、機器ドライバ部２、プロトコル変換部３及びネットワーク通信部４に、決定した接続方法に設定させる。

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明 細 書

遠隔機器管理システム、遠隔機器管理方法及び遠隔機器管理用プログラム

技術分野

[0001] 本発明は、遠隔機器管理システム、遠隔機器管理方法及び遠隔機器管理用プログラムに関し、特に、ネットワーク非対応型の機器を含む多種多様な電子機器又はデバイスを、インターネット等の通信ネットワークを介して遠隔管理できる遠隔機器管理システム、遠隔機器管理方法及び遠隔機器管理用プログラムに関するものである。

背景技術

[0002] 関連する遠隔機器管理方法として、例えば、特許文献1には、電子機器をLANを介して利用可能とした遠隔機器管理方法の一例が記載されている。特許文献1に記載された関連する電子機器をLANを介して利用する方法は、管理対象の電子機器と制御端末(電子機器を制御する端末)とが固有のプロトコルで接続され通信可能に構成される。また、その電子機器と制御端末との接続経路の間に標準通信プロトコルに変換する情報コンセントを配置し、情報コンセント間の通信に標準的なネットワーク通信を用いて情報コンセントを接続する。そのような構成を有することによって、特許文献1に記載された遠隔機器管理方法では、RS－232CやSCSI等のインターフェースのみを有する電子機器を、イーサネット(TCP／IP)等の標準的なネットワークを介して、遠隔から利用することを可能とする。なお、イーサネットは登録商標である。

[0003] また、関連する遠隔機器管理方法を用いた装置として、例えば、特許文献2には、互換性のないネットワークにおけるプロトコルデータユニットを相互変換する装置の一例が記載されている。特許文献2に記載された関連する互換性のないネットワークにおけるプロトコルデータユニットを相互変換する装置は、通信端末と、それら通信端末が接続された通信ネットワークと、その通信ネットワークと接続されたローカルエリアネットワークと、ローカルエリアネットワーク内に含まれる電子機器とから構成される。そのような環境において、特許文献2に記載された装置は、通信ネットワークとローカ

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ルエリアネットワークとの間にあって、機器識別子と、制御命令と、制御有効情報とを双方向に変換して伝送し、通信端末からローカルエリアネットワーク内の電子機器を遠隔制御することを可能とする。

[0004] また、例えば、特許文献3には、関連する機器制御プロトコルが異なる電子機器間で機器ネットワークを構成することを可能とする方法の一例が記載されている。図1は、関連する機器制御プロトコルが異なる電子機器間で機器ネットワークを構成する場合の構成例を示すブロック図である。図1に示すように、この関連する機器制御プロトコルが異なる電子機器間で機器ネットワークを構成することを可能とする方法において、各電子機器に対応する機器制御装置は、仮想プロトコル提供部502と、仮想プロトコル実行部503と、仮想プロトコル転送部504と、仮想プロトコル変換部とを有する。仮想プロトコル提供部502は、ある機器制御アプリケーション501から送信される一般化した制御情報を受信する。また、仮想プロトコル実行部503は、受信した制御情報の仮想プロトコルを解釈する。また、仮想プロトコル変換部505は、受信した制御情報を、実際に電子機器の制御に用いるプロトコルに変換する。

[0005] 上記のような構成を有する関連する機器制御装置の動作について説明する。ネットワーク上に複数の電子機器が存在する場合において、ある機器制御アプリケーション501は、異なった種類の機器制御プロトコルを並列的に又は直列的に逐次実行する。また、機器制御アプリケーション501は、その機器制御プロトコルに従った処理を実行した結果発見された電子機器を抽出し、電子機器のIDや型名、型番等の機器情報及びネットワークアドレスを認識する。図1に示す機器制御装置は、これらの機器情報やネットワークアドレス等の情報を用いて、一般化した制御情報を含む仮想プロトコルから各電子機器固有の制御プロトコルに変換する。

[0006] また、例えば、特許文献4には、関連するネットワークプラグアンドプレイ非対応のデバイスを管理し制御する方法の一例が記載されている。特許文献4に記載された関連するネットワークプラグアンドプレイ非対応のデバイスを管理し制御する方法は、ネットワークに接続されたネットワークプラグアンドプレイ非対応の電子機器と、制御端末と、プロキシサーバとから構成されるシステムに適用される。そのようなシステムにおいて、プロキシサーバは、電子機器のネットワーク情報及び機器情報を保持する

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。また、プロキシサーバは、クライアント(具体的には、パーソナルコンピュータ(PC))からネットワークプラグアンドプレイの制御／管理要求があった場合に、電子機器に代わって、その制御／管理要求を処理して応答する。また、プロキシサーバは、必要に応じて、電子機器固有のプロトコルを用いて電子機器を制御する。また、プロキシサーバは、電子機器のネットワーク情報及び機器情報を、SNMPプロトコル等の手段を用いて、探索したり情報収集することも可能である。

[0007] 特許文献1:特開平8－274835号公報

特許文献2:特表2002－536914号公報

特許文献3:特開2005－85238号公報

特許文献4:特開2005－309617号公報

発明の開示

発明が解決しようとする課題

[0008] 特許文献1～特許文献4に記載された装置や方法を用いたとしても、管理対象となる電子機器が多種多様であり、かつ管理対象となる電子機器が多数存在するインターネットのような環境では、計算処理の負荷やネットワークの負荷、電子機器や制御端末の移動等の状況の変化に対応して、円滑に接続を変更することはできない。

[0009] 具体的には、特許文献1～特許文献4に記載された装置や方法を用いれば、通信プロトコルを電子機器や制御端末に応じて変換する方式を提供したり、接続する電子機器を探索し、機器情報を収集し、適切な電子機器と制御端末とを接続する方式を提供することができる。しかし、例えば、利用するネットワーク環境がインターネットである場合、多種多様な電子機器がネットワークに接続されているとともに、多種多様なサービスが混在し、それらの電子機器やサービスが時々刻々と変化する可能性がある。そのため、電子機器と制御端末との接続が一定しない可能性がある。また、電子機器及び制御端末が携帯型の電子機器や制御端末である場合、電子機器や制御端末が移動することがあり、無線接続の状況が一定しない可能性がある。

[0010] 上記のような状況の変化に応じて、電子機器や制御端末の接続を変更したり、電子機器と制御端末との間の通信に用いるプロトコルを変更できるようにすることが考えられる。しかし、特許文献1～特許文献4に記載された装置や方法では、電子機器や

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制御端末の状況変化を監視する手段は開示されておらず、電子機器と制御端末との間の接続やプロトコルを安全に変更する手段も開示されていない。また、特許文献1～特許文献4に記載された装置や方法を用いたとしても、管理対象となる電子機器及び管理を実行する制御端末の位置を監視する手段を有していないため、電子機器及び制御端末の移動に対応することは困難である。さらに、電子機器が多種多様であり、かつネットワーク上に電子機器が多数存在するインターネットのような環境では、例えば、最善の接続方法で電子機器と制御端末とを接続できない場合に、次善の接続方法(いずれの電子機器に接続すればよいかや、いずれのプロトコルを用いればよいか)を瞬時に判断して変更することは困難である。

[0011] そこで、本発明は、管理対象となる電子機器が多種多様であり、かつ管理対象となる電子機器が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器や制御端末の移動等による状況の変化に対応して、円滑に接続を変更できる遠隔機器管理システム、遠隔機器管理方法及び遠隔機器管理用プログラムを提供することを目的とする。

課題を解決するための手段

[0012] かかる目的を達成するために、本発明は、以下の特徴を有することとする。

[0013] 本発明による遠隔機器管理システムは、電子機器を遠隔管理する遠隔機器管理システムであって、電子機器の状況を示す機器状況情報を収集する機器状況収集手段(例えば、機器状況収集部7によって実現される)と、電子機器と電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集手段(例えば、通信状況収集部6によって実現される)と、機器状況収集手段が収集した機器状況情報と通信状況収集手段が収集した通信状況情報とに基づいて、電子機器と制御端末との間の接続方法を決定する接続方法決定手段(例えば、接続方法決定部5によって実現される)と、接続方法決定手段の決定結果に基づいて、電子機器と制御端末の間の接続方法を設定する接続方法設定手段(例えば、接続方法決定部5によって実現される)とを備えたことを特徴とする。

[0014] また、遠隔機器管理システムは、電子機器と制御端末との間の接続方法を示す接続ルールを予め記憶する接続ルール記憶手段(例えば、接続ルール保持部8によっ

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て実現される)を備え、接続方法決定手段は、接続ルール記憶手段が記憶する接続ルールから、機器状況収集手段が収集した機器状況情報と通信状況収集手段が収集した通信状況情報とに合致する接続ルールを抽出するものであってもよい。

[0015] また、遠隔機器管理システムは、制御端末の状況を示す端末状況情報を収集する端末状況収集手段(例えば、端末状況収集部16によって実現される)を備え、接続方法設定手段は、機器状況情報及び通信状況情報に加えて、端末状況収集手段が収集した端末状況情報に基づいて、電子機器と制御端末との間の接続方法を決定するものであってもよい。

[0016] 本発明による遠隔機器管理システムの他の態様は、電子機器を制御する電子機器制御手段(例えば、機器ドライバ部2によって実現される)と、ネットワークに接続された制御端末とデータを送受信するデータ送受信手段(例えば、ネットワーク通信部4によって実現される)と、電子機器が入出力する制御データと制御端末が送受信するネットワーク通信データとの間でプロトコル変換を行なうプロトコル変換手段(例えば、プロトコル変換部3によって実現される)と、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集手段(例えば、機器状況収集部7によって実現される)と、ネットワーク通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段(例えば、通信状況収集部6によって実現される)と、機器状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段(例えば、接続ルール保持部8によって実現される)と、機器状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、プロトコル変換方式及びネットワーク通信方式を設定する接続方法設定手段(例えば、接続方法決定部5によって実現される)とを備えたことを特徴とする。

[0017] 本発明による遠隔機器管理システムのさらに他の態様は、ネットワークに接続された電子機器と制御データを送受信する制御データ送受信手段(例えば、ネットワーク通信部4Aによって実現される)と、制御端末とのインタフェースを実現するインタフェース手段(例えば、端末ドライバ部15によって実現される)と、電子機器が送受信するネットワーク制御データと制御端末が入出力する入出力インターフェースとの間で

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プロトコル変換を行なうプロトコル変換手段(例えば、プロトコル変換部3Aによって実現される)と、ネットワーク電子機器の種類、負荷、ネットワーク経路又は位置を含む通信状況を示す通信状況情報を収集する通信状況収集手段(例えば、通信状況収集部6Aによって実現される)と、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集手段(例えば、端末状況収集部16によって実現される)と、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段(例えば、接続ルール保持部8Aによって実現される)と、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、ネットワーク電子機器の通信制御方式、プロトコル変換方式及び端末インターフェース方式を設定する接続方法設定手段(例えば、接続方法決定部5Aによって実現される)とを備えたことを特徴とする。

[0018] 本発明による遠隔機器管理システムのさらに他の態様は、電子機器の通信アダプタ(例えば、コンピュータ1b)と、制御端末の通信アダプタ(例えば、コンピュータ1a)とを備え、電子機器の通信アダプタは、電子機器を制御する電子機器制御手段(例えば、機器ドライバ部2bによって実現される)と、ネットワーク通信を行なう機器側通信手段(例えば、ネットワーク通信部4bによって実現される)と、電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換手段(例えば、プロトコル変換部3bによって実現される)と、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集手段(例えば、端末状況収集部16Bによって実現される)と、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集手段(例えば、機器状況収集部7Bによって実現される)と、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段(例えば、通信状況収集部6Bによって実現される)と、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段(例えば、接続ルール保持部8Bによって実現される)と、機器状況、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定手段(例えば、接続

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方法決定部5Bによって実現される)とを含み、制御端末の通信アダプタは、制御端末とのインタフェースを実現するインタフェース手段(例えば、端末ドライバ部15aによって実現される)と、ネットワーク通信を行なう制御側通信手段(例えば、ネットワーク通信部4aによって実現される)と、制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換手段(例えば、プロトコル変換部3aによって実現される)とを含むことを特徴とする。

[0019] 本発明による遠隔機器管理システムのさらに他の態様は、電子機器の通信アダプタ(例えば、コンピュータ1b)と、制御端末の通信アダプタ(例えば、コンピュータ1a)とを備え、電子機器の通信アダプタは、電子機器を制御する電子機器制御手段(例えば、機器ドライバ部2bによって実現される)と、ネットワーク通信を行なう機器側通信手段(例えば、ネットワーク通信部4bによって実現される)と、電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換手段(例えば、プロトコル変換部3bによって実現される)とを含み、制御端末の通信アダプタは、制御端末とのインタフェースを実現するインタフェース手段(例えば、端末ドライバ部15aによって実現される)と、ネットワーク通信を行なう制御側通信手段(例えば、ネットワーク通信部4aによって実現される)と、制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換手段(例えば、プロトコル変換部3aによって実現される)と、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集手段(例えば、端末状況収集部16Bによって実現される)と、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集手段(例えば、機器状況収集部7Bによって実現される)と、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段(例えば、通信状況収集部6Bによって実現される)と、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段(例えば、接続ルール保持部8Bによって実現される)と、機器状況、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定手段(例えば、接続方

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法決定部5Bによって実現される)とを含むことを特徴とする。

[0020] 本発明による遠隔機器管理システムのさらに他の態様は、電子機器の通信アダプタ(例えば、コンピュータ1b)と、制御端末の通信アダプタ(例えば、コンピュータ1a)とを備え、電子機器の通信アダプタは、電子機器を制御する電子機器制御手段(例えば、機器ドライバ部2bによって実現される)と、ネットワーク通信を行なう機器側通信手段(例えば、ネットワーク通信部4bによって実現される)と、電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換手段(例えば、プロトコル変換部3bによって実現される)とを含み、制御端末の通信アダプタは、制御端末とのインタフェースを実現するインタフェース手段(例えば、端末ドライバ部15aによって実現される)と、ネットワーク通信を行なう制御側通信手段(例えば、ネットワーク通信部4aによって実現される)と、制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換手段(例えば、プロトコル変換部3aによって実現される)とを含み、さらに、ネットワーク上を介して制御を行なうプログラムモジュール(例えば、接続管理モジュール20によって実現される)を備え、プログラムモジュールは、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を、ネットワークを介して収集する端末状況収集手段(例えば、端末状況収集部16Bによって実現される)と、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を、ネットワークを介して収集する機器状況収集手段(例えば、機器状況収集部7Bによって実現される)と、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段(例えば、通信状況収集部6Bによって実現される)と、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段(例えば、接続ルール保持部8Bによって実現される)と、機器状況、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を、ネットワークを介して設定する接続方法設定手段(例えば、接続方法決定部5Bによって実現される)とを含むことを特徴とする。

[0021] また、遠隔機器管理システムは、機器状況、端末状況及び通信状況に合致した通

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信接続方法を示す接続ルールを表示するルール表示手段（例えば、接続方法UI部13によって実現される）と、ユーザ操作に従って、接続ルールを編集するルール編集手段（例えば、接続方法UI部13によって実現される）とを含むものであってもよい。

[0022] また、遠隔機器管理システムは、収集した端末状況、機器状況又は通信状況と、機器状況、端末状況又は通信状況に合致した通信接続方法を示す接続ルールとを照合して特定した接続方法の候補を表示する候補表示手段（例えば、接続方法UI部13によって実現される）と、ユーザ操作に従って、候補表示手段が表示した候補から接続方法を選択する接続方法選択手段（例えば、接続方法UI部13によって実現される）とを含むものであってもよい。

[0023] また、遠隔機器管理システムは、電子機器から入力したデータを保存するデータ保存手段（例えば、プロトコル変換部3によって実現される）と、制御端末からの制御要求に対して、データ保存手段が保存するデータを用いて、電子機器と制御端末とを非同期で動作させる動作制御手段（例えば、プロトコル変換部3によって実現される）とを含むものであってもよい。

[0024] また、遠隔機器管理システムは、制御端末からの入力データを保存する入力データ保存手段（例えば、プロトコル変換部3によって実現される）と、電子機器からの入力要求に対して、入力データ保存手段が保存するデータを用いて、電子機器と制御端末とを非同期で動作させることを可能とする動作制御手段（例えば、プロトコル変換部3によって実現される）とを含むものであってもよい。

[0025] また、遠隔機器管理システムは、保存データが有効であるか無効であるかを選択するとともに、保存データを編集する選択編集手段（例えば、プロトコル変換部3によって実現される）を含むものであってもよい。

[0026] また、遠隔機器管理システムは、電子機器から入力したデータを保存するデータ保存手段（例えば、プロトコル変換部3によって実現される）と、電子機器から制御端末への通信を行なう際に、通信データの欠落があった場合に、データ保存手段が保存する保存データを用いて通信データを再送するデータ再送手段（例えば、プロトコル変換部3によって実現される）とを含むものであってもよい。

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[0027] また、遠隔機器管理システムは、制御端末からの入力データを保存する入力データ保存手段（例えば、プロトコル変換部3によって実現される）と、制御端末から電子機器への通信を行なう際に、通信データの欠落があった場合に、入力データ保存手段が保存する保存データを用いて通信データを再送するデータ再送手段（例えば、プロトコル変換部3によって実現される）とを含むものであってもよい。

[0028] 本発明による遠隔機器管理方法は、電子機器を遠隔管理する遠隔機器管理方法であって、電子機器の状況を示す機器状況情報を収集する機器状況収集ステップと、電子機器と電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集ステップと、収集した機器状況情報と通信状況情報とに基づいて、電子機器と制御端末との間の接続方法を決定する接続方法決定ステップと、接続方法の決定結果に基づいて、電子機器と制御端末の間の接続方法を設定する接続方法設定ステップとを含むことを特徴とする。

[0029] また、遠隔機器管理方法は、電子機器と制御端末との間の接続方法を示す接続ルールを予め記憶する接続ルール記憶ステップを含み、接続方法決定ステップで、記憶する接続ルールから、収集した機器状況情報と通信状況情報とに合致する接続方法を抽出するものであってもよい。

[0030] また、遠隔機器管理方法は、制御端末の状況を示す端末状況情報を収集する端末状況収集ステップを含み、接続方法設定ステップで、機器状況情報及び通信状況情報に加えて、収集した端末状況情報に基づいて、電子機器と制御端末との間の接続方法を決定するものであってもよい。

[0031] 本発明による遠隔機器管理方法の他の態様は、電子機器を制御する電子機器制御ステップと、ネットワークに接続された制御端末とデータを送受信するデータ送受信ステップと、電子機器が入出力する制御データと制御端末が送受信するネットワーク通信データとの間でプロトコル変換を行なうプロトコル変換ステップと、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集ステップと、ネットワーク通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、機器状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、機器状況及

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び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、プロトコル変換方式及びネットワーク通信方式を設定する接続方法設定ステップとを含むことを特徴とする。

[0032] 本発明による遠隔機器管理方法のさらに他の態様は、ネットワークに接続された電子機器と制御データを送受信する制御データ送受信ステップと、制御端末とのインタフェースを実現するインタフェースステップと、電子機器が送受信するネットワーク制御データと制御端末が入出力する入出力インターフェースとの間でプロトコル変換を行なうプロトコル変換ステップと、ネットワーク電子機器の種類、負荷、ネットワーク経路又は位置を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、制御端末の種類、負荷又は位置を含む端末状況をを示す端末状況情報を収集する端末状況収集ステップと、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、ネットワーク電子機器の通信制御方式、プロトコル変換方式及び端末インターフェース方式を設定する接続方法設定ステップとを含むたことを特徴とする。

[0033] 本発明による遠隔機器管理方法のさらに他の態様は、電子機器の通信アダプタが、電子機器を制御する電子機器制御ステップと、電子機器の通信アダプタが、ネットワーク通信を行なう機器側通信ステップと、電子機器の通信アダプタが、電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換ステップと、電子機器の通信アダプタが、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集ステップと、電子機器の通信アダプタが、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集ステップと、電子機器の通信アダプタが、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、電子機器の通信アダプタが、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、電子機器の通信アダプタが、機器状況、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネッ

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トワーク通信方式及びプロトコル変換方式を設定する接続方法設定ステップと、制御端末の通信アダプタが、制御端末とのインタフェースを実現するインタフェースステップと、制御端末の通信アダプタが、ネットワーク通信を行なう制御側通信ステップと、制御端末の通信アダプタが、制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換ステップとを含むことを特徴とする。

[0034] 本発明による遠隔機器管理方法のさらに他の態様は、電子機器の通信アダプタが、電子機器を制御する電子機器制御ステップと、電子機器の通信アダプタが、ネットワーク通信を行なう機器側通信ステップと、電子機器の通信アダプタが、電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換ステップと、制御端末の通信アダプタが、制御端末とのインタフェースを実現するインタフェースステップと、制御端末の通信アダプタが、ネットワーク通信を行なう制御側通信ステップと、制御端末の通信アダプタが、制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換ステップと、制御端末の通信アダプタが、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集ステップと、制御端末の通信アダプタが、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集ステップと、制御端末の通信アダプタが、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、制御端末の通信アダプタが、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、制御端末の通信アダプタが、機器状況、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定ステップとを含むことを特徴とする。

[0035] 本発明による遠隔機器管理方法のさらに他の態様は、電子機器の通信アダプタが、電子機器を制御する電子機器制御ステップと、電子機器の通信アダプタが、ネットワーク通信を行なう機器側通信ステップと、電子機器の通信アダプタが、電子機器が

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送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換ステップと、制御端末の通信アダプタが、制御端末とのインタフェースを実現するインタフェースステップと、制御端末の通信アダプタが、ネットワーク通信を行なう制御側通信ステップと、制御端末の通信アダプタが、制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換ステップと、ネットワーク上を介して制御を行なうプログラムモジュールが、制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を、ネットワークを介して収集する端末状況収集ステップと、プログラムモジュールが、電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を、ネットワークを介して収集する機器状況収集ステップと、プログラムモジュールが、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、プログラムモジュールが、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、プログラムモジュールが、機器状況、端末状況及び通信状況と接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を、ネットワークを介して設定する接続方法設定ステップとを含むことを特徴とする。

[0036] また、遠隔機器管理方法は、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを表示するルール表示ステップと、ユーザ操作に従って、接続ルールを編集するルール編集ステップとを含むものであってもよい。

[0037] また、遠隔機器管理方法は、収集した端末状況、機器状況又は通信状況と、機器状況、端末状況又は通信状況に合致した通信接続方法を示す接続ルールとを照合して特定した接続方法の候補を表示する候補表示ステップと、ユーザ操作に従って、表示した候補から接続方法を選択する接続方法選択ステップとを含むものであってもよい。

[0038] また、遠隔機器管理方法は、電子機器から入力したデータを保存するデータ保存ステップと、制御端末からの制御要求に対して、保存するデータを用いて、電子機器と制御端末とを非同期で動作させる動作制御ステップとを含むものであってもよい。

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[0039] また、遠隔機器管理方法は、制御端末からの入力データを保存する入力データ保存ステップと、電子機器からの入力要求に対して、保存するデータを用いて、電子機器と制御端末とを非同期で動作させることを可能とする動作制御ステップとを含むものであってもよい。

[0040] また、遠隔機器管理方法は、保存データが有効であるか無効であるかを選択するとともに、保存データを編集する選択編集ステップを含むものであってもよい。

[0041] また、遠隔機器管理方法は、電子機器から入力したデータを保存するデータ保存ステップと、電子機器から制御端末への通信を行なう際に、通信データの欠落があった場合に、保存する保存データを用いて通信データを再送するデータ再送ステップとを含むものであってもよい。

[0042] また、遠隔機器管理方法は、制御端末からの入力データを保存する入力データ保存ステップと、制御端末から電子機器への通信を行なう際に、通信データの欠落があった場合に、保存する保存データを用いて通信データを再送するデータ再送ステップとを含むものであってもよい。

[0043] 本発明による遠隔機器管理用プログラムは、電子機器を遠隔管理するための遠隔機器管理用プログラムであって、コンピュータに、電子機器の状況を示す機器状況情報を収集する機器状況収集処理と、電子機器と電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集処理と、収集した機器状況情報と通信状況情報とに基づいて、電子機器と制御端末との間の接続方法を決定する接続方法決定処理と、接続方法の決定結果に基づいて、電子機器と制御端末の間の接続方法を設定する接続方法設定処理とを実行させるためのものである。

[0044] 本発明による遠隔機器管理システム、遠隔機器管理方法及び遠隔機器管理用プログラムは、上記のような構成を採用し、インターネット環境及びモバイルネットワーク環境における機器状況や端末状況、通信状況の変化に対応することができ、本発明の目的を達成することができる。

発明の効果

[0045] 本発明によれば、機器状況情報及び通信状況情報を収集し、収集した機器状況

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情報と通信状況情報とに基づいて、電子機器と制御端末との間の接続方法を決定する。そして、その決定結果に基づいて、電子機器と制御端末との接続方法を設定する。従って、管理対象となる電子機器が多種多様であり、かつ管理対象となる電子機器が多数存在する環境において、計算処理の負荷や通信の負荷、及び電子機器や制御端末の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、電子機器の状況変化と通信状況の変化との両方に対応して、電子機器と制御端末との間の接続方法を円滑に変更することができる。

[0046] また、本発明において、電子機器と制御端末の間の接続方法を示す接続ルールを予め記憶し、収集した機器状況情報と通信状況情報とに合致する接続ルールを抽出するように構成すれば、予め用意する接続ルールを用いて、電子機器と制御端末の間の接続方法を容易に設定することができる。

[0047] また、本発明において、端末状況情報を収集するようにし、機器状況情報及び通信状況情報に加えて、端末状況情報に基づいて接続方法を決定するように構成すれば、電子機器の状況変化及び通信状況の変化だけではなく、制御端末の状況変化にも対応して、電子機器と制御端末との間の接続方法を円滑に変更することができる。

発明を実施するための最良の形態

[0048] 実施の形態1.

以下、本発明の第1の実施の形態について図面を参照して説明する。図2は、本発明による遠隔機器管理システムの構成の一例を示すブロック図である。図2に示すように、遠隔機器管理システムは、複数の電子機器10と、電子機器10を制御する制御端末9と、コンピュータ1とを含む。また、図2に示すように、コンピュータ1と制御端末9とは、1つ又は複数のネットワーク11（例えば、インターネットやLAN）を介して接続される。

[0049] 電子機器10は、多種多様な用途に用いられ多種多様な機能を有する機器であり、多種多様なプロトコルを用いてデータの入出力や送受信を行う機器である。具体的には、電子機器10として、デジタルカメラや携帯電話機、RFIDリーダライタ、車載用センサ（位置センサや速度センサ）、気象観測装置、GPS受信機等を用いることがで

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きる。また、電子機器10は、ネットワーク上のサーバであってもよい。

[0050] 制御端末9は、複数の電子機器10を遠隔制御する端末であり、具体的には、パーソナルコンピュータ等のデータ処理装置によって実現される。また、制御端末9は、CPUやプロセッサを搭載したテレビジョン受信機等の家電製品によって実現されてもよい。

[0051] コンピュータ1は、電子機器10とネットワーク11とを接続するための装置であって、具体的には、プログラム制御により動作するパーソナルコンピュータ等のデータ処理装置によって実現される。なお、コンピュータ1は、中央処理装置やプロセッサ等によって実現されてもよい。また、コンピュータ1は、データ処理能力を備えたネットワーク機器(例えば、ルータ)によって実現されてもよい。また、例えば、電子機器10がデジタルカメラや携帯電話機である場合には、コンピュータ1は、プロセッサを搭載した充電器等によって実現されてもよい。

[0052] コンピュータ1は、機器ドライバ部2と、プロトコル変換部3と、ネットワーク通信部4と、接続方法決定部5と、通信状況収集部6と、機器状況収集部7と、接続ルール保持部8とを含む。

[0053] 機器ドライバ部2は、制御信号を出力して電子機器10を制御する機能を備える。ネットワーク通信部4は、ネットワーク11に接続された制御端末9と、ネットワーク11を介してデータ(制御信号等を含む)を送受信する機能を備える。プロトコル変換部3は、機器ドライバ部2が出力する制御情報と、ネットワーク通信部4が送受信する入出力データとの間で、プロトコル変換を行う機能を備える。

[0054] 機器状況収集部7は、電子機器10の種類や負荷、位置等の機器状況を収集する機能を備える。通信状況収集部6は、ネットワーク11を介した制御端末9との通信の種類や経路、負荷等の通信状況を収集する機能を備える。

[0055] 接続ルール保持部8は、ある機器状況や通信状況に適した電子機器10と制御端末9との通信接続方法を示す接続ルールを保持する機能を備える。具体的には、接続ルール保持部8は、機器状況を示す機器状況データや通信状況を示す通信状況データに対応付けて、接続ルールをハードディスク装置やメモリ等の記憶装置に記憶している。

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[0056] 接続方法決定部5は、機器状況収集部7が収集した機器状況や通信状況収集部6が収集した通信状況と、接続ルール保持部8が保持する接続ルールとを照合して、適切な接続方法を示す接続ルールを接続ルール保持部8から抽出する機能を備える。また、接続方法決定部5は、抽出した接続ルールを出力することによって、機器ドライバ部2、プロトコル変換部3及びネットワーク通信部4に、適切な接続方式を通知し適切な接続方法を設定させる機能を備える。

[0057] なお、コンピュータ1を実現するデータ処理装置の記憶装置は、電子機器10の遠隔管理を行うための各種プログラムを記憶している。例えば、コンピュータ1を実現するデータ処理装置の記憶装置は、コンピュータに、電子機器の状況を示す機器状況情報を収集する機器状況収集処理と、電子機器と電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集処理と、収集した機器状況情報と通信状況情報とに基づいて、電子機器と制御端末との間の接続方法を決定する接続方法決定処理と、接続方法の決定結果に基づいて、電子機器と制御端末の間の接続方法を設定する接続方法設定処理とを実行させるための遠隔機器管理用プログラムを記憶している。

[0058] 次に、動作について説明する。図3は、遠隔機器管理システムにおいて電子機器10と制御端末9との接続変更を行う処理の一例を示すフローチャートである。まず、ユーザは、電子機器10の制御を行いたい場合には、制御端末9を操作してコンピュータ1への接続を指示する。すると、制御端末9は、ユーザの操作に従って、コンピュータ1に任意の手段で(例えば、インターネットやLAN等のネットワーク11を介して)ネットワーク接続する(ステップS1)。

[0059] 次に、制御端末9によって接続されると、コンピュータ1の機器状況収集部7は、機器ドライバ部2を介して、コンピュータ1に接続されている電子機器10を探索する。例えば、機器状況収集部7は、コンピュータ1に接続されている機器を探索する方式として、プラグアンドプレイ等の既知の技術を用いることによって、電子機器10を検索することができる。この場合に、機器状況収集部7は、探索された電子機器10に関して、その電子機器10の機器状況を示すデータ(機器状況データ)を収集する(ステップS2)。例えば、機器状況収集部7は、電子機器10の識別子やプロトコル、接続アド

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レスに加えて、電子機器10の最大計算処理量や現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I／O（入出力）量、現在のI／O（入出力）量、最大接続数、現在の接続数、電子機器10の位置、所有者、所有グループ、アクセス制御情報等を含む機器状況データを、電子機器10から入力する。

[0060] なお、機器状況収集部7は、SNMP等の標準管理プロトコルを用いて、これら機器状況データを取得するようにしてもよい。また、例えば、コンピュータ1に別途これらの機器状況データを保持する記憶部を設け、機器状況収集部7は、その記憶部から機器状況データの読み出しを行ってもよい。

[0061] また、通信状況収集部6は、ネットワーク通信部4を介して、コンピュータ1から利用可能なネットワーク11（電子機器10と制御端末9との接続に用いることができるネットワーク）を探索する。例えば、通信状況収集部6は、コンピュータから利用可能なネットワークを探索する方式として、IEEE802．11b等の無線LANの規格やBOOTP、DHCP等を用いた既知の技術を用いることによって、電子機器10と制御端末9との接続に用いることができるネットワーク11を検索することができる。この場合に、通信状況収集部6は、探索されたネットワーク11に関して、そのネットワーク11の通信状況を示すデータ（通信状況データ）を収集する（ステップS3）。例えば、通信状況収集部6は、ネットワーク11の識別子やプロトコル、接続アドレスに加えて、現在時刻や接続可能な制御端末9、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報を含む通信状況データを、ネットワーク11を介して受信する。

[0062] なお、通信状況収集部6は、SNMP等の標準管理プロトコルを用いて、これら通信状況データを取得するようにしてもよい。また、例えば、コンピュータ1に別途これらの通信状況データを保持する記憶部を設け、通信状況収集部6は、その記憶部から通信状況データの読み出しを行ってもよい。

[0063] また、本実施の形態では、通信状況収集部6は、ステップS3において、上記に示した通信状況を示す情報に加えて、制御端末9の端末状況を示す情報（例えば、制御端末9の識別子やプロトコル、接続アドレス）も含む通信状況データを受信する。

[0064] また、ステップS2及びステップS3の処理は、順次実行されてもよいし、並列的に実行されてもよい。例えば、コンピュータ1は、まずステップS2の処理を完了してから、ス

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テップS3の処理を実行するように順次処理してもよい。また、例えば、コンピュータ1は、ステップS2の処理を実行しつつ、並行してステップS3の処理も実行してもよい。

[0065] 次に、接続方法決定部5は、収集した機器状況データと通信状況データとを検索キーとして、接続ルール保持部8から、現在の機器状況及び通信状況に適した接続方法を示す接続ルールを抽出する(ステップS4)。

[0066] 例えば、接続ルール保持部8は、機器状況データや通信状況データに対応付けて、接続ルールを予めハードディスク装置やメモリ等の記憶装置に記憶している。この場合、ステップS4において、接続方法決定部5は、記憶装置が記憶する機器状況データや通信状況データのうち、収集した機器状況データや通信状況データに合致するデータを特定する。そして、接続方法決定部5は、特定した機器状況データや通信状況データに対応する接続ルールを、接続ルール保持部8(具体的には、記憶装置)から抽出する。

[0067] また、例えば、機器状況データは、電子機器10の識別子やプロトコル、接続アドレス、最大計算処理量、現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I/O(入出力)量、現在のI/O(入出力)量、最大接続数、現在の接続数、電子機器10の位置、所有者、所有グループ、アクセス制御情報等の複数の要素を含んでいてもよい。この場合、接続ルール保持部8は、これら機器状況データの各要素に対応付けて、接続ルールを予め記憶装置に記憶していてもよい。また、接続方法決定部5は、記憶装置が記憶する機器状況データの各要素のうち、収集した機器状況データの要素に合致する要素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、接続方法決定部5は、算出したスコア値が最大となる接続ルールを、接続ルール保持部8から抽出してもよい。

[0068] また、例えば、通信状況データは、ネットワーク11の識別子やプロトコル、接続アドレス、現在時刻や接続可能な制御端末9、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等の複数の要素を含んでもよい。この場合、接続ルール保持部8は、これら通信状況データの各要素に対応付けて、接続ルールを予め記憶装置に記憶していてもよい。また、接続方法決定部5は、記憶装置が記憶する通信状況データの各要素のうち、収集した通信状況データの要素に合致する要

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素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、接続方法決定部5は、算出したスコア値が最大となる接続ルールを、接続ルール保持部8から抽出してもよい。

[0069] また、例えば、通信状況データは、制御端末9の識別子やプロトコル、接続アドレス等の端末状況を示す情報を含んでもよい。この場合、接続ルール保持部8は、これら端末状況を含む通信状況データに対応付けて、接続ルールを予め記憶装置に記憶していてもよい。また、接続方法決定部5は、記憶装置が記憶する端末状況を含む通信状況データのうち、収集した端末状況を含む通信状況データに合致するデータを特定してもよい。そして、接続方法決定部5は、特定した機器状況を含む通信状況データに対応する接続ルールを、接続ルール保持部8(具体的には、記憶装置)から抽出してもよい。

[0070] 次に、接続方法決定部5は、抽出した接続ルールが接続の切断を示すものであるか否かを確認する(ステップS5)。抽出した接続ルールに示されるアクションが終了処理を示すものであれば、接続方法決定部5は、電子機器10と制御端末9との接続を切断する旨の通知信号を、機器ドライバ部2、プロトコル変換部3及びネットワーク通信部4に出力する。そして、電子機器10と制御端末9との接続が切断され、動作の停止となる。例えば、電子機器10と制御端末9との間で通信が行われず、又は接続の切替処理も行われずにタイムアウトした場合には、接続方法決定部5は、接続切断を示す接続ルールを抽出し、処理を終了する。

[0071] 次に、接続方法決定部5は、抽出した接続ルールに従って、接続方法を指定する通知信号を、機器ドライバ部2、プロトコル変換部3及びネットワーク通信部4に出力し、それぞれ接続ルールに示される接続方法に設定させる。

[0072] 例えば、機器ドライバ部2は、電子機器10に接続するための複数の設定情報を備え、接続方法決定部5から入力した通知信号に示される接続方法に従って設定情報を選択する。そして、機器ドライバ部2は、選択した設定情報を、電子機器10との入出力のプロトコル変換に用いる設定情報として設定する(ステップS6)。

[0073] また、例えば、プロトコル変換部3は、電子機器10と制御端末9との通信データのプロトコル変換に用いる複数の設定情報を備え、接続方法決定部5から入力した通知

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信号に示される接続方法に従って設定情報を選択する。そして、プロトコル変換部3は、選択した設定情報を、電子機器10と制御端末9との通信データのプロトコル変換に用いる設定情報として設定する(ステップS7)。

[0074] また、例えば、ネットワーク通信部4は、ネットワーク11に接続するための複数の設定情報を備え、接続方法決定部5から入力した通知信号に示される接続方法に従って設定情報を選択する。そして、ネットワーク通信部4は、選択した設定情報を、ネットワーク11を介したデータ送受信のプロトコル変換に用いる設定情報として設定する(ステップS8)。

[0075] 次に、制御端末9から、電子機器10を制御するための制御情報の送信が開始される。すると、コンピュータ1のネットワーク通信部4は、ネットワーク11を介して、制御信号を制御端末9から受信する(ステップS9)。そして、ネットワーク通信部4は、受信した制御信号をプロトコル変換部3に渡す(出力する)。

[0076] プロトコル変換部3は、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS10)。そして、プロトコル変換部3は、機器ドライバ部2に、プロトコル変換した制御情報を渡す(出力する)。機器ドライバ部2は、入力した制御情報に基づいて、制御信号を出力し電子機器10を制御する。また、機器ドライバ部2は、出力した制御信号に対する応答情報を、電子機器10から入力する(ステップS11)。

[0077] プロトコル変換部3は、機器ドライバ部2から応答情報を受信(入力)すると、設定情報に基づいて、応答情報についてプロトコル変換を行う(ステップS12)。そして、プロトコル変換部3は、ネットワーク通信部4に、プロトコル変換した応答情報を渡す(出力する)。

[0078] 制御端末9は、コンピュータ1のネットワーク通信部4から、ネットワーク11を介して応答情報を受信する。そして、制御端末9は、受信した応答情報に基づいて、さらに電子機器10に対する応答情報を出力する(ステップS13)。

[0079] 次に、コンピュータ1は、機器状況や通信状況の次の状況変化の有無を繰り返し監視するため、ステップS2, S3の処理に戻る。そして、コンピュータ1は、ステップS2～S13の処理を、ステップS5でタイムアウトするまで繰り返し実行する。

[0080] 次に、プロトコル変換の動作について説明する。図4は、電子機器10からのデータ

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をプロトコル変換する処理(ステップS12のプロトコル変換処理)の一例を示すフローチャートである。また、図5は、制御端末9からのデータをプロトコル変換する処理(ステップS10のプロトコル変換処理)の一例を示すフローチャートである。

[0081] 本実施の形態において、プロトコル変換とは、基本的には、電子機器10と制御端末9との間で送受信されるデータについて、電子機器10で用いられる制御プロトコルや、ネットワーク11で用いられる通信プロトコルへの変換を行う処理である。電子機器10は、制御プロトコルとして、例えば、USBやIEEE1394、Bluetooth、ZigBee、シリアル方式、パラレル方式、PS/2、IrDA等のプロトコルを用いる。

[0082] まず、電子機器10から制御端末9方向に送信されるデータに対するプロトコル変換処理(すなわち、ステップS12のプロトコル変換処理)について説明する。

[0083] プロトコル変換部3は、機器ドライバ部2が電子機器10からデータ(例えば、応答情報)を入力すると、機器制御プロトコルに従って、機器ドライバ部2から一定サイズのデータを取得(入力)する(ステップS221)。

[0084] データを入力すると、プロトコル変換部3は、入力したデータを保存する必要があるか否かを識別(判定)する(ステップS222)。例えば、入力したデータを別のタイミング(非同期)で利用する場合や、接続変更や接続障害等でデータ通信に欠落が生じた時にデータを再送する場合に、プロトコル変換部3は、入力データを保存すると判定する。そして、プロトコル変換部3は、入力データをハードディスク装置やメモリ等の記憶装置に保存する(ステップS223)。

[0085] すなわち、入力したデータを別のタイミング(非同期)で利用する場合、プロトコル変換部3は、電子機器10から入力したデータを保存するデータ保存手段、及び制御端末9からの制御要求に対して、データ保存手段が保存するデータを用いて、電子機器10と制御端末9とを非同期で動作させる動作制御手段として機能する。又は、プロトコル変換部3は、制御端末9からの入力データを保存する入力データ保存手段、及び電子機器10からの入力要求に対して、入力データ保存手段が保存するデータを用いて、電子機器10と制御端末9とを非同期で動作させることを可能とする動作制御手段として機能する。なお、この場合、プロトコル変換部3は、保存データが有効であるか無効であるかを選択するとともに、保存データを編集する選択編集手段として機

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能してもよい。

[0086] また、接続変更や接続障害等でデータ通信に欠落が生じた時にデータを再送する場合、プロトコル変換部3は、電子機器10から入力したデータを保存するデータ保存手段、及び電子機器10から制御端末9への通信を行なう際に、通信データの欠落があった場合に、データ保存手段が保存する保存データを用いて通信データを再送するデータ再送手段として機能する。又は、プロトコル変換部3は、制御端末9からの入力データを保存する入力データ保存手段、及び制御端末9から電子機器10への通信を行なう際に、通信データの欠落があった場合に、入力データ保存手段が保存する保存データを用いて通信データを再送するデータ再送手段として機能する。

[0087] また、プロトコル変換部3は、入力データを制御端末9に送信する必要があるか否かを識別(判定)する(ステップS224)。例えば、電子機器10と制御端末9との間で通信されるデータが、映像や音声等の途中のデータが一部抜けてもよいようなデータである場合には、データをサンプリングするサンプリング間隔の制御が可能である。この場合、例えば、機器ドライバ2が30Hzのサンプリング周波数で映像を取得(入力)していたとすると、プロトコル変換部3は、15Hzのサンプリング周波数に変換してサンプリング精度を落としてもよい。また、プロトコル変換部3は、複数のデータをマージしたり補間したりする変換を施して、サンプリング精度を向上させるようにしてもよい。

[0088] ステップS224で送信する必要がないと判定した場合には、プロトコル変換部3は、そのままプロトコル変換処理を終了する。送信する必要があると判定した場合には、プロトコル変換部3は、ステップS225以降の処理に移行する。

[0089] また、プロトコル変換部3は、電子機器10とは全くデータの入出力を行わずに、恰もプロトコル変換部3自身が電子機器10であるかのように動作して、制御端末9に対して応答してもよい。この場合、プロトコル変換部3は、送信対象のデータを既に取得済みであるか否かを判定する(ステップS225)。例えば、プロトコル変換部3は、送信対象のデータをハードディスク装置やメモリ等の記憶装置に記憶しているか否かを判定する。送信対象のデータがあれば、プロトコル変換部3は、記憶装置等から送信すべきデータを読み出す(ステップS226)。そのようにすることによって、電子機器10についての計算処理及び通信処理に影響されることなく、制御端末9における円滑な

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操作を可能とする。また、この場合、プロトコル変換部3は、過去にステップS223で保存したデータを利用（例えば、ステップS223で保存したデータを送信対象のデータとして読出）してもよい。

[0090] 次に、ステップS224で送信すると判定した場合や、ステップS225，S226で送信対象データを読み出した場合、プロトコル変換部3は、送信データについて所定のデータ変換を行う必要があるか否かを識別（判定）する（ステップS227）。例えば、送信データが映像や画像である場合、プロトコル変換部3は、解像度や色数、画像サイズの変換を行う必要があると判定する。そして、プロトコル変換部3は、送信データ（例えば、映像や画像）について、所定のデータ変換（例えば、解像度や色数、画像サイズを変換）を行う（ステップS228）。

[0091] 次に、プロトコル変換部3は、送信データを圧縮及び暗号処理する必要があるか否かを識別（判定）する（ステップS229）。圧縮処理や暗号処理の必要があると判定すると、プロトコル変換部3は、入力データについて圧縮処理や暗号処理を施す（ステップS230）。例えば、プロトコル変換部3は、圧縮及び暗号のCODEC変換のパラメータとして、圧縮方式や圧縮率、圧縮処理するウィンドウサイズ、暗号方式、暗号処理するウィンドウサイズ等を用いて、圧縮処理や暗号処理を実行する。

[0092] 次に、プロトコル変換部3は、通信ヘッダを設定し、送信データに通信ヘッダを付加して、通信データを作成する（ステップS231）。そして、作成した通信データについてネットワーク通信を行う。なお、通信ヘッダには、コンピュータ1の送信元アドレスや、制御端末9の送信先アドレスが含まれる。また、通信ヘッダに、必要に応じて、通信経路やTTLをプロトコルオプションとして付与してもよい。

[0093] 次に、プロトコル変換部3は、ネットワーク通信部4のネットワークパラメータを設定する（ステップS232）。なお、ネットワークパラメータには、RWINやMTU、通信チャネル、電力管理等がある。また、パラメータに変更がない場合には、プロトコル変換部3は、ステップS232でネットワークパラメータ設定を行うことは不要である。

[0094] そして、プロトコル変換部3は、ステップS231で生成した通信データを、ネットワーク通信部4に送出（送信）させる（ステップS233）。

[0095] 次に、制御端末9から電子機器10方向に送信されるデータに対するプロトコル変換

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処理(すなわち、ステップS10のプロトコル変換処理)について説明する。

[0096] まず、プロトコル変換部3は、図4に示すステップS232と同様の処理に従って、ネットワーク通信部4のネットワークパラメータを設定する(ステップS301)。なお、パラメータに変更がない場合には、プロトコル変換部3は、ステップS301でネットワークパラメータ設定を行うことは不要である。

[0097] 次に、プロトコル変換部3は、制御端末9からの受信データがあるか否かを判定する(ステップS302)。受信データがなければ、プロトコル変換部3は、そのままプロトコル変換処理を終了する。受信データがあれば、プロトコル変換部3は、ステップS303以降の処理に移行する。なお、プロトコル変換部3は、ネットワーク通信部4が制御端末9から通信データを受信したものの、通信設定がノンブロックであるために受信データがない場合には、受信データがないと判定し、そのまま処理を終了する。

[0098] 次に、プロトコル変換部3は、受信データのうち通信ヘッダを除いたデータ本体を抽出し、受信データが圧縮及び暗号処理されているか否かを識別(判定)する(ステップS303)。圧縮処理及び暗号処理されていれば、プロトコル変換部3は、受信データを復号処理する(ステップS304)。

[0099] 次に、プロトコル変換部3は、受信データを保存する必要があるか否かを識別(判定)する(ステップS305)。例えば、受信した制御情報が電子機器10の状態設定の制御命令を示すものである場合、受信した制御情報を別のタイミングで利用してもよい。そのような場合には、プロトコル変換部3は、受信した制御情報を保存すると判定する。そして、プロトコル変換部3は、受信データをハードディスク装置やメモリ等の記憶装置に保存する(ステップS306)。また、例えば、接続方法を変更する場合に受信データが欠落する可能性がある。そのような場合に、プロトコル変換部3は、保存データを利用して、データ再送やデータ復旧を行うことも可能である。

[0100] また、プロトコル変換部3は、制御端末9とは実際には全く通信を行わずに、恰もプロトコル変換部3自身が制御端末9であるかのように動作して、機器ドライバ部2に制御情報を渡して(出力して)もよい。この場合、プロトコル変換部3は、出力対象の制御情報を既に取得済みであるか否かを判定する(ステップS307)。例えば、プロトコル変換部3は、出力対象の制御情報をハードディスク装置やメモリ等の記憶装置に

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記憶しているか否かを判定する。出力対象の制御情報があれば、プロトコル変換部3は、制御情報を任意の記憶部から読み出す（ステップS308）。そのようにすることによって、制御端末9との通信における遅延に影響されることなく、電子機器10の制御を可能とする。また、この場合、プロトコル変換部3は、過去にステップS306で保存したデータを利用（例えば、ステップS306で保存したデータを制御情報として読出）してもよい。

[0101] そして、プロトコル変換部3は、抽出した制御情報に基づいて、機器ドライバ部2を介して電子機器10を制御する（ステップS309）。

[0102] 以上のように、本実施の形態によれば、機器状況情報及び通信状況情報を収集して監視し、収集した機器状況や通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って接続方法を変更する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、電子機器10の状況変化と通信状況の変化との両方に対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

[0103] 実施の形態2.

次に、本発明の第2の実施の形態について図面を参照して説明する。図6は、第2の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。図6に示すように、本実施の形態では、コンピュータ1が、第1の実施の形態で示した構成要素に加えて、接続方法を設定及び確認するための手段（接続方法UI部）13を含む。また、本実施の形態では、コンピュータ1は、ユーザ14によって操作可能とされる。

[0104] 接続方法UI部13は、接続ルール保持部8が保持する接続ルールをディスプレイ装置等の表示装置に表示して、ユーザ14に提示する機能を備える。また、接続方法UI部13は、ユーザ14の操作に従って、接続ルール保持部8が記憶する接続ルールを編集処理する機能を備える。そのようにすることによって、ユーザ14による接続ルールの編集を可能とする。また、接続方法UI部13は、収集した機器状況データや通信

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状況データと照合して接続方法決定部5が選択した接続ルールに従って、設定する接続方法の候補を表示装置に表示する機能を備える。また、接続方法UI部13は、ユーザ14の操作に従って、設定する接続方法を決定する機能を備える。そのようにすることによって、複数の接続方法の候補から、設定する接続方法をユーザ14が選択することを可能とする。

[0105] 次に、動作について説明する。図7は、第2の実施の形態における遠隔機器管理システムにおいて電子機器10と制御端末9との接続変更を行う処理例を示すフローチャートである。なお、本実施の形態では、主として第1の実施の形態と異なる部分について説明する。

[0106] まず、コンピュータ1の接続方法UI部13は、ユーザ14からの操作を受け付ける準備をする(ステップS51)。例えば、接続方法UI部13は、ユーザログイン画面の各種表示画面等を表示装置に表示させ、ユーザ14にユーザIDやパスワード等の入力を促す。なお、接続方法UI部13は、例えば、Webサーバのデーモンプログラムやシリアル経由のコンソールI/O等の任意のユーザインターフェース方式を用いて、各種表示画面を表示させる。

[0107] 次に、接続方法UI部13は、ユーザ14によるアクセス制限を行う場合には、ユーザ14の操作に従って、ユーザIDやパスワードを入力し、ユーザ14のログイン処理を行う(ステップS52)。そして、コンピュータ1は、ステップS53以降のループ処理に移行し、ユーザ14の操作によるイベント発生や、機器状況又は通信状況についてのイベント発生に応じて、ループ処理内の各種処理に分岐して処理を実行する。

[0108] 例えば、ユーザ14によって接続ルールの編集操作が行われた場合には、接続方法UI部13は、接続ルール保持部8から、機器状況データ及び通信状況データを抽出するとともに、それら機器状況データ及び通信状況データに対応する電子機器10と制御端末9との接続方法を示す複数の接続ルール(以下、ルールセットともいう)を抽出する(ステップS53)。

[0109] 次に、接続方法UI部13は、抽出した機器状況データ、通信状況データ、及び接続方法を示す接続ルールの各表示項目に関して、ソート及び絞込み処理を実行する(ステップS54)。そして、接続方法UI部13は、ソート及び絞り込み処理した機器状況

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データ、通信状況データ及び接続ルールを表示装置に表示させ、ユーザ14に提示する。この場合、各接続ルールに、過去に接続方法決定部5で適用された履歴情報を含むようにしてもよい。そして、接続方法UI部13は、各接続ルールに含まれる履歴情報に基づいて、ソート及び絞込み処理を実行してもよい。

[0110] 接続方法UI部13は、ユーザ14の操作に従って、提示した接続ルール中のある接続ルールを選択して、機器状況や通信状況、接続方法の編集処理を行う。又は、接続方法UI部13は、ユーザ14の操作に従って、新たに機器状況や通信状況、接続方法を入力して、新たに接続ルールを作成して接続ルール保持部8に追加して記憶させる(ステップS55)。

[0111] また、例えば、ユーザ14によって接続ルールの保存操作や閲覧操作が行われた場合には、接続方法UI部13は、ユーザ14の操作に従って、ある接続ルールのセット(機器状況データ、通信状況データ及び接続ルールのセット)を接続ルール保持部8に保存し、又は過去に保存した接続ルールのセットを接続ルール保持部8から読み込むことも可能である(ステップS56)。

[0112] また、例えば、制御端末9からの接続要求等を受信した場合には、コンピュータ1は、ステップS57以降の処理を実行し、電子機器10と制御端末9との接続を開始する。なお、図7において、ステップS57～S60の処理は、第1の実施の形態で示したステップS1～S4の処理(図3参照)の処理とそれぞれ同様である。なお、電子機器10と制御端末9との接続方法の設定について自動設定を行うことが設定されていない場合には、接続方法決定部5は、ステップS60において、ユーザ14に接続ルールの候補として提示するための複数の接続ルールを抽出するようにしてもよい。

[0113] なお、本実施の形態では、電子機器10と制御端末9との接続処理を開始するときに、ステップS57の処理を実行した後に一旦ループ処理の先頭に戻り、次のループ処理でステップS58, S59の処理に移行する場合を説明するが、ステップS57の処理を実行した後にそのままステップS58, S59に移行するようにしてもよい。

[0114] 次に、コンピュータ1は、接続方法決定部5が抽出した接続ルールについて、自動設定を行うことが設定されているか否かを確認する(ステップS61)。具体的には、コンピュータ1は、接続ルールに自動処理を行うことを指定するフラグ(自動処理フラグ

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ともいう)が付与されているか否かを確認する(後述するステップS66参照)。自動設定を行うことが設定されていれば、そのままステップS71～S73の処理に移行する。自動設定を行うことが設定されていなければ、ステップS62～S63の処理に移行する。

[0115] 自動設定すること設定されていない場合、接続方法UI部13は、ユーザ14の操作に応じて、機器状況収集部7が収集した機器状況のデータを表示装置に表示させる(ステップS62)。例えば、接続方法UI部13は、電子機器10に関して、機器の識別子やプロトコル、接続アドレス、機器の最大計算処理量、現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I／O量、現在のI／O量、最大接続数、現在の接続数、電子機器の位置、所有者、所有グループ、アクセス制御情報等のデータを表示させる。

[0116] また、接続方法UI部13は、ユーザ14の操作に応じて、通信状況収集部6が収集した通信状況のデータを表示装置に表示させる(ステップS63)。例えば、接続方法UI部13は、ネットワーク11の識別子やプロトコル、接続アドレス、接続可能な制御端末9、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等のデータを表示させる。

[0117] また、接続方法UI部13は、ユーザ14の操作に応じて、収集した機器状況データや通信状況データに適した接続方法、又は適用の可能性がある接続方法を表示装置に表示させる(ステップS64)。この場合、接続方法UI部13は、ステップS60で接続方法決定部5によって抽出された接続ルールに従って、接続方法(又は、複数の接続方法の候補)を表示させる。例えば、接続方法UI部13は、接続方法として、機器ドライバ部2の設定方法や、プロトコル変換部3の設定方法、ネットワーク通信部4の設定方法、過去に適用された接続方法を示す履歴情報を表示させる。

[0118] ユーザ14は、抽出された接続ルールに示される接続方法で電子機器10と制御端末9とを接続してよいと判断すれば、コンピュータ1を操作して、提示された接続方法での接続実行を指示する。又は、ユーザ14は、コンピュータ1を操作して、提示された複数の接続方法の候補の中から、適用する接続方法の選択を指示する。すると、接続方法UI部13は、ユーザ14の確認操作に従って、接続方法決定部5が抽出した

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接続ルールを適用する旨の通知信号を、機器ドライバ部2、プロトコル変換部3及びネットワーク通信部4に出力し、その接続ルールに示される接続方法に設定させる。又は、接続方法UI部13は、ユーザ14によって選択された接続ルールを適用する旨の通知信号を出力し、その接続ルールに示される接続方法に設定させる(ステップS65)。

[0119] 次に、コンピュータ1は、選択した接続ルールについて、今後ユーザ14による確認操作が必要なければ、自動処理フラグを接続ルールに付与する(ステップS66)。例えば、コンピュータ1は、ユーザ14によって自動処理を行う旨の指示操作が行われた場合には、その接続ルールに自動処理フラグを付与する。そして、以降のループ処理において、ステップ60で自動処理フラグが付与された接続ルールが抽出された場合には、コンピュータ1は、ステップS61でYと判定し、そのままステップS71～S73に移行して(ステップS62～S66の処理はスキップして)、自動的に接続方法の設定処理を行う。

[0120] なお、自動処理に関して、コンピュータ1は、機器状況や通信状況と接続ルールとの照合結果についての所定の確からしさを示す値を算出し、一定の確からしさ以上を示す値が得られた場合に限って、ステップS71～S73に移行して、自動的に接続方法の設定処理を行うようにしてもよい。例えば、コンピュータ1は、機器状況データや通信状況データが複数の要素を含む場合に、接続ルール保持部8が記憶する機器状況データや通信状況データの各要素のうち、収集した機器状況データや通信状況データの要素に合致する要素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、コンピュータ1は、スコア値が所定の閾値以上であることを条件として、そのままステップS71～S73の処理に移行するようにしてもよい。

[0121] なお、機器状況データや通信状況データは多様なパラメータを含むため、接続ルールとの照合においてあいまい性が生じる。そのため、機器状況や通信状況と接続ルールとの照合を行うためには、所定の閾値処理が必要となる。データセットに対するあいまい性を有する検索結果の確からしさを示す値の算出には、いくつかの手法が知られているが、本発明の趣旨ではないので詳細な説明を省略する。

[0122] 以下、ステップS71～S78の処理は、第1の実施の形態で示したステップS6～S13

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の処理(図3参照)とそれぞれ同様である。

[0123] そして、コンピュータ1は、次のユーザ操作を処理するために、ループ処理の先頭の処理に戻る。次のユーザ操作がログアウト操作であれば、コンピュータ1は、ログアウト処理を実行し、処理を終了する(ステップS99)。

[0124] 以上のように、本実施の形態によれば、機器状況情報及び通信状況情報を収集して監視し、収集した機器状況や通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って接続方法を変更する。また、ユーザの操作に従って接続ルールを管理(例えば、閲覧や編集)可能に構成する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、ユーザの操作に応じて容易に接続ルールを管理することができる。また、電子機器10の状況変化と通信状況の変化との両方に対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

[0125] 実施の形態3.

次に、本発明の第3の実施の形態について図面を参照して説明する。図8は、第3の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。図8に示すように、遠隔機器管理システムは、電子機器10と、電子機器10を制御する複数の制御端末9と、コンピュータ1Aとを含む。また、図8に示すように、コンピュータ1Aと電子機器10とは、1つ又は複数のネットワーク11(例えば、インターネットやLAN)を介して接続される。

[0126] コンピュータ1Aは、制御端末9とネットワーク11とを接続するための装置であって、具体的には、プログラム制御により動作するパーソナルコンピュータ等のデータ処理装置によって実現される。なお、コンピュータ1Aは、中央処理装置やプロセッサ等によって実現されてもよい。また、コンピュータ1Aは、データ処理能力を備えたネットワーク機器(例えば、ルータ)によって実現されてもよい。

[0127] コンピュータ1Aは、プロトコル変換部3Aと、ネットワーク通信部4Aと、接続方法決定部5Aと、通信状況収集部6Aと、接続ルール保持部8Aと、端末ドライバ部15と、

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端末状況収集部16とを含む。

[0128] 端末ドライバ部15は、各制御端末9とデータを送受信する機能を備える。ネットワーク通信部4Aは、ネットワーク11に接続された電子機器10と、ネットワーク11を介してデータを送受信する機能を備える。プロトコル変換部3Aは、端末ドライバ部15が出力する入出力データとネットワーク通信部4Aが送受信する入出力データとの間で、プロトコル変換を行う機能を備える。

[0129] 端末状況収集部16は、制御端末9の種類や負荷、位置等の端末状況を収集する機能を備える。通信状況収集部6Aは、ネットワーク11を介した電子機器10との通信の種類や経路、負荷等の通信状況を収集する機能を備える。

[0130] 接続ルール保持部8Aは、ある端末状況や通信状況に適した電子機器10と制御端末9との通信接続方法を示す接続ルールを保持する機能を備える。具体的には、接続ルール保持部8Aは、端末状況を示す端末状況データや通信状況を示す通信状況データに対応付けて、接続ルールをハードディスク装置やメモリ等の記憶装置に記憶している。

[0131] 接続方法決定部5Aは、端末状況収集部16が収集した端末状況や通信状況収集部6Aが収集した通信状況と、接続ルール保持部8Aが保持する接続ルールとを照合して、適切な接続方法を示す接続ルールを抽出する機能を備える。また、接続方法決定部5Aは、抽出した接続ルールを出力することによって、端末ドライバ部15、プロトコル変換部3A及びネットワーク通信部4Aに、適切な接続方式を通知し適切な接続方法を設定させる機能を備える。

[0132] 次に、動作について説明する。図9は、第3の実施の形態における遠隔機器管理システムにおいて電子機器10と制御端末9との接続変更を行う処理例を示すフローチャートである。まず、電子機器10は、所定のタイミングで(例えば、予め定めた時間毎に)、コンピュータ1Aに任意の手段で(例えば、インターネットやLAN等のネットワーク11を介して)ネットワーク接続する(ステップS101)。

[0133] 次に、電子機器10によって接続されると、コンピュータ1Aの端末状況収集部16は、端末ドライバ部15を介して、コンピュータ1Aに接続されている制御端末9を探索する。例えば、端末状況収集部16は、コンピュータ1Aに接続されている端末を探索す

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る方式として、プラグアンドプレイ等の既知の技術を用いることによって、制御端末9を検索することができる。この場合に、端末状況収集部16は、探索された制御端末9に関して、その制御端末9の端末状況を示すデータ(端末状況データ)を収集する(ステップS102)。例えば、端末状況収集部16は、制御端末9の識別子やプロトコル、接続アドレスに加えて、制御端末9の最大計算処理量や現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I/O(入出力)量、現在のI/O(入出力)量、最大接続数、現在の接続数、制御端末9の位置、所有者、所有グループ、アクセス制御情報等を含む端末状況データを、制御端末9から入力する。

[0134] なお、端末状況収集部16は、SNMP等の管理プロトコルを用いて、これら端末状況データを取得するようにしてもよい。また、例えば、コンピュータ1Aに別途これらの端末状況データを保持する記憶部を設け、端末状況収集部16は、その記憶部から端末状況データの読み出しを行ってもよい。

[0135] また、通信状況収集部6Aは、ネットワーク通信部4Aを介して、コンピュータ1Aから利用可能なネットワーク11(電子機器10と制御端末9との接続に用いることができるネットワーク)を探索する。例えば、通信状況収集部6Aは、コンピュータから利用可能なネットワークを探索する方式として、IEEE802.11b等の無線LANの規格やBOOTP、DHCP等を用いた既知の技術を用いることによって、電子機器10と制御端末9との接続に用いることができるネットワーク11を検索することができる。この場合に、通信状況収集部6Aは、探索されたネットワーク11に関して、そのネットワーク11の通信状況を示すデータ(通信状況データ)を収集する(ステップS103)。例えば、通信状況収集部6Aは、ネットワーク11の識別子やプロトコル、接続アドレスに加えて、現在時刻や接続可能な電子機器10、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等を含む通信状況データを、ネットワーク11を介して受信する。

[0136] なお、通信状況収集部6Aは、SNMP等の管理プロトコルを用いて、これら通信状況データを取得するようにしてもよい。また、例えば、コンピュータ1Aに別途これらの通信状況データを保持する記憶部を設け、通信状況収集部6Aは、その記憶部から通信状況データの読み出しを行ってもよい。

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[0137] また、本実施の形態では、通信状況収集部6Aは、ステップS103において、上記に示した通信状況を示す情報に加えて、電子機器10の機器状況を示す情報(例えば、電子機器10の識別子やプロトコル、接続アドレス)も含む通信状況データを受信する。

[0138] また、ステップS102及びステップS103の処理は、順次実行されてもよいし、並列的に実行されてもよい。例えば、コンピュータ1Aは、まずステップS102の処理を完了してから、ステップS103の処理を実行するように順次処理してもよい。また、例えば、コンピュータ1Aは、ステップS102の処理を実行しつつ、並行してステップS103の処理も実行してもよい。

[0139] 次に、接続方法決定部5Aは、収集した端末状況データと通信状況データとを検索キーとして、接続ルール保持部8Aから、現在の端末状況及び通信状況に適した接続方法を示す接続ルールを抽出する(ステップS104)。

[0140] 例えば、接続ルール保持部8Aは、端末状況データや通信状況データに対応付けて、接続ルールを予めハードディスク装置やメモリ等の記憶装置に記憶している。この場合、ステップS104において、接続方法決定部5Aは、記憶装置が記憶する端末状況データや通信状況データのうち、収集した端末状況データや通信状況データに合致するデータを特定する。そして、接続方法決定部5Aは、特定した端末状況データや通信状況データに対応する接続ルールを、接続ルール保持部8A(具体的には、記憶装置)から抽出する。

[0141] また、例えば、端末状況データは、制御端末9の識別子やプロトコル、接続アドレス、最大計算処理量、現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I/O(入出力)量、現在のI/O(入出力)量、最大接続数、現在の接続数、制御端末9の位置、所有者、所有グループ、アクセス制御情報等の複数の要素を含んでいもよい。この場合、接続ルール保持部8Aは、これら端末状況データの各要素に対応付けて、接続ルールを予め記憶装置に記憶していてもよい。また、接続方法決定部5Aは、記憶装置が記憶する端末状況データの各要素のうち、収集した端末状況データの要素に合致する要素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、接続方法決定部5Aは、算出したスコア値が最大となる接続ルールを、

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接続ルール保持部8Aから抽出してもよい。

[0142] また、例えば、通信状況データは、ネットワーク11の識別子やプロトコル、接続アドレス、現在時刻や接続可能な電子機器10、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等の複数の要素を含んでもよい。この場合、接続ルール保持部8Aは、これら通信状況データの各要素に対応付けて、接続ルールを予め記憶装置に記憶していてもよい。また、接続方法決定部5Aは、記憶装置が記憶する通信状況データの各要素のうち、収集した通信状況データの要素に合致する要素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、接続方法決定部5Aは、算出したスコア値が最大となる接続ルールを、接続ルール保持部8から抽出してもよい。

[0143] また、例えば、通信状況データは、電子機器10の識別子やプロトコル、接続アドレス等の機器状況を示す情報を含んでもよい。この場合、接続ルール保持部8Aは、これら機器状況を含む通信状況データに対応付けて、接続ルールを予め記憶装置に記憶していてもよい。また、接続方法決定部5Aは、記憶装置が記憶する機器状況を含む通信状況データのうち、収集した機器状況を含む通信状況データに合致するデータを特定してもよい。そして、接続方法決定部5Aは、特定した機器状況を含む通信状況データに対応する接続ルールを、接続ルール保持部8A(具体的には、記憶装置)から抽出してもよい。

[0144] 次に、接続方法決定部5Aは、抽出した接続ルールが接続の切断を示すものであるか否かを確認する(ステップS105)。抽出した接続ルールに示されるアクションが終了処理を示すものであれば、接続方法決定部5Aは、電子機器10と制御端末9との接続を切断する旨の通知信号を、端末ドライバ部15、プロトコル変換部3A及びネットワーク通信部4Aに出力する。そして、電子機器10と制御端末9との接続が切断され、動作の停止となる。例えば、電子機器10と制御端末9との間で通信が行われず、又は接続の切替処理も行われずにタイムアウトした場合には、接続方法決定部5Aは、接続切断を示す接続ルールを抽出し、処理を終了する。

[0145] 次に、接続方法決定部5Aは、抽出した接続ルールに従って、接続方法を指定する通知信号を、端末ドライバ部15、プロトコル変換部3A及びネットワーク通信部4A

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に出力し、それぞれ接続ルールに示される接続方法に設定させる。

[0146] 例えば、端末ドライバ部15は、制御端末9に接続するための複数の設定情報を備え、接続方法決定部5Aから入力した通知信号に示される接続方法に従って設定情報を選択する。そして、端末ドライバ部15は、選択した設定情報を、制御端末9との入出力のプロトコル変換に用いる設定情報として設定する(ステップS106)。

[0147] また、例えば、プロトコル変換部3Aは、電子機器10と制御端末9との通信データのプロトコル変換に用いる複数の設定情報を備え、接続方法決定部5Aから入力した通知信号に示される接続方法に従って設定情報を選択する。そして、プロトコル変換部3Aは、選択した設定情報を、電子機器10と制御端末9との通信データのプロトコル変換に用いる設定情報として設定する(ステップS107)。

[0148] また、例えば、ネットワーク通信部4Aは、ネットワーク11に接続するための複数の設定情報を備え、接続方法決定部5Aから入力した通知信号に示される接続方法に従って設定情報を選択する。そして、ネットワーク通信部4Aは、選択した設定情報を、ネットワーク11を介したデータ送受信のプロトコル変換に用いる設定情報として設定する(ステップS108)。

[0149] 次に、電子機器10から、制御端末9に対する制御情報の送信が開始される。すると、コンピュータ1Aのネットワーク通信部4Aは、ネットワーク11を介して、制御情報を電子機器10から受信する(ステップS109)。そして、ネットワーク通信部4Aは、受信した制御情報をプロトコル変換部3Aに渡す(出力する)。

[0150] プロトコル変換部3Aは、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS110)。そして、プロトコル変換部3Aは、端末ドライバ部15に、プロトコル変換した制御情報を渡す(出力する)。端末ドライバ部15は、入力した制御情報に基づいて、電子機器10の制御に必要な入出力データを制御端末9と送受信する(ステップS111)。

[0151] プロトコル変換部3Aは、端末ドライバ部15から制御情報を受信(入力)すると、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS112)。そして、プロトコル変換部3Aは、ネットワーク通信部4Aに、プロトコル変換した制御情報

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を渡す（出力する）。

[0152] 電子機器10は、コンピュータ1Aのネットワーク通信部4Aから、ネットワーク11を介して制御情報を受信する。そして、電子機器10は、受信した制御情報に基づいて各種制御を実行し、制御情報に対する応答情報を出力する（ステップS113）。

[0153] 次に、コンピュータ1Aは、端末状況や通信状況の次の状況変化の有無を繰り返し監視するため、ステップS102，S103の処理に戻る。そして、コンピュータ1Aは、ステップS102～S113の処理を、ステップS105でタイムアウトするまで繰り返し実行する。

[0154] 次に、プロトコル変換の動作について説明する。図10は、第3の実施の形態における制御端末9からのデータをプロトコル変換する処理（ステップS112のプロトコル変換処理）の一例を示すフローチャートである。また、図11は、第3の実施の形態における電子機器10からのデータをプロトコル変換する処理（ステップS110のプロトコル変換処理）の一例を示すフローチャートである。

[0155] 本実施の形態において、プロトコル変換とは、基本的には、電子機器10と制御端末9との間で送受信されるデータについて、制御端末9で用いられる入出力プロトコルや、電子機器10の制御に用いられる機器制御通信プロトコルへの変換を行う処理である。制御端末9は、入出力プロトコルとして、例えば、USBやシリアル方式、TCP／IP、HTTP、VNC、リモートデスクトップ方式等のプロトコルを用いる。一方、コンピュータ1Aや電子機器10は、機器制御通信プロトコルとして、UPnPやECHONET、JINI等のプロトコルを用いる。

[0156] まず、制御端末9から電子機器10方向に送信されるデータに対するプロトコル変換処理（すなわち、ステップS112のプロトコル変換処理）について説明する。

[0157] プロトコル変換部3Aは、端末ドライバ部15が制御端末9からデータ（例えば、制御情報）を入力すると、端末制御プロトコルに従って、端末ドライバ部15から一定サイズのデータを取得（入力）する（ステップS121）。

[0158] データを入力すると、プロトコル変換部3Aは、入力したデータを保存する必要があるか否かを識別（判定）する（ステップS122）。例えば、入力したデータを別のタイミングで利用する場合や、接続変更や接続障害等でデータ通信に欠落が生じた時にデ

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ータを再送する場合に、プロトコル変換部3Aは、入力データを保存すると判定する。そして、プロトコル変換部3Aは、入力データをハードディスク装置やメモリ等の記憶装置に保存する(ステップS123)。

[0159] また、プロトコル変換部3は、入力データを電子機器10に送信する必要があるか否かを識別(判定)する(ステップS124)。例えば、電子機器10と制御端末9との間で通信されるデータが、映像や音声等の途中のデータが一部抜けてもよいようなデータである場合には、データをサンプリングするサンプリング間隔の制御が可能である。この場合、例えば、ネットワーク通信部4Aが30Hzのサンプリング周波数で映像を取得(入力)していたとすると、プロトコル変換部3Aは、15Hzのサンプリング周波数に変換してサンプリング精度を落としてもよい。また、プロトコル変換部3Aは、複数のデータをマージしたり補間したりする変換を施して、サンプリング精度を向上させるようにしてもよい。

[0160] ステップS124で送信する必要がないと判定した場合には、プロトコル変換部3Aは、そのままプロトコル変換処理を終了する。送信する必要があると判定した場合には、プロトコル変換部3Aは、ステップS125以降の処理に移行する。

[0161] また、プロトコル変換部3Aは、制御端末9とは全くデータの入出力を行わずに、恰もプロトコル変換部3A自身が制御端末9から操作されているかのように動作して、電子機器10に対して応答してもよい。この場合、プロトコル変換部3Aは、送信対象のデータを既に取得済みであるか否かを判定する(ステップS125)。例えば、プロトコル変換部3Aは、送信対象のデータをハードディスク装置やメモリ等の記憶装置に記憶しているか否かを判定する。送信対象のデータがあれば、プロトコル変換部3Aは、記憶装置等から送信すべきデータを読み出す(ステップS126)。そのようにすることによって、制御端末9についての計算処理及び通信処理に影響されることなく、電子機器10における制御を可能とする。また、この場合、プロトコル変換部3Aは、過去にステップS123で保存したデータを利用(例えば、ステップS123で保存したデータを送信対象のデータとして読出)してもよい。

[0162] 次に、プロトコル変換部3Aは、送信データを圧縮及び暗号処理する必要があるか否かを識別(判定)する(ステップS127)。圧縮処理や暗号処理の必要があると判定

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すると、プロトコル変換部3Aは、入力データについて圧縮処理や暗号処理を施す(ステップS128)。例えば、プロトコル変換部3は、圧縮及び暗号のCODEC変換のパラメータとして、圧縮方式や圧縮率、圧縮処理するウィンドウサイズ、暗号方式、暗号処理するウィンドウサイズ等を用いて、圧縮処理や暗号処理を実行する。

[0163] 次に、プロトコル変換部3Aは、通信ヘッダを設定し、送信データに通信ヘッダを付加して、通信データを作成する(ステップS129)。そして、作成した通信データについてネットワーク通信を行う。なお、通信ヘッダには、コンピュータ1Aの送信元アドレスや、電子機器10の送信先アドレスが含まれる。また、通信ヘッダに、必要に応じて、通信経路やTTLをプロトコルオプションとして付与してもよい。

[0164] 次に、プロトコル変換部3Aは、ネットワーク通信部4Aのネットワークパラメータを設定する(ステップS130)。なお、ネットワークパラメータには、RWINやMTU、通信チャネル、電力管理等がある。また、パラメータに変更がない場合には、プロトコル変換部3Aは、ステップS130でネットワークパラメータ設定を行うことは不要である。

[0165] そして、プロトコル変換部3Aは、ステップS129で生成した通信データを、ネットワーク通信部4Aに送出(送信)させる(ステップS131)。

[0166] 次に、電子機器10から制御端末9方向に送信されるデータに対するプロトコル変換処理(すなわち、ステップS110のプロトコル変換処理)について説明する。

[0167] まず、プロトコル変換部3Aは、図10に示すステップS130と同様の処理に従って、ネットワーク通信部4Aのネットワークパラメータを設定する(ステップS331)。なお、パラメータに変更がない場合には、プロトコル変換部3Aは、ステップS331でネットワークパラメータ設定を行うことは不要である。

[0168] 次に、プロトコル変換部3Aは、電子機器10からの受信データがあるか否かを判定する(ステップS332)。受信データがなければ、プロトコル変換部3Aは、そのままプロトコル変換処理を終了する。受信データがあれば、プロトコル変換部3Aは、ステップS333以降の処理に移行する。なお、プロトコル変換部3Aは、ネットワーク通信部4Aが電子機器10から通信データを受信したものの、通信設定がノンブロックであるために受信データがない場合には、受信データがないと判定し、そのまま処理を終了する。

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[0169] 次に、プロトコル変換部3Aは、受信データのうち通信ヘッダを除いたデータ本体を抽出し、受信データが圧縮及び暗号処理されているか否かを識別(判定)する(ステップS333)。圧縮処理及び暗号処理されていれば、プロトコル変換部3Aは、受信データを復号処理する(ステップS334)。

[0170] 次に、プロトコル変換部3Aは、受信データについて所定のデータ変換を行う必要があるか否かを識別(判定)する(ステップS335)。例えば、受信データが映像や画像データである場合、プロトコル変換部3Aは、解像度や色数、画像サイズの変換を行う必要があると判定する。そして、プロトコル変換部3Aは、受信データ(例えば、映像や画像)について、所定のデータ変換(例えば、解像度や色数、画像サイズを変換)を行う(ステップS336)。

[0171] 次に、プロトコル変換部3Aは、受信データを保存する必要があるか否かを識別(判定)する(ステップS337)。例えば、受信した制御情報を別のタイミングで利用する可能性がある場合には、プロトコル変換部3Aは、受信したデータを保存すると判定する。そして、プロトコル変換部3Aは、受信データをハードディスク装置やメモリ等の記憶装置に保存する(ステップS338)。また、例えば、接続方法を変更する場合に受信データが欠落する可能性がある。そのような場合に、プロトコル変換部3Aは、保存したデータを用いて、データ再送やデータ復旧を行うことも可能である。

[0172] また、プロトコル変換部3Aは、電子機器10とは実際には全く通信を行わずに、恰もプロトコル変換部3A自身が電子機器10であるかのように動作して、端末ドライバ部15に制御情報を渡して(出力して)もよい。この場合、プロトコル変換部3Aは、出力対象の制御情報を既に取得済みであるか否かを判定する(ステップS339)。例えば、プロトコル変換部3Aは、出力対象の制御情報をハードディスク装置やメモリ等の記憶装置に記憶しているか否かを判定する。出力対象の制御情報があれば、プロトコル変換部3Aは、制御情報を任意の記憶部から読み出す(ステップS340)。そのようにすることによって、電子機器10との通信における遅延に影響されることなく、制御端末9での操作を可能とする。た、この場合、プロトコル変換部3Aは、過去にステップS338で保存したデータを利用(例えば、ステップS338で保存したデータを制御情報として読出)してもよい。

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[0173] そして、プロトコル変換部3Aは、抽出した制御情報に基づいて、端末ドライバ部15を介して、電子機器10の制御に必要な情報を制御端末9と入出力する(ステップS341)。

[0174] 以上のように、本実施の形態によれば、通信状況情報及び端末状況情報を収集して監視し、収集した端末状況や通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って接続方法を変更する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネット環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、電子機器10の状況変化と通信状況の変化との両方に対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。さらに、電子機器10の状況変化及び通信状況の変化だけではなく、制御端末9の状況変化にも対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

[0175] 実施の形態4.

次に、本発明の第4の実施の形態について図面を参照して説明する。図12は、第4の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。図12に示すように、本実施の形態では、コンピュータ1Aが、第3の実施の形態で示した構成要素に加えて、接続方法を設定及び確認するための手段(接続方法UI部)13を含む。また、本実施の形態では、コンピュータ1Aは、ユーザ14によって操作可能とされる。

[0176] 接続方法UI部13は、接続ルール保持部8Aが保持する接続ルールをディスプレイ装置等の表示装置に表示して、ユーザ14に提示する機能を備える。また、接続方法UI部13は、ユーザ14の操作に従って、接続ルール保持部8Aが記憶する接続ルールを編集処理する機能を備える。そのようにすることによって、ユーザ14による接続ルールの編集を可能とする。また、接続方法UI部13は、収集した端末状況データや通信状況データと照合して接続方法決定部5Aが選択した接続ルールに従って、設定する接続方法の候補を表示装置に表示する機能を備える。また、接続方法UI部1

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3は、ユーザ14の操作に従って、設定する接続方法を決定する機能を備える。そのようにすることによって、複数の接続方法の候補から、設定する接続方法をユーザ14が選択することを可能とする。

[0177] 次に、動作について説明する。図13は、第4の実施の形態における遠隔機器管理システムにおいて電子機器10と制御端末9との接続変更を行う処理例を示すフローチャートである。なお、本実施の形態では、主として第3の実施の形態と異なる部分について説明する。

[0178] まず、本実施の形態において、コンピュータ1Aの接続方法UI部13が実行する最初のステップS151～S156の処理は、第2の実施の形態で示したステップS51～S56の処理(図7参照)と同様である。

[0179] また、例えば、電子機器10からの接続要求等を受信した場合には、コンピュータ1Aは、ステップS157以降の処理を実行し、電子機器10と制御端末9との接続を開始する。なお、図13において、ステップS157～ステップS160の処理は、第3の実施の形態で示したステップS101～ステップS104の処理(図9参照)の処理と同様である。なお、電子機器10と制御端末9との接続方法の設定について自動設定を行うことが設定されていない場合には、接続方法決定部5Aは、ステップS160において、ユーザ14に接続ルールの候補として提示するための複数の接続ルールを抽出するようにしてもよい。

[0180] なお、本実施の形態では、電子機器10と制御端末9との接続処理を開始するときに、ステップS157の処理を実行した後に一旦ループ処理の先頭に戻り、次のループ処理でステップS158, S159の処理に移行する場合を説明するが、ステップS157の処理を実行した後にそのままステップS158, S159に移行するようにしてもよい。

[0181] 次に、コンピュータ1Aは、接続方法決定部5Aが抽出した接続ルールについて、自動設定を行うことが設定されているか否かを確認する(ステップS161)。具体的には、コンピュータ1Aは、接続ルールに自動処理を行うことを指定するフラグ(自動処理フラグともいう)が付与されているか否かを確認する(後述するステップS166参照)。自動設定を行うことが設定されていれば、そのままステップS171～S173の処理に移行する。自動設定を行うことが設定されていなければ、ステップS162～S163の処

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理

に移行する。

[0182] 次に、自動設定すること設定されていない場合、接続方法UI部13は、ユーザ14の操作に応じて、端末状況収集部16が収集した端末状況のデータを表示装置に表示させる(ステップS162)。例えば、接続方法UI部13は、制御端末9に関して、端末の識別子やプロトコル、接続アドレス、端末の識別子、プロトコル、接続アドレスに加えて、端末の最大計算処理量、現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I/O量、現在のI/O量、最大接続数、現在の接続数、最大解像度/色数、現在の解像度/色数、画面サイズ、制御端末の位置、所有者、所有グループ、アクセス制御情報等のデータを表示させる。

[0183] また、接続方法UI部13は、ユーザ14の操作に応じて、通信状況収集部6Aが収集した通信状況のデータを表示装置に表示させる(ステップS163)。例えば、接続方法UI部13は、ネットワーク11の識別子やプロトコル、接続アドレス、接続可能な電子機器10、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等のデータを表示させる。

[0184] また、接続方法UI部13は、ユーザ14の操作に応じて、収集した端末状況データや通信状況データに適した接続方法、又は適用の可能性がある接続方法を表示装置に表示させる(ステップS164)。この場合、接続方法UI部13は、ステップS160で接続方法決定部5Aによって抽出された接続ルールに従って、接続方法(又は、複数の接続方法の候補)を表示させる。例えば、接続方法UI部13は、接続方法として、端末ドライバ部15の設定方法や、プロトコル変換部3Aの設定方法、ネットワーク通信部4Aの設定、過去に適用された接続方法を示す履歴情報を表示させる。

[0185] ユーザ14は、抽出された接続ルールに示される接続方法で電子機器10と制御端末9とを接続してよいと判断すれば、コンピュータ1Aを操作して、提示された接続方法での接続実行を指示する。又は、ユーザ14は、コンピュータ1Aを操作して、提示された複数の接続方法の候補の中から、適用する接続方法の選択を指示する。すると、接続方法UI部13は、ユーザ14の確認操作に従って、接続方法決定部5Aが抽出した接続ルールを適用する旨の通知信号を、端末ドライバ部15、プロトコル変換

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部3A及びネットワーク通信部4Aに出力し、その接続ルールに示される接続方法に設定させる。又は、接続方法UI部13は、ユーザ14によって選択された接続ルールを適用する旨の通知信号を出力し、その接続ルールに示される接続方法に設定させる(ステップS165)。

[0186] 次に、コンピュータ1Aは、選択した接続ルールについて、今後ユーザ14による確認操作が必要なければ、自動処理フラグを接続ルールに付与する(ステップS166)。例えば、コンピュータ1Aは、ユーザ14によって自動処理を行う旨の指示操作が行われた場合には、その接続ルールに自動処理フラグを付与する。そして、以降のループ処理において、ステップS160で自動処理フラグが付与された接続ルールが抽出された場合には、コンピュータ1Aは、ステップS161でYと判定し、そのままステップS171～S173に移行して(ステップS162～S166の処理はスキップして)、自動的に接続方法の設定処理を行う。

[0187] なお、自動処理に関して、コンピュータ1Aは、端末状況や通信状況と接続ルールとの照合結果についての所定の確からしさを示す値を算出し、一定の確からしさ以上を示す値が得られた場合に限って、ステップS171～S173に移行して、自動的に接続方法の設定処理を行うようにしてもよい。例えば、コンピュータ1Aは、端末状況データや通信状況データが複数の要素を含む場合に、接続ルール保持部8Aが記憶する端末状況データや通信状況データの各要素のうち、収集した端末状況データや通信状況データの要素に合致する要素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、コンピュータ1Aは、スコア値が所定の閾値以上であることを条件として、そのままステップS171～S173の処理に移行するようにしてもよい。

[0188] なお、端末状況データや通信状況データは多様なパラメータを含むため、接続ルールとの照合においてあいまい性が生じる。そのため、端末状況や通信状況と接続ルールとの照合を行うためには、所定の閾値処理が必要となる。データセットに対するあいまい性を有する検索結果の確からしさを示す値の算出には、いくつかの手法が知られているが、本発明の趣旨ではないので詳細な説明を省略する。

[0189] 以下、ステップS171～S178の処理は、第3の実施の形態で示したステップS106～S113の処理(図9参照)とそれぞれ同様である。

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[0190] そして、コンピュータ1Aは、次のユーザ操作を処理するために、ループ処理の先頭の処理に戻る。次のユーザ操作がログアウト操作であれば、コンピュータ1Aは、ログアウト処理を実行し、処理を終了する(ステップS199)。

[0191] 以上のように、本実施の形態によれば、端末状況情報及び通信状況情報を収集して監視し、収集した端末状況や通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って接続方法を変更する。また、ユーザの操作に従って接続ルールを管理(例えば、閲覧や編集)可能に構成する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、ユーザの操作に応じて容易に接続ルールを管理することができる。また、電子機器10の状況変化と通信状況の変化との両方に対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。さらに、電子機器10の状況変化及び通信状況の変化だけではなく、制御端末9の状況変化にも対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

[0192] 実施の形態5.

次に、本発明の第5の実施の形態について図面を参照して説明する。図14は、第5の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。図14に示すように、遠隔機器管理システムは、複数の電子機器10と、電子機器10を制御する複数の制御端末9と、制御端末9に接続されるコンピュータ1aと、電子機器10に接続されるコンピュータ1bと、接続管理モジュール20とを含む。また、図14に示すように、コンピュータ1aとコンピュータ1bとは、1つ又は複数のネットワーク11(例えば、インターネットやLAN)を介して接続される。

[0193] コンピュータ1aは、制御端末9とネットワーク11とを接続するための装置(制御端末9の通信アダプタ)であって、具体的には、プログラム制御により動作するパーソナルコンピュータ等のデータ処理装置によって実現される。なお、コンピュータ1aは、中央処理装置やプロセッサ等によって実現されてもよい。また、コンピュータ1aは、データ

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処理能力を備えたネットワーク機器（例えば、ルータ）によって実現されてもよい。

[0194] コンピュータ1aは、プロトコル変換部3aと、ネットワーク通信部4aと、端末ドライバ部15aとを含む。

[0195] 端末ドライバ部15aは、制御端末9とデータを送受信する機能を備える。ネットワーク通信部4aは、ネットワーク11に接続されたコンピュータ1bと、ネットワーク11を介してデータを送受信する機能を備える。プロトコル変換部3aは、端末ドライバ部15aが入出力する入出力データと、ネットワーク通信部4aが送受信する入出力データとの間で、プロトコル変換を行う機能を備える。

[0196] コンピュータ1bは、電子機器10とネットワーク11とを接続するための装置（電子機器10の通信アダプタ）であって、具体的には、プログラム制御により動作するパーソナルコンピュータ等のデータ処理装置によって実現される。なお、コンピュータ1bは、中央処理装置やプロセッサ等によって実現されてもよい。また、コンピュータ1bは、データ処理能力を備えたネットワーク機器（例えば、ルータ）によって実現されてもよい。

[0197] コンピュータ1bは、機器ドライバ部2bと、プロトコル変換部3bと、ネットワーク通信部4bとを含む。

[0198] 機器ドライバ部2bは、電子機器10と制御信号を送受信する機能を備える。ネットワーク通信部4bは、ネットワーク11に接続されたコンピュータ1aと、ネットワーク11を介してデータを送受信する機能を備える。プロトコル変換部3bは、機器ドライバ部2bが入出力する入出力データと、ネットワーク通信部4bが送受信する入出力データとの間で、プロトコル変換を行う機能を備える。

[0199] 接続管理モジュール20は、具体的には、ソフトウェアによって実現される手段として、コンピュータ1a又はコンピュータ1bのいずれかに搭載されてもよい。また、接続管理モジュール20は、コンピュータ1a及びコンピュータ1bとは別のコンピュータを用いて実現されてもよい。

[0200] 接続管理モジュール20は、接続方法決定部5Bと、通信状況収集部6Bと、機器状況収集部7Bと、接続ルール保持部8Bと、端末状況収集部16Bとを含む。

[0201] 端末状況収集部16Bは、制御端末9の種類や負荷、位置等の端末状況を収集する機能を備える。機器状況収集部7Bは、電子機器10の種類や負荷、位置等の機器

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状況を収集する機能を備える。通信状況収集部6Bは、ネットワーク11を介した制御端末9との通信の種類や経路、負荷等の通信状況を収集する機能を備える。

[0202] 接続ルール保持部8Bは、ある機器状況や端末状況、通信状況に適した電子機器10と制御端末9との通信接続方法を示す接続ルールを保持する機能を備える。具体的には、接続ルール保持部8Bは、機器状況を示す機器状況データや、端末状況を示す端末状況データ、通信状況を示す通信状況データに対応付けて、接続ルールをハードディスク装置やメモリ等の記憶装置に記憶している。

[0203] 接続方法決定部5Bは、機器状況収集部7Bが収集した機器状況や端末状況収集部16Bが収集した端末状況、通信状況収集部6が収集した通信状況と、接続ルール保持部8Bが保持する接続ルールとを照合して、適切な接続方法を示す接続ルールを接続ルール保持部8Bから抽出する機能を備える。また、接続方法決定部5Bは、抽出した接続ルールを出力することによって、機器ドライバ部2b、端末ドライバ部15a、プロトコル変換部3a，3b及びネットワーク通信部4a，4bに、適切な接続方式を通知し適切な接続方法を設定させる機能を備える。

[0204] 次に、動作について説明する。図15は、第5の実施の形態における遠隔機器管理システムにおいて電子機器10と制御端末9との接続変更を行う処理例を示すフローチャートである。

[0205] まず、制御端末9や電子機器10は、所定のタイミングで（例えば、予め定めた時間毎や、ユーザ操作に応じて）、それぞれ任意の手段で（例えば、インターネットやLAN等のネットワーク11を介して）コンピュータ1a，1bに接続する（ステップS201）。

[0206] 次に、電子機器10や制御端末9によって接続されると、接続管理モジュール20の端末状況収集部16Bは、端末ドライバ部15aを介して、コンピュータ1aに接続されている制御端末9を探索する。この場合に、端末状況収集部16Bは、探索された制御端末9に関して、その制御端末9の端末状況を示すデータ（端末状況データ）を収集する（ステップS202）。例えば、端末状況収集部16Bは、制御端末9の識別子やプロトコル、接続アドレスに加えて、制御端末9の最大計算処理量や現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I／O（入出力）量、現在のI／O（入出力）量、最大接続数、現在の接続数、最大解像度／色数、現在の解像度／色数、画

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面サイズ、制御端末の位置、所有者、所有グループ、アクセス制御情報等の端末状況のデータを含む端末状況データを、制御端末9から入力する。

[0207] また、機器状況収集部7Bは、機器ドライバ部2bを介して、コンピュータ1bに接続されている電子機器10を探索する。この場合に、機器状況収集部7Bは、探索された電子機器10に関して、その電子機器10の機器状況を示すデータ(機器状況データ)を収集する(ステップS203)。例えば、機器状況収集部7Bは、電子機器10の識別子やプロトコル、接続アドレスに加えて、電子機器10の最大計算処理量や現在の計算処理量、利用可能メモリ量、現在の利用メモリ量、最大I/O(入出力)量、現在のI/O(入出力)量、最大接続数、現在の接続数、電子機器の位置、所有者、所有グループ、アクセス制御情報等の機器状況のデータを含む機器状況データを、電子機器10から入力する。

[0208] また、通信状況収集部6Bは、ネットワーク通信部4a, 4bを介して、又は直接ネットワーク11を調査し、ネットワーク11を探索する。例えば、通信状況収集部6Bは、コンピュータから利用可能なネットワークを探索する方式として、IEEE802. 11b等の無線LANの規格やBOOTP、DHCP等の広く利用されている既知の技術を用いることによって、電子機器10と制御端末9との接続に用いることができるネットワーク11を検索することができる。この場合に、通信状況収集部6Bは、探索されたネットワーク11に関して、そのネットワーク11の通信状況を示すデータ(通信状況データ)を収集する(ステップS204)。例えば、通信状況収集部6Bは、ネットワーク11の識別子やプロトコル、接続アドレスに加えて、現在時刻や最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等を含む通信状況データを、ネットワーク11を介して受信する。

[0209] 次に、接続方法決定部5Bは、収集した、端末状況、機器状況及び通信状況のデータを検索キーとして、接続ルール保持部8Bから、現在の端末状況、機器状況及び通信状況に適した接続方法を示す接続ルールを抽出する(ステップS205)。

[0210] 次に、接続方法決定部5Bは、抽出した接続ルールが接続の切断を示すものであるか否かを確認する(ステップS206)。抽出した接続ルールに示されるアクションが終了処理を示すものであれば、接続方法決定部5Bは、電子機器10と制御端末9と

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の接続を切断する旨の通知信号を、端末ドライバ部15a、機器ドライバ部2b、プロトコル変換部3a，3b及びネットワーク通信部4a，4bに出力する。そして、電子機器10と制御端末9との接続が切断され、動作の停止となる。

[0211] 次に、接続方法決定部5Bは、抽出した接続ルールに従って、接続方法を指定する通知信号を、端末ドライバ部15a、機器ドライバ部2b、プロトコル変換部3a，3b、及びネットワーク通信部4a，4bに出力し、それぞれ接続ルールに示される接続方法に設定させる(ステップS207～S210)。

[0212] 次に、電子機器10から、制御情報の送信が開始される。すると、コンピュータ1bの機器ドライバ部2bは、制御情報を電子機器10からで受信する(ステップS211)。そして、機器ドライバ部2bは、受信した制御情報をプロトコル変換部3bに渡す(出力する)。

[0213] プロトコル変換部3bは、制御情報を受信(入力)すると、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS212)。そして、プロトコル変換部3bは、ネットワーク通信部4bに、プロトコル変換した制御情報を渡す(出力する)。ネットワーク通信部4bは、いずれかのネットワーク11を経由して、コンピュータ1aのネットワーク通信部4aに制御情報を送信する(ステップS213)。

[0214] ネットワーク通信部4aが制御情報を受信すると、コンピュータ1aのプロトコル変換部3aは、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS214)。そして、プロトコル変換部3aは、端末ドライバ部15aに、プロトコル変換した制御情報を渡す(出力する)。すると、端末ドライバ部15aは、制御端末9とデータの入出力を行い(ステップS215)、制御端末9から電子機器10に対する制御情報を入力する得る。

[0215] 端末ドライバ部15aが制御端末9から制御情報を受信すると、プロトコル変換部3aは、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS216)。そして、プロトコル変換部3aは、ネットワーク通信部4aに、プロトコル変換した制御情報を渡す(出力する)。ネットワーク通信部4aは、いずれかのネットワーク11を経由して、コンピュータ1bのネットワーク通信部4bに制御情報を送信する(ステップS217)。

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[0216] ネットワーク通信部4bが制御情報を受信すると、プロトコル変換部3bは、設定情報に基づいて、制御情報についてプロトコル変換を行う(ステップS218)。そして、プロトコル変換部3bは、機器ドライバ部2bに、プロトコル変換した制御情報を渡す(出力する)。

[0217] 電子機器10は、コンピュータ1bの機器ドライバ部2bから制御情報を受信(入力)する。そして、電子機器10は、入力した制御情報に基づいて各種制御を実行し、制御情報に対する応答情報を出力する(ステップS219)。

[0218] 次に、コンピュータ1a, 1b及び接続管理モジュール20は、端末状況や機器状況、通信状況の次の状況変化の有無を繰り返し監視するため、ステップS202～S204の処理に戻る。そして、コンピュータ1a, 1b及び接続管理モジュール20は、ステップS202～S219の処理を、ステップS206でタイムアウトするまで繰り返し実行する。

[0219] 以上のように、本実施の形態によれば、通信状況情報、端末状況情報及び機器状況情報を収集して監視し、収集した端末状況や機器状況、通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って接続方法を変更する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、電子機器10の状況変化、制御端末9の状況変化、及び通信状況の変化の全てに対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

[0220] 実施の形態6.

次に、本発明の第6の実施の形態について図面を参照して説明する。図16は、第6の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。図16に示すように、本実施の形態では、接続管理モジュール20が、第5の実施の形態で示した構成要素に加えて、接続方法を設定及び確認するための手段(接続方法UI部)13を含む。また、本実施の形態では、接続管理モジュール20は、ユーザ14によって操作可能とされる。

[0221] 接続方法UI部13は、接続ルール保持部8Bが保持する接続ルールをディスプレイ

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装置等の表示装置に表示して、ユーザ14に提示する機能を備える。また、接続方法UI部13は、ユーザ14の操作に従って、接続ルール保持部8Bが記憶する接続ルールを編集処理する機能を備える。そのようにすることによって、ユーザ14による接続ルールの編集を可能とする。また、接続方法UI部13は、収集した端末状況データや、機器状況データ、通信状況データと照合して接続方法決定部5Bが選択した接続ルールに従って、設定する接続方法の候補を表示装置に表示する機能を備える。また、接続方法UI部13は、ユーザ14の操作に従って、設定する接続方法を決定する機能を備える。そのようにすることによって、複数の接続方法の候補から、設定する接続方法をユーザ14が選択することを可能とする。

[0222] 次に、動作について説明する。図17は、第6の実施の形態における遠隔機器管理システムにおいて電子機器10と制御端末9との接続変更を行う処理例を示すフローチャートである。なお、本実施の形態では、主として第5の実施の形態と異なる部分について説明する。

[0223] まず、本実施の形態において、接続管理モジュール20の接続方法UI部13が実行する最初のステップS251～S256の処理は、第2の実施の形態で示したステップS51～S56の処理(図7参照)と同様である。

[0224] また、例えば、電子機器10や制御端末9からの接続要求等を受信した場合には、接続管理モジュール20は、ステップS261以降の処理を実行し、電子機器10と制御端末9との接続を開始する。なお、図17において、ステップ261～ステップ265の処理は、第5の実施の形態で示したステップ201～ステップ205の処理(図15参照)の処理と同様である。なお、電子機器10と制御端末9との接続方法の設定について自動設定を行うことが設定されていない場合には、接続方法決定部5Bは、ステップS265において、ユーザ14に接続ルールの候補として提示するための複数の接続ルールを抽出するようにしてもよい。

[0225] なお、本実施の形態では、電子機器10と制御端末9との接続処理を開始するときに、ステップS261の処理を実行した後に一旦ループ処理の先頭に戻り、次のループ処理でステップS262, S263の処理に移行する場合を説明するが、ステップS261の処理を実行した後にそのままステップS262, S263に移行するようにしてもよい。

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[0226] 次に、接続管理モジュール20は、接続方法決定部5Bが抽出した接続ルールについて、自動設定を行うことが設定されいるか否かを確認する(ステップS266)。具体的には、接続管理モジュール20は、接続ルールに自動処理を行うことを指定するフラグ(自動処理フラグともいう)が付与されているか否かを確認する(後述するステップS272参照)。自動設定を行うことが設定されていれば、そのままステップS273～S276の処理に移行する。自動設定を行うことが設定されていなければ、ステップS267～S270の処理に移行する。

[0227] 次に、自動設定すること設定されていない場合、接続方法UI部13は、ユーザ14の操作に応じて、端末状況収集部16Bが収集した端末状況のデータを表示装置に表示させる(ステップS267)。また、接続方法UI部13は、ユーザ14の操作に応じて、機器状況収集部7Bが収集した機器状況のデータを表示装置に表示させる(ステップS268)。また、接続方法UI部13は、ユーザ14の操作に応じて、通信状況収集部6Bが収集した通信状況のデータを表示装置に表示させる(ステップS269)。さらに、接続方法UI部13は、ユーザ14の操作に応じて、収集した端末状況データや、機器状況データ、通信状況データに適した接続方法、又は適用の可能性がある接続方法を表示装置に表示させる(ステップS270)。

[0228] ユーザ14は、抽出された接続ルールに示される接続方法電子機器10と制御端末9とを接続してよいと判断すれば、接続管理モジュール20を操作して、提示された接続方法での接続実行を指示する。又は、ユーザ14は、接続管理モジュール20を操作して、提示された複数の接続方法の候補の中から、適用する接続方法の選択を指示する。すると、接続方法UI部13は、ユーザ14の確認操作に従って、接続方法決定部5Bが抽出した接続ルールを適用する旨の通知信号を、端末ドライバ部15a、機器ドライバ部2b、プロトコル変換部3a，3b及びネットワーク通信部4a，4bに出力し、その接続ルールに示される接続方法に設定させる。又は、接続方法UI部13は、ユーザ14によって選択された接続ルールを適用する旨の通知信号を出力し、その接続ルールに示される接続方法に設定させる(ステップS271)。

[0229] 次に、接続管理モジュール20は、選択した接続ルールについて、今後ユーザ14による確認操作が必要なければ、自動処理フラグを接続ルールに付与する(ステップ

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S272)。例えば、接続管理モジュール20は、ユーザ14によって自動処理を行う旨の指示操作が行われた場合には、その接続ルールに自動処理フラグを付与する。そして、以降のループ処理において、ステップ265で自動処理フラグが付与された接続ルールが抽出された場合には、接続管理モジュール20は、ステップS266でYと判定し、ステップS273～S276に移行して(ステップS267～S272の処理はスキップして)、自動的に接続方法の設定処理を行う。

[0230] なお、自動処理に関して、接続管理モジュール20は、端末状況や機器状況、通信状況と接続ルールとの照合結果についての所定の確からしさを示す値を算出し、一定の確からしさ以上を示す値が得られた場合に限って、ステップS273～S276に移行して、自動的に接続方法の設定処理を行うようにしてもよい。例えば、接続管理モジュール20は、端末状況データや機器状況データ、通信状況データが複数の要素を含む場合に、接続ルール保持部8Bが記憶する端末状況データや機器状況データ、通信状況データの各要素のうち、収集した端末状況データや機器状況データ、通信状況データの要素に合致する要素を全て特定し、合致する要素数をスコア値として算出してもよい。そして、接続管理モジュール20は、スコア値が所定の閾値以上であることを条件として、そのままステップS273～S276の処理に移行するようにしてもよい。

[0231] なお、機器状況データや端末状況データ、通信状況データは多様なパラメータを含むため、接続ルールとの照合においてあいまい性が生じる。そのため、端末状況や機器状況、通信状況と接続ルールとの照合を行うためには、所定の閾値処理が必要となる。データセットに対するあいまい性を有する検索結果の確からしさを示す値の算出には、いくつかの手法が知られているが、本発明の趣旨ではないので詳細な説明を省略する。

[0232] 以下、ステップS273～S285までの処理は、第5の実施の形態で示したステップS207～S219までの処理(図15参照)とそれぞれ同様である。

[0233] そして、接続管理モジュール20は、次のユーザ操作を処理するために、ループ処理の先頭の処理に戻る。次のユーザ操作がログアウト操作であれば、接続管理モジュール20は、ログアウト処理を実行し、処理を終了する(ステップS299)。

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[0234] 以上のように、本実施の形態によれば、機器状況情報、端末状況情報及び通信状況情報を収集して監視し、収集した機器状況や端末状況、通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って接続方法を変更する。また、ユーザの操作に従って接続ルールを管理(例えば、閲覧や編集)可能に構成する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、ユーザの操作に応じて容易に接続ルールを管理することができる。また、電子機器10の状況変化、制御端末9の状況変化、及び通信状況の変化の全てに対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

[0235] 実施の形態7.

次に、本発明の第7の実施の形態について図面を参照して説明する。図18は、第7の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。図18に示すように、遠隔機器管理システムは、複数の電子機器10と、電子機器10を制御する複数の制御端末9と、制御端末9に接続されるコンピュータ1aと、電子機器10に接続される複数のコンピュータ1bと、コンピュータ1cとを含む。また、図18に示すように、コンピュータ1a、各コンピュータ1b及びコンピュータ1cは、1つ又は複数のネットワーク11(例えば、インターネットやLAN)を介して接続される。

[0236] コンピュータ1aは、制御端末9とネットワーク11とを接続するための装置であって、具体的には、プログラム制御により動作するするパーソナルコンピュータ等のデータ処理装置によって実現される。なお、コンピュータ1aは、中央処理装置やプロセッサ等によって実現されてもよい。また、コンピュータ1aは、データ処理能力を備えたネットワーク機器(例えば、ルータ)によって実現されてもよい。

[0237] コンピュータ1aは、プロトコル変換部3aと、ネットワーク通信部4aと、端末ドライバ部15aとを含む。

[0238] 端末ドライバ部15aは、制御端末9とデータを送受信する機能を備える。ネットワーク通信部4aは、ネットワーク11を介してデータを送受信する機能を備える。プロトコル

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変換部3aは、端末ドライバ部15aが入出力する入出力データと、ネットワーク通信部4aが送受信する入出力データとの間で、プロトコル変換を行う機能を備える。

[0239] 各コンピュータ1bは、電子機器10とネットワーク11とを接続するための装置であって、具体的には、プログラム制御により動作するパーソナルコンピュータ等のデータ処理装置によって実現される。なお、各コンピュータ1bは、中央処理装置やプロセッサ等によって実現されてもよい。また、各コンピュータ1bは、データ処理能力を備えたネットワーク機器（例えば、ルータ）によって実現されてもよい。

[0240] 各コンピュータ1bは、機器ドライバ部2bと、プロトコル変換部3bと、ネットワーク通信部4bとを含む。

[0241] 機器ドライバ部2bは、電子機器10と制御信号を送受信する機能を備える。ネットワーク通信部4bは、ネットワーク11を介してデータを送受信する機能を備える。プロトコル変換部3bは、機器ドライバ部2bが入出力する入出力データと、ネットワーク通信部4bが送受信する入出力データとの間で、プロトコル変換を行う機能を備える。

[0242] コンピュータ1cは、ネットワーク11に接続され、具体的には、プログラム制御により動作するするパーソナルコンピュータ等のデータ処理装置によって実現される。なお、コンピュータ1cは、中央処理装置やプロセッサ等によって実現されてもよい。また、コンピュータ1cは、データ処理能力を備えたネットワーク機器（例えば、ルータ）によって実現されてもよい。

[0243] コンピュータ1cは、ネットワーク通信部4cと、接続方法決定部5cと、接続ルール保持部8cと、状況収集部21とを含む。

[0244] ネットワーク通信部4cは、ネットワーク11を介してデータを送受信する機能を備える。状況収集部21は、制御端末9、電子機器10及びネットワーク通信の種類や負荷、位置等の状況を収集する機能を備える。

[0245] 接続ルール保持部8cは、ある機器状況や端末状況、通信状況に適した電子機器10と制御端末9との通信接続方法を示す接続ルールを保持する機能を備える。具体的には、接続ルール保持部8cは、機器状況を示す機器状況データや、端末状況を示す端末状況データ、通信状況を示す通信状況データに対応付けて、接続ルールをハードディスク装置やメモリ等の記憶装置に記憶している。

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[0246] 接続方法決定部5cは、状況収集部21が収集した機器状況や端末状況、通信状況と、接続ルール保持部8cが保持する接続ルールとを照合して、適切な接続方法を示す接続ルールを接続ルール保持部8cから抽出する機能を備える。また、接続方法決定部5cは、抽出した接続ルールを出力することによって、コンピュータ1aや、各コンピュータ1b、コンピュータ1cに、ネットワーク通信部4cを介して適切な接続方式を示す配布(例えば、通知信号を送信)する機能を備える。

[0247] なお、この実施の形態では、コンピュータ1aと、各コンピュータ1bと、コンピュータ1cとが、それぞれ別々の装置として実現される場合を説明しているが、これらのいずれか1つ又は複数が一体型の装置として実現されてもよい。例えば、コンピュータ1aとコンピュータ1cとが、一体型の装置として1台で実現されてもよい。

[0248] 以上のように、本実施の形態によれば、ネットワークを介して分散して配置される複数の電子機器10から機器状況情報を収集するとともに、通信状況情報及び端末状況情報を収集して監視し、収集した機器状況や端末状況、通信状況に適した接続方法を示す接続ルールを決定する。そして、決定した接続ルールに従って、接続方法を変更する。そのため、管理対象となる電子機器10が多種多様であり、かつ管理対象となる電子機器10が多数存在するインターネットのような環境において、計算処理の負荷や通信の負荷、及び電子機器10や制御端末9の移動等による状況の変化に対応して、円滑に接続を変更することができる。また、複数の電子機器10の状況変化、制御端末9の状況変化、及び通信状況の変化の全てに対応して、電子機器10と制御端末9との間の接続方法を円滑に変更することができる。

実施例

[0249] 次に、本発明の実施例について図面を参照して説明する。本実施例では、一例として、利用者がデジタルカメラで画像を撮影し、帰宅後にデジタルカメラを玄関にある充電器に置いて、その後、寝室のテレビジョン受信機を用いて、撮影した画像を家族で閲覧する場合に、遠隔機器管理システムを適用する場合を説明する。

[0250] 本実施例で示すシステムは、本発明の第5の実施の形態で示した遠隔機器管理システムに対応する。本実施例において、デジタルカメラは、図14に示す電子機器10に相当する。また、テレビジョン受信機は、制御端末9に相当する。また、本実施例で

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は、コンピュータ1aは、テレビジョン受信機に含まれている(例えば、テレビジョン受信機が搭載するCPUやプロセッサ)とする。また、コンピュータ1bは、充電器に含まれている(例えば、充電器がプロセッサを搭載していてもよいし、充電器をパーソナルコンピュータ等の端末に接続してもよい)とする。また、接続管理モジュール20は、家庭内のホームサーバに搭載されているとする。

[0251] まず、充電器にデジタルカメラがUSBを用いて接続されると、プラグアンドプレイ機能によってコンピュータ(例えば、ホームサーバ)のオペレーティングシステム(OS)で認識される。そして、コンピュータは、デジタルカメラ用のUSBドライバを読み込む。さらに、接続された電子機器(デジタルカメラ)の情報がネットワークを介してホームサーバに登録される。なお、ホームサーバのネットワークアドレスは、予め設定済みであるとする。例えば、ホームサーバのネットワークアドレスとして、USBに準拠し、「BusID 5-1 ID 0ea0:6828 XXX Technology, Inc. OTI-6828 Flash Disk 」と登録されているものとする。

[0252] 次に、寝室において、テレビジョン受信機を用いて、デジタルカメラで撮影した画像の閲覧を行なう手順を説明する。まず、テレビジョン受信機は、Webブラウザを起動し、テレビジョン受信機内のローカルなWebサーバに接続すると、所定の操作画面を表示する。例えば、テレビジョン受信機は、図19に示すような操作可能なメニュー画面を表示する。

[0253] 図19に示すメニュー画面の3番目の項目は、ホームサーバへのリンクを示している。ユーザが、メニュー画面の3番目の項目「マネージャに登録されたマシンを表示する」を選択操作すると、テレビジョン受信機は、ホームサーバに登録された利用可能なマシン(パーソナルコンピュータ(PC)や充電器)を表示する。例えば、図20に示すような利用可能なマシンの表示画面を表示する。

[0254] さらに、ユーザが、図20に示す表示画面から「接続されているUSB機器を表示」を選択操作すると、そのマシンに登録されている機器一覧の情報がHTTPを用いてテレビジョン受信機に転送される。そして、テレビジョン受信機は、図21に示すような、USB機器の一覧表示画面を表示する。

[0255] 図20において、表示画面のアクション列には、「使用する」と「切断する」との表示が

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ある。ユーザがそれらの項目を選択操作すると、ホームサーバは、制御端末（例えば、テレビジョン受信機）と電子機器（例えば、デジタルカメラ）とを接続する。又は、ホームサーバは、接続中の電子機器と制御端末とを切断する。

[0256] テレビジョン受信機（制御端末）によって指定されたデジタルカメラ（電子機器）を接続するためには、ホームサーバは、通常のネットワークで利用されるTCP／IPプロトコルを用いて、充電器（マシン）に対して接続要求を行う。接続要求を受けたマシンは、予め登録された接続ルールに従って、USB／IPの接続情報をTCP／IPプロトコルにパックし、制御端末に送信する。本実施例では、接続ルールは、制御端末情報として、ネットワーク接続可能なプロトコルのリスト例えば、USB-IP、Echonet 、UPnP、．．．）を含む。一方、マシン側も、接続可能なプロトコルのリスト（例えば、USB-IP、Havi、UPnP、．．．）を備える。

[0257] ホームサーバの接続管理モジュールは、それら両方のプロトコルに共通するプロトコル（例えば、USB-IP:2、UPnP:6）を抽出する。なお、プロトコルUSB-IP:2、UPnP:6において、数字は、プロトコルのリスト番号の和を示しており、その値が小さいほど優先度が高いものする。ここでは、USB-IPが選択されたとする。

[0258] また、無線LANの電波状況が不安定で性能が劣悪なネットワーク状況であれば、ホームサーバは、接続時のバッファパラメータを大きめにする設定を行なう。また、逆に、ネットワーク状況が良好であれば、ホームサーバは、同期性を重視し、バッファを少なくする設定を行う。

[0259] 次に、USB-IPによる接続について説明する。制御端末は、受信したUSBの接続情報を恰もUSB機器が接続されたかのように、オペレーティングシステム（OS）に通知する。そのため、テレビジョン受信機は、充電器に接続されているデジタルカメラが恰もテレビジョン受信機に直接接続されているかのように動作し、通常のプラグアンドプレイを開始する。ここで、予め画像ビューアのプログラムがプラグアンドプレイで登録されていれば、テレビジョン受信機は、ビューアプログラムに従った処理を開始する。

[0260] ビューアプログラムのデジタルカメラに対するデータアクセスを行なう場合、テレビジョン受信機は、まず、USB機器のアクセス要求をTCP／IPパケットで包みこみ（パケット化し）、ネットワークを介してマシンに送信する。マシンは、受信したパケットの包み

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を解き、通常のUSB機器アクセス要求として、デジタルカメラに送信する。

[0261] アクセスに対する応答を行なう場合には、上記に示した処理と逆経路に従って処理を行なう。マシンは、通常のUSB機器のアクセス応答としてデジタルカメラから応答データを受信し、TCP／IPパケットでその応答データを包み込み、テレビジョン受信機に送信する。テレビジョン受信機は、受信したパケットの包みを解き、通常のUSB機器のアクセス応答として、ビューアプログラムに渡す。

[0262] 接続中の電子機器を切断する場合には、テレビジョン受信機は、まず、ビューアプログラムを終了し、プラグアンドプレイでロードされた各種ドライバをアンロードし、通信を切断する。

[0263] なお、この出願は、2006年12月15日に出願した、日本特許出願番号2006－338964号を基礎とする優先権を主張し、その開示の全てをここに取り込む。

産業上の利用可能性

[0264] 本発明は、電子機器の機器状況や通信状況の変化に動的に対応する遠隔機器管理システムの用途に適用できる。また、遠隔機器管理システムをコンピュータを用いて実現するためのプログラムの用途に適用できる。また、電子機器の機器状況や通信状況の変化に動的に対応する遠隔管理機能を搭載した各種装置や端末の用途に適用できる。例えば、パーソナルコンピュータや、制御端末に搭載されている端末エミュレーション装置、電子機器に搭載される組み込み型ネットワークインタフェースの用途にも適用できる。

図面の簡単な説明

[0265] [図1]関連する機器制御プロトコルが異なる電子機器間で機器ネットワークを構成する場合の構成例を示すブロック図である。

[図2]本発明による遠隔機器管理システムの構成の一例を示すブロック図である。

[図3]遠隔機器管理システムにおいて電子機器と制御端末との接続変更を行う処理の一例を示すフローチャートである。

[図4]電子機器からのデータをプロトコル変換する処理の一例を示すフローチャートである。

[図5]制御端末からのデータをプロトコル変換する処理の一例を示すフローチャート

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である。

[図6]第2の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。

[図7]第2の実施の形態における遠隔機器管理システムにおいて電子機器と制御端末との接続変更を行う処理例を示すフローチャートである。

[図8]第3の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。

[図9]第3の実施の形態における遠隔機器管理システムにおいて電子機器と制御端末との接続変更を行う処理例を示すフローチャートである。

[図10]第3の実施の形態における制御端末からのデータをプロトコル変換する処理の一例を示すフローチャートである。

[図11]第3の実施の形態における電子機器からのデータをプロトコル変換する処理の一例を示すフローチャートである。

[図12]第4の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。

[図13]第4の実施の形態における遠隔機器管理システムにおいて電子機器と制御端末との接続変更を行う処理例を示すフローチャートである。

[図14]第5の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。

[図15]第5の実施の形態における遠隔機器管理システムにおいて電子機器と制御端末との接続変更を行う処理例を示すフローチャートである。

[図16]第6の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。

[図17]第6の実施の形態における遠隔機器管理システムにおいて電子機器と制御端末との接続変更を行う処理例を示すフローチャートである。

[図18]第7の実施の形態における遠隔機器管理システムの構成例を示すブロック図である。

[図19]操作可能なメニュー画面の表示例を示す説明図である。

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[図20]利用可能なマシンの表示画面の表示例を示す説明図である。

[図21]USB機器の一覧表示画面の表示例を示す説明図である。

符号の説明

[0266] 1, 1A, 1a, 1b, 1c コンピュータ(データ処理装置;プロセッサ;中央処理装置)

2, 2b 機器ドライバ部

3, 3A, 3a, 3b プロトコル変換部

4, 4A, 4a, 4b, 4c ネットワーク通信部

5, 5A, 5B, 5c 接続方法決定部

6, 6A, 6B 通信状況収集部

7, 7B 機器状況収集部

8, 8A, 8B, 8c 接続ルール保持部

9 制御端末

10 電子機器

11 ネットワーク

13 接続方法UI部

14 ユーザ

15, 15a 端末ドライバ部

16, 16B 端末状況収集部

20 接続管理モジュール

21 状況収集部

請求の範囲

[1] 電子機器を遠隔管理する遠隔機器管理システムであって、

前記電子機器の状況を示す機器状況情報を収集する機器状況収集手段と、

前記電子機器と前記電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集手段と、

前記機器状況収集手段が収集した機器状況情報と前記通信状況収集手段が収集した通信状況情報とに基づいて、前記電子機器と前記制御端末との間の接続方法を決定する接続方法決定手段と、

前記接続方法決定手段の決定結果に基づいて、前記電子機器と前記制御端末の間の接続方法を設定する接続方法設定手段とを

備えたことを特徴とする遠隔機器管理システム。

[2] 電子機器と制御端末との間の接続方法を示す接続ルールを予め記憶する接続ルール記憶手段を備え、

接続方法決定手段は、前記接続ルール記憶手段が記憶する接続ルールから、機器状況収集手段が収集した機器状況情報と通信状況収集手段が収集した通信状況情報とに合致する接続ルールを抽出する

請求項1記載の遠隔機器管理システム。

[3] 制御端末の状況を示す端末状況情報を収集する端末状況収集手段を備え、

接続方法設定手段は、機器状況情報及び通信状況情報に加えて、前記端末状況収集手段が収集した端末状況情報に基づいて、電子機器と前記制御端末との間の接続方法を決定する

請求項1又は請求項2記載の遠隔機器管理システム。

[4] 電子機器を制御する電子機器制御手段と、

ネットワークに接続された制御端末とデータを送受信するデータ送受信手段と、

電子機器が入出力する制御データと制御端末が送受信するネットワーク通信データとの間でプロトコル変換を行なうプロトコル変換手段と、

電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集手段と、

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ネットワーク通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段と、

機器状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段と、

機器状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、プロトコル変換方式及びネットワーク通信方式を設定する接続方法設定手段とを

備えたことを特徴とする遠隔機器管理システム。

[5] ネットワークに接続された電子機器と制御データを送受信する制御データ送受信手段と、

制御端末とのインタフェースを実現するインタフェース手段と、

電子機器が送受信するネットワーク制御データと制御端末が入出力する入出力インターフェースとの間でプロトコル変換を行なうプロトコル変換手段と、

ネットワーク電子機器の種類、負荷、ネットワーク経路又は位置を含む通信状況を示す通信状況情報を収集する通信状況収集手段と、

制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集手段と、

端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段と、

端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、ネットワーク電子機器の通信制御方式、プロトコル変換方式及び端末インターフェース方式を設定する接続方法設定手段とを

備えたことを特徴とする遠隔機器管理システム。

[6] 電子機器の通信アダプタと、

制御端末の通信アダプタとを備え、

前記電子機器の通信アダプタは、

前記電子機器を制御する電子機器制御手段と、

ネットワーク通信を行なう機器側通信手段と、

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前記電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換手段と、

前記制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集手段と、

前記電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集手段と、

通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段と、

機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段と、

機器状況、端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定手段とを含み、

前記制御端末の通信アダプタは、

前記制御端末とのインタフェースを実現するインタフェース手段と、

ネットワーク通信を行なう制御側通信手段と、

前記制御端末の人出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換手段とを含む

ことを特徴とする遠隔機器管理システム。

[7] 電子機器の通信アダプタと、

制御端末の通信アダプタとを備え、

前記電子機器の通信アダプタは、

前記電子機器を制御する電子機器制御手段と、

ネットワーク通信を行なう機器側通信手段と、

前記電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換手段とを含み、

前記制御端末の通信アダプタは、

前記制御端末とのインタフェースを実現するインタフェース手段と、

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ネットワーク通信を行なう制御側通信手段と、

前記制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換手段と、

前記制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集手段と、

前記電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集手段と、

通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段と、

機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段と、

機器状況、端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定手段とを含む

ことを特徴とする遠隔機器管理システム。

[8] 電子機器の通信アダプタと、

制御端末の通信アダプタとを備え、

前記電子機器の通信アダプタは、

前記電子機器を制御する電子機器制御手段と、

ネットワーク通信を行なう機器側通信手段と、

前記電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換手段とを含み、

前記制御端末の通信アダプタは、

前記制御端末とのインタフェースを実現するインタフェース手段と、

ネットワーク通信を行なう制御側通信手段と、

前記制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換手段とを含み、

さらに、ネットワーク上を介して制御を行なうプログラムモジュールを備え、

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前記プログラムモジュールは、

前記制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を、ネットワークを介して収集する端末状況収集手段と、

前記電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を、ネットワークを介して収集する機器状況収集手段と、

通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集手段と、

機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持手段と、

機器状況、端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を、ネットワークを介して設定する接続方法設定手段とを含む

ことを特徴とする遠隔機器管理システム。

[9] 機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを表示するルール表示手段と、

ユーザ操作に従って、前記接続ルールを編集するルール編集手段とを含む

請求項1から請求項8のうちのいずれか1項に記載の遠隔機器管理システム。

[10] 収集した端末状況、機器状況又は通信状況と、前記機器状況、前記端末状況又は前記通信状況に合致した通信接続方法を示す接続ルールとを照合して特定した接続方法の候補を表示する候補表示手段と、

ユーザ操作に従って、前記候補表示手段が表示した候補から接続方法を選択する接続方法選択手段とを含む

請求項1から請求項9のうちのいずれか1項に記載の遠隔機器管理システム。

[11] 電子機器から入力したデータを保存するデータ保存手段と、

制御端末からの制御要求に対して、前記データ保存手段が保存するデータを用いて、前記電子機器と前記制御端末とを非同期で動作させる動作制御手段とを含む

請求項1から請求項10のうちのいずれか1項に記載の遠隔機器管理システム。

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[12] 制御端末からの入力データを保存する入力データ保存手段と、

電子機器からの入力要求に対して、前記入力データ保存手段が保存するデータを用いて、前記電子機器と前記制御端末とを非同期で動作させることを可能とする動作制御手段とを含む

請求項1から請求項11のうちのいずれか1項に記載の遠隔機器管理システム。

[13] 保存データが有効であるか無効であるかを選択するとともに、前記保存データを編集する選択編集手段を含む請求項11又は請求項12記載の遠隔機器管理システム。

[14] 電子機器から入力したデータを保存するデータ保存手段と、

前記電子機器から制御端末への通信を行なう際に、通信データの欠落があった場合に、

前記データ保存手段が保存する保存データを用いて通信データを再送するデータ再送手段とを含む

請求項1から請求項13のうちのいずれか1項に記載の遠隔機器管理システム。

[15] 制御端末からの入力データを保存する入力データ保存手段と、

前記制御端末から電子機器への通信を行なう際に、通信データの欠落があった場合に、

前記入力データ保存手段が保存する保存データを用いて通信データを再送するデータ再送手段とを含む

請求項1から請求項14のうちのいずれか1項に記載の遠隔機器管理システム。

[16] 電子機器を遠隔管理する遠隔機器管理方法であって、

前記電子機器の状況を示す機器状況情報を収集する機器状況収集ステップと、

前記電子機器と前記電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集ステップと、

収集した前記機器状況情報と前記通信状況情報とに基づいて、前記電子機器と前記制御端末との間の接続方法を決定する接続方法決定ステップと、

前記接続方法の決定結果に基づいて、前記電子機器と前記制御端末の間の接続方法を設定する接続方法設定ステップとを

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含むことを特徴とする遠隔機器管理方法。

[17] 電子機器と制御端末との間の接続方法を示す接続ルールを予め記憶する接続ルール記憶ステップを含み、

接続方法決定ステップで、記憶する前記接続ルールから、収集した機器状況情報と通信状況情報とに合致する接続方法を抽出する

請求項16記載の遠隔機器管理方法。

[18] 制御端末の状況を示す端末状況情報を収集する端末状況収集ステップを含み、

接続方法設定ステップで、機器状況情報及び通信状況情報に加えて、収集した前記端末状況情報に基づいて、電子機器と前記制御端末との間の接続方法を決定する

請求項16又は請求項17記載の遠隔機器管理方法。

[19] 電子機器を制御する電子機器制御ステップと、

ネットワークに接続された制御端末とデータを送受信するデータ送受信ステップと、

電子機器が入出力する制御データと制御端末が送受信するネットワーク通信データとの間でプロトコル変換を行なうプロトコル変換ステップと、

電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集ステップと、

ネットワーク通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、

機器状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、

機器状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、プロトコル変換方式及びネットワーク通信方式を設定する接続方法設定ステップとを

含むことを特徴とする遠隔機器管理方法。

[20] ネットワークに接続された電子機器と制御データを送受信する制御データ送受信ステップと、

制御端末とのインタフェースを実現するインタフェースステップと、

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電子機器が送受信するネットワーク制御データと制御端末が入出力する入出力インターフェースとの間でプロトコル変換を行なうプロトコル変換ステップと、

ネットワーク電子機器の種類、負荷、ネットワーク経路又は位置を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、

制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集ステップと、

端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、

端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、ネットワーク電子機器の通信制御方式、プロトコル変換方式及び端末インターフェース方式を設定する接続方法設定ステップとを

含むたことを特徴とする遠隔機器管理方法。

[21] 電子機器の通信アダプタが、前記電子機器を制御する電子機器制御ステップと、

前記電子機器の通信アダプタが、ネットワーク通信を行なう機器側通信ステップと、

前記電子機器の通信アダプタが、前記電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換ステップと、

前記電子機器の通信アダプタが、前記制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集ステップと、

前記電子機器の通信アダプタが、前記電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集ステップと、

前記電子機器の通信アダプタが、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、

前記電子機器の通信アダプタが、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、

前記電子機器の通信アダプタが、機器状況、端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定ステップと、

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前記制御端末の通信アダプタが、前記制御端末とのインタフェースを実現するインタフェースステップと、

前記制御端末の通信アダプタが、ネットワーク通信を行なう制御側通信ステップと、

前記制御端末の通信アダプタが、前記制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換ステップとを含むことを特徴とする遠隔機器管理方法。

[22] 電子機器の通信アダプタが、前記電子機器を制御する電子機器制御ステップと、

前記電子機器の通信アダプタが、ネットワーク通信を行なう機器側通信ステップと、

前記電子機器の通信アダプタが、前記電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換ステップと、

制御端末の通信アダプタが、前記制御端末とのインタフェースを実現するインタフェースステップと、

前記制御端末の通信アダプタが、ネットワーク通信を行なう制御側通信ステップと、

前記制御端末の通信アダプタが、前記制御端末の入出力インターフェースとネットワー

ク通信との間でプロトコル変換を行なう制御側プロトコル変換ステップと、

前記制御端末の通信アダプタが、前記制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を収集する端末状況収集ステップと、

前記制御端末の通信アダプタが、前記電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を収集する機器状況収集ステップと、

前記制御端末の通信アダプタが、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、

前記制御端末の通信アダプタが、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、

前記制御端末の通信アダプタが、機器状況、端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を設定する接続方法設定ステップとを含む

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ことを特徴とする遠隔機器管理方法。

[23] 電子機器の通信アダプタが、前記電子機器を制御する電子機器制御ステップと、

前記電子機器の通信アダプタが、ネットワーク通信を行なう機器側通信ステップと、

前記電子機器の通信アダプタが、前記電子機器が送受信する制御データとネットワーク通信との間でプロトコル変換を行なう機器側プロトコル変換ステップと、

制御端末の通信アダプタが、前記制御端末とのインタフェースを実現するインタフェースステップと、

前記制御端末の通信アダプタが、ネットワーク通信を行なう制御側通信ステップと、

前記制御端末の通信アダプタが、前記制御端末の入出力インターフェースとネットワーク通信との間でプロトコル変換を行なう制御側プロトコル変換ステップと、

ネットワーク上を介して制御を行なうプログラムモジュールが、前記制御端末の種類、負荷又は位置を含む端末状況を示す端末状況情報を、ネットワークを介して収集する端末状況収集ステップと、

前記プログラムモジュールが、前記電子機器の種類、負荷又は位置を含む機器状況を示す機器状況情報を、ネットワークを介して収集する機器状況収集ステップと、

前記プログラムモジュールが、通信の種類、経路又は負荷を含む通信状況を示す通信状況情報を収集する通信状況収集ステップと、

前記プログラムモジュールが、機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを保持する接続ルール保持ステップと、

前記プログラムモジュールが、機器状況、端末状況及び通信状況と前記接続ルールとを照合して適切な接続方法を抽出し、電子機器の制御方式、端末インターフェース方式、ネットワーク通信方式及びプロトコル変換方式を、ネットワークを介して設定する接続方法設定ステップとを含む

ことを特徴とする遠隔機器管理方法。

[24] 機器状況、端末状況及び通信状況に合致した通信接続方法を示す接続ルールを表示するルール表示ステップと、

ユーザ操作に従って、前記接続ルールを編集するルール編集ステップとを含む

請求項16から請求項23のうちのいずれか1項に記載の遠隔機器管理方法。

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[25] 収集した端末状況、機器状況又は通信状況と、前記機器状況、前記端末状況又は前記通信状況に合致した通信接続方法を示す接続ルールとを照合して特定した接続方法の候補を表示する候補表示ステップと、

ユーザ操作に従って、表示した候補から接続方法を選択する接続方法選択ステップとを含む

請求項16から請求項24のうちのいずれか1項に記載の遠隔機器管理方法。

[26] 電子機器から入力したデータを保存するデータ保存ステップと、

制御端末からの制御要求に対して、保存するデータを用いて、前記電子機器と前記制御端末とを非同期で動作させる動作制御ステップとを含む

請求項16から請求項25のうちのいずれか1項に記載の遠隔機器管理方法。

[27] 制御端末からの入力データを保存する入力データ保存ステップと、

電子機器からの入力要求に対して、保存するデータを用いて、前記電子機器と前記制御端末とを非同期で動作させることを可能とする動作制御ステップとを含む

請求項16から請求項26のうちのいずれか1項に記載の遠隔機器管理方法。

[28] 保存データが有効であるか無効であるかを選択するとともに、前記保存データを編集する選択編集ステップを含む請求項16又は請求項27記載の遠隔機器管理方法。

[29] 電子機器から入力したデータを保存するデータ保存ステップと、

前記電子機器から制御端末への通信を行なう際に、通信データの欠落があった場合に、保存する保存データを用いて通信データを再送するデータ再送ステップとを含む

請求項16から請求項28のうちのいずれか1項に記載の遠隔機器管理方法。

[30] 制御端末からの入力データを保存する入力データ保存ステップと、

前記制御端末から電子機器への通信を行なう際に、通信データの欠落があった場合に、保存する保存データを用いて通信データを再送するデータ再送ステップとを含む

請求項16から請求項29のうちのいずれか1項に記載の遠隔機器管理方法。

[31] 電子機器を遠隔管理するための遠隔機器管理用プログラムであって、

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コンピュータに、

前記電子機器の状況を示す機器状況情報を収集する機器状況収集処理と、

前記電子機器と前記電子機器を制御する制御端末との間の通信状況を示す通信状況情報を収集する通信状況収集処理と、

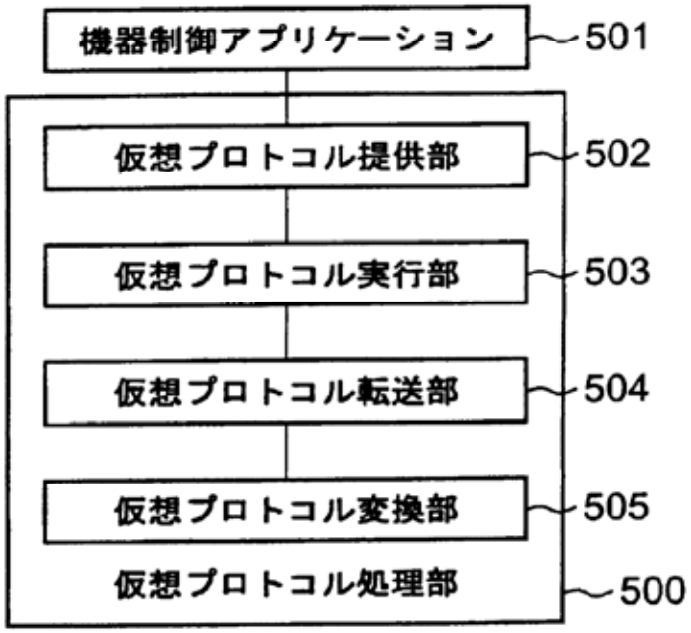
収集した前記機器状況情報と前記通信状況情報とに基づいて、前記電子機器と前記制御端末との間の接続方法を決定する接続方法決定処理と、

前記接続方法の決定結果に基づいて、前記電子機器と前記制御端末の間の接続方法を設定する接続方法設定処理とを

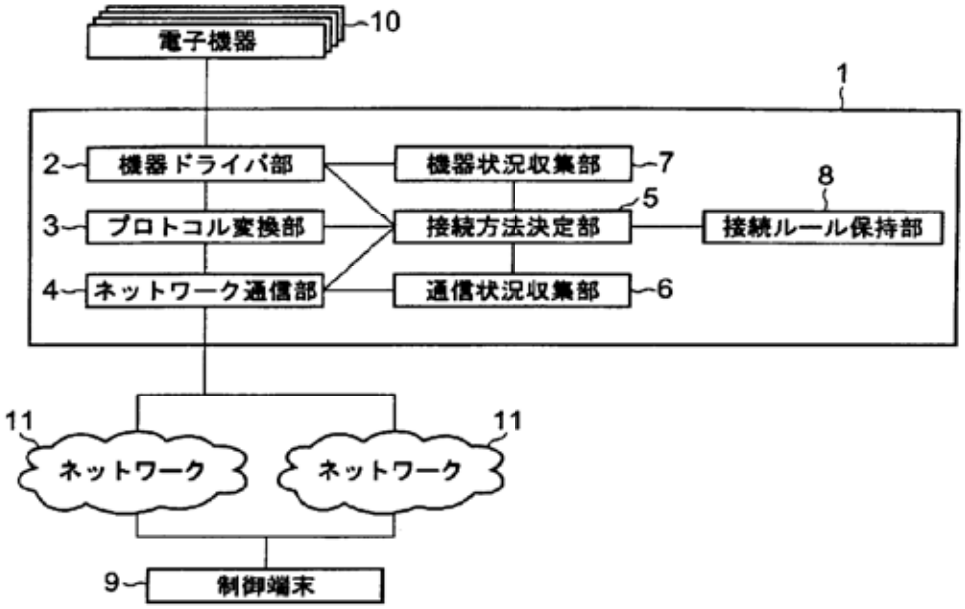
実行させるための遠隔機器管理プログラム。

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[図1]

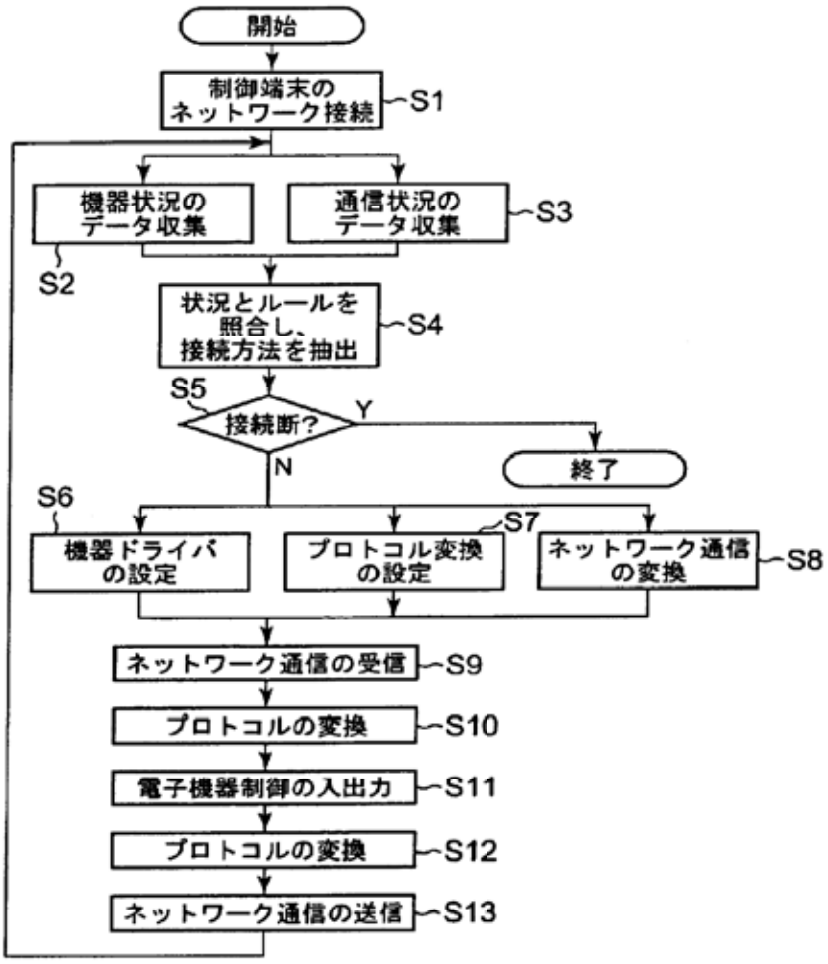


[図2]



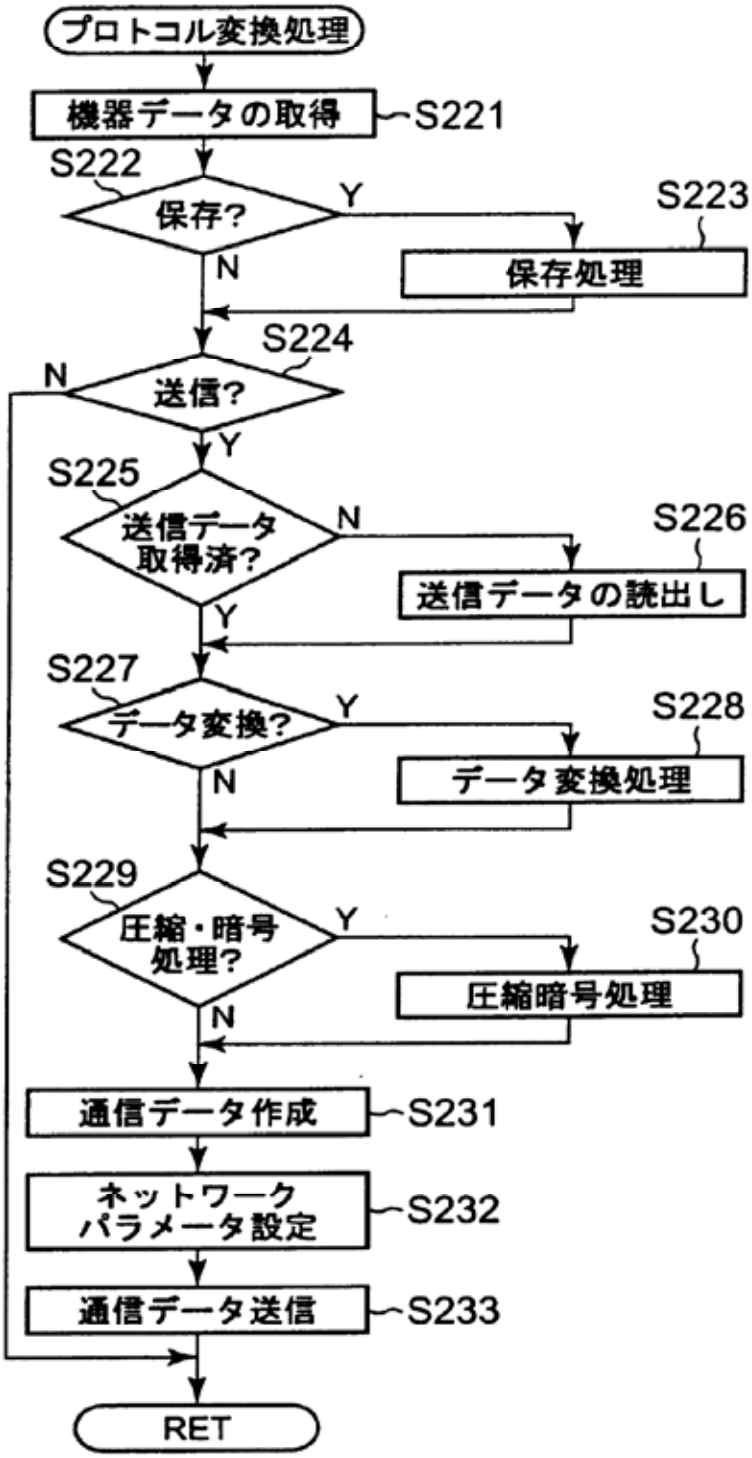
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[図3]



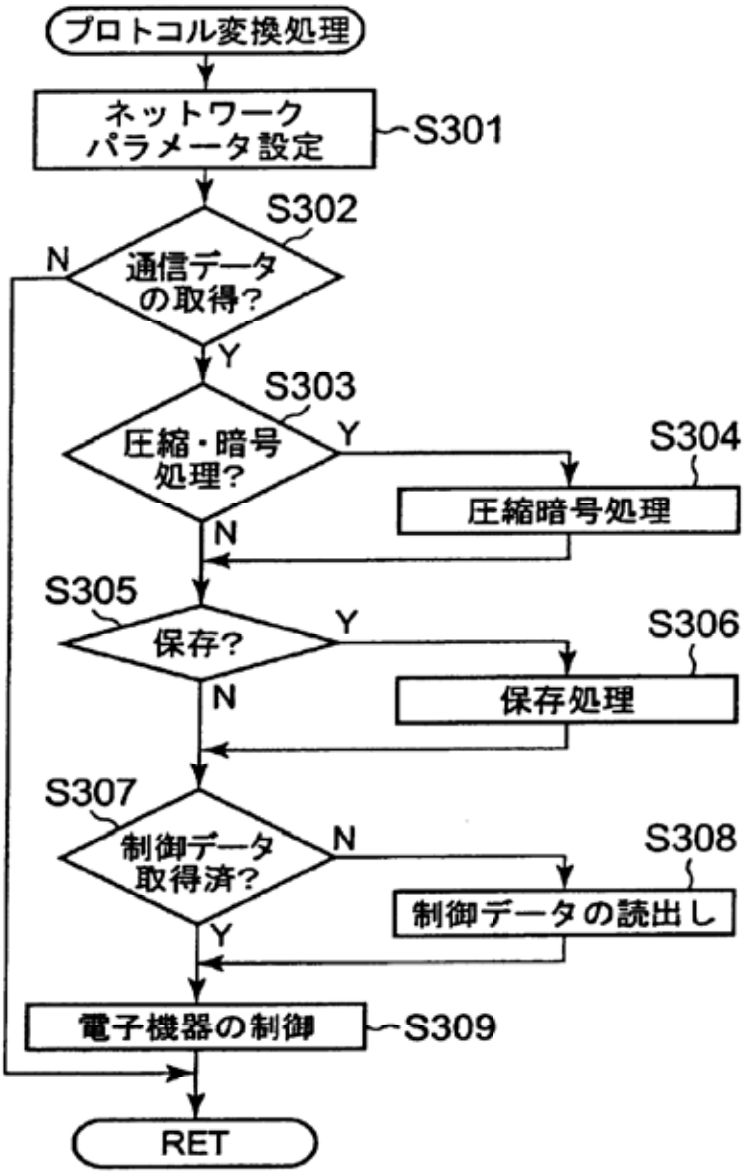
Charter Communications, Inc.
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[図4]

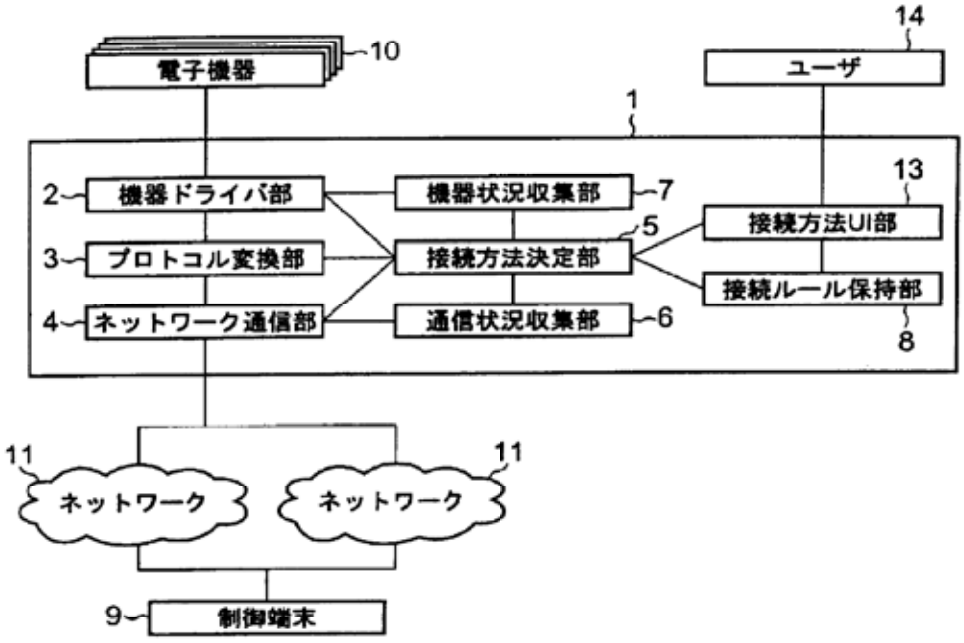


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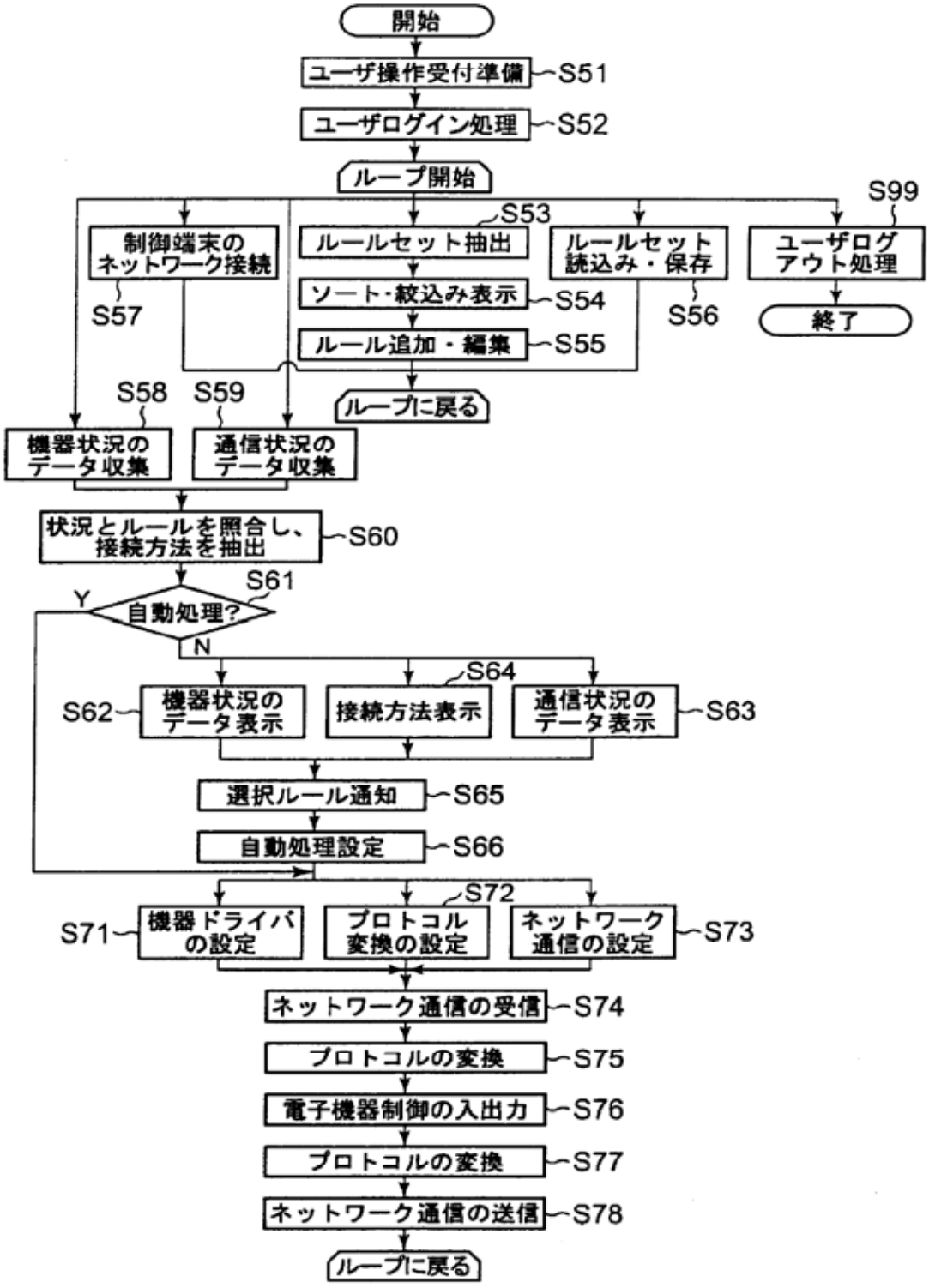
[図5]


プロトコル変換処理
ネットワーク
パラメータ設定
S301
S302
通信データ
の取得?
N
Y
S303
圧縮・暗号
処理?
Y
S304
圧縮暗号処理
N
S305
保存?
Y
S306
保存処理
N
S307
制御データ
取得済?
N
S308
制御データの読出し
Y
電子機器の制御
S309
RET

[図6]

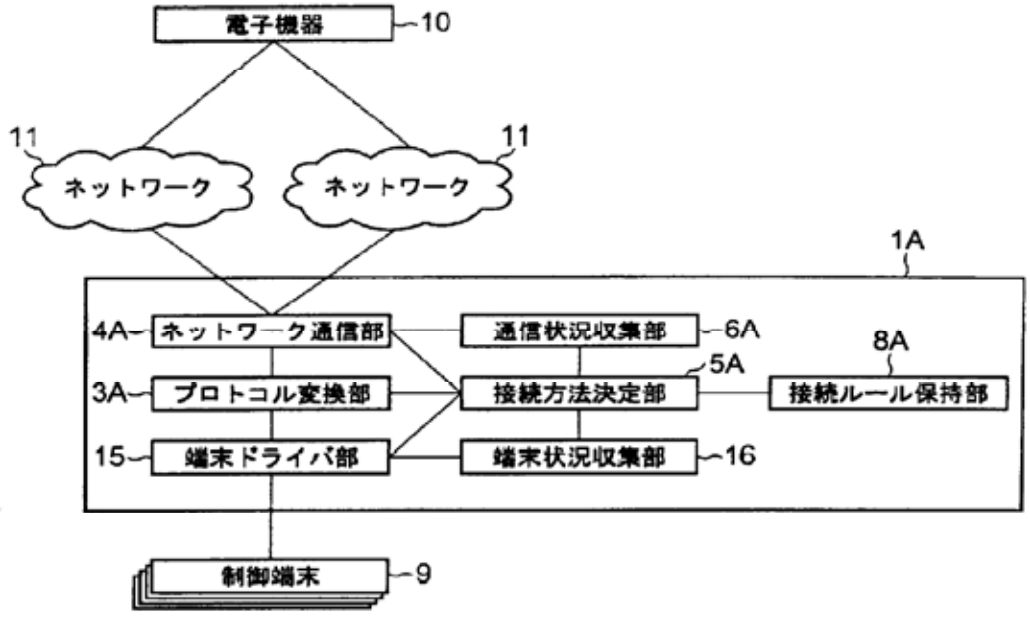

14
ユーザ
10
電子機器
1
13
2
機器ドライバ部
機器状況収集部
7
接続方法UI部
5
3
プロトコル変換部
接続方法決定部
接続ルール保持部
4
ネットワーク通信部
通信状況収集部
6
8
11
11
ネットワーク
ネットワーク
9
制御端末

[図7]

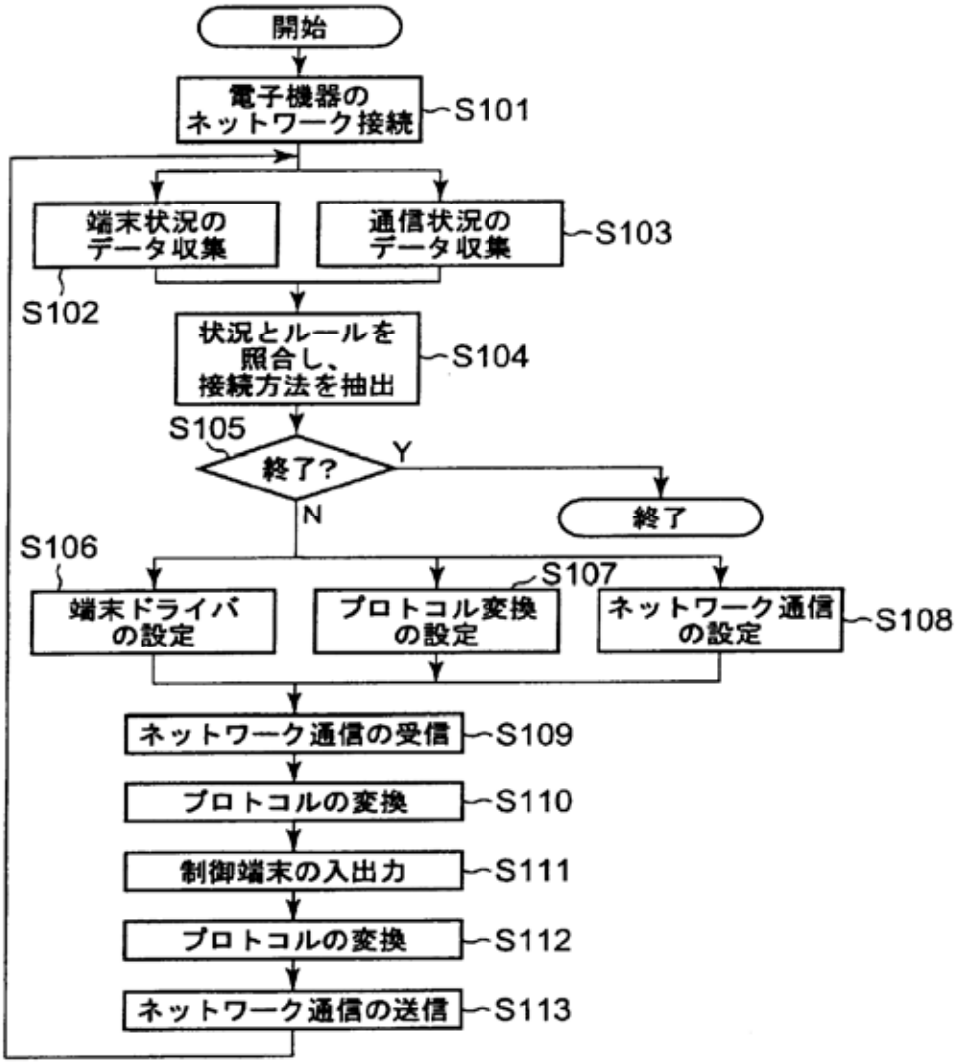


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[図8]

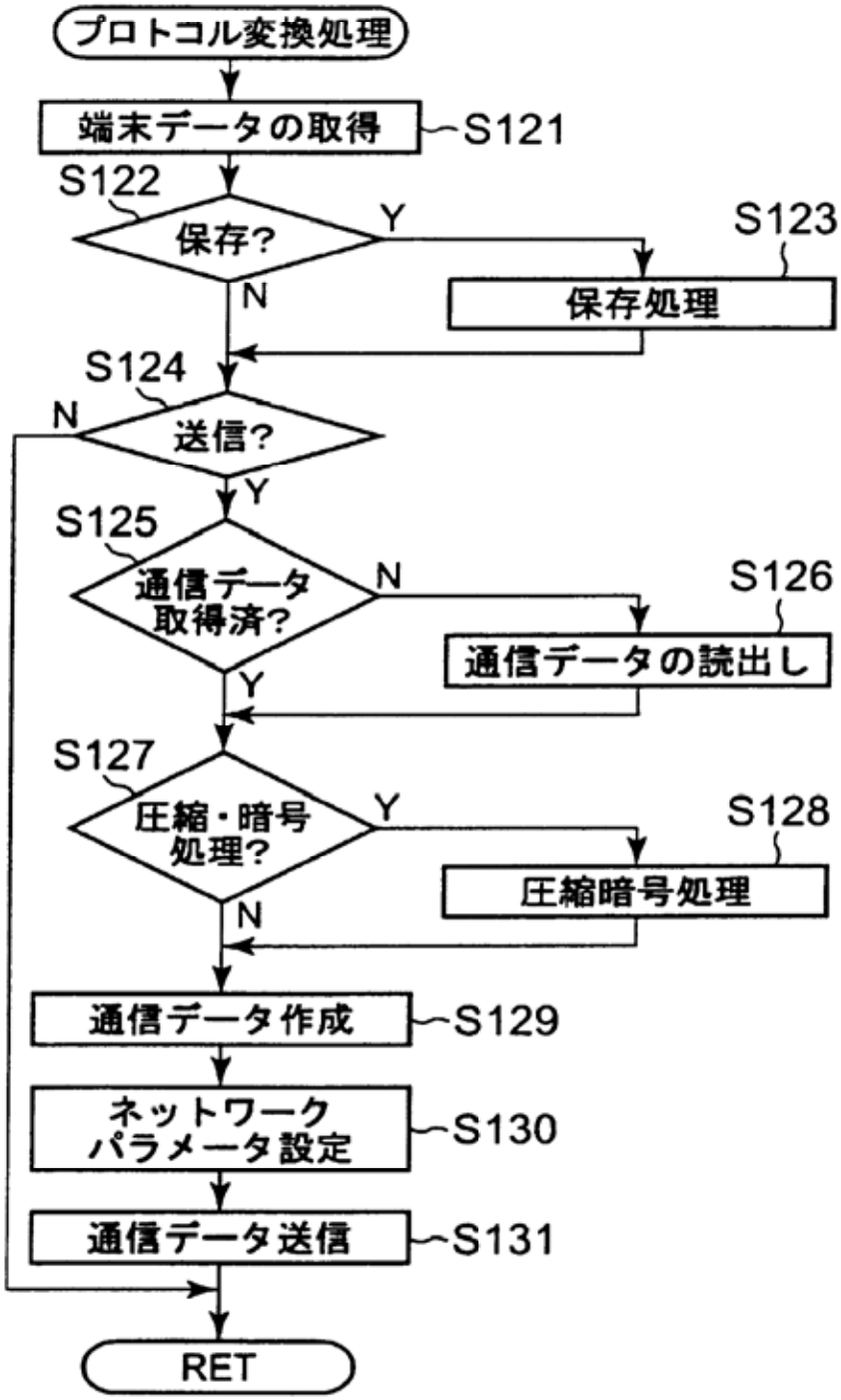

電子機器
10
11
ネットワーク
11
ネットワーク
1A
4A
ネットワーク通信部
通信状況収集部
6A
8A
5A
3A
プロトコル変換部
接続方法決定部
接続ルール保持部
15
端末ドライバ部
端末状況収集部
16
制御端末
9

[図9]



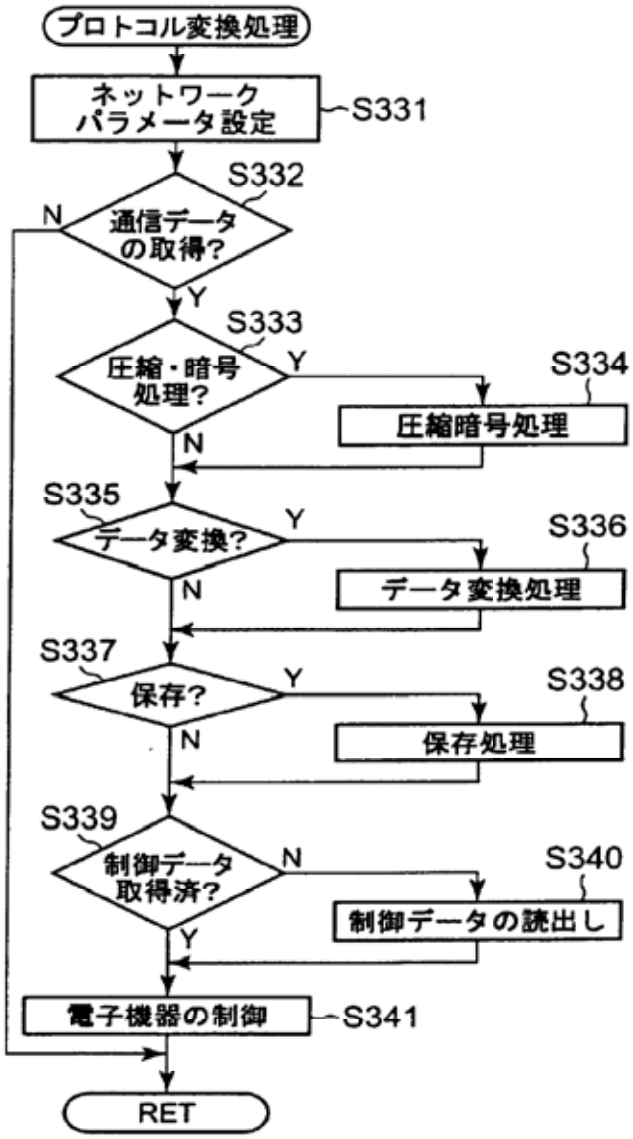
Charter Communications, Inc.
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[図10]



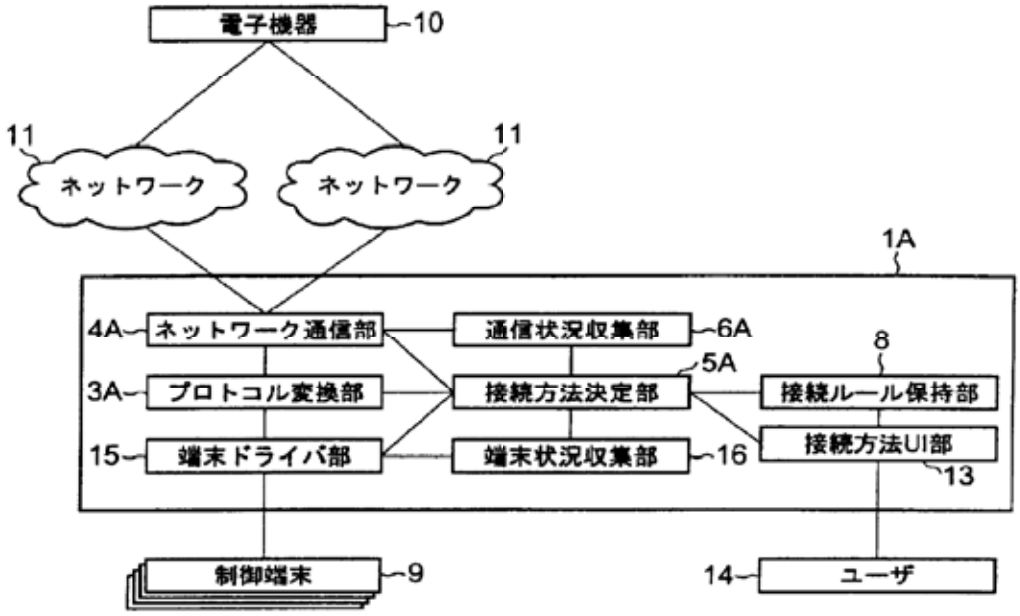
Charter Communications, Inc.
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Page #1836

[図11]



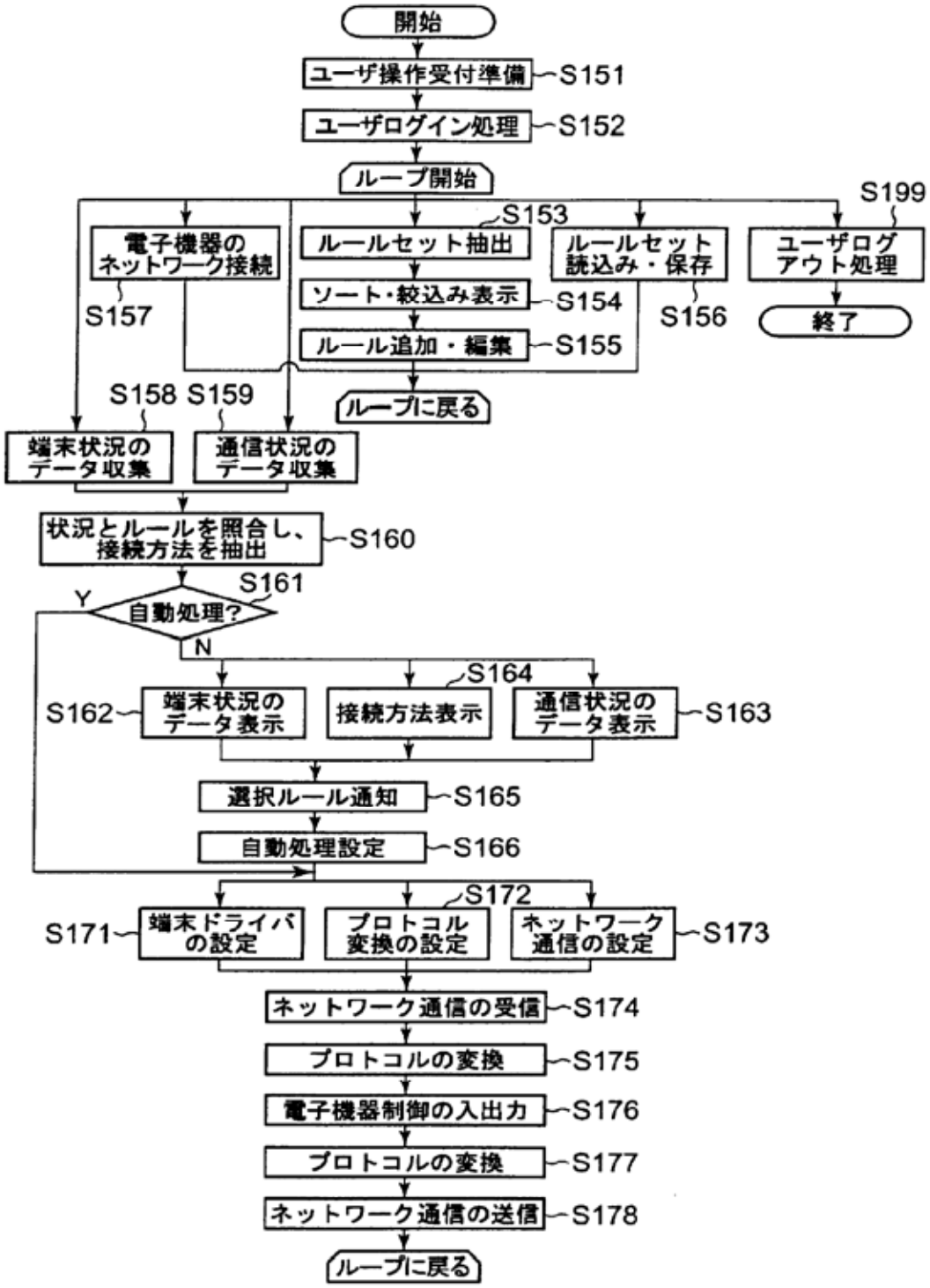
Charter Communications, Inc.
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[図12]



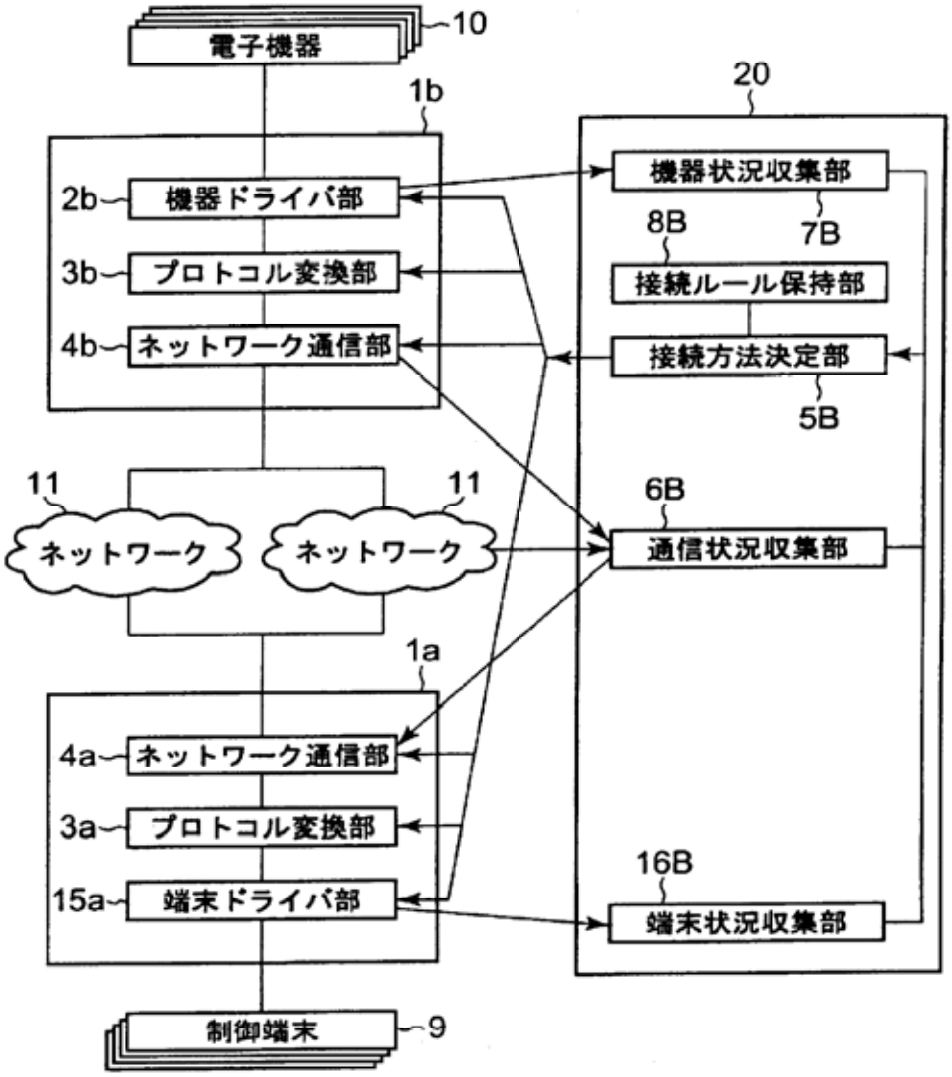
Charter Communications, Inc.
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Page #1838

[図13]



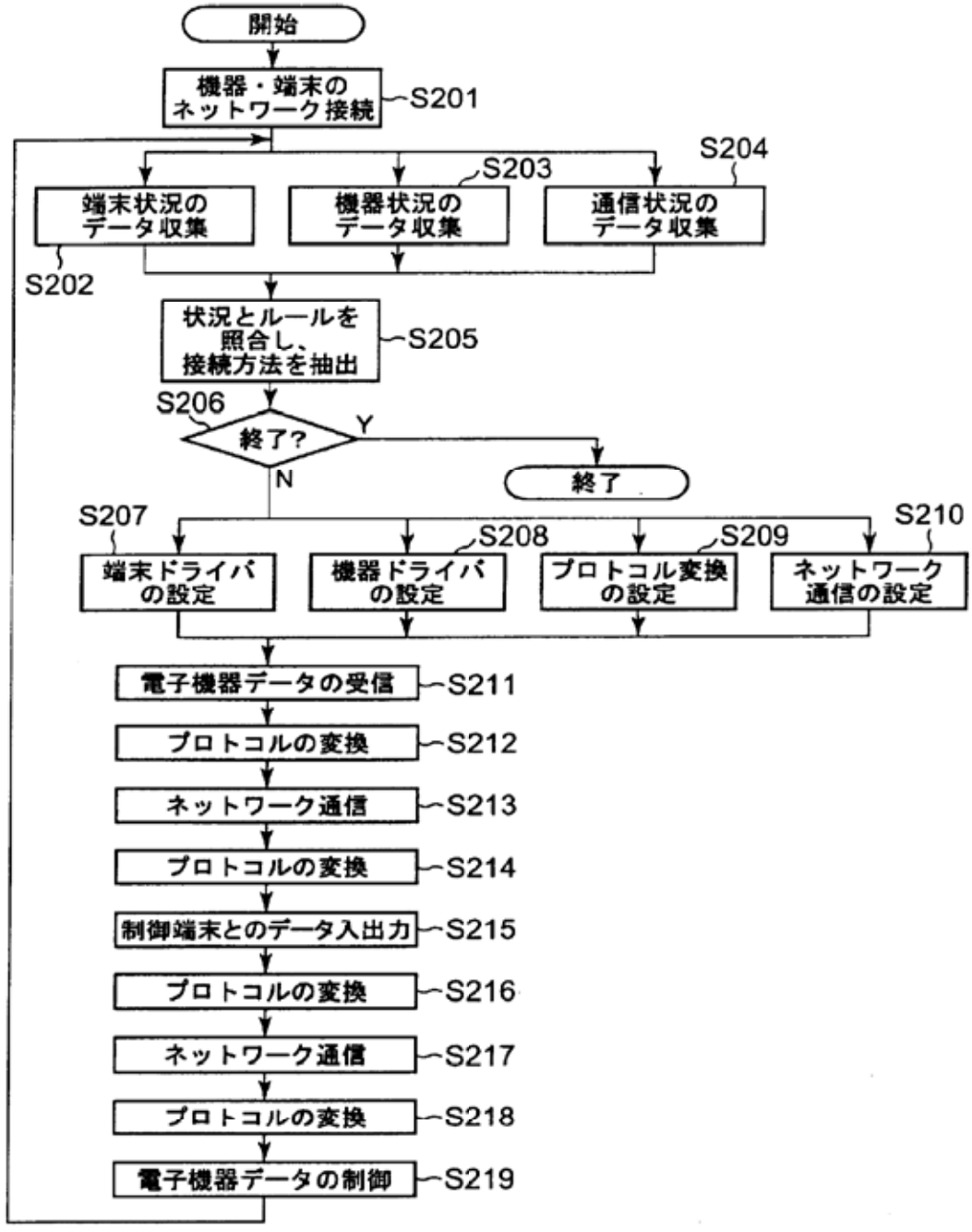
Charter Communications, Inc.
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[図14]



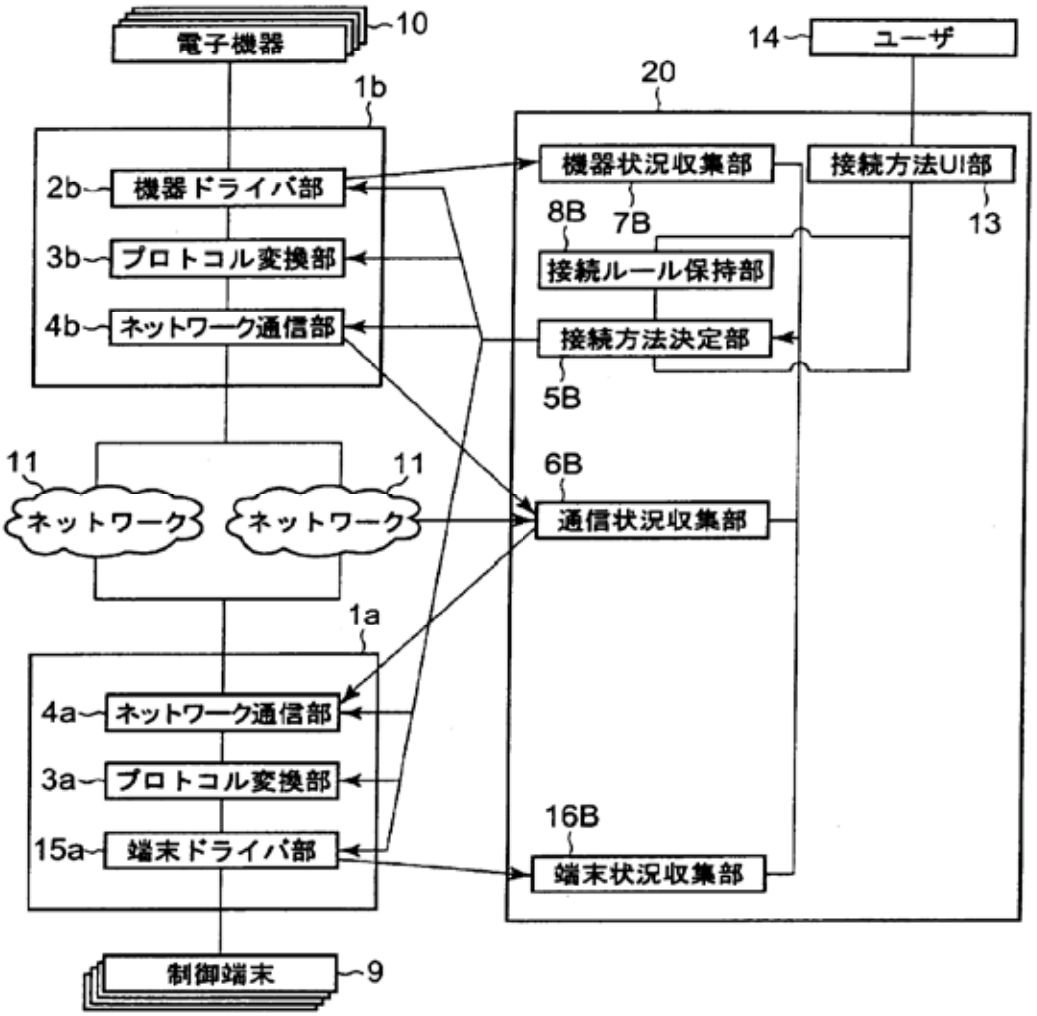
Charter Communications, Inc.
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[図15]



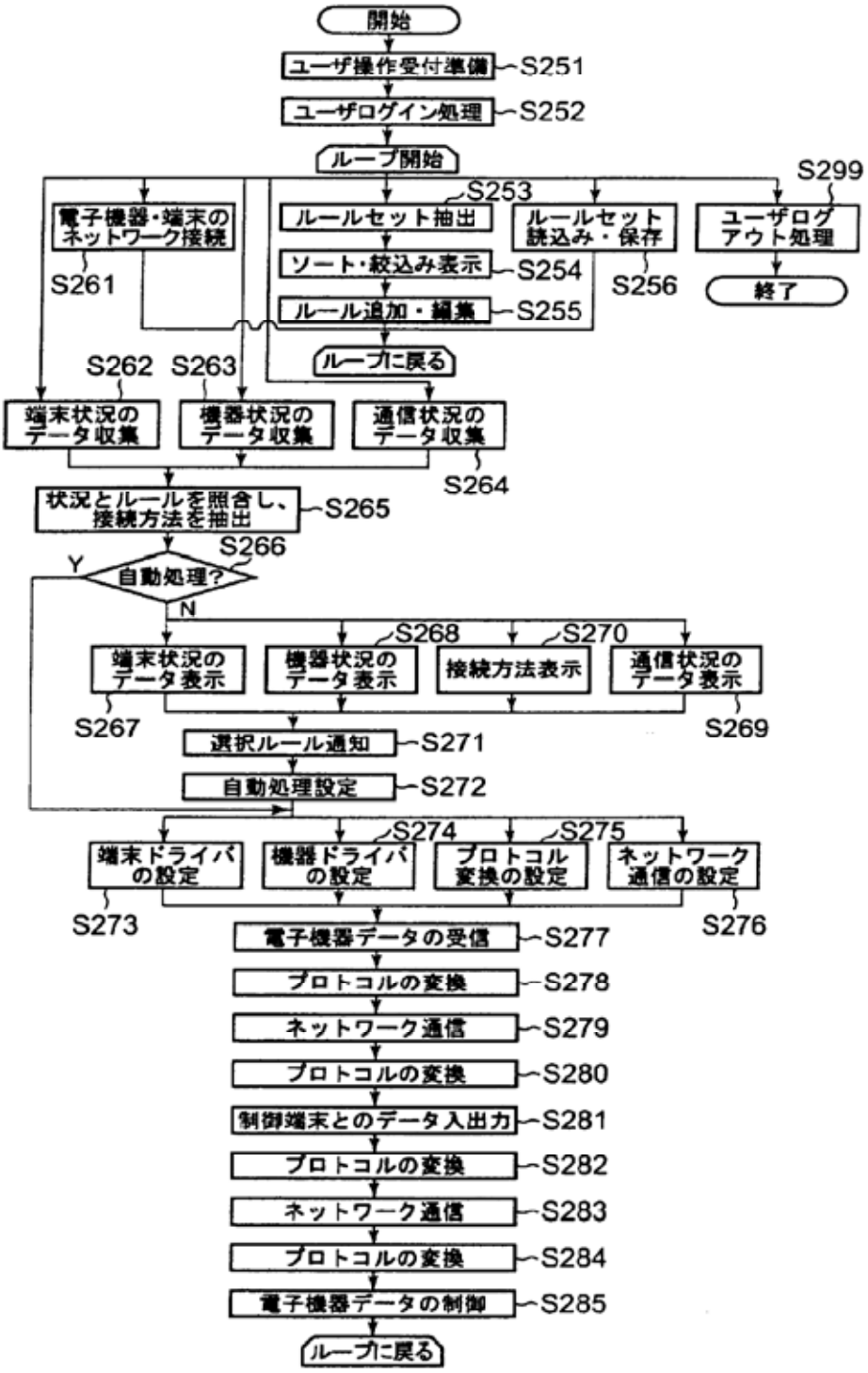
Charter Communications, Inc.
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[図16]



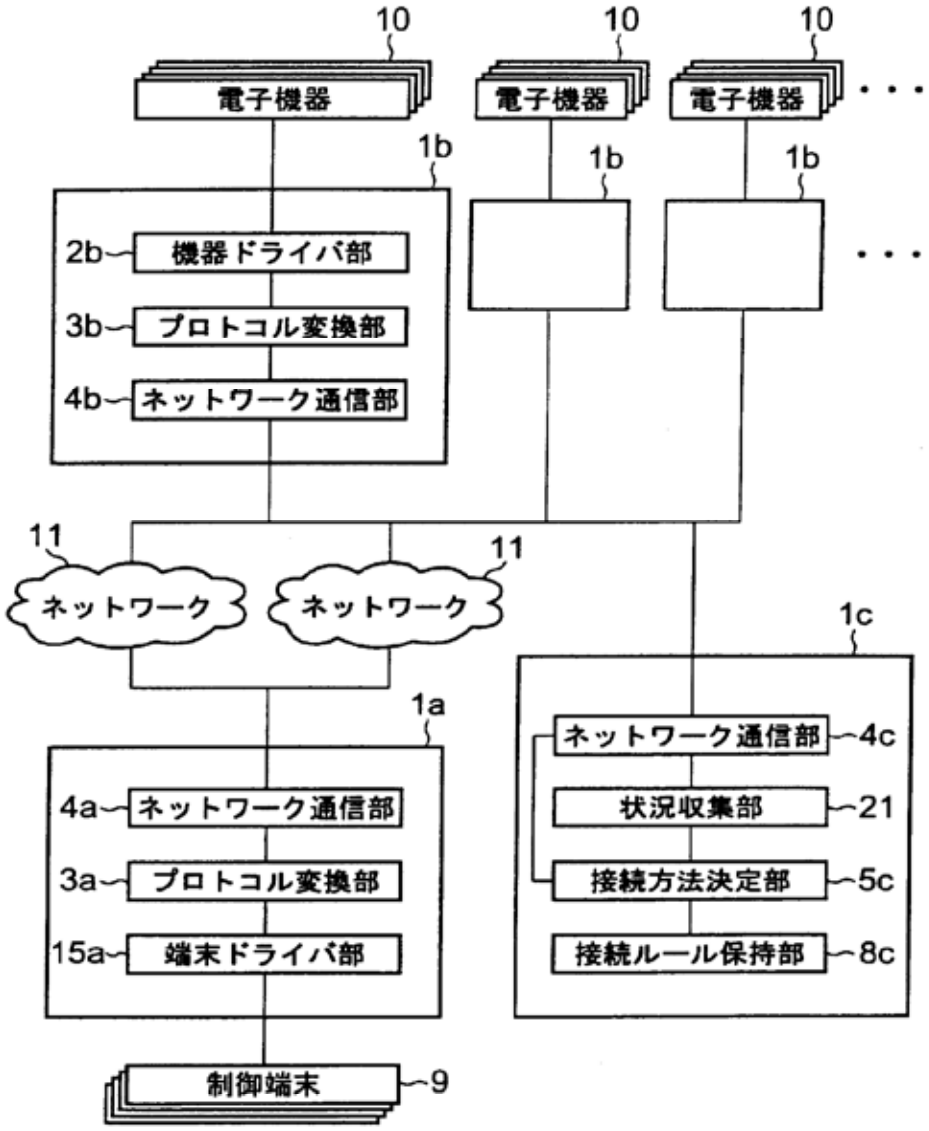
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[図17]

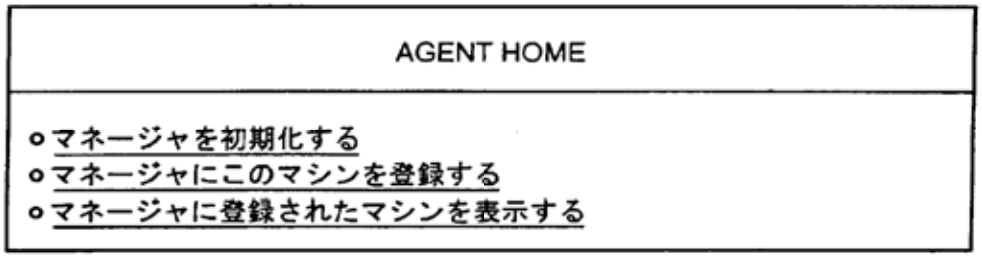


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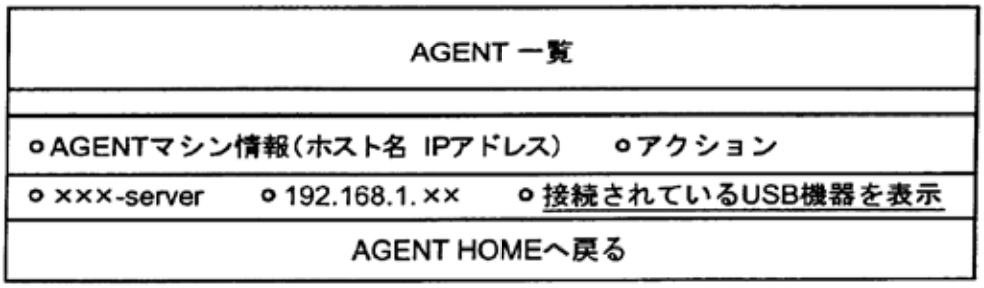
[図18]


10
10
10
電子機器
電子機器
電子機器
1b
1b
1b
2b
機器ドライバ部
3b
プロトコル変換部
4b
ネットワーク通信部
11
11
ネットワーク
ネットワーク
1c
1a
ネットワーク通信部
4c
状況収集部
21
接続方法決定部
5c
接続ルール保持部
8c
4a
ネットワーク通信部
3a
プロトコル変換部
15a
端末ドライバ部
制御端末
9

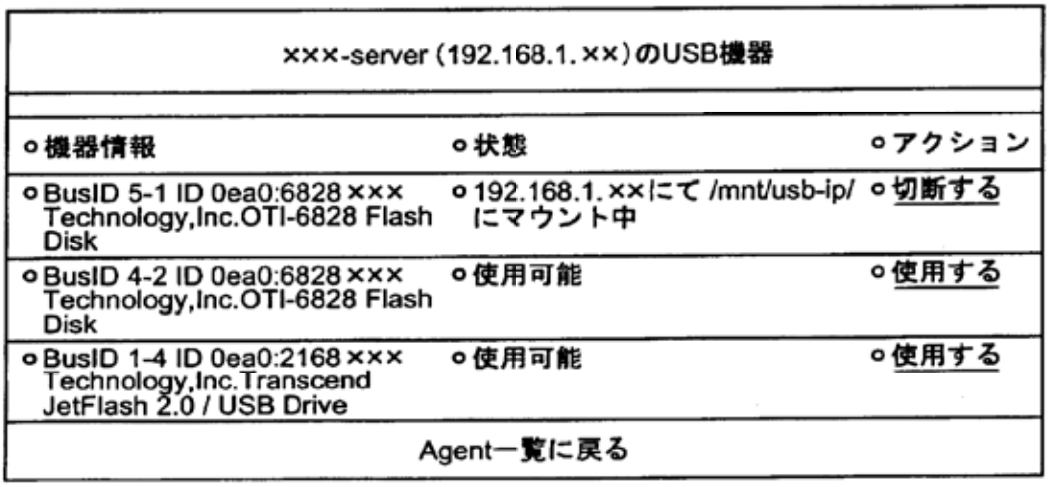
[図19]


AGENT HOME
マネージャを初期化する
マネージャにこのマシンを登録する
マネージャに登録されたマシンを表示する

[図20]



[図21]



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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/073809

A. CLASSIFICATION OF SUBJECT MATTER
G06F13/00(2006.01)i, *H04Q9/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F13/00, H04Q9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2008
Kokai Jitsuyo Shinan Koho	1971-2008	Toroku Jitsuyo Shinan Koho	1994-2008

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2003-169056 A (Murata Machinery Ltd.), 13 June, 2003 (13.06.03), Par. No. [0040]; Fig. 2 (Family: none)	4-15,19-30
A	JP 2000-013435 A (NEC Corp.), 14 January, 2000 (14.01.00), Abstract & US 2003/0105802 A1	4-15,19-30
A	JP 2001-290720 A (Fujitsu Ltd.), 19 October, 2001 (19.10.01), Par. No. [0012] & US 2001/0011010 A1	4-15,19-30

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
04 March, 2008 (04.03.08)	11 March, 2008 (11.03.08)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

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Page #1846

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/073809

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-136742 A (Fujitsu Ltd.), 26 May, 2005 (26.05.05), Abstract; Par. No. [0005] & US 2005/0094563 A1	4-15,19-30
A	JP 2005-142735 A (Fujitsu Ltd.), 02 June, 2005 (02.06.05), Par. No. [0013] & US 2004/0223184 A1	4-15,19-30
A	JP 2004-120609 A (Mitsubishi Electric Corp.), 15 April, 2004 (15.04.04), Abstract (Family: none)	4-15,19-30

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2007/073809

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 1-3, 16-18 and 31
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
See the extra sheet.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

the

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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Continuation of Box No.II-2 of continuation of first sheet(2)

Each claim of the present application describes that a connecting method is set on the basis of instrument state information and communication state information.

The term of the connecting method, however, has extremely ambiguous meanings. Thus, since the description of the simple setting of a connecting method includes extremely ambiguous structures of the setting of a communication protocol used at connection, the setting of a communication parameter for connection, and the like, the structure of the invention cannot be specified.

Further, there are a few ambiguous indefinite aspects as to instrument state information and communication state information that are criteria for the setting of a connecting method.

That is, according to a paragraph 0067, as instrument state information, an identifier or a protocol of an electronic instrument, a connecting address, the maximum calculation processing amount, the present calculation processing amount, an available memory capacity, the present used memory capacity, the maximum I/O amount, the present I/O amount, the maximum number of connections, the present number of connections, a place of an electronic instrument, a communication delay, a packet loss rate, an owner, an owner group, access information and the like are exemplified.

Additionally, according to a paragraph 0068, as communication state information, an identifier or a protocol of a network, a connecting address, the present time or a connectable control terminal device, the maximum communication band, the present using band, a communication delay, a packet loss rate, access control information and the like are exemplified.

As instrument state information and communication state information, however, concretely, what connecting method is set in accordance with what information is used is little described in the detailed explanation of the invention. There are only few explanations in paragraphs 0256-0258.

First, in paragraphs 0256-0257, as a connecting method, the selection of a protocol (USB-IP, Echonet, UPnP, Havi, or the like) applicable to a control terminal device and an electronic instrument are described. Here, although it is unclear whether the protocol to which the control terminal device or the electronic instrument is applicable corresponds to instrument state information in the claims or communication state information, the selection is simply made in accordance with either one of them, and the setting of a connecting method based on both instrument state information in the claims or communication state information is not described.

(continue on the next page)

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Further, in paragraph 0258, if an electro-magnetic wave state of a wireless LAN is not stable and a network state is deteriorated, a buffer is made large but, reversely, if an electro-magnetic wave state of a wireless LAN is good, and its synchronization is deemed to be rather important, so that the buffer is made little. This electro-magnetic wave state is deemed to correspond to communication state information but no instrument state information is described.

Eventually, a lot of examples as to what information is used for the instrument state information and the communication state information are listed, but no example of a connecting method using both of them is described nor is it obvious for those skilled in the art.

Therefore, since the invention in each claim of the present application is ambiguous about the setting of a connecting method itself even in view of the detailed explanation of the invention and is difficult to specify the technical scope and, further, instrument state information and communication state information as criteria for the setting of a connecting method are not clear, the invention described in each claim of the present application as a whole is extremely indefinite.

In particular, in claims 1-3, 16-18 and 31, no definition of even either instrument state information or communication state information is described and their ambiguity is too significant to carry out a valid search.

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２００７／０７３８０９

Ａ．　発明の属する分野の分類（国際特許分類（ＩＰＣ））

Int.Cl.　G06F13/00(2006.01)i, H04Q9/00(2006.01)i

Ｂ．　調査を行った分野

調査を行った最小限資料（国際特許分類（ＩＰＣ））

Int.Cl.　G06F13/00, H04Q9/00

最小限資料以外の資料で調査を行った分野に含まれるもの

日本国実用新案公報	１９２２－１９９６年
日本国公開実用新案公報	１９７１－２００８年
日本国実用新案登録公報	１９９６－２００８年
日本国登録実用新案公報	１９９４－２００８年

国際調査で使用した電子データベース（データベースの名称、調査に使用した用語）

Ｃ．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
X	JP 2003-169056 A（村田機械株式会社）2003.06.13,　【００４０】、【図２】　（ファミリーなし）	4-15, 19-30
A	JP 2000-013435 A（日本電気株式会社）2000.01.14,　【要約】　& US 2003/0105802 A1	4-15, 19-30
A	JP 2001-290720 A（富士通株式会社）2001.10.19,　【００１２】　& US 2001/0011010 A1	4-15, 19-30

☑　Ｃ欄の続きにも文献が列挙されている。　　☐　パテントファミリーに関する別紙を参照。

＊　引用文献のカテゴリー
「Ａ」特に関連のある文献ではなく、一般的技術水準を示すもの
「Ｅ」国際出願日前の出願または特許であるが、国際出願日以後に公表されたもの
「Ｌ」優先権主張に疑義を提起する文献又は他の文献の発行日若しくは他の特別な理由を確立するために引用する文献（理由を付す）
「Ｏ」口頭による開示、使用、展示等に言及する文献
「Ｐ」国際出願日前で、かつ優先権の主張の基礎となる出願の日の後に公表された文献
「Ｔ」国際出願日又は優先日後に公表された文献であって出願と矛盾するものではなく、発明の原理又は理論の理解のために引用するもの
「Ｘ」特に関連のある文献であって、当該文献のみで発明の新規性又は進歩性がないと考えられるもの
「Ｙ」特に関連のある文献であって、当該文献と他の１以上の文献との、当業者にとって自明である組合せによって進歩性がないと考えられるもの
「＆」同一パテントファミリー文献

国際調査を完了した日 ０４．０３．２００８	国際調査報告の発送日 １１．０３．２００８
国際調査機関の名称及びあて先 日本国特許庁（ＩＳＡ／ＪＰ） 郵便番号１００－８９１５ 東京都千代田区霞が関三丁目４番３号	特許庁審査官（権限のある職員）　５Ｉ　３４５７ 石井　茂和 電話番号　０３－３５８１－１１０１　内線　３５６５

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Page #1851

Ｃ（続き）．　関連すると認められる文献

引用文献のカテゴリー＊	引用文献名　及び一部の箇所が関連するときは、その関連する箇所の表示	関連する請求の範囲の番号
A	JP 2005-136742 A（富士通株式会社）2005.05.26,　【要約】、【０００５】　& US 2005/0094563 A1	4-15, 19-30
A	JP 2005-142735 A（富士通株式会社）2005.06.02,　【００１３】　& US 2004/0223184 A1	4-15, 19-30
A	JP 2004-120609 A（三菱電機株式会社）2004.04.15,　【要約】　（ファミリーなし）	4-15, 19-30

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国際調査報告

国際出願番号　ＰＣＴ／ＪＰ２００７／０７３８０９

第Ⅱ欄　請求の範囲の一部の調査ができないときの意見（第１ページの２の続き）

法第8条第3項（ＰＣＴ17条(2)(a)）の規定により、この国際調査報告は次の理由により請求の範囲の一部について作成しなかった。

１．☐ 請求の範囲＿＿＿＿＿＿＿＿は、この国際調査機関が調査をすることを要しない対象に係るものである。
つまり、

２．☑ 請求の範囲 1-3,16-18,31＿＿＿＿＿＿は、有意義な国際調査をすることができる程度まで所定の要件を満たしていない国際出願の部分に係るものである。つまり、
特別ページ参照

３．☐ 請求の範囲＿＿＿＿＿＿＿＿は、従属請求の範囲であってＰＣＴ規則6.4(a)の第２文及び第3文の規定に従って記載されていない。

第Ⅲ欄　発明の単一性が欠如しているときの意見（第１ページの３の続き）

次に述べるようにこの国際出願に二以上の発明があるとこの国際調査機関は認めた。

１．☐ 出願人が必要な追加調査手数料をすべて期間内に納付したので、この国際調査報告は、すべての調査可能な請求の範囲について作成した。

２．☐ 追加調査手数料を要求するまでもなく、すべての調査可能な請求の範囲について調査することができたので、追加調査手数料の納付を求めなかった。

３．☐ 出願人が必要な追加調査手数料を一部のみしか期間内に納付しなかったので、この国際調査報告は、手数料の納付のあった次の請求の範囲のみについて作成した。

４．☐ 出願人が必要な追加調査手数料を期間内に納付しなかったので、この国際調査報告は、請求の範囲の最初に記載されている発明に係る次の請求の範囲について作成した。

追加調査手数料の異議の申立てに関する注意

☐ 追加調査手数料及び、該当する場合には、異議申立手数料の納付と共に、出願人から異議申立てがあった。

☐ 追加調査手数料の納付と共に出願人から異議申立てがあったが、異議申立手数料が納付命令書に示した期間内に支払われなかった。

☐ 追加調査手数料の納付はあったが、異議申立てはなかった。

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本願各請求項には、機器状況情報及び通信状況情報とに基づいて接続方法を設定することが記載されている。
しかしながら、接続方法という用語は極めて多義的な意味を有するものである。したがって、単に接続方法を設定するという記載のみでは、接続する通信回線を設定することや、接続の際に用いる通信プロトコルを設定することや、接続するための通信パラメータを設定することなどの、極めて多様な構成が含まれ、発明の構成が特定できない。

さらに、接続方法を設定するための基準となる機器状況情報と通信状況情報も曖昧で不明確な点が散見される。
すなわち、本願の００６７段落によると、機器状況情報として、電子機器の識別子やプロトコル、接続アドレス、最大計算処理量、現在の計算処理量、利用可能なメモリ量、現在の利用メモリ量、最大Ｉ／Ｏ量、現在のＩ／Ｏ量、最大接続数、現在の接続数、電子機器の位置、所有者、所有グループ、アクセス制御情報等が例示されている。
また、００６８段落によると、通信状況情報として、ネットワークの識別子やプロトコル、接続アドレス、現在時刻や接続可能な制御端末、最大通信帯域、現在の利用帯域、通信遅延、パケットロス率、アクセス制御情報等が例示されている。
しかしながら、機器状況情報や通信状況情報として具体的にどのような情報に基づいてどのような接続方法を設定するのかについて、発明の詳細な説明を見てもほとんど記載されておらず、０２５６～０２５８段落にわずかな説明があるのみである。
まず、０２５６～０２５７段落には、接続方法として制御端末と電子機器の対応可能なプロトコル（ＵＳＢ－ＩＰ、Ｅｃｈｏｎｅｔ、ＵＰｎＰ、Ｈａｖｉ等）を選択することが記載されている。ここで、制御端末や電子機器が利用できるプロトコルが、請求項の機器状況情報に対応するのか、通信状況情報に対応するのかは不明であるが、いずれにせよ、どちらか一方に基づいて選択しているにすぎず、機器状況情報と通信状況情報の両方の情報に基づいて、接続方法を設定することについては記載されていない。
また、０２５８段落には、無線ＬＡＮの電波状況が不安定で劣悪なネットワーク状況であればバッファを大きくし、逆に、良好であれば同期性を重視して、バッファを少なくすることが記載されている。この電波状況は請求項における通信状況情報に対応するものであると解されるが、機器状況情報を利用することについては記載されていない。
結局、本願の発明の詳細には、機器状況情報と通信状況情報のそれぞれについては、どのような情報を用いるか数多く列挙されているものの、機器状況情報と通信状況情報の両者を用いて接続方法を選択する例については何ら記載されていないし、当業者にとって自明であるともいえない。

したがって、本願各請求項に係る発明は、発明の詳細な説明を参酌しても、接続方法の設定自体が曖昧で技術的範囲の特定が困難であるのに加えて、接続方法の設定のための判断基準となる機器状況情報と通信状況情報についても不明確であるから、本願各請求項に記載された発明は全体として極めて不明確である。
特に、請求の範囲１～３，１６～１８，３１においては、機器状況情報や通信状況情報の定義すら記載されておらず、不明確さが著しいため、有効な調査が行えない。

Charter Communications, Inc.
Exhibit 1006
Page #1854

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application No.	14/356,581
Filing Date	May 6, 2014
First Inventor	Wonjong RHEE
Art Unit	2447
Examiner Name	Hwang, Joon H.
Attorney Docket No.	8241P054 Conf. No. 4319

DUTY OF DISCLOSURE STATEMENT

In accordance with the duty of disclosure, enclosed is a copy of an Information Disclosure Statement (IDS) Citation Form PTO/SB/08 or PTO-1449, together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed). This IDS and IDS Citation Form are being submitted before the mailing of a first Office Action on the merits. It is respectfully requested that the cited references be considered and that the enclosed copy of PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

The submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made in the subject application and is not to be construed as an admission that the information cited in this statement is material to patentability.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

OR

☒ None

☐ The IDS Filing Fee in the amount of $180.00 as set forth in 37 CFR 1.17(p) has been submitted herewith.

☒ It is requested that any requisite fees be debited from Deposit Account 02-2666.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of signature.

Signature	/Gregory D. Caldwell/	Date (MM-DD-YYYY)	07-23-2015
Name/Print	Gregory D. Caldwell	Registration Number	39,926

I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Lisa Bennett/

Lisa Bennett *Date* *07-23-15*

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
14/356,581	05/06/2014	Wonjong Rhee	8241P054

CONFIRMATION NO. 4319

8791
BLAKELY SOKOLOFF TAYLOR & ZAFMAN
1279 Oakmead Parkway
Sunnyvale, CA 94085-4040

PUBLICATION NOTICE

OC00000071267898

Title:METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

Publication No.US-2014-0304408-A1
Publication Date:10/09/2014

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

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Substitute for form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet 1 of 1

Complete if Known

Application Number	14/356,581
Filing Date	May 6, 2014
First Named Inventor	Wonjong Rhee
Group Art Unit	2447
Examiner Name	
Attorney Docket No:	8241P054

US PATENT DOCUMENTS					
Examiner Initial *	Cite No [1]	USP Document Number	Publication or Issue Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No [1]	Foreign Patent Document Country Code/Number/Kind Code (If known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T [2]

OTHER DOCUMENTS -- NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	Cite No [1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T [2]
		International Preliminary Report on Patentability for International Patent Application No. PCT/US2011/060265 (Attorney Docket No. 8241P054PCT), mailed 5/22/2014, 12 pages.	

EXAMINER **DATE CONSIDERED**

Based on PTO/SB/08A(09-06) - Substitute Disclosure Statement Form (PTO-1449) as modified by BGTZ 03/26/07

[1] EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [2] Applicant's unique citation designation number (optional). [3] Applicant is to place a check mark here if English language Translation is attached.

PATENT COOPERATION TREATY

ADVANCE E-MAIL

PCT

From the INTERNATIONAL BUREAU

NOTIFICATION CONCERNING TRANSMITTAL OF COPY OF INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY (CHAPTER I OF THE PATENT COOPERATION TREATY)
(PCT Rule 44bis.1(c))

To:

ASSIA
8241P054PCT
GOC-BV

VINCENT, Lester, J.
Blakely, Sokoloff, Taylor & Zafman LLP
1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
ETATS-UNIS D'AMERIQUE

Date of mailing *(day/month/year)* 22 May 2014 (22.05.2014)	
Applicant's or agent's file reference 8241P054PCT	IMPORTANT NOTICE
International application No. PCT/US2011/060265	International filing date *(day/month/year)* 10 November 2011 (10.11.2011)
Priority date *(day/month/year)*	
Applicant ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC. et al	

The International Bureau transmits herewith a copy of the International preliminary report on patentability (Chapter I of the Patent Cooperation Treaty)

RECEIVED
MAY 23 2014
BLAKELY SOKOLOFF TAYLOR ZAFMAN
SUNNYVALE

RECEIVED
MAY 23 2014
FIP DEPT.

Entered into FIP
By: 2

RECEIVED
MAY 27 2014
BEAVERTON

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Simin Baharlou
Facsimile No. +41 22 338 82 70	e-mail: pt09.pct@wipo.int

Form PCT/IB/326 (January 2004)

Reported by agp 5/30/14
Entered refs 5/30/14 (agp)

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference 8241P054PCT	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2011/060265	International filing date *(day/month/year)* 10 November 2011 (10.11.2011)	Priority date *(day/month/year)*
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC.		

1. This International preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 11 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☒	Box No. VIII	Certain observations on the international application

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 13 May 2014 (13.05.2014)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Simin Baharlou e-mail: pt09.pct@wipo.int

Form PCT/IB/373 (January 2004)

Charter Communications, Inc.
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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)* see form PCT/ISA/210 (second sheet)	
Applicant's or agent's file reference see form PCT/ISA/220	**FOR FURTHER ACTION** See paragraph 2 below
International application No. PCT/US2011/060265	International filing date *(day/month/year)* 10.11.2011
Priority date *(day/month/year)*	
International Patent Classification (IPC) or both national classification and IPC INV. H04L1/00 H04L1/20	
Applicant ASSIA, INC.	

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Meister, Mark Telephone No. +49 89 2399-0

Form PCT/ISA/237 (Cover Sheet) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2011/060265

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

   ☐ on paper

   ☐ in electronic form

   b. (time)

   ☐ in the international application as filed

   ☐ together with the international application in electronic form

   ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	6, 7, 15, 22-24, 28, 40, 41, 49, 50
	No:	Claims	1-5, 8-14, 16-21, 25-27, 29-39, 42-48, 51, 52
Inventive step (IS)	Yes:	Claims	6, 15, 22, 28, 40, 49
	No:	Claims	1-5, 7-14, 16-21, 23-27, 29-39, 41-48, 50-52
Industrial applicability (IA)	Yes:	Claims	1-52
	No:	Claims	

2. Citations and explanations

see separate sheet

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 WO 2007/136337 A2 (ERICSSON TELEFON AB L M [SE]) 29 November 2007 (2007-11-29)

D2 US 7 840 220 B1 (MITCHELL JAMES P [US]) 23 November 2010 (2010-11-23)

2 The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of the independent claims is not new. Reasons follow.

2.1 D1 discloses (the references in parenthesis applying to this document):

A method for optimizing performance (page 2, lines 7-9 and 19-24: according to the method of D1, CQI for link adaptation is generated as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable. This way the performance of the communication unit(s) is optimized) of one or more communication units (page 5, lines 7-18, page 7, lines 9-12, page 16, lines 26-28, figure 1, reference sign 12) by a remote server (page 5, lines 23-25, page 7, lines 9-12, figure 1, reference sign 10: the base station 10 can be seen as a remote server), the method comprising:
collecting data from the one or more communication units (according to D1, different types of data concerning the wireless communication devices can be collected by the base station: information on fast/slow fading, page 4, lines 31-35, page 16, lines 21-23, claim 39, relative motion with respect to the base station, page 6, lines 17-21, identification number of the devices, page 7, lines 28-30, location of the devices, page 6, lines 20-22);
generating a policy, for each of the one or more communication units (page 16, lines 26-28), based on the collected data (page 1, lines 27-35, page 5, line 32, page 6, line 2, page 8, lines 17-37, page 12, lines 1-5, page 16, lines 21-28: the

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first policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of long-term propagation channel characteristics, e.g. NACK rate, while the second policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of short-term channel estimates); and
sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy (page 7, lines 9-12, "a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode") according to time-varying data (link adaptation is inherently performed according to time-varying data).

As all the features of claim 1 are disclosed in the same combination in D1, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.2 D2 discloses (the references in parenthesis applying to this document):

A method for optimizing performance of one or more communication units (figure 2, reference sign 12a: the communication unit is the DTV station 12a. There can be more than one DTV stations 12a, see column 8, line 6, "Some DTV stations 12a...") by a remote server (column 5, lines 13-31, figure 2, reference sign 13: the remote server is the EOC 13, which is connected to the DTV station(s) 12a via the WAN 18), the method comprising:
collecting data from the one or more communication units (column 7, line 19 - column 8, line 11: data, i.e. RF statistics over a geographic region, is collected by the EOC 13 during a field survey. The data can be collected from the mobile clients 16 but also from DTV stations 12a, see column 8, lines 6-9, "This data may be used for the field survey data...");
generating a policy, for each of the one or more communication units, based

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on the collected data (column 5, line 62 - column 6, line 47: a FEC policy is generated at the EOC 13 for the DTV station (s) on the basis of the data collected during the field survey); and
sending the policy to each of the one or more communication units (column 6, lines 39-41, "An assigned FEC method and strength is used with a data payload for broadcast over the DTV broadcast network 12 to the mobile client 16"), wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy (column 6, line 54 - column 7, line 6: the conditions for operation comprise link adaptation strategies) according to time-varying data (column 6, line 54 - column 7, line 6: the time-varying data correspond to the GPS position and speed of the mobile clients 16 and to time information).

As all the features of claim 1 are disclosed in the same combination in D2, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.3 The same applies to the corresponding independent claims 10, 27, 34 and 44, the subject-matter of which is thus also not new (Article 33(2) PCT).

2.4 D1 discloses (the references in parenthesis applying to this document):

A method for optimizing performance (page 2, lines 7-9 and 19-24: according to the method of D1, CQI for link adaptation is generated as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable. This way the performance of the communication unit(s) is optimized) of one or more communication units (page 5, lines 7-18, page 7, lines 9-12, page 16, lines 26-28, figure 1, reference sign 12), the method comprising:
sending data from one or more communication units to a remote server (according to D1, different types of data concerning the wireless communication devices can be sent to the base station, which can be seen as a remote server: information on fast/slow fading, page 4, lines 31-35, page 16, lines 21-23, claim 39, relative motion with respect to the base station, page 6, lines 17-21,

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Page #1865

identification number of the devices, page 7, lines 28-30, location of the devices, page 6, lines 20-22);
receiving a policy from the remote server (page 7, lines 9-12, "a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode"), wherein the policy comprises conditions for operation of the one or more communication units (page 1, lines 27-35, page 5, line 32, page 6, line 2, page 8, lines 17-37, page 12, lines 1-5, page 16, lines 21-28: the first policy corresponds to a link adaptation mode in which the channel quality information to be computed by the wireless communication devices is generated as a function of long-term propagation channel characteristics, e.g. NACK rate, while the second policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of short-term channel estimates); and
executing the policy (implicit) by implementing one of first and second algorithms (the two algorithms correspond to the above mentioned two link adaptation modes corresponding to fast-fading and slow-fading) based on the conditions and time-varying data (link adaptation is inherently performed according to time-varying data).

As all the features of claim 17 are disclosed in the same combination in D1, the subject-matter of claim 17 is not new (Article 33(2) PCT).

2.5 D2 discloses (the references in parenthesis applying to this document):

A method for optimizing performance of one or more communication units (figure 2, reference sign 12a: the communication unit is the DTV station 12a. There can be more than one DTV stations 12a, see column 8, line 6, "Some DTV stations 12a..."), the method comprising:
sending data from one or more communication units to a remote server (column 5, lines 13-31, figure 2, reference sign 13: the remote server is the EOC 13, which is connected to the DTV station(s) 12a via the WAN 18. Column 7, line 19 -

Charter Communications, Inc.
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column 8, line 11: data, i.e. RF statistics over a geographic region, is collected by the EOC 13 during a field survey. The data can be collected from the mobile clients 16 but also from DTV stations 12a, see column 8, lines 6-9, "This data may be used for the field survey data...");
receiving a policy from the remote server (column 6, lines 39-41, "An assigned FEC method and strength is used with a data payload for broadcast over the DTV broadcast network 12 to the mobile client 16"), wherein the policy comprises conditions for operation of the one or more communication units (column 6, line 54 - column 7, line 6: the conditions for operation comprise link adaptation strategies); and
executing the policy by implementing one of first and second algorithms (column 6, line 54 - column 7, line 6, figure 3: the link adaptation strategies corresponding to Zones 1 and 2 can be seen as first and second algorithms) based on the conditions and time-varying data (column 6, line 54 - column 7, line 6: the time-varying data corresponds to the GPS position and speed of the mobile clients 16 and to time information).

2.6 As all the features of claim 17 are disclosed in the same combination in D2, the subject-matter of claim 17 is not new (Article 33(2) PCT).

2.7 The same applies to the corresponding independent claim 27, the subject-matter of which is thus also not new (Article 33(2) PCT).

3 Dependent claims 2-5, 7-9, 11-14, 16, 18-21, 23-26, 29-33, 35-39, 41-43, 45-48, 50-52 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty (Article 33(2) PCT) and/or inventive step (Article 33(3) PCT), see the documents and the corresponding passages cited in the international search report.

4 The combination of the features of dependent claims 6, 15, 22, 28, 40 and 49 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows: the fact of generating the (software) code for an adaptation algorithm at the server and of sending the code to the communication unit(s) for being executed on the communication unit(s) allows to increase the flexibility and adaptability of the link adaptation policies to be used in the system (e.g. with respect to sending only link adaptation

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parameters as in D2). In other words, the link adaptation algorithms to be executed at the communication unit(s) can be better dynamically updated and adapted to the specific situations of the network and of each of the communication units. The generation of the (software) code for an adaptation algorithm at the server is neither disclosed nor suggested by the available documents of the prior art.

Re Item VIII

Certain observations on the international application

5 The expression "pseudo-code" used in claims 6, 15, 22, 28, 40 and 49 renders the subject-matter of these claims unclear (Article 6 PCT) for the following reasons:

5.1 Wikipedia (http://en.wikipedia.org/wiki/Pseudocode) gives the following definition of pseudo-code: "In computer science and numerical computation, pseudocode is an informal high-level description of the operating principle of a computer program or other algorithm. It uses the structural conventions of a programming language, but **is intended for human reading rather than machine reading**. Pseudocode typically omits details that are not essential for human understanding of the algorithm, such as variable declarations, system-specific code and some subroutines. The programming language is augmented with natural language description details, where convenient, or with compact mathematical notation. The purpose of using pseudocode is that it is easier for people to understand than conventional programming language code, and that it is an efficient and environment-independent description of the key principles of an algorithm. It is commonly used in textbooks and scientific publications that are documenting various algorithms, and also in planning of computer program development, for sketching out the structure of the program before the actual coding takes place. No standard for pseudocode syntax exists, as **a program in pseudocode is not an executable program**."

5.2 The following statements are in the description: "The pseudo-code may be coded in any software coding language that is executable by the communication unit" and "when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code" (§ 0030, 0058, 0064). These statements clearly contradict the well-known, common meaning of "pseudo-code", as shown above. A pseudo-code is not executable by a processor. For this reason, the intended limitations for claims 6, 15, 22, 28, 40 and 49 are not clear, contrary to the requirements of Article 6 PCT.

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The expression "pseudo-code or code" used in claims 6, 15, 22, 28, 40 and 49 should have been changed into "software code" in order to meet the requirements of Article 6 PCT.

6 Claims 10, 12, 13, 14 refers to method steps to be implemented by the communication unit(s), even though claims 10, 12, 13, 14 refer to a machine-readable storage medium having computer executable instructions to be executed by the remote server. The intended limitations for claims 10, 12, 13, 14 are therefore not clear, contrary to the requirements of Article 6 PCT.

7 Claims 34, 36, 37, 38, 39 refers to apparatus features of the communication unit(s), even though claims 34, 36, 37, 38, 39 refer to the server apparatus. The intended limitations for claims 34, 36, 37, 38, 39 are therefore not clear, contrary to the requirements of Article 6 PCT.

8 Although claims 34 and 44 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and/or in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

Charter Communications, Inc.
Exhibit 1006
Page #1869

Electronic Acknowledgement Receipt

EFS ID:	19958965
Application Number:	14356581
International Application Number:	
Confirmation Number:	4319
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong Rhee
Customer Number:	8791
Filer:	Gregory D. Caldwell/Lisa Bennett
Filer Authorized By:	Gregory D. Caldwell
Attorney Docket Number:	8241P054
Receipt Date:	25-AUG-2014
Filing Date:	06-MAY-2014
Time Stamp:	18:13:00
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		8241P054_IDS_1449_As_Filed.pdf	60512 5024734ca7ef3b6cda480a2e265da7e6a5a9102a9f	yes	2

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	1	
	Information Disclosure Statement (IDS) Form (SB08)		2	2	
Warnings:					
Information:					
2	Other Reference-Patent/App/Search documents	8241P054PCT_IPRP_052214.pdf	2233464 b2d6c876539fae432eccc2ddacd67c49280f0f35	no	12
Warnings:					
Information:					
		Total Files Size (in bytes):	2293976		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application No.	14/356,581
Filing Date	May 6, 2014
First Inventor	Wonjong RHEE
Art Unit	2447
Examiner Name	
Attorney Docket No.	8241P054 Conf. No. 4319

DUTY OF DISCLOSURE STATEMENT

In accordance with the duty of disclosure, enclosed is a copy of an Information Disclosure Statement (IDS) Citation Form PTO/SB/08 or PTO-1449, together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed). This IDS and IDS Citation Form are being submitted before the mailing of a first Office Action on the merits. It is respectfully requested that the cited references be considered and that the enclosed copy of PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

The submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made in the subject application and is not to be construed as an admission that the information cited in this statement is material to patentability.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

OR

☒ None

☐ The IDS Filing Fee in the amount of $180.00 as set forth in 37 CFR 1.17(p) has been submitted herewith.

☒ It is requested that any requisite fees be debited from Deposit Account 02-2666.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of signature.

Signature	/Gregory D. Caldwell/	Date (MM-DD-YYYY)	08-25-2014
Name/Print	Gregory D. Caldwell	Registration Number	39,926

I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

/Lisa Bennett/
Lisa Bennett *Date* *08-25-14*

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
14/356,581	Wonjong Rhee	8241P054

8791
BLAKELY SOKOLOFF TAYLOR & ZAFMAN
1279 Oakmead Parkway
Sunnyvale, CA 94085-4040

INTERNATIONAL APPLICATION NO.	
PCT/US2011/060265	
I.A. FILING DATE	PRIORITY DATE
11/10/2011	

CONFIRMATION NO. 4319
371 ACCEPTANCE LETTER

OC000000069262495

Date Mailed: 06/30/2014

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

05/06/2014	05/06/2014
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1), (c)(2) and (c)(4) REQUIREMENTS	DATE OF COMPLETION OF ALL 35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).*

The following items have been received:

- Copy of the International Application filed on 05/06/2014
- Copy of the International Search Report filed on 05/06/2014
- Preliminary Amendments filed on 05/06/2014
- Information Disclosure Statements filed on 05/06/2014
- Inventor's Oath or Declaration filed on 05/06/2014
- Request for Immediate Examination filed on 05/06/2014
- U.S. Basic National Fees filed on 05/06/2014
- Assignee Statement for PGPUB filed on 05/06/2014
- Specification filed on 05/06/2014
- Claims filed on 05/06/2014
- Abstracts filed on 05/06/2014
- Drawings filed on 05/06/2014

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Page #1873

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

DIAN S GORDON

Telephone: (571) 272-3915

FORM PCT/DO/EO/903 (371 Acceptance Notice)

Charter Communications, Inc.
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Page #1874

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 14/356,581

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	280
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	600
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	720
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 80 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*				x 420 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1600

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
14/356,581	05/06/2014		1480	8241P054	20	3

CONFIRMATION NO. 4319

8791
BLAKELY SOKOLOFF TAYLOR & ZAFMAN
1279 Oakmead Parkway
Sunnyvale, CA 94085-4040

FILING RECEIPT



Date Mailed: 06/30/2014

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Inventor(s)
Wonjong Rhee, Seoul, KOREA, REPUBLIC OF;

Applicant(s)
Wonjong Rhee, Seoul, KOREA, REPUBLIC OF;

Assignment For Published Patent Application
ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC., Redwood City, CA

Power of Attorney: The patent practitioners associated with Customer Number 08791

Domestic Priority data as claimed by applicant
This application is a 371 of PCT/US2011/060265 11/10/2011

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

If Required, Foreign Filing License Granted: 06/25/2014

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 14/356,581**

Projected Publication Date: 10/09/2014

Non-Publication Request: No

Early Publication Request: No

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Page #1876

Title

METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

Charter Communications, Inc.
Exhibit 1006
Page #1877

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
14356581	

Applicant(s) Wonjong RHEE

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1		1			
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Total Indep	6		3		0	
Total Depend	46	↵	17	↵	0	↵
Total Claims	52		20		0	

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PTO-1390 (05-13)
Approved for use through 6/30/2013. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

Attorney Docket No.	
8241P054	
U.S. Application No. (if known, see 37 CFR 1.5)	

International Application No.	International Filing Date	Priority Date Claimed
PCT/US2011/060265	November 10, 2011	November 10, 2011

Title of Invention
METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

First Named Inventor
Wonjong RHEE

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information.

1. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). NOTE: The express request under 35 U.S.C. 371(f) will not be effective unless the requirements under 35 U.S.C. 371(c)(1), (2), and (4) for payment of the basic national fee, copy of the International Application and English translation thereof (if required), and the oath or declaration of the inventor(s) have been received.
2. ☑ A copy of the International Application (35 U.S.C. 371(c)(2)) is attached hereto (not required if the International Application was previously communicated by the International Bureau or was filed in the United States Receiving Office (RO/US)).
3. An English language translation of the International Application (35 U.S.C. 371(c)(2))
   a. ☐ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
4. An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))
   a. ☑ is attached.
   b. ☐ was previously filed in the international phase under PCT Rule 4.17(iv).

Items 5 to 8 below concern amendments made in the international phase.

PCT Article 19 and 34 amendments

5. ☐ Amendments to the claims under PCT Article 19 are attached (not required if communicated by the International Bureau) (35 U.S.C. 371(c)(3)).
6. ☐ English translation of the PCT Article 19 amendment is attached (35 U.S.C. 371(c)(3)).
7. ☐ English translation of annexes (Article 19 and/or 34 amendments only) of the International Preliminary Examination Report is attached (35 U.S.C. 371(c)(5)).

Cancellation of amendments made in the international phase

8a. ☐ Do not enter the amendment made in the international phase under PCT Article 19.

8b. ☐ Do not enter the amendment made in the international phase under PCT Article 34.

NOTE: A proper amendment made in English under Article 19 or 34 will be entered in the U.S. national phase application absent a clear instruction from applicant not to enter the amendment(s).

The following items 9 to 17 concern a document(s) or information included.

9. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
10. ☑ A preliminary amendment.
11. ☑ An Application Data Sheet under 37 CFR 1.76.
12. ☐ A substitute specification. NOTE: A substitute specification cannot include claims. See 37 CFR 1.125(b).
13. ☐ A power of attorney and/or change of address letter.
14. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821-1.825.
15. ☐ Assignment papers *(cover sheet and document(s))*. Name of Assignee: _____
16. ☐ 37 CFR 3.73(c) Statement *(when there is an Assignee)*.

This collection of information is required by 37 CFR 1.414 and 1.491-1.492. The information is required to obtain or retain a benefit by the public, which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

PTO-1390 (05-13)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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U.S. APPLN. No. (if known – see 37 CFR 1.5)	INTERNATIONAL APPLICATION No.	ATTORNEY DOCKET No.
	PCT/US2011/060265	8241P045

17. ☐ Other items or information:

The following fees have been submitted.	CALCULATIONS	PTO USE ONLY
18. ☐ Basic national fee (37 CFR 1.492(a)) **$280**	$ 280.00	
19. ☐ Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$720**	$ 720.00	
20. ☐ Search fee (37 CFR 1.492(b)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ..... **$480** All other situations **$600**	$ 480.00	
TOTAL OF 18, 19, and 20 =	$ 1480.00	
☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). Fee for each additional 50 sheets of paper or fraction thereof **$400**		

Total Sheets	Extra Sheets	Number of each addition 50 or fraction thereof (round **up** to a whole number)	RATE	
- 100 =	/ 50 =		x **$400**	$
Surcharge of **$140.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).				$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	20 - 20 =	0	x **$80**	$	
Independent claims	1 - 3 =	0	x **$420**	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$780**	$	
Processing fee of **$140.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +				$	
TOTAL OF ABOVE CALCULATIONS =				$	
☐ **Applicant asserts small entity status.** See 37 CFR 1.27. Fees above are reduced by ½.					
☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Fees above are reduced by ¾. Applicant must attach form PTO/SB/15A or B or equivalent.					
TOTAL NATIONAL FEE =				$ 1480	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property. +				$	
TOTAL FEES ENCLOSED =				$ 1480	
				Amount to be refunded:	$
				Amount to be charged:	$

Charter Communications, Inc.
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a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☑ Please charge my Deposit Account No. 02-2666 in the amount of $ 5300.00 to cover the above fees.

c. ☑ The Director is hereby authorized to charge additional fees which may be required, or credit any overpayment, to Deposit Account No. 02-2666 as follows:

i. ☐ any required fee.

ii. ☐ any required fee except for excess claims fees required under 37 CFR 1.492(d) and (e) and multiple dependent claim fee required under 37 CFR 1.492(f).

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

ADVISORY: If filing by EFS-Web, do **NOT** attach the PTO-2038 form as a PDF along with your EFS-Web submission. Please be advised that this is **not** recommended and by doing so your **credit card information may be displayed via PAIR**. To protect your information, it is recommended to pay fees online by using the electronic payment method.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

Correspondence Address

☑ The address associated with Customer Number: 08791 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone			
Email					

Signature	/Usman A. Mughal/	Date	5/6/2014
Name (Print/Type)	Usman A. Mughal	Registration No. (Attorney/Agent)	62,887

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PATENT COOPERATION TREATY

RECEIVED
JUN 27 2012
BEA PCT

RECEIVED
JUN 26 2012
FIP DEPT.

From the INTERNATIONAL SEARCHING AUTHORITY

To:
Vincent, Lester J.
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
1279 Oakmead Parkway
Sunnyvale CA 94085-4040
ETATS-UNIS D'AMERIQUE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

Applicant's or agent's file reference 8241P054PCT	Date of mailing *(day/month/year)* 21 June 2012 (21-06-2012)
International application No. PCT/US2011/060265	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
Applicant ASSIA, INC.	International filing date *(day/month/year)* 10 November 2011 (10-11-2011)

RECEIVED
SUNNYVALE
JUN 26 2012
BLAKELY SOKOLOFF
TAYLOR ZAFMAN

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 - 9.011.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the International Searching Authority European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	Authorized officer TOSCANO OLIVEROS, Lucia Tel: +49 (0)89 2399-5747 Entered into FIP By:

Form PCT/ISA/220 (July 2010)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
8241P054PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2011/060265	10/11/2011	
Applicant		
ASSIA, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language,** the international search was carried out on the basis of:
      [X] the international application in the language in which it was filed
      [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. [ ] **Certain claims were found unsearchable** (See Box No. II)
3. [ ] **Unity of invention is lacking** (see Box No III)
4. With regard to the **title,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority
6. With regard to the **drawings,**
   a. the figure of the **drawings** to be published with the abstract is Figure No. 4
      [X] as suggested by the applicant
      [ ] as selected by this Authority, because the applicant failed to suggest a figure
      [ ] as selected by this Authority, because this figure better characterizes the invention
   b. [ ] none of the figures is to be published with the abstract

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/060265

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L1/00 H04L1/20
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/136337 A2 (ERICSSON TELEFON AB L M [SE]) 29 November 2007 (2007-11-29) page 2, lines 7-9,19-24 page 4, lines 27-35 page 5, lines 7-18,23-25 page 5, line 32 - page 6, line 2 page 6, lines 17-22 page 7, lines 9-12,28-30 page 8, lines 17-37 page 12, lines 1-5 page 16, lines 21-28 claim 39 figure 1 -/--	1-5, 7-14, 16-21, 23-25, 27, 29-39, 41-48, 50-52

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2012	21/06/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Meister, Mark

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Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/060265

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.

X	US 7 840 220 B1 (MITCHELL JAMES P [US]) 23 November 2010 (2010-11-23)	1-5, 7-14, 16-21, 23-27, 29-39, 41-48, 50-52
	column 5, lines 13-31 column 5, line 62 - column 6, line 47 column 6, line 54 - column 7, line 6 column 7, line 19 - column 8, line 11 figures 2,3	

A	WO 2011/079612 A1 (ZTE CORP [CN]; ZHANG QINGHONG [CN]; LI HANG [CN]) 7 July 2011 (2011-07-07) the whole document	1-52
L	-& EP 2 426 983 A1 (ZTE CORP [CN]) 7 March 2012 (2012-03-07) paragraphs [0004] - [0010] paragraphs [0012], [0013] paragraphs [0020] - [0024] paragraph [0026] paragraphs [0034] - [0036] figure 1	1-52

1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/060265

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007136337 A2	29-11-2007	CN 101449503 A	03-06-2009
		EP 2020111 A2	04-02-2009
		JP 2009538559 A	05-11-2009
		TW 200805931 A	16-01-2008
		US 2007275665 A1	29-11-2007
		US 2010183064 A1	22-07-2010
		US 2011105046 A1	05-05-2011
		WO 2007136337 A2	29-11-2007
US 7840220 B1	23-11-2010	NONE	
WO 2011079612 A1	07-07-2011	AU 2010338867 A1	22-12-2011
		CN 101765161 A	30-06-2010
		EP 2426983 A1	07-03-2012
		WO 2011079612 A1	07-07-2011
EP 2426983 A1	07-03-2012	AU 2010338867 A1	22-12-2011
		CN 101765161 A	30-06-2010
		EP 2426983 A1	07-03-2012
		WO 2011079612 A1	07-07-2011

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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2011/060265	10.11.2011	

International Patent Classification (IPC) or both national classification and IPC
INV. H04L1/00 H04L1/20

Applicant
ASSIA, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Meister, Mark Telephone No. +49 89 2399-0

Form PCT/ISA/237 (Cover Sheet) (July 2009)

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	6, 7, 15, 22-24, 28, 40, 41, 49, 50
	No:	Claims	1-5, 8-14, 16-21, 25-27, 29-39, 42-48, 51, 52
Inventive step (IS)	Yes:	Claims	6, 15, 22, 28, 40, 49
	No:	Claims	1-5, 7-14, 16-21, 23-27, 29-39, 41-48, 50-52
Industrial applicability (IA)	Yes:	Claims	1-52
	No:	Claims	

2. Citations and explanations

see separate sheet

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 WO 2007/136337 A2 (ERICSSON TELEFON AB L M [SE]) 29 November 2007 (2007-11-29)

D2 US 7 840 220 B1 (MITCHELL JAMES P [US]) 23 November 2010 (2010-11-23)

2 The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of the independent claims is not new. Reasons follow.

2.1 D1 discloses (the references in parenthesis applying to this document):

A method for optimizing performance (page 2, lines 7-9 and 19-24: according to the method of D1, CQI for link adaptation is generated as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable. This way the performance of the communication unit(s) is optimized) of one or more communication units (page 5, lines 7-18, page 7, lines 9-12, page 16, lines 26-28, figure 1, reference sign 12) by a remote server (page 5, lines 23-25, page 7, lines 9-12, figure 1, reference sign 10: the base station 10 can be seen as a remote server), the method comprising:
collecting data from the one or more communication units (according to D1, different types of data concerning the wireless communication devices can be collected by the base station: information on fast/slow fading, page 4, lines 31-35, page 16, lines 21-23, claim 39, relative motion with respect to the base station, page 6, lines 17-21, identification number of the devices, page 7, lines 28-30, location of the devices, page 6, lines 20-22);
generating a policy, for each of the one or more communication units (page 16, lines 26-28), based on the collected data (page 1, lines 27-35, page 5, line 32, page 6, line 2, page 8, lines 17-37, page 12, lines 1-5, page 16, lines 21-28: the

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first policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of long-term propagation channel characteristics, e.g. NACK rate, while the second policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of short-term channel estimates); and
sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy (page 7, lines 9-12, "a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode") according to time-varying data (link adaptation is inherently performed according to time-varying data).

As all the features of claim 1 are disclosed in the same combination in D1, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.2 D2 discloses (the references in parenthesis applying to this document):

A method for optimizing performance of one or more communication units (figure 2, reference sign 12a: the communication unit is the DTV station 12a. There can be more than one DTV stations 12a, see column 8, line 6, "Some DTV stations 12a...") by a remote server (column 5, lines 13-31, figure 2, reference sign 13: the remote server is the EOC 13, which is connected to the DTV station(s) 12a via the WAN 18), the method comprising:
collecting data from the one or more communication units (column 7, line 19 - column 8, line 11: data, i.e. RF statistics over a geographic region, is collected by the EOC 13 during a field survey. The data can be collected from the mobile clients 16 but also from DTV stations 12a, see column 8, lines 6-9, "This data may be used for the field survey data...");
generating a policy, for each of the one or more communication units, based

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on the collected data (column 5, line 62 - column 6, line 47: a FEC policy is generated at the EOC 13 for the DTV station (s) on the basis of the data collected during the field survey); and
sending the policy to each of the one or more communication units (column 6, lines 39-41, "An assigned FEC method and strength is used with a data payload for broadcast over the DTV broadcast network 12 to the mobile client 16"), wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy (column 6, line 54 - column 7, line 6: the conditions for operation comprise link adaptation strategies) according to time-varying data (column 6, line 54 - column 7, line 6: the time-varying data correspond to the GPS position and speed of the mobile clients 16 and to time information).

As all the features of claim 1 are disclosed in the same combination in D2, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.3 The same applies to the corresponding independent claims 10, 27, 34 and 44, the subject-matter of which is thus also not new (Article 33(2) PCT).

2.4 D1 discloses (the references in parenthesis applying to this document):

A method for optimizing performance (page 2, lines 7-9 and 19-24: according to the method of D1, CQI for link adaptation is generated as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable. This way the performance of the communication unit(s) is optimized) of one or more communication units (page 5, lines 7-18, page 7, lines 9-12, page 16, lines 26-28, figure 1, reference sign 12), the method comprising:
sending data from one or more communication units to a remote server (according to D1, different types of data concerning the wireless communication devices can be sent to the base station, which can be seen as a remote server: information on fast/slow fading, page 4, lines 31-35, page 16, lines 21-23, claim 39, relative motion with respect to the base station, page 6, lines 17-21,

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identification number of the devices, page 7, lines 28-30, location of the devices, page 6, lines 20-22);
receiving a policy from the remote server (page 7, lines 9-12, "a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode"), wherein the policy comprises conditions for operation of the one or more communication units (page 1, lines 27-35, page 5, line 32, page 6, line 2, page 8, lines 17-37, page 12, lines 1-5, page 16, lines 21-28: the first policy corresponds to a link adaptation mode in which the channel quality information to be computed by the wireless communication devices is generated as a function of long-term propagation channel characteristics, e.g. NACK rate, while the second policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of short-term channel estimates); and
executing the policy (implicit) by implementing one of first and second algorithms (the two algorithms correspond to the above mentioned two link adaptation modes corresponding to fast-fading and slow-fading) based on the conditions and time-varying data (link adaptation is inherently performed according to time-varying data).

As all the features of claim 17 are disclosed in the same combination in D1, the subject-matter of claim 17 is not new (Article 33(2) PCT).

2.5 D2 discloses (the references in parenthesis applying to this document):

A method for optimizing performance of one or more communication units (figure 2, reference sign 12a: the communication unit is the DTV station 12a. There can be more than one DTV stations 12a, see column 8, line 6, "Some DTV stations 12a..."), the method comprising:
sending data from one or more communication units to a remote server (column 5, lines 13-31, figure 2, reference sign 13: the remote server is the EOC 13, which is connected to the DTV station(s) 12a via the WAN 18. Column 7, line 19 -

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column 8, line 11: data, i.e. RF statistics over a geographic region, is collected by the EOC 13 during a field survey. The data can be collected from the mobile clients 16 but also from DTV stations 12a, see column 8, lines 6-9, "This data may be used for the field survey data...");
receiving a policy from the remote server (column 6, lines 39-41, "An assigned FEC method and strength is used with a data payload for broadcast over the DTV broadcast network 12 to the mobile client 16"), wherein the policy comprises conditions for operation of the one or more communication units (column 6, line 54 - column 7, line 6: the conditions for operation comprise link adaptation strategies); and
executing the policy by implementing one of first and second algorithms (column 6, line 54 - column 7, line 6, figure 3: the link adaptation strategies corresponding to Zones 1 and 2 can be seen as first and second algorithms) based on the conditions and time-varying data (column 6, line 54 - column 7, line 6: the time-varying data corresponds to the GPS position and speed of the mobile clients 16 and to time information).

2.6 As all the features of claim 17 are disclosed in the same combination in D2, the subject-matter of claim 17 is not new (Article 33(2) PCT).

2.7 The same applies to the corresponding independent claim 27, the subject-matter of which is thus also not new (Article 33(2) PCT).

3 Dependent claims 2-5, 7-9, 11-14, 16, 18-21, 23-26, 29-33, 35-39, 41-43, 45-48, 50-52 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty (Article 33(2) PCT) and/or inventive step (Article 33(3) PCT), see the documents and the corresponding passages cited in the international search report.

4 The combination of the features of dependent claims 6, 15, 22, 28, 40 and 49 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows: the fact of generating the (software) code for an adaptation algorithm at the server and of sending the code to the communication unit(s) for being executed on the communication unit(s) allows to increase the flexibility and adaptability of the link adaptation policies to be used in the system (e.g. with respect to sending only link adaptation

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parameters as in D2). In other words, the link adaptation algorithms to be executed at the communication unit(s) can be better dynamically updated and adapted to the specific situations of the network and of each of the communication units. The generation of the (software) code for an adaptation algorithm at the server is neither disclosed nor suggested by the available documents of the prior art.

Re Item VIII

Certain observations on the international application

5 The expression "pseudo-code" used in claims 6, 15, 22, 28, 40 and 49 renders the subject-matter of these claims unclear (Article 6 PCT) for the following reasons:

5.1 Wikipedia (http://en.wikipedia.org/wiki/Pseudocode) gives the following definition of pseudo-code: "In computer science and numerical computation, pseudocode is an informal high-level description of the operating principle of a computer program or other algorithm. It uses the structural conventions of a programming language, but **is intended for human reading rather than machine reading**. Pseudocode typically omits details that are not essential for human understanding of the algorithm, such as variable declarations, system-specific code and some subroutines. The programming language is augmented with natural language description details, where convenient, or with compact mathematical notation. The purpose of using pseudocode is that it is easier for people to understand than conventional programming language code, and that it is an efficient and environment-independent description of the key principles of an algorithm. It is commonly used in textbooks and scientific publications that are documenting various algorithms, and also in planning of computer program development, for sketching out the structure of the program before the actual coding takes place. No standard for pseudocode syntax exists, as **a program in pseudocode is not an executable program**."

5.2 The following statements are in the description: "The pseudo-code may be coded in any software coding language that is executable by the communication unit" and "when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code" (§ 0030, 0058, 0064). These statements clearly contradict the well-known, common meaning of "pseudo-code", as shown above. A pseudo-code is not executable by a processor. For this reason, the intended limitations for claims 6, 15, 22, 28, 40 and 49 are not clear, contrary to the requirements of Article 6 PCT.

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The expression "pseudo-code or code" used in claims 6, 15, 22, 28, 40 and 49 should have been changed into "software code" in order to meet the requirements of Article 6 PCT.

6 Claims 10, 12, 13, 14 refers to method steps to be implemented by the communication unit(s), even though claims 10, 12, 13, 14 refer to a machine-readable storage medium having computer executable instructions to be executed by the remote server. The intended limitations for claims 10, 12, 13, 14 are therefore not clear, contrary to the requirements of Article 6 PCT.

7 Claims 34, 36, 37, 38, 39 refers to apparatus features of the communication unit(s), even though claims 34, 36, 37, 38, 39 refer to the server apparatus. The intended limitations for claims 34, 36, 37, 38, 39 are therefore not clear, contrary to the requirements of Article 6 PCT.

8 Although claims 34 and 44 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and/or in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

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Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO-ISA)

General information	For all international applications filed on or after 01/01/2004 the competent ISA will establish an ISR. It is accompanied by the WO-ISA. Unlike the former written opinion of the IPEA (Rule 66.2 PCT), the WO-ISA is not meant to be responded to, but to be taken into consideration for further procedural steps. This document explains about the possibilities.
Amending claims under Art. 19 PCT	Within 2 months after the date of mailing of the ISR and the WO-ISA the applicant may file amended claims under Art. 19 PCT directly with the International Bureau of WIPO. The PCT reform of 2004 did not change this procedure. For further information please see Rule 46 PCT as well as form PCT/ISA/220 and the corresponding Notes to form PCT/ISA/220.
Filing a demand for international preliminary examination	In principle, the WO-ISA will be considered as the written opinion of the IPEA. This should, in many cases, make it unnecessary to file a demand for international preliminary examination. If the applicant nevertheless wishes to file a demand this must be done before expiry of 3 months after the date of mailing of the ISR/WO-ISA or 22 months after priority date, whichever expires later (Rule 54bis PCT). Amendments under Art. 34 PCT can be filed with the IPEA as before, normally at the same time as filing the demand (Rule 66.1 (b) PCT). If a demand for international preliminary examination is filed and no comments/amendments have been received the WO-ISA will be transformed by the IPEA into an IPRP (International Preliminary Report on Patentability) which would merely reflect the content of the WO-ISA. The demand can still be withdrawn (Art. 37 PCT).
Filing informal comments	After receipt of the ISR/WO-ISA the applicant may file informal comments on the WO-ISA directly with the International Bureau of WIPO. These will be communicated to the designated Offices together with the IPRP (International Preliminary Report on Patentability) at 30 months from the priority date. Please also refer to the next box.
End of the international phase	At the end of the international phase the International Bureau of WIPO will transform the WO-ISA or, if a demand was filed, the written opinion of the IPEA into the IPRP, which will then be transmitted together with possible informal comments to the designated Offices. The IPRP replaces the former IPER (international preliminary examination report).
Relevant PCT Rules and more information	Rule 43 PCT, Rule 43bis PCT, Rule 44 PCT, Rule 44bis PCT, PCT Newsletter 12/2003, OJ 11/2003, OJ 12/2003

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ADVANCE E-MAIL

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION RELATING TO
DECLARATION MADE UNDER PCT RULE 4.17

(PCT Rules 26*ter* and 48.2(a)(x)
and Administrative Instructions, Section 419)

To:

VINCENT, Lester, J.
Blakely, Sokoloff, Taylor & Zafman LLP
1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
ETATS-UNIS D'AMERIQUE

Date of mailing *(day/month/year)* 24 November 2011 (24.11.2011)	
Applicant's or agent's file reference 8241P054PCT	IMPORTANT NOTIFICATION
International application No PCT/US2011/060265	International filing date *(day/month/year)* 10 November 2011 (10.11.2011)
Applicant ASSIA, INC. et al	

1. The applicant is hereby **notified** of the following regarding the declaration indicated below in respect of RHEE, Wonjong :

   (i) ☐ declaration as to the identity of the inventor (Rules 4.17(i) and 51*bis*.1(a)(i) and Section 211)

   (ii) ☐ declaration as to the applicant's entitlement, as at the international filing date, to apply for or be granted a patent (Rules 4.17(ii) and 51*bis*.1(a)(ii) and Section 212)

   (iii) ☐ declaration as to the applicant's entitlement, as at the international filing date, to claim priority of the earlier application (Rules 4.17(iii) and 51*bis*.1(a)(iii) and Section 213)

   (iv) ☒ declaration of inventorship (for the purposes of the designation of the United States of America) (Rules 4.17(iv) and 51*bis*.1(a)(iv) and Section 214)

   (v) ☐ declaration as to non-prejudicial disclosures or exceptions to lack of novelty (Rules 4.17(v) and 51*bis*.1(a)(v) and Section 215)

2. ☒ **Addition or correction of the declaration within the time limit under Rule 26*ter*.1.**

   The added or corrected declaration was received on 24 November 2011 (24.11.2011) , which was within the time limit under Rule 26*ter*.1.

   Any declaration referred to under items 1(i) to (v), whether or not the declaration complies with Rule 4.17, will be published as part of the international application pursuant to Rule 48.2(a)(x).

3. ☐ **Failure to add or correct the declaration within the time limit under Rule 26*ter*.1.**

   The declaration was received on which was **after** the expiration of the time limit under Rule 26*ter*.1; therefore, that declaration, as added or corrected, referred to under items 1(i) to (v) will **not** be published as part of the international application, and any signed declaration referred to under item 1(iv) is attached. **Such declaration should be submitted by the applicant directly to the designated Office(s) concerned.**

4. The applicant's attention is drawn to Rule 51*bis*.2 which provides that the designated Office shall not, unless it may reasonably doubt the veracity of the declaration concerned, require any document or evidence relating to the subject matter of any declaration complying with Rule 4.17(i) to (iv) which is contained in the request or submitted to the International Bureau or directly to the designated Office. Note, however, that Rule 51*bis*.2 may not apply in respect of certain States. For further information, see Notes to the request form, Box No. VIII.

5. A copy of this notification is being sent to the receiving Office and the International Searching Authority.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 71 30	Authorized officer Adelise Andre e-mail pt09.pct@wipo.int Telephone No. +41 22 338 74 09

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**Declaration of Inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv))
for the purposes of the designation of the United States of America:**

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

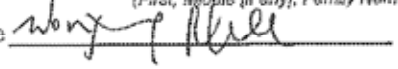
Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR:

Full Name: Wonjong Rhee
(First, Middle (if any), Family Name (or Surname), and Suffix (if any))

Inventor's Signature  Date Nov 10, 2011

Residence San Francisco, CA US *(City, State, Country)* Citizenship KR *(Country)*

Mailing Address 235 Berry Street #606
San Francisco, CA 94158 US

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application No.	Not yet assigned
Filing Date	2014-05-06
First Inventor	Wonjong RHEE
Art Unit	Not yet assigned
Examiner Name	Not yet assigned
Attorney Docket No.	8241P054 Conf. No.

DUTY OF DISCLOSURE STATEMENT

In accordance with the duty of disclosure, enclosed is a copy of an Information Disclosure Statement (IDS) Citation Form PTO/SB/08 or PTO-1449, together with copies of the documents cited on that form, except for copies not required to be submitted (e.g., copies of U.S. patents and U.S. published patent applications need not be enclosed). This IDS and IDS Citation Form are being submitted . It is respectfully requested that the cited references be considered and that the enclosed copy of PTO/SB/08 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s). Some or all of the references listed on the enclosed PTO/SB/08 were previously identified in the parent application (Application No. PCT/US2011/060265, filed November 10, 2011) and copies of the references were furnished at that time. Accordingly, per 37 CFR §1.98(d)(1) additional copies of those references are not submitted herewith.

The references listed were cited in a Search Report dated June 21, 2012 (copy enclosed herewith and, if not in the English language, a cover sheet with English language translation is attached).

The submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made in the subject application and is not to be construed as an admission that the information cited in this statement is material to patentability.

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

OR

☐ None

☐ The IDS Filing Fee in the amount of $180.00 as set forth in 37 CFR 1.17(p) has been submitted herewith.

☒ It is requested that any requisite fees be debited from Deposit Account 02-2666.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of signature.

Signature	/Usman A. Mughal/	Date (MM-DD-YYYY)	05-06-2014
Name/Print	Usman A. Mughal	Registration Number	62887

I hereby certify that this correspondence is being submitted electronically via EFS Web on the date shown below.

Lisa Puccinelli /Lisa Puccinelli/ *Date* *05-06-14*

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Substitute for form 1449A/PTO	Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT *(Use as many sheets as necessary)*	**Application Number**	Not yet assigned
	Filing Date	2014-05-06
	First Named Inventor	Rhee, Wonjong
	Group Art Unit	Not yet assigned
	Examiner Name	Not yet assigned
Sheet 1 of 1	Attorney Docket No: 8241P054	

US PATENT DOCUMENTS					
Examiner Initial *	**Cite No [1]**	**USP Document Number**	**Publication or Issue Date MM-DD-YYYY**	**Name of Patentee or Applicant of cited Document**	**Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear**
	1	US-7,840,220	11/23/2010	Mitchell, James P.	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	**Cite No [1]**	**Foreign Patent Document** Country Code/Number/Kind Code (if known)	**Publication Date MM-DD-YYYY**	**Name of Patentee or Applicant of cited Document**	**Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear**	**T [2]**
	2	EP-2426983	03/07/2012	Zhang, Qinghong , et al.		
	3	WO-2007136337	11/29/2007	Molnar, Karl J., et al.		
	4	WO-2011079612	07/07/2011	Zhang, Qinghong, et al.		

OTHER DOCUMENTS -- NON PATENT LITERATURE DOCUMENTS			
Examiner Initials*	**Cite No [1]**	**Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.**	**T [2]**
	5	International Search Report and Written Opinion for International Patent Application No. PCT/US2011/060265.(Attorney Docket No. 8241P054PCT). Mailed 6/21/2012..	

EXAMINER **DATE CONSIDERED**

Based on PTO/SB/08A(09-06) - Substitute Disclosure Statement Form (PTO-1449) as modified by BGTZ 03/26/07

* EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional) [2] Applicant is to place a check mark here if English language Translation is attached

PATENT COOPERATION TREATY

RECEIVED
JUN 27 2012
BEA PCT

RECEIVED
JUN 26 2012
FIP DEPT.

From the INTERNATIONAL SEARCHING AUTHORITY

To:
Vincent, Lester J.
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
1279 Oakmead Parkway
Sunnyvale CA 94085-4040
ETATS-UNIS D'AMERIQUE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)* 21 June 2012 (21-06-2012)
Applicant's or agent's file reference 8241P054PCT	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US2011/060265	International filing date *(day/month/year)* 10 November 2011 (10-11-2011)
Applicant ASSIA, INC.	

RECEIVED
SUNNYVALE
JUN 26 2012
BLAKELY SOKOLOFF
TAYLOR ZAFMAN

1. [X] The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

   Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Fascimile No.: (41-22) 338.82.70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 - 9.011.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. [ ] **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   [ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

   [ ] no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. Following the expiration of 30 months from the priority date, these comments will also be made available to the public.

   Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

   In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

   For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	TOSCANO OLIVEROS, Lucia Tel: +49 (0)89 2399-5747 Entered into FIP By:

Form PCT/ISA/220 (July 2010)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
8241P054PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US2011/060265	10/11/2011	
Applicant		
ASSIA, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language,** the international search was carried out on the basis of:
      [X] the international application in the language in which it was filed
      [ ] a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))
   b. [ ] This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.
2. [ ] **Certain claims were found unsearchable** (See Box No. II)
3. [ ] **Unity of invention is lacking** (see Box No III)
4. With regard to the **title,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established by this Authority to read as follows:
5. With regard to the **abstract,**
   [X] the text is approved as submitted by the applicant
   [ ] the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority
6. With regard to the **drawings,**
   a. the figure of the **drawings** to be published with the abstract is Figure No. 4
      [X] as suggested by the applicant
      [ ] as selected by this Authority, because the applicant failed to suggest a figure
      [ ] as selected by this Authority, because this figure better characterizes the invention
   b. [ ] none of the figures is to be published with the abstract

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/060265

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L1/00 H04L1/20
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2007/136337 A2 (ERICSSON TELEFON AB L M [SE]) 29 November 2007 (2007-11-29) page 2, lines 7-9,19-24 page 4, lines 27-35 page 5, lines 7-18,23-25 page 5, line 32 - page 6, line 2 page 6, lines 17-22 page 7, lines 9-12,28-30 page 8, lines 17-37 page 12, lines 1-5 page 16, lines 21-28 claim 39 figure 1 -/--	1-5, 7-14, 16-21, 23-25, 27, 29-39, 41-48, 50-52

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2012	21/06/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Meister, Mark

1

Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/060265

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.

X	US 7 840 220 B1 (MITCHELL JAMES P [US]) 23 November 2010 (2010-11-23)	1-5, 7-14, 16-21, 23-27, 29-39, 41-48, 50-52
	column 5, lines 13-31 column 5, line 62 - column 6, line 47 column 6, line 54 - column 7, line 6 column 7, line 19 - column 8, line 11 figures 2,3	

A	WO 2011/079612 A1 (ZTE CORP [CN]; ZHANG QINGHONG [CN]; LI HANG [CN]) 7 July 2011 (2011-07-07) the whole document	1-52
L	-& EP 2 426 983 A1 (ZTE CORP [CN]) 7 March 2012 (2012-03-07) paragraphs [0004] - [0010] paragraphs [0012], [0013] paragraphs [0020] - [0024] paragraph [0026] paragraphs [0034] - [0036] figure 1	1-52

1

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

Charter Communications, Inc.
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Page #1907

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/060265

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007136337 A2	29-11-2007	CN 101449503 A	03-06-2009
		EP 2020111 A2	04-02-2009
		JP 2009538559 A	05-11-2009
		TW 200805931 A	16-01-2008
		US 2007275665 A1	29-11-2007
		US 2010183064 A1	22-07-2010
		US 2011105046 A1	05-05-2011
		WO 2007136337 A2	29-11-2007
US 7840220 B1	23-11-2010	NONE	
WO 2011079612 A1	07-07-2011	AU 2010338867 A1	22-12-2011
		CN 101765161 A	30-06-2010
		EP 2426983 A1	07-03-2012
		WO 2011079612 A1	07-07-2011
EP 2426983 A1	07-03-2012	AU 2010338867 A1	22-12-2011
		CN 101765161 A	30-06-2010
		EP 2426983 A1	07-03-2012
		WO 2011079612 A1	07-07-2011

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PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

see form PCT/ISA/220

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2011/060265	10.11.2011	

International Patent Classification (IPC) or both national classification and IPC
INV. H04L1/00 H04L1/20

Applicant
ASSIA, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notifed the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:	Date of completion of this opinion	Authorized Officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465	see form PCT/ISA/210	Meister, Mark Telephone No. +49 89 2399-0

Form PCT/ISA/237 (Cover Sheet) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2011/060265

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed

   ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

      ☐ on paper

      ☐ in electronic form

   b. (time)

      ☐ in the international application as filed

      ☐ together with the international application in electronic form

      ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	6, 7, 15, 22-24, 28, 40, 41, 49, 50
	No:	Claims	1-5, 8-14, 16-21, 25-27, 29-39, 42-48, 51, 52
Inventive step (IS)	Yes:	Claims	6, 15, 22, 28, 40, 49
	No:	Claims	1-5, 7-14, 16-21, 23-27, 29-39, 41-48, 50-52
Industrial applicability (IA)	Yes:	Claims	1-52
	No:	Claims	

2. Citations and explanations

see separate sheet

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

D1 WO 2007/136337 A2 (ERICSSON TELEFON AB L M [SE]) 29 November 2007 (2007-11-29)

D2 US 7 840 220 B1 (MITCHELL JAMES P [US]) 23 November 2010 (2010-11-23)

2 The present application does not meet the criteria of Article 33(2) PCT, because the subject-matter of the independent claims is not new. Reasons follow.

2.1 D1 discloses (the references in parenthesis applying to this document):

A method for optimizing performance (page 2, lines 7-9 and 19-24: according to the method of D1, CQI for link adaptation is generated as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable. This way the performance of the communication unit(s) is optimized) of one or more communication units (page 5, lines 7-18, page 7, lines 9-12, page 16, lines 26-28, figure 1, reference sign 12) by a remote server (page 5, lines 23-25, page 7, lines 9-12, figure 1, reference sign 10: the base station 10 can be seen as a remote server), the method comprising:
collecting data from the one or more communication units (according to D1, different types of data concerning the wireless communication devices can be collected by the base station: information on fast/slow fading, page 4, lines 31-35, page 16, lines 21-23, claim 39, relative motion with respect to the base station, page 6, lines 17-21, identification number of the devices, page 7, lines 28-30, location of the devices, page 6, lines 20-22);
generating a policy, for each of the one or more communication units (page 16, lines 26-28), based on the collected data (page 1, lines 27-35, page 5, line 32, page 6, line 2, page 8, lines 17-37, page 12, lines 1-5, page 16, lines 21-28: the

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first policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of long-term propagation channel characteristics, e.g. NACK rate, while the second policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of short-term channel estimates); and
sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy (page 7, lines 9-12, "a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode") according to time-varying data (link adaptation is inherently performed according to time-varying data).

As all the features of claim 1 are disclosed in the same combination in D1, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.2 D2 discloses (the references in parenthesis applying to this document):

A method for optimizing performance of one or more communication units (figure 2, reference sign 12a: the communication unit is the DTV station 12a. There can be more than one DTV stations 12a, see column 8, line 6, "Some DTV stations 12a...") by a remote server (column 5, lines 13-31, figure 2, reference sign 13: the remote server is the EOC 13, which is connected to the DTV station(s) 12a via the WAN 18), the method comprising:
collecting data from the one or more communication units (column 7, line 19 - column 8, line 11: data, i.e. RF statistics over a geographic region, is collected by the EOC 13 during a field survey. The data can be collected from the mobile clients 16 but also from DTV stations 12a, see column 8, lines 6-9, "This data may be used for the field survey data...");
generating a policy, for each of the one or more communication units, based

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on the collected data (column 5, line 62 - column 6, line 47: a FEC policy is generated at the EOC 13 for the DTV station (s) on the basis of the data collected during the field survey); and
sending the policy to each of the one or more communication units (column 6, lines 39-41, "An assigned FEC method and strength is used with a data payload for broadcast over the DTV broadcast network 12 to the mobile client 16"), wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy (column 6, line 54 - column 7, line 6: the conditions for operation comprise link adaptation strategies) according to time-varying data (column 6, line 54 - column 7, line 6: the time-varying data correspond to the GPS position and speed of the mobile clients 16 and to time information).

As all the features of claim 1 are disclosed in the same combination in D2, the subject-matter of claim 1 is not new (Article 33(2) PCT).

2.3 The same applies to the corresponding independent claims 10, 27, 34 and 44, the subject-matter of which is thus also not new (Article 33(2) PCT).

2.4 D1 discloses (the references in parenthesis applying to this document):

A method for optimizing performance (page 2, lines 7-9 and 19-24: according to the method of D1, CQI for link adaptation is generated as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable. This way the performance of the communication unit(s) is optimized) of one or more communication units (page 5, lines 7-18, page 7, lines 9-12, page 16, lines 26-28, figure 1, reference sign 12), the method comprising:
sending data from one or more communication units to a remote server (according to D1, different types of data concerning the wireless communication devices can be sent to the base station, which can be seen as a remote server: information on fast/slow fading, page 4, lines 31-35, page 16, lines 21-23, claim 39, relative motion with respect to the base station, page 6, lines 17-21,

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identification number of the devices, page 7, lines 28-30, location of the devices, page 6, lines 20-22);
receiving a policy from the remote server (page 7, lines 9-12, "a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode"), wherein the policy comprises conditions for operation of the one or more communication units (page 1, lines 27-35, page 5, line 32, page 6, line 2, page 8, lines 17-37, page 12, lines 1-5, page 16, lines 21-28: the first policy corresponds to a link adaptation mode in which the channel quality information to be computed by the wireless communication devices is generated as a function of long-term propagation channel characteristics, e.g. NACK rate, while the second policy corresponds to a link adaptation mode in which the channel quality information is generated as a function of short-term channel estimates); and
executing the policy (implicit) by implementing one of first and second algorithms (the two algorithms correspond to the above mentioned two link adaptation modes corresponding to fast-fading and slow-fading) based on the conditions and time-varying data (link adaptation is inherently performed according to time-varying data).

As all the features of claim 17 are disclosed in the same combination in D1, the subject-matter of claim 17 is not new (Article 33(2) PCT).

2.5 D2 discloses (the references in parenthesis applying to this document):

A method for optimizing performance of one or more communication units (figure 2, reference sign 12a: the communication unit is the DTV station 12a. There can be more than one DTV stations 12a, see column 8, line 6, "Some DTV stations 12a..."), the method comprising:
sending data from one or more communication units to a remote server (column 5, lines 13-31, figure 2, reference sign 13: the remote server is the EOC 13, which is connected to the DTV station(s) 12a via the WAN 18. Column 7, line 19 -

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column 8, line 11: data, i.e. RF statistics over a geographic region, is collected by the EOC 13 during a field survey. The data can be collected from the mobile clients 16 but also from DTV stations 12a, see column 8, lines 6-9, "This data may be used for the field survey data..."); receiving a policy from the remote server (column 6, lines 39-41, "An assigned FEC method and strength is used with a data payload for broadcast over the DTV broadcast network 12 to the mobile client 16"), wherein the policy comprises conditions for operation of the one or more communication units (column 6, line 54 - column 7, line 6: the conditions for operation comprise link adaptation strategies); and executing the policy by implementing one of first and second algorithms (column 6, line 54 - column 7, line 6, figure 3: the link adaptation strategies corresponding to Zones 1 and 2 can be seen as first and second algorithms) based on the conditions and time-varying data (column 6, line 54 - column 7, line 6: the time-varying data corresponds to the GPS position and speed of the mobile clients 16 and to time information).

2.6 As all the features of claim 17 are disclosed in the same combination in D2, the subject-matter of claim 17 is not new (Article 33(2) PCT).

2.7 The same applies to the corresponding independent claim 27, the subject-matter of which is thus also not new (Article 33(2) PCT).

3 Dependent claims 2-5, 7-9, 11-14, 16, 18-21, 23-26, 29-33, 35-39, 41-43, 45-48, 50-52 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty (Article 33(2) PCT) and/or inventive step (Article 33(3) PCT), see the documents and the corresponding passages cited in the international search report.

4 The combination of the features of dependent claims 6, 15, 22, 28, 40 and 49 is neither known from, nor rendered obvious by, the available prior art. The reasons are as follows: the fact of generating the (software) code for an adaptation algorithm at the server and of sending the code to the communication unit(s) for being executed on the communication unit(s) allows to increase the flexibility and adaptability of the link adaptation policies to be used in the system (e.g. with respect to sending only link adaptation

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parameters as in D2). In other words, the link adaptation algorithms to be executed at the communication unit(s) can be better dynamically updated and adapted to the specific situations of the network and of each of the communication units. The generation of the (software) code for an adaptation algorithm at the server is neither disclosed nor suggested by the available documents of the prior art.

Re Item VIII

Certain observations on the international application

5 The expression "pseudo-code" used in claims 6, 15, 22, 28, 40 and 49 renders the subject-matter of these claims unclear (Article 6 PCT) for the following reasons:

5.1 Wikipedia (http://en.wikipedia.org/wiki/Pseudocode) gives the following definition of pseudo-code: "In computer science and numerical computation, pseudocode is an informal high-level description of the operating principle of a computer program or other algorithm. It uses the structural conventions of a programming language, but **is intended for human reading rather than machine reading**. Pseudocode typically omits details that are not essential for human understanding of the algorithm, such as variable declarations, system-specific code and some subroutines. The programming language is augmented with natural language description details, where convenient, or with compact mathematical notation. The purpose of using pseudocode is that it is easier for people to understand than conventional programming language code, and that it is an efficient and environment-independent description of the key principles of an algorithm. It is commonly used in textbooks and scientific publications that are documenting various algorithms, and also in planning of computer program development, for sketching out the structure of the program before the actual coding takes place. No standard for pseudocode syntax exists, as **a program in pseudocode is not an executable program**."

5.2 The following statements are in the description: "The pseudo-code may be coded in any software coding language that is executable by the communication unit" and "when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code" (§ 0030, 0058, 0064). These statements clearly contradict the well-known, common meaning of "pseudo-code", as shown above. A pseudo-code is not executable by a processor. For this reason, the intended limitations for claims 6, 15, 22, 28, 40 and 49 are not clear, contrary to the requirements of Article 6 PCT.

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The expression "pseudo-code or code" used in claims 6, 15, 22, 28, 40 and 49 should have been changed into "software code" in order to meet the requirements of Article 6 PCT.

6 Claims 10, 12, 13, 14 refers to method steps to be implemented by the communication unit(s), even though claims 10, 12, 13, 14 refer to a machine-readable storage medium having computer executable instructions to be executed by the remote server. The intended limitations for claims 10, 12, 13, 14 are therefore not clear, contrary to the requirements of Article 6 PCT.

7 Claims 34, 36, 37, 38, 39 refers to apparatus features of the communication unit(s), even though claims 34, 36, 37, 38, 39 refer to the server apparatus. The intended limitations for claims 34, 36, 37, 38, 39 are therefore not clear, contrary to the requirements of Article 6 PCT.

8 Although claims 34 and 44 have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and/or in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

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Possible steps after receipt of the international search report (ISR) and written opinion of the International Searching Authority (WO-ISA)

General information	For all international applications filed on or after 01/01/2004 the competent ISA will establish an ISR. It is accompanied by the WO-ISA. Unlike the former written opinion of the IPEA (Rule 66.2 PCT), the WO-ISA is not meant to be responded to, but to be taken into consideration for further procedural steps. This document explains about the possibilities.
Amending claims under Art. 19 PCT	Within 2 months after the date of mailing of the ISR and the WO-ISA the applicant may file amended claims under Art. 19 PCT directly with the International Bureau of WIPO. The PCT reform of 2004 did not change this procedure. For further information please see Rule 46 PCT as well as form PCT/ISA/220 and the corresponding Notes to form PCT/ISA/220.
Filing a demand for international preliminary examination	In principle, the WO-ISA will be considered as the written opinion of the IPEA. This should, in many cases, make it unnecessary to file a demand for international preliminary examination. If the applicant nevertheless wishes to file a demand this must be done before expiry of 3 months after the date of mailing of the ISR/WO-ISA or 22 months after priority date, whichever expires later (Rule 54bis PCT). Amendments under Art. 34 PCT can be filed with the IPEA as before, normally at the same time as filing the demand (Rule 66.1 (b) PCT). If a demand for international preliminary examination is filed and no comments/amendments have been received the WO-ISA will be transformed by the IPEA into an IPRP (International Preliminary Report on Patentability) which would merely reflect the content of the WO-ISA. The demand can still be withdrawn (Art. 37 PCT).
Filing informal comments	After receipt of the ISR/WO-ISA the applicant may file informal comments on the WO-ISA directly with the International Bureau of WIPO. These will be communicated to the designated Offices together with the IPRP (International Preliminary Report on Patentability) at 30 months from the priority date. Please also refer to the next box.
End of the international phase	At the end of the international phase the International Bureau of WIPO will transform the WO-ISA or, if a demand was filed, the written opinion of the IPEA into the IPRP, which will then be transmitted together with possible informal comments to the designated Offices. The IPRP replaces the former IPER (international preliminary examination report).
Relevant PCT Rules and more information	Rule 43 PCT, Rule 43bis PCT, Rule 44 PCT, Rule 44bis PCT, PCT Newsletter 12/2003, OJ 11/2003, OJ 12/2003

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 426 983 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

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(21) Application number: **10840401.3**

(22) Date of filing: **30.06.2010**

(51) Int Cl.:
H04W 28/08 *(2009.01)*

(86) International application number:
PCT/CN2010/074869

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(54) METHOD FOR LINK ADAPTATION AND APPARATUS THEREOF

(57) A method for link adaptation includes: classifying a radio channel; setting a set of link adaptation modes; and selecting a corresponding link adaptation mode according to a radio channel type. An apparatus for link adaptation includes: a classification module for performing a classification on a radio channel; a setting module for setting a set of link adaptation modes; and a mode selection module for selecting a corresponding link adaptation mode from the setting module according to a radio channel type of the classification. The present invention accordingly selects effective link adaptation modes in accordance with different types of radio channels, and is able to ensure to implement the maximum system throughput in different fading channels and maintain the stable and reliable link quality.

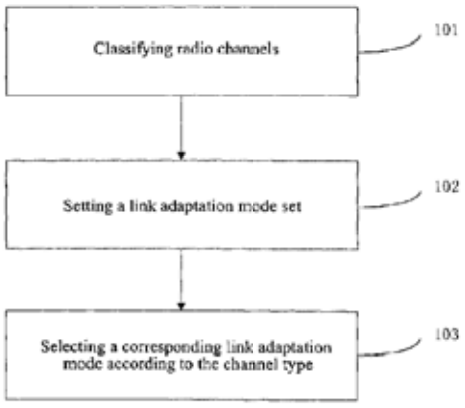


FIG. 1

EP 2 426 983 A1

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Description

Technical Field

[0001] The present invention relates to wireless communication systems, and more particularly, to a link adaptation technique.

Background of the Related Art

[0002] In wireless communication systems, since the radio channel is complex and there is no fixed rules to follow, in order to implement the maximum throughput of the wireless communication systems, wireless communication systems are expected to be able to automatically adjust the transmission rate according to the channel condition change, namely the link adaptation technique. The conventional method for link adaptation is taking the latest channel quality measurement result as a basis of selecting the future link rate.

Summary of the Invention

[0003] In the prior art, the conventional method for link adaptation is taking the latest channel quality measurement results as a basis of selecting the future link rate, and this method has the following problems:

the channel quality measurement results always contain measurement errors and random interference affects, namely the measurement results cannot accurately reflect the actual channel conditions;

radio channel conditions randomly change with the change of the time, and that is to say that the past measurement results cannot completely reflect the future channel conditions.

[0004] In view of this, the technical problem to be solve in the present invention is to provide a method and an apparatus for link adaptation, which are able to ensure the maximum throughput of the system implemented in different fading channels and maintain the stable and reliable link quality.

[0005] To solve the above technical problem, one aspect of the present invention is to provide a method for link adaptation, and the method comprises:

classifying a radio channel;

setting a link adaptation mode set; and

selecting a corresponding link adaptation mode according to a radio channel type.

[0006] In the step of classifying the radio channel, the radio channel is classified based on a time-variant characteristic of the radio channel.

[0007] In the step of classifying the radio channel, the radio channel is classified into:

a flat channel, a slow fading channel and a fast fading channel; or

the slow fading channel and the fast fading channel; or

the slow fading channel, the fast fading channel and a mutant channel.

[0008] The link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

[0009] The step of selecting the corresponding link adaptation mode according to the ratio channel type comprises: determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

[0010] After the step of selecting the corresponding link adaptation mode according to the radio channel type, the method also comprises: obtaining channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and obtaining a link rate matching with the channel prediction information at the to-be scheduling time.

[0011] Another aspect of the present invention also provides an apparatus for link adaptation, which comprises:

a classification module, which is configured to classify a radio channel;

a setting module, which is configured to set a link adaptation mode set; and

a mode selection module, which is configured to select a corresponding link adaptation mode from the setting module according to a radio channel type in the classification.

[0012] The classification module is configured to perform the classification on the radio channel based on a time-variant characteristic of the radio channel.

[0013] The classification module is configured to classify the radio channels into:

a flat channel, a slow fading channel and a fast fading channel; or

the slow fading channel and the fast fading channel; or

the slow fading channel, the fast fading channel and

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a mutant channel.

[0014] The link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

[0015] The mode selection module is configured to select the corresponding link adaptation mode according to the radio channel type in a following way:

determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

[0016] The apparatus also comprises:

a channel learning module, which is configured to analyze and process the historical measurement information of the radio channel to obtain a the current radio channel type; and

a link rate determination module, which is configured to: obtain the channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and select a link rate matching with the channel prediction information at the to-be scheduling time.

[0017] With the technique in the present invention, an effective link adaptation processing mode can be selected specifically according to different radio channel types, which is able to ensure to implement the maximum system throughput in different fading channels and to maintain a stable and reliable link quality.

Brief Description of Drawings

[0018] The drawings described herein is used to provide a better understanding of the present invention and forms a part of this application, the illustrative examples of the present invention and their descriptions are used to explain the present invention rather than forming the improper restriction on the present invention. In the drawings:

FIG. 1 is a flow chart of the method for link adaptation in accordance with the present invention;

FIG. 2 is a flow chart of the method for link adaptation in accordance with the example 1 of the present invention;

FIG. 3 is a schematic diagram of the classification of the radio channels;

FIG. 4 is a block diagram of the apparatus for link adaptation in accordance with the present invention.

Preferred Embodiments of the Present Invention

[0019] The specific embodiments of the present invention will be illustrated in detail with reference to drawings and examples.

[0020] The basic idea of the method for link adaptation in accordance with the present invention is shown in FIG. 1, which comprises:

step 101, the radio channels are classified;

step 102, a link adaptation mode set is set;

step 103, a corresponding link adaptation mode is selected according to the radio channel type.

Example 1

[0021] As shown in FIG. 2, this example comprises the following steps of:

step 201, the radio channels are classified, and the corresponding link adaptation mode set is set.

[0022] Specifically, in this example, the radio channels are classified into three types according to the time-variant characteristics of the radio channels, and as shown in FIG. 3, the three types of radio channels are: flat channels, slow fading channels and fast fading channels;
then further a corresponding link adaptation mode set is set according to the channel fading types;
the corresponding link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode and statistical quantile prediction mode, wherein:

the instantaneous value prediction mode refers to take the latest channel measurement result as a basis to select a link rate at the channel scheduling time.

[0023] The historical value prediction mode refers to use the curve fitting method to predict the channel conditions at the to-be scheduling time according to the historical channel measurement results for use by selecting the link rate.

[0024] The statistical quantile prediction mode refers to take a certain quantile of the cumulative distribution function of the historical measurement results as the basis to select the link rate at the to-be scheduling time. For example:

(1) flat channels: in the instantaneous value prediction mode, and predictable, that is, the prediction error is in the acceptable range;
suppose:

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the channel measurement result at the time t is denoted as SINR(t), the current time is denoted as t0, the to-be scheduling time is t0+n, where n is the sum of the system processing delay and the air interface transmission delay; the latest measurement result obtained at the current time is SINR(tx), and tx≤t0, therefore: the instantaneous value prediction result SINR_estimate (t0+n) is SINR_estimate(t0+n)=SINR(tx), the estimation error at the time t is denoted as Err (t), then: Err(t) = ISINR_estimate(t)-SINR(t)I
The predictable (estimable) probability is expressed as:
the probability function P(Err(t)≤Error_threholdI t = t0-w+1,t0-w+2,...,t0) ≥P1, 0≤P1≤1, w≥0, where Error_threshold is the estimation error threshold, when Err(t)≤Error_threhold, it indicates that the estimation at the time t is correct, otherwise, it indicates that the estimation is wrong, and the smaller the Error_threshold is, the higher the estimation precision is, otherwise, the estimation precision is lower; P1 denotes the probability threshold of the correct estimation, and that is, the probability of correct estimation is P1. When the probability of correct estimation is larger than the threshold P1, it indicates that the channel is estimable in this prediction mode (or predictable). Where, w indicates the statistical time window length, and the smaller the w is, the lower the switching between the channel modes is, the more accurate the statistical result is, the faster the switching between the development modes is and the lower the judgment precision is.

(2) Slow fading channels: in the historical value prediction mode, and predictable, that is, the prediction error is in the acceptable range.
The concept of predictability is as the above description and is not repeated herein;
the historical value prediction mode refers to: use the historical channel measurement results SINR(t0-w' +1), SINR(t0-w' +2),···, SINR(t0), use the selected basis function f(t) to perform the curve fitting on SINR (t), t = t0-w, + 1, t0-w, +2, -, t0 to obtain the mathematical expression of f(t), so that f (t) = SINR (t), t= t0-w' +1, t0-w' +2,···,t0. The historical value prediction result SINR_estimate (t)= f (t). Where w' denotes the number of historical measurement results; f(t) can be any basis functions such as the trigonometric function, the power function, the logarithmic function as well as the polynomial function and so on.

(3) Fast Fading Channels: other cases, that is, unpredictable;
those are unpredictable by the above two methods are determined as the fast fading channels, and the corresponding link adaptation mode is the statistical quantile prediction mode;
the statistical quantile prediction mode is the mode applying the probability distribution function:

P(x) = P(SINR(t)<x I t =t= t0-w"+1, t0-w"+2..... t0), the quantile at the point of alpha of the P(x) is taken as the statistical quantile prediction result SINR_estimate(t), that is, SINR_estimate(t) = P^{-1}(alpha) , and P^{-1}(x) is the inverse function of P(x); 0≤alpha≤1, the larger the alpha is, the higher the rate is, and the worse the reliability is, otherwise, the lower the rate is, and the better the reliability is;
step 202, the fading type of the radio channel is obtained according to the analysis of the historical measurement information of the radio channel, and that is, the fading type of the radio channel is obtained via the channel learning.

[0025] Step 202 comprises:

202.1, the historical measurement results are denoised, and a general de-noising way can be used, for example the filtering way or the sliding window average way;

202.2 N historical measurement results are observed, and if the channel is predictable in the instantaneous value prediction mode, the channel is a flat channel; if the channel is predictable in the historical value prediction mode, the channel is a slow fading channel; otherwise the channel is a fast fading channel.

[0026] Step 203, a link adaptation mode is selected from the link adaptation mode set according to the fading type of the radio channel obtained in step 202;
if the channel is a flat channel, the instantaneous value prediction mode is selected; if the channel is a slow fading channel, the historical value prediction mode is selected; and if the channel is a fast fading channel, the statistical quantile prediction mode is selected.

[0027] Step 204, the channel condition prediction information at the to-be scheduling time point is obtained according to the radio channel type and link adaptation mode;
the channel condition prediction information might include the Signal Interference Noise Radio (SINR), and the Block Error Rate (BLER), and so on;
it is assumed that the latest historical measurement value is SINR(t), and measurement value at the to-be scheduling time is SINR-estimate(tx);
the channel condition prediction information corresponding to the channel classification results is as follows:

in flat channels: SINR estimate(tx) = SINR(t);

in slow fading channels: SINR estimate(tx) = f(tx);

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in fast fading channels: SINR_estimate(tx)=P^{-1}(tx).

step 205, the matching link rate is obtained according to the channel condition prediction information obtained in step 204;

it is assumed that the channel SINR prediction result is SINR1 and the service BLER requirement is BLER1; the maximum rate that can be reached by the link in the conditions of SINR=SINR1 and BELR=BLER1 is the Modulation Code Scheme 1 (MCS1), therefore, the output result in this step is MCS1.

[0028] Step 206, the link adaptation process is complete.

Example 2

[0029] In addition, the present invention can further classify the radio channels into two types according to the time-variant characteristics of the radio channels, namely: slow fading channels and fast fading channels. The processing method is as the example 1 and is not repeated herein.

Example 3

[0030] In addition, the present invention can further classify the radio channels into: fast fading channels, slow fading channels and mutant channels according to the time-variant characteristics of the radio channels.

[0031] Wherein, the method for processing the fast fading channels and the slow fading channels is as the example 1 and is not repeated herein.

[0032] For a mutant channel, the channel is suddenly good or bad, the corresponding link adaptation mode is the mutation processing mode.

[0033] For the mutant channel, the mutant processing mode is applied, and the mutation processing mode refers to: clear the historical information, use the initial default channel prediction way which might use any one of the historical value prediction mode or the instantaneous value prediction mode, and the specific selection is determined according to the data reliability requirements.

Example 4

[0034] Based on the same inventive concept, the example of the present invention also provides an apparatus for link adaptation, since the principle of the apparatus for solving the problem is similar to the method for link adaptation, the implementation of the apparatus can refer to the implementation of the method, and the overlaps are not repeated herein.

[0035] FIG. 4 shows a schematic diagram of the structure of the apparatus for link adaptation in accordance of the present invention, and as shown in FIG. 4, the apparatus comprises a classification module, a setting module and a mode selection module, wherein

the classification module 401 is configured to perform a classification on the radio channels;

the setting module 402 is configured to set a link adaptation mode set;

the mode selection module 403 is configured to select the corresponding link adaptation mode from the setting module according to the radio channel type in the classification.

[0036] Preferably, the apparatus for the link adaptation in the present invention also comprises a channel learning module and a link rate determination module, wherein the channel learning module is configured to analyze and process the historical measurement information of the radio channels to obtain the current radio channel type; the link rate determination module is configured to obtain the channel prediction information at the to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and to select the matching link rate.

[0037] It can be understood by those skilled in the art that some or all steps in the above mentioned method can be fulfilled by instructing the relevant hardware with a program, and said program is stored in a computer readable storage medium such as the read only memory, the magnetic disk or the optical disk. Optionally, some or all steps in the above mentioned examples can be implemented with one or more integrated circuits. Correspondingly, each module/unit in the above mentioned examples can be implemented in the form of hardware or in the form of software function module, or their combinations.

[0038] The principle of the present invention is illustrated in detail in the above description, however, the description is only a plurality of examples illustrated for understanding the present invention rather than the restriction of the protection scope of the present invention. For those skilled in the art, various corresponding modifications and transformations can be made according to the present invention without departing from the spirit and essence of the present invention, and such modification or transformations should fall into the protection scope of the appended claims of the present invention.

Industrial Applicability

[0039] With the technique in the present invention, an effective link adaptation processing mode can be selected specifically according to different radio channel types, which is able to ensure the maximum system throughput in different fading channels and to maintain a stable and reliable link quality.

Claims

1. A method for link adaptation, wherein, the method

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comprising:

classifying a radio channel;
setting a link adaptation mode set; and
selecting a corresponding link adaptation mode according to a radio channel type.

2. The method of claim 1, wherein, in the step of classifying the radio channel, the radio channel is classified based on a time-variant characteristic of the radio channel.

3. The method of claim 2, wherein, in the step of classifying the radio channel, the radio channel is classified into:

a flat channel, a slow fading channel and a fast fading channel; or
the slow fading channel and the fast fading channel; or
the slow fading channel, the fast fading channel and a mutant channel.

4. The method of claim 1, wherein the link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

5. The method of claim 4, wherein the step of selecting the corresponding link adaptation mode according to the ratio channel type comprises:

determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

6. The method of claim 5, after the step of selecting the corresponding link adaptation mode according to the radio channel type, the method also comprising:

obtaining channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and obtaining a link rate matching with the channel prediction information at the to-be scheduling time.

7. An apparatus for link adaptation, comprising:

a classification module, which is configured to perform a classification on a radio channel;
a setting module, which is configured to set a link adaptation mode set; and
a mode selection module, which is configured to select a corresponding link adaptation mode from the setting module according to a radio channel type in the classification.

8. The apparatus of claim 7, wherein the classification module is configured to perform the classification on the radio channel based on a time-variant characteristic of the radio channel.

9. The apparatus of claim 8, wherein the classification module is configured to classify the radio channel into:

a flat channel, a slow fading channel and a fast fading channel; or
the slow fading channel and the fast fading channel; or
the slow fading channel, the fast fading channel and a mutant channel.

10. The apparatus of claim 7, wherein the link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

11. The apparatus of claim 10, wherein the mode selection module is configured to select the corresponding link adaptation mode according to the radio channel type in a following way:

determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

12. The apparatus of claim 7, the apparatus also comprising:

a channel learning module, which is configured to analyze and process historical measurement information of the radio channel to obtain a current radio channel type; and
a link rate determination module, which is configured to: obtain the channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and select a link rate matching with the channel prediction information at the to-be scheduling time.

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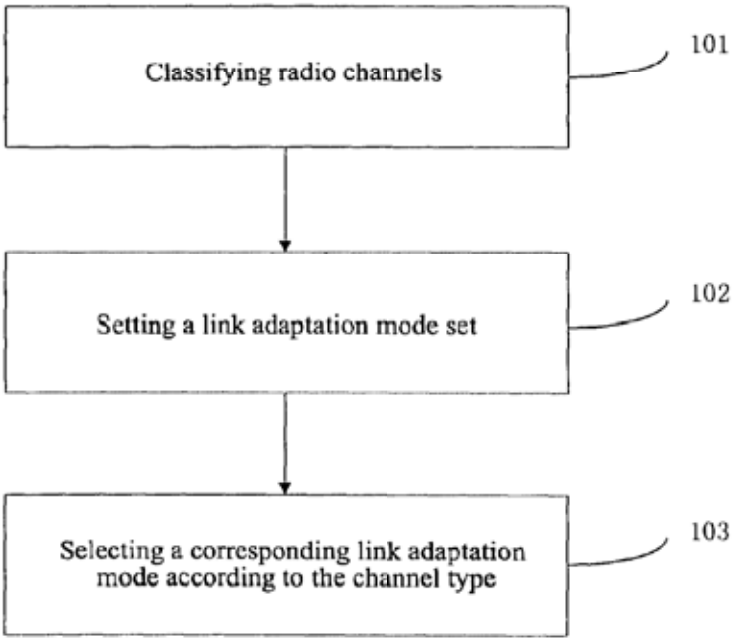


FIG. 1

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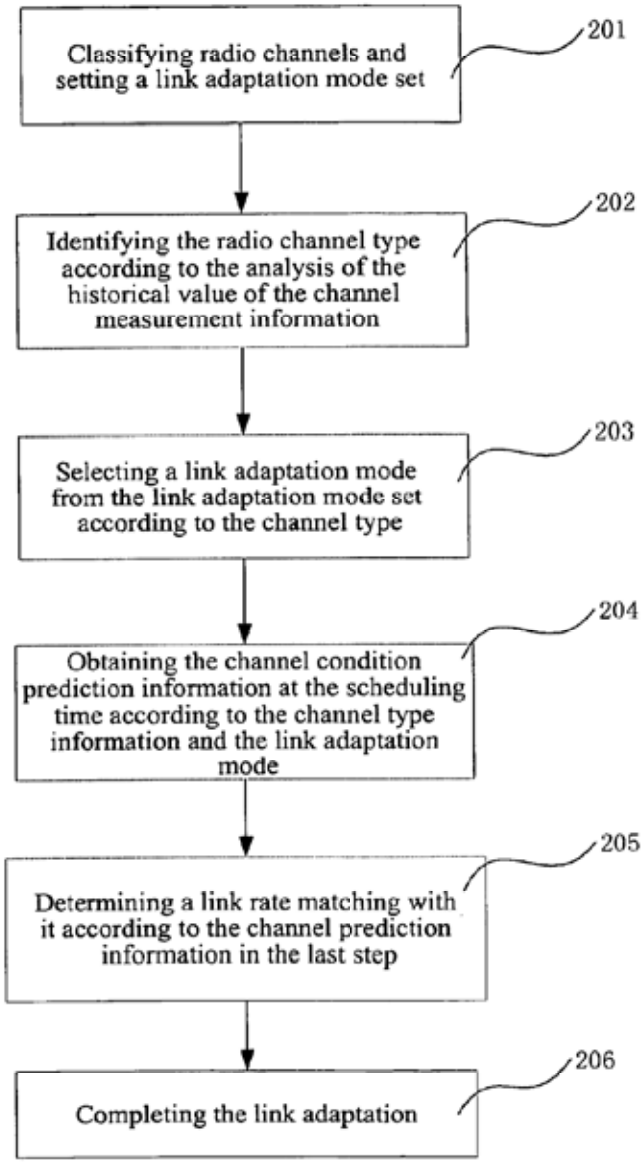


FIG. 2

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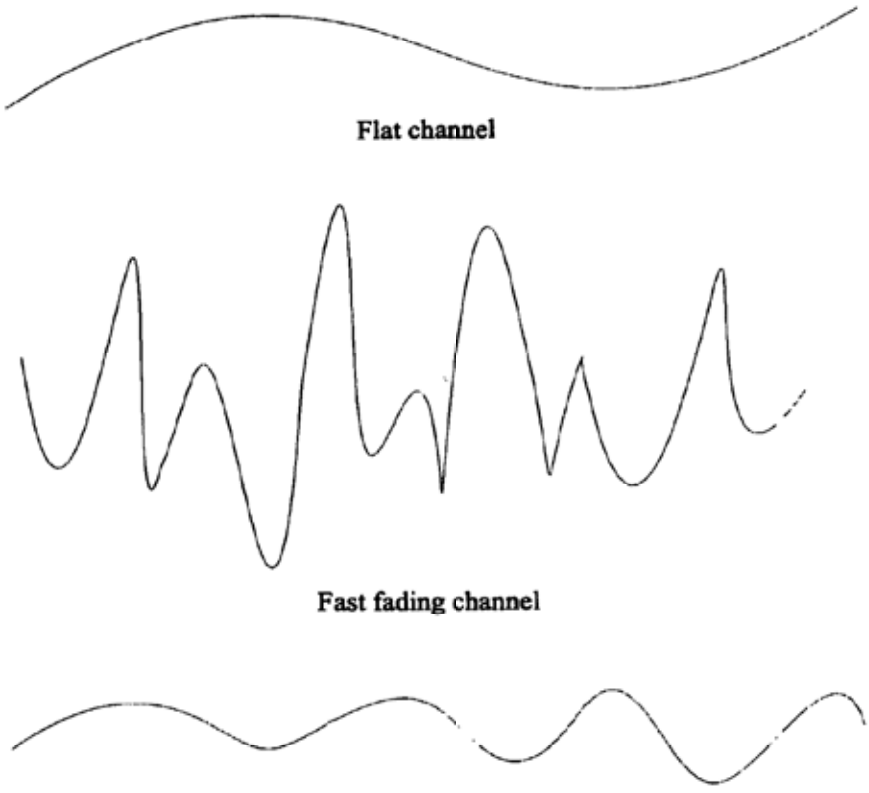


FIG. 3

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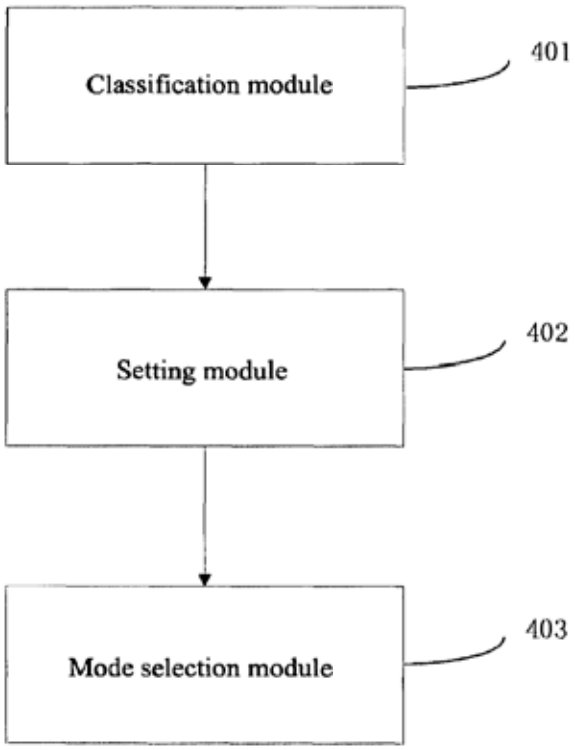


FIG. 4

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/074869

A. CLASSIFICATION OF SUBJECT MATTER

H04W 28/08 (2009.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W H04L H04J H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT; CNKI; WPI; EPODOC; link?, channel?, adaptation, adaptive, classif+, type?, mode?, pattern?, rate, throughput, fading, predict+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1829113A (MATSUSHITA ELECTRIC IND CO LTD) 06 Sep. 2006 (06.09.2006)	1-3,7-9
Y	description, page 2, lines 1-7, page 3, lines 14-19, figures 3, 6	4-6,10-12
Y	CN1399436A (INTEL CORP) 26 Feb. 2003 (26.02.2003) description, page 4, line 3 to page 6, line 22, page 10, line 19 to page 11, line 31, figures 2-5	4-6,10-12
A	CN1862995A (ZHONGXING COMMUNICATION CO LTD SHENZHEN) 15 Nov. 2006 (15.11.2006) full text	1-12
A	US20090310550A1(BECEEM COMMUNICATIONS INC)17 Dec. 2009(17.12.2009) full text	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 Sep. 2010 (25.09.2010)	**28 Oct. 2010 (28.10.2010)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer Meng, Tiange Telephone No. (86-10)62411653

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
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CN1399436A	26.02.2003	US20030178354A1	23.01.2003
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Declarations under Rule 4.17:
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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:
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(54) Title: METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION

(57) Abstract: A method and apparatus for generating channel quality information, such as may be used for transmit link adaptation, provide different operating modes, such as a first mode that may be used when propagation channel estimates are not reliable, and a second mode that may be used when the propagation channel estimates are reliable. In one or more embodiments, channel quality information is generated using receiver performance informatio that characterizes receiver performance in terms of a defined channel quality metric, e.g., supported data rates, for different values of receiver input signal quality over a range of propagation channel realizations. Channel quality information can be generated by selecting channel quality metrics according to receiver input signal quality and a desired probability of meeting a defined performance requirement over a range of propagation channel realizations, or by selecting channel quality metrics according to receiver input signal quality and particularized propagation channel realizations.

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METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION

BACKGROUND

The present invention generally relates to generating wireless communications, and particularly relates to generating channel quality information.

Channel quality information can be expressed in a number of ways, such as a channel quality indicator identifying the effective signal quality of a wireless communication receiver. The effective signal quality represents the benefits of any interference cancellation gains, diversity combining gains, coding gains, etc., that may be provided by the receiver. In other words, the output signal quality of a given receiver may be significantly better than the receiver's input signal quality, which generally is expressed as the "raw," uncompensated ratio of received signal energy to background noise and interference.

Those skilled in the wireless communications art will appreciate the value of generating channel quality information based on the output signal quality rather than the input signal quality, because the output signal quality better represents the actual signal quality bearing on the quality of demodulation and decoding performance. That is, assuming that the channel quality information is used for link adaptation, e.g., picking the modulation and coding scheme (MCS) that is appropriate for transmitting to the receiver, using input signal quality rather than output signal quality would result in chronically underutilizing the transmission link.

Accurately determining output signal quality as part of ongoing receiver operations is not, however, a straightforward proposition for some types of receivers. In particular, non-linear receivers generally have a complex relationship between input signal quality and output signal quality. Examples of non-linear receivers include multi-stage receivers employing successive interference cancellation, and joint-detection receivers.

Further, even assuming the calculability of output signal quality, such calculations may be inaccurate under some circumstances. For example, the performance achievable by a given receiver depends on a number of variables, including propagation channel conditions. Some channel conditions translate into better receiver performance than others. Thus, even for the same receiver input signal, the receiver output signal quality will vary as a function of changing channel conditions. If channel conditions are changing rapidly, or the input signal is too weak to make reliable channel estimates, reporting output signal quality, or some metric relating to output signal quality, may lead to control errors.

For example, a supporting base station may perform transmit link adaptation responsive to receiving channel quality information from a wireless communication device, that identifies the quality of the channel in terms of some metric, such as a channel quality indicator, a rate selection indicator, or the like. Thus, the base station can adjust the transmit data rate, for example, in accordance with the channel quality indicators reported by the device. This control

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mechanism works well if the actual channel conditions change slowly in comparison to the link adaptation control lag. However, performing link adaptation in consideration of actual propagation channel conditions becomes unreliable if those conditions change rapidly in comparison to the link adaptation control timing.

SUMMARY

According to one or more method and apparatus embodiments taught herein, different modes of operation are used for determining channel quality information for a wireless communication device, depending on, for example, the reliability of propagation channel estimates for the wireless communication device. For example, in one embodiment, channel quality information is determined in a first mode by mapping receiver input signal quality to a data rate that can be supported at a desired probability over a range of propagation channel realizations. A supported data rate may be defined as an allowable data rate that can be achieved with a desired performance requirement, e.g., Block Error Rate (BLER). Further, in the second mode, the channel quality information is determined by mapping receiver input signal quality to a data rate that can be supported for a particular propagation channel realization, or that can be supported for a constrained range of propagation channel conditions, corresponding to the current channel estimates obtained by the wireless communication device.

Thus, the first mode provides for generating channel quality information as a function of long-term propagation channel conditions when short-term propagation channel estimates are not reliable, such as where the time lag associated with transmit link adaptation is large compared to the coherent time of propagation channel fading. Conversely, the second mode provides for generating channel quality information as a function of short-term propagation channel conditions when short-term propagation channel estimates are reliable. Modal operation can be driven by determining whether the channel estimates being generated by the wireless communication device are reliable. Reliability may be determined by evaluating the mobility—e.g., rate of movement, Doppler frequency, etc.—of the wireless communication device, or by evaluating the channel estimates.

With the above in mind, in one embodiment, a method of determining channel quality information for a transmit propagation channel associated with a wireless communication device comprises in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates, and in a second mode, generating channel quality information according to a second algorithm that depends on channel estimates. Receiver performance data characterizing receiver performance for a type of receiver associated with the wireless communication device may be used to generate the channel quality feedback in the first and second modes, and such generation may be performed by the wireless communication device itself, or by a base station in a supporting wireless communication network.

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For example, a wireless communication device or a base station may comprise one or more processing circuits configured to determine channel quality information for one or more signals received by the wireless communication device, based on, in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates, and in a second mode, generating channel quality information according to a second algorithm that depends on channel estimates. The processing circuit(s) are, in one or more embodiments, configured to operate selectively in the first or second mode based on whether the channel estimates are reliable.

Complementing the above method of channel quality information generation, one embodiment of a receiver performance characterization method comprises, at each of a number of receiver input signal qualities, computing an error rate expected for each of a number of propagation channel realizations, and, for each of the error rates computed, computing a data rate that can be supported for each propagation channel realization at each receiver input signal quality, and, for each receiver input signal quality, computing the cumulative distribution function (CDF) of the supported data rates corresponding to the propagation channel realizations. Such performance characterization data may be stored by the wireless communication device, or by the supporting wireless communication network. Generally, the performance characterization data is specific for a receiver type, and different data can be stored for different receiver types. For example, a particular type of Generalized RAKE (G-RAKE) or other Minimum Mean Squared Error (MMSE) receiver would have different characterization data than would a particular type of Joint Detection (JD) receiver. Similarly, different performance characterization data can be stored for different transmit/reception modes (MISO, MIMO, etc.), even for the same receiver type.

A corresponding method of providing rate adaptation feedback from a wireless communication device to a supporting wireless communication network operates in a first mode by selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements obtained by the wireless communication device, and a desired probability of achieving the selected data rate for a range of propagation channel realizations. In the second mode, the channel quality information is generated using the receiver performance data by selecting a supported data rate according to receiver input signal quality and a particular propagation channel realization, or a constrained range of the propagation channel realizations, corresponding to channel estimates obtained by the wireless communication device.

Of course, the present invention is not limited to the above features and advantages. Indeed, those skilled in the art will recognize additional features and advantages upon reading the following detailed description, and upon viewing the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram of a base station and a wireless communication device, such as a mobile station, wherein channel quality information is generated according to one or more method embodiments taught herein.

Fig. 2 is a logic flow diagram for one embodiment of processing logic for modal generation of channel quality information.

Fig. 3 is a logic flow diagram for one embodiment of selecting operating modes in the context of Fig. 2.

Fig. 4 is a logic flow diagram for another embodiment of selecting operating modes in the context of Fig. 2.

Fig. 5 is a logic flow diagram for one embodiment of a receiver performance characterization method.

Figs. 6 and 7 are graphs depicting receiver performance characterizations obtained by the receiver performance characterization method of Fig. 5, for different types of wireless communication device receivers.

Fig. 8 is a logic flow diagram for one embodiment of modally generating channel quality information using receiver performance data.

Fig. 9 is a block diagram for one embodiment of a wireless communication device that is configured to generate channel quality information.

Figs. 10 and 11 are block diagrams of embodiments of processing circuits used in generating channel quality information.

Fig. 12 is a block diagram of one embodiment of a base station that is configured to generate channel quality information based on receiving channel quality measurements for the wireless communication device.

DETAILED DESCRIPTION

Fig. 1 illustrates a base station 10 and a wireless communication device 12, wherein the channel quality information generated for the downlink between the base station 10 and the wireless communication device 12 is, in a first mode of operation, not dependent on current propagation channel estimates, and, in a second mode, is dependent on current propagation channel estimates. Thus, the first mode of generating channel quality information may be used where estimates of the downlink propagation channel are not reliable, such as when the wireless communication device 12 is moving at a high rate relative to the base station 10, or is otherwise experiencing fast fading conditions, or when the received signal strength is too low for reliable channel estimation.

Before describing various embodiments of the above method of generating channel quality information, it should be understood that the processing logic associated with generating the channel quality information can be performed wholly in the wireless communication

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device 12, wholly in the base station 10, or performed cooperatively using both the base station 10 and the wireless communication device 12. In all such cases, the attendant processing may be implemented in hardware, software, or any combination thereof. Moreover, it should be understood that the base station 10 and the wireless communication device 12 are not limited to any particular configuration, nor are they limited to any particular wireless communications standards or protocols.

For example, in one or more embodiments, the wireless communication device 12 comprises a cellular radiotelephone or other type of mobile station, configured for operation with a supporting wireless communication network that includes the base station 10. In such embodiments, the base station 10 may comprise a Wideband CDMA (WCDMA) base station configured to provide High Speed Downlink Packet Access (HSDPA) services.

Correspondingly, the wireless communication device 12 may comprise a WCDMA-based access terminal configured to provide channel quality information, or related feedback, to the base station 10, in support of adapting downlink transmit data rates to changing reception conditions at the wireless communication device 12. In general, however, the wireless communication device 12 may comprise a mobile station or other type of handset, a pager, a Portable Digital Assistant (PDA), a palmtop or laptop computer, or a wireless communication module for use therein, or essentially any other type of communication device.

Keeping the method's broad applicability in mind, Fig. 2 illustrates one embodiment of a method of generating channel quality information, wherein it should be understood that at least some of the illustrated processing steps may be performed in other than the illustrated order. Further, although illustrated as serial processing, actual implementation of the method may involve concurrent, parallel processing, as part of ongoing communication operations. Also, it should be understood that the illustrated processing may be implemented in the base station 10, the wireless communication device 12, or in some combination thereof.

Processing "begins" with a determination of whether to operate in a first mode of generating channel quality information (Step 100). If the first mode is selected, processing continues with generating channel quality information according to a first algorithm that does not depend on channel estimates (Step 102). Conversely, if the first mode is not selected, i.e., the second mode of operation is selected, processing continues with generating channel quality information according to a second algorithm that depends on channel estimates (Step 104).

In at least one embodiment taught herein, the first mode of generating channel quality information is used during fast fading conditions, or whenever conditions are such that the short-term channel estimates obtained by the wireless communication device 12 are "unreliable." The second mode of generating channel quality information is used during slow fading conditions, or, more generally, whenever the channel estimates are reliable. In other words, channel quality information is generated as a function of long-term propagation channel characteristics when short-term estimates of the channel are not reliable. Conversely, channel

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quality information is generated as a function of the short-term propagation channel characteristics when the channel estimates are reliable.

It should be understood that various methods of assessing channel estimation reliability are contemplated herein, and it should be understood that conditions deemed to give rise to unreliable channel estimations in one application may not be considered as such in another application. For example, the reliability of a short-term channel estimate may be viewed in terms of fading speed versus link adaptation control lag. That is, channel estimates may be deemed more or less reliable in dependence on how quickly channel conditions change relative to the transmit link adaptations being made. In some embodiments, the link adaptation lag—i.e., the time between a reported channel quality metric and the corresponding transmit link adjustment—may be used to influence whether, or to what extent, short-term propagation channel conditions are considered in generating channel quality information.

With such variations in mind, Fig. 3 illustrates one embodiment of processing logic for determining whether to operate in the first or second modes of Fig. 2. Modal selection processing "begins" with evaluating propagation channel fading conditions (Step 106). As will be detailed later herein, the evaluation may comprise assessing the reliability of the channel estimates to determine whether fast-fading conditions apply. In other embodiments, fast-fading may be recognized by evaluating mobility, such as by evaluating the Doppler frequency shift of transmissions on the downlink and/or uplink channels between the base station 10 and the wireless communication device 12. Of course, other indicators bearing on the reliability of short-term channel estimates may be used. For example, certain service areas may make channel estimates inherently suspect, such as radio sectors in downtown or urban areas.

If fast fading conditions apply (Step 108), channel quality generation operates in the first mode, wherein channel quality information is generated in a manner that is not dependent on channel estimates (Step 110). Conversely, if fast fading conditions do not apply, channel quality information is generated in a manner that is dependent on channel estimates (Step 112).

Fig. 4 illustrates another embodiment of processing logic for determining whether to operate in the first or second modes of Fig. 2. Modal selection processing "begins" with evaluating the network usage or load conditions (Step 114). In a lightly loaded wireless network, the reliability of the channel estimates and the derived channel quality information can be compromised even if the propagation channel fading conditions change slowly or remain static. For example, because of bursty and fast varying of inter-cell interference that is characteristic of a lightly load network, the channel quality and hence the supportable data rate realized during actual transmission of the data can be rather different than what was measured prior to the transmission.

Thus, if the network is lightly loaded (Step 116), it can be advantageous to select the first mode of determining channel quality information (Step 118). Conversely, if the network is more heavily loaded, or the loading is otherwise more stable, channel quality information can be

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determined according to the second mode of operation (Step 119). The selection of which operating mode to use for channel quality information determination can be evaluated and/or applied to individual wireless communication devices 12, or can be applied to sets or subsets of wireless communication devices 12, within a given sector or cell of the network. For example, the first mode may be used for some wireless communication devices 12, while the second mode may be used for others. The determination of which mode to use may be set according to the service needs of individual wireless communication devices 12, for example.

Note that this modal selection can be implemented in ways that are non-transparent or transparent to the wireless communication devices 12. In one embodiment, a base station 10 in the wireless communication network can instruct one or more devices in a plurality of wireless communication devices 12 to feed back information that is compatible with the preferred operating mode. Alternatively, based on the network load conditions, the base station 10 can receive information supporting the second mode of operation, but can choose to ignore all or some of that information, in favor of operating in the first mode. In other words, the base station 10 may choose not to use all of the feedback that it receives.

In some circumstances, the radio resource cost required to support operation in the second mode is higher than that for operation in the first mode. For instance, to support operation in the second mode, feedback generally has to been sent by the wireless communication devices 12 more frequently than is required for operation in the first mode, to reflect changing propagation channel conditions. The amount of feedback also could be larger to describe the propagation channel conditions in sufficient detail for operation in the second mode. The strain on the feedback channel is further exacerbated by the fact that a plurality of wireless communication devices 12 simultaneously transmits feedback information to the network. Thus, the first mode of operation may be preferred even when operation in the second mode is viable, simply based on propagation channel condition considerations.

In one or more embodiments, channel quality information determination considers the potentially higher radio resource costs on the feedback channel associated with operation in the second mode. More particularly, the second mode of operation can be reserved for contractually privileged devices or services. The privilege level of a given communication device 12 can be referenced from a database with the identification number of the device. Channel quality information can be determined according to operation in the second mode for devices with higher privilege. The contractual requirement of a service can also be a factor in considering the appropriate operation mode. For instance, for services with stringent delay or jitter requirements such as packet voice services, the quality of service can be more easily maintained if channel quality information is determined according to operation in the second mode.

Deciding whether to determine channel quality information according to the first or second modes of operation also may be adapted to transmission schemes that consist of

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separable components. Non-limiting examples of these types of transmission schemes include multi-carrier CDMA and orthogonal frequency division multiplexing (OFDM) transmission. To support operation in the second mode, the amount of feedback can scale directly with the number of separable components, e.g., four feedback values for four-carrier CDMA or eighty values for OFDM with eighty frequency resource units. For large packets or data units that would occupy entire or large portions of the components, the relative benefits of operating in the second mode instead of the first mode can be significantly smaller than for small packets or data units that would occupy small portions of the components. To conserve radio resources, it is therefore advantageous to include packet or data unit lengths as a factor in operating mode selection.

Such operation is, in one or more embodiments, supported by the use of receiver performance data that characterizes the performance of the wireless communication device's receiver type over a range of propagation channel conditions, such that the performance data indicates the expected performance of the receiver over a range of propagation channel conditions, and for particularized propagation channel conditions. Determining channel propagation conditions for channel quality information determination—e.g., for supportable rate computation—may be required for operation in the first and/or second modes of operation. For the first operating mode, long-term channel propagation conditions are determined and, in one or more embodiments, the propagation channel conditions include one or more of the following quantities: a characterization of the fading speed of the channel (for example, based on the estimated Doppler frequency, known mobile speed, rate of negative acknowledgements - i.e. NACK rate, ...); and an estimate of the power delay profile (PDP) of the propagation channel associated with the wireless communication device 12, assuming that the PDP does not change quickly over time.

In one or more embodiments, the estimation of long-term propagation channel conditions is used for any one or more of the following processing actions: construction of a CDF of the achievable (supportable) data rates; selection of an achievable data rate curve CDF from a table of CDF curves that most closely matches the estimated long-term propagation channel conditions. Thus, it should be understood that in one or more embodiments, CDF curves may be predefined. In such embodiments, the received signal quality and/or long-term characterization of the propagation channel associated with the wireless communication device 12 can be used to select a point or range along a predefined CDF curve to identify channel quality information for the wireless communication device 12—e.g., to identify an achievable data rate. In one or more other embodiments, the long-term propagation channel conditions as estimated are used to partially or wholly construct one or more CDF curves, which can then be used to identify achievable data rates, for example, as a function of measured signal quality at the wireless communication device 12.

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In more detail, for purposes of CDF curve construction, the PDP is considered a known quantity, and estimates of the delay tap (channel) coefficient values can be generated and used to further determine the propagation channel realization for the given PDP. At least one embodiment estimates propagation channel coefficients based on pilot or other measurements, to support characterization of long-term propagation channel conditions. It should be understood that traditional techniques for propagation channel estimation may be used as needed or desired. Note that the estimation of channel coefficients represents a longer-term estimate, rather than the short-term (instantaneous) estimates that are generally used in the second mode of operation.

In any case, it should be understood that, however they are constructed, the CDF curves characterize the (expected) performance of a particular receiver type, or types. Fig. 5 illustrates one method of characterizing receiver performance based on CDF curves, but it should be understood that other methodology may be used to characterize receiver performance for long-term and short-term propagation channel conditions.

In more detail, Fig. 5 illustrates an embodiment of a receiver performance characterization method that may be performed using empirical testing, software simulation, dynamic measurements, or any combination thereof. Because different receiver types offer different levels of performance, such characterization is done for the particular receiver type associated with the wireless communication device 12. (If the channel quality information is generated by the wireless communication device 12, the receiver performance data can be stored in the wireless communication device 12. If the channel quality information is generated in the base station 10, the base station 10 may store characterization data for different types of receivers, and use the appropriate sets of receiver performance data for different wireless communication devices.)

In any case, processing begins by computing an expected error rate for each one in a number of receiver input signal quality values, for each one in a number of modulation and coding schemes, and for each one in a number of propagation channel realizations (Step 120). Error rate may be expressed, for example, as Bit Error Rate (BER), Block Error Rate (BLER), Frame Error Rate (FER), etc., and the particular manner in which error rate is expressed may be based on the type of data transmissions involved.

As used herein, unless otherwise noted, the term "receiver input signal quality" denotes the ratio of total received signal energy per chip, E_T, over the noise plus interference, N_o. Measurements of receiver input signal quality represent the "raw" input signal quality for the receiver embodied within the wireless communication device 12, and does not depend on the receiver's interference suppression and signal gain performance, and thus does not depend on the accuracy of short-term propagation channel estimates. Moreover, receiver input signal quality measurements are the same for simple and complex receiver structures, e.g., the same whether the device's receiver is a simple linear receiver, or a complex non-linear receiver.

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Further, as used herein, the term "propagation channel realization" represents a particular combination of propagation channel tap weights. For example, a plurality of three-tap characterizations of the propagation channel comprises different combinations of three complex tap coefficients, corresponding to different propagation channel conditions. The different propagation channel realizations may be based on a fixed Power Delay Profile (PDP). Alternatively, a given fast fading realization may be used for different PDPs, and different CDFs may be used for the different PDPs.

In any case, each propagation channel realization may be understood as representing a particular hypothesis of actual propagation channel conditions for the transmit link between the base station 10 and the wireless communication device 12. For the same input signal quality, the wireless communication device 12 will exhibit different output signal quality for different channel realizations.

For each receiver input signal quality and each modulation and coding scheme, receiver performance characterization processing continues by, for each of the error rates computed, computing the data rate (R) that can be achieved (supported) for each propagation channel realization (Step 122). The achievable data rate, also referred to as the supported data rate, represents the data rate (R) that can be used for transmitting to the wireless communication device 12 while still meeting a defined performance requirement, e.g., a BLER target. For example, if the computed error rate is less than the target BLER, i.e., BLER < BLER(target), the data rate (R_{mcs}) corresponding the modulation and coding scheme can be the supported data rate ($R = R_{mcs}$), otherwise the supported data rate can be zero ($R = 0$). If ARQ is used, then the supported data rate (R) can be calculated as $R = R_{mcs}(1\text{-BLER})$, where R_{mcs} is the data rate corresponding the modulation and coding scheme and BLER is the computed error rate. If HARQ is used, then the supported data rate can be calculated as $R_{mcs}/(1+\text{BLER})$.

Processing continues by, for each receiver input signal quality, computing the cumulative distribution function (CDF) of the supported data rates corresponding to the propagation channel realizations (Step 124). Note that the generation of CDF curves can be a one-time process, or can be wholly or partially a dynamic process. For example, as was noted earlier, ongoing estimation of one or more parameters bearing on the longer-term propagation channel conditions for the wireless communication device 12. Again, such parameters can include, but are not limited to, any one or more of the PDP, estimated channel coefficients, current data service type and/or data characteristics such as packet size, mobility/rate-of-travel estimates, etc.

Fig. 6 graphically depicts receiver performance data generated according to the method of Fig. 5 for a Minimum Mean Square Error (MMSE) receiver type. More particularly, Fig. 6 graphs receiver input signal quality (SNR) curves stepped from -22 dB to +12 dB in 2 dB increments over defined data rate points, according to the CDFs of the supported data rates for the hypothesized set of propagation channel realizations. The leftmost curve corresponds to

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input SNR of -22 dB, whereas the rightmost curve corresponds to input SNR of +12 dB. Fig. 7 depicts similar performance characterization data for a Joint Detection (JD) receiver architecture, and it should be understood that the particular receiver performance data used for the wireless communication device 12 would be matched to its particular receiver type. (Further, because some types of receivers have different reception modes that yield different performance characteristics, different receiver performance data can be used in each such mode.)

In determining channel quality information using the performance curves of Fig. 6, for example, consider the case of higher rates of travel, where the channel fading conditions become more temporally uncorrelated between the measurement time at which propagation channel conditions are estimated, and the transmit time at which transmit link adaptations based on those channel estimates are performed. If the channel conditions are changing more rapidly than link adaptation control can keep up with, link adaptation—e.g., transmit data rate selection—should be based on the statistical propagation characteristics determined by the path gain and shadowing, rather than based on the channel estimates.

Given signal quality measured by the wireless communication device 12, the transmit data rate can be selected from the corresponding signal quality curve in the receiver performance data, according to a desired CDF level. For example, choosing the tenth percentile for the appropriate SNR curve corresponds to the data rate achievable for ninety-percent of the hypothesized propagation channel realizations. The particular value to choose generally depends on the particular performance requirements of the system, such as determined by a defined performance requirement, like maximum tolerable BLER. In one or more embodiments, the signal quality represents a long-term signal quality—average input SNR—as measured by the wireless communication device, or as averaged by the network. In other embodiments, such as where channel estimates are reliable, the instantaneous or short-term receiver input signal quality may be used.

In either case, the above approach effectively quantizes the rate values in the performance characterization graph to the rates represented by quantized input signal quality measurements, which is sufficient for slow link adaptation in a rapidly varying channel. That is, for fast fading conditions, the channel quality information may be generated as data rate selections based on selecting an SNR curve from the graph corresponding to long-term measured signal quality at the wireless communication device 12, and then identifying the data rate that is achievable at a desired probability for the defined performance requirement, e.g., for a defined BLER limit. Effectively, the method amounts to generating channel quality information as a function of long-term propagation channel characteristics based on mapping a receiver input signal quality measurement to a data rate selection that is achievable at a desired probability over a range of short-term propagation channel characteristics.

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As the channel becomes more reliable, for example, when vehicle speeds become slower or actual input SNR at the receiver becomes larger due to improved path gain, the channel quality information generation process can be transitioned to a mode where more refined information is generated, i.e., a mode where the short-term propagation channel conditions prevailing at the wireless communication device 12 are explicitly considered. The same performance characterization data that was used for slow adaptation during fast fading may be used for fast adaptation during slow fading. In other words, the same receiver performance curves can be used for slow and fast link adaptation in a hierarchical manner. That is, channel quality metrics can be used to characterize the long-term properties of the channel, which can then be characterized further for fast link adaptation when the channel becomes more reliable.

One method for accomplishing the above operation is to quantize the channel state values for each input signal quality (SNR) and store the quantized values in a codebook. For specific input SNR and channel estimates obtained at the wireless communication device 12, the quantized values can be looked up in the codebook, and the corresponding data rate selected for channel quality information reporting.

Fig. 8 illustrates one embodiment of hierarchical channel quality information generation, wherein the channel quality information is generated in terms of data rate reports. Such processing may be performed at the wireless communication device 12, at the base station 10, or cooperatively. In any case, processing begins with evaluation of the propagation channel conditions (Step 130). Evaluation may comprise evaluating short-term propagation channel estimates being generated by the wireless communication device 12 as a means of determining whether the estimates are reliable, or may comprise checking Doppler shifts, etc.

If the channel estimates are not reliable (Step 132), a supported data rate is selected using receiver performance data, such as illustrated in Figs. 6 and 7. More particularly, if the channel estimates are not reliable, the measured receiver input signal quality can be mapped to one of the quantized SNR curves, and a corresponding supported data rate can be identified according to the desired probability of achieving that rate over the range of propagation channel realizations used to generate the performance data (Step 134). A tenth percentile selection means that ninety-percent of the hypothesized propagation channel realizations will support the selected data rate at the desired error rate performance.

As such, if the channel estimates are not reliable, the transmit data rate is selected probabilistically, rather than based on any specific consideration of the short-term propagation channel conditions existent at the wireless communication device 12. Further, in cases where the channel estimates are not reliable, the receiver input signal quality used to select the appropriate quantized SNR curve may be a long-term (average) receiver input signal quality. Averaging may be done at the wireless communication device 12, or instantaneous values reported by the wireless communication device 12 may be averaged by the network.

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On the other hand, if the channel estimates are reliable (Step 132), the measured receiver input signal quality may represent a shorter term, e.g., instantaneous, measurement. Of course, averaged values may still be used. In either case, with the availability of reliable channel estimates, the receiver input signal quality can be mapped to one of the quantized SNR curves and a particular propagation channel realization, or a constrained range of propagation channel realizations, corresponding to the channel estimates (Step 136). In one variation of this approach, different SNR/CDF curves can be stored for long-term and short-term SNR measurements, with the different SNR curves reflecting different probabilistic characteristics. Then, in operation, the set of curves to be used is selected depending on whether long-term or short-term SNR values are being used, which may switch as a function of channel estimate reliability.

This hierarchical approach to channel quality information generation can be implemented in the wireless communication device 12, such as by including appropriately configured processing circuits in the device 12, along with storing appropriate receiver performance data. Fig. 9 illustrates one embodiment of the wireless communication device 12, configured for carrying out a method of channel quality information generation using receiver performance data. The illustrated embodiment comprises a receive/transmit antenna 20, a switch/duplexer 21, a receiver front-end 22, a transmitter 24, a baseband (BB) controller 26, a system controller 28, input/output (I/O) interface circuits 30, and a user interface (UI) 32.

Of particular interest regarding channel quality information generation, the baseband controller 26 includes one or more processing circuits 40, which are configured for channel quality information generation, and which have access, direct or indirect, to a memory 42 storing receiver performance data. The stored data may comprise a data structure representing quantized SNR curves and corresponding CDFs of supported rates for a plurality of propagation channel realizations, e.g., a set of 1000 channel realizations, such as illustrated in Fig. 6 or 7. However, at least some of the performance data may be obtained using curve-fitting calculations—e.g., polynomials—and it should be understood that various methods of storing and representing receiver performance data are contemplated herein.

In operation according to one embodiment, the wireless communication device 12 maintains a long-term estimate of receiver input signal quality—average SNR—and further maintains short-term (instantaneous) propagation channel estimates. If the propagation channel estimates are not reliable, the wireless communication device 12 operates in a first mode of channel quality information generation. In the first mode, the wireless communication device 12 maps measured, average receiver input signal quality to the closest corresponding receiver input signal quality represented in the receiver performance data, and then uses that SNR curve to identify the data rate that can be supported at a desired probability over a range of propagation channel realizations. As such, the wireless communication device 12 returns channel quality information to the base station 10 in the form of updated transmit data rate

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selections that are identified probabilistically, without regard to the actual channel estimates. A transmit link adaptation control circuit 38 in the base station 10 uses the reported data rate selections to adjust the transmit data rate used to send traffic to the wireless communication device 12.

If the propagation channel estimates are reliable, the wireless communication device 12 operates in a second mode. In the second mode, the wireless communication device 12 selects the SNR value in the receiver performance data most closely corresponding to the average receiver input signal quality as measured by the wireless communication device 12, and further selects a propagation channel realization, or a constrained range of propagation channel realizations, in the receiver performance data that most closely corresponds with current channel estimates. The wireless communication device 12 thus uses the receiver performance data to identify the data rates that can be supported for measured receiver input signal quality and corresponding channel estimates, and reports the identified data rate selections to the base station 10.

In both the first and second modes, the base station 10 receives channel quality information in the form of data rate selections, and the base station 10 performs corresponding transmit data rate adjustments for forward link transmissions to the wireless communication device 12. As such, whether the channel quality information is being generated in consideration of current channel estimates may be transparent to the base station 10. That is, from the base station's perspective, link adaptation may transparently shift between the first and second modes, without need for explicit signaling. In some embodiments, however, the mode of channel quality information generation may be signaled, or otherwise indicated. For example, the rate at which channel quality information is reported to the base station 10 may change in dependence on whether channel quality information is being generated in the first or second modes.

Figs. 10 and 11 illustrate embodiments of processing circuits that may be included in, or associated with, the baseband controller 40 of the wireless communication device 12, and used to implement generation of channel quality information in the first and second modes. Fig. 10, in particular, illustrates the processing circuit(s) 40 as comprising a channel quality information generation circuit 44, which generates channel quality information, e.g., rate selection data, in first and second modes. The circuit 44 may be configured to provide an indication of the type of channel quality information being generated, i.e., it may indicate the mode that it is operating in.

The processing circuit(s) 40 may further include, or may further be associated with, a channel estimate reliability evaluation circuit 46 and a channel estimation circuit 48. The channel estimate reliability evaluation circuit 46 is configured to estimate the reliability of the channel estimates being generated by the channel estimation circuit 48, which generates instantaneous propagation channel estimates based on the received signal and pilot information. The channel estimate reliability evaluation circuit 46 may receive, among other

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things, the channel estimates from the channel estimation circuit 48 and/or the pilot values. Operation may be switched between the first and second modes based on the reliability indicator output by the reliability evaluation circuit 46.

Note, too, that the channel quality information generation circuit 44 may be configured to perform the receiver input signal quality measurements, i.e., the E_T/N_o calculations, or another functional circuit may be included for that purpose in the processing circuit(s) 40. On that point, it should be understood that illustrations of the processing circuit(s) 40 may represent functional rather than physical circuit elements. For example, the processing circuit(s) 40 may comprise all or a portion of a microprocessor-based circuit, an FPGA, ASIC, etc.

Continuing with function circuit descriptions, Fig. 11 illustrates one embodiment of the channel quality information generation circuit 44 that is depicted in Fig. 10. One sees that the reliability indicator drives a mode select circuit 50, which selects the source circuit for the channel quality information being output. If the reliability indicator indicates that the channel estimates are not reliable, the mode select circuit 50 selects a long-term channel quality information estimation circuit 52 as the source circuit. The long-term channel quality information estimation circuit 52 selects supported data rates using the receiver performance data based on long-term estimates of receiver input signal quality and desired CDF probabilities.

Conversely, if the reliability indicator indicates that the channel estimates are reliable, the mode select circuit 50 selects an instantaneous (short-term) channel quality information estimation circuit 54 as the source circuit. In one embodiment, the instantaneous channel quality information estimation circuit 54 selects supported data rates using the receiver performance data based on long-term estimates of receiver input signal quality and the channel estimates. In another embodiment, instantaneous channel quality information is generated by calculating receiver output signal quality. In such embodiments, channel quality information is determined in the first mode using receiver input signal quality, and determined in the second mode using receiver output signal quality.

In any case, it should be understood that the base station 10 can be configured to generate channel quality information according to any of the above embodiments, based on the wireless communication device feeding back channel quality measurements. For example, Fig. 12 illustrates a channel quality information generation circuit 60 and a memory 62, which may be included in the base station 10. The memory 62 stores receiver performance data for one or more receiver types, with at least one set of receiver performance data matching the type of receiver implemented in the wireless communication device 12.

More generally, in such embodiments, the base station 10 comprises one or more processing circuits configured to determine channel quality information for a transmit propagation channel corresponding to the wireless communication device 12. Such generation may be based on, in a first mode, generating channel quality information according to a first algorithm that does not depend on channel estimates for the wireless communication device 12,

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and in a second mode, generating channel quality information according to a second algorithm that depends on the channel estimates.

In one embodiment, in the first mode, the base station 10 receives at least receiver input signal quality information for the wireless communication device 12. As described, the first algorithm may comprise mapping receiver input signal quality to a data rate that is achievable at a desired probability over a range of propagation channel realizations. For the second mode of operation, the base station 10 receives receiver input signal quality information and propagation channel information from the wireless communication device 12—e.g., quantized long-term SNR values and quantized short-term propagation channel estimates.

If the base station 10 stores code books of SNR values and propagation channel realizations, the wireless communication device 12 need only return code book indices corresponding to its measurements. In any case, the second algorithm may comprise mapping receiver input signal quality to a data rate that is achievable for a particular propagation channel realization, or for a constrained range of propagation channel realizations, corresponding to the propagation channel estimates.

As such, the base station 10 can be configured to select operation in the first mode if it receives receiver input signal quality information for the wireless communication device 12 without receiving corresponding channel estimates. Alternatively, the wireless communication device 12 can be configured always to report channel estimates and signal quality, and the base station 10 can be configured to select operation in the first or second modes based on evaluating the reliability of the channel estimates. In at least one embodiment, the base station 10 selects the mode based on determining whether the wireless communication device 12 is operating in fast fading conditions. If the wireless communication device 12 is operating in fast fading conditions, the base station 10 operates in the first mode. If the wireless communication device 12 is not operating in fast fading conditions, the base station 10 operates in the second mode. Of course, it should be understood that first and second modes of operation may be managed independently for individual ones in a plurality of wireless communication devices being supported by the base station 10.

Further, and more generally, it should be understood that channel quality information generation as taught in one or more embodiments described herein uses receiver performance data to determine channel quality information metrics, such as supported data rates, based on using receiver performance data. The receiver performance data characterizes supported data rates in terms of propagation channel realizations, for each in a plurality of quantized receiver input signal qualities. In a first mode of operation, the data rate that can be achieved at a desired probability over a range of propagation channel conditions, e.g., all hypothesized propagation channel realizations, are selected for the receiver input signal quality value that corresponds to measurements obtained by the wireless communication device 12. As such, the data rate is not set in consideration of the instantaneous channel conditions prevailing at the

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wireless communication device 12, but rather set probabilistically, in consideration of the long-term channel conditions. As such, the first mode of operation can be selected whenever reliable channel estimates are not available.

In a second mode of operation, where reliable channel estimates are available, data rates are selected using receiver input signal qualities and propagation channel realizations corresponding to measurements obtained at the wireless communication device 12. In other words, short-term propagation channel conditions are considered when the estimates of those conditions are reliable. In this regard, the same receiver performance data can be used to generate channel quality information metrics with or without using current propagation channel estimates. As such, it is convenient to modify transmit link adaptation to switch between slow link adaptation—i.e., the first mode of operation—and fast link adaptation—i.e., the second mode of operation.

Of course, the present invention is not limited by the foregoing discussion, nor is it limited by the accompanying drawings. Indeed, the present invention is limited only by the following claims, and their legal equivalents.

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CLAIMS

What is claimed is:

1. A method of determining channel quality information for a transmit propagation channel associated with a wireless communication device (12), the method characterized by:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates; and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates.

2. The method of claim 1, further characterized by determining whether to operate in the first mode or in the second mode as a function of propagation channel fading conditions.

3. The method of claim 1, further characterized by determining whether to operate in the first mode or in the second mode responsive to evaluating a reliability of propagation channel estimates made by the wireless communication device (12).

4. The method of claim 1, wherein generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions.

5. The method of claim 4, wherein mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

6. The method of claim 5, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

7. The method of claim 6, further characterized by generating one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

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8. The method of claim 7, wherein generating one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) comprises generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

9. The method of claim 1, wherein generating channel quality information according to a second algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable for propagation channel conditions corresponding to the current propagation channel estimates.

10. The method of claim 1, wherein the wireless communication device (12) generates the channel quality information as feedback for transmit link adaptation.

11. The method of claim 1, wherein the wireless communication device (12) generates channel quality measurements and a base station (10) in a supporting wireless communication network generates the channel quality information based on receiving the channel quality measurements.

12. The method of claim 11, wherein the channel quality measurements for the first mode comprise at least receiver input signal quality measurements, and wherein the channel quality measurements for the second mode comprise receiver input signal quality measurements and corresponding propagation channel estimates.

13. The method of claim 1, further characterized by storing receiver performance data for use in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

14. The method of claim 13, wherein generating the channel quality information according to the first algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

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15. The method of claim 13, wherein generating the channel quality information according to the second algorithm comprises selecting a receiver input signal quality corresponding to receiver input signal quality measurements made by the wireless communication device (12), selecting a propagation channel realization or a constrained range of propagation channel realizations corresponding to propagation channel estimates made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

16. The method of claim 1, further characterized by selectively operating in the first and second modes as a function of at least one of (a) packet lengths of data to be transmitted by the wireless communication device (12), (b) delay requirements associated with packet data to be transmitted by the wireless communication device (12), (c) delay requirements associated with a communication service active at the wireless communication device (12), (d) identification of the wireless communication device (12), and (e) network usage or congestion levels.

17. A wireless communication device (12) comprising one or more processing circuits (40) configured to determine channel quality information for one or more signals received by the wireless communication device (12), operation of said one or more processing circuits for determing the channel quality information characterized by:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates; and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates.

18. The wireless communication device (12) of claim 17, wherein the one or more processing circuits (40) comprise a channel quality information generation circuit (44) that is configured to generate the channel quality information by selectively operating in the first and second modes.

19. The wireless communication device (12) of claim 18, wherein the one or more processing circuits (40) include a reliability evaluation circuit (46) to generate a reliability indicator indicating whether propagation channel estimates being generated at the wireless communication device (12) are reliable, and wherein the channel quality information generation circuit (44) is configured to select the first mode of operation if the reliability indicator indicates that the propagation channel estimates are not reliable, and to select the second mode of operation if the reliability indicator indicates that the channel estimates are reliable.

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20. The wireless communication device (12) of claim 17, wherein one or more processing circuits (40) are configured to determine whether to operate in the first mode or in the second mode according to a reliability of propagation channel estimates made by the wireless communication device (12).

21. The wireless communication device (12) of claim 17, wherein the first algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions.

22. The wireless communication device (12) of claim 21, wherein mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

23. The wireless communication device (12) of claim 22, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

24. The wireless communication device (12) of claim 23, wherein the one or more processing circuits (40) are configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

25. The wireless communication device (12) of claim 24, wherein the one or more processing circuits (4) are configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) by generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

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26. The wireless communication device (12) of claim 17, wherein the second algorithm comprises mapping a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable for propagation channel conditions corresponding to the current propagation channel estimates.

27. The wireless communication device (12) of claim 17, wherein the wireless communication device (12) includes memory (42) storing receiver performance data for use by the one or more processing circuits (40) in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

28. The wireless communication device (12) of claim 27, wherein the first algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identifying a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

29. The wireless communication device (12) of claim 27, wherein the second algorithm comprises selecting a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), selecting a propagation channel realization or a constrained range of propagation channel realizations corresponding to propagation channel estimates made by the wireless communication device (12), and identifying a data rate can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

30. A base station (10) comprising one or more processing circuits (60) configured to determine channel quality information for a transmit propagation channel corresponding to a wireless communication device (12) associated with the base station (10), based on:

in a first mode, generating channel quality information according to a first algorithm that does not depend on current propagation channel estimates for the wireless communication device (12); and

in a second mode, generating channel quality information according to a second algorithm that depends on current propagation channel estimates for the wireless communication device (12).

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31. The base station (10) of claim 30, wherein, in the first mode, the base station (10) receives at least receiver input signal quality information for the wireless communication device (12), and wherein the first algorithm comprises mapping receiver input signal quality to a data rate that is achievable at a desired probability over a range of propagation channel realizations.

32. The base station (10) of claim 31, wherein the base station (10) is configured to map a receiver input signal quality for the wireless communication device (12) to a data rate selection that is achievable at a desired probability over a range of propagation channel conditions comprises using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations.

33. The base station (10) of claim 32, wherein using a Cumulative Distribution Function (CDF) and the receiver input signal quality to identify a data rate that is achievable with respect to a desired error limit over a range of hypothesized propagation channel realizations comprises selecting a CDF curve that relates received signal quality to achievable data rates over a set of hypothesized propagation channel realizations.

34. The base station (10) of claim 33, wherein the base station (10) is configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12).

35. The base station (10) of claim 34, wherein the base station (10) is configured to generate one or more CDF curves to support mapping of the received signal quality based on estimating long-term propagation channel conditions for the propagation channel associated with the wireless communication device (12) by generating the one or more CDF curves based on one or more of long-term propagation channel estimates, rate-of-travel of the wireless communication device (12), type of data services active for or requested for the wireless communication device (12), downlink bandwidth assigned to or available for the wireless communication device (12), and a modulation and coding scheme being used for or desired for the wireless communication device (12).

36. The base station (10) of claim 30, wherein, in the second mode, the base station (10) receives receiver input signal quality information and propagation channel estimates for the wireless communication device (12), and wherein the second algorithm comprises mapping receiver input signal quality to a data rate that is achievable for a particular propagation channel

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realization, or for a constrained range of propagation channel realizations, corresponding to the propagation channel estimates.

37. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if it receives receiver input signal quality information for the wireless communication device (12) without receiving corresponding propagation channel estimates for the wireless communication device (12).

38. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if it determines that propagation channel estimates for the wireless communication device (12) are not reliable.

39. The base station (10) of claim 30, wherein the base station (10) is configured to select operation in the first mode if the wireless communication device (12) is operating in fast fading conditions, and is configured to select operation in the second mode if the wireless communication device (12) is not operating in fast fading conditions.

40. The base station (10) of claim 30, wherein the base station (10) includes memory (62) storing receiver performance data for use by the one or more processing circuits (60) in generating the channel quality information in at least the first mode, said receiver performance data characterizing a type of receiver corresponding to the wireless communication device (12) and identifying, for each in a plurality of receiver input signal qualities, supported data rates for a plurality of propagation channel realizations.

41. The base station (10) of claim 40, wherein the first algorithm comprises using the receiver performance data to select a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), and identify a data rate that can be supported for the receiver input signal quality over a range of propagation channel realizations.

42. The base station (10) of claim 40, wherein the second algorithm comprises using the receiver performance data to select a receiver input signal quality corresponding to a receiver input signal quality measurement made by the wireless communication device (12), select a propagation channel realization or a constrained range of propagation channel realizations, corresponding to propagation channel estimates made by the wireless communication device (12), and identify a data rate can be supported for the receiver input signal quality and the selected propagation channel realization or constrained range of propagation channel realizations.

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43. A method of characterizing receiver performance, said method characterized by:

for each of a number of receiver input signal qualities and each of a number of modulation and coding schemes, computing an error rate expected for each of a number of propagation channel realizations:

for each of said receiver input signal qualities and each of said modulation and coding schemes, computing a data rate that can be supported for each propagation channel realization; and

for each receiver input signal quality, computing the cumulative distribution function of the supported data rates corresponding to the propagation channel realizations.

44. The method of claim 43, wherein computing a data rate that can be supported for each propagation channel realization comprises determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization.

45. The method of claim 44, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization comprises calculating R as $R = R_{mcs} (1\text{-BLER})$.

46. The method of claim 44, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, and a Block Error Rate (BLER) expected for the propagation channel realization comprises calculating R as $R = R_{mcs}/(1\text{-BLER})$.

47. The method of claim 43, wherein computing a data rate that can be supported for each propagation channel realization comprises determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, a Block Error Rate (BLER) expected for the propagation channel realization, and a target Block Error Rate (BLER(target)).

48. The method of claim 47, wherein determining the data rate (R) that can be supported as a function of a data rate (R_{mcs}) corresponding to the modulation and coding scheme, a Block Error Rate (BLER) expected for the propagation channel realization, and a target Block Error Rate (BLER(target)) comprises determining R as $R = R_{mcs}$ if BLER < BLER(target), and otherwise determining R as R = 0.

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49. A method of providing rate adaptation feedback from a wireless communication device (12) to a supporting wireless communication network characterized by storing receiver performance data determined according to the method of characterizing receiver performance of claim 43, and, in a first mode of operation, selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements made by the wireless communication device and a desired probability of achieving the selected data rate for a range of propagation channel realizations, and, in a second mode of operation, selecting a supported data rate using the receiver performance data according to a receiver input signal quality corresponding to measurements made by the wireless communication device and a particular propagation channel realization, or a constrained range of the propagation channel realizations, corresponding to propagation channel estimates for the wireless communication device (12).

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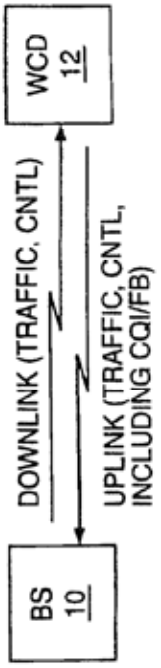


FIG. 1

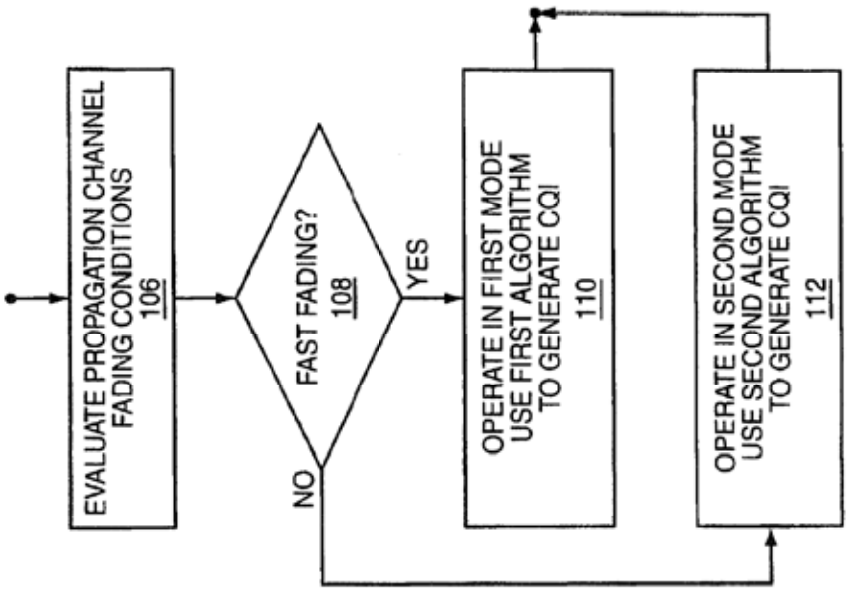


FIG. 3

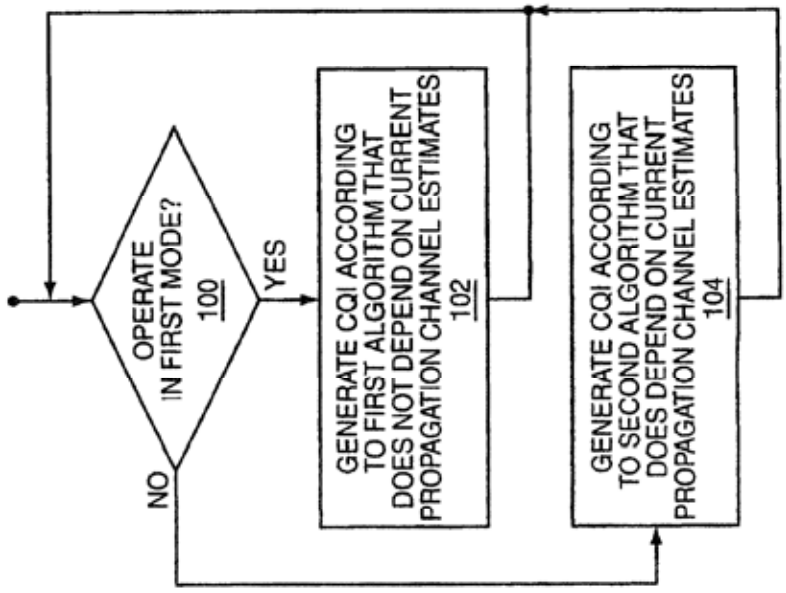


FIG. 2

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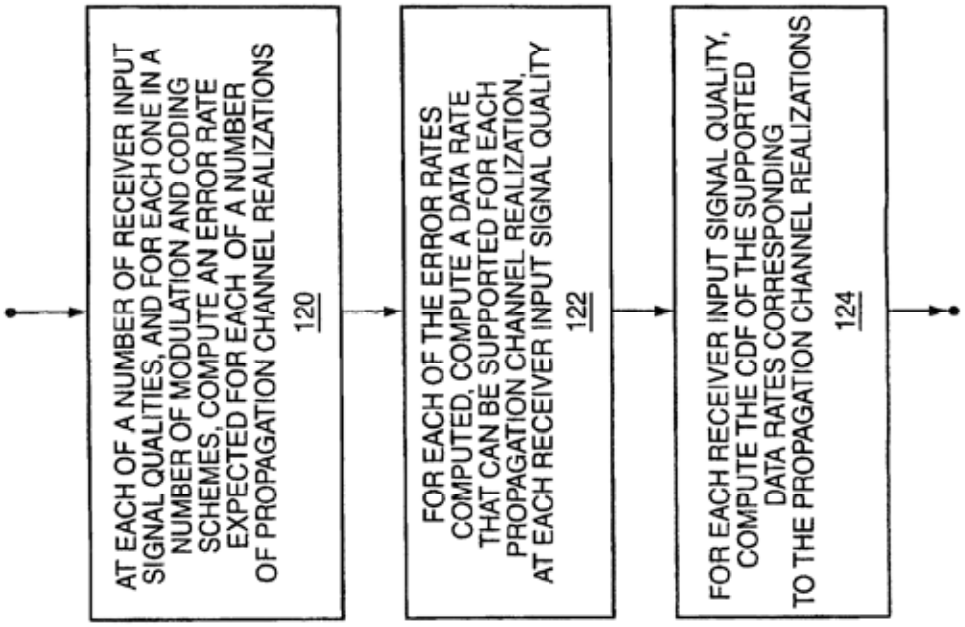


FIG. 5

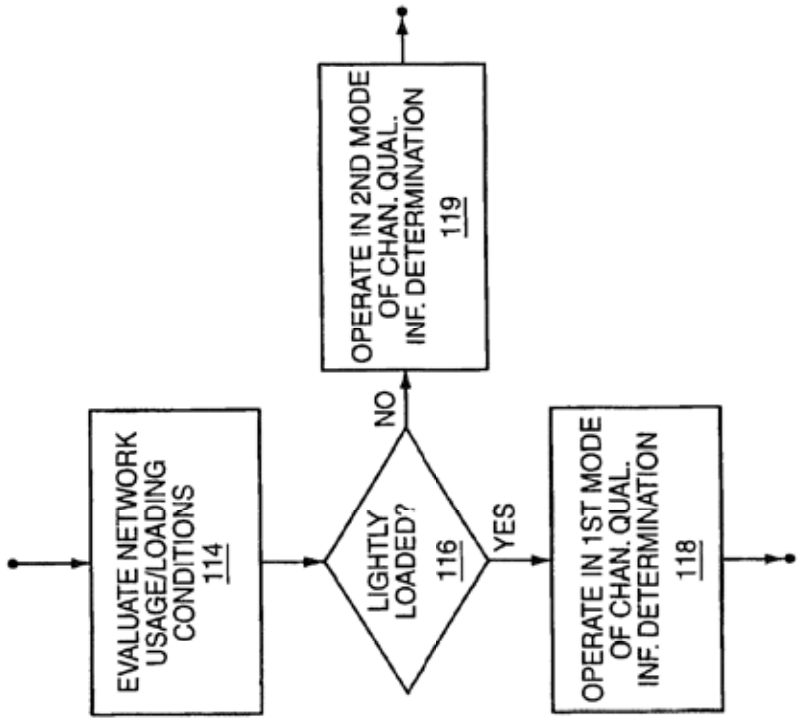


FIG. 4

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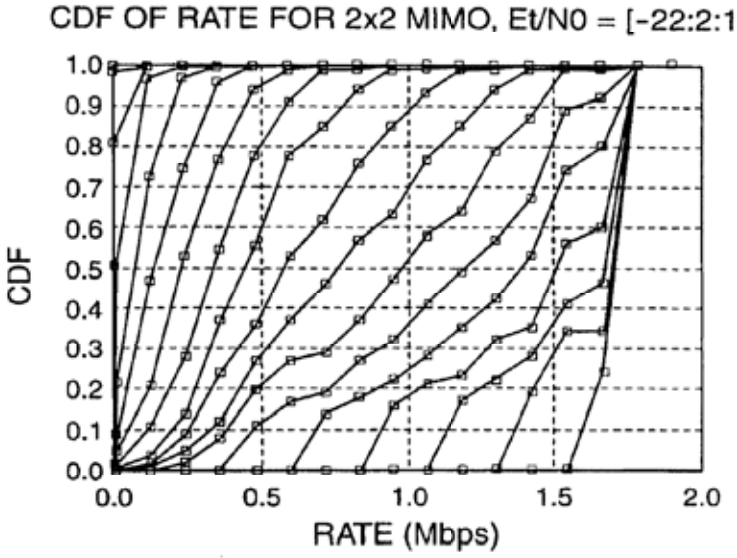


FIG. 6

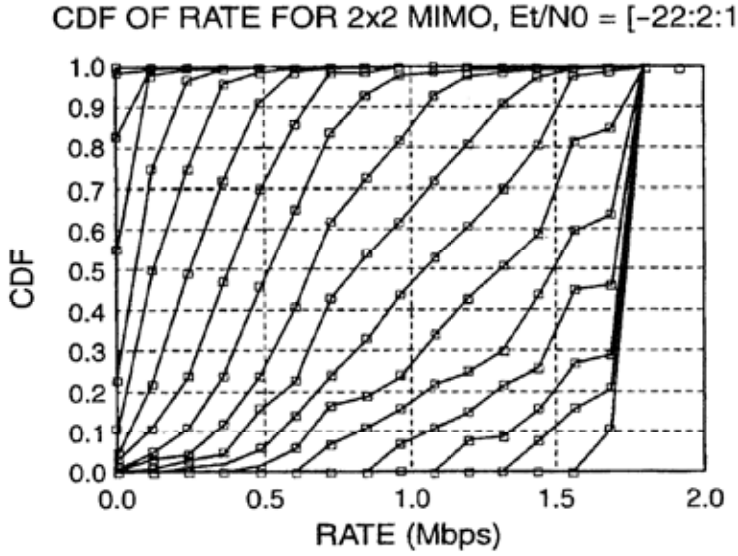


FIG. 7

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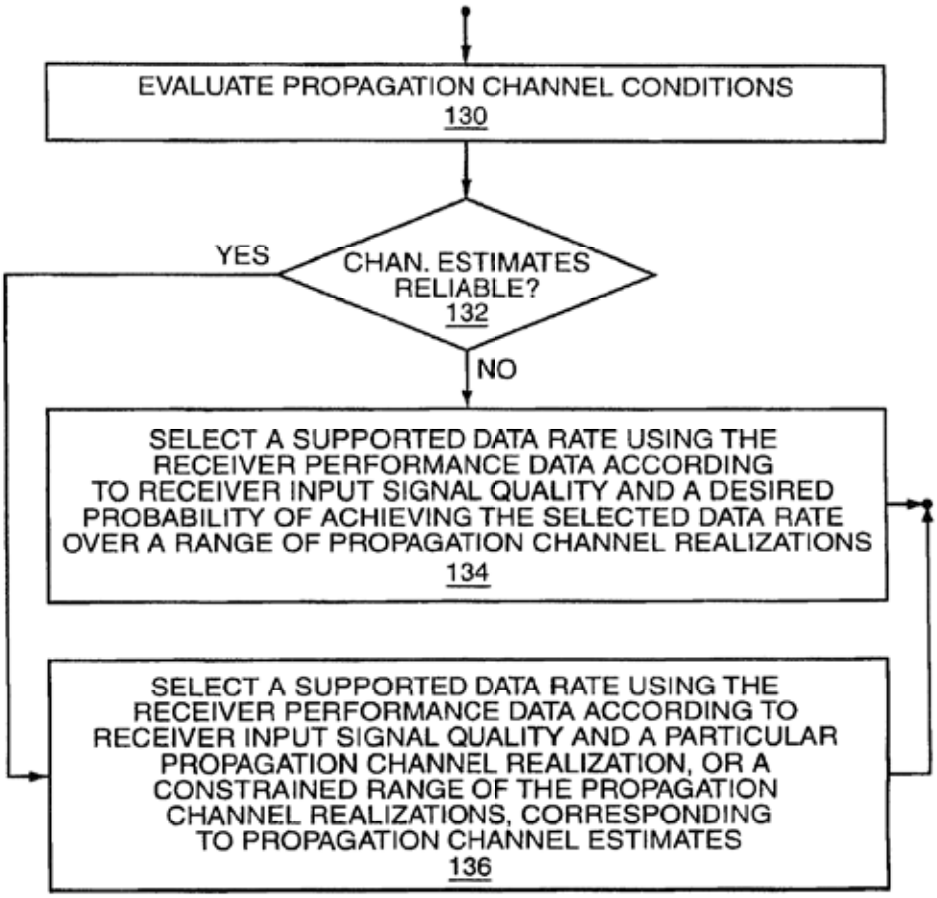


FIG. 8

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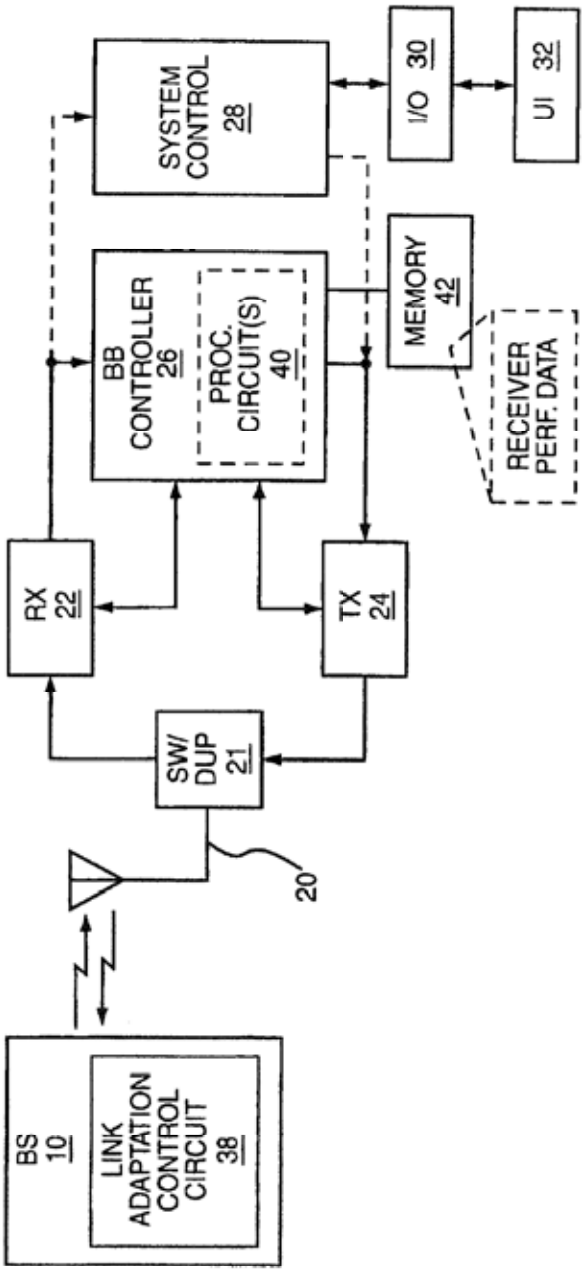


FIG. 9

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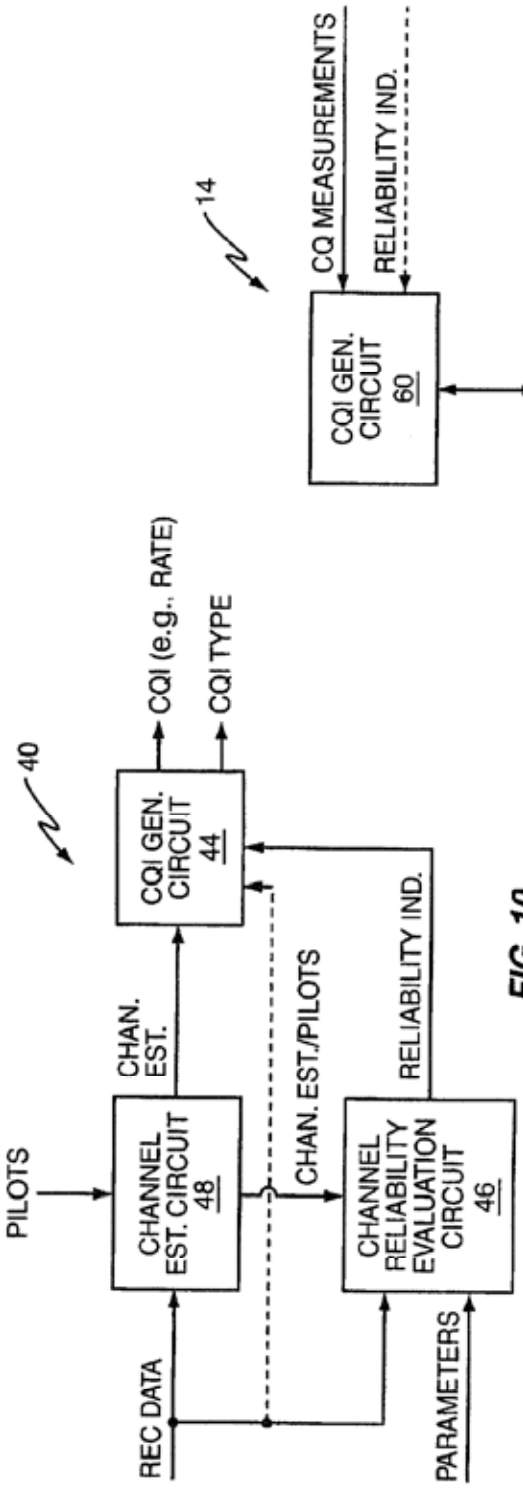


FIG. 10

FIG. 12

FIG. 11

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

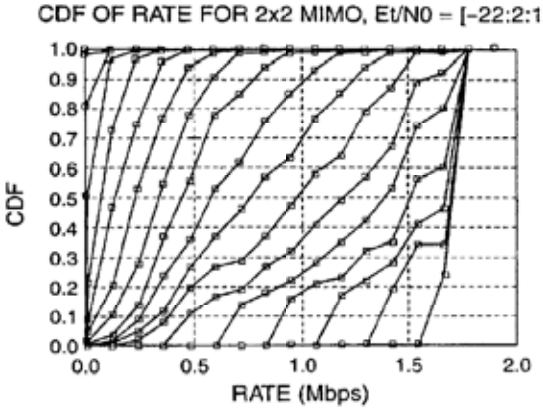
(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:
— *with international search report*

[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR GENERATING CHANNEL QUALITY INFORMATION FOR WIRELESS COMMUNICATION



(57) Abstract: A method and apparatus for generating channel quality information, such as may be used for transmit link adaptation, provide different operating modes, such as a first mode that may be used when propagation channel estimates are not reliable, and a second mode that may be used when the propagation channel estimates are reliable. In one or more embodiments, channel quality information is generated using receiver performance informatio that characterizes receiver performance in terms of a defined channel quality metric, e.g., supported data rates, for different values of receiver input signal quality over a range of propagation channel realizations. Channel quality information can be generated by selecting channel quality metrics according to receiver input signal quality and a desired probability of meeting a defined performance requirement over a range of propagation channel realizations, or by selecting channel quality metrics according to receiver input signal quality and particularized propagation channel realizations.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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Page #1967

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2007/050216

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04L, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	YUEN, P ET AL: "Variable rate speech and channel coding for mobile communication", Vehicular Technology Conference, 1994 IEEE 44th, 8-10 June 1994, Stockholm, Sweden, pages 1709-1713, vol 3, ISBN 0-7803-1927-3, AN 4846908, see chapter 1. Introduction, abstract ---	1-42
A	PARIS, J F ET AL: "Impact of channel estimation error on adaptive modulation performance in flat fading", IEEE Transactions on Communications, May 2004, Vol. 52, Iss. 5, pag. 716-720, ISSN 0090-6778, AN 7966596, see chapters "I Introduction" and "II System model", abstract ---	1-42

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 February 2008	27-02-2008
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Markus Stålö /ABW Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2004042982 A2 (INTERDIGITAL TECHNOLOGY CORP), 21 May 2004 (21.05.2004), abstract ---	1-42
A	EP 1643700 B1 (LUCENT TECHNOLOGIES INC), 31 October 2007 (31.10.2007), paragraph [0005], abstract ---	1-42
X	MINGZHE, L ET AL: "Modeling and Simulating Packet Dispersion in Wireless 802.11 Networks",Technical Report WPI-CS-TR-06-03, March 2006. Page 4, left column, figure 3, abstract ---	43-48
X	HAITAO, Z ET AL: "Optimizing the ARQ performance in Xownlink packet data systems with scheduling" This paper appears in: Wireless Communications, IEEE Transactions on Publication Date: March 2005, Vol. 4 Issue: 2 On page(s): 495 - 506 ISSN:1536-1276, INSPEC Accession Number:8354284, Digital Object Identifier: 10.1109/TWC.2004.843012 Posted online: 2005-04-04 09:25:11.0. Page 500, left column, line 25- page 501, right column, line 8, abstract ---	43-48
A	JOSTSCHULTE; K ET AL: "High efficiency wireless LAN for multimedia home networks" This paper appears in: Consumer Electronics, 2005. ICCE. 2005 Digest of Technical Papers. International Conference on Publication Date: 8-12 Jan. 2005. ISBN: 0-7803-8838-0. Figure 2, chapter III link measurements/B. Data Rates. ---	43-49

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INTERNATIONAL SEARCH REPORT

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PCT/SE2007/050216

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	LARSSON,P ET AL: "Multiuser diversity forwarding in multihop packet radio networks". This paper appears in: Wireless Communications and Networking Conference, 2005 IEEE Publication Date:13-17 March 2005 Vol. 4. ISSN: 1525-3511. ISBN: 0-7803-8966-2 INSPEC Accession Number:8521136 Digital Object Identifier:10.1109/WCNC.2005.1424856 Posted online: 2005-05-02 09:08:51.0. Figure 7, page 2193, left column, line 52- right column, last line, abstract -- --------	43-49

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International patent classification (IPC)
H04L 1/00 (2006.01)
H04L 1/20 (2006.01)

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Use the application number as username.
The password is **WMGDRNOPCQ**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

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PCT/SE2007/050216

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1: Claims 1-42 directed to a method, a wireless communication device and a base station for determining channel quality information according to two different modes.

2: Claims 43-49 directed to a method of characterizing a receiver performance, and a method of providing rate adaptation from a wireless communication device to a supporting wireless communication network based on stored receiver performance. The rate adaptation in claim 49 is performed according to two different modes.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

26/01/2008

International application No.
PCT/SE2007/050216

WO	2004042982	A2	21/05/2004	AU	2003287399	A	07/06/2004
				CA	2502844	A	21/05/2004
				CN	1709001	A	14/12/2005
				EP	1557057	A	27/07/2005
				JP	2006505221	T	09/02/2006
				KR	20050083880	A	26/08/2005
				KR	20050098971	A	12/10/2005
				NO	20052411	A	13/05/2005
				TW	245523	B	11/12/2005
				US	20040142698	A	22/07/2004
EP	1643700	B1	31/10/2007	CN	1756436	A	05/04/2006
				DE	602005003088	D	00/00/0000
				JP	2006109458	A	20/04/2006
				KR	20060051925	A	19/05/2006
				US	20060072508	A	06/04/2006

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(81) 指定国 (除另有指明, 要求每一种可提供的国家保护): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW。

(84) 指定国 (除另有指明, 要求每一种可提供的地区保护): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), 欧亚 (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), 欧洲 (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)。

[见续页]

(54) **Title:** METHOD FOR LINK ADAPTATION AND APPARATUS THEREOF

(54) **发明名称**: 一种链路自适应方法及装置

(57) **Abstract**: A method for link adaptation comprises: classifying radio channels; setting a set of link adaptation modes; and selecting a corresponding link adaptation mode according to the type of the radio channel. An apparatus for link adaptation comprises: classification module for classifying radio channels; setting module for setting a set of link adaptation modes; and mode selection module for selecting a corresponding link adaptation mode from the setting module according to the type of the classified radio channel. By accordingly selecting effective link adaptation modes in accordance with different types of radio channels, realizing the throughput maximization of system in different fading channels can be ensured, and the stable and reliable link quality can be maintained.

[见续页]

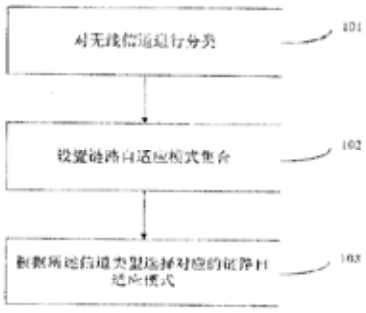


图 1 / Fig. 1

101 CLASSIFY RADIO CHANNELS
102 SET A SET OF LINK ADAPTATION MODES
103 SELECT A CORRESPONDING LINK ADAPTATION MODE ACCORDING TO THE TYPE OF THE RADIO CHANNEL

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本国际公布:

— 包括国际检索报告(条约第 21 条(3))。

(57) 摘要:

一种链路自适应方法，其包括：对无线信道进行分类；设置链路自适应模式集合；以及根据所述无线信道的类型选择对应的链路自适应模式。一种链路自适应装置，其包括：分类模块，用于对无线信道进行分类；设置模块，用于设置链路自适应模式集合；以及模式选择模块，用于根据所述分类的无线信道类型从设置模块中选择对应的链路自适应模式。本发明根据无线信道的不同类型有针对性地选择有效的链路自适应模式，能够保证在不同的衰落信道下实现系统的吞吐量最大化，保持稳定可靠的链路质量。

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一种链路自适应方法及装置

技术领域

本发明涉及无线通信系统，尤其涉及一种链路自适应的技术。

背景技术

在无线通信系统中，由于无线信道复杂多变，且无固定的变化规律可循，为了实现无线通信系统的吞吐量最大化，就希望无线通信系统能够根据信道条件变化自动调整传输速率，即链路自适应技术。常规的链路自适应的方法就是将最新的信道质量的测量结果作为未来链路速率选择的依据。

发明内容

现有技术中的常规的链路自适应的方法是将最新的信道质量的测量结果作为未来链路速率选择的依据，该方法存在以下问题：

信道质量测量结果总会包含测量误差和随机干扰影响，即测量结果并不能准确反映实际信道条件；

无线信道条件总是随着时间的变化而随机变化，也就是说过去的测量结果并不能完全反映未来的信道条件。

鉴于此，本发明要解决的技术问题是提出一种链路自适应方法和装置，能够保证在不同的衰落信道下实现系统的吞吐量最大化，保持稳定可靠的链路质量。

为了解决以上技术问题，本发明一方面提供了一种链路自适应的方法，其包括：

对无线信道进行分类；

设置链路自适应模式集合；以及

根据所述无线信道的类型选择对应的链路自适应模式。

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对无线信道进行分类的步骤中，是根据无线信道的时变特性进行分类的。

对无线信道进行分类的步骤中，是将无线信道分类为：

平坦信道、慢衰落信道和快衰落信道；或者

慢衰落信道和快衰落信道；或者

慢衰落信道、快衰落信道和突变信道。

所述链路自适应模式集合包括：即时值预测模式、历史值预测模式、统计分位数预测模式和突变处理模式。

根据所述无线信道的类型选择对应的链路自适应模式的步骤包括：通过分析无线信道的历史测量信息，判断得出当前无线信道的类型，根据所述当前无线信道的类型从所述链路自适应模式集合中选择对应的链路自适应模式。

根据所述无线信道的类型选择对应的链路自适应模式的步骤之后，所述方法还包括：根据所述无线信道类型和对应的链路自适应模式，得出待调度时刻的信道预测信息，选择与所述待调度时刻的信道预测信息匹配的链路速率。

本发明另一方面还提供了一种链路自适应装置，包括：

分类模块，其设置为：对无线信道进行分类；

设置模块，其设置为：设置链路自适应模式集合；以及

模式选择模块，其设置为：根据所述分类的无线信道类型从设置模块中选择对应的链路自适应模式。

所述分类模块是设置为根据无线信道的时变特性对无线信道进行分类的。

所述分类模块是设置为将无线信道分类为：

平坦信道、慢衰落信道和快衰落信道；或者

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慢衰落信道和快衰落信道；或者

慢衰落信道、快衰落信道和突变信道。

所述链路自适应模式集合包括：即时值预测模式、历史值预测模式、统计分位数预测模式和突变处理模式。

所述模式选择模块是设置为按如下方式根据所述无线信道的类型选择对应的链路自适应模式：

通过分析无线信道的历史测量信息，判断得出当前无线信道的类型，根据所述当前无线信道的类型从所述链路自适应模式集合中选择对应的链路自适应模式。

所述装置还包括：

信道学习模块，其设置为：分析处理无线信道的历史测量信息，得出当前无线信道的类型；以及

链路速率确定模块，其设置为：根据所述无线信道类型和对应的链路自适应模式，得出待调度时刻的信道预测信息，选择与所述待调度时刻的信道预测信息匹配的链路速率。

通过采用本发明的技术，根据无线信道的不同分类有针对性的选择有效的链路自适应处理模式，能够保证在不同的衰落信道下实现系统的吞吐量最大化，保持稳定可靠的链路质量。

附图概述

此处所说明的附图用来提供对本发明的进一步理解，构成本申请的一部分，本发明的示意性实施例及其说明用于解释本发明，并不构成对本发明的不当限定。在附图中：

图 1 为本发明链路自适应方法的流程图；

图 2 为本发明实施例一的链路自适应方法的流程图；

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图 3 为无线信道的一种分类示意图;

图 4 为本发明链路自适应的装置框图。

本发明的较佳实施方式

下面结合附图和实施例，对本发明的具体实施方式做详细说明。

本发明的链路自适应方法基本思想原理如图 1 所示，包括:

步骤 101，对无线信道进行分类;

步骤 102，设置链路自适应模式集合;

步骤 103，根据所述无线信道的类型来选择对应的链路自适应模式。

实施例 1

如图 2 所示，本实施例包括以下步骤:

步骤 201，对无线信道进行分类，并设置相应的链路自适应模式集合。

具体地，本实施例中，根据无线信道的时变特性将无线信道类型分为三种，如图 3 所示，为：平坦信道、慢衰落信道和快衰落信道;

进而根据信道衰落分类，设置与之相应的链路自适应模式集合;

相应的链路自适应模式集合为：即时值预测模式、历史值预测模式和统计分位数预测模式。其中:

即时值预测模式指，以最新的信道测量结果作为信道待调度时刻的链路速率选择依据。

历史值预测模式指，根据信道的历史测量结果，采用曲线拟合的方式预测待调度时刻的信道条件用于链路速率的选择。

统计分位数预测模式指，采用历史测量结果的累积分布函数的某个分位数作为待调度时刻的链路速率选择依据。例如:

（1）平坦信道：即时值预测模式下，可预测的，即预测误差在可接收的范围内;

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设：

t 时刻的信道测量结果记为 SINR(t)，当前时刻记为 t0，待调度时刻为 t0+n，其中 n 为系统处理时延与空口传输时延总和；当前时刻获得的最新测量结果为 SINR(tx)，tx ⩽ t0，则：即时值预测结果 SINR_estimate(t0+n)为 SINR_estimate(t0+n)=SINR(tx)，t 时刻的估计误差记为 Err(t)，则：
Err(t)= |SINR_estimate(t)-SINR(t)|

可预测的（可估计的）可能的公式表达为：

概率函数 P(Err(t) ⩽ Error_threhold | t = t0-w+1,t0-w+2,…,t0) ⩾ P1，0 ⩽ P1 ⩽ 1，w ⩾ 0，其中 Error_threhold 为估计误差的门限，当 Err(t) ⩽ Error_threhold 表示 t 时刻估计正确，否则估计错误，Error_threhold 越小估计精度要求越高，反之则估计精度越低；P1 表示估计正确的概率门限，即正确估计的概率为 P1。当正确估计的概率大于门限值 P1 时，称信道在该预测模式下是可估计的（或称可预测的）。其中，w 表示统计时间窗长，w 越低，信道模式之间的切换就越慢，统计结果就越准确，发展模式切换就越快，判断精确性会下降。

（2）慢衰落信道：历史值预测模式下，可预测的，即预测误差在可接收的范围内。

可预测的概念同上，此处不赘述；

历史值预测模式是指，利用历史的信道测量结果 SINR(t0-w' +1), SINR(t0-w' +2),…, SINR(t0)，采用选取基函数 f(t)对 SINR（t），t= t0-w' +1, t0-w' +2,…,t0 做曲线拟合，求出 f(t)的数学表达式，使得 f(t)=SINR(t), t = t0-w' +1, t0-w' +2。历史值预测结果 SINR_estimate（t）= f（t）。其中 w' 表示历史测量结果的个数；f(t)可以取任何基函数，例如三角函数、幂函数、对数函数以及多项式函数等。

（3）快衰落信道：其它情况，即，不可以预测；

对于以上两种方法均不可预测的，则判定为快衰落信道，与之对应的链路自适应模式为统计分位数预测模式；

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统计分位数预测模式，即采用概率分布函数的模式:

P(x) = P (SINR(t)<x | t =t= t0-w' ' +1, t0-w' ' +2,…,t0) ，取 P(x)的 alpha 点分位数，作为统计分位数预测结果 SINR_estimate(t)，即，SINR_estimate(t) = P^{-1} (alpha) ， P^{-1}(x)为 P(x)的反函数; 0≤alpha≤1，alpha 越大速率越高可靠性越差，反之速率越低可靠性越高;

步骤 202，根据对无线信道的历史测量信息的分析获得无线信道的衰落类型，即通过信道学习来获得无线信道的衰落类型。

步骤 202 包括:

202.1，对历史测量结果进行去噪处理，采用一般的去噪方式即可，如:滤波方式或滑动窗口平均方式;

202.2,观察历史的 N 次测量结果,如果是在即时值预测模式下可预测的，则该信道为平坦信道; 如果是在历史值预测模式下可预测的，则该信道为慢衰落信道; 否则为快衰落信道。

步骤 203，根据步骤 202 中获取的无线信道衰落类型，在链路自适应模式集合中选择链路自适应模式;

如果信道为平坦信道，则选取即时值预测模式; 如果信道为慢衰落信道，则选取历史值预测模式; 如果信道为快衰落信道，则选取统计分位数预测模式。

步骤 204，根据无线信道的分类和链路自适应模式，给出待调度时刻的信道条件预测信息;

此处的信道条件预测信息可以包括: 信干噪比 (Signal Interference Noise Ratio, SINR) 、误块率 (Block Error Rate, BLER) 等;

设，最新的测量历史值为 SINR(t)，待调度时刻为 SINR_estimate(tx);

信道分类结果对应的信道条件预测信息如下:

平坦信道下: SINR_estimate(tx)=SINR(t)

慢衰落信道下: SINR_estimate(tx)=f(tx);

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快衰落信道下：SINR_estimate(tx)=P^{-1}(tx)。

步骤 205，根据步骤 204 得到的信道条件预测信息，获得与之相匹配的链路速率；

设：信道的信干噪比（Signal Interference Noise Ratio，SINR）预测结果为 SINR1，业务的误块率（Block Error Rate,BLER）要求是 BLER1；在 SINR=SINR1，BELR=BLER1 的条件下链路所能达到的最大速率为调制编码方式 1（Modulation Code Scheme，即 MCS1），则本步骤输出结果为 MCS1。

步骤 206，链路自适应过程完成。

实施例 2

另，本发明还可以根据无线信道的时变特性将无线信道分为两种：即慢衰落信道和快衰落信道。处理方式如实施例 1，此处不赘述。

实施例 3

另，本发明还可以根据无线信道的时变特征将无线信道分为：快衰落信道、慢衰落信道和突变信道。

其中快衰落信道和慢衰落信道的处理方式如实施例 1，此处不赘述。

突变信道，即信道突然变好或变坏，对应的链路自适应模式为突变处理模式。

对于突变信道，采用突变处理模式，突变处理模式是指：清除历史信息，采用初始默认的信道预测方法，初始默认预测方法可采用历史值预测模式或即时值预测模式中的任意一种，具体选择视数据可靠性要求而定。

实施例 4

基于同一发明构思，本发明实施例中还提供了一种用于链路自适应的装置，由于该装置解决问题的原理与链路自适应的方法相似，因此该装置的实施可以参见方法的实施，重复之处不再赘述。

图 4 示出了本发明链路自适应的装置结构示意图，如图 4 所示，该装置包括分类模块、设置模块和模式选择模块。其中：

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分类模块 401 设置为：对无线信道进行分类；

设置模块 402 设置为：设置链路自适应模式集合；

模式选择模块 403 设置为：根据所述分类的无线信道类型从设置模块中选择对应的链路自适应模式。

优选地，本发明的链路自适应装置还包括信道学习模块和链路速率确定模块；其中：

信道学习模块设置为：分析处理无线信道的历史测量信息，得出当前无线信道的类型；

链路速率确定模块设置为：根据所述无线信道类型和对应的链路自适应模式，得出待调度时刻的信道预测信息，选择与之匹配的链路速率。

本领域普通技术人员可以理解上述方法中的全部或部分步骤可通过程序来指令相关硬件完成，所述程序可以存储于计算机可读存储介质中，如只读存储器、磁盘或光盘等。可选地，上述实施例的全部或部分步骤也可以使用一个或多个集成电路来实现。相应地，上述实施例中的各模块/单元可以采用硬件的形式实现，也可以采用软件功能模块的形式实现。本发明不限制于任何特定形式的硬件和软件的结合。

以上详细说明了本发明的原理，但这只是为了便于理解而举的一些实施例，并不构成对本发明保护范围的限定。在不背离本发明精神及实质的情况下，本领域技术人员当可根据本发明作出各种相应的改变和变形，但这些相应的改变和变形都属于本发明所付的权利要求的保护范围。

工业实用性

通过采用本发明的技术，根据无线信道的不同分类有针对性的选择有效的链路自适应处理模式，能够保证在不同的衰落信道下实现系统的吞吐量最大化，保持稳定可靠的链路质量。

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权 利 要 求 书

1、一种链路自适应方法，其包括:

对无线信道进行分类;

设置链路自适应模式集合; 以及

根据所述无线信道的类型选择对应的链路自适应模式。

2、根据权利要求 1 所述的方法，其中，对无线信道进行分类的步骤中，是根据无线信道的时变特性进行分类的。

3、根据权利要求 2 所述的方法，其中，对无线信道进行分类的步骤中，是将无线信道分类为:

平坦信道、慢衰落信道和快衰落信道; 或者

慢衰落信道和快衰落信道; 或者

慢衰落信道、快衰落信道和突变信道。

4、根据权利要求 1 所述的方法，其中，所述链路自适应模式集合包括: 即时值预测模式、历史值预测模式、统计分位数预测模式和突变处理模式。

5、根据权利要求 4 所述的方法，其中，根据所述无线信道的类型选择对应的链路自适应模式的步骤包括:

通过分析无线信道的历史测量信息，判断得出当前无线信道的类型，根据所述当前无线信道的类型从所述链路自适应模式集合中选择对应的链路自适应模式。

6、根据权利要求 5 所述的方法，其中，根据所述无线信道的类型选择对应的链路自适应模式的步骤之后，所述方法还包括:

根据所述无线信道类型和对应的链路自适应模式，得出待调度时刻的信

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道预测信息，获得与所述待调度时刻的信道预测信息匹配的链路速率。

7、一种链路自适应装置，其包括：

分类模块，其设置：对无线信道进行分类；

设置模块，其设置为：设置链路自适应模式集合；以及

模式选择模块，其设置为：根据所述分类的无线信道类型从设置模块中选择对应的链路自适应模式。

8、根据权利要求 7 所述的装置，其中，所述分类模块是设置为根据无线信道的时变特性对无线信道进行分类的。

9、根据权利要求 8 所述的装置，其中，所述分类模块是设置为将无线信道分类为：

平坦信道、慢衰落信道和快衰落信道；或者

慢衰落信道和快衰落信道；或者

慢衰落信道、快衰落信道和突变信道。

10、根据权利要求 7 所述的装置，其中，所述链路自适应模式集合包括：即时值预测模式、历史值预测模式、统计分位数预测模式和突变处理模式。

11、根据权利要求 10 所述的装置，其中，所述模式选择模块是设置为按如下方式根据所述无线信道的类型选择对应的链路自适应模式：

通过分析无线信道的历史测量信息，判断得出当前无线信道的类型，根据所述当前无线信道的类型从所述链路自适应模式集合中选择对应的链路自适应模式。

12、根据权利要求 7 所述的装置，其还包括：

信道学习模块，其设置为：分析处理无线信道的历史测量信息，得出当前无线信道的类型；以及

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链路速率确定模块，其设置为：根据所述无线信道类型和对应的链路自适应模式，得出待调度时刻的信道预测信息，获得与所述待调度时刻的信道预测信息匹配的链路速率。

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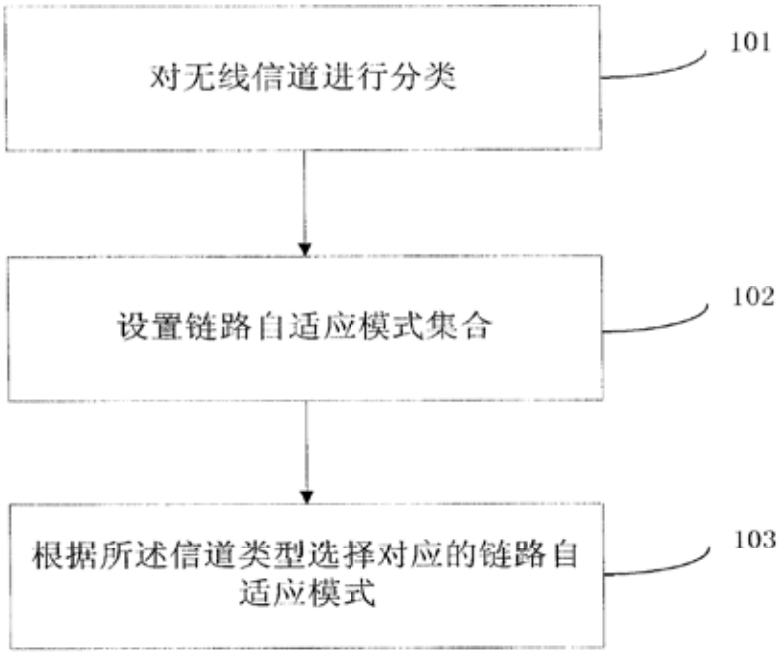


图 1

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Page #1987

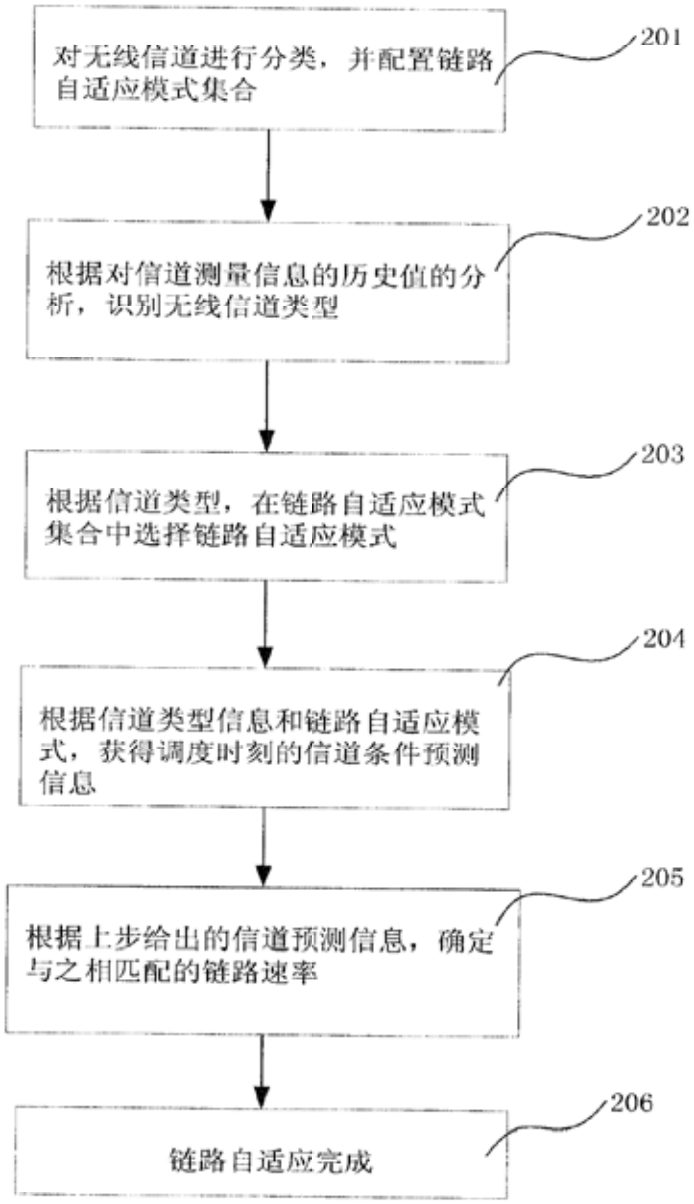


图 2

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平坦信道



快衰落信道



慢衰落信道

图 3

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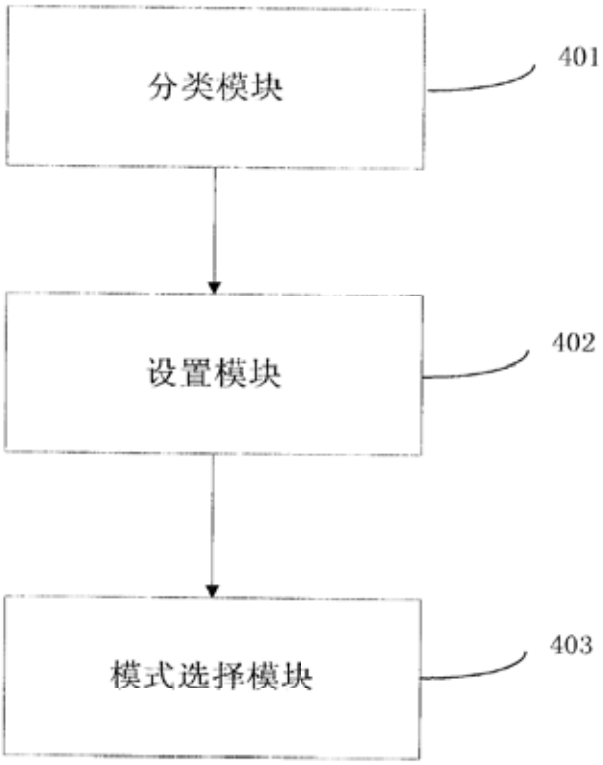


图 4

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/074869

A. CLASSIFICATION OF SUBJECT MATTER

H04W 28/08 (2009.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W H04L H04J H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT; CNKI; WPI; EPODOC; link?, channel?, adaptation, adaptive, classif+, type?, mode?, pattern?, rate, throughput, fading, predict+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1829113A (MATSUSHITA ELECTRIC IND CO LTD) 06 Sep. 2006 (06.09.2006)	1-3,7-9
Y	description, page 2, lines 1-7, page 3, lines 14-19, figures 3, 6	4-6,10-12
Y	CN1399436A (INTEL CORP) 26 Feb. 2003 (26.02.2003) description, page 4, line 3 to page 6, line 22, page 10, line 19 to page 11, line 31, figures 2-5	4-6,10-12
A	CN1862995A (ZHONGXING COMMUNICATION CO LTD SHENZHEN) 15 Nov. 2006 (15.11.2006) full text	1-12
A	US20090310550A1(BECEEM COMMUNICATIONS INC)17 Dec. 2009(17.12.2009) full text	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 Sep. 2010 (25.09.2010)	**28 Oct. 2010 (28.10.2010)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer Meng, Tiange Telephone No. (86-10)62411653

Form PCT/ISA /210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/074869

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1829113A	06.09.2006	none	
CN1399436A	26.02.2003	US2003017835A1	23.01.2003
		WO03009493A1	30.01.2003
		KR20030009140A	29.01.2003
		JP2003143065A	16.05.2003
		EP1410528A1	21.04.2004
		AU2002355087A1	03.03.2003
		TW574793A	01.02.2004
		CN1181634C	22.12.2004
		EP1410528B1	19.04.2006
		DE60210777E	24.05.2006
		JP3790723B2	28.06.2006
		SG125901A1	30.10.2006
		US7174178B2	06.02.2007
		DE60210777T2	19.04.2007
		KR100654282B1	05.12.2006
CN1862995A	15.11.2006	none	
US20090310550A1	17.12.2009	none	

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国际检索报告

国际申请号
PCT/CN2010/074869

A. 主题的分类

H04W 28/08 (2009.01) i

按照国际专利分类(IPC)或者同时按照国家分类和 IPC 两种分类

B. 检索领域

检索的最低限度文献(标明分类系统和分类号)

IPC: H04W H04L H04J H04B

包含在检索领域中的除最低限度文献以外的检索文献

在国际检索时查阅的电子数据库(数据库的名称，和使用的检索词（如使用）)

CNPAT; CNKI; WPI; EPODOC: 链路，信道，自适应，分类，类型，模式，速率，吞吐量，容量，衰落，预测; link?, channel?, adaptation, adaptive, classif+, type?, mode?, pattern?, rate, throughput, fading, predict+

C. 相关文件

类　型*	引用文件，必要时，指明相关段落	相关的权利要求
X	CN1829113A（松下电器产业株式会社）06.9 月 2006（06.09.2006）	1-3,7-9
Y	说明书第 2 页第 1-7 行，第 3 页第 14-19 行，图 3，6	4-6,10-12
Y	CN1399436A（英特尔公司）26.2 月 2003（26.02.2003） 说明书第 4 页第 3 行至第 6 页第 22 行，第 10 页第 19 行至第 11 页第 31 行，图 2-5	4-6,10-12
A	CN1862995A（中兴通讯股份有限公司）15.11 月 2006（15.11.2006） 全文	1-12
A	US20090310550A1（BECEEM COMMUNICATIONS INC）17.12 月 2009（17.12.2009）全文	1-12

☐ 其余文件在 C 栏的续页中列出。　　☒ 见同族专利附件。

* 引用文件的具体类型：

"A" 认为不特别相关的表示了现有技术一般状态的文件

"E" 在国际申请日的当天或之后公布的在先申请或专利

"L" 可能对优先权要求构成怀疑的文件，或为确定另一篇引用文件的公布日而引用的或者因其他特殊理由而引用的文件（如具体说明的）

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"&" 同族专利的文件

国际检索实际完成的日期	国际检索报告邮寄日期
25.9 月 2010（25.09.2010）	**28.10 月 2010 (28.10.2010)**
ISA/CN 的名称和邮寄地址： 中华人民共和国国家知识产权局 中国北京市海淀区蓟门桥西土城路 6 号 100088 传真号：　(86-10)62019451	受权官员 **孟田革** 电话号码：(86-10) **62411653**

PCT/ISA/210 表(第 2 页) (2009 年 7 月)

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国际检索报告
关于同族专利的信息

国际申请号
PCT/CN2010/074869

检索报告中引用的专利文件	公布日期	同族专利	公布日期
CN1829113A	06.09.2006	无	
CN1399436A	26.02.2003	US2003017835A1	23.01.2003
		WO03009493A1	30.01.2003
		KR20030009140A	29.01.2003
		JP2003143065A	16.05.2003
		EP1410528A1	21.04.2004
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		CN1181634C	22.12.2004
		EP1410528B1	19.04.2006
		DE60210777E	24.05.2006
		JP3790723B2	28.06.2006
		SG125901A1	30.10.2006
		US7174178B2	06.02.2007
		DE60210777T2	19.04.2007
		KR100654282B1	05.12.2006
CN1862995A	15.11.2006	无	
US20090310550A1	17.12.2009	无	

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(54) METHOD FOR LINK ADAPTATION AND APPARATUS THEREOF

(57) A method for link adaptation includes: classifying a radio channel; setting a set of link adaptation modes; and selecting a corresponding link adaptation mode according to a radio channel type. An apparatus for link adaptation includes: a classification module for performing a classification on a radio channel; a setting module for setting a set of link adaptation modes; and a mode selection module for selecting a corresponding link adaptation mode from the setting module according to a radio channel type of the classification. The present invention accordingly selects effective link adaptation modes in accordance with different types of radio channels, and is able to ensure to implement the maximum system throughput in different fading channels and maintain the stable and reliable link quality.

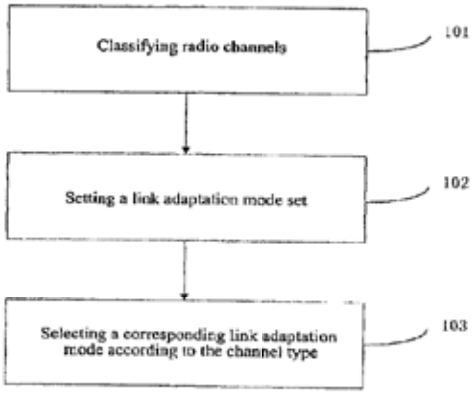


FIG. 1

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Description

Technical Field

[0001] The present invention relates to wireless communication systems, and more particularly, to a link adaptation technique.

Background of the Related Art

[0002] In wireless communication systems, since the radio channel is complex and there is no fixed rules to follow, in order to implement the maximum throughput of the wireless communication systems, wireless communication systems are expected to be able to automatically adjust the transmission rate according to the channel condition change, namely the link adaptation technique. The conventional method for link adaptation is taking the latest channel quality measurement result as a basis of selecting the future link rate.

Summary of the Invention

[0003] In the prior art, the conventional method for link adaptation is taking the latest channel quality measurement results as a basis of selecting the future link rate, and this method has the following problems:

the channel quality measurement results always contain measurement errors and random interference affects, namely the measurement results cannot accurately reflect the actual channel conditions;

radio channel conditions randomly change with the change of the time, and that is to say that the past measurement results cannot completely reflect the future channel conditions.

[0004] In view of this, the technical problem to be solve in the present invention is to provide a method and an apparatus for link adaptation, which are able to ensure the maximum throughput of the system implemented in different fading channels and maintain the stable and reliable link quality.

[0005] To solve the above technical problem, one aspect of the present invention is to provide a method for link adaptation, and the method comprises:

classifying a radio channel;

setting a link adaptation mode set; and

selecting a corresponding link adaptation mode according to a radio channel type.

[0006] In the step of classifying the radio channel, the radio channel is classified based on a time-variant characteristic of the radio channel.

[0007] In the step of classifying the radio channel, the radio channel is classified into:

a flat channel, a slow fading channel and a fast fading channel; or

the slow fading channel and the fast fading channel; or

the slow fading channel, the fast fading channel and a mutant channel.

[0008] The link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

[0009] The step of selecting the corresponding link adaptation mode according to the ratio channel type comprises: determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

[0010] After the step of selecting the corresponding link adaptation mode according to the radio channel type, the method also comprises: obtaining channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and obtaining a link rate matching with the channel prediction information at the to-be scheduling time.

[0011] Another aspect of the present invention also provides an apparatus for link adaptation, which comprises:

a classification module, which is configured to classify a radio channel;

a setting module, which is configured to set a link adaptation mode set; and

a mode selection module, which is configured to select a corresponding link adaptation mode from the setting module according to a radio channel type in the classification.

[0012] The classification module is configured to perform the classification on the radio channel based on a time-variant characteristic of the radio channel.

[0013] The classification module is configured to classify the radio channels into:

a flat channel, a slow fading channel and a fast fading channel; or

the slow fading channel and the fast fading channel; or

the slow fading channel, the fast fading channel and

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a mutant channel.

[0014] The link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

[0015] The mode selection module is configured to select the corresponding link adaptation mode according to the radio channel type in a following way:

determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

[0016] The apparatus also comprises:

a channel learning module, which is configured to analyze and process the historical measurement information of the radio channel to obtain a the current radio channel type; and

a link rate determination module, which is configured to: obtain the channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and select a link rate matching with the channel prediction information at the to-be scheduling time.

[0017] With the technique in the present invention, an effective link adaptation processing mode can be selected specifically according to different radio channel types, which is able to ensure to implement the maximum system throughput in different fading channels and to maintain a stable and reliable link quality.

Brief Description of Drawings

[0018] The drawings described herein is used to provide a better understanding of the present invention and forms a part of this application, the illustrative examples of the present invention and their descriptions are used to explain the present invention rather than forming the improper restriction on the present invention. In the drawings:

FIG. 1 is a flow chart of the method for link adaptation in accordance with the present invention;

FIG. 2 is a flow chart of the method for link adaptation in accordance with the example 1 of the present invention;

FIG. 3 is a schematic diagram of the classification of the radio channels;

FIG. 4 is a block diagram of the apparatus for link adaptation in accordance with the present invention.

Preferred Embodiments of the Present Invention

[0019] The specific embodiments of the present invention will be illustrated in detail with reference to drawings and examples.

[0020] The basic idea of the method for link adaptation in accordance with the present invention is shown in FIG. 1, which comprises:

step 101, the radio channels are classified;

step 102, a link adaptation mode set is set;

step 103, a corresponding link adaptation mode is selected according to the radio channel type.

Example 1

[0021] As shown in FIG. 2, this example comprises the following steps of:

step 201, the radio channels are classified, and the corresponding link adaptation mode set is set.

[0022] Specifically, in this example, the radio channels are classified into three types according to the time-variant characteristics of the radio channels, and as shown in FIG. 3, the three types of radio channels are: flat channels, slow fading channels and fast fading channels;
then further a corresponding link adaptation mode set is set according to the channel fading types;
the corresponding link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode and statistical quantile prediction mode, wherein:

the instantaneous value prediction mode refers to take the latest channel measurement result as a basis to select a link rate at the channel scheduling time.

[0023] The historical value prediction mode refers to use the curve fitting method to predict the channel conditions at the to-be scheduling time according to the historical channel measurement results for use by selecting the link rate.

[0024] The statistical quantile prediction mode refers to take a certain quantile of the cumulative distribution function of the historical measurement results as the basis to select the link rate at the to-be scheduling time. For example:

(1) flat channels: in the instantaneous value prediction mode, and predictable, that is, the prediction error is in the acceptable range;
suppose:

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the channel measurement result at the time t is denoted as SINR(t), the current time is denoted as t0, the to-be scheduling time is t0+n, where n is the sum of the system processing delay and the air interface transmission delay; the latest measurement result obtained at the current time is SINR(tx), and tx≤t0, therefore: the instantaneous value prediction result SINR_estimate (t0+n) is SINR_estimate(t0+n)=SINR(tx), the estimation error at the time t is denoted as Err (t), then: Err(t) = |SINR_estimate(t)-SINR(t)|
The predictable (estimable) probability is expressed as:
the probability function P(Err(t)≤Error_threholdl t = t0-w+1,t0-w+2,...,t0) ≥P1, 0≤P1≤1, w≥0, where Error_threshold is the estimation error threshold, when Err(t)≤Error_threhold, it indicates that the estimation at the time t is correct, otherwise, it indicates that the estimation is wrong, and the smaller the Error_threshold is, the higher the estimation precision is, otherwise, the estimation precision is lower; P1 denotes the probability threshold of the correct estimation, and that is, the probability of correct estimation is P1. When the probability of correct estimation is larger than the threshold P1, it indicates that the channel is estimable in this prediction mode (or predictable). Where, w indicates the statistical time window length, and the smaller the w is, the lower the switching between the channel modes is, the more accurate the statistical result is, the faster the switching between the development modes is and the lower the judgment precision is.

(2) Slow fading channels: in the historical value prediction mode, and predictable, that is, the prediction error is in the acceptable range.
The concept of predictability is as the above description and is not repeated herein;
the historical value prediction mode refers to: use the historical channel measurement results SINR(t0-w' +1), SINR(t0-w' +2),···, SINR(t0), use the selected basis function f(t) to perform the curve fitting on SINR (t), t = t0-w, + 1, t0-w, +2, -, t0 to obtain the mathematical expression of f(t), so that f (t) = SINR (t), t= t0-w' +1, t0-w' +2,···,t0. The historical value prediction result SINR_estimate (t) = f (t). Where w' denotes the number of historical measurement results; f(t) can be any basis functions such as the trigonometric function, the power function, the logarithmic function as well as the polynomial function and so on.

(3) Fast Fading Channels: other cases, that is, unpredictable;
those are unpredictable by the above two methods are determined as the fast fading channels, and the corresponding link adaptation mode is the statistical quantile prediction mode;
the statistical quantile prediction mode is the mode applying the probability distribution function:

P(x) = P(SINR(t)<x I t =t= t0-w'+1, t0-w'+2,..., t0), the quantile at the point of alpha of the P(x) is taken as the statistical quantile prediction result SINR_estimate(t), that is, SINR_estimate(t) = P^{-1}(alpha) , and P^{-1}(x) is the inverse function of P(x); 0≤alpha≤1, the larger the alpha is, the higher the rate is, and the worse the reliability is, otherwise, the lower the rate is, and the better the reliability is;
step 202, the fading type of the radio channel is obtained according to the analysis of the historical measurement information of the radio channel, and that is, the fading type of the radio channel is obtained via the channel learning.

[0025] Step 202 comprises:

202.1, the historical measurement results are de-noised, and a general de-noising way can be used, for example the filtering way or the sliding window average way;

202.2 N historical measurement results are observed, and if the channel is predictable in the instantaneous value prediction mode, the channel is a flat channel; if the channel is predictable in the historical value prediction mode, the channel is a slow fading channel; otherwise the channel is a fast fading channel.

[0026] Step 203, a link adaptation mode is selected from the link adaptation mode set according to the fading type of the radio channel obtained in step 202;
if the channel is a flat channel, the instantaneous value prediction mode is selected; if the channel is a slow fading channel, the historical value prediction mode is selected; and if the channel is a fast fading channel, the statistical quantile prediction mode is selected.
[0027] Step 204, the channel condition prediction information at the to-be scheduling time point is obtained according to the radio channel type and link adaptation mode;
the channel condition prediction information might include the Signal Interference Noise Radio (SINR), and the Block Error Rate (BLER), and so on;
it is assumed that the latest historical measurement value is SINR(t), and measurement value at the to-be scheduling time is SINR-estimate(tx);
the channel condition prediction information corresponding to the channel classification results is as follows:

in flat channels: SINR estimate(tx) = SINR(t);

in slow fading channels: SINR estimate(tx) = f(tx);

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in fast fading channels: SINR_estimate(tx)=P^{-1}(tx).

step 205, the matching link rate is obtained according to the channel condition prediction information obtained in step 204;

It is assumed that the channel SINR prediction result is SINR1 and the service BLER requirement is BLER1; the maximum rate that can be reached by the link in the conditions of SINR=SINR1 and BELR=BLER1 is the Modulation Code Scheme 1 (MCS1), therefore, the output result in this step is MCS1.

[0028] Step 206, the link adaptation process is complete.

Example 2

[0029] In addition, the present invention can further classify the radio channels into two types according to the time-variant characteristics of the radio channels, namely: slow fading channels and fast fading channels. The processing method is as the example 1 and is not repeated herein.

Example 3

[0030] In addition, the present invention can further classify the radio channels into: fast fading channels, slow fading channels and mutant channels according to the time-variant characteristics of the radio channels.

[0031] Wherein, the method for processing the fast fading channels and the slow fading channels is as the example 1 and is not repeated herein.

[0032] For a mutant channel, the channel is suddenly good or bad, the corresponding link adaptation mode is the mutation processing mode.

[0033] For the mutant channel, the mutant processing mode is applied, and the mutation processing mode refers to: clear the historical information, use the initial default channel prediction way which might use any one of the historical value prediction mode or the instantaneous value prediction mode, and the specific selection is determined according to the data reliability requirements.

Example 4

[0034] Based on the same inventive concept, the example of the present invention also provides an apparatus for link adaptation, since the principle of the apparatus for solving the problem is similar to the method for link adaptation, the implementation of the apparatus can refer to the implementation of the method, and the overlaps are not repeated herein.

[0035] FIG. 4 shows a schematic diagram of the structure of the apparatus for link adaptation in accordance of the present invention, and as shown in FIG. 4, the apparatus comprises a classification module, a setting module and a mode selection module, wherein

the classification module 401 is configured to perform a classification on the radio channels;

the setting module 402 is configured to set a link adaptation mode set;

the mode selection module 403 is configured to select the corresponding link adaptation mode from the setting module according to the radio channel type in the classification.

[0036] Preferably, the apparatus for the link adaptation in the present invention also comprises a channel learning module and a link rate determination module, wherein the channel learning module is configured to analyze and process the historical measurement information of the radio channels to obtain the current radio channel type; the link rate determination module is configured to obtain the channel prediction information at the to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and to select the matching link rate.

[0037] It can be understood by those skilled in the art that some or all steps in the above mentioned method can be fulfilled by instructing the relevant hardware with a program, and said program is stored in a computer readable storage medium such as the read only memory, the magnetic disk or the optical disk. Optionally, some or all steps in the above mentioned examples can be implemented with one or more integrated circuits. Correspondingly, each module/unit in the above mentioned examples can be implemented in the form of hardware or in the form of software function module, or their combinations.

[0038] The principle of the present invention is illustrated in detail in the above description, however, the description is only a plurality of examples illustrated for understanding the present invention rather than the restriction of the protection scope of the present invention. For those skilled in the art, various corresponding modifications and transformations can be made according to the present invention without departing from the spirit and essence of the present invention, and such modification or transformations should fall into the protection scope of the appended claims of the present invention.

Industrial Applicability

[0039] With the technique in the present invention, an effective link adaptation processing mode can be selected specifically according to different radio channel types, which is able to ensure the maximum system throughput in different fading channels and to maintain a stable and reliable link quality.

Claims

1. A method for link adaptation, wherein, the method

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comprising:

classifying a radio channel;
setting a link adaptation mode set; and
selecting a corresponding link adaptation mode according to a radio channel type.

2. The method of claim 1, wherein, in the step of classifying the radio channel, the radio channel is classified based on a time-variant characteristic of the radio channel.

3. The method of claim 2, wherein, in the step of classifying the radio channel, the radio channel is classified into:

a flat channel, a slow fading channel and a fast fading channel; or
the slow fading channel and the fast fading channel; or
the slow fading channel, the fast fading channel and a mutant channel.

4. The method of claim 1, wherein the link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

5. The method of claim 4, wherein the step of selecting the corresponding link adaptation mode according to the ratio channel type comprises:

determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

6. The method of claim 5, after the step of selecting the corresponding link adaptation mode according to the radio channel type, the method also comprising:

obtaining channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and obtaining a link rate matching with the channel prediction information at the to-be scheduling time.

7. An apparatus for link adaptation, comprising:

a classification module, which is configured to perform a classification on a radio channel;
a setting module, which is configured to set a link adaptation mode set; and
a mode selection module, which is configured to select a corresponding link adaptation mode from the setting module according to a radio channel type in the classification.

8. The apparatus of claim 7, wherein the classification module is configured to perform the classification on the radio channel based on a time-variant characteristic of the radio channel.

9. The apparatus of claim 8, wherein the classification module is configured to classify the radio channel into:

a flat channel, a slow fading channel and a fast fading channel; or
the slow fading channel and the fast fading channel; or
the slow fading channel, the fast fading channel and a mutant channel.

10. The apparatus of claim 7, wherein the link adaptation mode set includes: an instantaneous value prediction mode, a historical value prediction mode, a statistical quantile prediction mode and a mutation processing mode.

11. The apparatus of claim 10, wherein the mode selection module is configured to select the corresponding link adaptation mode according to the radio channel type in a following way:

determining a current radio channel type by analyzing historical measurement information of the radio channel, and selecting the corresponding link adaptation mode from the link adaptation mode set according to the current radio channel type.

12. The apparatus of claim 7, the apparatus also comprising:

a channel learning module, which is configured to analyze and process historical measurement information of the radio channel to obtain a current radio channel type; and
a link rate determination module, which is configured to: obtain the channel prediction information at a to-be scheduling time according to the radio channel type and the corresponding link adaptation mode, and select a link rate matching with the channel prediction information at the to-be scheduling time.

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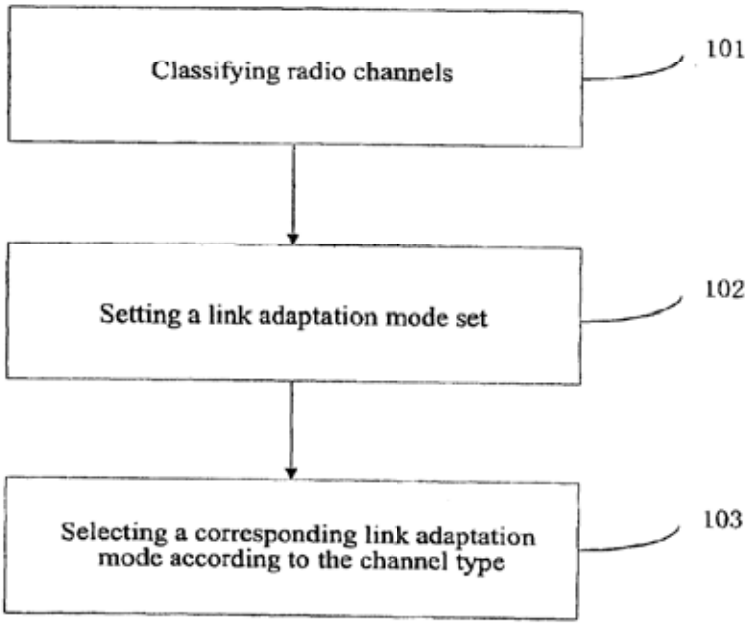


FIG. 1

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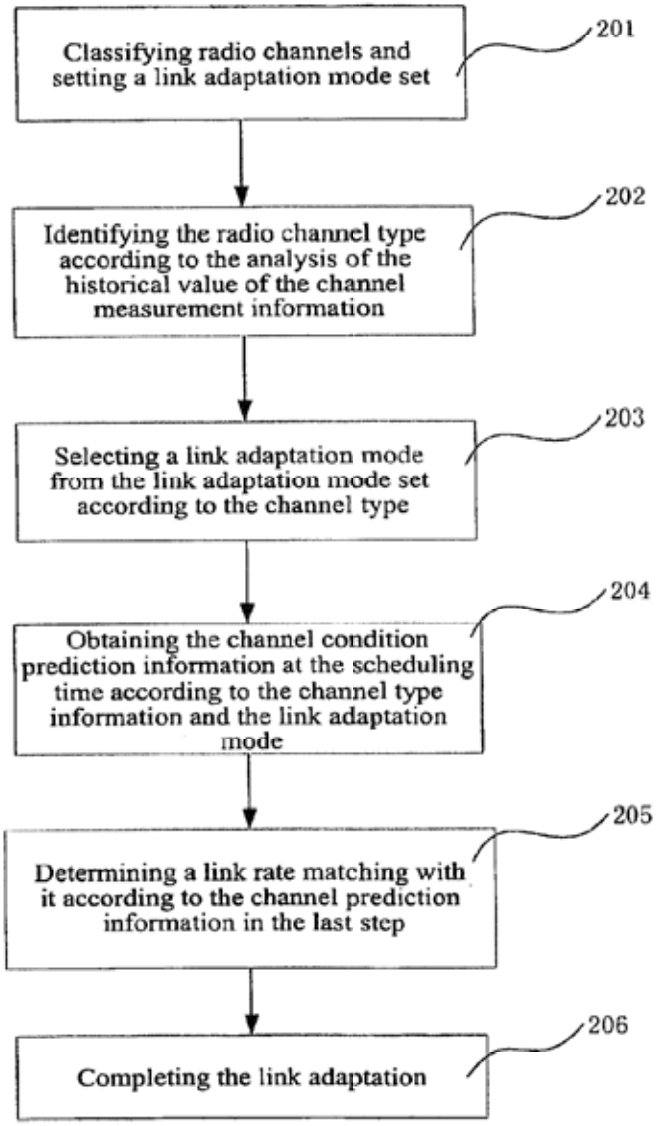


FIG. 2

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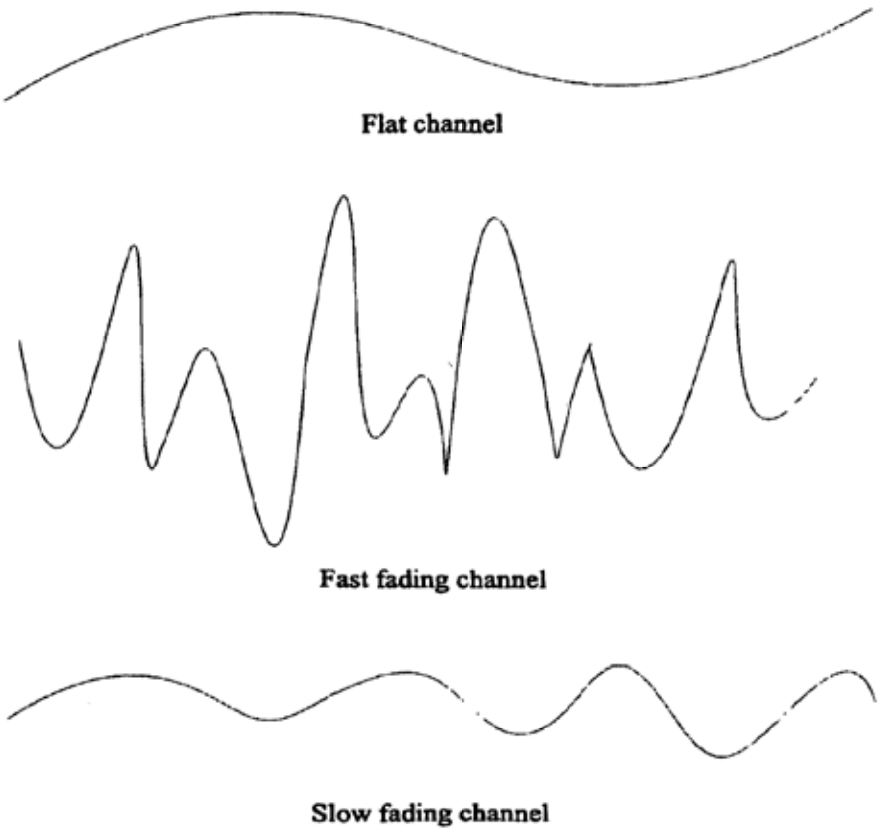


FIG. 3

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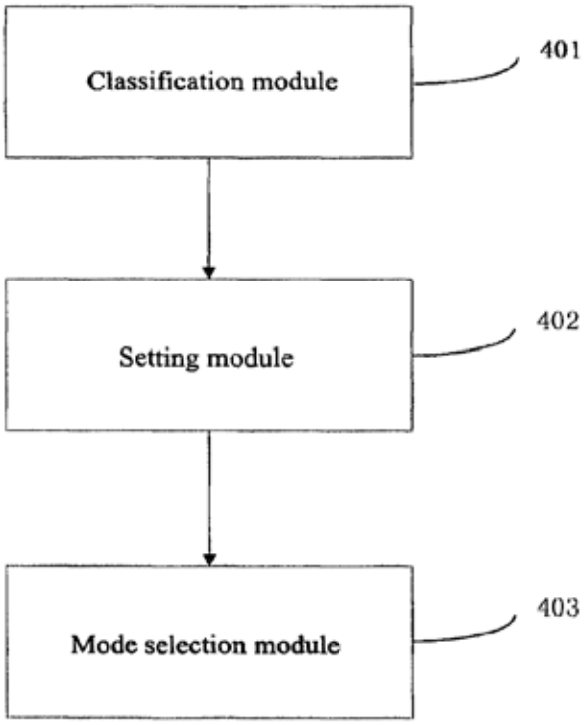


FIG. 4

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2010/074869

A. CLASSIFICATION OF SUBJECT MATTER

H04W 28/08 (2009.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H04W H04L H04J H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT; CNKI; WPI; EPODOC; link?, channel?, adaptation, adaptive, classif+, type?, mode?, pattern?, rate, throughput, finding, predict+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN1829113A (MATSUSHITA ELECTRIC IND CO LTD) 06 Sep. 2006 (06.09.2006)	1-3,7-9
Y	description, page 2, lines 1-7, page 3, lines 14-19, figures 3, 6	4-6,10-12
Y	CN1399436A (INTEL CORP) 26 Feb. 2003 (26.02.2003) description, page 4, line 3 to page 6, line 22, page 10, line 19 to page 11, line 31, figures 2-5	4-6,10-12
A	CN1862995A (ZHONGXING COMMUNICATION CO LTD SHENZHEN) 15 Nov. 2006 (15.11.2006) full text	1-12
A	US20090310550A1(BECHEM COMMUNICATIONS INC)17 Dec. 2009(17.12.2009) full text	1-12

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 Sep. 2010 (25.09.2010)	**28 Oct. 2010 (28.10.2010)**
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer Meng, Tiange Telephone No. (86-10)62411653

Form PCT/ISA /210 (second sheet) (July 2009)

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2010/074869

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
CN1829113A	06.09.2006	none	
CN1399436A	26.02.2003	US2003017835A1	23.01.2003
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		DE60210777T2	19.04.2007
		KR100654282B1	05.12.2006
CN1862995A	15.11.2006	none	
US20090310550A1	17.12.2009	none	

Form PCT/ISA /210 (patent family annex) (July 2009)

Charter Communications, Inc.
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8241P054
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Wonjong		RHEE	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Seoul	Country of Residence i	KR

Mailing Address of Inventor:

Address 1	Seo-Cho-gu Seo-Cho-Joong-Ang-Ro 15, A-1205		
Address 2	Seo-cho-dong Hyundai Supervill		
City	Seoul	**State/Province**	
Postal Code	137	**Country** i	KR

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	08791		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER		
Attorney Docket Number	8241P054	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	6	**Suggested Figure for Publication (if any)**	4

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8241P054
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

Filing By Reference :

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	08791		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the application number blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCTUS11060265	2011-11-10

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8241P054
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) [i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country [i]	Filing Date (YYYY-MM-DD)	Access Code [j] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8241P054
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◯ Assignee	◯ Legal Representative under 35 U.S.C. 117	◯ Joint Inventor
◯ Person to whom the inventor is obligated to assign.	◯ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8241P054
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

Mailing Address Information:			
Address 1			
Address 2			
City		**State/Province**	
Country [i]		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

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Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication . An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	Adaptive Spectrum and Signal Alignment, Inc.

Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1	333 Twin Dolphin Drive		
Address 2			
City	Redwood City	**State/Province**	CA
Country [i]	US	Postal Code	94065
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Usman A. Mughal/	Date (YYYY-MM-DD)	2014-05-06

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	8241P054
	Application Number	
Title of Invention	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	

First Name	Usman	Last Name	Mughal	Registration Number	62887

Additional Signature may be generated within this form by selecting the Add button. Add

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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Page #2014

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants: Wonjong RHEE		
Serial No.:	NOT YET ASSIGNED (U.S. National Phase Filing of PCT/US2011/060265 under 35 U.S.C. 371)	Confirmation No.: Not Yet Assigned
Filed: Herewith		Art Unit: Not Yet Assigned
For	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER	
Docket No.:	8241P054	

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Applicant respectfully requests that the following Preliminary Amendment be entered prior to examination of the above-identified patent application. The Examiner is requested to enter this amendment before calculating the fee.

I hereby certify that this correspondence is being deposited via EFS Web on the date below:

5/6/2014
Date of Deposit

/Lisa Puccinelli /
Lisa Puccinelli

AMENDMENTS TO THE SPECIFICATION

At page 1, line 2, add the following:

CLAIM OF PRIORITY

[0001] This application is a U.S. National Phase application under 35 U.S.C. § 371 of International Application No. PCT/US2011/060265, filed November 10, 2011, entitled "METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER" the entire contents of which are incorporated herein by reference.

Applicants respectfully submit that no new matter has been entered, and the amendments correct and clarify the previously submitted claim of priority.

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AMENDMENT TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Original) A method for optimizing performance of one or more communication units by a remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

2. (Original) The method of claim 1, wherein the policy further comprises first and second algorithms.

3. (Original) The method of claim 2, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

4. (Original) The method of claim 1, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

5. (Original) The method of claim 1, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

6. (Original) The method of claim 1, wherein generating the policy comprises:

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generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

7. (Original) The method of claim 1, wherein collecting data from the one or more communication units is performed periodically.

8. (Original) The method of claim 1, wherein the one or more communication units comprises at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;
a wireless WiFi compatible base station;
a wireless mobile device repeater;
a wireless mobile device base station;
a set-top box (STB)/set-top unit (STU) customer electronics device;
an Internet Protocol (IP) enabled television;
an IP enabled media player;
an IP enabled gaming console;
an Ethernet gateway;
a computing device connected to the LAN;
an Ethernet connected computer peripheral device;

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an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

an Ethernet connected network switch.

9. (Original) The method of claim 1, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

10. (Original) A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform a method for optimizing performance of one or more communication units by the remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

11. (Original) The machine-readable storage medium of claim 10, wherein the policy further comprises first and second algorithms.

12. (Original) The machine-readable storage medium of claim 11, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

13. (Original) The machine-readable storage medium of claim 10, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

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14. (Original) The machine-readable storage medium of claim 10, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

15. (Original) The machine-readable storage medium of claim 10, wherein generating the policy comprises:

generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

16. (Original) The machine-readable storage medium of claim 10, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

17. – 33. (**Cancelled**)

34. (Original) An apparatus comprising:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from one or more communication units;

generate a policy, for each of the one or more communication units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

35. (Original) The apparatus of claim 34, wherein the policy further comprises first and second algorithms.

36. (Original) The apparatus of claim 35, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based

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on the conditions.

37. (Original) The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions and the time-varying data.

38. -52 **(Cancelled)**

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REMARKS

Specification is amended to provide claim of priority. Claims 17-33 and claims 38-52 are cancelled without prejudice. Claims 1-16 and 34-37 are pending. Applicants submit that no new matter has been added.

CONCLUSION

The Commissioner is authorized to charge or credit any deficiencies or overpayments in connection with this submission to Deposit Account No. 02-2666, and is requested to notify us of same.

Respectfully submitted,
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN, LLP

5/6/2014
Date

/Usman A. Mughal/
Usman A. Mughal
Reg. No. 62,887

1279 Oakmead Parkway
Sunnyvale, CA 94085-4040
Telephone: 503-439-8778

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
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16 May 2013 (16.05.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/070232 A1

(51) International Patent Classification:
H04L 1/00 (2006.01) *H04L 1/20* (2006.01)

(21) International Application Number:
PCT/US2011/060265

(22) International Filing Date:
10 November 2011 (10.11.2011)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **ASSIA, INC.** [US/US]; 333 Twin Dolphin Drive, Redwood City, CA 94065 (US).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **RHEE, Woujong** [KR/US]; 235 Berry Street, #606, San Francisco, CA 94158 (US).

(74) Agents: **VINCENT, Lester, J.** et al.; Blakely, Sokoloff, Taylor & Zafman LLP, 1279 Oakmead Parkway, Sunnyvale, CA 94085-4040 (US).

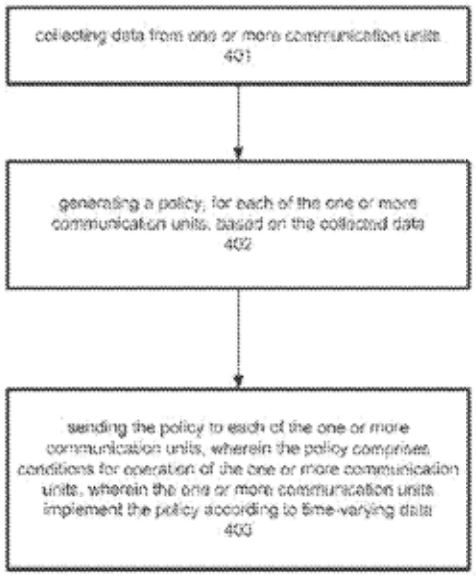
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[Continued on next page]

(54) Title: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

FIG. 4



(57) Abstract: Described herein are apparatus, system, and method for optimizing performance of one or more communication units by a remote server. The method comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data, and sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data. The system comprises: one or more communication units, and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to perform the method discussed above.

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METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

FIELD OF THE INVENTION

[0001] Embodiments of the invention relate generally to the field of communication systems. More particularly, embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server.

BACKGROUND

[0002] **Fig. 1** is an exemplary prior art communication system (CS) 100 with an access point (AP) 101 and one or more wireless stations 102_{1-N}. The AP 101 exchanges user data with the one or more stations 102_{1-N} over wireless channels indicated by the arrows. The characteristics of the wireless channels and noise/interference are not constant and vary rapidly over time. For example, noise and interference levels from nearby noise/interference sources rapidly changes that cause the characteristics of the wireless environment to change. To cope with such rapid changes in the noise and interference levels, the CS 100 adapts transmission strategies to enhance performance of CS 100. One such known strategy is Adaptation Algorithm. The term "Adaptation Algorithm" herein refers to time-varying and environment-change-dependent transmission or control strategies for a CS. The adaptation algorithm is implemented in the AP 101 that adapts the wireless channels and noise/interference for communication with the one or more stations 102_{1-N}.

[0003] For instance, the transmission rate of Institute of Electrical and Electronics Engineer (IEEE) 802.11g standard based WiFi communication system is rapidly adapted between 6Mbps and 54Mbps depending on the link quality and the rate selection method (also known as the rate adaptation algorithm) implemented in the WiFi communication system. Such rate adaptation algorithm within the WiFi communication system uses real-time data that are collected by the AP 101 of the WiFi communication system itself as an input to the adaptation algorithm 103, and a rate change in the link occurs when the real-time data meets a pre-defined criteria.

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[0004] A possible rate adaptation algorithm 103 is to change transmission rate of signals by the AP 101 within the WiFi communication system when the measured RSSI (Received Signal Strength Indication) becomes too large or too small for the current rate in use. Another possible adaptation algorithm 103 is to increase the transmission rate of signals by the AP 101 whenever packets are successfully received by the AP 101 and/or the one or more stations $102_{1..N}$ for M (e.g., 3) times and decrease rate whenever packets are unsuccessfully received for P (e.g., 2) times. While such adaptation algorithms 103 are required for WiFi communication systems to function properly, the rules and thresholds used by the methods are decided by a system designer of the WiFi communication system. Furthermore, a specific adaptation algorithm 103 is included in the firmware and loaded to the WiFi communication system. Hence, the adaption algorithm 103 is static in nature.

[0005] Therefore, the actual performance of the rate adaptation algorithm 103 is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and the WiFi communication system 100 may suffer from low performance due to non-ideal design of the static adaptation algorithm 103.

[0006] The impact of such differences in the assumptions can be significant in a large-scale deployment where many communication devices, such as AP's, independently operate. In such a deployment, every single communication environment is unique and the best adaptation method for each environment can be quite dependent on its own environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments of the invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

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[0008] **Fig. 1** is a high level system of a typical communication system using a static adaptive algorithm.

[0009] **Fig. 2** is a system for optimizing performance of a WiFi communication system by a remote server, according to one embodiment of the invention.

[0010] **Fig. 3** is a system for optimizing performance of a Digital Subscriber Line (DSL) communication system by a remote server, according to one embodiment of the invention.

[0011] **Fig. 4** is a method performed by a remote server for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0012] **Fig. 5** is a method performed by the communication system for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0013] **Fig. 6** is a processor-based system having machine-readable storage medium with computer executable instructions for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

SUMMARY OF THE INVENTION

[0014] The following presents a simplified summary of the embodiments of the invention in order to provide a basic understanding of some aspects of the embodiments. This summary is not an extensive overview of the embodiments of the invention. It is intended to neither identify key or critical elements of the embodiments nor delineate the scope of the embodiments. Its sole purpose is to present some concepts of the embodiments of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0015] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. In one embodiment, the method for optimizing performance of one or more communication units by a remote server, comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of

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the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0016] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform the method for optimizing performance of one or more communication units by the remote server.

[0017] In one embodiment, the communications system comprises a WiFi Access Point or a Digital Subscriber Line Access Multiplexer (DSLAM) to perform a method for optimizing performance of one or more communication units coupled to the WiFi Access Point or the DSLAM. In one such embodiment, the method comprises: sending data from one or more communication units to a remote server; receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0018] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that, when executed, cause a processor, of the WiFi Access Point or the DSLAM, to perform the method for optimizing performance of one or more communication units discussed above.

[0019] In one embodiment, the apparatus comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from one or more communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0020] In one embodiment, the system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from the one or more

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communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0021] In one embodiment, the communication unit comprises: a transmitter to send data to a remote server; a receiver to receive a policy from the remote server, wherein the policy comprises conditions for operation of the communication unit; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0022] The embodiments of the invention are not limited to DSL or WiFi communication systems of the examples and embodiments above, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect the communication performance. The policy generated by the remote server can be a result of analyzing hundreds (or even millions) of similarly situated communication units, or any other expert knowledge made available to the remote server. Generally, a communication unit does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, a communication unit typically does not have access to historical data related to communications with other stations. Additionally, communication units may lose history data when there is power outage or user-initiated power cycling. The remote server resolves the above problems and provides an optimum policy for the communication units to use that can be based on analysis of a large amount of operational data of the communication units and other similarly situated communication units or any other expert knowledge.

[0023] While the summary of the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the following description. The embodiments of the invention are

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intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0024] The following description and the annexed drawings set forth in detail certain illustrative aspects of the embodiments of the invention. These aspects, however, are only indicative of the various ways in which the principles of the embodiments of the invention may be employed. The embodiments of the invention are intended to embrace all equivalents in the form of alternatives, modifications, and variations that fall within the broad scope of the appended claims. Other advantages and novel features of the embodiments of the invention will become apparent from the following detailed description of the embodiments of the invention when considered in conjunction with the drawings.

DETAILED DESCRIPTION

[0025] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. As mentioned in the background section, the actual performance of the communication unit could be dependent on the assumptions made by the designer of the communication system. In one example, as provided in the background section, the actual performance of the WiFi rate adaptation algorithm is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and a WiFi communication system might suffer from low performance due to non-ideal design of the adaptation algorithm.

[0026] To overcome the above problem, the embodiments herein describe a method, system and apparatus that analyzes real-time and history of operational data related to a communication system and provides rules and conditions for the communication system to improve its performance. The rules and conditions specify the characteristics of the real-time and historical operational data such that the communication unit can select and use the most desired adaptation algorithm to use. In one embodiment, a remote server (also called an optimization center) is operable to collect and process large amounts of data related to the communication system and determine rules and conditions for the communication system that will

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improve the performance of the communication system. In one embodiment, the remote server collects data periodically and provides updated rules and conditions periodically for the communication system to adapt so that it may improve its performance. The embodiments herein are not limited to a communication system but can be used for any type of communication system that needs to be updated over time to improve its performance to changing environments.

[0027] The term "performance" herein refers to a combination of factors including data rate, throughput, power consumption, power, error rate, latency, jitter, etc. Improving performance of the communication system includes increasing data rate, throughput, reducing error rate and latency, improving jitter, power consumption, etc for the communicating system.

[0028] The technical effect of the embodiments discussed herein is the improvement of performance of a communication system (e.g., WiFi, Digital Subscriber Line (DSL), etc) by providing the communication system with rules and conditions that were previously not conceivable by the communication system due to lack of information and processing power needed to generate the rules and conditions. In one embodiment, a dedicated server (also referred as "remote server" or "optimization center") may be used to collect operational data related to the communication system, where the operational data may not be accessible or storable by the communication system itself (e.g., data from other communication units or old data that cannot be stored due to memory limitations) process the operational data and provide rules and conditions that when adapted by the communication system causes the performance of the communication system to improve.

[0029] For example, the remote server is operable to perform a statistical analysis of hundreds (or even millions) of communication systems working in a similar environment as the communication system of interest. In one embodiment, the remote server is operable to indicate to the communication system of interest how it can improve its overall performance, for example, by aggressively choosing higher transmission rates as opposed to conservatively choosing lower transmission rates.

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[0030] In one embodiment, when the WiFi communication system has the capability to decode and execute a pre-defined pseudo-code, the remote server can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units. For example, the remote server develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory of an Access Point. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by a processor of the Access Point. In one embodiment, as the remote server becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units of the communication system.

[0031] In the following description, numerous details are discussed to provide a more thorough explanation of embodiments of the present invention. It will be apparent, however, to one skilled in the art, that embodiments of the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring embodiments of the present invention.

[0032] Note that in the corresponding drawings of the embodiments, signals are represented with lines. Some lines may be thicker, to indicate more constituent signal paths, and/or have arrows at one or more ends, to indicate primary information flow direction. Such indications are not intended to be limiting. Rather, the lines are used in connection with one or more exemplary embodiments to facilitate easier understanding of a circuit or a logical unit. Any represented signal, as dictated by design needs or preferences, may actually comprise one or more signals that may travel in either direction and may be implemented with any suitable type of signal scheme.

[0033] In the following description and claims, the term "coupled" and its derivatives may be used. The term "coupled" herein refers to two or more elements which are in direct contact (physically, electrically, magnetically, optically, etc.).

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The term "coupled" herein may also refer to two or more elements that are not in direct contact with each other, but still cooperate or interact with each other.

[0034] As used herein, unless otherwise specified the use of the ordinal adjectives "first," "second," and "third," etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking or in any other manner.

[0035] **Fig. 2** is a system 220 for optimizing performance of a WiFi communication system 200 by a remote server 204, according to one embodiment of the invention. In one embodiment, the communication system 200 is similar to the communication system of **Fig. 1**, but is operable to communicate with the remote server 204 (interchangeably referred to as an optimization center). In one embodiment, the WiFi communication system 200 includes an Access Point (AP) 201 which comprises a processor 209, memory 210, and an adaptation algorithm 203 (which may be stored in the memory 210). In one embodiment, the AP 201 is operable to communicate with one or more stations 202_{1-N}, where N is an integer equal to or greater than 1, by WiFi signals 211_{1-N}. The term "adaptation algorithm" is interchangeably referred to as "algorithm."

[0036] While the embodiment of **Fig. 2** illustrates a WiFi communication system 200 with a single AP 201, multiple APs may be used in the WiFi communication system 200 which are operable to communicate with the remote server 204 via the Communication Channel 208. In the embodiments discussed herein the remote server 204 is not part of the communication system 200. In such an embodiment, the communication channel may be one of: the Internet, a TR-069 (Technical Report 069) compatible communications protocol; a Transmission Control Protocol/Internet Protocol (TCP/IP) communications protocol; a Simple Network Management Protocol (SNMP) communications protocol; an out-of-band telephone line protocol; a Digital Subscriber Line Ethernet over Coax (DSL EOC) communications protocol; a cable control channel communications protocol; a powerline control channel communications protocol; a Command Line protocol (CLI); via a wireless device; or via a mobile device.

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[0037] In one embodiment, the logic unit representing AP 201 and/or the stations 202_{1-N} can be at least one of the following communication units: a base station; a wireless Local Area Network (LAN) device; a DSLAM; a gateway; a performance enhancement device; a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home powerline device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a set-top box (STB)/set-top unit (STU) customer electronics device; an Internet Protocol (IP) enabled television; an IP enabled media player; an IP enabled gaming console; an Ethernet gateway; a computing device connected to the LAN; an Ethernet connected computer peripheral device; an Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0038] In one embodiment, the remote server 204 is operable to communicate with the AP 201 and/or with any or all of the stations 202_{1-N} via the communication Channel 208. In one embodiment the remote server 204 is a cloud server. In one embodiment, the remote server 204 comprises a processor 206, which may be one or more processors, a memory 207 for storing processor executable instructions, and a database 205 to manage data related to the communication system 200.

[0039] In one embodiment, the remote server 204 performs a method for optimizing performance of one or more communication units including the AP 201 and the stations 202_{1-N}. In one embodiment, the remote server 204 is operable to collect data from the one or more communication units (AP 201 and/or the stations 202_{1-N}). In one embodiment, the remote server 204 periodically collects data from the one or more communication units. The term "periodically" herein refers to regular intervals e.g., once a day, morning and evening of every day, etc.

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[0040] In one embodiment, the remote server 204 is operable to generate a policy, for each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) based on the collected data. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. Generally, an AP does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, an AP does not have access to historical data related to communication with other stations. Additionally, APs may lose data when there is power outage or user-initiated power cycling. The remove server 204 resolves the above problems and provides an optimum policy for the AP 201 to use based on analysis of large amount of operational data of the communication system 200 and other similarly situated communication systems.

[0041] Examples of similarly situated communication systems include communications systems having similar communication units. For example, an AP with same power, speed, and brand, and operating with similar (i.e., within 10%) number of stations. Similarly situated communication systems also include communications systems in different geographical areas.

[0042] In one embodiment, the remote server 204 transmits/sends the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) periodically. For example, the remote server 204 may transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) when the bandwidth usage of the AP 201 is low (e.g., the AP 201 is operating less than 50% of its capacity to serve communication units) so that it may implement the new policy sent by the remote server 204.

[0043] In one embodiment, the policy comprises rules and/or conditions for operation of the one or more communication units (AP 201 and/or the stations 202_{1-N}). For example, the policy comprises first and second algorithms for adapting the AP 201 to improve its performance. In one embodiment, the one or more communication units (AP 201 and/or the stations 202_{1-N}) implement the policy

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according to time-varying data. In one embodiment, the time-varying data comprises location information, current time, and operational data of the one or more communication units (AP 201 and/or the stations $202_{1..N}$). In one embodiment, the location information is determined from a Global Positioning System (GPS) device or setup. The embodiments herein are not limited to two algorithms, but any number of algorithms may be used.

[0044] In one embodiment, the communication unit (AP 201 and/or the stations $202_{1..N}$) comprises a transmitter to send data to the remote server 204; a receiver to receive a policy from the remote server 204; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data. The communication units generally do not have the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc. Therefore, the prior art communication units cannot use such information for improving their performance. The transmitter discussed above provides data to a central location, i.e. the remote server 204, that has the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc, so that it may use such information generate rules and conditions for operating the communication units with enhanced performance. These rules and conditions were previously not conceivable by the communication system (e.g., communication system of **Fig. 1**) due to lack of information and processing power needed to generate the rules and conditions. The remote server 204, after computing the rules and conditions, provides the rules and conditions to the processors of the communication units, wherein the processors executes their respective policies by implementing one of first and second algorithms based on the rules and/or conditions and time-varying data.

[0045] In one embodiment, the one or more communication units (AP 201 and/or the stations $202_{1..N}$) are operable to receive the policy along with one of the first and second algorithms based on the conditions and/or the time-varying data, wherein the first and second algorithms did not exist in the one or more

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communication units (AP 201 and/or the stations $202_{1..N}$) prior to being provided by the remove server 204. In such an embodiment, the remote server 204 installs a new algorithm 203 in the AP 201, where the new algorithm is executed by the processor 209 of the AP 201.

[0046] In one embodiment, the one or more communication units (AP 201 and/or the stations $202_{1..N}$) are operable to receive the policy and implement one of first and second algorithms based on the rule and/or conditions and/or the time-varying data, wherein the first and second algorithms previously existed in the one or more communication units (AP 201 and/or the stations $202_{1..N}$). In such an embodiment, the remote server provides recommendations to the communication units (AP 201 and/or the stations $202_{1..N}$) to use either the first or second algorithm so the communication system 200 may improve its performance.

[0047] The conditions may include at least one of: choice of selecting one of the first or second algorithms based on current SNIR (Signal to Noise and Interference Ratio); choice of selecting one of the first or second algorithms based on current time; choice of selecting one of the first or second algorithms based on operational data of the one or more communication units; and choice of selecting one of the first or second algorithms based on location information. In other embodiments, other conditions may be used in conjunction or absence to the above listed conditions. The rules may include equations, when executed in the algorithms, will change how the conditions are evaluated by the algorithms.

[0048] In one embodiment, the remote server 204 generates the policy by performing analysis on the collected data, wherein the collected data comprises operational information and historical data about each of the one or more communication units. In one embodiment, the remote server 204 applies the analysis to generate conditions for when to implement one of the first and second algorithms. In one embodiment, the remote server 204 generates the policy by generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units (AP 201 and/or the stations $202_{1..N}$).

[0049] In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a data rate according to a

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mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a data rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0050] The following is an exemplary embodiment showing the process of determining an optimum algorithm by the remote server 204. In one embodiment, the remote server 204 selects one of the first or second algorithms for the communication units (AP 201 and/or the stations $202_{1..N}$) to achieve optimal performance efficiency for the communication system 200. In one embodiment, first algorithm determines data transmission rates for the communication units based on RSSI while the second algorithm determines data transmission rates based on a number of consecutive successful transmissions and on a number of consecutive failed transmissions. As mentioned above, in one embodiment, the communication units (AP 201 and/or the stations $202_{1..N}$) have the first and second algorithms previously stored, but do not know which algorithm is more efficiency for the communication system 200. In such an embodiment, the remote server 204 provides recommendations to the communication units about which algorithm to use.

[0051] In one embodiment, in the first algorithm the communication units (AP 201 and/or the stations $202_{1..N}$) monitor the RSSI in real-time and adapts their transmission rates according to the instantaneous RSSI value using a mapping table (Table 1) as shown below.

RSSI value	Rate
-92dBm or below	6Mbps
-92dBm~-90dBm	9Mbps
-90dBm~-88dBm	12Mbps

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-88dBm~-86dBm	18Mbps
-86dBm~-84dBm	24Mbps
-84dBm~-82dBm	36Mbps
-82dBm~-80dBm	48Mbps
-80dBm or above	54Mbps

Table 1: RSSI to rate mapping for first algorithm

[0052] Table 1 is only shown as an example and a person skilled in the art would realize that the communication units may use different rates for different RSSI values other than the ones shown above.

[0053] In one embodiment, the second algorithm for the communication units (AP 201 and/or the stations 202_{1-N}) uses a higher data rate after K (e.g., 10) consecutive successful transmissions, and uses a lower data rate after M (e.g., 2) consecutive failed transmissions. In one embodiment, the communication units (AP 201 and/or the stations 202_{1-N}) provide to the remove server 204 operational data including RSSI, SNR, rate used for transmitting a packet, corresponding result on successful packet delivery, and other relevant data collected in real-time. In one embodiment, communication units (AP 201 and/or the stations 202_{1-N}) may accumulate such data within the communication units (AP 201 and/or the stations 202_{1-N}) and then send the accumulated data to the remote server 204. In one embodiment, the data transmitted to the remote server 204 is non-real-time data because it is sent after some time (e.g., end of the day).

[0054] In one embodiment, the remote server 204 stores such data in its database 205 and performs a full analysis based on all the stored data and any other knowledge available at the remote server 204. In one embodiment, the other knowledge includes similar statistics, as those provided by the communication units (AP 201 and/or the stations 202_{1-N}) to the remote server 204, from other similar communication units in other similar geographical localities.

[0055] In one embodiment, the remote server 204 determines the presence of intermittent high-power interference from other near-by WiFi systems. When

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other WiFis' high-power packets collide with the communication system 200's packet, the packet is lost regardless of the rate selection. In one embodiment, the remote server 204 determines that other noise or interference is never observed for the communication system 200, and concludes that it is best to adapt rates for the communication units (AP 201 and/or the stations 202_{1-N}) as a function of channel strength, or RSSI, only. In such an embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations 202_{1-N}) asking the communication units (AP 201 and/or the stations 202_{1-N}) to use the first algorithm all the time instead of the second algorithm.

[0056] In one embodiment, the remote server 204 determines that there is no high-power WiFi interference at all, but channel changes faster than typical static indoor wireless channel (possibly due to people moving around the AP 201). For example, the channel variation tends to be faster between noon and midnight. In such an embodiment, the remote server 204 concludes that it is best to use the second algorithm instead of the first algorithm by the communication units (AP 201 and/or the stations 202_{1-N}). In one embodiment, the remote server 204 may determine optimum values for K and M to be used by the communication units (AP 201 and/or the stations 202_{1-N}) in different times of the day. For example, K=10 and M=1 between noon and midnight; and K=20 and M=2 between midnight and noon.

[0057] In one embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations 202_{1-N}) asking communication units (AP 201 and/or the stations 202_{1-N}) to use the second algorithm with the optimized K and M values depending on time in the day. In case the WiFi communication system 200 is not capable of changing the values of K and M as a function of time, the remote server 204 can send two control signals per day, one at noon and another at midnight.

[0058] In one embodiment, when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (AP 201

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and/or the stations 202_{1-N}). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 210 of the AP 201. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 209 of the AP 201. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units (AP 201 and/or the stations 202_{1-N}) of the communication system 200.

[0059] **Fig. 3** is a system 320 for optimizing performance of a Digital Subscriber Line (DSL) communication system 300 by the remote server 204, according to one embodiment of the invention. The embodiment of **Fig. 3** is similar to the embodiment of **Fig. 2** in concept, but applicable for DSL systems. The embodiments of the invention are not limited to DSL or WiFi communication systems, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect communication performance.

[0060] In one embodiment, the DSL communication system 320 comprises a Digital Subscriber Line Access Multiplexer (DSLAM) 301 that connects to one or more Customer Premises Equipment (CPEs) 302_{1-N} by means of DSL signals 304_{1-N}, where N is an integer equal to or greater than 1. In one embodiment, the remote server 204 performs a method for optimizing performance of the one or more communication units including the DSLAM 301 and the CPEs 302_{1-N}. In one embodiment, the remote server 204 is operable to collect operational data from the one or more communication units (DSLAM 301 and/or the CPE 302_{1-N}). In one embodiment, the remote server 204 periodically collects operational data from the one or more communication units.

[0061] In one embodiment, the operational data collected by the remote server 204 includes at least one of: band preference indication; margin cap mode

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indication; indication that margin per tone should be kept smaller than the maximum SNR (Signal to Noise Ratio) margin; service priorities pertaining to net data rate; service priorities pertaining to excess margin; service priorities pertaining to excess margin per tone; service priorities pertaining to delay; service priorities pertaining to impulse noise protection; indication of loading algorithms used with a first DSL system; indication of power allocation algorithms used with the first DSL system; maximum attainable data rate; current data rate; margin; channel attenuation per tone; average attenuation; quiet line noise per tone; active line noise per tone; SNR per tone; transmitted PSD per tone; downstream power back-off shaped parameters (DPBOSHAPED); upstream power back-off shaped parameters (UPBOSHAPED); echo response; band preference; margin cap mode; Forward Error Correction (FEC) count; code violation count; errored seconds; severely errored seconds; number of retraining count; current delay; error distributions; current impulse noise protection; or FEC and interleaving parameters. The above listed operational data is not an exclusive list. More operational data may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0062] In one embodiment, the remote server 204 collects configuration parameters associated with the one or more communication units. The configuration parameters include at least one of: maximum nominal power spectral density (MAXNOMPSD); maximum nominal aggregate transmit power (MAXNOMATP); power cutback (PCB); DPBOSHAPED; UPBOSHAPED; fine gains; gi; transmit spectral scaling factors; tssi; power spectral density mask (PSDMASK); power spectral density level; maximum received power (MAXRXPWR); upstream power "back-off" parameters (UPBOKLE); margin cap mode; carrier mask (CARMASK); minimum impulse noise protection (MININP); maximum delay (MAXDELAY); target margin (TARSNRM); minimum SNR margin (MINSNRM); maximum SNR margin (MAXSNRM); band preference indication (PREFBAND); target data rate; minimum data rate; maximum data rate; FEC and interleaving parameters; per tone bit cap (BCAP[n]); per tone target margin (TARSNRM[n]); reference noise (REFNOISE). The above listed configuration parameters is not an exclusive list. More configuration parameters

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may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0063] As discussed with reference to **Fig. 2**, the remote server 204 of **Fig. 3** is operable to generate a policy, for each of the one or more communication units (DSLAM 301 and/or the stations 302_{1-N}), based on the collected operational data, according to one embodiment. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (DSLAM 301 and/or the CPE 302_{1-N}). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. The DSLAM 301 does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, DSLAM 301 does not have access to historical data related to communication with other CPEs connected to other DSLAMs. Additionally, DSLAM 301 may loose data when there is power outage or user-initiated power cycling. The remote server 204 resolves the above problems and provides an optimum policy for the DSLAM 301 to use based on analysis of large amount of operational data of the communication system 300 and other similarly situated communication systems. The optimum policy can be determined based on expert knowledge outside of the communication system where the expert knowledge can be obtained from lab testing, simulation or any other research methods. The policy can be adaptively modified even after the full deployment of the communication system, and hence does not suffer from limited knowledge that is used at the time of manufacturing the communication system. In the embodiments discussed herein the remote server 204 is not part of the communication system 300.

[0064] In one embodiment, when the DSL communication system 300 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (DSLAM 301 and/or the CPEs 302_{1-N}). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its

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communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 310 of the DSLAM 301. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 309 of the DSLAM 301. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication units to use one or more of them by sending a proper pseudo-code to the communication units (DSLAM 301 and/or the CPEs 302_{1-N}) of the communication system 300.

[0065] Following is an exemplary embodiment of how the remote server 204 can improve the performance of a DSL system. In DSL systems, for example the system 300, downstream (DS) margin is an important line performance metric that can be monitored by CPEs 302_{1-N} in real-time. In general, a higher margin indicates an exponentially smaller chance of errors for the delivery of video or data packets over DSL links 304_{1-N}. When the margin becomes very small, typically below 0dB, the link will experience errors that can cause serious impacts on packet delivery to the CPEs 302_{1-N}. To prevent continuation of such an unreliable link quality over a long time, CPEs 302_{1-N} can initiate a retraining procedure and improve the operation conditions. The retraining procedure may take 20 to 60 seconds. In one embodiment, the above feature of DSL systems is implemented by CPEs 302_{1-N} monitoring DS margins and initializing a retraining process when the margin becomes below a pre-configured threshold value 'T.' Conventionally, 'T' is set to 0dB and controlled via the DSL line's profile.

[0066] The remote server 204 may collect operational and performance data of the DSL system 300, analyze the historical data (operational and performance data) associated with the DSL system 300, and determine the best estimated value of 'T' for each line and applies the value to each line.

[0067] The term "line" herein refers to a communication link (wired or wireless) between the DSLAM 301 and the corresponding CPE. The value of 'T' may be analyzed per-line basis by the remote server 204. Different values of 'T' can be applied by the remote server 204 to different DSL lines depending on their historical and environmental characteristics.

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[0068] Each CPE among the CPEs 302_{1-N} applies an algorithm to tune its performance. For example, the CPE applies a rule and/or condition to adapt the value of 'T' in real-time as a function of the real-time data (operational and performance) that is available in the corresponding CPE. The CPEs 302_{1-N} are operable to apply the following rules and conditions. If video traffic is observed by the CPE over the line for more than t_1 (e.g., 1 minute), then the CPE updates the value of 'T' to 'T_1' (e.g., 2dB). Such a rule allows the CPE to react fast on pixelization problems associated with video traffic. In this example, the conditions are the choice of 't_1' and 'T_1', while the rule is the "if, then" equation. Typically each retraining process of the CPE causes discontinuation/interruption of video and data services for a short time (e.g., 10~45 seconds), but such an interruption can be preferable to a persistent pixelization problem of the video traffic for several minutes or more. If no video traffic is observed by the CPE for more than 't_2' (e.g., 10 minutes) then the CPE updates the value of 'T' to 'T_2' (e.g., 0dB). In this example, the conditions are the choice of 't_2' and 'T_2,' while the rule is the "if, then" equation. This rule allows the CPE to reduce the chance of initiating a retraining process that can interrupt data traffic. Data service is more resilient to errors compared to video traffic, and the errors that can happen for a small margin (e.g., 0~2dB) are likely tolerable for data traffic.

[0069] The above example of the rule and/or condition involves real-time monitoring of the data of the DSL system 300 and real-time adaptation algorithm within the DSL system 300. In some embodiments, the data of the DSL system 300 may not be entirely in real-time but the data update may be frequent enough (e.g., 5 minutes) to behave like real-time data.

[0070] In one embodiment, the threshold values 't_1,' 't_2,' 'T_1' and 'T_2' used by the rules/conditions discussed above are not statically kept in the DSL system 300, but optimized by the remote server 204. In one embodiment, the CPE continues to keep its rule/condition, but the parameters of the rules, i.e. the threshold values (conditions) 't_1,' 't_2,' 'T_1' and 'T_2,' are updated in the CPEs 302_{1-N} by the remote server 204. In such an embodiment, the remote server 204 collects and

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analyzes historical operational data and any side information (e.g., data from other similarly situated DSL systems) that is available at the remote server 204.

[0071] Continuing with the exemplary embodiment discussed above, the remote server 204 will choose 'T_1' = 0dB for a DSL line if pixelization has hardly happened even for margins between 0 and 2dB in the historical operational data, but will choose 'T_1' = 4dB if pixelization always occurred and continued for several minutes for margins between 0 and 4B. Such long-term adaptation of the rules by remote server 204 allows the DSL system 300 to perform at its optimum ability under all circumstances. In one embodiment, the switching of modes discussed above happens in real-time or very frequently, but the update of threshold values or rules to be used by the CPEs 302_{1-N} happens at a much lower frequency. In one embodiment, the remote server transmits the updated policy (with new threshold values) to the DSL system 300 a once per day.

[0072] While the embodiments of **Fig. 3** are discussed in terms of margin and video traffic in the DSL system 300, the embodiments can be applied to any DSL or other communication system adaptation algorithm that reacts in real-time to other data parameters without changing the essence of the embodiments of the invention.

[0073] **Fig. 4** is a method 400 performed by a remote server for optimizing performance of a communication system, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to **Fig 4** are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of **Fig. 4** is illustrated with reference to the embodiments of **Figs. 2-3**.

[0074] At block 401, the remote server 204 collects data (operational and/or performance data) from the one or more communication units. As discussed above, the communication units in **Fig. 2** are AP 201 and/or the stations 202_{1-N} while communication units in **Fig. 3** are DSLAM 301 and/or the CPE 302_{1-N}. In one embodiment, the communication units are at least one of a base station; a wireless LAN device; a DSLAM; a gateway; a performance enhancement device; a DSL

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CPE modem; an in-home powerline device; a HPNA based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a STB/STU customer electronics device; an IP enabled television; an IP enabled media player; an IP enabled gaming console; an Ethernet gateway; a computing device connected to the LAN; an Ethernet connected computer peripheral device; an Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0075] At block 402, the remote server 204 generates a policy, for each of the one or more communication units based on the collected data. As discussed above, the policy with reference to **Fig. 2** comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0076] With reference to **Fig. 3**, the policy may comprise rules and conditions such as the threshold values 't_1,' 't_2,' 'T_1' and 'T_2' for the DSL system 300 and equations that use these threshold values. Other policies may be used for the above systems of **Figs. 2-3** and for other systems.

[0077] At block 403, the remote server 204 sends the policy to each of the one or more communication units, wherein the one or more communication units

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implement the policy according to time-varying data (data collected by the communication units of the communication systems).

[0078] **Fig. 5** is a method 500 performed by a communication system for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to **Fig 5** are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of **Fig. 5** is illustrated with reference to the embodiments of **Figs. 2-3**. So as to avoid repetitiveness, only the processes performed by the communication units are discussed.

[0079] At block 501, the one or more communication units send data to the remote server 204. The data may be operational data, performance data, or any other time-varying data. At block 502, the one or more communication units receive a policy generated by the remove server 204, wherein the policy comprises rules and/or conditions for operation of the one or more communication units. At block 503, the one or more communication units execute the policy sent by the remote server 204 to implement an algorithm based on the rules and/or conditions and time-varying data. As discussed above, the policy with reference to **Fig. 2** comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms. With reference to **Fig. 3**, the policy may comprise rules and conditions

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such as the threshold values t_1, t_2, T_1 and T_2 for the DSL system 300. Other policies may be used for the above systems of **Figs. 2-3** and for other systems.

[0080] **Fig. 6** is a processor-based system 600 having machine-readable storage medium with computer executable instructions 604 for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Machine-readable storage medium is one of 207, 210, or 310 (collectively referred to as "207/201/310"). The computer/machine-readable/executable instructions are executed by a processor (e.g., processor 206 of the remote server, or processors 209 and 309 of the AP 201 or DSLAM 301 respectively). Elements of embodiments are also provided as a machine-readable medium for storing the computer-executable instructions (e.g., instructions to implement the flowcharts of **Figs. 4-5** and other processes discussed in the description).

[0081] In one embodiment, the processor-based system 600 further comprises a database 601 to store data used by the instructions 604. In one embodiment, the processor-based system includes a network interface 602 to communicate with other devices. In one embodiment, the components of the processor-based system 600 communicate with one another via a network bus 603.

[0082] The machine-readable storage medium 207/210/310 may include, but is not limited to, flash memory, optical disks, hard disk drive (HDD), Solid State Drive (SSD), CD-Read Only Memory (CD-ROMs), DVD ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, or other type of machine-readable media suitable for storing electronic or computer-executable instructions. For example, embodiments of the invention may be downloaded as a computer program (e.g., BIOS) which may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals via a communication link (e.g., a modem or network connection).

[0083] Reference in the specification to "an embodiment," "one embodiment," "some embodiments," or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments. The

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various appearances of "an embodiment," "one embodiment," or "some embodiments" are not necessarily all referring to the same embodiments. If the specification states a component, feature, structure, or characteristic "may," "might," or "could" be included, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to "a" or "an" element, that does not mean there is only one of the elements. If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

[0084] While the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the foregoing description.

[0085] For example, the embodiments discussed above can apply to a communication system comprising a performance enhancement device. A performance enhancement device may comprise a signal conditioning device, a diagnostic and remedy guidance device, or a noise cancellation device. A noise cancellation device, among other things, acts to cancel noise and interference present on the DSL line, either autonomously or in conjunction with commands from the remote server. In one embodiment, the performance enhancement device is communicatively coupled to the remote server 204 via the Communication Channel 208. In such an embodiment, impulse noise cancellation feature of the performance enhancement device may be turned on and off based on the real-time observation of noise, and the actual algorithm for deciding on-off can be distributed where long-term thresholds/rules and conditions are calculated by the remote server 204 and transmitted to the performance enhancement device. In one embodiment, the remote server 204 forces the actual transition in the performance enhancement device as a function of real-time observation of the noise data.

[0086] Another alternative embodiment related to a WiFi system is described as follows. In a typical WiFi communication system, Carrier Sense Multiple Access (CSMA) protocol is used for multiple access. Due to the nature of wireless channel, some of the stations (clients) might not be able to hear each other while both can reach the AP with strong power. This phenomenon is known as

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Hidden Node problem. One way to resolve this problem is to schedule the data transmission using Request to Send (RTS) and Clear to Send (CTS) mechanisms. Such a use of RTS/CTS incurs overhead in channel usage, but prevents disastrous packet collisions by the two stations.

[0087] In one embodiment, the remote server 204 collects operational and performance data of the WiFi AP 201 (and other APs) and/or stations 202_{1-N}. In one embodiment, the remote server 204 analyzes the historical data and determines the best value for each AP (on or off) and applies the value to each AP. In one embodiment, the value is analyzed per-AP by the remote server 204, and therefore different values can be applied to different APs depending on their data characteristics.

[0088] In one embodiment, each AP is operable to apply a rule with conditions to adapt RTS/CTS on/off in real-time as a function of real-time data available to the local AP. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is detected for more than t_1 (e.g., 1 minute), the AP turns on RTS/CTS. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is not detected for more than t_2 (e.g., 10 minutes), then the AP turns off RTS/CTS.

[0089] In the above embodiment, two or more operation modes are described in context of a local communication device (e.g., AP) selecting the operation mode to use in real-time. In one embodiment, the selection of the operation mode is a function of the real-time data that is locally available. In other embodiments, the data might not be in real-time but the data update may be frequent enough for this idea to consider the data as real-time.

[0090] In one embodiment, the rules and/or conditions e.g., the threshold values 't_1' and 't_2,' and equations applying them, are not statically kept as in AP, but optimized by the remote server 204. In one embodiment, the threshold values 't_1' and 't_2,' and/or the equations are updated by the remote server 204 using historical data and any side information that is available at the remote server side. In the above alternative embodiment, RTS/CTS was involved, however, the essence of the embodiments can be applied to any WiFi adaptation algorithm that reacts in

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real-time to other data parameters. WiFi adaptation algorithms include control of fragmentation, channels, association, etc.

[0091] The embodiments of the invention are intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0092] An abstract is provided that will allow the reader to ascertain the nature and gist of the technical disclosure. The abstract is submitted with the understanding that it will not be used to limit the scope or meaning of the claims. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separate embodiment.

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CLAIMS

We claim:

1. A method for optimizing performance of one or more communication units by a remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

2. The method of claim 1, wherein the policy further comprises first and second algorithms.

3. The method of claim 2, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

4. The method of claim 1, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

5. The method of claim 1, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

6. The method of claim 1, wherein generating the policy comprises:

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generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

7. The method of claim 1, wherein collecting data from the one or more communication units is performed periodically.

8. The method of claim 1, wherein the one or more communication units comprises at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;
a wireless WiFi compatible base station;
a wireless mobile device repeater;
a wireless mobile device base station;
a set-top box (STB)/set-top unit (STU) customer electronics device;
an Internet Protocol (IP) enabled television;
an IP enabled media player;
an IP enabled gaming console;
an Ethernet gateway;
a computing device connected to the LAN;

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an Ethernet connected computer peripheral device;
an Ethernet connected router;
an Ethernet connected wireless bridge;
an Ethernet connected network bridge; and
an Ethernet connected network switch.

9. The method of claim 1, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

10. A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform a method for optimizing performance of one or more communication units by the remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

11. The machine-readable storage medium of claim 10, wherein the policy further comprises first and second algorithms.

12. The machine-readable storage medium of claim 11, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

13. The machine-readable storage medium of claim 10, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

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14. The machine-readable storage medium of claim 10, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

15. The machine-readable storage medium of claim 10, wherein generating the policy comprises:

generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

16. The machine-readable storage medium of claim 10, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

17. A method for optimizing performance of one or more communication units, the method comprising:

sending data from one or more communication units to a remote server;

receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and

executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

18. The method of claim 17, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

19. The method of claim 17, wherein the first and second algorithms previously existed in the one or more communication units.

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20. The method of claim 17, wherein the policy further comprises the first and second algorithms.

21. The method of claim 20, wherein implementing one of the first and second algorithms based on the conditions and time-varying data comprises implementing one of the first and second algorithms provided with the policy.

22. The method of claim 17, wherein executing the policy comprises:

executing a pseudo-code or code for an adaption algorithm, the pseudo-code generated by the remote server.

23. The method of claim 17, wherein the remote server resides in a cloud.

24. The method of claim 17, wherein sending data from one or more communication units to the remote server is performed periodically.

25. The method of claim 17, wherein the one or more communication units comprises at least one of:

an access point (AP);

a base station;

a wireless LAN device;

a DSLAM;

a gateway;

a performance enhancement device;

a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;

an in-home powerline device;

a Home Phoneline Network Alliance (HPNA) based device;

an in-home coax distribution device;

a G.hn (Global Home Networking Standard) compatible device;

an in-home metering communication device;

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an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;
a wireless WiFi compatible base station;
a wireless mobile device repeater;
a wireless mobile device base station;
a set-top box (STB)/set-top unit (STU) customer electronics device;
an Internet Protocol (IP) enabled television;
an IP enabled media player;
an IP enabled gaming console;
an Ethernet gateway;
a computing device connected to the LAN;
an Ethernet connected computer peripheral device;
an Ethernet connected router;
an Ethernet connected wireless bridge;
an Ethernet connected network bridge; and
an Ethernet connected network switch.

26. The method of claim 17, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

27. A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor to perform a method for optimizing performance of one or more communication units, the method comprising:

sending data from one or more communication units to a remote server;

receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and

executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

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28. The machine-readable storage medium of claim 27, wherein executing the policy comprises:

executing a pseudo-code or code for an adaption algorithm, the pseudo-code generated by the remote server.

29. The machine-readable storage medium of claim 27, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

30. The machine-readable storage medium of claim 27, wherein the first and second algorithms previously existed in the one or more communication units.

31. The machine-readable storage medium of claim 27, wherein the policy further comprises the first and second algorithms.

32. The machine-readable storage medium of claim 31, wherein implementing one of the first and second algorithms based on the conditions and time-varying data comprises implementing one of the first and second algorithms provided with the policy.

33. The machine-readable storage medium of claim 27, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

34. An apparatus comprising:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from one or more communication units;

generate a policy, for each of the one or more communication

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units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

35. The apparatus of claim 34, wherein the policy further comprises first and second algorithms.

36. The apparatus of claim 35, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

37. The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions and the time-varying data.

38. The apparatus of claim 37, wherein the time-varying data comprises location information, current time, and operational data of the one or more communication units.

39. The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

40. The apparatus of claim 34, wherein the processor is operable to generate the policy by performing a method comprising generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

41. The apparatus of claim 34, wherein processor to collect data periodically for

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analysis from the one or more communication units.

42. The apparatus of claim 34, wherein the one or more communication units comprise at least one of:

an access point (AP);

a base station;

a wireless LAN device;

a DSLAM;

a gateway;

a performance enhancement device;

a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;

an in-home powerline device;

a Home Phoneline Network Alliance (HPNA) based device;

an in-home coax distribution device;

a G.hn (Global Home Networking Standard) compatible device;

an in-home metering communication device;

an in-home appliance communicatively interfaced with the LAN;

a wireless femtocell base station;

a wireless WiFi compatible base station;

a wireless mobile device repeater;

a wireless mobile device base station;

a set-top box (STB)/set-top unit (STU) customer electronics device;

an Internet Protocol (IP) enabled television;

an IP enabled media player;

an IP enabled gaming console;

an Ethernet gateway;

a computing device connected to the LAN;

an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

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an Ethernet connected network switch.

43. The apparatus of claim 34, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

44. A system comprising:

one or more communication units; and

a server operable to communicate with the one or more communication units, wherein the server comprises:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from the one or more communication units;

generate a policy, for each of the one or more communication units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

45. The system of claim 44, wherein the policy further comprises first and second algorithms.

46. The system of claim 44, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

47. The system of claim 44, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more

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communication units.

48. The system of claim 44, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

49. The system of claim 44, wherein the processor is operable to generate the policy by performing a method comprising generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

50. The system of claim 44, wherein processor to collect data periodically for analysis from the one or more communication units.

51. The system of claim 44, wherein the one or more communication units comprise at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;

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a wireless WiFi compatible base station;

a wireless mobile device repeater;

a wireless mobile device base station;

a set-top box (STB)/set-top unit (STU) customer electronics device;

an Internet Protocol (IP) enabled television;

an IP enabled media player;

an IP enabled gaming console;

an Ethernet gateway;

a computing device connected to the LAN;

an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

an Ethernet connected network switch.

52. The system of claim 44, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

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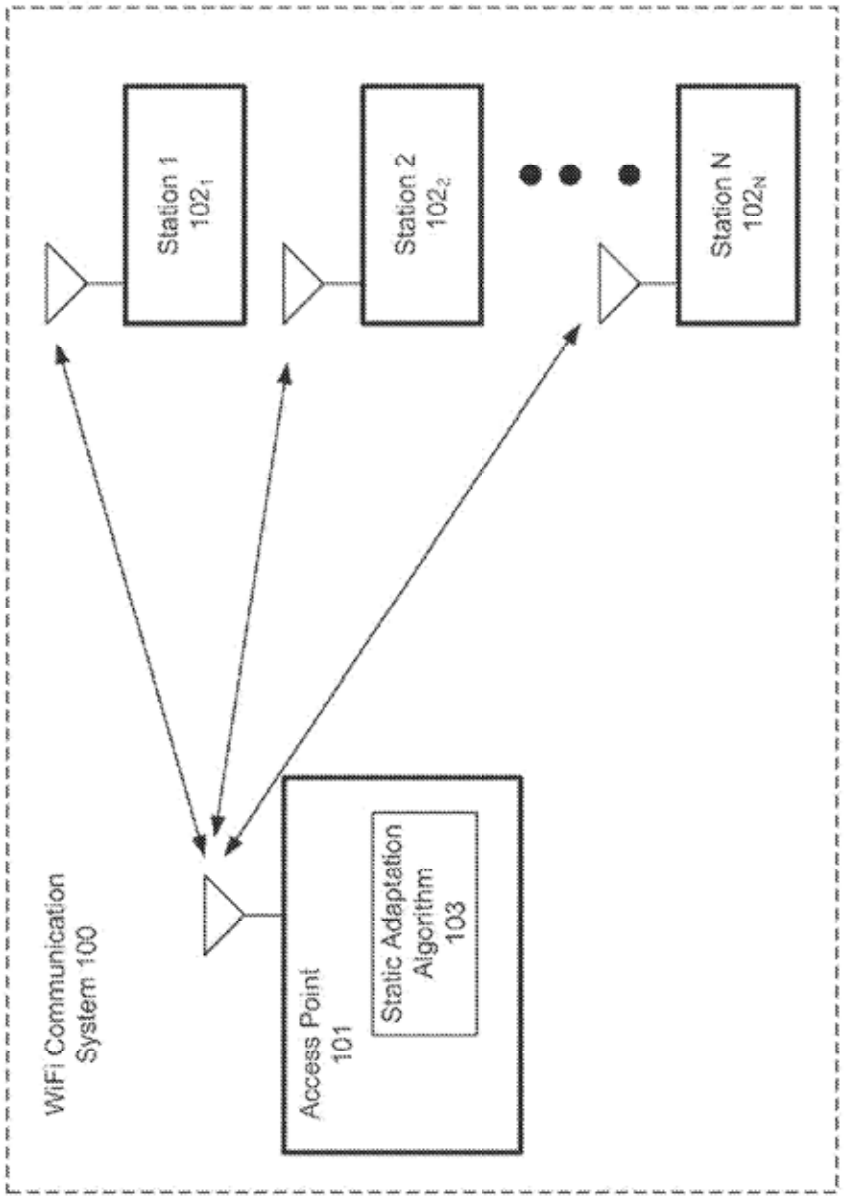


FIG. 1 (prior Art)

Charter Communications, Inc.
Exhibit 1006
Page #2065

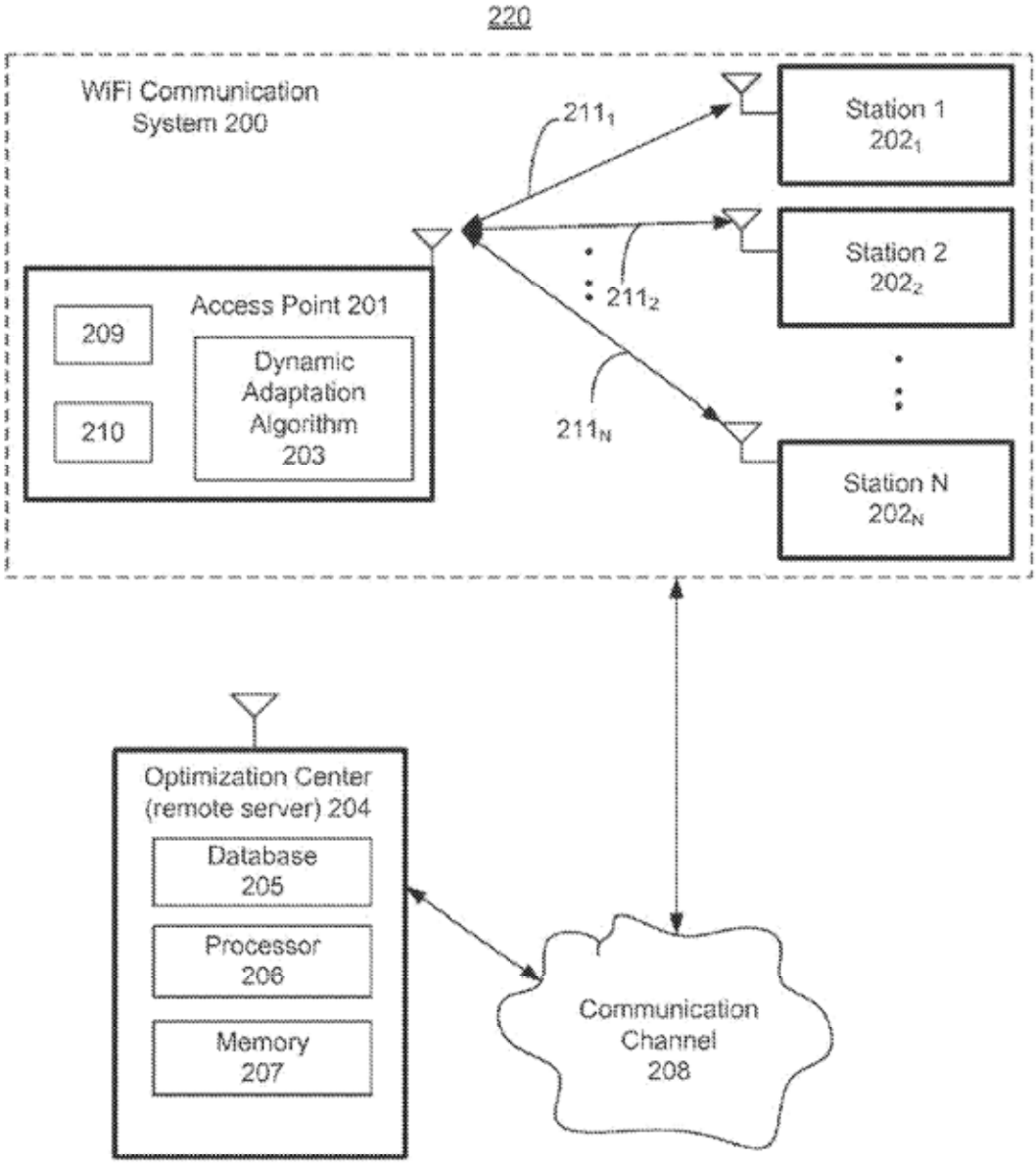


FIG. 2

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320

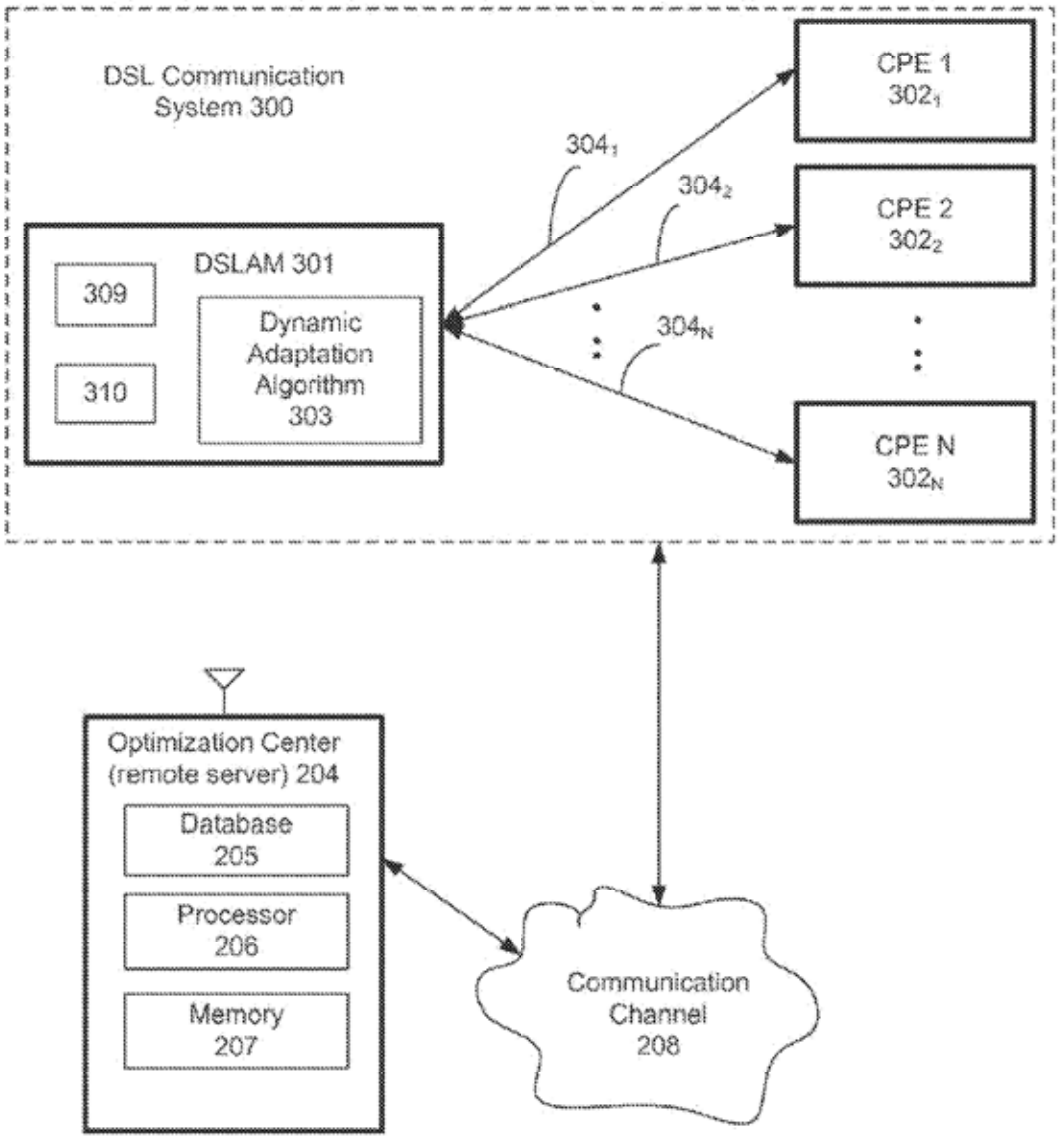


FIG. 3

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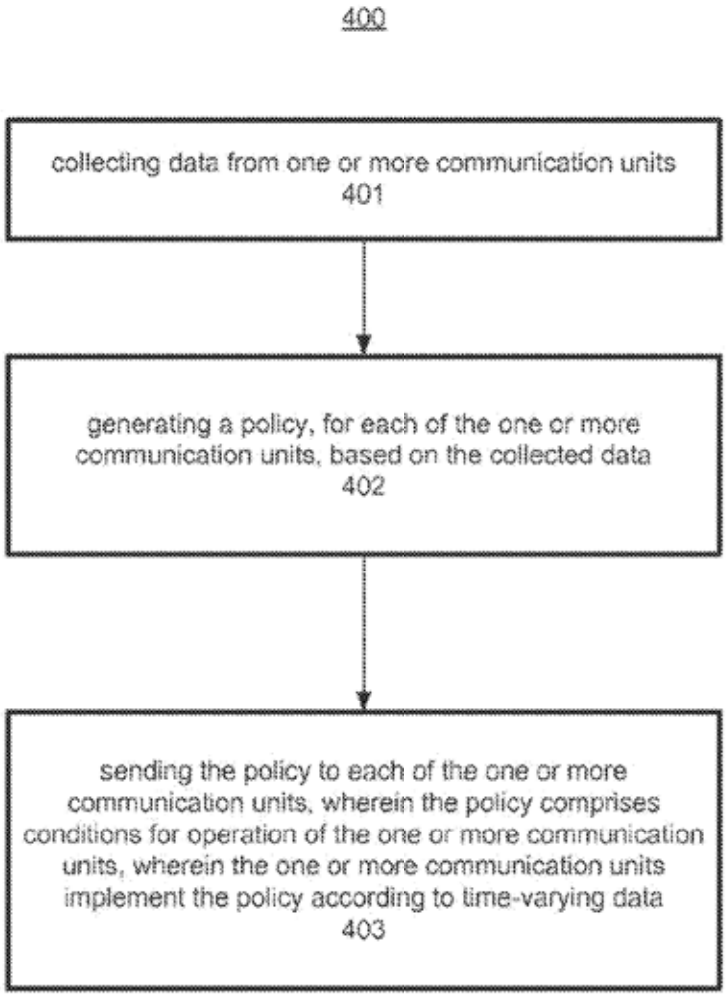


FIG. 4

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Page #2068

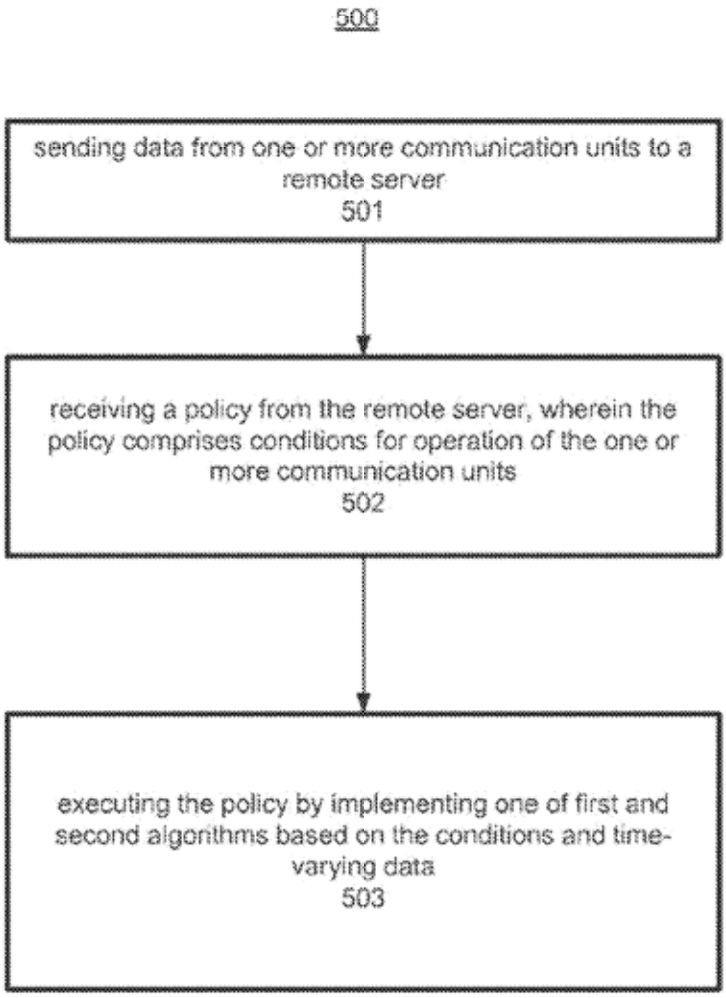


FIG. 5

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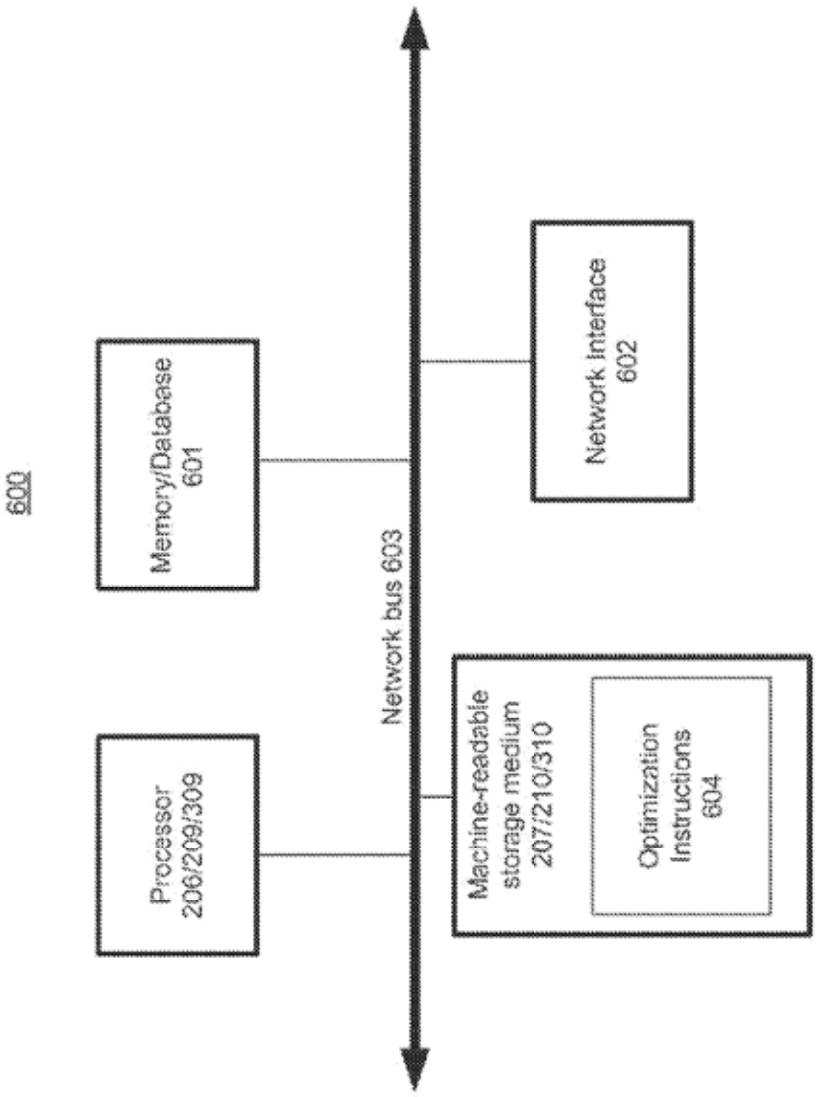


FIG. 6

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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong RHEE
Filer:	Usman Mughal
Attorney Docket Number:	8241P054

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
National Stage Fee	1631	1	280	280
Natl Stage Search Fee - Report provided	1642	1	480	480
National Stage Exam - all other cases	1633	1	720	720
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1480**

Electronic Acknowledgement Receipt

EFS ID:	18961000
Application Number:	14356581
International Application Number:	PCT/US11/60265
Confirmation Number:	4319
Title of Invention:	METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER
First Named Inventor/Applicant Name:	Wonjong RHEE
Customer Number:	8791
Filer:	Usman Mughal/Lisa Puccinelli
Filer Authorized By:	Usman Mughal
Attorney Docket Number:	8241P054
Receipt Date:	06-MAY-2014
Filing Date:	
Time Stamp:	20:05:24
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1480
RAM confirmation Number	5695
Deposit Account	022666
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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Charge any Additional Fees required under 37 C.F.R. Section 1.17 (Patent application and reexamination processing fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)	
Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)	
Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	8241P054_Transmittal_Letter_2014-05-06_As_Filed.pdf	216900 106c67d113292a664fbe88fc91598ee35ae54ad14c	no	4
Warnings:					
Information:					
2	Documents submitted with 371 Applications	8241P054PCT_International_search_report_and_written_opinion_062112.pdf	2867948 329ef66297a77d45132c51cae5df8e39a3efbc9c	no	16
Warnings:					
Information:					
3	Documents submitted with 371 Applications	8241P05PCT_IB371.pdf	229053 c87fd553899b2f58a34d11dff807ec283c967657be7c	no	1
Warnings:					
Information:					
4	Documents submitted with 371 Applications	8241P054PCT_Declaration_As_Filed.pdf	90090 a07b998619e59259de74574df818f28386d55705	no	1
Warnings:					
Information:					
5		8241P054_IDS_and_1449_2014-05-06_As_Filed.pdf	678565 47e4de9786253098972d7e032e9dfb2bb648fa4	yes	2

Multipart Description/PDF files in .zip description

Document Description	Start	End
Transmittal Letter	1	1
Information Disclosure Statement (IDS) Form (SB08)	2	2

Warnings:					
Information:					
6	Other Reference-Patent/App/Search documents	Ref-8241P054PCT_International_search_report_and_written_opinion_062112.pdf	2867948 329ef66297a77d45132c51cae5df8e39a3efbc9c	no	16
Warnings:					
Information:					

7	Foreign Reference	Ref-EP2426983A1.pdf	516032 58ce6d3a6c2099a53e282ace6cef3e1fae79e1e8	no	12
Warnings:					
Information:					
8	Foreign Reference	Ref-WO2007136337.pdf	7280803 0616defb4f13ae30240362e9ac41ef27c05a9d	no	42
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9	Foreign Reference	Ref-WO2011079612.pdf	4613768 9a0bafaa6fef8c8bf2cd00add8bd1692b69defa14d	no	34
Warnings:					
Information:					
10	Application Data Sheet	8241P054_ADS_2014-05-06_As_Filed.pdf	1561335 bc2e6714ccb0c9a8af04d7267080473a880140bb	no	7
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11		8241P054_Preliminary_Amendment_for_National_Phase_2014-05-06-As_Filed.pdf	91349 0eee04b0c9c64a6808eabe637002ed84051906e	yes	8

Multipart Description/PDF files in .zip description

Document Description	Start	End
Preliminary Amendment	1	1
Specification	2	2
Claims	3	7
Applicant Arguments/Remarks Made in an Amendment	8	8

Warnings:					
Information:					
12	Documents submitted with 371 Applications	WO2013070232A1.pdf	6946979 c29c29c0484ab1c3039ab157e6390a949aeb59ee	no	48
Warnings:					
Information:					
13	Fee Worksheet (SB06)	fee-info.pdf	33547 734b58ceb2086966ba3956708aa3dcf7cc9c2f0e	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	27994317

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Declaration of Inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv))
for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

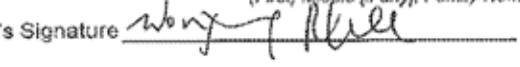
Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

NAME OF SOLE OR FIRST INVENTOR:

Full Name: Wonjong Rhee
(First, Middle (if any), Family Name (or Surname), and Suffix (if any))

Inventor's Signature  Date Nov 10, 2011

Residence San Francisco, CA US
(City, State, Country)

Citizenship KR
(Country)

Mailing Address 235 Berry Street #606
San Francisco, CA 94158 US

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

PCT/US11/60265
International Application No.

10 NOV 2011 (10.11.11)
International Filing Date

PCT INTERNATIONAL APPLICATION
RO/US
Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* 8241P054PCT

Box No. I TITLE OF INVENTION

METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

ASSIA, INC.
333 Twin Dolphin Drive
Redwood City, California 94065
United States of America

Telephone No.

Facsimile No.

Applicant's registration No. with the Office

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☐ as advance copies followed by paper notifications; or ☐ exclusively in electronic form (no paper notifications will be sent).

E-mail address:

State *(that is, country)* of nationality: US

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☒ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

VINCENT, Lester J.
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP
1279 Oakmead Parkway
Sunnyvale, California 94085-4040
United States of America

Telephone No.
(408) 720-8300

Facsimile No.
(408) 720-8383

Agent's registration No. with the Office
31,460

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send, notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.

☒ as advance copies followed by paper notifications; or ☐ exclusively in electronic form (no paper notifications will be sent).

E-mail address: mail@bstz.com

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

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Page #2078

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

RHEE, Wonjong
235 Berry Street, # 606
San Francisco, California 94158
United States of America

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality: KR

State *(that is, country)* of residence: US

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

---

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

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Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

---

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

Applicant's registration No. with the Office

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

---

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

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Page #2079

Supplemental Box *If the Supplemental Box is not used, this sheet should not be included in the request.*

1. *If, in any of the Boxes, except Boxes Nos. VIII(i) to (v) for which a special continuation box is provided,* ***the space is insufficient*** *to furnish all the information: in such case, write "Continuation of Box No...." (indicate the number of the Box) and furnish the information in the same manner as required according to the captions of the Box in which the space was insufficient, in particular:*

   (i) ***if more than one person is to be indicated as applicant and/or inventor*** *and no "continuation sheet" is available: in such case, write "Continuation of Box No. III" and indicate for each additional person the same type of information as required in Box No. III. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below;*

   (ii) *if, in Box No. II or in any of the sub-boxes of Box No. III, the indication* ***"the States indicated in the Supplemental Box"*** *is checked: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the applicant(s) involved and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is applicant;*

   (iii) *if, in Box No. II or in any of the sub-boxes of Box No. III,* ***the inventor or the inventor/applicant is not inventor for the purposes of all designated States or for the purposes of the United States of America****: in such case, write "Continuation of Box No. II" or "Continuation of Box No. III" or "Continuation of Boxes No. II and No. III" (as the case may be), indicate the name of the inventor(s) and, next to (each) such name, the State(s) (and/or, where applicable, ARIPO, Eurasian, European or OAPI patent) for the purposes of which the named person is inventor;*

   (iv) *if, in addition to the agent(s) indicated in Box No. IV, there are* ***further agents****: in such case, write "Continuation of Box No. IV" and indicate for each further agent the same type of information as required in Box No. IV;*

   (v) *if, in Box No. VI, there are* ***more than three earlier applications whose priority is claimed****: in such case, write "Continuation of Box No. VI" and indicate for each additional earlier application the same type of information as required in Box No. VI.*

2. *If the applicant intends to make an indication of the wish that the international application be treated, in certain designated States, as an application for a patent of addition, certificate of addition, inventor's certificate of addition or utility certificate of addition: in such case, write the name or two-letter code of each designated State concerned and the indication "****patent of addition,****" "****certificate of addition,****" "****inventor's certificate of addition****" or "****utility certificate of addition,****" the number of the parent application or parent patent or other parent grant and the date of grant of the parent patent or other parent grant or the date of filing of the parent application (Rules 4.11(a)(i) and 49bis.1(a) or (b)).*

3. *If the applicant intends to make an indication of the wish that the international application be treated, in the United States of America, as a continuation or continuation-in-part of an earlier application: in such case, write "United States of America" or "US" and the indication "****continuation****" or "****continuation-in-part****" and the number and the filing date of the parent application (Rules 4.11(a)(ii) and 49bis.1(d)).*

4. *If the applicant wishes to request the receiving Office or the International Bureau to obtain a priority document from a digital library but* ***that document is only held in a digital library in connection with another application*** *which also relied upon that priority document to support a priority claim (and unless that digital library is to be accessed through the Digital Access Service for Priority Documents), in such cases write "Continuation of Box No. VI", indicate for each earlier application concerned the same type of information as required in Box No. VI and indicate the number under which the application is stored (and, if known, the digital library concerned) (Section 716(a)(ii)).*

Continuation of Box No. IV
Further Agent Names

Farzad Amini, Reg. No. 42,261
W. Thomas Babbit, Reg. No. 39,591
Michael A. Bernadicou, Reg. No. 35,934
Roger W. Blakely, Jr., Reg. No. 25,831
Gregory D. Caldwell; Reg. No. 39,926
Cory G. Claassen, Reg. No. 50,296
Thomas M. Coester, Reg. No. 39,637
Daniel M. De Vos, Reg. No. 37,813
James Go, Reg. No. 40,621
Willmore Holbrow III, Reg. No. 41,845
Sheryl Sue Holloway, Reg. No. 37,850
George W. Hoover II, Reg. No. 32,992
Eric S. Hyman, Reg. No. 30,139
Aslam Jaffery, Reg. No. 51,841
Gordon R. Lindeen III, Reg. No. 33,192
Michael J. Mallie, Reg. No. 36,591
Paul A. Mendonsa; Reg. No. 42,879
Jonathan Miller, Reg. No. 48,534
Thinh V. Nguyen, Reg. No. 42,034
Robert B. O'Rourke, Reg. No. 46,972
Daniel E. Ovanezian, Reg. No. 41,236
Marina G. Portnova, Reg. No. 45,750
William W. Schaal, Reg. No. 39,018
James C. Scheller, Jr., Reg. No. 31,195
Kevin Shao, Reg. No. 45,095
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Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a) the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

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(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1)				
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

☐ The **International Bureau** is requested to obtain from a digital library, a certified copy of the earlier application(s) *(if the earlier application(s) is available to it from a digital library)* identified above as:*

☐ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☐ The **receiving Office** is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(if the earlier application(s) was filed with the Office which for the purposes of this international application is the receiving Office)* or to obtain a certified copy of the earlier application(s) from a digital library and transmit a copy of it to the International Bureau *(if the earlier application(s) is available to the receiving Office from a digital library)*, identified above as:*

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* Where the certified copy of the earlier application(s) is not stored in a digital library under the number of the earlier application indicated above but under the application number of another application which also claims priority from it, indicate that number in the supplemental sheet (item 4).

Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (_____). *(See also the Notes to Box No. VI: further information **must** be provided to support a request to restore the right of priority.)*

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if more than one International Searching Authority is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/ EP

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RO/US EX OFFICIO

Sheet No. 5

Box No. IX **CHECK LIST for EFS-Web filings** - this sheet is only to be used when filing an international application with RO/US via **EFS-Web**

This international application **contains** the following:	Number of sheets
(a) request form PCT/RO/101 (including any declarations and supplemental sheets)	5 ~~8~~
(b) description (excluding any sequence listing part of the description, see (f), below)	28
(c) claims	12
(d) abstract	1
(e) drawings (if any)	6
(f) sequence listing part of the description in the form of an **image file** (e.g. PDF)	
Total number of sheets (including the sequence listing part of the description if **filed as an image file**)	52 ~~53~~

(g) sequence listing part of the description

- ☐ filed in the form of an **Annex C/ST.25 text file**
- ☐ WILL BE filed separately on physical data carrier(s), on the same day and in the form of an **Annex C/ST.25 text file**

Indicate type and number of physical data carrier(s)

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item):*	Number of items
1. ☒ fee calculation sheet	1
2. ☒ original separate power of attorney	1
3. ☐ original general power of attorney	
4. ☐ copy of general power of attorney; reference number:	
5. ☐ statement explaining lack of signature	
6. ☐ priority document(s) identified in Box No. VI as item(s)	
7. ☐ Translation of international application into *(language)*:	
8. ☐ separate indications concerning deposited microorganism or other biological material	
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10. ☐ *(only where item (f) is marked in the left column)* a statement confirming that "the information recorded in electronic form submitted under Rule 13*ter* is identical to the sequence listing as contained in the international application" as filed via EFS-Web:	
11. ☐ copy of results of earlier search(es) (Rule 12*bis*.1(a))	
12. ☒ other *(specify)*: Transmittal Letter	1

Figure of the drawings which should accompany the abstract: 4

Language of filing of the international application: English

Box No. X **SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE**

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

/Gregory D. Caldwell/
Gregory D. Caldwell
Attorney for Applicant(s)
Reg. No. 39,926

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1. Date of actual receipt of the purported international application: 10 N0VEMBER 2011 (10.11.11)
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA / EP
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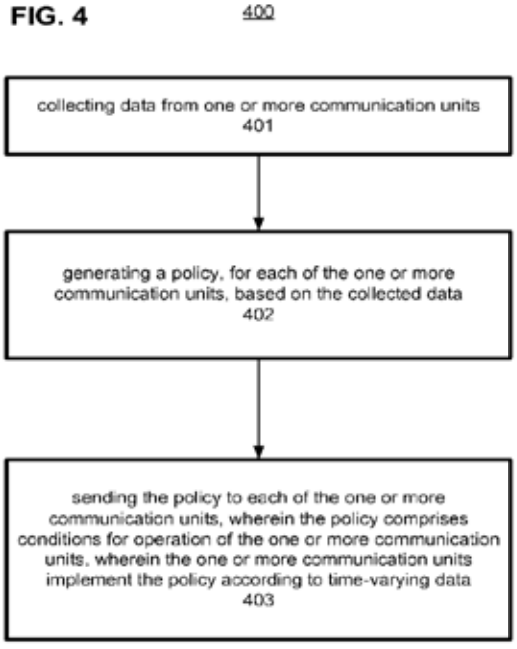
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[Continued on next page]

(54) Title: METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

FIG. 4



(57) Abstract: Described herein are apparatus, system, and method for optimizing performance of one or more communication units by a remote server. The method comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time- varying data. The system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to perform the method discussed above.

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Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

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METHOD, APPARATUS, AND SYSTEM FOR OPTIMIZING PERFORMANCE OF A COMMUNICATION UNIT BY A REMOTE SERVER

FIELD OF THE INVENTION

[0001] Embodiments of the invention relate generally to the field of communication systems. More particularly, embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server.

BACKGROUND

[0002] **Fig. 1** is an exemplary prior art communication system (CS) 100 with an access point (AP) 101 and one or more wireless stations $102_{1\text{-}N}$. The AP 101 exchanges user data with the one or more stations $102_{1\text{-}N}$ over wireless channels indicated by the arrows. The characteristics of the wireless channels and noise/interference are not constant and vary rapidly over time. For example, noise and interference levels from nearby noise/interference sources rapidly changes that cause the characteristics of the wireless environment to change. To cope with such rapid changes in the noise and interference levels, the CS 100 adapts transmission strategies to enhance performance of CS 100. One such known strategy is Adaptation Algorithm. The term "Adaptation Algorithm" herein refers to time-varying and environment-change-dependent transmission or control strategies for a CS. The adaptation algorithm is implemented in the AP 101 that adapts the wireless channels and noise/interference for communication with the one or more stations $102_{1\text{-}N}$.

[0003] For instance, the transmission rate of Institute of Electrical and Electronics Engineer (IEEE) 802.11g standard based WiFi communication system is rapidly adapted between 6Mbps and 54Mbps depending on the link quality and the rate selection method (also known as the rate adaptation algorithm) implemented in the WiFi communication system. Such rate adaptation algorithm within the WiFi communication system uses real-time data that are collected by the AP 101 of the WiFi communication system itself as an input to the adaptation algorithm 103, and a rate change in the link occurs when the real-time data meets a pre-defined criteria.

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[0004] A possible rate adaptation algorithm 103 is to change transmission rate of signals by the AP 101 within the WiFi communication system when the measured RSSI (Received Signal Strength Indication) becomes too large or too small for the current rate in use. Another possible adaptation algorithm 103 is to increase the transmission rate of signals by the AP 101 whenever packets are successfully received by the AP 101 and/or the one or more stations $102_{1\text{-}N}$ for M (e.g., 3) times and decrease rate whenever packets are unsuccessfully received for P (e.g., 2) times. While such adaptation algorithms 103 are required for WiFi communication systems to function properly, the rules and thresholds used by the methods are decided by a system designer of the WiFi communication system. Furthermore, a specific adaptation algorithm 103 is included in the firmware and loaded to the WiFi communication system. Hence, the adaption algorithm 103 is static in nature.

[0005] Therefore, the actual performance of the rate adaptation algorithm 103 is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and the WiFi communication system 100 may suffer from low performance due to non-ideal design of the static adaptation algorithm 103.

[0006] The impact of such differences in the assumptions can be significant in a large-scale deployment where many communication devices, such as AP's, independently operate. In such a deployment, every single communication environment is unique and the best adaptation method for each environment can be quite dependent on its own environment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Embodiments of the invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

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[0008] **Fig. 1** is a high level system of a typical communication system using a static adaptive algorithm.

[0009] **Fig. 2** is a system for optimizing performance of a WiFi communication system by a remote server, according to one embodiment of the invention.

[0010] **Fig. 3** is a system for optimizing performance of a Digital Subscriber Line (DSL) communication system by a remote server, according to one embodiment of the invention.

[0011] **Fig. 4** is a method performed by a remote server for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0012] **Fig. 5** is a method performed by the communication system for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

[0013] **Fig. 6** is a processor-based system having machine-readable storage medium with computer executable instructions for optimizing performance of the communication system by the remote server, according to one embodiment of the invention.

SUMMARY OF THE INVENTION

[0014] The following presents a simplified summary of the embodiments of the invention in order to provide a basic understanding of some aspects of the embodiments. This summary is not an extensive overview of the embodiments of the invention. It is intended to neither identify key or critical elements of the embodiments nor delineate the scope of the embodiments. Its sole purpose is to present some concepts of the embodiments of the invention in a simplified form as a prelude to the more detailed description that is presented later.

[0015] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. In one embodiment, the method for optimizing performance of one or more communication units by a remote server, comprises: collecting data from the one or more communication units; generating a policy, for each of the one or more communication units, based on the collected data; and sending the policy to each of

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the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0016] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform the method for optimizing performance of one or more communication units by the remote server.

[0017] In one embodiment, the communications system comprises a WiFi Access Point or a Digital Subscriber Line Access Multiplexer (DSLAM) to perform a method for optimizing performance of one or more communication units coupled to the WiFi Access Point or the DSLAM. In one such embodiment, the method comprises: sending data from one or more communication units to a remote server; receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0018] In one embodiment, the system includes a machine-readable storage medium having computer executable instructions stored thereon that, when executed, cause a processor, of the WiFi Access Point or the DSLAM, to perform the method for optimizing performance of one or more communication units discussed above.

[0019] In one embodiment, the apparatus comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from one or more communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0020] In one embodiment, the system comprises: one or more communication units; and a server operable to communicate with the one or more communication units, wherein the server comprises: a memory; and a processor, coupled to the memory, and operable to: analyze data from the one or more

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communication units; generate a policy, for each of the one or more communication units, based on the collected data; and send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

[0021] In one embodiment, the communication unit comprises: a transmitter to send data to a remote server; a receiver to receive a policy from the remote server, wherein the policy comprises conditions for operation of the communication unit; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

[0022] The embodiments of the invention are not limited to DSL or WiFi communication systems of the examples and embodiments above, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect the communication performance. The policy generated by the remote server can be a result of analyzing hundreds (or even millions) of similarly situated communication units, or any other expert knowledge made available to the remote server. Generally, a communication unit does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, a communication unit typically does not have access to historical data related to communications with other stations. Additionally, communication units may lose history data when there is power outage or user-initiated power cycling. The remote server resolves the above problems and provides an optimum policy for the communication units to use that can be based on analysis of a large amount of operational data of the communication units and other similarly situated communication units or any other expert knowledge.

[0023] While the summary of the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the following description. The embodiments of the invention are

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intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0024] The following description and the annexed drawings set forth in detail certain illustrative aspects of the embodiments of the invention. These aspects, however, are only indicative of the various ways in which the principles of the embodiments of the invention may be employed. The embodiments of the invention are intended to embrace all equivalents in the form of alternatives, modifications, and variations that fall within the broad scope of the appended claims. Other advantages and novel features of the embodiments of the invention will become apparent from the following detailed description of the embodiments of the invention when considered in conjunction with the drawings.

DETAILED DESCRIPTION

[0025] Embodiments of the invention relate to method, apparatus, and system for optimizing performance of a communication unit by a remote server. As mentioned in the background section, the actual performance of the communication unit could be dependent on the assumptions made by the designer of the communication system. In one example, as provided in the background section, the actual performance of the WiFi rate adaptation algorithm is dependent on the assumptions made by the designer of the WiFi communication system. These assumptions may be static assumptions that do not change over time. The designer's assumptions, however, may be quite different from the actual operational environments and a WiFi communication system might suffer from low performance due to non-ideal design of the adaptation algorithm.

[0026] To overcome the above problem, the embodiments herein describe a method, system and apparatus that analyzes real-time and history of operational data related to a communication system and provides rules and conditions for the communication system to improve its performance. The rules and conditions specify the characteristics of the real-time and historical operational data such that the communication unit can select and use the most desired adaptation algorithm to use. In one embodiment, a remote server (also called an optimization center) is operable to collect and process large amounts of data related to the communication system and determine rules and conditions for the communication system that will

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improve the performance of the communication system. In one embodiment, the remote server collects data periodically and provides updated rules and conditions periodically for the communication system to adapt so that it may improve its performance. The embodiments herein are not limited to a communication system but can be used for any type of communication system that needs to be updated over time to improve its performance to changing environments.

[0027] The term "performance" herein refers to a combination of factors including data rate, throughput, power consumption, power, error rate, latency, jitter, etc. Improving performance of the communication system includes increasing data rate, throughput, reducing error rate and latency, improving jitter, power consumption, etc for the communicating system.

[0028] The technical effect of the embodiments discussed herein is the improvement of performance of a communication system (e.g., WiFi, Digital Subscriber Line (DSL), etc) by providing the communication system with rules and conditions that were previously not conceivable by the communication system due to lack of information and processing power needed to generate the rules and conditions. In one embodiment, a dedicated server (also referred as "remote server" or "optimization center") may be used to collect operational data related to the communication system, where the operational data may not be accessible or storable by the communication system itself (e.g., data from other communication units or old data that cannot be stored due to memory limitations) process the operational data and provide rules and conditions that when adapted by the communication system causes the performance of the communication system to improve.

[0029] For example, the remote server is operable to perform a statistical analysis of hundreds (or even millions) of communication systems working in a similar environment as the communication system of interest. In one embodiment, the remote server is operable to indicate to the communication system of interest how it can improve its overall performance, for example, by aggressively choosing higher transmission rates as opposed to conservatively choosing lower transmission rates.

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[0030] In one embodiment, when the WiFi communication system has the capability to decode and execute a pre-defined pseudo-code, the remote server can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units. For example, the remote server develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory of an Access Point. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by a processor of the Access Point. In one embodiment, as the remote server becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units of the communication system.

[0031] In the following description, numerous details are discussed to provide a more thorough explanation of embodiments of the present invention. It will be apparent, however, to one skilled in the art, that embodiments of the present invention may be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring embodiments of the present invention.

[0032] Note that in the corresponding drawings of the embodiments, signals are represented with lines. Some lines may be thicker, to indicate more constituent signal paths, and/or have arrows at one or more ends, to indicate primary information flow direction. Such indications are not intended to be limiting. Rather, the lines are used in connection with one or more exemplary embodiments to facilitate easier understanding of a circuit or a logical unit. Any represented signal, as dictated by design needs or preferences, may actually comprise one or more signals that may travel in either direction and may be implemented with any suitable type of signal scheme.

[0033] In the following description and claims, the term "coupled" and its derivatives may be used. The term "coupled" herein refers to two or more elements which are in direct contact (physically, electrically, magnetically, optically, etc.).

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The term "coupled" herein may also refer to two or more elements that are not in direct contact with each other, but still cooperate or interact with each other.

[0034] As used herein, unless otherwise specified the use of the ordinal adjectives "first," "second," and "third," etc., to describe a common object, merely indicate that different instances of like objects are being referred to, and are not intended to imply that the objects so described must be in a given sequence, either temporally, spatially, in ranking or in any other manner.

[0035] **Fig. 2** is a system 220 for optimizing performance of a WiFi communication system 200 by a remote server 204, according to one embodiment of the invention. In one embodiment, the communication system 200 is similar to the communication system of **Fig. 1**, but is operable to communicate with the remote server 204 (interchangeably referred to as an optimization center). In one embodiment, the WiFi communication system 200 includes an Access Point (AP) 201 which comprises a processor 209, memory 210, and an adaptation algorithm 203 (which may be stored in the memory 210). In one embodiment, the AP 201 is operable to communicate with one or more stations $202_{1\text{-}N}$, where N is an integer equal to or greater than 1, by WiFi signals $211_{1\text{-}N}$. The term "adaptation algorithm" is interchangeably referred to as "algorithm."

[0036] While the embodiment of **Fig. 2** illustrates a WiFi communication system 200 with a single AP 201, multiple APs may be used in the WiFi communication system 200 which are operable to communicate with the remote server 204 via the Communication Channel 208. In the embodiments discussed herein the remote server 204 is not part of the communication system 200. In such an embodiment, the communication channel may be one of: the Internet, a TR-069 (Technical Report 069) compatible communications protocol; a Transmission Control Protocol/Internet Protocol (TCP/IP) communications protocol; a Simple Network Management Protocol (SNMP) communications protocol; an out-of-band telephone line protocol; a Digital Subscriber Line Ethernet over Coax (DSL EOC) communications protocol; a cable control channel communications protocol; a powerline control channel communications protocol; a Command Line protocol (CLI); via a wireless device; or via a mobile device.

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[0037] In one embodiment, the logic unit representing AP 201 and/or the stations $202_{1\text{-}N}$ can be at least one of the following communication units: a base station; a wireless Local Area Network (LAN) device; a DSLAM; a gateway; a performance enhancement device; a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem; an in-home powerline device; a Home Phoneline Network Alliance (HPNA) based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a set-top box (STB)/set-top unit (STU) customer electronics device; an Internet Protocol (IP) enabled television; an IP enabled media player; an IP enabled gaming console; an Ethernet gateway; a computing device connected to the LAN; an Ethernet connected computer peripheral device; an Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0038] In one embodiment, the remote server 204 is operable to communicate with the AP 201 and/or with any or all of the stations $202_{1\text{-}N}$ via the communication Channel 208. In one embodiment the remote server 204 is a cloud server. In one embodiment, the remote server 204 comprises a processor 206, which may be one or more processors, a memory 207 for storing processor executable instructions, and a database 205 to manage data related to the communication system 200.

[0039] In one embodiment, the remote server 204 performs a method for optimizing performance of one or more communication units including the AP 201 and the stations $202_{1\text{-}N}$. In one embodiment, the remote server 204 is operable to collect data from the one or more communication units (AP 201 and/or the stations $202_{1\text{-}N}$). In one embodiment, the remote server 204 periodically collects data from the one or more communication units. The term "periodically" herein refers to regular intervals e.g., once a day, morning and evening of every day, etc.

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[0040] In one embodiment, the remote server 204 is operable to generate a policy, for each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) based on the collected data. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. Generally, an AP does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, an AP does not have access to historical data related to communication with other stations. Additionally, APs may lose data when there is power outage or user-initiated power cycling. The remove server 204 resolves the above problems and provides an optimum policy for the AP 201 to use based on analysis of large amount of operational data of the communication system 200 and other similarly situated communication systems.

[0041] Examples of similarly situated communication systems include communications systems having similar communication units. For example, an AP with same power, speed, and brand, and operating with similar (i.e., within 10%) number of stations. Similarly situated communication systems also include communications systems in different geographical areas.

[0042] In one embodiment, the remote server 204 transmits/sends the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) periodically. For example, the remote server 204 may transmit/send the policy to each of the one or more communication units (AP 201 and/or the stations 202_{1-N}) when the bandwidth usage of the AP 201 is low (e.g., the AP 201 is operating less than 50% of its capacity to serve communication units) so that it may implement the new policy sent by the remote server 204.

[0043] In one embodiment, the policy comprises rules and/or conditions for operation of the one or more communication units (AP 201 and/or the stations 202_{1-N}). For example, the policy comprises first and second algorithms for adapting the AP 201 to improve its performance. In one embodiment, the one or more communication units (AP 201 and/or the stations 202_{1-N}) implement the policy

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according to time-varying data. In one embodiment, the time-varying data comprises location information, current time, and operational data of the one or more communication units (AP 201 and/or the stations $202_{1\text{-}N}$). In one embodiment, the location information is determined from a Global Positioning System (GPS) device or setup. The embodiments herein are not limited to two algorithms, but any number of algorithms may be used.

[0044] In one embodiment, the communication unit (AP 201 and/or the stations $202_{1\text{-}N}$) comprises a transmitter to send data to the remote server 204; a receiver to receive a policy from the remote server 204; and a processor to execute the policy by implementing one of first and second algorithms based on the conditions and time-varying data. The communication units generally do not have the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc. Therefore, the prior art communication units cannot use such information for improving their performance. The transmitter discussed above provides data to a central location, i.e. the remote server 204, that has the capability in terms of processing resources, access to historical operational data, access to operational data of other similarly situated communication units, etc, so that it may use such information generate rules and conditions for operating the communication units with enhanced performance. These rules and conditions were previously not conceivable by the communication system (e.g., communication system of **Fig. 1**) due to lack of information and processing power needed to generate the rules and conditions. The remote server 204, after computing the rules and conditions, provides the rules and conditions to the processors of the communication units, wherein the processors executes their respective policies by implementing one of first and second algorithms based on the rules and/or conditions and time-varying data.

[0045] In one embodiment, the one or more communication units (AP 201 and/or the stations $202_{1\text{-}N}$) are operable to receive the policy along with one of the first and second algorithms based on the conditions and/or the time-varying data, wherein the first and second algorithms did not exist in the one or more

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communication units (AP 201 and/or the stations 202_{1-N}) prior to being provided by the remove server 204. In such an embodiment, the remote server 204 installs a new algorithm 203 in the AP 201, where the new algorithm is executed by the processor 209 of the AP 201.

[0046] In one embodiment, the one or more communication units (AP 201 and/or the stations 202_{1-N}) are operable to receive the policy and implement one of first and second algorithms based on the rule and/or conditions and/or the time-varying data, wherein the first and second algorithms previously existed in the one or more communication units (AP 201 and/or the stations 202_{1-N}). In such an embodiment, the remote server provides recommendations to the communication units (AP 201 and/or the stations 202_{1-N}) to use either the first or second algorithm so the communication system 200 may improve its performance.

[0047] The conditions may include at least one of: choice of selecting one of the first or second algorithms based on current SNIR (Signal to Noise and Interference Ratio); choice of selecting one of the first or second algorithms based on current time; choice of selecting one of the first or second algorithms based on operational data of the one or more communication units; and choice of selecting one of the first or second algorithms based on location information. In other embodiments, other conditions may be used in conjunction or absence to the above listed conditions. The rules may include equations, when executed in the algorithms, will change how the conditions are evaluated by the algorithms.

[0048] In one embodiment, the remote server 204 generates the policy by performing analysis on the collected data, wherein the collected data comprises operational information and historical data about each of the one or more communication units. In one embodiment, the remote server 204 applies the analysis to generate conditions for when to implement one of the first and second algorithms. In one embodiment, the remote server 204 generates the policy by generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units (AP 201 and/or the stations 202_{1-N}).

[0049] In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a data rate according to a

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mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a data rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0050] The following is an exemplary embodiment showing the process of determining an optimum algorithm by the remote server 204. In one embodiment, the remote server 204 selects one of the first or second algorithms for the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) to achieve optimal performance efficiency for the communication system 200. In one embodiment, first algorithm determines data transmission rates for the communication units based on RSSI while the second algorithm determines data transmission rates based on a number of consecutive successful transmissions and on a number of consecutive failed transmissions. As mentioned above, in one embodiment, the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) have the first and second algorithms previously stored, but do not know which algorithm is more efficiency for the communication system 200. In such an embodiment, the remote server 204 provides recommendations to the communication units about which algorithm to use.

[0051] In one embodiment, in the first algorithm the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) monitor the RSSI in real-time and adapts their transmission rates according to the instantaneous RSSI value using a mapping table (Table 1) as shown below.

RSSI value	Rate
-92dBm or below	6Mbps
-92dBm~-90dBm	9Mbps
-90dBm~-88dBm	12Mbps

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-88dBm~-86dBm	18Mbps
-86dBm~-84dBm	24Mbps
-84dBm~-82dBm	36Mbps
-82dBm~-80dBm	48Mbps
-80dBm or above	54Mbps

Table 1: RSSI to rate mapping for first algorithm

[0052] Table 1 is only shown as an example and a person skilled in the art would realize that the communication units may use different rates for different RSSI values other than the ones shown above.

[0053] In one embodiment, the second algorithm for the communication units (AP 201 and/or the stations 202_{1-N}) uses a higher data rate after K (e.g., 10) consecutive successful transmissions, and uses a lower data rate after M (e.g., 2) consecutive failed transmissions. In one embodiment, the communication units (AP 201 and/or the stations 202_{1-N}) provide to the remove server 204 operational data including RSSI, SNR, rate used for transmitting a packet, corresponding result on successful packet delivery, and other relevant data collected in real-time. In one embodiment, communication units (AP 201 and/or the stations 202_{1-N}) may accumulate such data within the communication units (AP 201 and/or the stations 202_{1-N}) and then send the accumulated data to the remote server 204. In one embodiment, the data transmitted to the remote server 204 is non-real-time data because it is sent after some time (e.g., end of the day).

[0054] In one embodiment, the remote server 204 stores such data in its database 205 and performs a full analysis based on all the stored data and any other knowledge available at the remote server 204. In one embodiment, the other knowledge includes similar statistics, as those provided by the communication units (AP 201 and/or the stations 202_{1-N}) to the remote server 204, from other similar communication units in other similar geographical localities.

[0055] In one embodiment, the remote server 204 determines the presence of intermittent high-power interference from other near-by WiFi systems. When

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other WiFis' high-power packets collide with the communication system 200's packet, the packet is lost regardless of the rate selection. In one embodiment, the remote server 204 determines that other noise or interference is never observed for the communication system 200, and concludes that it is best to adapt rates for the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) as a function of channel strength, or RSSI, only. In such an embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations $202_{1\text{-}N}$) asking the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) to use the first algorithm all the time instead of the second algorithm.

[0056] In one embodiment, the remote server 204 determines that there is no high-power WiFi interference at all, but channel changes faster than typical static indoor wireless channel (possibly due to people moving around the AP 201). For example, the channel variation tends to be faster between noon and midnight. In such an embodiment, the remote server 204 concludes that it is best to use the second algorithm instead of the first algorithm by the communication units (AP 201 and/or the stations $202_{1\text{-}N}$). In one embodiment, the remote server 204 may determine optimum values for K and M to be used by the communication units (AP 201 and/or the stations $202_{1\text{-}N}$) in different times of the day. For example, K=10 and M=1 between noon and midnight; and K=20 and M=2 between midnight and noon.

[0057] In one embodiment, the remote server 204 sends a control signal to communication units (AP 201 and/or the stations $202_{1\text{-}N}$) asking communication units (AP 201 and/or the stations $202_{1\text{-}N}$) to use the second algorithm with the optimized K and M values depending on time in the day. In case the WiFi communication system 200 is not capable of changing the values of K and M as a function of time, the remote server 204 can send two control signals per day, one at noon and another at midnight.

[0058] In one embodiment, when the WiFi communication system 200 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (AP 201

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and/or the stations 202_{1-N}). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 210 of the AP 201. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 209 of the AP 201. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication systems to use one of them by sending a proper pseudo-code to the communication units (AP 201 and/or the stations 202_{1-N}) of the communication system 200.

[0059] **Fig. 3** is a system 320 for optimizing performance of a Digital Subscriber Line (DSL) communication system 300 by the remote server 204, according to one embodiment of the invention. The embodiment of **Fig. 3** is similar to the embodiment of **Fig. 2** in concept, but applicable for DSL systems. The embodiments of the invention are not limited to DSL or WiFi communication systems, but apply to any communication system that needs to run/execute adaptation algorithms (also called algorithms) to cope with real-time variations in link channel, noise, interference, and other factors that affect communication performance.

[0060] In one embodiment, the DSL communication system 320 comprises a Digital Subscriber Line Access Multiplexer (DSLAM) 301 that connects to one or more Customer Premises Equipment (CPEs) 302_{1-N} by means of DSL signals 304_{1-N}, where N is an integer equal to or greater than 1. In one embodiment, the remote server 204 performs a method for optimizing performance of the one or more communication units including the DSLAM 301 and the CPEs 302_{1-N}. In one embodiment, the remote server 204 is operable to collect operational data from the one or more communication units (DSLAM 301 and/or the CPE 302_{1-N}). In one embodiment, the remote server 204 periodically collects operational data from the one or more communication units.

[0061] In one embodiment, the operational data collected by the remote server 204 includes at least one of: band preference indication; margin cap mode

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indication; indication that margin per tone should be kept smaller than the maximum SNR (Signal to Noise Ratio) margin; service priorities pertaining to net data rate; service priorities pertaining to excess margin; service priorities pertaining to excess margin per tone; service priorities pertaining to delay; service priorities pertaining to impulse noise protection; indication of loading algorithms used with a first DSL system; indication of power allocation algorithms used with the first DSL system; maximum attainable data rate; current data rate; margin; channel attenuation per tone; average attenuation; quiet line noise per tone; active line noise per tone; SNR per tone; transmitted PSD per tone; downstream power back-off shaped parameters (DPBOSHAPED); upstream power back-off shaped parameters (UPBOSHAPED); echo response; band preference; margin cap mode; Forward Error Correction (FEC) count; code violation count; errored seconds; severely errored seconds; number of retraining count; current delay; error distributions; current impulse noise protection; or FEC and interleaving parameters. The above listed operational data is not an exclusive list. More operational data may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0062] In one embodiment, the remote server 204 collects configuration parameters associated with the one or more communication units. The configuration parameters include at least one of: maximum nominal power spectral density (MAXNOMPSD); maximum nominal aggregate transmit power (MAXNOMATP); power cutback (PCB); DPBOSHAPED; UPBOSHAPED; fine gains; gi; transmit spectral scaling factors; tssi; power spectral density mask (PSDMASK); power spectral density level; maximum received power (MAXRXPWR); upstream power "back-off" parameters (UPBOKLE); margin cap mode; carrier mask (CARMASK); minimum impulse noise protection (MININP); maximum delay (MAXDELAY); target margin (TARSNRM); minimum SNR margin (MINSNRM); maximum SNR margin (MAXSNRM); band preference indication (PREFBAND); target data rate; minimum data rate; maximum data rate; FEC and interleaving parameters; per tone bit cap (BCAP[n]); per tone target margin (TARSNRM[n]); reference noise (REFNOISE). The above listed configuration parameters is not an exclusive list. More configuration parameters

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may be used by the remote server 204 to compute rules and/or conditions for the communication units.

[0063] As discussed with reference to **Fig. 2**, the remote server 204 of **Fig. 3** is operable to generate a policy, for each of the one or more communication units (DSLAM 301 and/or the stations $302_{1\text{-}N}$), based on the collected operational data, according to one embodiment. In one embodiment, the remote server 204 is operable to transmit/send the policy to each of the one or more communication units (DSLAM 301 and/or the CPE $302_{1\text{-}N}$). The policy generated by the remote server 204 is a result of analyzing hundreds (or even millions) of similarly situated communication units. The DSLAM 301 does not have the processing power, storage space, or access to large amounts of data to generate the best policy to achieve optimal performance efficiency. Furthermore, DSLAM 301 does not have access to historical data related to communication with other CPEs connected to other DSLAMs. Additionally, DSLAM 301 may loose data when there is power outage or user-initiated power cycling. The remote server 204 resolves the above problems and provides an optimum policy for the DSLAM 301 to use based on analysis of large amount of operational data of the communication system 300 and other similarly situated communication systems. The optimum policy can be determined based on expert knowledge outside of the communication system where the expert knowledge can be obtained from lab testing, simulation or any other research methods. The policy can be adaptively modified even after the full deployment of the communication system, and hence does not suffer from limited knowledge that is used at the time of manufacturing the communication system. In the embodiments discussed herein the remote server 204 is not part of the communication system 300.

[0064] In one embodiment, when the DSL communication system 300 has the capability to decode and execute a pre-defined pseudo-code, the remote server 204 can consider many more algorithms that are known to it and send the rules and/or conditions for the algorithm to be used by communication units (DSLAM 301 and/or the CPEs $302_{1\text{-}N}$). In one embodiment, the remote server 204 develops a pseudo-code for the communication unit to execute so that it may improve its

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communication performance. In one embodiment, the pseudo-code is stored in the memory of the communication unit, example memory 310 of the DSLAM 301. The pseudo-code may be coded in any software coding language that is executable by the communication unit, example by the processor 309 of the DSLAM 301. In one embodiment, as the remote server 204 becomes aware of newer and better algorithms, it enforces some of the communication units to use one or more of them by sending a proper pseudo-code to the communication units (DSLAM 301 and/or the CPEs $302_{1\text{-}N}$) of the communication system 300.

[0065] Following is an exemplary embodiment of how the remote server 204 can improve the performance of a DSL system. In DSL systems, for example the system 300, downstream (DS) margin is an important line performance metric that can be monitored by CPEs $302_{1\text{-}N}$ in real-time. In general, a higher margin indicates an exponentially smaller chance of errors for the delivery of video or data packets over DSL links $304_{1\text{-}N}$. When the margin becomes very small, typically below 0dB, the link will experience errors that can cause serious impacts on packet delivery to the CPEs $302_{1\text{-}N}$. To prevent continuation of such an unreliable link quality over a long time, CPEs $302_{1\text{-}N}$ can initiate a retraining procedure and improve the operation conditions. The retraining procedure may take 20 to 60 seconds. In one embodiment, the above feature of DSL systems is implemented by CPEs $302_{1\text{-}N}$ monitoring DS margins and initializing a retraining process when the margin becomes below a pre-configured threshold value 'T.' Conventionally, 'T' is set to 0dB and controlled via the DSL line's profile.

[0066] The remote server 204 may collect operational and performance data of the DSL system 300, analyze the historical data (operational and performance data) associated with the DSL system 300, and determine the best estimated value of 'T' for each line and applies the value to each line.

[0067] The term "line" herein refers to a communication link (wired or wireless) between the DSLAM 301 and the corresponding CPE. The value of 'T' may be analyzed per-line basis by the remote server 204. Different values of 'T' can be applied by the remote server 204 to different DSL lines depending on their historical and environmental characteristics.

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[0068] Each CPE among the CPEs 302_{1-N} applies an algorithm to tune its performance. For example, the CPE applies a rule and/or condition to adapt the value of 'T' in real-time as a function of the real-time data (operational and performance) that is available in the corresponding CPE. The CPEs 302_{1-N} are operable to apply the following rules and conditions. If video traffic is observed by the CPE over the line for more than t_1 (e.g., 1 minute), then the CPE updates the value of 'T' to 'T_1' (e.g., 2dB). Such a rule allows the CPE to react fast on pixelization problems associated with video traffic. In this example, the conditions are the choice of 't_1' and 'T_1', while the rule is the "if, then" equation. Typically each retraining process of the CPE causes discontinuation/interruption of video and data services for a short time (e.g., 10~45 seconds), but such an interruption can be preferable to a persistent pixelization problem of the video traffic for several minutes or more. If no video traffic is observed by the CPE for more than 't_2' (e.g., 10 minutes) then the CPE updates the value of 'T' to 'T_2' (e.g., 0dB). In this example, the conditions are the choice of 't_2' and 'T_2,' while the rule is the "if, then" equation. This rule allows the CPE to reduce the chance of initiating a retraining process that can interrupt data traffic. Data service is more resilient to errors compared to video traffic, and the errors that can happen for a small margin (e.g., 0~2dB) are likely tolerable for data traffic.

[0069] The above example of the rule and/or condition involves real-time monitoring of the data of the DSL system 300 and real-time adaptation algorithm within the DSL system 300. In some embodiments, the data of the DSL system 300 may not be entirely in real-time but the data update may be frequent enough (e.g., 5 minutes) to behave like real-time data.

[0070] In one embodiment, the threshold values 't_1,' 't_2,' 'T_1' and 'T_2' used by the rules/conditions discussed above are not statically kept in the DSL system 300, but optimized by the remote server 204. In one embodiment, the CPE continues to keep its rule/condition, but the parameters of the rules, i.e. the threshold values (conditions) 't_1,' 't_2,' 'T_1' and 'T_2,' are updated in the CPEs 302_{1-N} by the remote server 204. In such an embodiment, the remote server 204 collects and

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analyzes historical operational data and any side information (e.g., data from other similarly situated DSL systems) that is available at the remote server 204.

[0071] Continuing with the exemplary embodiment discussed above, the remote server 204 will choose 'T_1'= 0dB for a DSL line if pixelization has hardly happened even for margins between 0 and 2dB in the historical operational data, but will choose 'T_1'= 4dB if pixelization always occurred and continued for several minutes for margins between 0 and 4B. Such long-term adaptation of the rules by remote server 204 allows the DSL system 300 to perform at its optimum ability under all circumstances. In one embodiment, the switching of modes discussed above happens in real-time or very frequently, but the update of threshold values or rules to be used by the CPEs $302_{1\text{-}N}$ happens at a much lower frequency. In one embodiment, the remote server transmits the updated policy (with new threshold values) to the DSL system 300 a once per day.

[0072] While the embodiments of **Fig. 3** are discussed in terms of margin and video traffic in the DSL system 300, the embodiments can be applied to any DSL or other communication system adaptation algorithm that reacts in real-time to other data parameters without changing the essence of the embodiments of the invention.

[0073] **Fig. 4** is a method 400 performed by a remote server for optimizing performance of a communication system, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to **Fig 4** are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of **Fig. 4** is illustrated with reference to the embodiments of **Figs. 2-3**.

[0074] At block 401, the remote server 204 collects data (operational and/or performance data) from the one or more communication units. As discussed above, the communication units in **Fig. 2** are AP 201 and/or the stations $202_{1\text{-}N}$ while communication units in **Fig. 3** are DSLAM 301 and/or the CPE $302_{1\text{-}N}$. In one embodiment, the communication units are at least one of a base station; a wireless LAN device; a DSLAM; a gateway; a performance enhancement device; a DSL

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CPE modem; an in-home powerline device; a HPNA based device; an in-home coax distribution device; a G.hn (Global Home Networking Standard) compatible device; an in-home metering communication device; an in-home appliance communicatively interfaced with the LAN; a wireless femtocell base station; a wireless WiFi compatible base station; a wireless mobile device repeater; a wireless mobile device base station; a STB/STU customer electronics device; an IP enabled television; an IP enabled media player; an IP enabled gaming console; an Ethernet gateway; a computing device connected to the LAN; an Ethernet connected computer peripheral device; an Ethernet connected router; an Ethernet connected wireless bridge; an Ethernet connected network bridge; and an Ethernet connected network switch.

[0075] At block 402, the remote server 204 generates a policy, for each of the one or more communication units based on the collected data. As discussed above, the policy with reference to **Fig. 2** comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms.

[0076] With reference to **Fig. 3**, the policy may comprise rules and conditions such as the threshold values 't_1,' 't_2,' 'T_1' and 'T_2' for the DSL system 300 and equations that use these threshold values. Other policies may be used for the above systems of **Figs. 2-3** and for other systems.

[0077] At block 403, the remote server 204 sends the policy to each of the one or more communication units, wherein the one or more communication units

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implement the policy according to time-varying data (data collected by the communication units of the communication systems).

[0078] **Fig. 5** is a method 500 performed by a communication system for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Although the blocks in the flowcharts with reference to **Fig 5** are shown in a particular order, the order of the actions can be modified. Thus, the illustrated embodiments can be performed in a different order, and some actions/blocks may be performed in parallel. The flow chart of **Fig. 5** is illustrated with reference to the embodiments of **Figs. 2-3**. So as to avoid repetitiveness, only the processes performed by the communication units are discussed.

[0079] At block 501, the one or more communication units send data to the remote server 204. The data may be operational data, performance data, or any other time-varying data. At block 502, the one or more communication units receive a policy generated by the remove server 204, wherein the policy comprises rules and/or conditions for operation of the one or more communication units. At block 503, the one or more communication units execute the policy sent by the remote server 204 to implement an algorithm based on the rules and/or conditions and time-varying data. As discussed above, the policy with reference to **Fig. 2** comprises first and second algorithms (also called adaptive algorithms). In one embodiment, the first algorithm comprises: monitoring received signal strength indication (RSSI); and adapting a transfer rate according to a mapping of the RSSI from a lookup table. In one embodiment, the second algorithm comprises: counting a first number of consecutive successful transmissions from the one or more communication units to other communication units; counting a second number of consecutive failed transmissions from the one or more communication units to other communication units; adjusting a transfer rate when the first number exceeds a first threshold; and adjusting the transfer rate when the second number exceeds a second threshold. In other embodiments, other algorithms may be used for first and second algorithms. With reference to **Fig. 3**, the policy may comprise rules and conditions

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such as the threshold values t_1, t_2, T_1 and T_2 for the DSL system 300. Other policies may be used for the above systems of **Figs. 2-3** and for other systems.

[0080] **Fig. 6** is a processor-based system 600 having machine-readable storage medium with computer executable instructions 604 for optimizing performance of the communication system by a remote server, according to one embodiment of the invention. Machine-readable storage medium is one of 207, 210, or 310 (collectively referred to as "207/201/310"). The computer/machine-readable/executable instructions are executed by a processor (e.g., processor 206 of the remote server, or processors 209 and 309 of the AP 201 or DSLAM 301 respectively). Elements of embodiments are also provided as a machine-readable medium for storing the computer-executable instructions (e.g., instructions to implement the flowcharts of **Figs. 4-5** and other processes discussed in the description).

[0081] In one embodiment, the processor-based system 600 further comprises a database 601 to store data used by the instructions 604. In one embodiment, the processor-based system includes a network interface 602 to communicate with other devices. In one embodiment, the components of the processor-based system 600 communicate with one another via a network bus 603.

[0082] The machine-readable storage medium 207/210/310 may include, but is not limited to, flash memory, optical disks, hard disk drive (HDD), Solid State Drive (SSD), CD-Read Only Memory (CD-ROMs), DVD ROMs, RAMs, EPROMs, EEPROMs, magnetic or optical cards, or other type of machine-readable media suitable for storing electronic or computer-executable instructions. For example, embodiments of the invention may be downloaded as a computer program (e.g., BIOS) which may be transferred from a remote computer (e.g., a server) to a requesting computer (e.g., a client) by way of data signals via a communication link (e.g., a modem or network connection).

[0083] Reference in the specification to "an embodiment," "one embodiment," "some embodiments," or "other embodiments" means that a particular feature, structure, or characteristic described in connection with the embodiments is included in at least some embodiments, but not necessarily all embodiments. The

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various appearances of "an embodiment," "one embodiment," or "some embodiments" are not necessarily all referring to the same embodiments. If the specification states a component, feature, structure, or characteristic "may," "might," or "could" be included, that particular component, feature, structure, or characteristic is not required to be included. If the specification or claim refers to "a" or "an" element, that does not mean there is only one of the elements. If the specification or claims refer to "an additional" element, that does not preclude there being more than one of the additional element.

[0084] While the invention has been described in conjunction with specific embodiments thereof, many alternatives, modifications and variations of such embodiments will be apparent to those of ordinary skill in the art in light of the foregoing description.

[0085] For example, the embodiments discussed above can apply to a communication system comprising a performance enhancement device. A performance enhancement device may comprise a signal conditioning device, a diagnostic and remedy guidance device, or a noise cancellation device. A noise cancellation device, among other things, acts to cancel noise and interference present on the DSL line, either autonomously or in conjunction with commands from the remote server. In one embodiment, the performance enhancement device is communicatively coupled to the remote server 204 via the Communication Channel 208. In such an embodiment, impulse noise cancellation feature of the performance enhancement device may be turned on and off based on the real-time observation of noise, and the actual algorithm for deciding on-off can be distributed where long-term thresholds/rules and conditions are calculated by the remote server 204 and transmitted to the performance enhancement device. In one embodiment, the remote server 204 forces the actual transition in the performance enhancement device as a function of real-time observation of the noise data.

[0086] Another alternative embodiment related to a WiFi system is described as follows. In a typical WiFi communication system, Carrier Sense Multiple Access (CSMA) protocol is used for multiple access. Due to the nature of wireless channel, some of the stations (clients) might not be able to hear each other while both can reach the AP with strong power. This phenomenon is known as

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Hidden Node problem. One way to resolve this problem is to schedule the data transmission using Request to Send (RTS) and Clear to Send (CTS) mechanisms. Such a use of RTS/CTS incurs overhead in channel usage, but prevents disastrous packet collisions by the two stations.

[0087] In one embodiment, the remote server 204 collects operational and performance data of the WiFi AP 201 (and other APs) and/or stations $202_{1\text{-}N}$. In one embodiment, the remote server 204 analyzes the historical data and determines the best value for each AP (on or off) and applies the value to each AP. In one embodiment, the value is analyzed per-AP by the remote server 204, and therefore different values can be applied to different APs depending on their data characteristics.

[0088] In one embodiment, each AP is operable to apply a rule with conditions to adapt RTS/CTS on/off in real-time as a function of real-time data available to the local AP. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is detected for more than t_1 (e.g., 1 minute), the AP turns on RTS/CTS. In one embodiment, the rule generated by remote server and made available in the AP is that if a large packet error rate is not detected for more than t_2 (e.g., 10 minutes), then the AP turns off RTS/CTS.

[0089] In the above embodiment, two or more operation modes are described in context of a local communication device (e.g., AP) selecting the operation mode to use in real-time. In one embodiment, the selection of the operation mode is a function of the real-time data that is locally available. In other embodiments, the data might not be in real-time but the data update may be frequent enough for this idea to consider the data as real-time.

[0090] In one embodiment, the rules and/or conditions e.g., the threshold values 't_1', and 't_2,' and equations applying them, are not statically kept as in AP, but optimized by the remote server 204. In one embodiment, the threshold values 't_1', and 't_2,' and/or the equations are updated by the remote server 204 using historical data and any side information that is available at the remote server side. In the above alternative embodiment, RTS/CTS was involved, however, the essence of the embodiments can be applied to any WiFi adaptation algorithm that reacts in

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real-time to other data parameters. WiFi adaptation algorithms include control of fragmentation, channels, association, etc.

[0091] The embodiments of the invention are intended to embrace all such alternatives, modifications, and variations as to fall within the broad scope of the appended claims.

[0092] An abstract is provided that will allow the reader to ascertain the nature and gist of the technical disclosure. The abstract is submitted with the understanding that it will not be used to limit the scope or meaning of the claims. The following claims are hereby incorporated into the detailed description, with each claim standing on its own as a separate embodiment.

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CLAIMS

We claim:

1. A method for optimizing performance of one or more communication units by a remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

2. The method of claim 1, wherein the policy further comprises first and second algorithms.

3. The method of claim 2, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

4. The method of claim 1, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

5. The method of claim 1, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

6. The method of claim 1, wherein generating the policy comprises:

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generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

7. The method of claim 1, wherein collecting data from the one or more communication units is performed periodically.

8. The method of claim 1, wherein the one or more communication units comprises at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;
a wireless WiFi compatible base station;
a wireless mobile device repeater;
a wireless mobile device base station;
a set-top box (STB)/set-top unit (STU) customer electronics device;
an Internet Protocol (IP) enabled television;
an IP enabled media player;
an IP enabled gaming console;
an Ethernet gateway;
a computing device connected to the LAN;

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an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

an Ethernet connected network switch.

9. The method of claim 1, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

10. A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor of a remote server to perform a method for optimizing performance of one or more communication units by the remote server, the method comprising:

collecting data from the one or more communication units;

generating a policy, for each of the one or more communication units, based on the collected data; and

sending the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

11. The machine-readable storage medium of claim 10, wherein the policy further comprises first and second algorithms.

12. The machine-readable storage medium of claim 11, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

13. The machine-readable storage medium of claim 10, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

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14. The machine-readable storage medium of claim 10, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

15. The machine-readable storage medium of claim 10, wherein generating the policy comprises:

generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

16. The machine-readable storage medium of claim 10, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

17. A method for optimizing performance of one or more communication units, the method comprising:

sending data from one or more communication units to a remote server;

receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and

executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

18. The method of claim 17, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

19. The method of claim 17, wherein the first and second algorithms previously existed in the one or more communication units.

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20. The method of claim 17, wherein the policy further comprises the first and second algorithms.

21. The method of claim 20, wherein implementing one of the first and second algorithms based on the conditions and time-varying data comprises implementing one of the first and second algorithms provided with the policy.

22. The method of claim 17, wherein executing the policy comprises:

executing a pseudo-code or code for an adaption algorithm, the pseudo-code generated by the remote server.

23. The method of claim 17, wherein the remote server resides in a cloud.

24. The method of claim 17, wherein sending data from one or more communication units to the remote server is performed periodically.

25. The method of claim 17, wherein the one or more communication units comprises at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;

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an in-home appliance communicatively interfaced with the LAN;

a wireless femtocell base station;

a wireless WiFi compatible base station;

a wireless mobile device repeater;

a wireless mobile device base station;

a set-top box (STB)/set-top unit (STU) customer electronics device;

an Internet Protocol (IP) enabled television;

an IP enabled media player;

an IP enabled gaming console;

an Ethernet gateway;

a computing device connected to the LAN;

an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

an Ethernet connected network switch.

26. The method of claim 17, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

27. A machine-readable storage medium having computer executable instructions stored thereon that when executed cause a processor to perform a method for optimizing performance of one or more communication units, the method comprising:

sending data from one or more communication units to a remote server;

receiving a policy from the remote server, wherein the policy comprises conditions for operation of the one or more communication units; and

executing the policy by implementing one of first and second algorithms based on the conditions and time-varying data.

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28. The machine-readable storage medium of claim 27, wherein executing the policy comprises:

executing a pseudo-code or code for an adaption algorithm, the pseudo-code generated by the remote server.

29. The machine-readable storage medium of claim 27, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more communication units.

30. The machine-readable storage medium of claim 27, wherein the first and second algorithms previously existed in the one or more communication units.

31. The machine-readable storage medium of claim 27, wherein the policy further comprises the first and second algorithms.

32. The machine-readable storage medium of claim 31, wherein implementing one of the first and second algorithms based on the conditions and time-varying data comprises implementing one of the first and second algorithms provided with the policy.

33. The machine-readable storage medium of claim 27, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

34. An apparatus comprising:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from one or more communication units;

generate a policy, for each of the one or more communication

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units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

35. The apparatus of claim 34, wherein the policy further comprises first and second algorithms.

36. The apparatus of claim 35, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

37. The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions and the time-varying data.

38. The apparatus of claim 37, wherein the time-varying data comprises location information, current time, and operational data of the one or more communication units.

39. The apparatus of claim 34, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

40. The apparatus of claim 34, wherein the processor is operable to generate the policy by performing a method comprising generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

41. The apparatus of claim 34, wherein processor to collect data periodically for

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analysis from the one or more communication units.

42. The apparatus of claim 34, wherein the one or more communication units comprise at least one of:

an access point (AP);

a base station;

a wireless LAN device;

a DSLAM;

a gateway;

a performance enhancement device;

a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;

an in-home powerline device;

a Home Phoneline Network Alliance (HPNA) based device;

an in-home coax distribution device;

a G.hn (Global Home Networking Standard) compatible device;

an in-home metering communication device;

an in-home appliance communicatively interfaced with the LAN;

a wireless femtocell base station;

a wireless WiFi compatible base station;

a wireless mobile device repeater;

a wireless mobile device base station;

a set-top box (STB)/set-top unit (STU) customer electronics device;

an Internet Protocol (IP) enabled television;

an IP enabled media player;

an IP enabled gaming console;

an Ethernet gateway;

a computing device connected to the LAN;

an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

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an Ethernet connected network switch.

43. The apparatus of claim 34, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

44. A system comprising:

one or more communication units; and

a server operable to communicate with the one or more communication units, wherein the server comprises:

a memory; and

a processor, coupled to the memory, and operable to:

analyze data from the one or more communication units;

generate a policy, for each of the one or more communication units, based on the collected data; and

send the policy to each of the one or more communication units, wherein the policy comprises conditions for operation of the one or more communication units, wherein the one or more communication units implement the policy according to time-varying data.

45. The system of claim 44, wherein the policy further comprises first and second algorithms.

46. The system of claim 44, wherein the one or more communication units are operable to receive the policy and implement one of the first and second algorithms based on the conditions.

47. The system of claim 44, wherein the time-varying data comprises location information, current time, and/or operational data of the one or more

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communication units.

48. The system of claim 44, wherein the one or more communication units are operable to receive the policy and implement one of first and second algorithms based on the conditions, wherein the first and second algorithms previously existed in the one or more communication units.

49. The system of claim 44, wherein the processor is operable to generate the policy by performing a method comprising generating a pseudo-code or code for an adaption algorithm to be executed on the one or more communication units.

50. The system of claim 44, wherein processor to collect data periodically for analysis from the one or more communication units.

51. The system of claim 44, wherein the one or more communication units comprise at least one of:

an access point (AP);
a base station;
a wireless LAN device;
a DSLAM;
a gateway;
a performance enhancement device;
a Digital Subscriber Line (DSL) Customer Premises Equipment (CPE) modem;
an in-home powerline device;
a Home Phoneline Network Alliance (HPNA) based device;
an in-home coax distribution device;
a G.hn (Global Home Networking Standard) compatible device;
an in-home metering communication device;
an in-home appliance communicatively interfaced with the LAN;
a wireless femtocell base station;

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a wireless WiFi compatible base station;

a wireless mobile device repeater;

a wireless mobile device base station;

a set-top box (STB)/set-top unit (STU) customer electronics device;

an Internet Protocol (IP) enabled television;

an IP enabled media player;

an IP enabled gaming console;

an Ethernet gateway;

a computing device connected to the LAN;

an Ethernet connected computer peripheral device;

an Ethernet connected router;

an Ethernet connected wireless bridge;

an Ethernet connected network bridge; and

an Ethernet connected network switch.

52. The system of claim 44, wherein the conditions specify the characteristics of real-time and historical operational data for the one or more communication units to select and apply a most desired adaptation algorithm.

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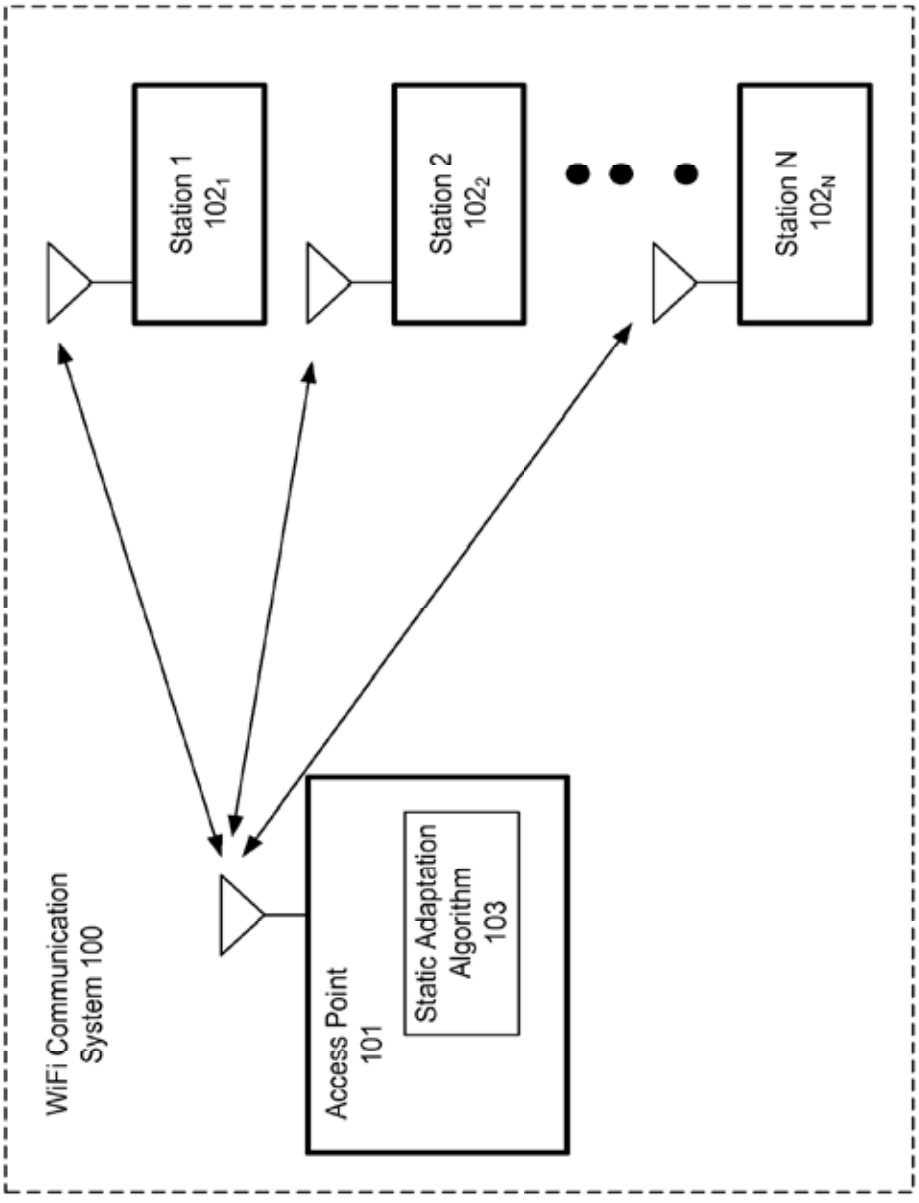


FIG. 1 (prior Art)

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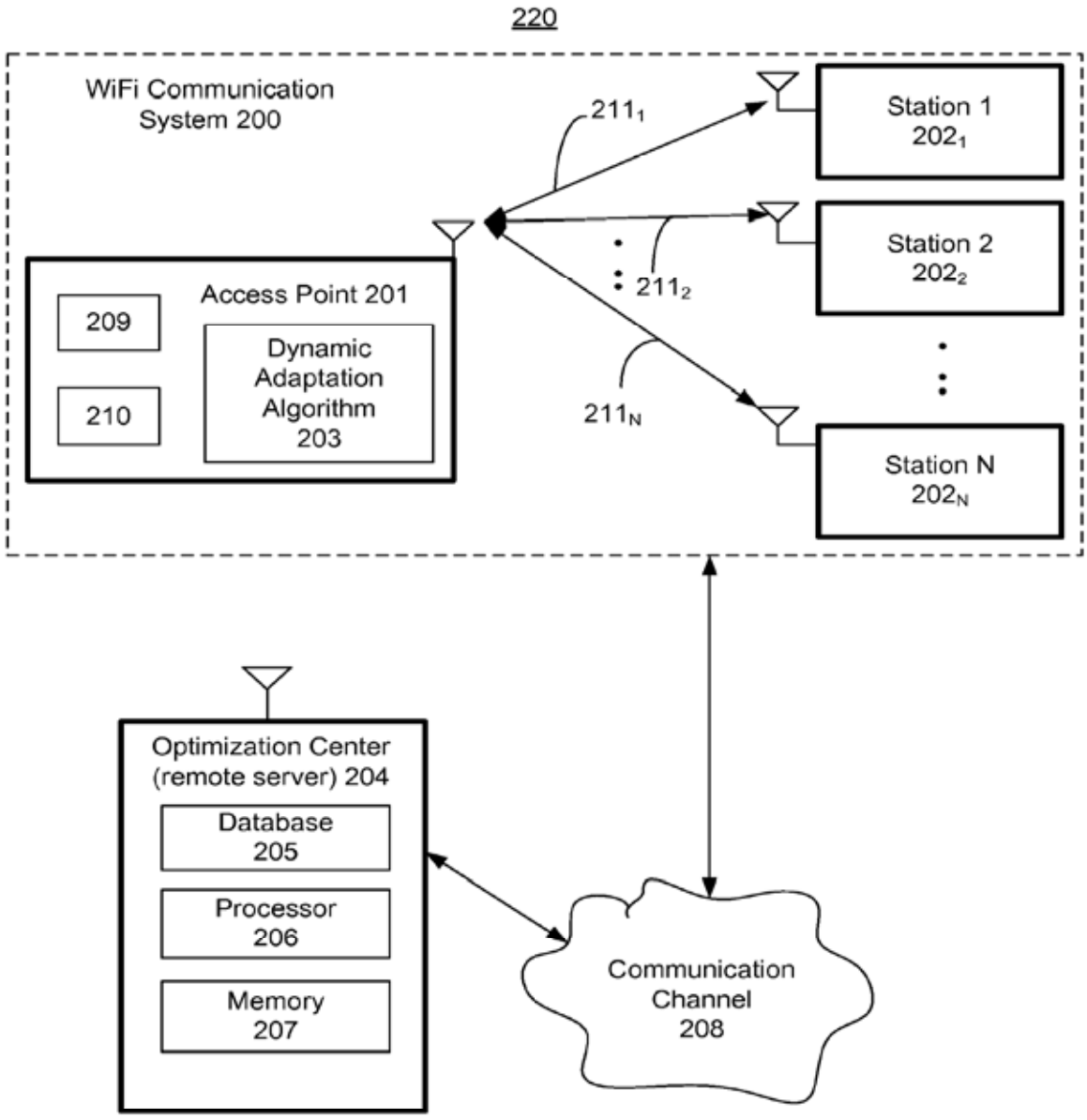


FIG. 2

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320

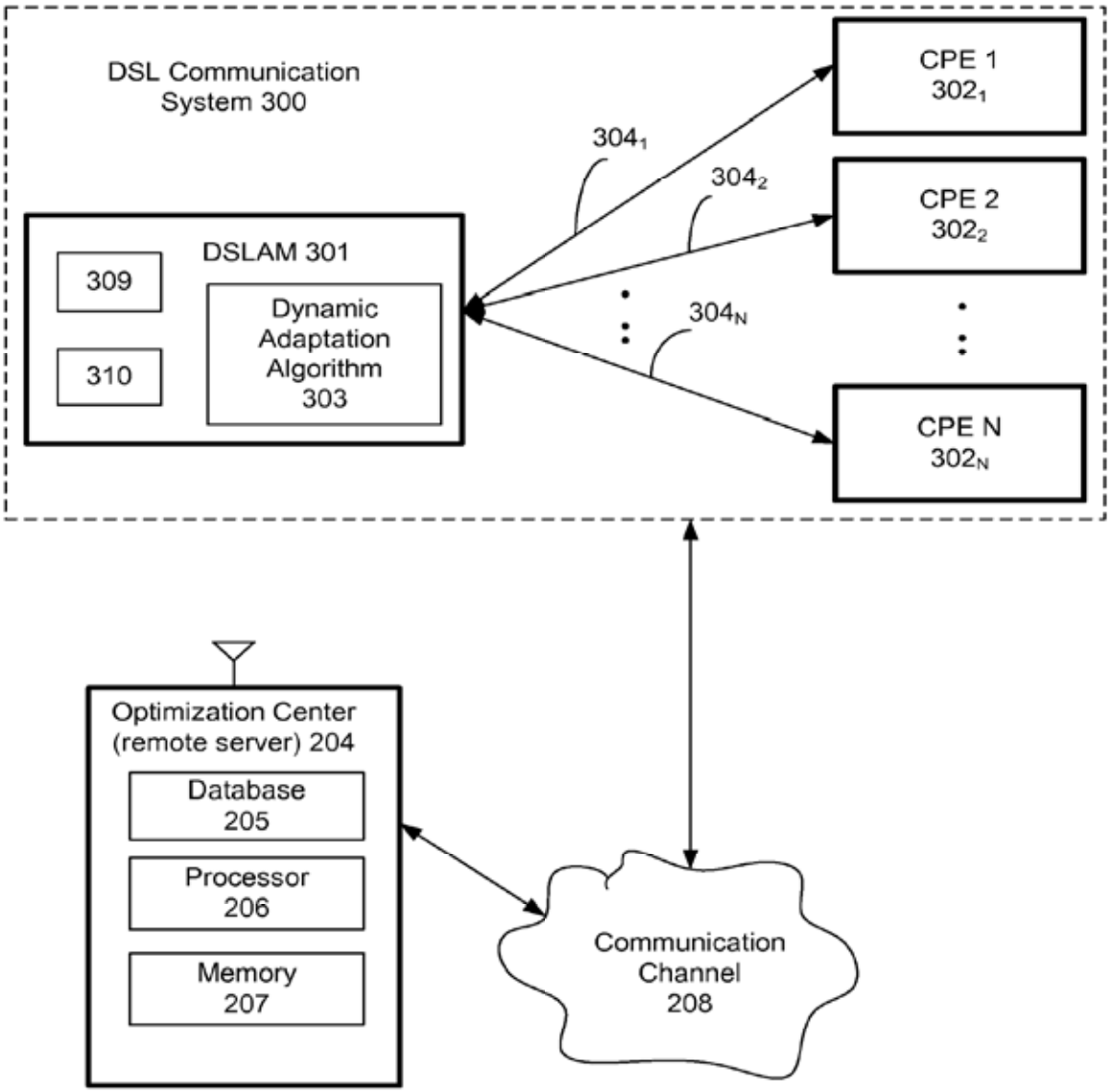


FIG. 3

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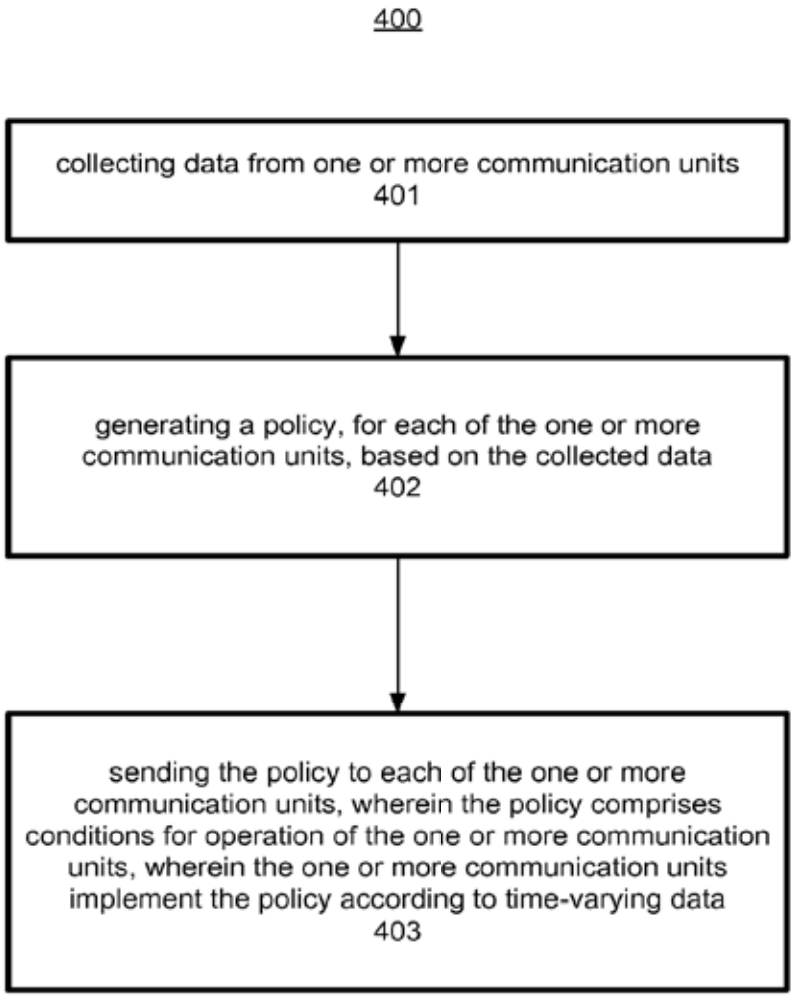


FIG. 4

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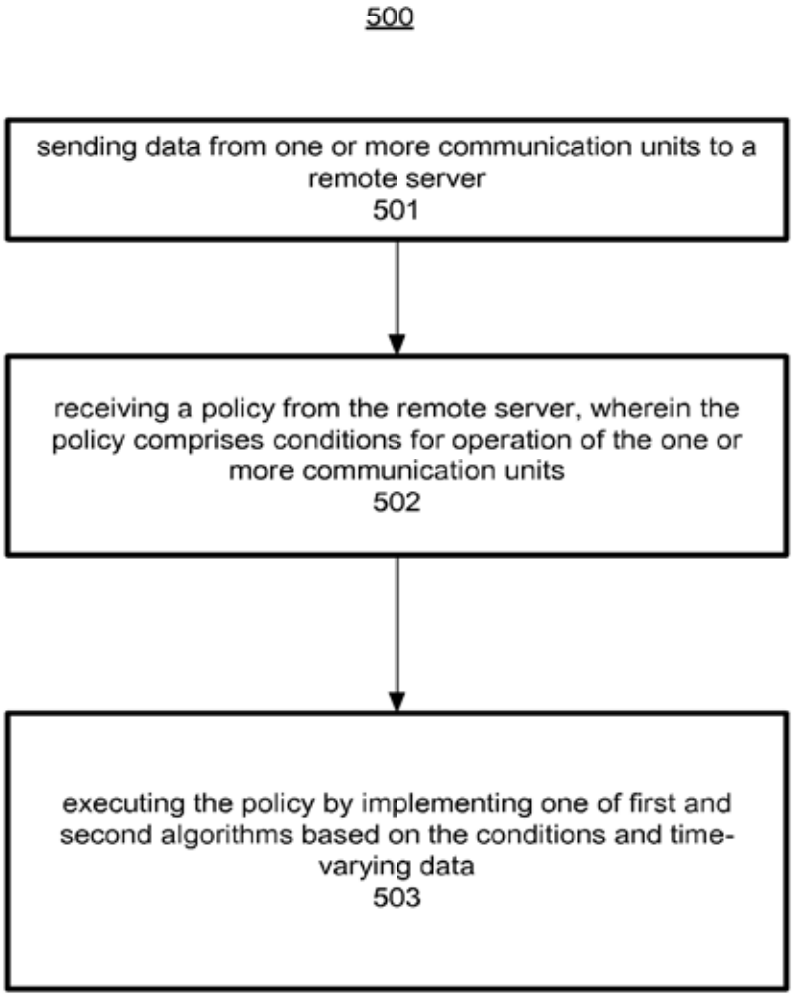


FIG. 5

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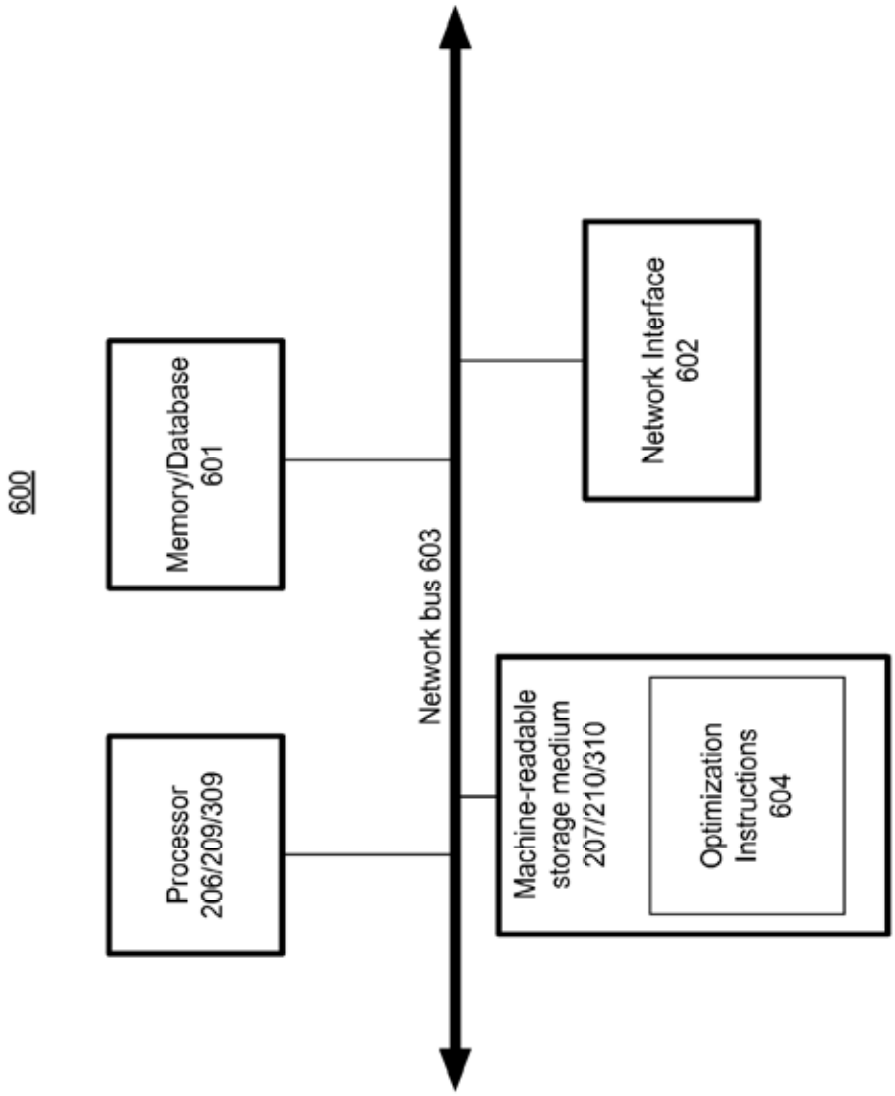


FIG. 6

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PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
14/356,581	05/06/2014	

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☒ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	280
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	280

APPLICATION AS AMENDED – PART II

AMENDMENT 05/06/2014

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/TER JACKSON WOODRUFF/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.