

202 和回程 110 的 QoS 确定，以查看问题是否出现在终端 106 这一端。进一步根据该实例，如果通过 PQMF 分组的传输确定从终端 106 到呼叫终止单元 114 的通信链路的质量良好，则终端 106 可以进一步配置为向对等通信终端 116 发送用于指示通信链路质量良好的消息。

在配置完第一分组之后，如方框 304 所示，在通信链路或网络上，向位于终止设备（例如，终止单元 114 或 216）附近的服务器（例如，PQMF 服务器 122 或 222）传输该分组。并且，端点终端（例如，106 或 202）可以实现该过程。此外，该服务器位于呼叫终止单元附近，以确保第一分组在 LAN 以及回程链路上传输。在传输第一分组之后，如方框 306 所示，响应于所传输的每个相应的第一分组，该服务器传输一个或多个第二分组。就是说，服务器通过向终端返回对应的第二分组来对所接收的每个第一分组类型进行响应。要注意，根据一个方面，将第二分组配置为与第一分组类型具有相同的共有特性，以确保在下行链路路径中具有相同的服务对待等级。然而可以预见，第一和第二分组不一定需要彼此匹配。此外，可以将服务器配置为计算与第一分组的传输有关的统计值。在这种情况下，还可以将一个或多个第二分组配置为向终端携带这些计算的统计值。

如方框 308 所示，在第二分组的传输之后，基于与所传输的第一分组相对应的所接收的第二分组的传输特性，确定通信链路的路径质量。该特性包括在传输第一分组的设备处接收到第二分组的时间，提供了第一和第二分组的往返程时间，可以利用该往返程时间确定延迟。其它特性可以包括当分别发送和接收多个第一和第二分组时的分组丢失和抖动的确定。在一个实例中，从多个分组中，包括过去所交换的分组，计算分组丢失和抖动。在方框 308 的过程之后，要注意进一步的过程（未显示）可以包括基于路径质量确定结果来确定对终端的切换触发。

要注意，希望在短时间内（低延时）执行过程 300，以提供路径质量估计的快速反馈。当有必要切换时，快速估计有助于更快地触发切换，并且不会在最终的切换中引入大的延时。相应地，快速切换将确保语言呼叫的 QoS。例如，可以想到两种用于更好地确保低延时的方法。

首先，应该快速完成 PQMF 过程。快速完成 PQMF 过程将会降低确定路径 QoS 时的延时，并且有助于降低该确定所需要的开销。

其次，应该尽早开始 PQMF 程序。PQMF 程序开始得越早，终端就可以越快地对质量降级做出响应。然而，用于启动 PQMF 程序的及早触发可能是错误肯定的，导致不必要的路径质量确定。这种错误肯定和相应的开销可以导致不希望的业务增加。此外，取决于协议的状态，可以较频繁或较不频繁地执行 PQMF 程序。例如，如果没有接收到返回的第二分组，则可以立即发送第一分组以再次对链路进行采样。当终端空闲时，可以较不频繁地执行 PQMF 过程，以便将网络负载最小化。

过程 300 还在网络中具有低开销。其中一个原因是，如果当路径质量恶化时执行 PQMF 过程，该过程不应该在网络中引入将该状况进一步恶化的大业务量。每个路径质量估计阶段（即，向 PQMF 服务器发送或接收分组）的传输数量应该少。并且，通过在连续的阶段之间引入足够的滞后量可以限制总阶段数量。

此外，过程 300 应该实现路径质量估计中的准确性。估计中的误差可以导致错误的切换判决，并且如前所述，不必要的切换将不会改善呼叫质量，并且将引起额外的开销，并且因此破坏通过将呼叫保持在局域网上所实现的任何优势。反之，当需要切换时不执行切换则可以不利地影响呼叫的 QoS。

此外，可以基于各种不同的标准来启动图 3 的过程 300。其中一个标准可以是响应于特定的检测条件来触发。实例可以包括但是不限于，在应用层检测到两个或更多个连续丢失的 RTP 帧、在预定数量的预期帧中有设定数量的丢失的 RTP 帧、在预定数量的连续 RTP 帧中观察到大的抖动、或者从其它端接收到对质量不满意的指示。可以使用 RTCP 报告或其它类型的报告。

用于执行过程 300 的另一个标准可以基于预定的周期或循环。更具体地，根据一个实例，可以在 PQMF 分组的传输之间设置大的时间段或时间间隔（这可以被称为“慢 PQMF”），以允许终端周期性地测量链路质量而不引入显著的网络开销。根据另一个实例，当慢 PQMF 过程指示出潜在的质量问题时，终端可以动态地切换到更小的时间间隔（称为“快 PQMF”），以更准确地测量链路质量统计值，例如分组丢失率。还可以由其他终端条件，例如 Wi-Fi 上的呼叫发起、下行链路分组丢失的突然增加等等，来触发

快 PQMF。这样，终端能够随时监视链路质量，同时保持低的网络开销。

此外，要注意，已知许多应用以不均匀的间隔发送分组。例如，诸如 AMR、EVRC 和 EVRC-B 的不连续语音编解码器可以在静默时期期间将分组间隔从 20ms 变成高达 640ms。这种声音合成器的估计分组丢失可以产生链路质量的不准确的估计。例如，在静默期间每 3 个帧丢失一个帧将显示出过度悲观的 33% 的丢失率，并且可以触发不必要的切换。对于在静默期间完全停止传输帧的编解码器，例如 G.711 的特定实现，分组丢失度量将完全不更新。对于在分组丢失测量时间间隔期间观察到非常少的分组的情况，终端可以依靠 PQMF 来准确地指示链路质量。

在本文要注意，本领域的熟练技术人员将理解为网络辅助方法所设想的各种实现。在以下讨论中，讨论了这种用于定位 PQMF 服务器的实现的一些实例，类似于图 2 所示的服务器 222。要进一步注意，该实现可以利用标准的或私有的协议，而不是实现专用 PQMF 分组协议。

在一个实例中，通信终端可以使用因特网控制消息协议 (ICMP) 来实现路径质量监视。在这种情况下，发起终端可以使用类似路由跟踪的功能来发现宽带终止，并且然后使用类似 ICMP ping 的功能来监视宽带所承担的质量。此外，第三代合作伙伴计划 (3GPP) 将分组数据网关 (PDG) 功能作为安全网关引入服务提供商的核心网中。对应的 3GPP2 功能被称为分组数据互通功能 (PDIF)。终端使用因特网密钥交换 (例如，IKEv2) 协议与 PDG 建立安全的 IPsec 隧道。在这种情况下，可以将 PQMF 定位在 PDG 处，因为 PDG 位于 VoIP 呼叫终止端附近。

VoIP 服务提供商通常管理 PDG，并且因此在 PDG 处的 PQMF 部署会更容易。并且，IKEv2 协议提供挂钩来帮助 PQMF 实现。运营商可以配置 VoIP 服务，使得去往和来自终端的信令和承载业务都经过 IPsec 隧道。在这种实现中，从终端到 PQMF 服务器的业务与共享网络路径上的 VoIP 业务具有相同的特性。

要注意，在 Skype™ 类型网络的一个实例中，承载业务通常经由超级节点路由。将类似的技术方案标准化为，经由中间媒体中继器来路由去往和来自终端的所有业务。在具有这种媒体中继器的情况下，可以将 PQMF “服务器” 位于该媒体中继器处。路径质量监视 (PQM) 协议交换和对应的度

量然后将指示共享网络路径向 VoIP 业务提供的质量。

此外,通用接入网(GAN)提出了一种结构,在该结构中,手机和 GAN 控制器(GANC)将 GSM NAS 信令和 GSM 编码语音封装到因特网协议安全(IPsec)隧道中。GANC 与 GSM 核心网接口,并且执行必要的仿真以保持到移动交换中心 MSC 的接口和到服务 GPRS 支持节点(SGSN)的 Gb 接口。在 GAN 网络中,PQMF 可以位于 GANC 处。所有信令和业务通过 GANC 路由。通过将 PQMF 放置在 GANC 处,PQMF“服务器”和终端可以协调以确定路径质量。因此,路径质量的降级可以作为用于执行从 GAN 到 GSM 的切换(漫游出)的必要的触发。可替换地,当检测到路径质量降级时,终端、媒体网关和 GANC 可以重新协商媒体特性,例如编码速率、冗余、打包等等。当 WAN 的覆盖范围不足以执行切换时,该重新协商可能有用。

图 1 和 2 当前所示的实例示出了网络辅助的方法,在该方法中,终端包含用于发起和检测路径质量的智能,同时位于呼叫终止端处或附近的服务器对终端发送的分组做出响应。要注意,本领域的熟练技术人员将理解,可以利用其它方法来实现本文所公开的路径质量监视功能。例如,可以改为利用网络控制的方法,在该方法中,用于发起和检测路径质量的智能位于网络中而不在终端中。在该实例中,网络将检测 QoS 降级并且如果批准了切换则通知终端。所设想的另一个方法是端到端的方法,在该方法中,用于检测路径质量降级的智能位于端点终端中。在 QoS 降级后,终端彼此协调以确定问题的源头,并且处于路径降级的终端采取恰当的措施来改善呼叫质量。

图 4 是示出了用于路径质量监视功能示例性实现的协议的方框图。如图所示,质量受到监视的路径是终端 402 与 PQMF 服务器 404 之间的路径。如方框 406 所示,终端 402 与诸如无线 LAN(WLAN)的局域网相关联。此外,在 VoIP 业务的实例中,终端 402 可以对那些特定的 LAN 网络基础架构进行 VoIP 注册,其中那些特定的 LAN 网络基础架构承担基于 IP 的基础架构上的数据、话音和移动网络技术的汇聚。

如方框 408 所示,在将终端与 LAN 相关联之后,然后可以发起 PQMF 发现。终端发现 PQMF 服务器或功能体 404 的 IP 地址。用于执行发现的具

体过程取决于基层协议的选择。如方框 410 所示，当发现 PQMF 服务器或功能体时，可以执行路径质量监视校准。具体地，终端 402 可以通过发起路径质量监视交换来校准路径质量。例如，终端 402 可以在每个 y_c 时长中向 PQMF 服务器 404 传输 x_c 个路径质量测量请求消息。PQMF 服务器 404 用路径质量测量响应消息来进行响应。终端 402 收集该响应并且确定度量，例如延迟、抖动和丢失率。例如，可以在 VoIP 呼叫期间或在空闲时执行校准过程。校准过程可以根据需要重复。此外，每个新的校准测量可用于过滤先前的校准测量。

无需每次注册时都执行校准过程 410。终端可以存储上一次校准的结果，并且将这些结果与例如 WLAN 标识相关联。例如在 Wi-Fi 网络情况下，WLAN 标识可以是 AP 的 MAC 地址。终端 402 可以在后续的关联中再次使用这些结果。可替换地，终端还可以将所需要的 QoS 参数的值写死，并且因此不需要校准过程。校准过程还可以用于确定是否在 WLAN 上进行 VoIP 呼叫。如果校准结果指示在涉及 WLAN 的路径上缺少足够的 QoS，则终端可以决定在 WAN 而非 LAN 上进行呼叫。此外，终端可以在本地数据库中存储校准的结果。此外，反复地无法支持需要的 QoS 还可用于在以后的呼叫中将特定 WLAN 列入黑名单。

如方框 412 所示，在校准之后，执行路径质量评估。根据一个实例，终端 402 可以以预定义的时间间隔或在发生触发之后执行 PQMF 交换。终端 402 在每个 y_t 时长中向 PQMF 服务器 404 传输 x_t 个路径质量测量请求消息（例如，以上关于图 3 所述的第一分组）。应该对用于发送请求消息的时长和速率进行优化，以确保准确的测量，而又不会实质上影响被测量路径上的业务。PQMF 服务器 404 用路径质量测量响应消息（例如，结合图 3 所述的第二分组）来进行响应。终端 402 可以收集该响应并且确定度量，例如延迟、抖动和丢失率。

在方框 412 中的路径质量评估之后，如方框 414 所示，终端 420 可以发起进一步的路径质量分析，并且基于分析结果确定切换判决。终端 402 将触发度量与先前定下的已校准度量进行比较。在检测到路径质量降级后，终端 402 可以发起到诸如 WAN 的另一个网络的切换，或者可替换地，可以调整它的数据速率和编码速率。

要注意，图 4 的其中一些功能块是可选的，例如注册和发现。并且方框 408、410、412 和 414 的功能没有必要按顺序执行，并且这些功能的其中两个或更多个可以并行地执行。

还要注意，可以通过使用分组/消息定制协议来实现上述的本文所公开的 PQMF 方法和装置。并且，本领域的熟练技术人员将理解，还可以重新使用或修改当前已知的协议，例如因特网控制消息协议（ICMP）和因特网密钥交换（IKE），来实现本文所公开的路径质量监视。在图 4 的上下文中来描述这些可替换的协议。

关于 ICMP，如果 PQMF 服务器 404 位于 PDG/PDIF 处，则发现程序 408 将识别 PQMF 服务器的 IP 地址，以便终端（例如，图 4 的 402）发现 PQMF 服务器。通过使用 ICMP，终端 402 可以使用 ICMP 回响请求分组作为路径质量测量请求消息。服务器 404 所执行的 PQMF 然后可以使用 ICMP 回响响应分组作为路径质量测量响应消息。重新使用 ICMP 过程来进行 PQMF，使得不需要开发新的协议，因此将部署过程的延迟和复杂度最小化。

要注意，如果终端 402 试图用 DSLAM 或 CMTS 路由器来进行 ICMP 过程，则 ICMP 过程有可能失败，这是因为网络元件出于安全原因经常禁止 ICMP 过程。为了确保 PQMF 发现和评估的成功，PQMF 服务器可以位于 PDG/PDIF 处。为此，VoIP 服务提供商可以在 PDG/PDIF 处支持 ICMP 过程。终端然后可以通过 IPsec 隧道与 PDG/PDIF 执行 ICMP 过程。因为中间路由器类似于处理媒体业务（例如，VoIP 业务）一样处理 ICMP 分组是有益的，所以终端 402 可以用与媒体业务相同的服务类型（TOS）字段（区分服务标记）来标记携带 ICMP 回响请求的 IP 数据报。PQMF 还可以恰当地标记 ICMP 回响响应。

通常，仅标记 ICMP 分组的 TOS 字段是不够的，因为中间路由器可能查看额外的字段，例如协议类型，以调度分组处理。然而，由于使用 IPsec 隧道来路由 ICMP 分组，所以中间路由器不能检查内部分组。外部分组上所作的标记确保在终端和 PQMF 之间的网络路径上对 ICMP 分组和 VoIP 分组进行相同的处理，以确保对所关注媒体业务的准确的路径质量测量。

第二个可选项是使用 IKE（例如，IKEv2）协议，其提供挂钩来辅助路径质量监视功能（PQMF）的实现。具体地，IKEv2 支持信息交换，其中 IKEv2

信息交换中的请求消息可以不包含有效载荷。根据该协议, IKEv2 对等端必须用响应消息来响应该请求。这种保持活跃 (keep-alive) 特征可以用于估计路径特性。设想终端 402 和 PQMF 服务器 404 可以将这些 IKEv2 消息用于路径质量测量请求和路径质量测量响应消息。并且, 终端 402 用与 VoIP 业务相同的区分业务标记来标记 IKEv2 信息请求, 以确保该请求的传输与网络对 VoIP 业务的传输相匹配, 并且因此确保准确的测量。同样, PQMF 服务器 404 还将恰当地标记 IKEv2 信息响应。

如前所述, 还可以设想用于在通信系统中实现 PQMF 的由网络控制的方法。图 5 示出了在通信系统 500 中, 网络控制方式的 PQMF 的示例性实现。具体地, 这种方法将 PQMF 功能置于 PDG/PDIF 502 处, PDG/PDIF 502 观察 VoIP 业务流。通过监视来自每个端点的流, PDG/PDIF 502 处的 PQMF 可以辨别发生了质量降级的地方。当 PQMF 确定在终端 504 和 PQMF 之间的路径上 (例如, AP 506 和回程 508) 发生降级时, 则 PQMF 可以与 PCRF 510 和 P-CSCF 512 协调, 以向终端 502 通知有关的质量降级和切换需要。位于 PDG 502 处的 PQMF 使用 Diameter 协议 (Gx 直径) 来向 PCRF 510 报告任何质量降级。PCRF 510 使用 Diameter 协议 (Gx 直径), 将该信息中继到 P-CSCF 512。P-CSCF 512 然后使用例如会话初始协议 (SIP) 信号 514 向终端 502 通知 QoS 不足。可替换地, PDG 502 处的 PQMF 和终端 504 可以使用定制协议彼此直接通信, 以向终端 502 通知需要执行切换。

由网络控制的 PQMF 实现的另一个实例可以包括使用毫微微蜂窝基站 (femtocell) 代替 WLAN AP。毫微微蜂窝基站可以配置为执行 PQMF 过程、与 PQMF 服务器交换 PQMF 分组。毫微微蜂窝基站服务器然后将发起终端的切换。

图 6 示出了用于确定通信链路路径质量的示例性装置。要注意, 装置 600 可被配置为通信终端或设备、或者在通信终端、设备或 AP 中使用的处理器或类似设备。如图所示, 该装置包括模块 602, 用于配置一个或多个第一分组以使其与需要进行质量确定的分组类型具有共有的特性。

经由总线 604 或类似的通信耦合, 将第一分组传递到模块 606, 模块 606 用于在到服务器 (即图 6 中所示的 PQMF 服务器) 的通信链路上传输一个或多个第一分组。如前所述, PQMF 服务器返回一个或多个第二分组,

模块 608 接收该第二分组。然后模块 610 评估所接收的第二分组的特性，以便基于所接收的第二分组的特性确定通信链路的质量。装置 600 还可以包括模块 612，用于发起或触发该装置从与诸如 WLAN 的当前网络的连接切换到诸如 WAN 的另一个网络。此外，在装置 600 被配置为通信终端而非处理器的情况下，装置 600 可选地可以包括处理器 614。在这种情况下，处理器 614 可以实现由这些模块所执行的过程的发起或调度。并且装置 600 还可以包括可选的计算机可读介质或存储器 616，用于存储计算机可读指令和数据，该指令和数据用于实现本文所公开的模块或处理器（在装置 600 被配置为终端的情况下）或方法的过程和行为。

应该理解，上述过程中任意步骤的特定次序或层次只是示例性方法的一个例子。应该理解，根据设计要求，在不超出本发明的范围的情况下，可重新安排过程中步骤的特定次序或层次。方法权利要求以示例性的次序表述了各个步骤的要素，但并不是要限制于所表述的特定次序或层次。

本领域技术人员应当理解，信息和信号可以使用多种不同的技术和方法来表示。例如，在整个说明书中提及的数据、指令、命令、信息、信号、比特、符号和码片可以用电压、电流、电磁波、磁场或粒子、光场或粒子或者其任意组合来表示。

本领域技术人员还应当明白，结合本申请的实施例描述的各种示例性的逻辑框、模块、电路和算法步骤中的任意一个可以实现成电子硬件、计算机软件或二者的组合。为了清楚地表示硬件和软件之间的可交换性，上文对各种示例性的部件、方框、模块、电路和步骤均围绕其功能进行了总体描述。至于这种功能是实现成硬件还是实现成软件，取决于特定的应用和对整个系统所施加的设计约束条件。本领域普通技术人员可以针对每个特定应用，以变通的方式实现所描述的功能，但是，这种实现决策不应解释为背离本发明的保护范围。

可以用通用处理器、数字信号处理器（DSP）、专用集成电路（ASIC）、现场可编程门阵列（FPGA）或其它可编程逻辑设备、分立门或者晶体管逻辑器件、分立硬件组件或设计用于执行本文所述的功能的上述任意组合来实现或执行结合本申请的实施例所描述的各种示例性的逻辑框、模块和电路。通用处理器可以是微处理器，可替换地，通用处理器也可以是任何常

规的处理器、控制器、微控制器或者状态机。处理器也可以实现为计算设备的组合，例如，DSP 和微处理器的组合、多个微处理器、一个或多个微处理器与 DSP 内核的结合，或者任何其它此种结构。

结合本申请的实施例所描述的方法或者算法的步骤可直接体现为硬件、由处理器执行的软件模块或其组合。软件模块可以位于 RAM 存储器、闪存、ROM 存储器、EPROM 存储器、EEPROM 存储器、寄存器、硬盘、移动磁盘、CD-ROM 或者本领域熟知的任何其它形式的存储介质中。一种示例性的存储介质（未示出）耦合至处理器，从而使处理器能够从该存储介质读取信息，且可向该存储介质写入信息。可替换地，存储介质可以是处理器的组成部分。处理器和存储介质可以位于 ASIC 中。该 ASIC 可以位于用户终端中。当然，处理器和存储介质也可以作为分立组件存在于用户终端中。

以上所述的实例仅仅是示例性的，并且本领域的熟练技术人员可以从上述的实例出发，在不脱离本发明所公开的发明性概念的前提下，做出各种使用。本领域的熟练技术人员可以容易地想到对于这些实例的各种修改，并且在不脱离本发明所公开的发明性概念的精神和范围的前提下，本文所定义的通用原理可以适用于其它实例，例如，在即时消息服务或任意通用无线数据通信应用的实例中。因此，本公开的范围并非意图限于本文所示的实例，而是要符合与此处公开的原理和新颖性特征相一致的最宽范围。要注意，本文所专门使用的词语“示例性的”意味着“作为实例、例子、例证”。本文所述的任意“示例性的”实例不一定解释为优选于或优于其它实例。因此，本文所述的新颖方面的范围仅是由附属的权利要求所定义的。

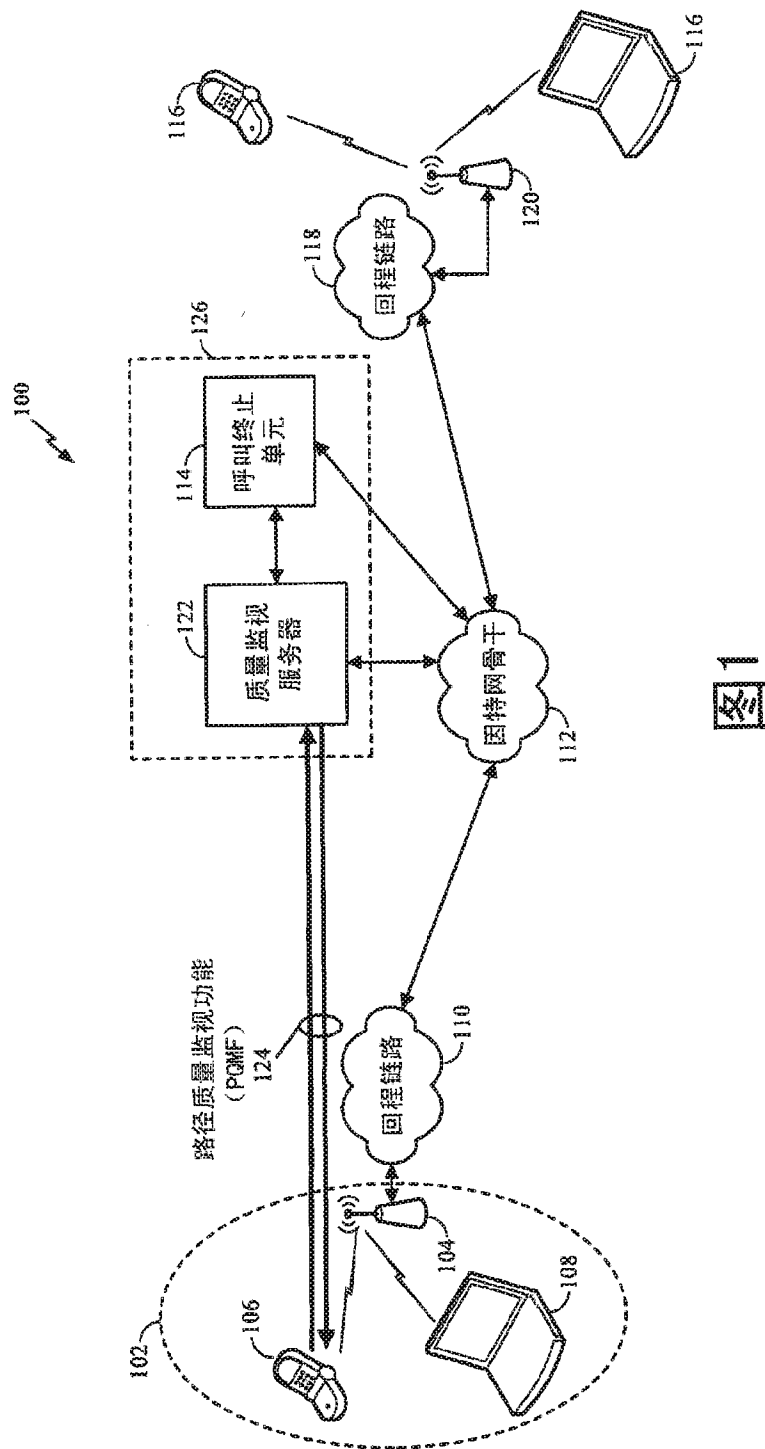


图1

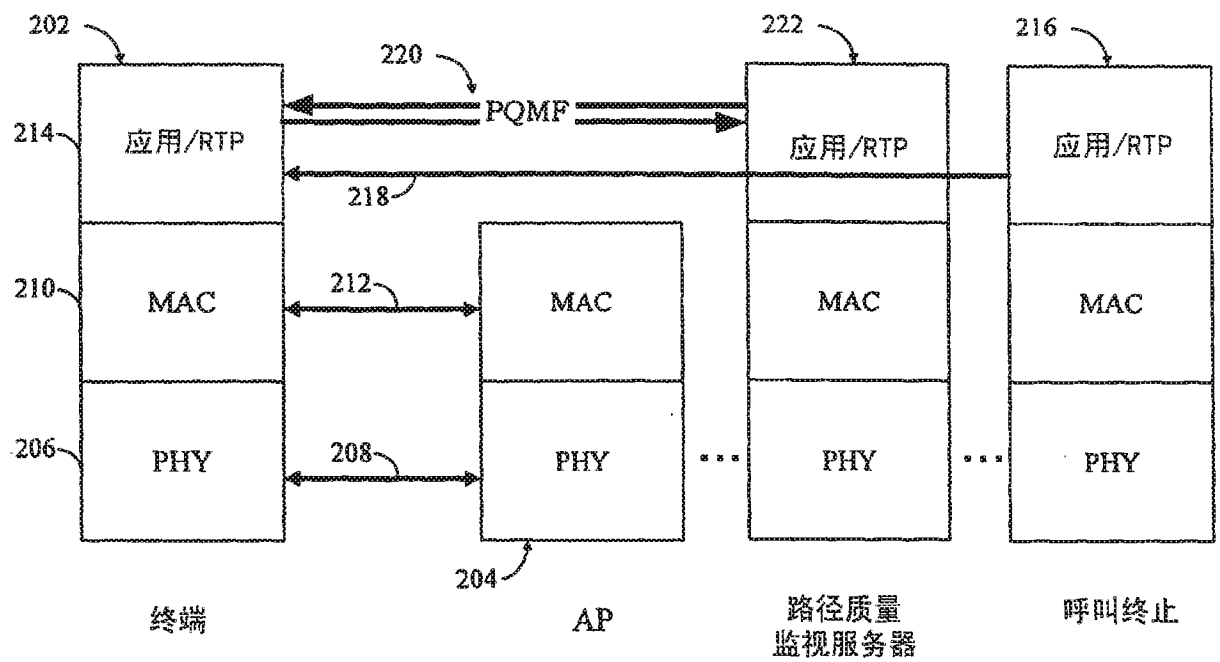


图2

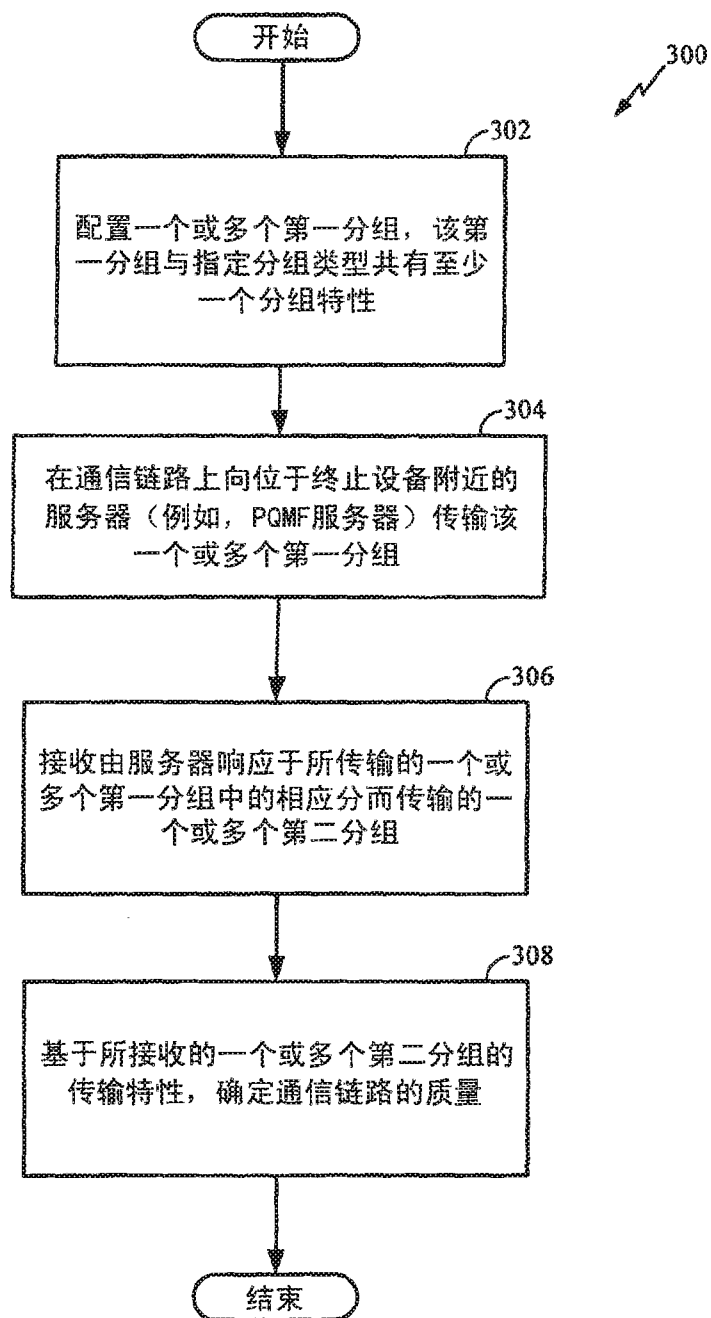


图3

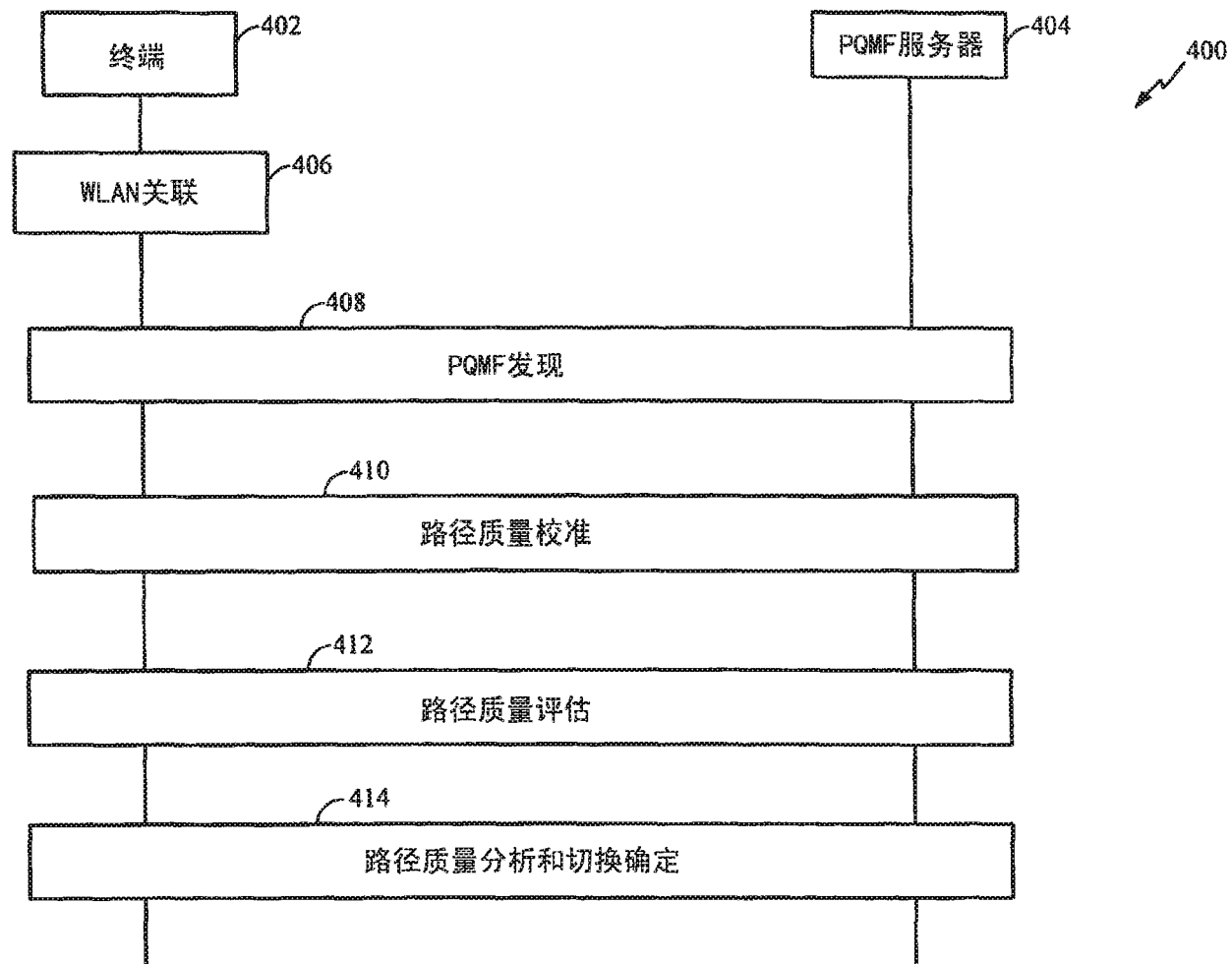


图4

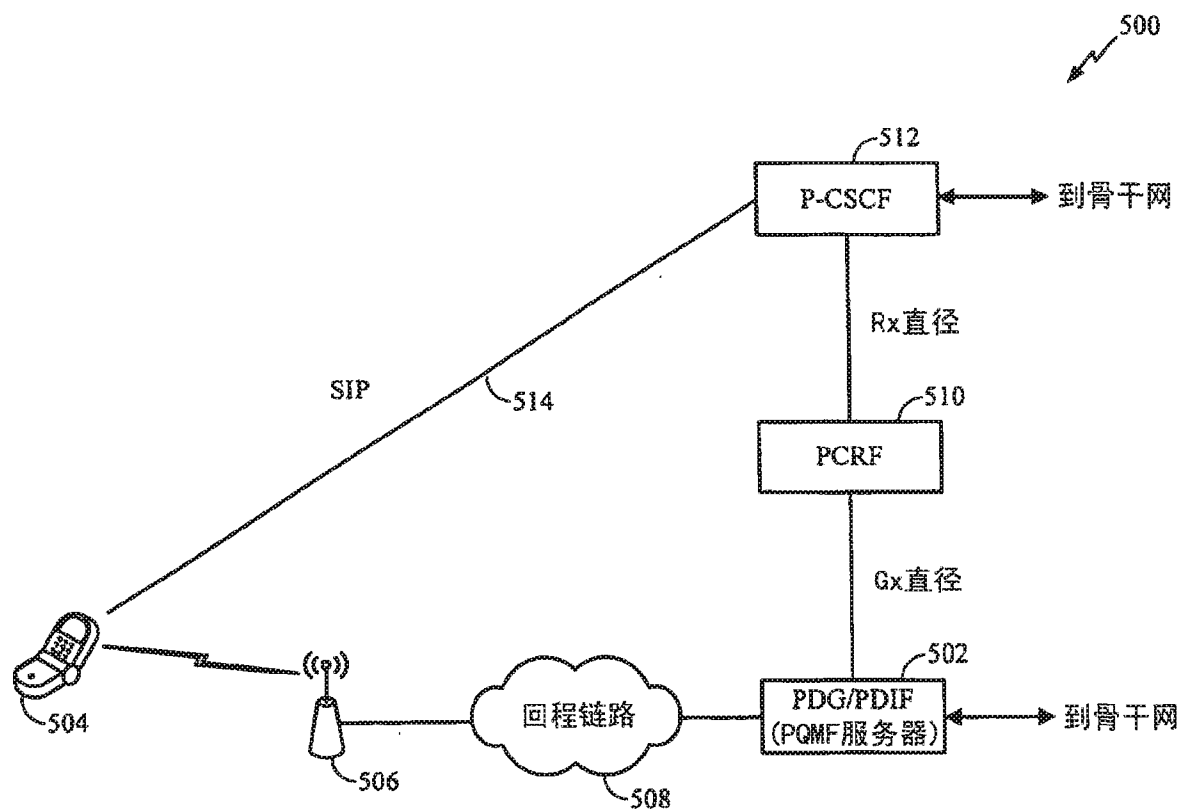


图5

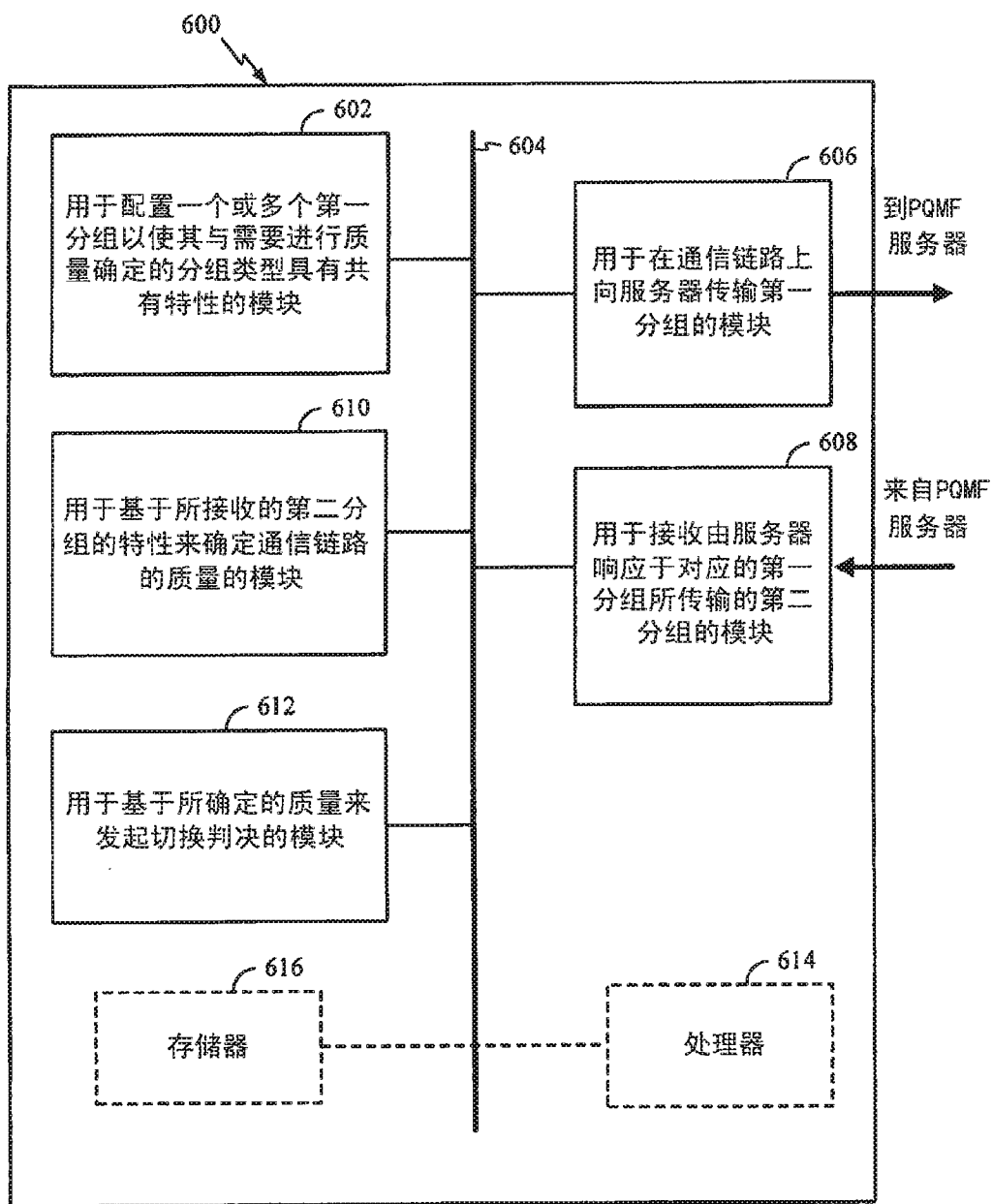


图6



Espacenet

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Mobile terminal device and wandering method thereof

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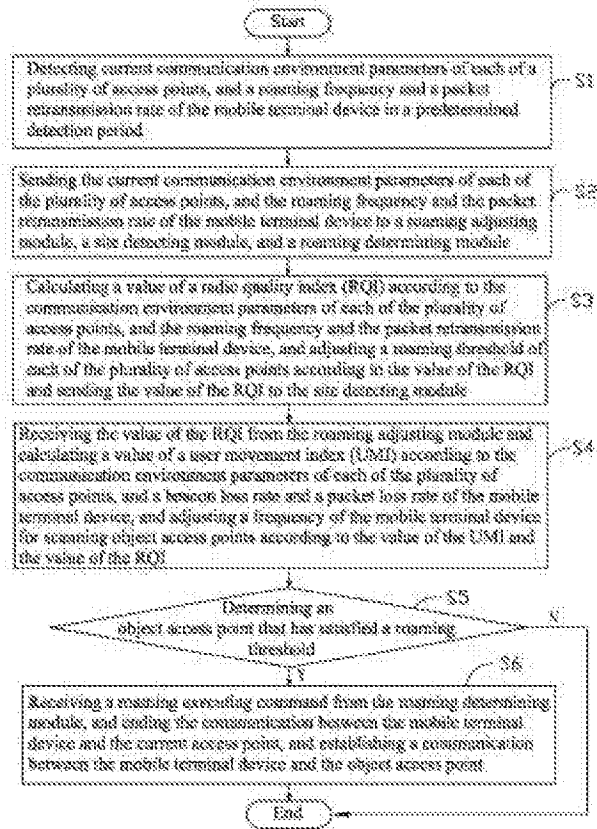
Priority number (s): CN200810302155 20080616

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Abstract of CN101610558 (A)

The invention relates to a mobile terminal device comprising a detection module, a wandering adjusting module, a position-sensing module, a wandering deciding module and a wandering executing module. The detection module detects prior communication environmental parameters of a plurality of base stations and a wandering frequency and an encapsulation-sending failure rate of the mobile terminal device; the wandering adjusting module receives the prior communication environmental parameters and the wandering frequency and the encapsulation-sending failure rate of the mobile terminal device and calculates an RQI; the position-sensing module calculates a UM1 according to the RQI and adjusts the frequency of the mobile terminal device for scanning destination base stations according to the UM1; the wandering deciding module receives the UM1 and judges whether a destination base station satisfying wandering conditions corresponding to the UMI exists or not; and the wandering executing module is used for receiving a wandering executing command, breaking up the communication between the mobile terminal device and the prior base station and establishing the communication between the mobile terminal device and the destination base station. The invention also provides a wandering method of the mobile terminal device. The

device and the method reduce the energy source consumption of the mobile terminal device in the wandering process.



Notice

This translation is machine-generated. It cannot be guaranteed that it is intelligible, accurate, complete, reliable or fit for specific purposes. Critical decisions, such as commercially relevant or financial decisions, should not be based on machine-translation output.

DESCRIPTION CN101610558

A mobile terminal device includes a detection module detecting a current communication environment parameter of a plurality of base stations and a roaming frequency of the mobile terminal device and a packet transmission failure rate; the roaming adjustment module receives the current communication environment parameter and the roaming frequency of the mobile terminal device and the packet transmission The failure rate calculates the RQI; the location detection module calculates the UMI according to the RQI, and adjusts the frequency of the mobile terminal device scanning the target base station according to the UMI; the roaming decision module receives the UMI, and determines whether there is a target that satisfies the roaming condition corresponding to the UMI. The base station, the roaming execution module is configured to receive the roaming execution command, disconnect the communication between the mobile terminal device and the current base station, and establish communication between the mobile terminal device and the target base station. The present invention also provides a method for roaming a mobile terminal device, which reduces energy consumption during roaming of the mobile terminal device.

Mobile terminal device and roaming method thereof

Technical field

The present invention relates to a mobile terminal device, and more particularly to a mobile terminal device roaming using communication environment parameters of a plurality of base stations and a roaming method thereof.

Background technique

With the widespread application of base stations, mobile terminal devices can access the Internet by establishing a connection with a wireless local area network (Access Point, AP). Generally, each base station can be connected to a certain number of wireless terminal devices. When the base station's Receive Signal Strength Indication (RSSI) is weakened or the current network congestion becomes severe, the base station and the base station are The connection of the mobile terminal device is interrupted, thereby interrupting the transmission of data. In order to prevent the interruption of the transmission of data due to the interruption of the connection, the mobile terminal device usually roams from the current base station to a target base station that is better than the current base station.

In the prior art, the mobile terminal device generally selects a base station with a stronger RSSI than the current base station and a better network quality than the current network as a roaming target, and the mobile terminal device continuously scans the target base station at a fixed frequency during the roaming process. Choosing a better base station as a target for roaming, but constantly scanning at a fixed frequency can result in rapid consumption of power to the mobile terminal device.

Summary of the invention

In view of the above, the present invention provides a mobile terminal device capable of saving power consumption and a roaming method thereof.

A mobile terminal device for roaming from a current base station to a target base station according to communication environment parameters of a plurality of base stations, where the mobile terminal device includes:

a detecting module, configured to detect, in a predetermined detection time, a current communication environment parameter of the plurality of base stations, a roaming frequency of the mobile terminal device, and a packet transmission failure rate;

a roaming adjustment module, configured to receive a current communication environment parameter of the plurality of base stations, a roaming frequency of the mobile terminal device, and a packet transmission failure rate, and calculate a Radio Quality Index (RQI) value, and according to the The RQI value adjusts a roaming threshold of the current base station;

a location detection module, configured to receive an RQI value of the roaming adjustment module, calculate a User Movement Index (UMI) value, and adjust, according to the UMI value, the mobile terminal device to scan a target base station frequency;

a roaming determining module, configured to receive, by the detecting module, a current communication environment parameter of the plurality of base stations, a roaming frequency of the mobile terminal device, and a packet transmission failure rate, and receive the a UMI value, and a target base station for determining whether a roaming condition corresponding to the UMI value is met; and

a roaming execution module, configured to: when the roaming determination module determines that there is a target base station that satisfies a roaming condition corresponding to the UMI value, receive a roaming execution command sent by the roaming determining module and a receiving signal of the target base station a Received Signal Strength Indication (RSSI) value, disconnecting the mobile terminal device from communication with the current base station, and establishing communication between the mobile terminal device and the target base station.

A roaming method applied to the mobile terminal device includes the following steps:

The detecting module detects a current communication environment parameter of the base station area, a roaming frequency of the mobile terminal device, and a packet transmission failure rate in a predetermined detection time;

The detecting module sends a current communication environment parameter of the base station area, a roaming frequency of the mobile terminal device, and a packet transmission failure rate to the roaming adjustment module and the roaming decision module;

The roaming adjustment module obtains a Radio Quality Index (RQI) value by calculating a current communication environment parameter of the base station area, and adjusts a roaming threshold value of the current base station according to the RQI value, and a sending station. Deriving the RQI value to the position detecting module;

The location detection module receives an RQI value of the roaming adjustment module, and calculates a User Movement Index (UMI) value according to the RQI value, and adjusts the mobile terminal device scan according to the UMI value. The frequency of the target base station;

The roaming decision module determines whether there is a target base station that satisfies a roaming condition corresponding to the UMI value; and

If there is a target base station that satisfies the roaming condition, the roaming execution module receives a Received Signal Strength Indication (RSSI) value of the target base station of the roaming execution command sent by the roaming decision module, and disconnects the The communication between the mobile terminal device and the base station is established, and communication between the mobile terminal device and the target base station is established, and if there is no target base station that satisfies the roaming condition corresponding to the UMI value, the operation ends.

Compared with the prior art, the mobile terminal device and the method for roaming by using the communication environment parameters of the plurality of base stations, the location detecting module, according to the UMI value, adjusting the frequency at which the mobile terminal device scans the target base station, The roaming decision module enables the mobile terminal device to successfully roam to the target base station according to whether there is a target base station that satisfies the roaming condition corresponding to the UMI value, and the mobile terminal device according to the user during the roaming process The mobile state automatically adjusts the frequency of scanning the target base station in real time, and reduces the energy consumption during the roaming process of the mobile terminal device by adjusting the scanning frequency.

DRAWINGS

The present invention will be further described in detail below with reference to the accompanying drawings in conjunction with the preferred embodiments.

FIG. 1 is a schematic diagram of communication between a preferred embodiment of a mobile terminal device and a base station according to the present invention.

2 is a block diagram of a preferred embodiment of a mobile terminal device of the present invention.

3 is a flow chart of a preferred embodiment of a method for roaming the mobile terminal device of FIG. 1.

Referring to FIG. 1, a preferred embodiment of the mobile terminal device 200 of the present invention is applied to a base station area 100. The base station area 100 includes a number of base stations, such as base stations 110, 120, 130, ... In this embodiment, the mobile terminal device 200 and the base stations 110, 120, 130, ... are devices conforming to the WiFi standard of the Institute of Electrical and Electronics Engineers (IEEE) 802.11. The mobile terminal device 200 and the base station 110, 120, 130, ... may also be devices that comply with other standards.

In this implementation manner, the mobile terminal device 200 communicates with the base station 110, when the communication environment in which the base station 110 is located gradually deteriorates to prevent the mobile terminal device 200 from being always in the WiFi network. The mobile terminal device 200 interrupts the communication connection with the base station 110. At this time, the mobile terminal device 200 needs to roam from the base station 110 to another base station such as the base stations 120, 130, ... In order to keep the mobile terminal device 200 in the WiFi network.

Referring to FIG. 2, the mobile terminal device 200 includes a detection module 210, a roaming adjustment module 220, a bit detection module 230, a roaming decision module 240, and a roaming execution module 250. The various modules in the mobile terminal device 200 can be constructed by a computer program or circuitry.

The detecting module 210 is configured to detect a communication environment condition of an environment where the mobile terminal device 200 is located within a predetermined detection time, where the communication environment condition includes a current communication environment parameter of the base station area 100 and roaming of the mobile terminal device 200. Frequency and packet transmission failure rate. The current communication environment parameter of the base station area 100 includes a quality of service basic service set (QBSS) of the basic service unit of the base station area 100 and a received signal strength indicator of the base station area 100 (Received Signal) Strength Indication, RSSI) Rate of change. The QBSS of the base station area 100 identifies the current channel utilization rate of each base station and the load amount of each base station. The larger the value of the QBSS, the smaller the utilization rate of the current channel of each base station is. The greater the load per base station, that is, the worse the quality of service of the base station area 100. The RSSI change rate of the base station area 100 is the amount of change of the base station area 100 during the detection time, and identifies the working stability of each base station. The larger the RSSI value, the higher the service quality of each base station. it is good. The roaming frequency of the mobile terminal device 200 is that the detecting module 210 detects the number of times the mobile terminal device 200 roams during the system working time within a predetermined detection time, and the roaming frequency of the mobile terminal device 200 identifies the mobile terminal The stability of the communication connection between the device 200 and the base station area 100, the higher the roaming frequency of the mobile terminal device 200, the worse the

communication connection stability of the mobile terminal device 200 and the base station area 100 is. The packet transmission failure rate of the mobile terminal device 200 is the number of times the packet transmission fails during the voice operation time, and the communication between the mobile terminal device 200 and the base station (in the present embodiment, the base station 110) corresponding to the communication is identified. The connection stability is higher, and the higher the packet transmission failure rate of the mobile terminal device 200, the worse the communication connection stability of the mobile terminal device 200 and the base station 110 is. The detection time, the system operation time, and the voice operation time may be set to the same value or different values according to actual needs.

The roaming adjustment module 220 is configured to receive a current communication environment parameter of the base station area 100 and a roaming frequency and a packet transmission failure rate of the mobile terminal device 200, and calculate a radio quality indicator. A (Radio Quality Index, RQI) value, and a roaming threshold (Roaming Threshold) of the base station in communication with the mobile terminal device 200 is adjusted based on the calculated RQI value. In this embodiment, the roaming adjustment module 220 obtains an RQI value by using an operation formula.

The calculation formula of the RQI value is:

$$RQI = \text{Max_RQI} - iRQI, (1)$$

Where the maximum RQI is the default value, and

$$iRQI = (((\text{Avg_QBSS} \div \text{Max_QBSS}) * \text{Max_RQI}) * 0.5) +$$

$$(((\text{Roam_Freq} \div \text{Max_Freq}) * \text{Max_RQI}) * 0.2) +$$

$$(((\text{Retx_Rate} \div \text{Max_Retx_Rate}) * \text{Max_RQI}) * 0.2) +$$

$$(((\text{Avg_RSSI_Variance} \div \text{Max_RSSI_Variance}) * \text{Max_RQI}) * 0.1).$$

(2)

among them,

Max_RQI: maximum value of RQI;

Max_QBSS: QBSS maximum;

Avg_QBSS: QBSS average;

Max_Freq: the maximum number of roaming times;

Roam_Freq: the number of current roamings of the mobile terminal device 200;

Max_Retx_Rate: the maximum packet transmission failure rate;

Retx_Rate: current packet transmission failure rate of the mobile terminal device 200;

Max_RSSI_Variance: the maximum value of the RSSI change rate of the base station area 100;

Avg_RSSI_Variance: The average of the RSSI rate of change of the base station area 100.

The value of Max_RQI is preset to 100, the value of Max_QBSS is preset to 100, and Avg_QBSS is the average value of QBSS of all base stations in the base station area 100. Max_Freq is the maximum number of times the mobile terminal device 200 is roaming during the system operating time. Roam_Freq detects, for the detection module 210, the number of actual current roamings of the mobile terminal device 200 during the system operating time within a predetermined detection time. Max_Retx_Rate is the maximum packet transmission failure rate of the mobile terminal device 200 during the voice job time. The Retx_Rate detects, for the detection module 210, the actual current packet transmission failure rate of the mobile terminal device 200 during the voice working time within a predetermined detection time.

Max_RSSI_Variance is the maximum value of the rate of change of the RSSI of the base station area 100 within the detection time.

The Avg_RSSI_Variance is an average value of the RSSI change rate of the base station area 100 detected by the detecting module 210 within a predetermined detection time.

In this embodiment, different RQI values identify different communication environment states, including a normal state, a high traffic state, and an interference state (or a severe interference state). The two preset values 40, 70 are preset in the roaming adjustment module 220. If the RQI value is greater than or equal to the preset value 70, the communication environment state of the base station area 100 is in a normal state, and the communication environment quality is normal; If the RQI value is greater than or equal to the preset value 40 and less than the preset value 70, the communication environment state of the base station area 100 is in a high traffic state, and the communication environment quality is relatively poor; if the RQI value is less than the preset value 40 The communication environment state of the base station area 100 is in an interference state, and the communication environment quality is even worse. More or less communication environment quality states may be distinguished according to the RQI value, and the threshold values of the various communication environment quality states are not limited to the preset values 40 and 70, and different values may be set according to actual needs.

In this implementation manner, the roaming adjustment module 220 may adjust a roaming threshold value of the base station area 100 that is in communication with the mobile terminal device 200 according to an RQI value. If the RQI value is less than 70, the roaming adjustment module 220 increases the roaming threshold of the base station 110 in communication with the mobile terminal device 200. The smaller the RQI value, the higher the roaming threshold will be adjusted. The roaming threshold value includes a difference between a target base station of the mobile terminal device 200 after roaming and an RSSI of the base station 110 currently communicating with the mobile terminal device 200, and a difference between QBSS.

The location detecting module 230 is configured to find an alternate target base station for the mobile terminal device 200 when the mobile terminal device 200 communicates with the base station 110, when the mobile terminal device 200 and the base station 110 communication is interrupted to enable the mobile terminal device 200 to quickly roam to the alternate target base station. The location detection module 230 calculates a User Movement Index (UMI) value according to the RQI value of the roaming adjustment module 220, and adjusts the mobile terminal device 200 to scan the target base station according to the UMI value. frequency.

In this embodiment, different UMI values identify different user movement states, and the user movement states include a stationary state, a walking state, and a running state. If the user moves to the quiescent state, the

communication signal between the mobile terminal device 200 and the base station region 100 is stable, and the standby target base station can be found by shortening the scanning frequency, that is, expanding the scanning interval, and if the user moves to the walking state, Because the user moves at a speed that is not fast, the communication signal of the mobile terminal device 200 and the base station area 100 does not rapidly decrease, and the scan frequency can be adjusted between the scanning frequency of the stationary state and the scanning frequency of the running state. If the user moves to the running state, because the user moves quickly, the communication signal of the mobile terminal device 200 and the base station area 100 is rapidly weakened or even interrupted, and the mobile terminal device 200 needs to quickly find a backup. The target base station can therefore set a higher scanning frequency to cause the mobile terminal device 200 to quickly roam to the target base station. Since the above three states use different scanning frequencies, and the prior art uses only one fixed frequency scanning, the present invention can effectively save power.

The roaming decision module 240 is configured to receive the current communication environment parameter of the base station area 100 and the roaming frequency of the mobile terminal device 200, and receive the UMI sent by the location detecting module 230. The roaming decision module 240 is configured to determine whether there is a target base station that satisfies the roaming condition corresponding to the UMI value, and if there is a target base station that satisfies the roaming condition corresponding to the UMI, the roaming decision module Sending a roaming execution command to the roaming execution module 250, notifying the roaming execution module 250 to establish a connection with the target base station; if there is no target base station that satisfies the roaming condition corresponding to the UMI value, ending the operation .

The roaming execution module 250 is configured to receive the roaming execution command sent by the roaming decision module 240 and the RSSI of the base station area 100, disconnect the mobile terminal device 200 from the base station 110, and establish a The communication of the mobile terminal device 200 with the target base station.

3 is a preferred embodiment of the method for communicating the mobile terminal device 200 and the base station in FIG. 2, including the following steps:

Step S1: The detecting module 210 detects a current communication environment parameter of the base station area 100 and a roaming frequency and a packet transmission failure rate of the mobile terminal device 200 within a predetermined detection time.

Step S2: The detecting module 210 sends the current communication environment parameter of the base station area 100, the roaming frequency of the mobile terminal device 200, and the packet transmission failure rate to the roaming adjustment module 220 and the roaming decision module 240.

Step S3: The roaming adjustment module 220 obtains an RQI value by calculating a current communication environment of all the base stations, and adjusts a roaming threshold value of the base station area 100 according to the RQI value, and sends the RQI value to the The position detection module 230 is described.

Step S4: The location detecting module 230 receives the RQI value of the roaming adjustment module 220, calculates a user mobility index UMI value according to the RQI value, and adjusts the scanning target of the mobile terminal device 200 according to the UMI value. The frequency of the base station.

Step S5: The roaming decision module 240 determines whether there is a target base station that satisfies the roaming condition corresponding to the UMI value.

Step S6: If there is a target base station that satisfies the roaming condition corresponding to the UMI, the roaming execution module 250 receives the roaming execution command sent by the roaming decision module, and disconnects the mobile terminal device 200 from the base. The communication of the station 110 establishes communication between the mobile terminal device 200 and the target base station, and if there is no target base station that satisfies the roaming condition corresponding to the UMI value, the operation ends.

The mobile terminal device 200 and the method for roaming by using the communication environment parameters of the plurality of base stations, by adjusting the frequency of the mobile terminal device 200 scanning the target base station, the mobile terminal device 200 can successfully roam to the target base station, The mobile terminal device automatically adjusts the frequency of scanning the target base station in real time according to the mobile state of the user during the roaming process, and reduces the energy consumption during the roaming process of the mobile terminal device by adjusting the scanning frequency.

Notice

This translation is machine-generated. It cannot be guaranteed that it is intelligible, accurate, complete, reliable or fit for specific purposes. Critical decisions, such as commercially relevant or financial decisions, should not be based on machine-translation output.

CLAIMS CN101610558

1.

A mobile terminal device for roaming from a current base station to a target base station according to communication environment parameters of a plurality of base stations, where the mobile terminal device includes:

a detecting module, configured to detect, in a predetermined detection time, a current communication environment parameter of the plurality of base stations, a roaming frequency of the mobile terminal device, and a packet transmission failure rate;

a roaming adjustment module, configured to receive a current communication environment parameter of the plurality of base stations, a roaming frequency of the mobile terminal device, and a packet transmission failure rate, and calculate a Radio Quality Index (RQI) value, and according to the RQI value adjust a roaming threshold of the current base station;

a location detection module, configured to receive an RQI value of the roaming adjustment module, calculate a User Movement Index (UMI) value, and adjust, according to the UMI value, the mobile terminal device to scan a target base station frequency;

a roaming determining module, configured to receive, by the detecting module, a current communication environment parameter of the plurality of base stations, a roaming frequency of the mobile terminal device, and a packet transmission failure rate, and receive the a UMI value, and a target base station for determining whether a

roaming condition corresponding to the UMI value is met; and

a roaming execution module, configured to: when the roaming determination module determines that there is a target base station that satisfies a roaming condition corresponding to the UMI value, receive a roaming execution command sent by the roaming determining module and a receiving signal of the target base station a Received Signal Strength Indication (RSSI) value, disconnecting the mobile terminal device from communication with the current base station, and establishing communication between the mobile terminal device and the target base station.

2.

The mobile terminal device according to claim 1, wherein the current communication environment parameters of the plurality of base stations comprise a quality of service basic service set (QBSS) value of the basic service unit of the plurality of base stations and The RSSI change rate of the plurality of base stations, the QBSS of the plurality of base stations identifying the utilization rate of the channel of each base station and the load amount of each base station, and the RSSI change rate is the each base station in the The amount of change during the detection time is used to identify the operational stability of each base station.

3.

The mobile terminal device according to claim 1, wherein the roaming frequency of the mobile terminal device is that the detecting module detects that the mobile terminal device is within a system working time of the mobile terminal device within a predetermined detection time. The number of roamings, the roaming frequency of the mobile terminal device identifies the communication stability of the mobile terminal device and the current base station, and the higher the roaming frequency of the mobile terminal device, the mobile terminal device and the current base station The worse the communication stability.

4.

The mobile terminal device according to claim 1, wherein the packet transmission failure rate of the mobile terminal device is the number of times the packet transmission fails during the voice operation time, and the current base station that identifies the mobile terminal device to communicate with it Communication stability.

5.

The mobile terminal device according to claim 1, wherein the RQI value is calculated as:

$$RQI = \text{Max_RQI} - iRQI,$$

(1)

$$iRQI = (((Avg_QBSS \div Max_QBSS) * Max_RQI) * 0.5) +$$
$$(((Roam_Freq \div Max_Freq) * Max_RQI) * 0.2) +$$
$$(((Retx_Rate \div Max_Retx_Rate) * Max_RQI) * 0.2) +$$
$$(((Avg_RSSI_Variance \div Max_RSSI_Variance) * Max_RQI) * 0.1), (2)$$

among them,

Max_RQI=100;

Max_QBSS=100;

Max_RQI: maximum value of RQI;

Max_QBSS: QBSS maximum;

Avg_QBSS: QBSS average;

Max_Freq: the maximum number of roaming times;

Roam_Freq: the number of current roaming of the mobile terminal device;

Max_Retx_Rate: the maximum packet transmission failure rate;

Retx_Rate: the current packet transmission failure rate of the mobile terminal device;

Max_RSSI_Variance: the maximum value of the RSSI change rate of the base station area;

Avg_RSSI_Variance: The average of the RSSI rate of change for the base station area.

6.

The mobile terminal device according to claim 5, wherein said different RQI values identify different communication environment states, and said communication environment states include a normal state, a high traffic state, and an interference state.

7.

The mobile terminal device according to claim 6, wherein the roaming adjustment module presets a first preset value and a second preset value, and the first preset value is greater than the second preset a value, if the RQI value is greater than or equal to the first preset value, the communication environment state of the current base station is in a normal state, and the communication environment quality is normal; if the RQI value is greater than or equal to a second preset value And being less than the first preset value, the communication environment state of the current base station is in a high traffic state, and the communication environment quality is relatively poor; if the RQI value is less than the second preset value, the current base station The communication environment state is in an interference state, and the communication environment quality is very poor.

8.

The mobile terminal device according to claim 1, wherein the roaming threshold value comprises a difference between the target base station of the mobile terminal device after roaming and an RSSI of the current base station, and a basic service unit The difference in Quality of Service Basic Service Set (QBSS).

9.

A roaming method applied to the mobile terminal device of claim 1, comprising the steps of:

The detecting module detects a current communication environment parameter of the base station area, a roaming frequency of the mobile terminal device, and a packet transmission failure rate in a predetermined detection time;

The detecting module sends a current communication environment parameter of the base station area, a roaming frequency of the mobile terminal device, and a packet transmission failure rate to the roaming adjustment module and the roaming decision module;

The roaming adjustment module obtains a Radio Quality Index (RQI) value by calculating current communication environment parameters of all base stations, and adjusts a roaming threshold value of the base station area according to the RQI value, and a sending station. Deriving the RQI value to the position detecting module;

The location detection module receives the RQI value of the roaming adjustment module, calculates a User Movement Index (UMI) value according to the RQI value, and adjusts the mobile terminal device scanning target according to the UMI value. The frequency of the base station;

The roaming decision module determines whether there is a target base station that satisfies a roaming condition corresponding to the UMI value; and

If there is a target base station that satisfies the UMI value roaming condition, the roaming execution module receives a roaming execution command sent by the roaming decision module and a Received Signal Strength Indication (RSSI) of the target base station. And disconnecting the communication between the mobile terminal device and the base station, and establishing communication between the mobile terminal device and the target base station, if there is no target base station that satisfies the roaming condition corresponding to the UMI value, Then the operation ends.

10.

The method for roaming a mobile terminal device according to claim 9, wherein the current communication environment parameters of the plurality of base stations comprise quality of service of the basic service units of the plurality of base stations (Quality of Service Basic Service Set, QBSS) a value and an RSSI change rate of the plurality of base stations, the QBSS of the plurality of base stations identifying a utilization rate of a channel of each base station and a load amount of each base station, the RSSI change rate being the each base The amount of change of the station during the detection time identifies the operational stability of each base station.

11.

The method for roaming a mobile terminal device according to claim 9, wherein the roaming frequency of the

mobile terminal device is that the detecting module detects that the mobile terminal device is in the calling terminal device within a predetermined detection time. The number of times of roaming in the system operating time, the roaming frequency of the mobile terminal device identifies the communication stability of the mobile terminal device and the current base station, and the higher the roaming frequency of the mobile terminal device, the mobile terminal device The communication stability with the current base station is worse.

12.

The method for roaming a mobile terminal device according to claim 9, wherein the packet transmission failure rate of the mobile terminal device is a number of times the packet transmission fails during the voice operation time, and the mobile terminal device is identified to communicate with the corresponding The communication stability of the current base station.

13.

The method for roaming a mobile terminal device according to claim 9, wherein the calculation formula of the RQI value is:

$$RQI = \text{Max_RQI} - iRQI,$$

(1)

$$iRQI = (((\text{Avg_QBSS} \div \text{Max_QBSS}) * \text{Max_RQI}) * 0.5) +$$

$$(((\text{Roam_Freq} \div \text{Max_Freq}) * \text{Max_RQI}) * 0.2) +$$

$$(((\text{Retx_Rate} \div \text{Max_Retx_Rate}) * \text{Max_RQI}) * 0.2) +$$

$$(((\text{Avg_RSSI_Variance} \div \text{Max_RSSI_Variance}) * \text{Max_RQI}) * 0.1), (2)$$

among them,

$$\text{Max_RQI} = 100;$$

Max_QBSS=100;

Max_RQI: maximum value of RQI;

Max_QBSS: QBSS maximum;

Avg_QBSS: QBSS average;

Max_Freq: the maximum number of roaming times;

Roam_Freq: the number of current roaming of the mobile terminal device;

Max_Retx_Rate: the maximum packet transmission failure rate;

Retx_Rate: the current packet transmission failure rate of the mobile terminal device;

Max_RSSI_Variance: the maximum value of the RSSI change rate of the base station area;

Avg_RSSI_Variance: The average of the RSSI rate of change for the base station area.

14.

A method of roaming a mobile terminal device according to claim 13, wherein said different RQI values identify different communication environment states, and the communication environment states include a normal state, a high traffic state, and an interference state.

15.

The method for roaming a mobile terminal device according to claim 14, wherein the roaming adjustment module presets a first preset value and a second preset value, and the first preset value is greater than the a second

preset value, if the RQI value is greater than or equal to the first preset value, the communication environment state of the current base station is in a normal state, and the communication environment quality is normal; if the RQI value is greater than or equal to the second The preset value is smaller than the first preset value, the communication environment state of the current base station is in a high traffic state, and the communication environment quality is relatively poor; if the RQI value is less than the second preset value, the The communication environment status of the current base station is in an interference state, and the communication environment quality is very poor.

16.

The method for roaming a mobile terminal device according to claim 9, wherein the roaming threshold value includes a difference between an RSSI of the target base station and the current base station after the mobile terminal device roams The difference between the Quality of Service Basic Service Set (QBSS) of the basic service unit.

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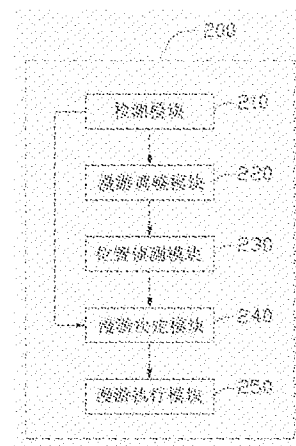
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移动终端设备及其漫游方法

[57] 摘要

一种移动终端设备,其包括检测模块检测若干基地台的当前通信环境参数及移动终端设备的漫游频率及封包发送失败率;漫游调整模块接收当前通信环境参数及移动终端设备的漫游频率及封包发送失败率,计算出 RQI;位置侦测模块根据 RQI 计算出 UMI,并根据 UMI 调整移动终端设备扫描目标基地台的频率;漫游决定模块接收 UMI,并判断是否有满足 UMI 相对应的漫游条件的目标基地台,漫游执行模块用于接收漫游执行命令,断开移动终端设备与当前基地台的通信,建立移动终端设备与目标基地台的通信。本发明还提供了一种移动终端设备漫游的方法,该设备及方法减少了移动终端设备漫游过程中的能源消耗。



【权利要求1】一种移动终端设备，用于根据若干基地台的通信环境参数从当前基地台漫游到目标基地台，所述移动终端设备包括：

检测模块，用于在预定检测时间内检测所述若干基地台的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率；

漫游调整模块，用于接收所述若干基地台的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率，并计算得出无线电质量指示（Radio Quality Index, RQI）值，及根据所述RQI值调整所述当前基地台的漫游门限值；

位置侦测模块，用于接收所述漫游调整模块的RQI值，并计算得出用户移动指数（User Movement Index, UMI）值，及根据所述UMI值调整所述移动终端设备扫描目标基地台的频率；

漫游决定模块，用于接收所述检测模块发送的所述若干基地台的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率，并接收所述位置侦测模块发送的所述UMI值，及判断是否有满足所述UMI值相对应的漫游条件的目标基地台；及

漫游执行模块，用于当所述漫游决定模块判断有满足所述UMI值相对应的漫游条件的目标基地台时，接收所述漫游决定模块发送的漫游执行命令及所述目标基地台的接收信号强度指示（Received Signal Strength Indication, RSSI）值，断开所述移动终端设备与所述当前基地台的通信，并建立所述移动终端设备与所述目标基地台的通信。

【权利要求2】如权利要求1所述的移动终端设备，其特征在于：所述若干基地台的当前通信环境参数包括所述若干基地台的基本服务单元的服务质量（Quality of service Basic Service Set, QBSS）值及所述若干基地台的RSSI变化率，所述若干基地台的QBSS标识每个基地台的信道的利用率及每个基地台的负载量，所述RSSI变化率为所述每个基地台在所述检测时间内的变化量，标识每个基地台的工作稳定度。

【权利要求3】如权利要求1所述的移动终端设备，其特征在于：所述移动终端设备的漫游频率为所述检测模块在预定检测时间内检测所述移动终端设备在所述移动终端设备

的系统作业时间内漫游的次数，所述移动终端设备的漫游频率标识所述移动终端设备与所述当前基地台的通信稳定度，所述移动终端设备的漫游频率越高，则所述移动终端设备与当前基地台的通信稳定度越差。

【权利要求4】如权利要求1所述的移动终端设备，其特征在于：所述移动终端设备的封包发送失败率为在语音作业时间内封包发送失败的次数，标识所述移动终端设备与其对应通信的当前基地台的通信稳定度。

【权利要求5】如权利要求1所述的移动终端设备，其特征在于：所述RQI值的计算公式为：

$$\begin{aligned} RQI &= \text{Max_RQI} - iRQI, \\ (1) \quad iRQI &= (((\text{Avg_QBSS} \div \text{Max_QBSS}) * \text{Max_RQI}) * 0.5) + \\ &(((\text{Roam_Freq} \div \text{Max_Freq}) * \text{Max_RQI}) * 0.2) + \\ &(((\text{Retx_Rate} \div \text{Max_Retx_Rate}) * \text{Max_RQI}) * 0.2) + \\ &(((\text{Avg_RSSI_Variance} \div \text{Max_RSSI_Variance}) * \text{Max_RQI}) * 0.1), \quad (2) \end{aligned}$$

其中，

Max_RQI=100；

Max_QBSS=100；

Max_RQI：RQI最大值；

Max_QBSS：QBSS最大值；

Avg_QBSS：QBSS平均值；

Max_Freq：最大的漫游次数限制；

Roam_Freq：移动终端设备的当前漫游的次数；

Max_Retx_Rate：最大的封包传送失败率；

Retx_Rate：移动终端设备的当前封包传送失败率；

Max_RSSI_Variance：基地台区域的RSSI变化率的最大值；

Avg_RSSI_Variance：基地台区域的RSSI变化率的平均值。

【权利要求6】如权利要求5所述的移动终端设备，其特征在于：所述不同的RQI值标识不同的通信环境状态，通信环境状态包括正常状态、高通信量状态及干扰状态。

【权利要求7】如权利要求6所述的移动终端设备，其特征在于：所述漫游调整模块预设一第一预设值及一第二预设值，且所述第一预设值大于所述第二预设值，若所述RQI

值大于或等于第一预设值，则所述当前基地台的通信环境状态处于正常状态，其通信环境质量正常；若所述RQI值大于或等于第二预设值，且小于第一预设值，则所述当前基地台的通信环境状态处于高通信量状态，其通信环境质量比较差；若所述RQI值小于第二预设值，则所述当前基地台的通信环境状态处于干扰状态，其通信环境质量非常差。

【权利要求8】如权利要求1所述的移动终端设备，其特征在于：所述漫游门限值包括所述移动终端设备漫游后的所述目标基地台与所述当前基地台的RSSI的差值及基本服务单元的服务质量（Quality of service Basic Service Set, QBSS）的差值。

【权利要求9】一种应用于权利要求1所述的移动终端设备的漫游方法，包括以下步骤：

所述检测模块在预定检测时间内检测所述基地台区域的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率；

所述检测模块发送所述基地台区域的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率至漫游调整模块及所述漫游决定模块；

所述漫游调整模块通过计算所有基地台的当前通信环境参数来获得无线电质量指示（Radio Quality Index, RQI）值，并根据所述RQI值调整所述基地台区域的漫游门限值，及发送所述RQI值给所述位置侦测模块；

所述位置侦测模块接收所述漫游调整模块的RQI值并根据所述RQI值计算得出用户移动指数（User Movement Index, UMI）值，并根据所述UMI值调整所述移动终端设备扫描目标基地台的频率；

所述漫游决定模块判断是否有满足所述UMI值相对应的漫游条件的目标基地台；及

若有满足所述UMI值漫游条件的目标基地台，则所述漫游执行模块接收所述漫游决定模块发送的漫游执行命令及所述目标基地台的接收信号强度指示（Received Signal Strength Indication, RSSI）值，断开所述移动终端设备与所述基地台的通信，并建立所述移动终端设备与所述目标基地台的通信，若没有满足所述UMI值相对应的漫游条件的目标基地台，则结束操作。

【权利要求10】如权利要求9所述的移动终端设备的漫游方法，其特征在于：所述若干基地台的当前通信环境参数包括所述若干基地台的基本服务单元的服务质量（Quality of service Basic Service Set, QBSS）值及所述若干基地台的RSSI变化率，所述若干基地台的QBSS标识每个基地台的信道的利用率及每个基地台的负载量，所述RSSI变化率为所述每个基地台在所述检测时间内的变化量，标识每个基地台的工作稳定度。

【权利要求11】如权利要求9所述的移动终端设备的漫游方法，其特征在于：所述移动终端设备的漫游频率为所述检测模块在预定检测时间内检测所述移动终端设备在所述移动终端设备的系统作业时间内漫游的次数，所述移动终端设备的漫游频率标识所述移动终端设备与所述当前基地台的通信稳定度，所述移动终端设备的漫游频率越高，则所述移动终端设备与当前基地台的通信稳定度越差。

【权利要求12】如权利要求9所述的移动终端设备的漫游方法，其特征在于：所述移动终端设备的封包发送失败率为在语音作业时间内封包发送失败的次数，标识所述移动终端设备与其对应通信的当前基地台的通信稳定度。

【权利要求13】如权利要求9所述的移动终端设备的漫游方法，其特征在于：所述RQI值的运算公式为：

$$\begin{aligned} RQI &= \text{Max_RQI} - iRQI, \\ (1) \quad iRQI &= (((\text{Avg_QBSS} \div \text{Max_QBSS}) * \text{Max_RQI}) * 0.5) + \\ &(((\text{Roam_Freq} \div \text{Max_Freq}) * \text{Max_RQI}) * 0.2) + \\ &(((\text{Retx_Rate} \div \text{Max_Retx_Rate}) * \text{Max_RQI}) * 0.2) + \\ &(((\text{Avg_RSSI_Variance} \div \text{Max_RSSI_Variance}) * \text{Max_RQI}) * 0.1), \quad (2) \end{aligned}$$

其中，

Max_RQI=100；

Max_QBSS=100；

Max_RQI：RQI最大值；

Max_QBSS：QBSS最大值；

Avg_QBSS：QBSS平均值；

Max_Freq：最大的漫游次数限制；

Roam_Freq：移动终端设备的当前漫游的次数；

Max_Retx_Rate：最大的封包传送失败率；

Retx_Rate：移动终端设备的当前封包传送失败率；

Max_RSSI_Variance：基地台区域的RSSI变化率的最大值；

Avg_RSSI_Variance：基地台区域的RSSI变化率的平均值。

【权利要求14】如权利要求13所述的移动终端设备的漫游方法，其特征在于：所述不同的RQI值标识不同的通信环境状态，通信环境状态包括正常状态、高通信量状态及干

扰状态。

【权利要求15】如权利要求14所述的移动终端设备的漫游方法，其特征在于：所述漫游调整模块预设一第一预设值及一第二预设值，且所述第一预设值大于所述第二预设值，若所述RQI值大于或等于第一预设值，则所述当前基地台的通信环境状态处于正常状态，其通信环境质量正常；若所述RQI值大于或等于第二预设值，且小于第一预设值，则所述当前基地台的通信环境状态处于高通信量状态，其通信环境质量比较差；若所述RQI值小于第二预设值，则所述当前基地台的通信环境状态处于干扰状态，其通信环境质量非常差。

【权利要求16】如权利要求9所述的移动终端设备的漫游方法，其特征在于：所述漫游门限值包括所述移动终端设备漫游后的所述目标基地台与所述当前基地台的RSSI的差值及基本服务单元的服务质量（Quality of service Basic Service Set, QBSS）的差值。

移动终端设备及其漫游方法

技术领域

本发明涉及一种移动终端设备，尤其涉及一种利用若干基地台的通信环境参数来漫游的移动终端设备及其漫游方法。

背景技术

随着基地台的普遍应用，移动终端设备可通过与无线局域网络基地台（Access Point, AP）建立连接来实现上网。通常每一个基地台可与一定数量的无线终端设备进行连接，当基地台的接收信号强度指示（Receive Signal Strength Indication, RSSI）变弱或当前网络的阻塞变得严重时，就会导致基地台与移动终端设备的连接中断，从而会中断数据的传送。为了防止因连接中断而导致数据的传送的中断，移动终端设备通常会从当前基地台漫游到比当前基地台更好的目标基地台。

现有技术中，移动终端设备通常选择RSSI比当前基地台更强且网络质量比当前网络更好的基地台作为漫游的目标，移动终端设备在漫游过程中会以固定频率不断扫描目标基地台以选择更好的基地台作为漫游的目标，但以固定频率不断地扫描会造成移动终端设备电源的快速消耗。

发明内容

鉴于以上内容，本发明提供一种可以节省电源消耗的移动终端设备及其漫游方法。

一种移动终端设备，用于根据若干基地台的通信环境参数从当前基地台漫游到目标基地台，所述移动终端设备包括：

检测模块，用于在预定检测时间内检测所述若干基地台的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率；

漫游调整模块，用于接收所述若干基地台的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率，并计算得出无线电质量指示（Radio Quality Index, RQI）值，及根据所述RQI值调整所述当前基地台的漫游门限值；

位置侦测模块，用于接收所述漫游调整模块的RQI值，并计算得出用户移动指数（User Movement Index, UMI）值，及根据所述UMI值调整所述移动终端设备扫描目标基地台的频率；

漫游决定模块，用于接收所述检测模块发送的所述若干基地台的当前通信环境参数及所

述移动终端设备的漫游频率及封包发送失败率，并接收所述位置侦测模块发送的所述UMI值，及判断是否有满足所述UMI值相对应的漫游条件的目标基地台；及

漫游执行模块，用于当所述漫游决定模块判断有满足所述UMI值相对应的漫游条件的目标基地台时，接收所述漫游决定模块发送的漫游执行命令及所述目标基地台的接收信号强度指示（Received Signal Strength Indication, RSSI）值，断开所述移动终端设备与所述当前基地台的通信，并建立所述移动终端设备与所述目标基地台的通信。

一种应用于所述的移动终端设备的漫游方法，包括以下步骤：

所述检测模块在预定检测时间内检测所述基地台区域的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率；

所述检测模块发送所述基地台区域的当前通信环境参数及所述移动终端设备的漫游频率及封包发送失败率至漫游调整模块及所述漫游决定模块；

所述漫游调整模块通过计算基地台区域的当前通信环境参数来获得无线电质量指示（Radio Quality Index, RQI）值，并根据所述RQI值调整所述当前基地台的漫游门限值，及发送所述RQI值给所述位置侦测模块；

所述位置侦测模块接收所述漫游调整模块的RQI值，并根据所述RQI值计算得出用户移动指数（User Movement Index, UMI）值，并根据所述UMI值调整所述移动终端设备扫描目标基地台的频率；

所述漫游决定模块判断是否有满足所述UMI值相对应的漫游条件的目标基地台；及

若有满足漫游条件的目标基地台，则所述漫游执行模块接收所述漫游决定模块发送的漫游执行命令所述目标基地台的接收信号强度指示（Received Signal Strength Indication, RSSI）值，断开所述移动终端设备与所述基地台的通信，并建立所述移动终端设备与所述目标基地台的通信，若没有满足所述UMI值相对应的漫游条件的目标基地台，则结束操作。

相较现有技术，所述移动终端设备及其利用若干基地台的通信环境参数来漫游的方法，所述位置侦测模块根据UMI值调整所述移动终端设备扫描所述目标基地台的频率，所述漫游决定模块根据是否有满足所述UMI值相对应的漫游条件的目标基地台使所述移动终端设备可成功漫游到所述目标基地台，所述移动终端设备在漫游过程中根据用户的移动状态实时自动调整扫描所述目标基地台的频率，通过调整扫描频率从而减少所述移动终端设备漫游过程中的能源消耗。

附图说明

下面参照附图结合较佳实施方式对本发明作进一步详细描述：

图1为本发明移动终端设备的较佳实施方式与基地台的通信示意图。

图2为本发明移动终端设备的较佳实施方式的框图。

图3为图1所述移动终端设备的漫游方法的较佳实施方式的流程图。

具体实施方式

请参考图1，本发明移动终端设备200的较佳实施方式应用于一基地台区域100。所述基地台区域100包括若干基地台如基地台110、120、130……。本实施方式中，所述移动终端设备200与所述基地台110、120、130……是符合电机电子工程师学会(Institute of Electrical and Electronics Engineers, IEEE) 802.11的WiFi标准的设备。所述移动终端设备200与所述基地台110、120、130……也可以是符合其它标准的设备。

本实施方式中，所述移动终端设备200与所述基地台110进行通信，当所述基地台110所处的通信环境逐步变差以使所述移动终端设备200不能一直保持在WiFi网络中时，所述移动终端设备200会中断与所述基地台110的通信连接，此时，所述移动终端设备200需从所述基地台110漫游到另一基地台如基地台120、130……，才能保持所述移动终端设备200一直处于WiFi网络中。

请继续参考图2，所述移动终端设备200包括一检测模块210、一漫游调整模块220、一位置侦测模块230、一漫游决定模块240及一漫游执行模块250。所述移动终端设备200中的各模块可以由计算机程序或电路来构成。

所述检测模块210用于在预定检测时间内检测所述移动终端设备200所在环境的通信环境状况，所述通信环境状况包括所述基地台区域100的当前通信环境参数和移动终端设备200的漫游频率及封包发送失败率。所述基地台区域100的当前通信环境参数包括所述基地台区域100的基本服务单元的服务质量(Quality of service Basic Service Set, QBSS)及所述基地台区域100的接收信号强度指示(Received Signal Strength Indication, RSSI)变化率。所述基地台区域100的QBSS标识当前每个基地台的信道的利用率及每个基地台的负载量，其中，QBSS的值越大，则当前每个基地台的信道的利用率越小，每个基地台的负载量越大，即所述基地台区域100的服务质量越差。所述基地台区域100的RSSI变化率为所述基地台区域100在检测时间内的变化量，标识每个基地台的工作稳定度，RSSI的值越大，则每个基地台的服务质量越好。所述移动终端设备200的漫游频率为所述检测模块210在预定检测时间内检测所述移动终端设备200在系统作业时间内漫游的次数，所述移动终端设备200的漫游频率标识所述移动终端设备200与所述基地台区域100的通信连接的稳定度，所述移动终端设备200的漫游频率越高，则所述移动终端设备200与所述基地台区域100的通信连接稳定度越差。

。所述移动终端设备200的封包发送失败率为在语音作业时间内封包发送失败的次数，标识所述移动终端设备200与其对应通信的基地台（本实施方式中为所述基地台110）的通信连接稳定度，所述移动终端设备200的封包发送失败率越高，则所述移动终端设备200与所述基地台110的通信连接稳定度越差。所述检测时间、系统作业时间及语音作业时间可以根据实际的需要设定为相同值或不同值。

所述漫游调整模块220用于接收所述检测模块210发送的所述基地台区域100的当前通信环境参数及所述移动终端设备200的漫游频率及封包发送失败率，并计算得出无线电质量指示（Radio Quality Index, RQI）值，并根据计算得出的RQI值调整与所述移动终端设备200通信的基地台的漫游门限值（Roaming Threshold）。本实施方式中，所述漫游调整模块220通过运算公式得出RQI值。

所述RQI值的运算公式为：

$$RQI = \text{Max_RQI} - iRQI, \quad (1)$$

其中RQI最大值为默认值，且

$$\begin{aligned} iRQI = & (((\text{Avg_QBSS} \div \text{Max_QBSS}) * \text{Max_RQI}) * 0.5) + \\ & (((\text{Roam_Freq} \div \text{Max_Freq}) * \text{Max_RQI}) * 0.2) + \\ & (((\text{Retx_Rate} \div \text{Max_Retx_Rate}) * \text{Max_RQI}) * 0.2) + \\ & (((\text{Avg_RSSI_Variance} \div \text{Max_RSSI_Variance}) * \text{Max_RQI}) * 0.1)。 \end{aligned} \quad (2)$$

其中，

Max_RQI：RQI最大值；

Max_QBSS：QBSS最大值；

Avg_QBSS：QBSS平均值；

Max_Freq：最大的漫游次数限制；

Roam_Freq：移动终端设备200的当前漫游的次数；

Max_Retx_Rate：最大的封包传送失败率；

Retx_Rate：移动终端设备200的当前封包传送失败率；

Max_RSSI_Variance：基地台区域100的RSSI变化率的最大值；

Avg_RSSI_Variance：基地台区域100的RSSI变化率的平均值。

其中，Max_RQI的值预设为100，Max_QBSS的值预设为100，Avg_QBSS为所述基地台区域100中的所有基地台的QBSS的平均值。Max_Freq为所述移动终端设备200在系统作业时间内漫游的最大次数限制。Roam_Freq为所述检测模块210在预定检测时间内检测所述移动终端设

备200在系统作业时间内实际的当前漫游的次数。Max_Retx_Rate为所述移动终端设备200在语音作业时间内最大的封包传送失败率。Retx_Rate为所述检测模块210在预定检测时间内检测所述移动终端设备200在语音作业时间内实际的当前封包传送失败率。

Max_RSSI_Variance为所述基地台区域100的RSSI在检测时间内的变化率的最大值。

Avg_RSSI_Variance为所述检测模块210在预定检测时间内检测所述基地台区域100的RSSI变化率的平均值。

本实施方式中，不同的RQI值标识不同的通信环境状态，所述通信环境状态包括正常状态、高通信量状态及干扰状态(或称为严重干扰状态)。两预设值40、70预设于所述漫游调整模块220中，若RQI值大于或等于预设值70，则所述基地台区域100的通信环境状态处于正常状态，其通信环境质量正常；若RQI值大于或等于预设值40，且小于预设值70，则所述基地台区域100的通信环境状态处于高通信量状态，其通信环境质量比较差；若RQI值小于预设值40，则所述基地台区域100的通信环境状态处于干扰状态，其通信环境质量更差。可以依据RQI值区分更多或更少的通信环境质量状态，且各种通信环境质量状态之临界值不限于所述预设值40与70，可以根据实际需要设定不同的值。

本实施方式中，所述漫游调整模块220可以根据RQI值调整与所述移动终端设备200通信的所述基地台区域100的漫游门限值。若RQI值小于70，则所述漫游调整模块220调高与所述移动终端设备200通信的所述基地台110的漫游门限值。RQI值越小，则漫游门限值将会被调的越高。所述漫游门限值包括所述移动终端设备200漫游后的目标基地台及当前与所述移动终端设备200通信的所述基地台110的RSSI的差值及QBSS的差值。

所述位置侦测模块230用于在所述移动终端设备200与所述基地台110通信时为所述移动终端设备200寻找一个备用目标基地台，当所述移动终端设备200与所述基地台110通信中断时，以使所述移动终端设备200能够快速的漫游到所述备用目标基地台。所述位置侦测模块230根据所述漫游调整模块220的RQI值计算得出用户移动指数(User Movement Index, UMI)值，并根据所述UMI值调整所述移动终端设备200扫描目标基地台的频率。

本实施方式中，不同的UMI值标识不同的用户移动状态，其用户移动状态包括静止状态、步行状态及跑步状态。若用户移动状态为静止状态，则所述移动终端设备200与所述基地台区域100的通信信号稳定，可以通过缩短扫描频率即扩大扫描间隔来寻找备用目标基地台，若用户移动状态为步行状态，因为用户移动速度不是很快，所以所述移动终端设备200与所述基地台区域100的通信信号不会快速减弱，可以调整扫描频率介于静止状态的扫描频率与跑步状态的扫描频率之间；若用户移动状态为跑步状态，因为用户移动速度很快，所以所

述移动终端设备200与所述基地台区域100的通信信号快速减弱甚至中断，此时所述移动终端设备200需要快速寻找备用目标基地台，因此可以设置较高的扫描频率以使所述移动终端设备200快速地漫游到所述目标基地台。由于上述三种状态使用的扫描频率不同，而现有技术仅用一种固定频率扫描，故本发明可有效节省电源。

所述漫游决定模块240用于接收所述检测模块210发送的所述基地台区域100的当前通信环境参数及所述移动终端设备200的漫游频率，并接收所述位置侦测模块230发送的UMI值，所述漫游决定模块240用于判断是否有满足所述UMI值相对应的漫游条件的目标基地台，如果有满足所述UMI相对应的漫游条件的目标基地台时，所述漫游决定模块240发送漫游执行命令至所述漫游执行模块250，通知所述漫游执行模块250与所述目标基地台建立连接；如果没有满足所述UMI值相对应的漫游条件的目标基地台时，则结束操作。

所述漫游执行模块250用于接收所述漫游决定模块240发送的漫游执行命令及所述基地台区域100的RSSI，断开所述移动终端设备200与所述基地台110的通信，并建立所述移动终端设备200与所述目标基地台的通信。

图3为图2中的移动终端设备200与基地台通信方法的较佳实施方式，包括以下步骤：

步骤S1：所述检测模块210在预定检测时间内检测所述基地台区域100的当前通信环境参数及所述移动终端设备200的漫游频率及封包发送失败率。

步骤S2：所述检测模块210发送所述基地台区域100的当前通信环境参数及所述移动终端设备200的漫游频率及封包发送失败率至漫游调整模块220及所述漫游决定模块240。

步骤S3：所述漫游调整模块220通过计算所有基地台的当前通信环境来获得RQI值，并根据所述RQI值调整所述基地台区域100的漫游门限值，及发送所述RQI值给所述位置侦测模块230。

步骤S4：所述位置侦测模块230接收所述漫游调整模块220的RQI值并根据所述RQI值计算出用户移动指数UMI值，并根据所述UMI值调整所述移动终端设备200扫描目标基地台的频率。

步骤S5：所述漫游决定模块240判断是否有满足所述UMI值相对应的漫游条件的目标基地台。

步骤S6：若有满足所述UMI相对应的漫游条件的目标基地台，则所述漫游执行模块250接收所述漫游决定模块发送的漫游执行命令，断开所述移动终端设备200与所述基地台110的通信，并建立所述移动终端设备200与所述目标基地台的通信，若没有满足所述UMI值相对应的漫游条件的目标基地台，则结束操作。

所述移动终端设备200及其利用若干基地台的通信环境参数来漫游的方法，通过调整所述移动终端设备200扫描所述目标基地台的频率使移动终端设备200可成功漫游到目标基地台，所述移动终端设备在漫游过程中根据用户的移动状态实时自动调整扫描所述目标基地台的频率，通过调整扫描频率从而减少所述移动终端设备漫游过程中的能源消耗。

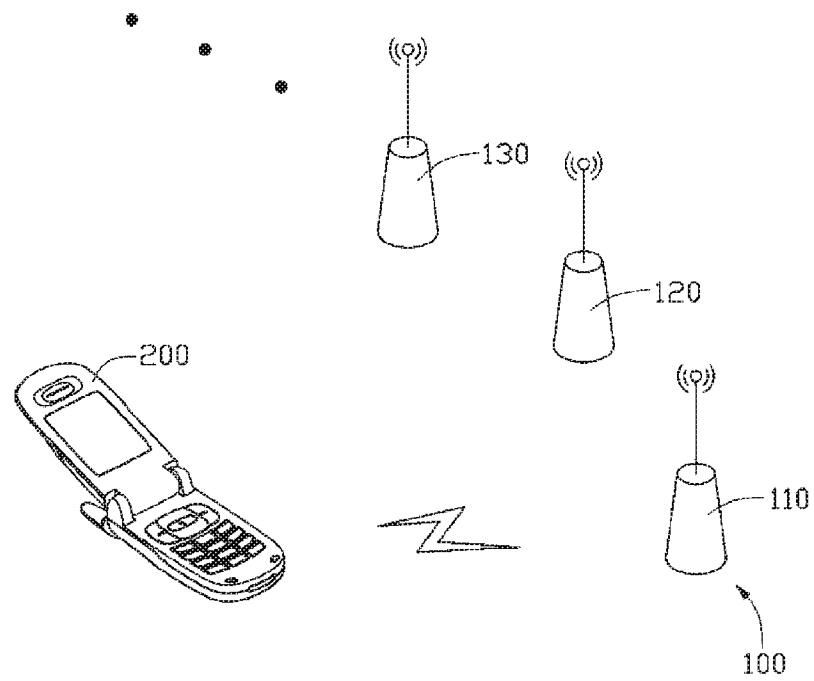


图 1

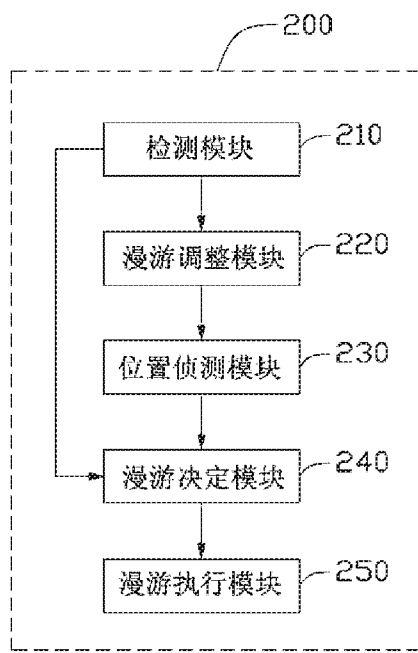


图 2

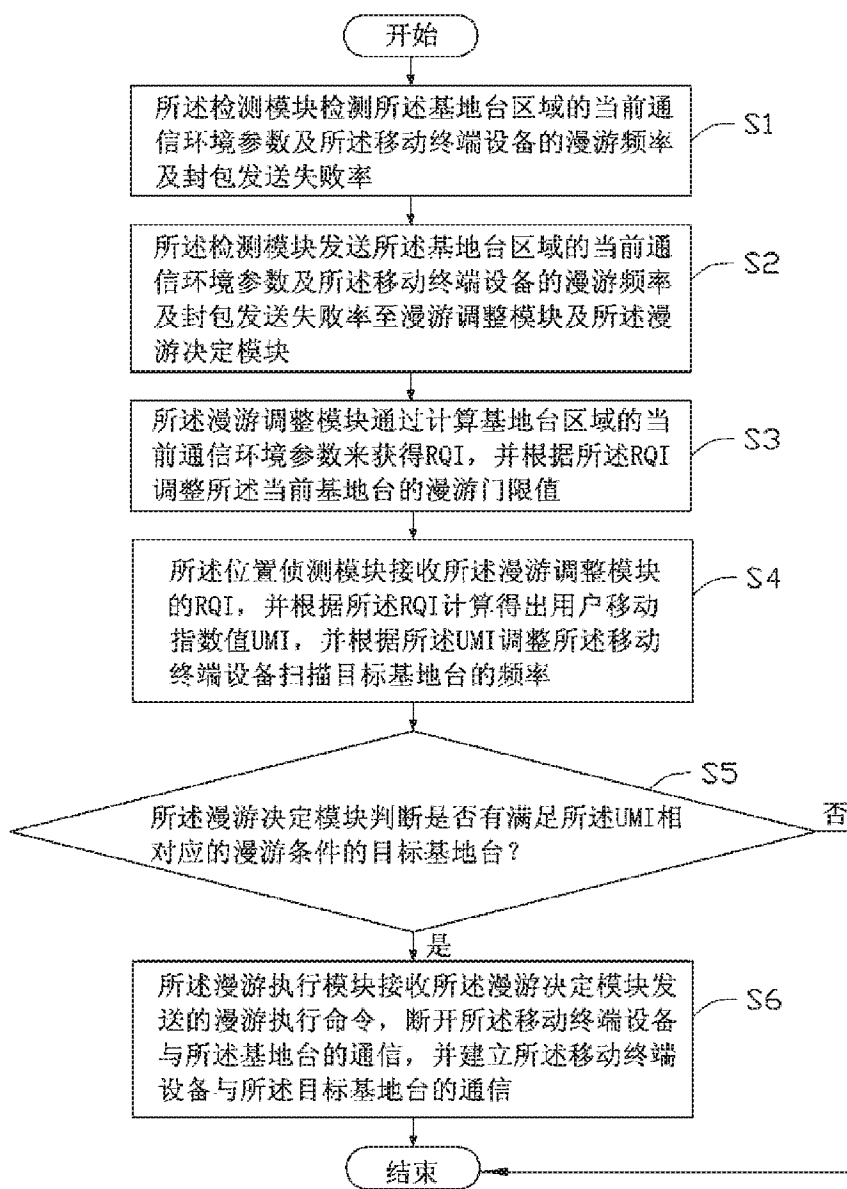


图 3



Espacenet

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Routing in a mesh network

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Abstract of CN101796869 (A)

Apparatus and method for associating with any one of a plurality of access points in a mesh network including estimating a plurality of metrics for the access points, the estimated metrics being related to throughputs provided by the access points, and selecting one of the access points to associate with based on the metrics and a plurality of backhaul metrics for the access points, the backhaul metrics being related to backhaul throughputs for the access points. The backhaul metrics may be advertised by the access points.

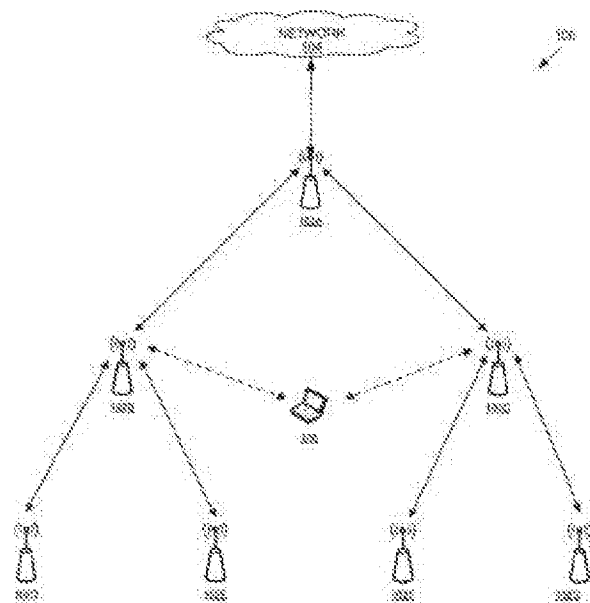


FIG. 2

Notice

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DESCRIPTION CN101796869

An apparatus and method for associating with any one of a plurality of access points in a mesh network, comprising: estimating a plurality of metrics of the access point, the estimated metrics by the access point Providing throughput related; and selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point, the degree of return and the access point The backhaul throughput is related. The amount of back can be advertised by the access point.

Routing in a mesh network

Technical field

The present disclosure relates generally to wireless communications and, more particularly, to various techniques for routing in a mesh network.

Background technique

In wireless communication systems, an access network is typically used to connect any number of access terminals to a wide area network (WAN) such as the Internet or the Public Switched Telephone Network (PSTN). These access networks are typically implemented with multiple wireless access points scattered throughout the geographic area. Each of these access points provides a wired backhaul connection to the WAN. A common example is a cellular network that provides voice, data, and signaling between a mobile access terminal and broadband Internet access. These cellular networks typically cover multiple cellular areas with fixed location access points in each cell for serving mobile access terminals.

Grid networks differ from this traditional approach in that any number of access points can be combined to provide backhaul services to mobile access terminals. The principle is similar to the way data is routed through the Internet. Basically, data in a mesh network is routed from one access point to another until it reaches its destination. The throughput of the mesh network will depend on the route established by the access point to forward the data.

When an access terminal uses an access network to connect to the Internet or some other WWAN, the access terminal typically attempts to associate with an access point that will provide the highest throughput to it. In a cellular network, the process of selecting an access point to associate is typically based on a geometric condition (ie, the closest access point). In this way, the primary uncertainty in throughput is based on the number and geometry of other access terminals served by the same access point. The ad hoc deployment of the mesh network may further contribute to the uncertainty of the throughput of the access terminals associated with the geometry based access points.

Accordingly, there is a need in the art to improve the processing used by access terminals for association with access points in a mesh network.

Summary of the invention

In an aspect of the disclosure, a method for associating with any one of a plurality of access points in a mesh network includes estimating a plurality of metrics of the access point, the estimated metrics and Determining, by the access point, the throughput provided by the access point; and selecting one of the access points to associate according to the metric and the multiple degree of the access point, the amount of the back The backhaul throughput of the access point is related.

In another aspect of the present disclosure, a method for announcing a degree of back-off in a mesh network includes estimating an amount of back-degree associated with throughput of a backhaul through the mesh network; and, advertising the The amount of the back level in the mesh network.

In another aspect of the disclosure, an apparatus for wireless communication in a mesh network having a plurality of access points includes a processing system for estimating a plurality of metrics of the access point The estimated metric is related to throughput provided by the access point, the processing system further configured to select, in the access point, based on the metric and a plurality of back-degrees of the access point An access

point is associated with the amount of backhaul associated with the backhaul throughput of the access point.

In another aspect of the disclosure, an apparatus for supporting a backhaul through a mesh network includes: a processing system for estimating a degree of return associated with throughput through the backhaul; and, announcing the network The amount of the degree of return in the grid.

In another aspect of the disclosure, an apparatus for wireless communication in a mesh network having a plurality of access points includes means for estimating a plurality of metrics of the access point, the estimated metrics Associated with throughput provided by the access point; and means for selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point The amount of back is related to the backhaul throughput of the access point.

In another aspect of the disclosure, an apparatus for supporting a backhaul through a mesh network includes: means for estimating a degree of backoff associated with throughput of a backhaul through the mesh network; and, for A module that advertises the amount of the back-end in the mesh network.

In another aspect of the disclosure, a computer program product for wireless communication includes a machine readable medium having instructions executable by a processing system for: estimating a plurality of metrics of the access point, estimated Metrics associated with the throughput provided by the access point; and selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point, The amount of return is related to the backhaul throughput of the access point.

In another aspect of the disclosure, a computer program product for wireless communication includes a machine readable medium having instructions executable by a processing system for: estimating throughput with a backhaul through the mesh network An associated amount of back; and, the amount of the back in the mesh network is advertised.

In another aspect of the disclosure, an access terminal for wireless communication in a mesh network having multiple access points includes a processing system for estimating a plurality of access points Metrics, the estimated metric being related to throughput provided by the access point, the processing system further configured to select the access point based on the metric and a plurality of back-degrees of the access point Associated with one of the access points, the amount of back is related to the backhaul throughput of the access point, and wherein the processing system is further configured to access with the selected one of the access points A point is associated; and a user interface for enabling a user to control communication between the processing system and the selected one of the access points.

In another aspect of the disclosure, an access point includes: a network adapter for supporting a backhaul through a mesh network; and a processing system for estimating a throughput related to passing through the backhaul. The amount of return, and the amount of the back in the mesh network is advertised.

Other aspects of the invention will be apparent to those skilled in the art. It will be appreciated that the invention is capable of other and various embodiments and embodiments. Accordingly, the drawings and detailed description are to be regarded as

DRAWINGS

In the figures, various aspects of a wireless communication system are illustrated by way of example and not limitation, in which:

FIG. 1 is a conceptual diagram illustrating an example of a mesh network;

2 is a conceptual diagram illustrating one example of an access terminal attempting to associate with a mesh network;

3 is a conceptual diagram illustrating another example of an access terminal attempting to associate with a mesh network;

4 is a block diagram illustrating an example of a function of an access terminal;

FIG. 5 is a block diagram illustrating an example of the function of an access point.

detailed description

The detailed description set forth below with reference to the drawings is intended to be a description of the various embodiments of the invention, and is not intended to represent the only configuration in which the

invention may be practiced. The detailed description includes specific details for a thorough understanding of the invention. However, it is apparent to those skilled in the art that the present invention may be practiced without these specific details. In some instances, well known structures and components are shown in block diagram form in order to avoid obscuring the inventive concept.

FIG. 1 is a conceptual diagram illustrating an example of a mesh network 100. The mesh network 100 is shown with a cluster of mesh access points (MAPs) 102 that are used together to provide backhaul services to one or more access terminals (not shown). The mesh network 100 includes a wireless node 102A that provides a wired backhaul connection to a network 104 (e.g., the Internet, a cellular network, etc.). This wireless node 102A is sometimes referred to as the root access point (RAP) of the cluster due to the wired backhaul connection of the wireless node 102A. However, this wireless node 102A may also provide backhaul services to access terminals along with other access points in different clusters having different RAPs.

The clusters in Figure 1 are created by establishing a radio link between MAPs 102A-102G. In the example shown in FIG. 1, RAP 102A has a radio link with MAPs 102B and 102C, MAP 102B also has a radio link with MAPs 102D and 102E, and MAP 102C also has a radio chain with MAP 102F and MAP 102G. Although not shown, one or more of the MAPs 102B-102G may have additional radio links to other MAPs in the same cluster and/or wireless nodes in other clusters. Moreover, one or more MAPs 102B-102G may also act as RAPs for other wireless nodes in one or more other clusters.

The air interface specifications used or employed to support the mesh network 100 may be based on any wireless technology that enables the mobile access terminal to share available radio resources. Examples of such wireless technologies include Code Division Multiple Access (CDMA), Wideband CDMA (W-CDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), or a combination. The air interface specification for supporting the radio link may be CDMA2000, Evolution Data Optimized (EV-DO), Ultra Mobile Broadband (UMB), IEEE 802.11, or any other suitable air interface specification now known or later developed. .

2 is a conceptual diagram illustrating one example of an access terminal 106 attempting to associate with a mesh network 100. Access terminal 106 may be any mobile user device capable of supporting radio communication with wireless node 102, including, for example, mobile or cellular telephones, personal digital assistants (PDAs), laptop computers, digital audio devices (eg, MP3 players) , game controllers, digital cameras or other voice, data, audio, video, messaging or multimedia devices. In some applications, the access terminal 106 can also serve as an access point for other wireless nodes in the same or different clusters of the mesh network 100.

When the access terminal 106 attempts to associate with the mesh network 100, the access terminal 106

determines how it should forward data to the RAP 102A. In this example, it is possible for the access terminal 106 to establish a route through one of the two MAPs 102B or 102C. Access terminal 106 can use a variety of possible correlation techniques to select a MAP that can provide the highest throughput. These techniques are also applicable to other wireless nodes attempting to join the mesh network 100, such as MAPs that were previously offline but are now ready to be part of a mesh network.

One association technique is based on certain metrics for each of the two MAPs 102B and 102C. Specifically, for each MAP 102B and 102C, the access terminal 106 estimates a metric related to the throughput that the MAP can provide. The access terminal 106 also obtains the amount of back of that MAP associated with the throughput that each MAP 102B and 102C's backhaul can provide. The amount of back can be advertised by MAPs 102B and 102C, or access terminal 106 can obtain them in another way. Access terminal 106 then selects one of the two MAPs 102B and 102C based on the metric and the amount of back.

An example of a metric is now introduced that includes the geometry of the MAP 102 in a mesh network. Referring to Figure 2, access terminal 106 determines the geometry of MAPs 102B and 102C. The geometry of the MAP can be determined, for example, by the signal strength of its beacon. The beacon can be sent from each MAP in a manner that avoids collisions. This is achieved by separating the beacons in time, using GPS synchronization, and having the MAPs transmit their beacons using the appropriate offsets in the beacon frames. Alternatively, the beacon can be transmitted on a different frequency. In either case, once the geometry of MAPs 102B and 102C is known, access terminal 106 can determine the throughput it can achieve through each of MAPs 102B and 102C.

Access terminal 106 then obtains the backhaul geometry for each of MAPs 102B and 102C. The backhaul geometry can be determined by measuring the signal strength of the beacon transmitted by the RAP 102A at both MAPs 102B and 102C. The backhaul geometry of each MAP 102B and 102C can then be advertised in their respective beacons, or each MAP 102B and 102C can transmit the backhaul geometry in response to a probe message from the access terminal 106. Once the backhaul geometry of MAPs 102B and 102C is obtained, access terminal 106 can determine the throughput that can be achieved by the backhaul of each of MAPs 102B and 102C.

The process of selecting the MAP to be associated is a two-step process. First, the access terminal 106 estimates the overall throughput it will achieve through each of the MAPs 102B and 102C by obtaining the minimum value: (1) throughput to the MAP (determined based on the estimated geometry); 2) The throughput that the MAP receives from its own connection to the RAP 102A (as determined by the backhaul geometry). Second, access terminal 106 selects the MAP that provides the greatest overall throughput.

The example just provided is well suited for grid network 100 that is unloaded or lightly loaded. In the loaded mesh network 100, the access terminal 106 or other wireless node may attempt to associate with the MAP for which the highest throughput is provided while the MAP follows its scheduling policy. In the example below, it is assumed that all MAPs employ the same scheduling policy, such as an Equal Service Level (EGOS) policy, but those skilled in the art can readily extend the principles provided in this example to any suitable scheduling policy. In this example, each MAP advertises its rate based on its scheduling policy and its backhaul geometry. Based on this advertisement and its own estimated geometry, the access terminal 106 can calculate the overall throughput it will receive when associated with any particular MAP. After the access terminal 106 is associated with the MAP, the MAP thus adjusts the rate it provides to all of the wireless nodes with which it is associated.

Access terminal 106 can use various other metrics to associate with MAP 102 in mesh network 100 to maximize throughput. For example, the access terminal 106 can use the channel gains in the mesh network 100 to select an appropriate MAP for association. Referring to Figure 2, access terminal 106 determines the channel gain that each MAP 102B and 102C can provide. The access terminal 106 also receives the channel gain (i.e., the channel gain between the MAP 102 and the RAP 102A) that the backhaul of each of the MAPs 102B and 102C can provide in the beacon or in response to the probe message. These metrics can then be used to calculate the overall throughput provided by each MAP 102B and 102C, and select the appropriate MAP 102 to associate with in a manner similar to that previously described in connection with the geometry based selection.

As an alternative to channel gain, the access terminal 106 can use the rate to select the appropriate MAP 102 to associate with. In this example, the access terminal 106 determines the rate that each MAP in its vicinity can provide and the backhaul rate that each MAP can support. These metrics are then used to calculate the overall throughput provided by each MAP to support the selection of the MAP 102 to be associated.

So far, the examples provided relate to a single-choice routing scheme between RAP and MAP. However, depending on the configuration of the mesh network, the load on the mesh network, and the channel conditions, the access terminal may select a path with multiple hops between the RAP and the MAP associated with the access terminal.

FIG. 3 is a conceptual diagram illustrating another example of an access terminal 106 attempting to associate with a mesh network 100. In this example, there are two MAPs 102E and 102F to which the access terminal 106 is likely to be associated, each of these MAPs 102E and 102F having a backhaul to the RAP 102A. The first MAP 102E has a backhaul through the MAP 102B to the RAP 102A, and the second MAP 102F has a backhaul through the MAP 102C to the RAP 102A.

When the access terminal 106 attempts to associate with the mesh network 100, it determines the metrics (e.g.,

geometry, channel gain, rate, etc.) for each of the MAPs 102E and 102F. Next, the access terminal 106 receives an announcement from each of the MAPs 102E and 102F, or otherwise obtains a degree of return for each. The degree of return includes a vector that contains a measure of each hop through the backhaul of the mesh network 100. For example, the access terminal 106 can obtain a vector from the MAP 102E that includes a first metric for a hop between the MAP 102E and the intermediate MAP 102B and a hop for the jump between the intermediate MAP 102B and the RAP 102A. Two metrics. The access terminal 106 then determines the throughput to each of the three hops of the RAP 102 and allocates the minimum throughput as the overall throughput supported by the MAP 102E over the mesh network. In a similar manner, the access terminal 106 determines the overall throughput supported by the MAP 102F and then selects the MAP with the largest overall throughput for association.

FIG. 4 is a block diagram illustrating an example of the functionality of the access terminal 106. Access terminal 106 is shown having processing system 402 and transceiver 404. The transceiver 404 can be used to implement an analog portion of the physical layer, and the processing system 402 can be used to implement a digital processing portion of the physical layer as well as a link layer. Processing system 402 can also be used to perform various other functions, including processing associated with access points in a mesh network. In particular, processing system 402 can provide a module 406 for estimating a plurality of metrics for an access point. These metrics can be related to the throughput provided by the access point. The processing system 402 can also provide a module 408 for selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point. The amount of back can be related to the backhaul throughput of the access point.

FIG. 5 is a block diagram illustrating an example of the functionality of the access point 102. Access point 102 is shown with processing system 502 and transceiver 504. Much like the access terminal discussed above in connection with FIG. 4, transceiver 504 can be used to implement the analog portion of the physical layer, and processing system 502 can be used to implement the digital processing portion of the physical layer as well as the link layer. Processing system 502 can also be used to perform various other functions including processing that enables an access terminal or other wireless node to associate with it to join a mesh network. In particular, processing system 502 can provide a module 506 for estimating the amount of back-degree associated with the throughput of the backhaul through the mesh network. Processing system 502 can also include a module 508 for announcing the amount of back-to-back in the mesh network.

Processing systems 402 and 502 described in connection with Figures 4 and 5 can be implemented using software, hardware, or a combination of both. For example, one or more integrated circuits (ICs) can be used to implement the processing system. An IC may include a general purpose processor, digital signal processor (DSP), application specific integrated circuit (ASIC), field programmable gate array (FPGA) or other programmable logic device, discrete door or other designed to perform the functions described herein. Transistor logic, discrete hardware components, electronic components, optical components, mechanical components, or any combination thereof, and can execute code or instructions that reside within the IC, external

to the IC, or both. A general purpose processor may be a microprocessor, but in the alternative, the general purpose processor may be any conventional processor, controller, microcontroller, or state machine. The processing system can also be implemented as a combination of computing devices, such as a combination of a DSP and a microprocessor, a combination of multiple microprocessors, a combination of one or more microprocessors in conjunction with a DSP core, or any other such configuration. .

The code or instructions may be embodied in one or more machine readable mediums to support a software application. Software should be interpreted broadly to mean instructions, programs, code or any other electronic media content, whether the electronic media content is referred to as software, firmware, middleware, microcode, hardware description language, or otherwise. The machine-readable medium can include a memory integrated with the processor, such as may be the case with an ASIC. The machine-readable medium can also include memory external to the processor, such as random access memory (RAM), flash memory, read only memory (ROM), programmable read only memory (PROM), erasable PROM (EPROM), Register, hard disk, removable disk, CD-ROM, DVD or any other suitable storage device. Additionally, a machine-readable medium can include a transmission line or a carrier wave that encodes a data signal. Those skilled in the art will recognize how best to implement the described functionality of the processing system. Moreover, in some aspects any suitable computer program product may comprise a computer readable medium or a machine readable medium comprising code related to one or more aspects of the present disclosure. In some aspects, a computer program product can include packaging materials.

The previous description is provided to enable any person skilled in the art to practice the various aspects described herein. Various modifications to these aspects will be apparent to those skilled in the art, and the general principles defined herein may be applied to other aspects. Therefore, the claims are not intended to be limited to the scope of the present invention, and the scope of the singular elements is not intended to mean "one and only one" (unless so specified). Instead, it means "one or more." Unless specifically stated otherwise, the term "some" means one or more. All of the structures and functions of elements that are known to those skilled in the art and which are equivalent to the various aspects described in the present disclosure are expressly incorporated herein by reference. Moreover, nothing disclosed herein is intended to be dedicated to the public, regardless of whether such disclosure is explicitly recited in the claims. The elements of any claim should not be interpreted in accordance with the provisions of the sixth paragraph of 35 USC § 112, unless the phrase "a module for" is used to explicitly state the element or, in the case of a method claim, The phrase "steps for" is used to state the elements.

Notice

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CLAIMS CN101796869

1.

A method for associating with any of a plurality of access points in a mesh network, comprising: estimating a plurality of metrics for the access point, the estimated metrics and provided by the access point Transmitting correlation; and selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point, the back-degree amount and a backhaul of the access point Throughput related.

2.

The method of claim 1 wherein said one of said access points is selected based on said metric and said amount of backhaul to provide a highest throughput through said mesh network.

3.

The method of claim 1, further comprising: saving a list of access points, and wherein the one of the access points is selected from the list based on the metric and the degree of return.

4.

The method of claim 3, further comprising receiving the list in an over-the-air transmission.

5.

The method of claim 1 wherein the metric comprises a geometry of the access point and the back level comprises a backhaul geometry of the access point.

6.

The method of claim 5, further comprising: receiving a traffic rate from the access point, and wherein selecting the one of the access points based on the metric, the amount of homing, and the traffic rate Describe an access point.

7.

The method of claim 1 wherein the metric comprises a channel gain provided by the access point and the back level amount comprises a backhaul channel gain of the access point.

8.

The method of claim 1 wherein the metric comprises a rate provided by the access point and the back level comprises a backhaul rate of the access point.

9.

The method of claim 1 further comprising receiving the amount of back-degree from the access point.

10.

The method of claim 9 wherein said back level is received in a beacon signal from said access point.

11.

The method of claim 9, further comprising transmitting a probe message to the access point, and wherein the back level is received from the access point in response to the probe message.

12.

A method for announcing a degree of back-off in a mesh network, comprising: estimating a degree of return associated with throughput of a backhaul through the mesh network; and announcing the back in the mesh network The amount of degree.

13.

The method of claim 12, further comprising transmitting a beacon signal, and wherein the back level is advertised in the beacon signal.

14.

The method of claim 12, further comprising receiving a probe message from the wireless node, and wherein the wireless node is advertised to the wireless node in response to the probe message.

15.

The method of claim 12 wherein said back level includes a geometric condition provided by said backhaul.

16.

The method of claim 12, further comprising following the scheduling policy to support the plurality of wireless nodes and advertising a traffic rate that can be provided to the other wireless node if the scheduling policy is followed.

17.

The method of claim 16 further comprising: supporting said additional wireless node and updating said advertised traffic rate based on support for said additional wireless node.

18.

The method of claim 12 wherein said back level amount comprises a channel gain provided by said backhaul.

19.

The method of claim 12 wherein said back level amount comprises a rate provided by said backhaul.

20.

An apparatus for wireless communication in a mesh network having a plurality of access points, comprising: a processing system for estimating a plurality of metrics of the access point, the estimated metrics by the access point The throughput provided by the point is related, the processing system is further configured to select one of the access points for association according to the metric and a plurality of back degrees of the access point, the degree of the back The amount is related to the backhaul throughput of the access point.

21.

The apparatus of claim 20, wherein the processing system is further configured to select the one of the access points to provide through the network based on the metric and the amount of back-degree The highest throughput of the grid.

22.

The apparatus according to claim 20, wherein said processing system is further configured to save a list of access points, said processing system further configured to select said one of said access points based on said metric and a degree of return Describe an access point.

23.

The apparatus of claim 22 wherein said processing system is further for receiving said list in over-the-air transmission.

24.

The apparatus of claim 22 wherein said list is provided to said processing system.

25.

The apparatus of claim 20 wherein the metric comprises a geometry of the access point and the amount of backhaul comprises a backhaul geometry of the access point.

26.

The apparatus of claim 25, wherein the processing system is further for receiving a traffic rate from the access point, and wherein the processing system is further for utilizing the metric, the amount of The traffic rate is selected to select the one of the access points.

27.

The apparatus of claim 20 wherein the metric comprises a channel gain provided by the access point and the back level amount comprises a backhaul channel gain of the access point.

28.

The apparatus of claim 20, wherein the metric comprises a rate provided by the access point and the back level amount comprises a backhaul rate of the access point.

29.

The apparatus of claim 20 wherein said processing system is further for receiving said back level amount from said access point.

30.

The apparatus of claim 29 wherein said processing system is further for receiving said back level amount in a beacon signal from said access point.

31.

The apparatus of claim 29, wherein the processing system is further configured to send a probe message to the access point, and wherein the processing system is further configured to receive from the access in response to the probe message The point receives the amount of the back.

32.

An apparatus for supporting a backhaul through a mesh network, comprising: a processing system for estimating a degree of backoff associated with throughput through the backhaul, and announcing the amount of back in the mesh network .

33.

The apparatus of claim 32 wherein said processing system is further for supporting transmission of a beacon signal, and wherein said back level is advertised in said beacon signal.

34.

The apparatus of claim 32, wherein the processing system is further for receiving a probe message from a wireless node, and wherein the amount of the degree of return is advertised to the wireless node in response to the probe message.

35.

The apparatus of claim 32 wherein said amount of back includes a geometric condition provided by said backhaul.

36.

The apparatus of claim 32, wherein the processing system is further for supporting a plurality of wireless nodes in accordance with a scheduling policy and advertising a traffic rate that can be provided to the other wireless node if the scheduling policy is followed.

37.

The apparatus of claim 36, wherein the processing system is further for supporting the additional wireless node and updating the advertised traffic rate based on support for the additional wireless node.

38.

The apparatus of claim 32 wherein said back level amount comprises a channel gain provided by said backhaul.

39.

The apparatus of claim 32 wherein said back level amount comprises a rate provided by said backhaul.

40.

An apparatus for wirelessly communicating in a mesh network having a plurality of access points, comprising: means for estimating a plurality of metrics of the access point, the estimated metrics and by the access point a throughput correlation provided; and means for selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point, the amount of The backhaul throughput of the access point is related.

41.

The apparatus of claim 40, wherein the means for selecting one of the access points is further for selecting the access point based on the metric and the amount of back-degree The one access point to provide the highest throughput through the mesh network.

42.

The apparatus of claim 40, further comprising: means for saving a list of access points, and wherein said means for selecting one of said access points is further for The metrics and the degree of return are used to select the one of the access points from the list.

43.

The apparatus of claim 42 further comprising means for receiving said list in over-the-air transmission.

44.

The apparatus of claim 42 further comprising: means for providing said list.

45.

The apparatus of claim 40, wherein the metric comprises a geometry of the access point and the amount of backhaul comprises a backhaul geometry of the access point.

46.

The apparatus of claim 45, further comprising: means for receiving a traffic rate from the access point, and wherein the means for selecting one of the access points is further for The one of the access points is selected based on the metric, the amount of back, and the traffic rate.

47.

The apparatus of claim 40, wherein the metric comprises a channel gain provided by the access point, and the back level amount comprises a backhaul channel gain of the access point.

48.

The apparatus of claim 40, wherein the metric comprises a rate provided by the access point and the back level amount comprises a backhaul rate of the access point.

49.

The apparatus of claim 40, further comprising means for receiving the amount of the degree of return from the access point.

50.

The apparatus of claim 49 wherein said means for receiving said back level is further for receiving said back level amount in a beacon signal from said access point.

51.

The apparatus of claim 49, further comprising: means for transmitting a probe message to the access point, and wherein the means for receiving the degree of return is further responsive to the probe message To receive the amount of return.

52.

An apparatus for supporting a backhaul through a mesh network, comprising: means for estimating a degree of return associated with throughput of a backhaul through the mesh network; and for advertising in the mesh network The module of the degree of return.

53.

The apparatus of claim 52, further comprising: means for transmitting a beacon signal, and wherein said means for advertising said back level is further for advertising said back in said beacon signal The amount of degree.

54.

The apparatus of claim 52, further comprising: means for receiving a probe message from the wireless node, and wherein the means for advertising the amount of back is further for responding to the probe message The wireless node announces the amount of back.

55.

The apparatus of claim 52 wherein said amount of back includes a geometric condition provided by said backhaul.

56.

The apparatus of claim 52, further comprising: means for supporting the plurality of wireless nodes in accordance with the scheduling policy and means for advertising the rate of service that can be provided to the other wireless node if the scheduling policy is followed .

57.

The apparatus of claim 56, further comprising means for supporting the additional wireless node and means for updating the advertised traffic rate based on support for the additional wireless node.

58.

The apparatus of claim 52 wherein said back level amount comprises a channel gain provided by said backhaul.

59.

The apparatus of claim 52 wherein said back level amount comprises a rate provided by said backhaul.

60.

A computer program product for wireless communication, comprising: a machine readable medium comprising instructions executable by a processing system for: estimating a plurality of metrics of the access point, the estimated metrics and The throughput provided by the access point is associated; and selecting one of the access points for association based on the metric and a plurality of back-degrees of the access point, the amount of The

backhaul throughput of the access point is related.

61.

A computer program product for wireless communication, comprising: a machine readable medium comprising instructions executable by a processing system for: estimating a degree of return associated with throughput of a backhaul through the mesh network; And announcing the amount of the degree of back in the mesh network.

62.

An access terminal for wireless communication in a mesh network having a plurality of access points, comprising: a processing system for estimating a plurality of metrics of the access point, the estimated metrics and The throughput provided by the access point is related, the processing system is further configured to select one of the access points to associate according to the metric and a plurality of back degrees of the access point, where The amount of back is related to the backhaul throughput of the access point, and wherein the processing system is further for associating with the selected one of the access points; and a user interface for making A user can control communication between the processing system and a selected one of the access points.

63.

An access point for wireless communication, comprising: a network adapter for supporting a backhaul through a mesh network; and a processing system for estimating a degree of return associated with throughput through the backhaul, and announcing the The amount of the degree of back in the mesh network.



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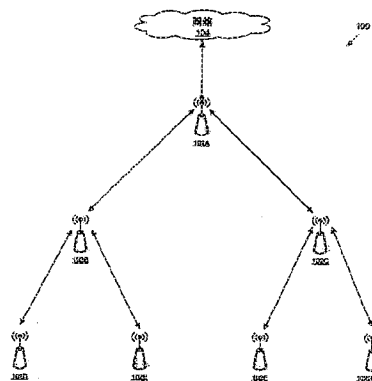
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(54) 发明名称

在网格网络中路由

(57) 摘要

一种用于与网格网络中的多个接入点中的任何一个相关联的装置和方法,包括:估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关;并且根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。可以通过所述接入点来通告所述回程度量。



1. 一种用于与网格网络中的多个接入点中的任何一个相关联的方法,包括:
估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关;以及
根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。
2. 根据权利要求 1 所述的方法,其中,根据所述度量和所述回程度量来选择所述接入点中的所述一个接入点,以提供通过所述网格网络的最高吞吐量。
3. 根据权利要求 1 所述的方法,还包括:保存接入点的列表,并且其中,根据所述度量和回程度量从所述列表中选择所述接入点中的所述一个接入点。
4. 根据权利要求 3 所述的方法,还包括:在空中传输中接收所述列表。
5. 根据权利要求 1 所述的方法,其中,所述度量包括所述接入点的几何状况,并且所述回程度量包括所述接入点的回程几何状况。
6. 根据权利要求 5 所述的方法,还包括:从所述接入点接收业务速率,并且其中,根据所述度量、所述回程度量和所述业务速率来选择所述接入点中的所述一个接入点。
7. 根据权利要求 1 所述的方法,其中,所述度量包括由所述接入点提供的信道增益,并且所述回程度量包括所述接入点的回程信道增益。
8. 根据权利要求 1 所述的方法,其中,所述度量包括由所述接入点提供的速率,并且所述回程度量包括所述接入点的回程速率。
9. 根据权利要求 1 所述的方法,还包括:从所述接入点接收所述回程度量。
10. 根据权利要求 9 所述的方法,其中,在来自所述接入点的信标信号中接收所述回程度量。
11. 根据权利要求 9 所述的方法,还包括:向所述接入点发送探测消息,并且其中,响应于所述探测消息来从所述接入点接收所述回程度量。
12. 一种用于通告在网格网络中的回程度量的方法,包括:
估计与通过所述网格网络的回程的吞吐量相关的回程度量;以及
通告所述网格网络中的所述回程度量。
13. 根据权利要求 12 所述的方法,还包括:发送信标信号,并且其中,在所述信标信号中通告所述回程度量。
14. 根据权利要求 12 所述的方法,还包括:从无线节点接收探测消息,并且其中,响应于所述探测消息来向所述无线节点通告所述回程度量。
15. 根据权利要求 12 所述的方法,其中,所述回程度量包括由所述回程提供的几何状况。
16. 根据权利要求 12 所述的方法,还包括:遵循调度策略来支持多个无线节点,并且通告在遵循所述调度策略的情况下能够提供给另外的无线节点的业务速率。
17. 根据权利要求 16 所述的方法,还包括:支持所述另外的无线节点,并且根据对所述另外的无线节点的支持来更新所通告的业务速率。
18. 根据权利要求 12 所述的方法,其中,所述回程度量包括由所述回程提供的信道增益。
19. 根据权利要求 12 所述的方法,其中,所述回程度量包括由所述回程提供的速率。
20. 一种用于在具有多个接入点的网格网络中进行无线通信的装置,包括:

处理系统,用于估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关,所述处理系统还用于根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。

21. 根据权利要求 20 所述的装置,其中,所述处理系统还用于根据所述度量和所述回程度量来选择所述接入点中的所述一个接入点,以提供通过所述网格网络的最高吞吐量。

22. 根据权利要求 20 所述的装置,其中,所述处理系统还用于保存接入点的列表,所述处理系统还用于根据所述度量和回程度量来选择所述接入点中的所述一个接入点。

23. 根据权利要求 22 所述的装置,其中,所述处理系统还用于在空中传输中接收所述列表。

24. 根据权利要求 22 所述的装置,其中,向所述处理系统提供所述列表。

25. 根据权利要求 20 所述的装置,其中,所述度量包括所述接入点的几何状况,并且所述回程度量包括所述接入点的回程几何状况。

26. 根据权利要求 25 所述的装置,其中,所述处理系统还用于从所述接入点接收业务速率,并且其中,所述处理系统还用于根据所述度量、所述回程度量和所述业务速率来选择所述接入点中的所述一个接入点。

27. 根据权利要求 20 所述的装置,其中,所述度量包括由所述接入点提供的信道增益,并且所述回程度量包括所述接入点的回程信道增益。

28. 根据权利要求 20 所述的装置,其中,所述度量包括由所述接入点提供的速率,并且所述回程度量包括所述接入点的回程速率。

29. 根据权利要求 20 所述的装置,其中,所述处理系统还用于从所述接入点接收所述回程度量。

30. 根据权利要求 29 所述的装置,其中,所述处理系统还用于在来自所述接入点的信标信号中接收所述回程度量。

31. 根据权利要求 29 所述的装置,其中,所述处理系统还用于向所述接入点发送探测消息,并且其中,所述处理系统还用于响应于所述探测消息来从所述接入点接收所述回程度量。

32. 一种用于支持通过网格网络的回程的装置,包括:

处理系统,用于估计与通过所述回程的吞吐量相关的回程度量,并且通告所述网格网络中的所述回程度量。

33. 根据权利要求 32 所述的装置,其中,所述处理系统还用于支持信标信号的传输,并且其中,在所述信标信号中通告所述回程度量。

34. 根据权利要求 32 所述的装置,其中,所述处理系统还用于从无线节点接收探测消息,并且其中,响应于所述探测消息来向所述无线节点通告所述回程度量。

35. 根据权利要求 32 所述的装置,其中,所述回程度量包括由所述回程提供的几何状况。

36. 根据权利要求 32 所述的装置,其中,所述处理系统还用于遵循调度策略来支持多个无线节点,并且通告在遵循所述调度策略的情况下能够提供给另外的无线节点的业务速率。

37. 根据权利要求 36 所述的装置,其中,所述处理系统还用于支持所述另外的无线节

点,并且根据对所述另外的无线节点的支持来更新所通告的业务速率。

38. 根据权利要求 32 所述的装置,其中,所述回程度量包括由所述回程提供的信道增益。

39. 根据权利要求 32 所述的装置,其中,所述回程度量包括由所述回程提供的速率。

40. 一种用于在具有多个接入点的网格网络中进行无线通信的装置,包括:

用于估计所述接入点的多个度量的模块,所估计的度量与由所述接入点提供的吞吐量相关;以及

用于根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联的模块,所述回程度量与所述接入点的回程吞吐量相关。

41. 根据权利要求 40 所述的装置,其中,所述用于选择所述接入点中的一个接入点的模块还用于根据所述度量和所述回程度量来选择所述接入点中的所述一个接入点,以提供通过所述网格网络的最高吞吐量。

42. 根据权利要求 40 所述的装置,还包括:用于保存接入点的列表的模块,并且其中,所述用于选择所述接入点中的一个接入点的模块还用于根据所述度量和回程度量来从所述列表中选择所述接入点中的所述一个接入点。

43. 根据权利要求 42 所述的装置,还包括:用于在空中传输中接收所述列表的模块。

44. 根据权利要求 42 所述的装置,还包括:用于提供所述列表的模块。

45. 根据权利要求 40 所述的装置,其中,所述度量包括所述接入点的几何状况,并且所述回程度量包括所述接入点的回程几何状况。

46. 根据权利要求 45 所述的装置,还包括:用于从所述接入点接收业务速率的模块,并且其中,所述用于选择所述接入点中的一个接入点的模块还用于根据所述度量、所述回程度量和所述业务速率来选择所述接入点中的所述一个接入点。

47. 根据权利要求 40 所述的装置,其中,所述度量包括由所述接入点提供的信道增益,并且所述回程度量包括所述接入点的回程信道增益。

48. 根据权利要求 40 所述的装置,其中,所述度量包括由所述接入点提供的速率,并且所述回程度量包括所述接入点的回程速率。

49. 根据权利要求 40 所述的装置,还包括:用于从所述接入点接收所述回程度量的模块。

50. 根据权利要求 49 所述的装置,其中,所述用于接收所述回程度量的模块还用于在来自所述接入点的信标信号中接收所述回程度量。

51. 根据权利要求 49 所述的装置,还包括:用于向所述接入点发送探测消息的模块,并且其中,所述用于接收所述回程度量的模块还用于响应于所述探测消息来接收所述回程度量。

52. 一种用于支持通过网格网络的回程的装置,包括:

用于估计与通过所述网格网络的回程的吞吐量相关的回程度量的模块;以及

用于通告所述网格网络中的所述回程度量的模块。

53. 根据权利要求 52 所述的装置,还包括:用于发送信标信号的模块,并且其中,所述用于通告所述回程度量的模块还用于在所述信标信号中通告所述回程度量。

54. 根据权利要求 52 所述的装置,还包括:用于从无线节点接收探测消息的模块,并且

其中,所述用于通告所述回程度量的模块还用于响应于所述探测消息来向所述无线节点通告所述回程度量。

55. 根据权利要求 52 所述的装置,其中,所述回程度量包括由所述回程提供的几何状况。

56. 根据权利要求 52 所述的装置,还包括:用于遵循调度策略来支持多个无线节点的模块和用于通告在遵循所述调度策略的情况下能够提供给另外的无线节点的业务速率的模块。

57. 根据权利要求 56 所述的装置,还包括:用于支持所述另外的无线节点的模块和用于根据对所述另外的无线节点的支持来更新所通告的业务速率的模块。

58. 根据权利要求 52 所述的装置,其中,所述回程度量包括由所述回程提供的信道增益。

59. 根据权利要求 52 所述的装置,其中,所述回程度量包括由所述回程提供的速率。

60. 一种用于无线通信的计算机程序产品,包括:

机器可读介质,其包括可由处理系统执行的指令,以用于:

估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关;以及根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。

61. 一种用于无线通信的计算机程序产品,包括:

机器可读介质,其包括可由处理系统执行的指令,以用于:

估计与通过所述网格网络的回程的吞吐量相关的回程度量;以及通告所述网格网络中的所述回程度量。

62. 一种用于在具有多个接入点的网格网络中进行无线通信的接入终端,包括:

处理系统,用于估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关,所述处理系统还用于根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关,并且其中,所述处理系统还用于与所述接入点中的所选择的一个接入点相关联;以及

用户接口,用于使得用户能够控制在所述处理系统和所述接入点中的所选择的一个接入点之间的通信。

63. 一种用于无线通信的接入点,包括:

网络适配器,用于支持通过网格网络的回程;以及

处理系统,用于估计与通过所述回程的吞吐量相关的回程度量,并且通告所述网格网络中的所述回程度量。

在网格网络中路由

技术领域

[0001] 本公开一般地涉及无线通信,并且更具体地涉及用于在网格网络中路由的各种技术。

背景技术

[0002] 在无线通信系统中,接入网一般用于将任何数量的接入终端连接到诸如因特网或者公共交换电话网络 (PSTN) 之类的广域网 (WAN)。通常用在地理区域中各处散布的多个无线接入点来实现这些接入网。这些接入点中的每个接入点向 WAN 提供有线的回程连接。一个常见示例是蜂窝网络,其在移动接入终端和宽带因特网接入之间提供语音、数据和信令。这些蜂窝网络一般覆盖多个蜂窝区域,在每个小区中有固定位置的接入点,用于服务于移动接入终端。

[0003] 网格网络与这种传统方式的不同之处在于:任何数量的接入点可以结合在一起来向移动接入终端提供回程服务。其原理类似于通过因特网来路由数据的方式。基本上,将网格网络中的数据从一个接入点路由到另一个接入点,直到其到达目的地。网格网络的吞吐量将依赖于由接入点建立的用于转发数据的路由。

[0004] 当接入终端使用接入网来连接到因特网或者某个其它的 WWAN 时,接入终端一般试图与会向其提供最高吞吐量的接入点相关联。在蜂窝网络中,选择要关联的接入点的处理通常基于几何状况(即,最近的接入点)。使用这种方式,在吞吐量上的主要不确定性是基于由同一接入点服务的其它接入终端的数量和几何状况。网格网络的自组织 (ad hoc) 部署可能进一步促成与基于几何状况的接入点相关联的接入终端的吞吐量的不确定性。

[0005] 因此,在本领域中需要改善由接入终端使用的用于与在网格网络中的接入点相关联的处理。

发明内容

[0006] 在本公开的一个方面,一种用于与网格网络中的多个接入点中的任何一个相关联的方法包括:估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关;并且根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。

[0007] 在本公开的另一个方面,一种用于通告在网格网络中的回程度量的方法包括:估计与通过所述网格网络的回程的吞吐量相关的回程度量;并且,通告所述网格网络中的所述回程度量。

[0008] 在本公开的另一个方面,一种用于在具有多个接入点的网格网络中进行无线通信的装置包括:处理系统,所述处理系统用于估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关,所述处理系统还用于根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。

[0009] 在本公开的另一个方面,一种用于支持通过网格网络的回程的装置包括:处理系统,其用于估计与通过所述回程的吞吐量相关的回程度量;并且,通告所述网格网络中的所述回程度量。

[0010] 在本公开的另一个方面,一种用于在具有多个接入点的网格网络中进行无线通信的装置包括:用于估计所述接入点的多个度量的模块,所估计的度量与由所述接入点提供的吞吐量相关;以及,用于根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联的模块,所述回程度量与所述接入点的回程吞吐量相关。

[0011] 在本公开的另一个方面,一种用于支持通过网格网络的回程的装置包括:用于估计与通过所述网格网络的回程的吞吐量相关的回程度量的模块;以及,用于通告所述网格网络中的所述回程度量的模块。

[0012] 在本公开的另一个方面,一种用于无线通信的计算机程序产品包括机器可读介质,其具有可由处理系统执行的指令,以用于:估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关;并且,根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关。

[0013] 在本公开的另一个方面,一种用于无线通信的计算机程序产品包括机器可读介质,其具有可由处理系统执行的指令,以用于:估计与通过所述网格网络的回程的吞吐量相关的回程度量;并且,通告所述网格网络中的所述回程度量。

[0014] 在本公开的另一个方面,一种用于在具有多个接入点的网格网络中进行无线通信的接入终端包括:处理系统,所述处理系统用于估计所述接入点的多个度量,所估计的度量与由所述接入点提供的吞吐量相关,所述处理系统还用于根据所述度量和所述接入点的多个回程度量来选择所述接入点中的一个接入点进行关联,所述回程度量与所述接入点的回程吞吐量相关,并且其中,所述处理系统还用于与所述接入点中的所选择的一个接入点相关联;以及,用户接口,其用于使得用户能够控制在所述处理系统和所述接入点中的所选择的一个接入点之间的通信。

[0015] 在本公开的另一个方面,一种接入点包括:网络适配器,所述网络适配器用于支持通过网格网络的回程;以及,处理系统,其用于估计与通过所述回程的吞吐量相关的回程度量,并且通告所述网格网络中的所述回程度量。

[0016] 可以理解,通过下面的详细说明,本发明的其它方面对于本领域内的技术人员来说将变得显而易见,其中,通过说明的方式来示出和描述了本发明的各个方面。可以明白,本发明能够具有其它和不同的配置和实现方式,并且能够在各个其它方面中修改其若干细节,这些都不偏离本公开的范围。因此,附图和详细说明实质上要看作是说明性的,而不是限定性的。

附图说明

[0017] 在附图中,通过示例而非限定的方式说明了无线通信系统的各个方面,其中:

[0018] 图 1 是说明了网格网络的一个示例的概念图;

[0019] 图 2 是说明了试图与网格网络相关联的接入终端的一个示例的概念图;

[0020] 图 3 是说明了试图与网格网络相关联的接入终端的另一个示例的概念图;

[0021] 图 4 是说明了接入终端的功能的示例的框图 ;以及

[0022] 图 5 是说明了接入点的功能的示例的框图。

具体实施方式

[0023] 下面结合附图所阐明的详细描述旨在作为本发明的各种配置的描述,而并非旨在表示可以实施本发明的仅有配置。详细描述包括具体细节,用于充分理解本发明。但是,对于本领域内的技术人员来说显然地,可以在没有这些具体细节的情况下实施本发明。在一些情况下,以框图的形式示出了公知的结构和部件,以避免混淆本发明的思想。

[0024] 图 1 是说明了网格网络 100 的示例的概念图。网格网络 100 被示出为具有一簇网格接入点 (MAP) 102,它们一起用于向一个或多个接入终端 (未示出) 提供回程服务。网格网络 100 包括无线节点 102A,其向网络 104 (例如,因特网、蜂窝网络等) 提供有线回程连接。由于无线节点 102A 的有线回程连接,因此这个无线节点 102A 有时被称为所述簇的根接入点 (RAP)。然而,这个无线节点 102A 也可以与在具有不同 RAP 的不同簇中的其它接入点一起向接入终端提供回程服务。

[0025] 通过在 MAP 102A-102G 之间建立无线电链路来创建在图 1 中的簇。在图 1 所示的示例中,RAP 102A 具有与 MAP 102B 和 102C 的无线电链路,MAP 102B 还具有与 MAP 102D 和 102E 的无线电链路,并且 MAP 102C 还具有与 MAP 102F 和 MAP 102G 的无线电链路。虽然未示出,但是 MAP 102B-102G 的一个或多个可以具有与在同一簇中的其它 MAP 和 / 或在其它簇中的无线节点的另外的无线电链路。而且,一个或多个 MAP 102B-102G 也可以作为在一个或多个其它簇中的其它无线节点的 RAP。

[0026] 使用或采用来支持网格网络 100 的空中接口规格可以基于使得移动接入终端能够共享可用的无线电资源的任何无线技术。这样的无线技术的示例包括码分多址 (CDMA)、宽带 CDMA (W-CDMA)、正交频分多址 (OFDMA)、时分多址 (TDMA)、频分多址 (FDMA) 或者它们的某个组合。用于支持无线电链路的所述空中接口规格可以是 CDMA2000、演进数据优化 (EV-DO)、超移动宽带 (UMB)、IEEE 802.11、或者现在已知或未来开发的任何其它适当的空中接口规格。

[0027] 图 2 是说明了试图与网格网络 100 相关联的接入终端 106 的一个示例的概念图。接入终端 106 可以是能够支持与无线节点 102 的无线电通信的任何移动用户设备,其中包括例如移动或者蜂窝电话、个人数字助理 (PDA)、膝上型计算机、数字音频设备 (例如, MP3 播放机)、游戏控制器、数字照相机或者其它语音、数据、音频、视频、消息传送或者多媒体设备。在一些应用中,接入终端 106 也可以作为用于在网格网络 100 的同一或者不同簇中的其它无线节点的接入点。

[0028] 当接入终端 106 试图与网格网络 100 相关联时,接入终端 106 确定其应当如何将数据转发到 RAP 102A。在这个示例中,接入终端 106 有可能通过两个 MAP 102B 或者 102C 中的一个来建立路由。接入终端 106 可以使用多种可能的关联技术来选择能够提供最高吞吐量的 MAP。这些技术也适用于试图加入网格网络 100 的其它无线节点,例如,先前离线但现在准备成为网格网络的一部分的 MAP。

[0029] 一种关联技术是基于两个 MAP 102B 和 102C 中的每个的某些度量。具体地,对于每个 MAP 102B 和 102C,接入终端 106 估计与 MAP 能够提供的吞吐量相关的度量。接入终端

106 还获得与每个 MAP 102B 和 102C 的回程能够提供的吞吐量相关的那个 MAP 的回程度量。回程度量可以被 MAP 102B 和 102C 通告,或者接入终端 106 可以以另一种方式来获得它们。接入终端 106 然后根据所述度量和所述回程度量来选择两个 MAP 102B 和 102C 中的一个。

[0030] 现在介绍一个度量的示例,其包括网格网络中的 MAP 102 的几何状况。参见图 2,接入终端 106 确定 MAP 102B 和 102C 的几何状况。MAP 的几何状况可以例如通过其信标的信号强度被确定。可以以避免冲突的方式来从每个 MAP 发送所述信标。通过下述方式来实现这一点:在时间上将信标分离,使用 GPS 同步,以及使得 MAP 使用在信标帧中的适当偏移来发送它们的信标。或者,可以在不同的频率上发送所述信标。在任何一种情况下,一旦已知 MAP 102B 和 102C 的几何状况,则接入终端 106 可以确定它通过 MAP 102B 和 102C 中的每个能够实现的吞吐量。

[0031] 接着,接入终端 106 获得 MAP 102B 和 102C 中的每个的回程几何状况。可以通过下述方式来确定回程几何状况:通过在 MAP 102B 和 102C 两者处测量由 RAP 102A 发送的信标的信号强度。每个 MAP 102B 和 102C 的回程几何状况随后可以在其各自的信标中被通告,或者每个 MAP 102B 和 102C 可以响应于来自接入终端 106 的探测消息来发送所述回程几何状况。一旦获得 MAP 102B 和 102C 的回程几何状况,则接入终端 106 可以确定通过 MAP 102B 和 102C 中的每个的回程能够实现的吞吐量。

[0032] 选择要关联的 MAP 的处理是两个步骤的处理。首先,接入终端 106 通过获得下述的最小值来估计其通过 MAP 102B 和 102C 中的每个将实现的整体吞吐量:(1)到 MAP 的吞吐量(根据估计的几何状况确定);(2)MAP 从其自身的到 RAP 102A 的连接接收的吞吐量(根据回程几何状况确定)。其次,接入终端 106 选择提供了最大整体吞吐量的 MAP。

[0033] 刚才提供的示例良好地适用于未加负载或者负载较轻的网格网络 100。在加载的网格网络 100 中,接入终端 106 或者其它无线节点可以在 MAP 遵循其调度策略的同时尝试与为其提供最高吞吐量的 MAP 相关联。在下面的示例中,假定所有的 MAP 采用同一调度策略,诸如相等服务级(EGOS)策略,但是本领域内的技术人员能够容易地将在这个示例中提供的原理扩展到任何适当的调度策略。在这个示例中,每个 MAP 根据其调度策略和其回程几何状况来通告其速率。接入终端 106 根据这个通告和其自身估计的几何状况,可以计算出与任何特定的 MAP 相关联时它将接收到的整体吞吐量。在接入终端 106 与 MAP 相关联后,所述 MAP 因此调整其向与其关联的所有无线节点提供的速率。

[0034] 接入终端 106 可以使用各种其它度量来与网格网络 100 中的 MAP 102 相关联,以最大化吞吐量。举例而言,接入终端 106 可以使用在网格网络 100 中的信道增益来选择适当的 MAP 进行关联。参见图 2,接入终端 106 确定每个 MAP 102B 和 102C 可以提供的信道增益。接入终端 106 还在信标中或者响应于探测消息来接收每个 MAP 102B 和 102C 的回程可以提供的信道增益(即,在 MAP 102 和 RAP 102A 之间的信道增益)。这些度量然后可以用于计算由每个 MAP 102B 和 102C 提供的整体吞吐量,并且以与前面结合基于几何状况的选择介绍的类似的方式来选择要关联的适当 MAP 102。

[0035] 作为对于信道增益的替代,接入终端 106 可以使用速率来选择要关联的适当 MAP 102。在这个示例中,接入终端 106 确定在其附近的各个 MAP 可以提供的速率和每个 MAP 可以支持的回程速率。这些度量然后用于计算由每个 MAP 提供的整体吞吐量,以支持对要关联的 MAP 102 的选择。

[0036] 至此,提供的示例涉及在 RAP 和 MAP 之间的具有单跳的路由方案。但是,根据网格网络的配置、在网格网络上的负载和信道状况,接入终端可以选择在 RAP 和与该接入终端相关联的 MAP 之间的具有多跳的路径。

[0037] 图 3 是说明了试图与网格网络 100 相关联的接入终端 106 的另一个示例的概念图。在这个示例中,存在接入终端 106 有可能关联的两个 MAP 102E 和 102F,这些 MAP 102E 和 102F 中的每个具有到 RAP 102A 的回程。第一 MAP 102E 具有通过 MAP 102B 到 RAP 102A 的回程,第二 MAP 102F 具有通过 MAP 102C 到 RAP 102A 的回程。

[0038] 当接入终端 106 试图关联于网格网络 100 时,其确定每个 MAP 102E 和 102F 的度量(例如,几何状况、信道增益、速率等)。接着,接入终端 106 从每个 MAP 102E 和 102F 接收通告,或者以其它方式获得每个的回程度量。回程度量包括向量,其包含通过网格网络 100 的回程的每跳的度量。举例而言,接入终端 106 可以从 MAP 102E 获得向量,其包含用于在 MAP 102E 和中间 MAP 102B 之间的跳的第一度量和用于在中间 MAP 102B 和 RAP 102A 之间的跳的第二度量。接入终端 106 然后确定到 RAP 102 的三跳的每个的吞吐量,并且将最小吞吐量分配为由 MAP 102E 通过网格网络支持的整体吞吐量。以类似的方式,接入终端 106 确定由 MAP 102F 支持的整体吞吐量,然后选择具有最大整体吞吐量的 MAP 来进行关联。

[0039] 图 4 是说明了接入终端 106 的功能的示例的框图。接入终端 106 被示出为具有处理系统 402 和收发机 404。收发机 404 可以用于实现物理层的模拟部分,并且处理系统 402 可以用于实现物理层的数字处理部分以及链路层。处理系统 402 也可以用于执行各种其它功能,其中包括与在网格网络中的接入点进行关联的处理。具体地,处理系统 402 可以提供模块 406,用于估计接入点的多个度量。这些度量可以与接入点提供的吞吐量有关。处理系统 402 还可以提供模块 408,用于根据所述度量和接入点的多个回程度量来选择接入点中的一个进行关联。所述回程度量可以与接入点的回程吞吐量有关。

[0040] 图 5 是说明了接入点 102 的功能的示例的框图。接入点 102 被示出为具有处理系统 502 和收发机 504。与前面结合图 4 所讨论的接入终端很像,收发机 504 可以用于实现物理层的模拟部分,并且处理系统 502 可以用于实现物理层的数字处理部分以及链路层。处理系统 502 还可以用于执行各种其它功能,其中包括使得接入终端或者其它无线节点能够与其关联以加入到网格网络中的处理。具体地,处理系统 502 可以提供模块 506,用于估计与通过网格网络的回程的吞吐量相关的回程度量。处理系统 502 还可以包括模块 508,用于通告网格网络中的回程度量。

[0041] 可以使用软件、硬件或者两者的组合来实现结合图 4 和 5 描述的处理系统 402 和 502。举例而言,可以使用一个或多个集成电路(IC)来实现处理系统。IC 可以包括被设计来执行本文所述的功能的通用处理器、数字信号处理器(DSP)、专用集成电路(ASIC)、现场可编程门阵列(FPGA)或者其它可编程逻辑设备、分立门或者晶体管逻辑、分立硬件部件、电子部件、光学部件、机械部件或者其任何组合,并且可以执行驻留在 IC 内部、IC 外部或者两处都有的代码或者指令。通用处理器可以是微处理器,但是作为替代,通用处理器可以是任何传统的处理器、控制器、微控制器或者状态机。处理系统也可以被实现为计算设备的组合,例如 DSP 和微处理器的组合、多个微处理器的组合、与 DSP 核心相结合的一个或多个微处理器的组合或者任何其它这样的配置。

[0042] 可以在一个或多个机器可读媒体中体现所述代码或者指令以支持软件应用。软件

应当广义地解释为表示指令、程序、代码或者任何其它电子媒体内容,不论所述电子媒体内容是被称为软件、固件、中间件、微码、硬件描述语言还是其它。机器可读媒体可以包括与处理器集成的存储器,例如可以是具有 ASIC 的情况。机器可读媒体还可以包括处理器外部的存储器,诸如随机存取存储器 (RAM)、快闪存储器、只读存储器 (ROM)、可编程只读存储器 (PROM)、可擦除 PROM (EPROM)、寄存器、硬盘、可移动盘、CD-ROM、DVD 或者任何其它适当的存储设备。另外,机器可读媒体可以包括传输线或者编码数据信号的载波。本领域内的技术人员可以认识到如何最佳地实现处理系统的所述功能。而且,在一些方面,任何适当的计算机程序产品可以包括计算机可读介质或者机器可读介质,其包括与本公开的一个或多个方面相关的代码。在一些方面,计算机程序产品可以包括封装材料。

[0043] 前述说明被提供来使得本领域内的任何技术人员能够实施本文所述的各个方面。对于这些方面的各种修改对于本领域内的技术人员是显而易见的,并且本文定义的一般原理可以被应用到其它方面。因此,权利要求不意欲限于本文所述的方面,而是要符合与字面权利要求一致的全部范围,其中,对于单数的元素的引用不意欲表示“一个并且仅仅一个”(除非如此具体说明),而是表示“一个或多个”。除非另外具体说明,术语“一些”表示一个或多个。本领域内的普通技术人员已知或者未来要知道的、等同于在整个本公开中所述的各个方面的元素的所有结构和功能通过引用被明确地包含在此,并且意欲被权利要求涵盖。而且,本文公开的所有内容都不意欲奉献于公众,而不论是否在权利要求中明确地陈述了这样的公开。不应按照 35U.S.C. § 112 的第六段落的规定来解释任何权利要求的元素,除非使用短语“用于...的模块”来明确地陈述所述元素,或者在方法权利要求的情况下,使用短语“用于...的步骤”来陈述所述元素。

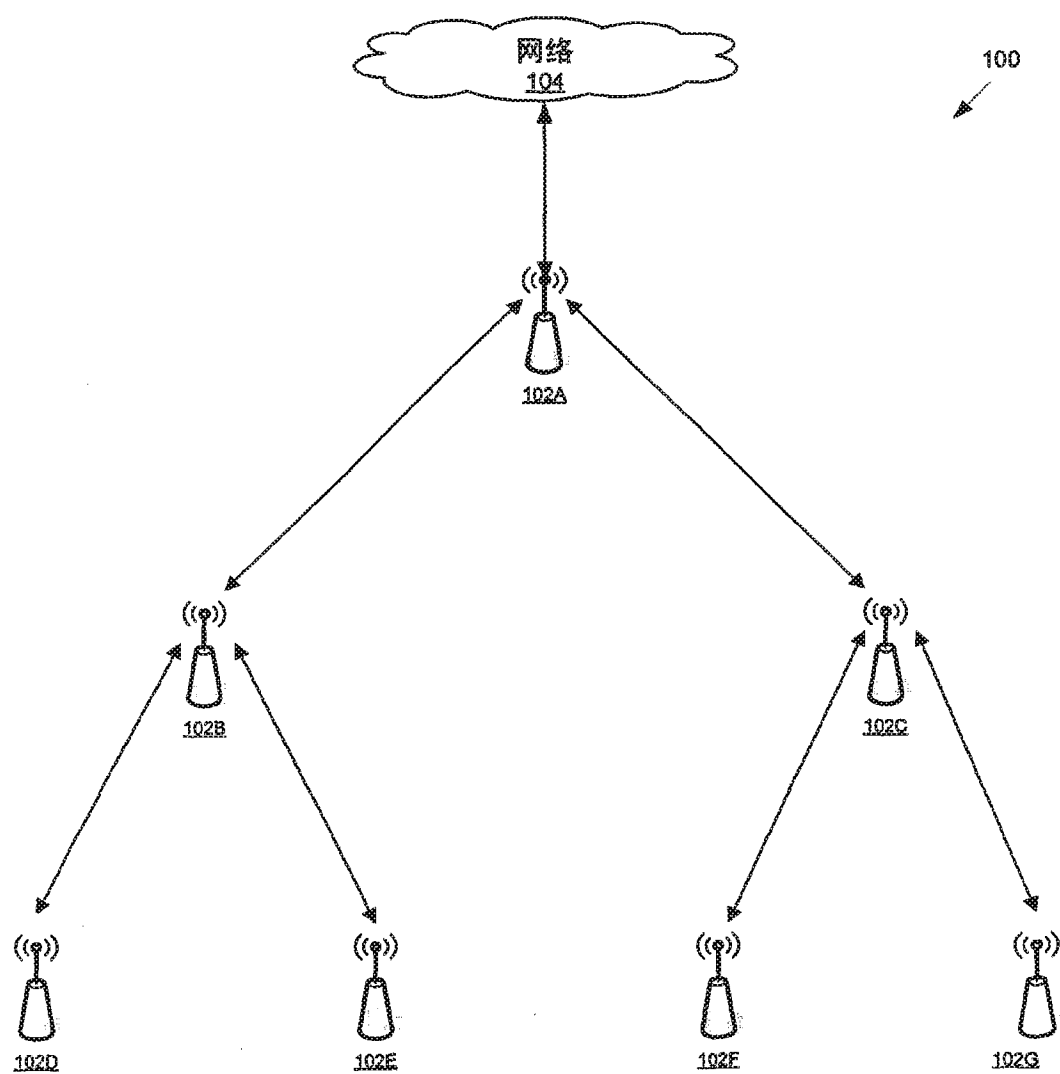


图 1

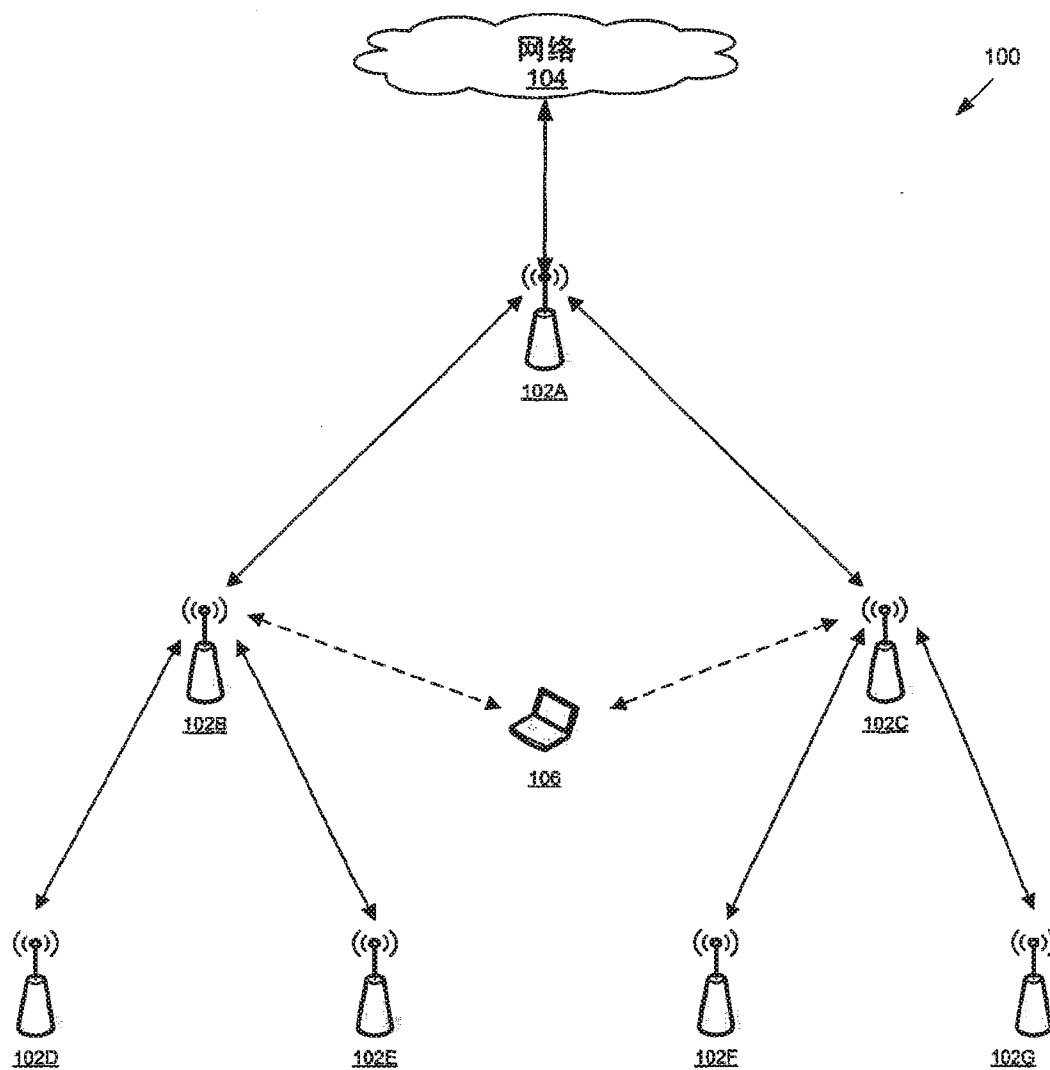


图 2

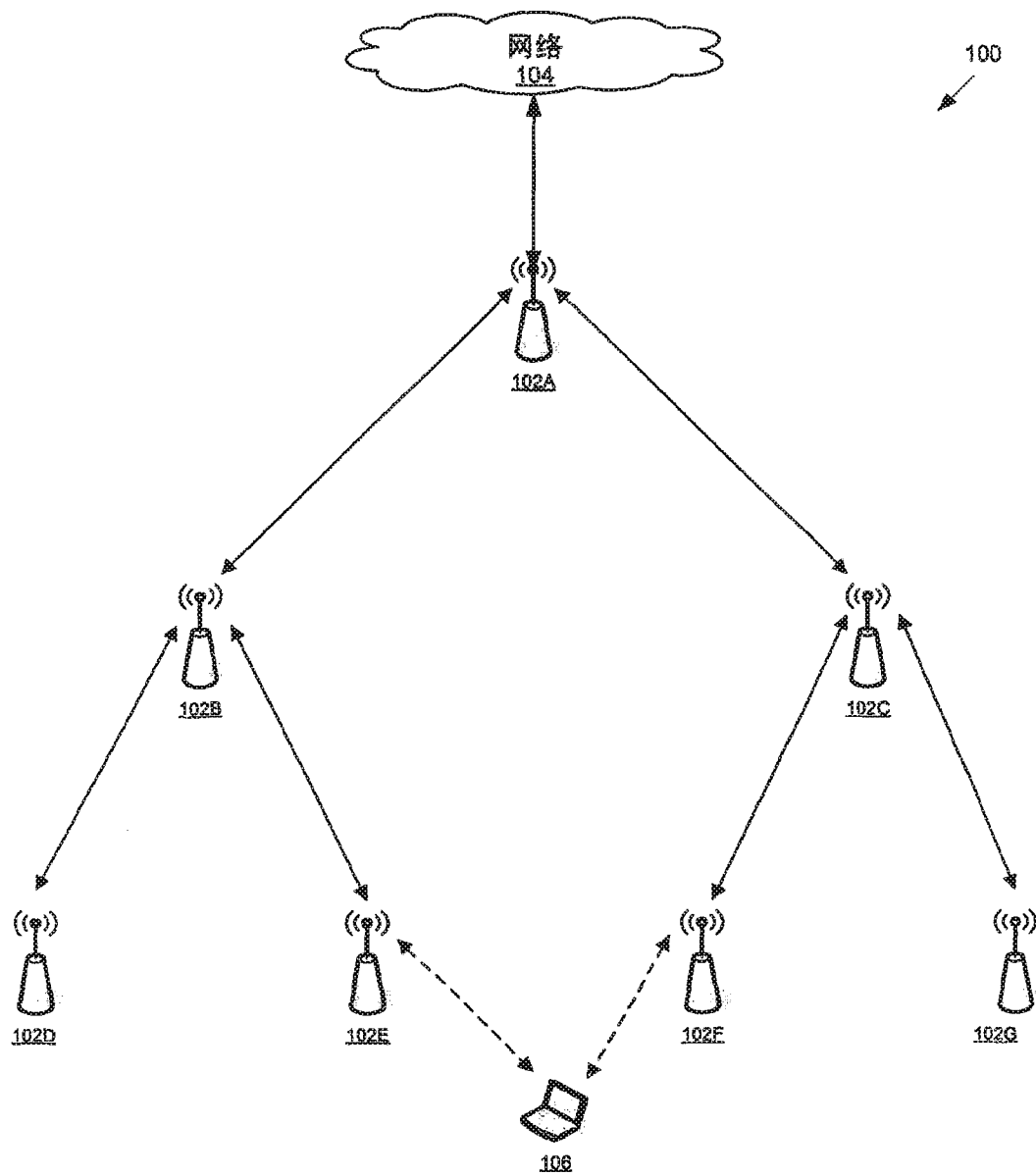


图 3

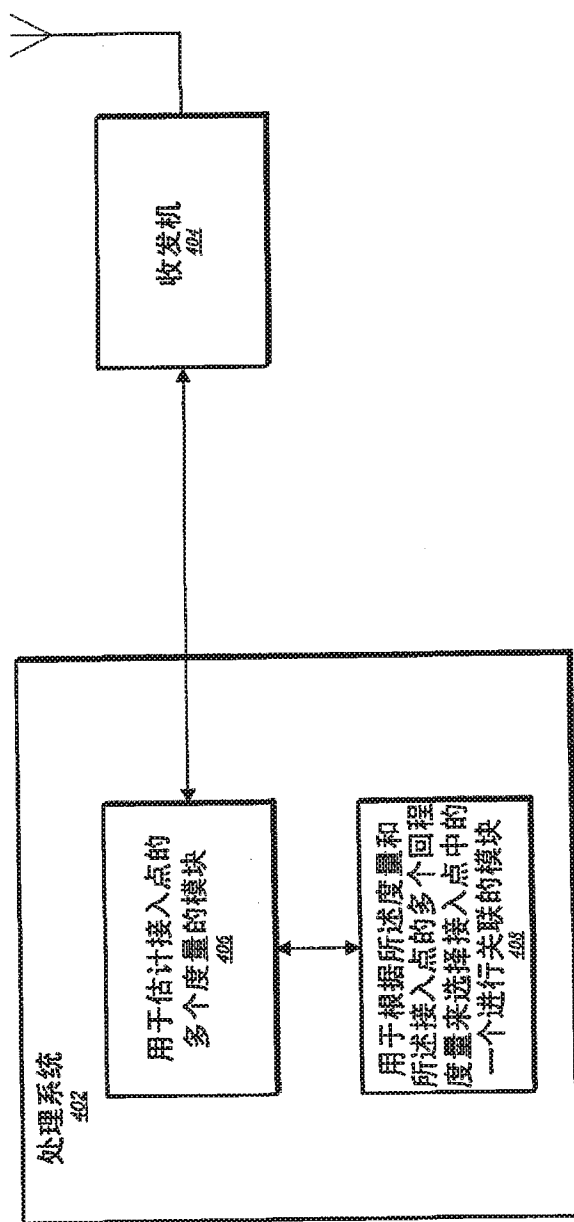


图 4

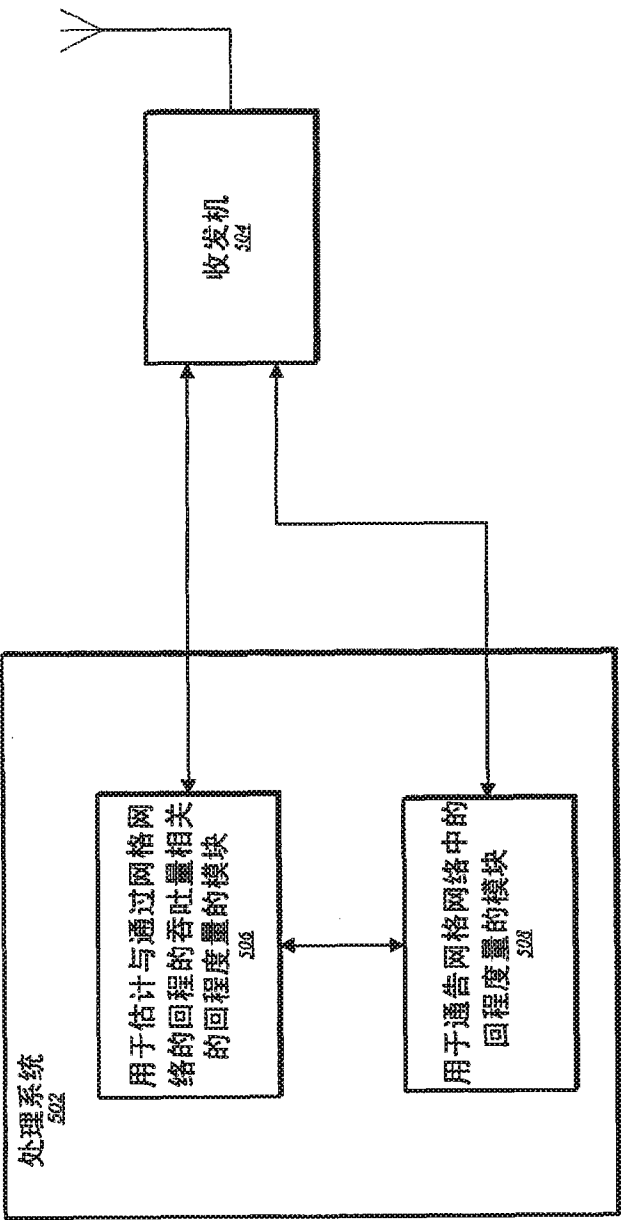


图 5



Espacenet

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Initial configuration method and device for wireless backhaul link

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Applicant(s): ZTE CORP ± (ZTE CORPORATION)

Classification: - international: *H04W28/26; H04W72/04*
- cooperative:

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Priority number(s): CN201010277368 20100903

Abstract of CN102387553 (A)

The invention discloses an initial configuration method and an initial configuration device for a wireless backhaul link. The method comprises the following steps of: starting an access node, and reporting information to a base station by using an original authorized frequency spectrum; and reconfiguring a wireless backhaul link between the base station and the access point according to a TVWS (Television White Spectrum) resource distributed by a system by using the base station, and switching the wireless backhaul link onto the distributed TVWS resource. According to the method and the device, the resource distribution problem of the wireless backhaul link is solved, and the volume or service quality of a wireless access link is not influenced simultaneously.

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DESCRIPTION CN102387553

The present invention discloses an initial configuration method and apparatus for a wireless backhaul link. The method includes: after the access node is turned on, the original authorized spectrum is used to report information to the base station; and the base station allocates a TV band white space (TVWS) resource according to the system. A reconfiguration of the wireless backhaul link between the base station and the access node is implemented, and the wireless backhaul link is switched to the allocated TVWS spectrum resource. The invention solves the problem of resource allocation of the wireless backhaul link, and does not affect the capacity or service quality of the wireless access link.

Initial configuration method and device for wireless backhaul link

Technical field

The present invention relates to the field of wireless communication and cognitive radio technologies, and more particularly to an initial configuration method and apparatus for a wireless backhaul link.

Background technique

For the LTE (Long Term Evolution) technology or the LTE-A (Long Term Evolution-advanced) technology, the current AP (Access Point) has the following types: enhanced macros. An enhanced Node Base Station, a Relay, a Femto NB, a Pico NB, and a Home NB. Some of these access nodes can be directly connected, and the link between the directly connected access nodes is called a backhaul link.

The backhaul link may be wireless in LTE/LTE-A, such as the following scenarios: remote areas, coverage of temporary hotspot areas, disaster relief periods, access nodes in nomadic states, and so on. In these scenarios, because the cost of deploying a wired connection is too high, or it is impossible to estimate its location and advance wired coverage, or wired communication is interrupted, it cannot be effectively covered by a wired connection. The wireless link can provide services quickly, so it is necessary to allocate frequency resources for this part of the backhaul link for wireless connection.

In the above scenario, for the resource allocation of the wireless backhaul link, it is basically considered that a part of the authorization is allocated to the spectrum resource of the LTE/LTE-A system for the wireless backhaul link connection according to the provisions of the spectrum management organization. Since the spectrum that each operator finally obtains for the operation of the LTE/LTE-A system is very limited, this way of dividing some resources into the wireless backhaul link is bound to cause loss of the capacity and quality of the access link. . Despite the strict physical layer and high-level protocol definitions, this loss can be minimized, but this loss must exist.

Therefore, how to solve the resource allocation problem of the wireless backhaul link without affecting the capacity or quality of the access link is a problem that needs to be solved in the prior art.

Summary of the invention

The technical problem to be solved by the present invention is to provide an initial configuration method and device for a wireless backhaul link, which solves the problem of resource allocation of the wireless backhaul link without affecting the capacity or service quality of the access link.

To solve the above technical problem, the present invention provides an initial configuration method of a wireless backhaul link, where the method includes:

After the access node is turned on, the original authorized spectrum is used to report information to the base station;

The base station performs reconfiguration of the wireless backhaul link between the base station and the access node according to the TV band white space (TVWS) resource allocated by the system, and switches the wireless backhaul link to the allocated TVWS spectrum resource.

The base station initiates a TVWS spectrum resource allocation request to the system for the wireless backhaul link;

After receiving the spectrum resource allocation request, the system determines that available TVWS spectrum resources are allocated to the base station according to the maintained available TVWS information.

The system maintains the available TVWS information according to the acquired TVWS information and the usage of the system by the TVWS spectrum resource;

The TVWS information refers to information of a television band spectrum resource that is not occupied by a TV band authorization service, and the available TVWS information refers to information of a TVWS spectrum resource that is not used by the system.

After receiving the spectrum resource allocation request, the system allocates available TVWS spectrum resources directly to the base station according to the available TVWS information, if there is currently available TVWS spectrum resources; if not currently available The TVWS spectrum resource is allocated to the base station by using TVWS spectrum resources used by other base stations by negotiating with other base stations in the system.

After receiving the spectrum resource allocation request, if the system does not currently have available TVWS spectrum resources and fails to negotiate with other base stations in the system, the system sends a failure response to the base station, and refuses to allocate spectrum to the base station. Resource

After receiving the failure response, the base station determines that the wireless backhaul link with the access node continues to use the original licensed spectrum resource.

The system updates the available TVWS information for maintenance after allocating available TVWS spectrum resources to the base station.

When the base station initiates the spectrum resource allocation request to the system, the base station applies for the spectrum resource only according to the actual requirement of the wireless backhaul link between the

subordinate access nodes, or applies for a certain resource reservation amount. Establish a wireless backhaul link with the newly opened access node.

The present invention also provides an initial configuration apparatus for a wireless backhaul link, the apparatus comprising a first configuration module in an access node, and a second configuration module in the base station,

The first configuration module is configured to report information to the base station by using the original licensed spectrum after the access node is enabled;

The second configuration module is configured to implement reconfiguration of a wireless backhaul link between the base station and the access node according to the allocated TVWS spectrum resource of the system, and switch the wireless backhaul link to the allocated TVWS spectrum resource. .

The device further includes a spectrum resource allocation request module in the base station, and a spectrum resource allocation module in the system,

The spectrum resource allocation requesting module is configured to initiate a spectrum resource allocation request to the spectrum resource allocation module for a wireless backhaul link between the base station and each of the subordinate access nodes;

And the spectrum resource allocation module is configured to determine, after receiving the spectrum resource allocation request, the available TVWS spectrum resource to be allocated to the base station according to the maintained available TVWS information.

The spectrum resource allocation module is further configured to maintain the available TVWS information according to the acquired TVWS information and the usage of the TVWS spectrum resource by the system;

The TVWS information refers to information of a television band spectrum resource that is not occupied by a TV band authorization service, and the available TVWS information refers to information of a TVWS spectrum resource that is not used by the system.

The spectrum resource allocation module is further configured to: after receiving the spectrum resource allocation request, according to the maintained TVWS information, if there is currently available TVWS spectrum resource, directly allocate the available TVWS to the base station. Spectrum resources; if there is currently no TVWS spectrum resource available, the TVWS spectrum resources used by other base stations are allocated to the base station by negotiating with other base stations in the system.

The spectrum resource allocation module is further configured to: after receiving the spectrum resource allocation request, if there is no TVWS spectrum resource currently available, and the other base stations in the system fail to negotiate, send a failure response to the base station, Refusing to allocate spectrum resources to the base station;

After receiving the failure response, the base station determines that the wireless backhaul link with the access node continues to use the original licensed spectrum resource.

The spectrum resource allocation module is further configured to: after the available TVWS spectrum resources are allocated to the base station, update the available TVWS information that is maintained.

The spectrum resource allocation requesting module is further configured to apply for the spectrum according to the actual requirement of the wireless backhaul link between the subordinate access nodes when the spectrum resource allocation request is initiated to the spectrum resource allocation module. Resources, or, apply for a certain amount of resource reservation to establish a wireless backhaul link with the newly opened access node.

The present invention obtains available TVWS spectrum resources by accessing a database and collecting usage information of the TV band spectrum of each base station in the system, and establishing a wireless backhaul link by using the available TVWS spectrum resources.

Compared with the prior art, the present invention has at least the following beneficial effects:

1.

Solve the problem of resource allocation of wireless backhaul link without affecting the capacity or quality of service of the wireless access link;

2.

The wireless backhaul link can be dynamically established without the need to pre-lay cables in advance (the location where the cables are laid may not be known in advance), saving manpower and material costs;

3.

For the wireless backhaul link, its setup and removal can be controlled only by software, increasing the flexibility of the backhaul link.

DRAWINGS

The drawings are intended to provide a further understanding of the invention, and are intended to be a part of the invention.

In the drawing:

1 is a schematic diagram of an application scenario of an initial configuration device of a wireless backhaul link according to an embodiment of the present invention;

2 is a schematic flowchart of initial configuration of a wireless backhaul link according to an embodiment of the present invention;

3 is a signaling flowchart of an initial configuration of a wireless backhaul link according to an embodiment of the present invention;

FIG. 4 is a signaling flowchart of an initial configuration of a wireless backhaul link according to another embodiment of the present invention.

detailed description

In order to overcome the deficiencies of the prior art, considering that the utilization rate of the existing television spectrum is not high and the stability is good, the present invention proposes a resource allocation method for a wireless backhaul link based on cognitive radio technology, and the core idea is According to the current wireless

backhaul link requirements and the collected TVWS (TV White Spaces) information, the TVWS spectrum resources are used to establish a temporary wireless backhaul link, thereby solving the problem of resource allocation of the wireless backhaul link. The capacity or quality of service of the wireless access link is affected.

Based on the above idea, the present invention provides a resource allocation method for a wireless backhaul link, and specifically adopts the following technical solutions:

After the access node is turned on, the original authorized spectrum is used to report information to the base station;

The base station implements reconfiguration of the wireless backhaul link between the base station and the access node according to the TVWS spectrum resource allocated by the system, and switches the wireless backhaul link to the allocated TVWS spectrum resource.

Further, the base station initiates a spectrum resource allocation request to the system for the wireless backhaul link;

After receiving the spectrum resource allocation request, the system determines that available TVWS spectrum resources are allocated to the base station according to the maintained available TVWS information.

Further, the system maintains the available TVWS information according to the acquired TVWS information and the usage of the TVWS spectrum resource by the system;

The TVWS information refers to information of a television band spectrum resource that is not occupied by a TV band authorization service, and the available TVWS information refers to information of a TVWS spectrum resource that is not used by the system.

Further, after receiving the spectrum resource allocation request, the system directly allocates available TVWS spectrum resources to the base station according to the available TVWS information that is maintained, if there is currently available TVWS spectrum resource; The available TVWS spectrum resources are allocated to the base station by using TVWS spectrum resources used by other base stations by negotiating with other base stations in the system.

Further, after receiving the spectrum resource allocation request, if the system does not currently have available TVWS spectrum resources and fails to negotiate with other base stations in the system, the system sends a failure response to the base station, and refuses to allocate the base station. Spectrum resources;

After receiving the failure response, the base station determines that the wireless backhaul link with the access node continues to use the original licensed spectrum resource.

In order to facilitate the description of the present invention, the implementation of the technical solution of the present invention will be further described in detail below with reference to the accompanying drawings and specific embodiments.

FIG. 1 shows an initial configuration procedure of a wireless backhaul link according to an embodiment of the present invention. Referring to FIG. 1, the initial configuration process of this embodiment mainly includes the following steps:

Step 1: The system obtains TVWS information and maintains available TVWS information;

The TVWS information refers to the information of the TV band spectrum resource that is not occupied by the TV band authorization service, and the available TVWS information refers to the information of the TVWS spectrum resource that is not used by the system.

The TVWS information may include, but is not limited to, an available channel (including a working frequency and bandwidth), a coverage, a possible duration, and a maximum transmit power allowed.

Step 2: The newly opened access node reports the information to the system by using the original licensed spectrum.

Step 3: The system makes a TVWS spectrum resource allocation decision;

The basis for the allocation decision mainly includes: the available TVWS information maintained by the system, and the reporting information of the newly opened access node.

The allocation decision can be made according to the needs of the actual application scenario, and a specific example of the assignment decision will be given below.

Step 4: Obtain a wireless Backhaul link reconfiguration of the TVWS spectrum resource, and switch to the obtained TVWS spectrum resource for communication;

Step 5: The system updates the available TVWS information.

The application scenario of the embodiment of the present invention is as shown in FIG. 2. The initial configuration device of the wireless backhaul link in this embodiment mainly involves the following network elements:

TV database (TVDB): It can be provided by a TV operator or a third party. The content of the TV database is the use of the TV spectrum (channel) of the TV operator locally or in several local areas, that is, 1.

The spectrum (channel) status being used, including but not limited to: channel number, bandwidth, possible duration, D/U requirements (power ratio of wanted and interfering signals expected for the TV receiver), spectrum mask, coverage Information such as range and isolation zone; 2.

Unused spectrum (channel) status, including but not limited to: channel number, working bandwidth, coverage range, possible duration, maximum allowable transmit power, etc.; Information about channels that are not allowed (may be admin domain restricted channels or carrier reserved channels, etc.), including but not limited to: channel number, working bandwidth, etc.

Central Control Point (CCP): CCP and TVDB can be fixed connections; Converging spectrum usage information from each BS and TVDB, obtaining and maintaining available TVWS information corresponding to each BS; 2. It is responsible for allocating TVWS resources to each BS, including initial spectrum allocation, and resource coordination allocation between wireless backhaul links under different BSs, and link switching assignment when primary users appear.

Base Station (BS): The BS can be directly connected to the CCP. Its functions include but are not limited to: 1.

The obtained TVWS resources are allocated to the wireless backhaul links connected thereto; Change or adjust the parameters of the wireless communication technology, for example, modulation type, transmission power; Manage and maintain the working spectrum, for example, operating frequency and frequency bands; Responsible for communication with the central control node; 5. Spectrum sensing function; 6. Perceive data processing capabilities.

Access Node (AP): The AP may be a Relay, a Femto NB, a Pico NB, and a Home NB. The AP aggregates user information and communicates with the BS (constituting a backhaul link). The AP interacts with the user through the AP. The coverage of the AP is significantly reduced compared to the BS. AP functions include but are not limited to: 1. Change or adjust the parameters of the wireless communication technology, for example, modulation type, transmission power; Adjust the working frequency and frequency band; 3. Spectrum sensing; 4. Two-way communication with the user and the BS.

In addition, in another embodiment of the present invention, an apparatus for initial configuration of a wireless backhaul link is provided, where the apparatus includes a first configuration module in an access node, and a second configuration module in the base station.

The first configuration module is configured to report information to the base station by using the original licensed spectrum after the access node is enabled;

The second configuration module is configured to implement reconfiguration of a wireless backhaul link between the base station and the access node according to the allocated TVWS spectrum resource of the system, and switch the wireless backhaul link to the allocated TVWS spectrum resource. .

The device further includes a spectrum resource allocation request module in the base station, and a spectrum resource allocation module in the system,

The spectrum resource allocation requesting module is configured to initiate a spectrum resource allocation request to the spectrum resource allocation module for a wireless backhaul link between the base station and each of the subordinate access nodes;

And the spectrum resource allocation module is configured to determine, after receiving the spectrum resource allocation request, the available TVWS spectrum resource to be allocated to the base station according to the maintained available TVWS information.

The spectrum resource allocation module is further configured to maintain the available TVWS information according to the acquired TVWS information and the usage of the TVWS spectrum resource by the system;

The TVWS information refers to information of a television band spectrum resource that is not occupied by a TV band authorization service, and the available TVWS information refers to information of a TVWS spectrum resource that is not used by the system.

The spectrum resource allocation module is further configured to: after receiving the spectrum resource allocation request, according to the maintained TVWS information, if there is currently available TVWS spectrum resource, directly allocate the available TVWS to the base station. Spectrum resources; if there is currently no TVWS spectrum resource available, the TVWS spectrum resources used by other base stations are allocated to the base station by negotiating with other base stations in the system.

The spectrum resource allocation module is further configured to: after receiving the spectrum resource allocation request, if there is no TVWS spectrum resource currently available, and the other base stations in the system fail to negotiate, send a failure response to the base station, Refusing to allocate spectrum resources to the base station;

After receiving the failure response, the base station determines that the wireless backhaul link with the access node continues to use the original licensed spectrum resource.

The spectrum resource allocation module is further configured to: after the available TVWS spectrum resources are allocated to the base station, update the available TVWS information that is maintained.

The spectrum resource allocation requesting module is further configured to apply for the spectrum according to the actual requirement of the wireless backhaul link between the subordinate access nodes when the spectrum resource allocation request is initiated to the spectrum resource allocation module. Resources, or, apply for a certain amount of resource reservation to establish a wireless backhaul link with the newly opened access node.

The signaling flow of the resource allocation method for the wireless backhaul link of the present invention will be further described below in conjunction with two specific embodiments.

Embodiment 1

As shown in FIG. 3, the resource allocation method of the wireless backhaul link in this embodiment is specifically described as follows:

Step 101: The CCP obtains the TVWS information in the TVDB (that is, the information of the TV band spectrum resource that is not occupied by the TV band authorization service), including but not limited to the available channels (including the working frequency and bandwidth), the coverage, and the possible duration. And the maximum transmit power allowed; the CCP maintains available TVWS information based on the acquired TVWS information and the usage information of the system on the TVWS spectrum resources stored in the CCP (hereinafter also referred to as TVWS usage information), ie, is not the system Information on the TVWS spectrum resources used;

The manner in which the CCP obtains the TVWS information may include one of the following modes or any combination thereof: the CCP periodically accesses the TVDB, or the CCP accesses the TVDB on demand, or the TVDB actively notifies the CCP.

Step 102: After the AP is turned on, it works in the original licensed spectrum.

Step 103: The AP reports information, including maximum transmit power, supported working frequency band, location information, and access terminal capability.

Step 104: The BS requests the TVWS spectrum resource allocation to the CCP according to the wireless backhaul link between the BS according to the information reported by the AP.

Step 105: The CCP makes a decision according to the resource application reported by the BS and the currently available TVWS information, determines the radio spectrum resource allocated to the BS, and sends the allocation result to the BS. If there is no TVWS spectrum resource available for the BS, the CCP first performs TVWS spectrum resource negotiation allocation with other BSs, that is, finds other BSs to exit or switch, for example, the wireless backhaul link of other low priority BSs can be taken out of the occupied network. TVWS spectrum resources, or, for a wireless backhaul link under a BS with multiple available TVWS spectrum resources, can be switched to other available TVWS spectrum resources, and the TVWS spectrum resources being used are assigned to be issued. The applied BS and the result of the distribution is sent to the relevant BS. If

there is still no TVWS spectrum resource available after negotiation, the failure response is returned to the base station. At this time, the base station will not perform the following operation, and the wireless backhaul link continues to use the original licensed spectrum resource.

Step 106: The BS determines, according to the information reported by the subordinate AP and the obtained TVWS spectrum resource, the radio resource used by the backhaul link.

Step 107: Perform reconfiguration of the wireless backhaul link whose working spectrum changes, and switch to the new spectrum resource for communication;

The wireless backhaul link between the working spectrum and the base station includes a wireless backhaul link between the new access node and the base station, and a wireless backhaul link between the other BSs and the access nodes of the CCP that the CCP negotiates to quit or switch.

Step 108: The BS sends resource allocation update information to the CCP, and the CCP feeds back the acknowledgement message.

Step 109: The CCP updates the TVWS usage information and the available TVWS information according to the resource allocation situation.

Embodiment 2

As shown in FIG. 4, the resource allocation method of the wireless backhaul link in this embodiment is specifically described as follows:

Step 201: The CCP obtains the TVWS information in the TVDB, and combines the information stored in the TVWS by the system in the CCP to maintain the corresponding available TVWS information;

The manner in which the CCP obtains the TVWS information may be a CCP periodic access to the TVDB, or a CCP access to the TVDB on demand, or a TVDB proactively notify the CCP, or a combination thereof.

Step 202: The AP is turned on and works in the original authorized spectrum.

Step 203: The AP reports information, including but not limited to a maximum transmit power, a supported working frequency band, location information, and an access terminal capability.

Step 204: The BS according to the information reported by the AP, if the BS has the reserved TVWS spectrum resource allocated to it by the CCP, the TVWS spectrum resource is reserved for the AP and the wireless backhaul link between the AP;

In the first embodiment, the BS requests the TVWS resource request to the CCP according to the actual needs of the AP. In the embodiment, the BS applies for the TVWS spectrum resource for the first time, according to the statistics of the previous cell traffic, the application resource has A certain amount of reservation, in order to subsequently open the AP, the TVWS resource allocation is reserved directly. In this case, the BS needs to maintain this part of the reserved resources to ensure that it is an available TVWS resource. If there is no reserved TVWS resource in the BS, the TVWS spectrum resource application may be performed according to the operation in the first embodiment.

Step 205: The wireless backhaul link whose working spectrum changes is reconfigured, and is switched to a new resource for communication;

Step 206: The BS sends resource allocation update information to the CCP, and the CCP feeds back the confirmation message.

Step 207: The CCP updates the TVWS usage information and the available TVWS information according to the resource allocation situation.

The above is only a preferred embodiment of the present invention, and is not intended to limit the present invention. The present invention may be embodied in various other embodiments without departing from the spirit and scope of the invention. Various changes and modifications may be made to the invention, and such changes and modifications are intended to be included within the scope of the appended claims.

One of ordinary skill in the art will appreciate that all or a portion of the above steps may be accomplished by a program instructing the associated hardware, such as a read-only memory, a magnetic disk, or an optical disk.

Alternatively, all or part of the steps of the above embodiments may also be implemented using one or more integrated circuits. Correspondingly, each module/unit in the foregoing embodiment may be implemented in the form of hardware or in the form of a software function module. The invention is not limited to any specific form of combination of hardware and software.

Notice

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CLAIMS CN102387553

1.

An initial configuration method for a wireless backhaul link, the method comprising:

After the access node is turned on, the original authorized spectrum is used to report information to the base station;

The base station performs reconfiguration of the wireless backhaul link between the base station and the access node according to the TV band white space (TVWS) resource allocated by the system, and switches the wireless backhaul link to the allocated TVWS spectrum resource.

2.

The method of claim 1 wherein

The base station initiates a TVWS spectrum resource allocation request to the system for the wireless backhaul link;

After receiving the spectrum resource allocation request, the system determines that available TVWS spectrum resources are allocated to the base station according to the maintained available TVWS information.

3.

The method of claim 2 wherein

The system maintains the available TVWS information according to the acquired TVWS information and the usage of the system by the TVWS spectrum resource;

The TVWS information refers to information of a television band spectrum resource that is not occupied by a TV band authorization service, and the available TVWS information refers to information of a TVWS spectrum resource that is not used by the system.

4.

The method of claim 3 wherein:

After receiving the spectrum resource allocation request, the system directly allocates available TVWS spectrum resources to the base station according to the available TVWS information, if there is currently available TVWS spectrum resources; if no TVWS is currently available The spectrum resource is allocated to the base station by using TVWS spectrum resources used by other base stations by negotiating with other base stations in the system.

5.

The method of claim 4 wherein:

After receiving the spectrum resource allocation request, if the system does not currently have available TVWS spectrum resources and fails to negotiate with other base stations in the system, the system sends a failure response to the base station, and rejects allocation of spectrum resources to the base station;

After receiving the failure response, the base station determines that the wireless backhaul link with the access node continues to use the original licensed spectrum resource.

6.

The method of claim 4 wherein:

After the system allocates available TVWS spectrum resources to the base station, the maintained TVWS information is updated.

7.

A method according to any one of claims 1 to 6, wherein

When the base station initiates the spectrum resource allocation request to the system, the base station applies for the spectrum resource only according to the actual requirement of the wireless backhaul link between the subordinate access nodes, or applies for a certain resource reservation amount to establish and A wireless backhaul link between newly opened access nodes.

8.

An apparatus for initially configuring a wireless backhaul link, the apparatus comprising: a first configuration module in an access node, and a second configuration module in a base station,

The first configuration module is configured to report information to the base station by using the original licensed spectrum after the access node is enabled;

The second configuration module is configured to implement reconfiguration of a wireless backhaul link between the base station and the access node according to the allocated TVWS spectrum resource of the system, and switch the wireless backhaul link to the allocated TVWS spectrum resource. .

9.

The apparatus according to claim 8, wherein said apparatus further comprises a spectrum resource allocation requesting module in the base station, and a spectrum resource allocation module in the system,

The spectrum resource allocation requesting module is configured to initiate a spectrum resource allocation request to the spectrum resource allocation module for a wireless backhaul link between the base station and each of the subordinate access nodes;

And the spectrum resource allocation module is configured to determine, after receiving the spectrum resource allocation request, the available TVWS spectrum resource to be allocated to the base station according to the maintained available TVWS information.

10.

The device of claim 9 wherein:

The spectrum resource allocation module is further configured to maintain the available TVWS information according to the acquired TVWS information and the usage of the TVWS spectrum resource by the system;

The TVWS information refers to information of a television band spectrum resource that is not occupied by a TV band authorization service, and the available TVWS information refers to information of a TVWS spectrum resource that is not used by the system.

11.

The device of claim 10 wherein:

The spectrum resource allocation module is further configured to: after receiving the spectrum resource allocation request, according to the maintained TVWS information, if the TVWS spectrum resource is currently available, directly allocate the available TVWS spectrum resource to the base station. If there is currently no TVWS spectrum resource available, the TVWS spectrum resources used by other base stations are allocated to the base station by negotiating with other base stations in the system.

12.

The device of claim 10 wherein:

The spectrum resource allocation module is further configured to: after receiving the spectrum resource allocation request, if there is no TVWS spectrum resource currently available, and the other base stations in the system fail to negotiate, send a failure response to the base station, and reject the The base station allocates spectrum resources;

After receiving the failure response, the base station determines that the wireless backhaul link with the access node continues to use the original licensed spectrum resource.

13.

The device of claim 11 wherein:

The spectrum resource allocation module is further configured to update the maintained TVWS information after the base station allocates available TVWS spectrum resources.

14.

The device of claim 9 wherein:

The spectrum resource allocation requesting module is further configured to apply for the spectrum resource only according to the actual requirement of the wireless backhaul link between the subordinate access nodes when the spectrum resource allocation module initiates the spectrum resource allocation request, Alternatively, apply for a certain resource reservation to establish a wireless backhaul link with the newly opened access node.



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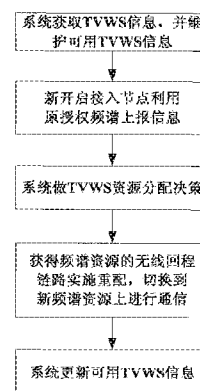
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(54) 发明名称

一种无线回程链路的初始配置方法及装置

(57) 摘要

本发明公开了一种无线回程链路的初始配置方法及装置,所述方法包括:接入节点开启后利用原授权频谱向基站上报信息;基站根据系统分配的电视频段空白频谱(TVWS)资源,实施该基站与该接入节点之间的无线回程链路的重配,将该无线回程链路切换到分配的TVWS频谱资源上。本发明解决了无线 backhaul link 的资源分配问题,同时不对无线接入链路的容量或者服务质量造成影响。



1. 一种无线回程链路的初始配置方法,其特征在于,所述方法包括:

接入节点开启后利用原授权频谱向基站上报信息;

基站根据系统分配的电视频段空白频谱 (TVWS) 资源,实施该基站与该接入节点之间的无线回程链路的重配,将该无线回程链路切换到分配的 TVWS 频谱资源上。

2. 如权利要求 1 所述的方法,其特征在于,

所述基站为所述无线回程链路向所述系统发起 TVWS 频谱资源分配请求;

所述系统收到所述频谱资源分配请求后,根据维护的可用 TVWS 信息,确定可用的 TVWS 频谱资源分配给所述基站。

3. 如权利要求 2 所述的方法,其特征在于,

所述系统根据获取的 TVWS 信息,以及本系统对 TVWS 频谱资源的使用情况,维护所述可用 TVWS 信息;

其中,所述 TVWS 信息是指未被电视频段授权业务占用的电视频段频谱资源的信息,所述可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

4. 如权利要求 3 所述的方法,其特征在于,

所述系统收到所述频谱资源分配请求后,根据维护的所述可用 TVWS 信息,如果当前有可用的 TVWS 频谱资源,则直接为所述基站分配可用的 TVWS 频谱资源;如果当前没有可用的 TVWS 频谱资源,则通过与本系统内其它基站协商,将其它基站使用的 TVWS 频谱资源分配给所述基站。

5. 如权利要求 4 所述的方法,其特征在于,

所述系统收到所述频谱资源分配请求后,如果当前没有可用的 TVWS 频谱资源,且与本系统内其它基站协商失败,则发送失败响应给所述基站,拒绝为所述基站分配频谱资源;

所述基站收到所述失败响应后,确定与所述接入节点间的所述无线回程链路继续使用原授权频谱资源。

6. 如权利要求 4 所述的方法,其特征在于,

所述系统为基站分配可用的 TVWS 频谱资源后,对维护的所述可用 TVWS 信息进行更新。

7. 如权利要求 1 至 6 之任一项所述的方法,其特征在于,

所述基站在向系统发起所述频谱资源分配请求时,仅按照与其下属各接入节点之间的无线回程链路的实际需求申请频谱资源,或者,申请一定的资源预留量,以建立与新开启的接入节点之间的无线回程链路。

8. 一种无线回程链路的初始配置装置,其特征在于,所述装置包括接入节点中的第一配置模块,和基站中的第二配置模块,

所述第一配置模块,用于在接入节点开启后,利用原授权频谱向基站上报信息;

所述第二配置模块,用于根据系统分配的 TVWS 频谱资源,实施该基站与该接入节点之间的无线回程链路的重配,将该无线回程链路切换到分配的 TVWS 频谱资源上。

9. 如权利要求 8 所述的装置,其特征在于,所述装置还包括基站中的频谱资源分配请求模块,和系统中的频谱资源分配模块,

所述频谱资源分配请求模块,用于为基站与各下属接入节点之间的无线回程链路向所述频谱资源分配模块发起频谱资源分配请求;

所述频谱资源分配模块,用于收到所述频谱资源分配请求后,根据维护的可用 TVWS 信

息,确定可用的 TVWS 频谱资源分配给所述基站。

10. 如权利要求 9 所述的装置,其特征在于,

所述频谱资源分配模块进一步用于,根据获取的 TVWS 信息,以及本系统对 TVWS 频谱资源的使用情况,维护所述可用 TVWS 信息;

其中,所述 TVWS 信息是指未被电视频段授权业务占用的电视频段频谱资源的信息,所述可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

11. 如权利要求 10 所述的装置,其特征在于,

所述频谱资源分配模块进一步用于,收到所述频谱资源分配请求后,根据维护的所述可用 TVWS 信息,如果当前有可用的 TVWS 频谱资源,则直接为所述基站分配可用的 TVWS 频谱资源;如果当前没有可用的 TVWS 频谱资源,则通过与本系统内其它基站协商,将其它基站使用的 TVWS 频谱资源分配给所述基站。

12. 如权利要求 10 所述的装置,其特征在于,

所述频谱资源分配模块进一步用于,收到所述频谱资源分配请求后,如果当前没有可用的 TVWS 频谱资源,且与本系统内其它基站协商失败,则发送失败响应给所述基站,拒绝为所述基站分配频谱资源;

所述基站收到所述失败响应后,确定与所述接入节点间的所述无线回程链路继续使用原授权频谱资源。

13. 如权利要求 11 所述的装置,其特征在于,

所述频谱资源分配模块进一步用于,为基站分配可用的 TVWS 频谱资源后,对维护的所述可用 TVWS 信息进行更新。

14. 如权利要求 9 所述的装置,其特征在于,

所述频谱资源分配请求模块进一步用于,在向所述频谱资源分配模块发起所述频谱资源分配请求时,仅按照与其下属各接入节点之间的无线回程链路的实际需求申请频谱资源,或者,申请一定的资源预留量,以建立与新开启的接入节点之间的无线回程链路。

一种无线回程链路的初始配置方法及装置

技术领域

[0001] 本发明涉及无线通信及认知无线电技术领域,更具体地,涉及一种无线回程链路的初始配置方法及装置。

背景技术

[0002] 对于 LTE(Long Term Evolution, 长期演进)技术或者 LTE-A(Long Term Evolution-advanced, 演进的长期演进)技术来说,目前的 AP(Access Point, 接入节点)主要有以下几种:增强的宏小区基站(enhanced Node Base Station)、中继(Relay)、微微小区基站(Femto NB)、微小区基站(Pico NB)和家庭基站(home NB)。这些接入节点之间有的能够直接相连,其中能够直接相连的接入节点之间的链路称作回程链路(backhaul link)。

[0003] backhaul link 在 LTE/LTE-A 中可能是无线的,如下列场景:偏远的地区、临时热点区域的覆盖、救灾时期、游牧状态的接入节点等。在这些场景下,由于部署有线的连接成本太高,或者无法估计其位置并提前进行有线覆盖,或者有线通信中断,都无法通过有线连接来进行有效覆盖。而无线链路可以迅速提供服务,因此,需要为这部分 backhaul link 分配频率资源,从而进行无线的连接。

[0004] 而上述场景下,针对无线 backhaul link 的资源分配,目前基本上还是考虑根据频谱管理组织的规定,将一部分授权分配给 LTE/LTE-A 系统的频谱资源用于无线 backhaul link 连接。由于每个运营商最终所得到的用于 LTE/LTE-A 系统运行的频谱是非常有限的,这种划分一部分资源给无线 backhaul link 的方式势必会对接入链路的容量和服务质量造成损失。尽管经过严格的物理层和高层协议的定义,可以尽量减少这种损失,但这种损失是一定会存在的。

[0005] 因此,如何解决无线 backhaul link 的资源分配问题,同时不对接入链路的容量或服务质量造成影响,是现有技术中需要解决的问题。

发明内容

[0006] 本发明解决的技术问题是提供一种无线回程链路的初始配置方法及装置,解决无线 backhaul link 的资源分配问题,同时不对接入链路的容量或服务质量造成影响。

[0007] 为解决上述技术问题,本发明提供了一种无线回程链路的初始配置方法,所述方法包括:

[0008] 接入节点开启后利用原授权频谱向基站上报信息;

[0009] 基站根据系统分配的电视频段空白频谱(TVWS)资源,实施该基站与该接入节点之间的无线回程链路的重配,将该无线回程链路切换到分配的 TVWS 频谱资源上。

[0010] 其中,所述基站为所述无线回程链路向所述系统发起 TVWS 频谱资源分配请求;

[0011] 所述系统收到所述频谱资源分配请求后,根据维护的可用 TVWS 信息,确定可用的 TVWS 频谱资源分配给所述基站。

[0012] 其中,所述系统根据获取的 TVWS 信息,以及本系统对 TVWS 频谱资源的使用情况,

维护所述可用 TVWS 信息；

[0013] 其中,所述 TVWS 信息是指未被电视频段授权业务占用的电视频段频谱资源的信息,所述可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

[0014] 其中,所述系统收到所述频谱资源分配请求后,根据维护的所述可用 TVWS 信息,如果当前有可用的 TVWS 频谱资源,则直接为所述基站分配可用的 TVWS 频谱资源;如果当前没有可用的 TVWS 频谱资源,则通过与本系统内其它基站协商,将其它基站使用的 TVWS 频谱资源分配给所述基站。

[0015] 其中,所述系统收到所述频谱资源分配请求后,如果当前没有可用的 TVWS 频谱资源,且与本系统内其它基站协商失败,则发送失败响应给所述基站,拒绝为所述基站分配频谱资源;

[0016] 所述基站收到所述失败响应后,确定与所述接入节点间的所述无线回程链路继续使用原授权频谱资源。

[0017] 其中,所述系统为基站分配可用的 TVWS 频谱资源后,对维护的所述可用 TVWS 信息进行更新。

[0018] 其中,所述基站在向系统发起所述频谱资源分配请求时,仅按照与其下属各接入节点之间的无线回程链路的实际需求申请频谱资源,或者,申请一定的资源预留量,以建立与新开启的接入节点之间的无线回程链路。

[0019] 本发明还提供了一种无线回程链路的初始配置装置,所述装置包括接入节点中的第一配置模块,和基站中的第二配置模块,

[0020] 所述第一配置模块,用于在接入节点开启后,利用原授权频谱向基站上报信息;

[0021] 所述第二配置模块,用于根据系统分配的 TVWS 频谱资源,实施该基站与该接入节点之间的无线回程链路的重配,将该无线回程链路切换到分配的 TVWS 频谱资源上。

[0022] 其中,所述装置还包括基站中的频谱资源分配请求模块,和系统中的频谱资源分配模块,

[0023] 所述频谱资源分配请求模块,用于为基站与各下属接入节点之间的无线回程链路向所述频谱资源分配模块发起频谱资源分配请求;

[0024] 所述频谱资源分配模块,用于收到所述频谱资源分配请求后,根据维护的可用 TVWS 信息,确定可用的 TVWS 频谱资源分配给所述基站。

[0025] 其中,所述频谱资源分配模块进一步用于,根据获取的 TVWS 信息,以及本系统对 TVWS 频谱资源的使用情况,维护所述可用 TVWS 信息;

[0026] 其中,所述 TVWS 信息是指未被电视频段授权业务占用的电视频段频谱资源的信息,所述可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

[0027] 其中,所述频谱资源分配模块进一步用于,收到所述频谱资源分配请求后,根据维护的所述可用 TVWS 信息,如果当前有可用的 TVWS 频谱资源,则直接为所述基站分配可用的 TVWS 频谱资源;如果当前没有可用的 TVWS 频谱资源,则通过与本系统内其它基站协商,将其它基站使用的 TVWS 频谱资源分配给所述基站。

[0028] 其中,所述频谱资源分配模块进一步用于,收到所述频谱资源分配请求后,如果当前没有可用的 TVWS 频谱资源,且与本系统内其它基站协商失败,则发送失败响应给所述基站,拒绝为所述基站分配频谱资源;

[0029] 所述基站收到所述失败响应后,确定与所述接入节点间的所述无线回程链路继续使用原授权频谱资源。

[0030] 其中,所述频谱资源分配模块进一步用于,为基站分配可用的 TVWS 频谱资源后,对维护的所述可用 TVWS 信息进行更新。

[0031] 其中,所述频谱资源分配请求模块进一步用于,在向所述频谱资源分配模块发起所述频谱资源分配请求时,仅按照与其下属各接入节点之间的无线回程链路的实际需求申请频谱资源,或者,申请一定的资源预留量,以建立与新开启的接入节点之间的无线回程链路。

[0032] 本发明通过访问数据库和收集本系统中各基站对 TV 频段频谱的使用情况信息,得到可用的 TVWS 频谱资源,并且利用该可用的 TVWS 频谱资源建立无线 backhaul link。

[0033] 与现有技术相比,本发明至少具有如下有益效果:

[0034] 1. 解决无线 backhaul link 的资源分配问题,同时不对无线接入链路的容量或者服务质量造成影响;

[0035] 2. 可动态地建立无线 backhaul link,无需事先预铺设电缆(事先可能也不知道铺设电缆的地点),节省了人力和物力成本;

[0036] 3. 对于无线 backhaul link,其建立和去除只需通过软件即可控制,增加了 backhaul link 的灵活性。

附图说明

[0037] 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:

[0038] 图 1 为本发明实施例的无线回程链路的初始配置装置应用场景示意图;

[0039] 图 2 为本发明实施例的无线 backhaul link 初始配置的流程示意图;

[0040] 图 3 为本发明实施例的无线 backhaul link 初始配置的信令流程图;

[0041] 图 4 为本发明另一实施例的无线 backhaul link 初始配置的信令流程图。

具体实施方式

[0042] 为克服现有技术的不足,考虑到现有电视频谱的利用率不高,而且稳定性较好,本发明提出一种基于认知无线电技术的无线回程链路的资源分配方法,其核心思想在于:根据当前无线 backhaul link 需求以及收集到的 TVWS(TV White Spaces,TV 频段空白频谱)使用信息,借用 TVWS 频谱资源建立临时的无线 backhaul link,从而解决无线 backhaul link 的资源分配问题,同时不会对无线接入链路的容量或者服务质量造成影响。

[0043] 基于上述思想,本发明提供一种无线回程链路的资源分配方法,具体采用如下技术方案:

[0044] 接入节点开启后利用原授权频谱向基站上报信息;

[0045] 基站根据系统分配的 TVWS 频谱资源,实施该基站与该接入节点之间的无线回程链路的重配,将该无线回程链路切换到分配的 TVWS 频谱资源上。

[0046] 进一步地,所述基站为所述无线回程链路向所述系统发起频谱资源分配请求;

[0047] 所述系统收到所述频谱资源分配请求后,根据维护的可用 TVWS 信息,确定可用的

TVWS 频谱资源分配给所述基站。

[0048] 进一步地,所述系统根据获取的 TVWS 信息,以及本系统对 TVWS 频谱资源的使用情况,维护所述可用 TVWS 信息;

[0049] 其中,所述 TVWS 信息是指未被电视频段授权业务占用的电视频段频谱资源的信息,所述可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

[0050] 进一步地,所述系统收到所述频谱资源分配请求后,根据维护的所述可用 TVWS 信息,如果当前有可用的 TVWS 频谱资源,则直接为所述基站分配可用的 TVWS 频谱资源;如果当前没有可用的 TVWS 频谱资源,则通过与本系统内其它基站协商,将其它基站使用的 TVWS 频谱资源分配给所述基站。

[0051] 进一步地,所述系统收到所述频谱资源分配请求后,如果当前没有可用的 TVWS 频谱资源,且与本系统内其它基站协商失败,则发送失败响应给所述基站,拒绝为所述基站分配频谱资源;

[0052] 所述基站收到所述失败响应后,确定与所述接入节点间的所述无线回程链路继续使用原授权频谱资源。

[0053] 为了便于阐述本发明,以下将结合附图及具体实施例对本发明技术方案的实施作进一步详细描述。

[0054] 图 1 示出了本发明实施例的无线 backhaul link 初始配置步骤,参见图 1,本实施例的初始配置流程主要包括以下步骤:

[0055] 步骤 1:系统获取 TVWS 信息,并维护可用 TVWS 信息;

[0056] 其中,TVWS 信息是指未被 TV 频段授权业务占用的电视频段频谱资源的信息,可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

[0057] 所述的 TVWS 信息可以包括但不限于可用频道(含工作频点和带宽)、覆盖范围,可能的持续时长及其允许的最大发射功率等。

[0058] 步骤 2:新开启接入节点利用原授权频谱向系统上报信息;

[0059] 步骤 3:系统做 TVWS 频谱资源分配决策;

[0060] 其中,分配决策的依据主要包括:系统维护的可用 TVWS 信息,以及新开启接入节点的上报信息等。

[0061] 所述的分配决策可依据实际应用场景的需求而制定,在下文中将给出分配决策的具体示例。

[0062] 步骤 4:获得 TVWS 频谱资源的无线 Backhaul link 实施重配,切换至获得的 TVWS 频谱资源上进行通信;

[0063] 步骤 5:系统更新可用 TVWS 信息。

[0064] 本发明实施例的应用场景如图 2 所示,本实施例中的无线回程链路的初始配置装置主要涉及以下网元:

[0065] 电视业务数据库(TV database,简称 TVDB):可由 TV 运营商或第三方提供,TV 数据库的内容为电视运营商在本地或包含本地的若干个地区的电视频谱(频道)的使用情况,即 1. 正在使用的频谱(频道)状态,包括但不限于:频道号,带宽,可能的持续时间,D/U 要求(为电视接收机期望的有用信号和干扰信号的功率比),频谱掩模,覆盖范围和隔离带等信息;2. 未使用的频谱(频道)状态,包括但不限于:频道号,工作带宽、覆盖范围、可能的

持续时间、允许最大发射功率等信息；3. 不允许使用的频道（可能是管理域限制频道或运营商预留频道等）信息，包括但不限于：频道号，工作带宽等信息。

[0066] 中心控制节点 (Central Control Point, 简称 CCP) : CCP 与 TVDB 间可以是固定的连接；1. 汇聚来自各 BS 以及 TVDB 的频谱使用情况信息，得到并维护对应各 BS 的可用 TVWS 信息；2. 负责向各 BS 分配 TVWS 资源，包括初始频谱分配，以及不同 BS 下无线 backhaul link 间的资源协调分配，以及主用户出现时的链路切换分配。

[0067] 基站 (Base Station, 简称 BS) : BS 可以直接与 CCP 相连，其功能包括但不限于：1. 将得到的 TVWS 资源分配到与其相连的各无线 backhaul link；2. 改变或调整无线通信技术的参数，例如，调制类型，发射功率；3. 管理和维护工作频谱，例如，工作频点和频段；4. 负责和中心控制节点的通信；5. 频谱感知功能；6. 感知数据处理能力。

[0068] 接入节点 (AP) : AP 可以是中继 (Relay)、微微小区基站 (Femto NB)、微小区基站 (Pico NB) 和家庭基站 (home NB)。AP 汇聚用户信息，并且和 BS 进行通信（构成 backhaul link），通过 AP，用户和 BS 之间进行信息交互。AP 的覆盖范围与 BS 相比，有较大幅度的缩减。AP 功能包括但不限于：1. 改变或调整无线通信技术的参数，例如，调制类型，发射功率；2. 调整工作频点和频段；3. 频谱感知；4. 与用户以及 BS 的双向通信。

[0069] 此外，本发明另一实施例中还提供了一种无线回程链路的初始配置装置，所述装置包括接入节点中的第一配置模块，和基站中的第二配置模块，

[0070] 所述第一配置模块，用于在接入节点开启后，利用原授权频谱向基站上报信息；

[0071] 所述第二配置模块，用于根据系统分配的 TVWS 频谱资源，实施该基站与该接入节点之间的无线回程链路的重配，将该无线回程链路切换到分配的 TVWS 频谱资源上。

[0072] 其中，所述装置还包括基站中的频谱资源分配请求模块，和系统中的频谱资源分配模块，

[0073] 所述频谱资源分配请求模块，用于为基站与各下属接入节点之间的无线回程链路向所述频谱资源分配模块发起频谱资源分配请求；

[0074] 所述频谱资源分配模块，用于收到所述频谱资源分配请求后，根据维护的可用 TVWS 信息，确定可用的 TVWS 频谱资源分配给所述基站。

[0075] 其中，所述频谱资源分配模块进一步用于，根据获取的 TVWS 信息，以及本系统对 TVWS 频谱资源的使用情况，维护所述可用 TVWS 信息；

[0076] 其中，所述 TVWS 信息是指未被电视频段授权业务占用的电视频段频谱资源的信息，所述可用 TVWS 信息是指未被本系统使用的 TVWS 频谱资源的信息。

[0077] 其中，所述频谱资源分配模块进一步用于，收到所述频谱资源分配请求后，根据维护的所述可用 TVWS 信息，如果当前有可用的 TVWS 频谱资源，则直接为所述基站分配可用的 TVWS 频谱资源；如果当前没有可用的 TVWS 频谱资源，则通过与本系统内其它基站协商，将其它基站使用的 TVWS 频谱资源分配给所述基站。

[0078] 其中，所述频谱资源分配模块进一步用于，收到所述频谱资源分配请求后，如果当前没有可用的 TVWS 频谱资源，且与本系统内其它基站协商失败，则发送失败响应给所述基站，拒绝为所述基站分配频谱资源；

[0079] 所述基站收到所述失败响应后，确定与所述接入节点间的所述无线回程链路继续使用原授权频谱资源。

[0080] 其中,所述频谱资源分配模块进一步用于,为基站分配可用的 TVWS 频谱资源后,对维护的所述可用 TVWS 信息进行更新。

[0081] 其中,所述频谱资源分配请求模块进一步用于,在向所述频谱资源分配模块发起所述频谱资源分配请求时,仅按照与其下属各接入节点之间的无线回程链路的实际需求申请频谱资源,或者,申请一定的资源预留量,以建立与新开启的接入节点之间的无线回程链路。

[0082] 以下将结合两个具体实施例对本发明的无线回程链路的资源分配方法的信令流程作进一步说明。

[0083] 实施例一

[0084] 如图 3 所示,本实施例的无线回程链路的资源分配方法具体描述如下:

[0085] 步骤 101:CCP 获取 TVDB 中的 TVWS 信息(即未被电视频段授权业务占用的电视频段频谱资源的信息),包括但不限于可用频道(含工作频点和带宽)、覆盖范围,可能的持续时长及其允许的最大发射功率;CCP 根据获取的 TVWS 信息,以及 CCP 中存储的本系统对 TVWS 频谱资源的使用情况信息(以下也称作 TVWS 使用信息),维护可用 TVWS 信息,即未被本系统使用的 TVWS 频谱资源的信息;

[0086] 其中,CCP 获取 TVWS 信息的方式可以包括以下方式中的一种或其任意组合:CCP 周期访问 TVDB,或 CCP 按需访问 TVDB,或 TVDB 主动通知 CCP。

[0087] 步骤 102:AP 开启后,工作于原授权频谱;

[0088] 步骤 103:AP 上报信息,包括最大发射功率、支持的工作频段、位置信息、接入终端的能力等;

[0089] 步骤 104:BS 根据 AP 上报的信息,将为与其之间的无线 backhaul link 向 CCP 请求 TVWS 频谱资源分配;

[0090] 步骤 105:CCP 根据 BS 上报的资源申请,以及当前可用 TVWS 信息进行决策,确定分配给该 BS 的无线频谱资源,并将分配结果发送给 BS。如果对于该 BS 没有可用的 TVWS 频谱资源,CCP 首先与其它 BS 进行 TVWS 频谱资源协商分配,即寻找其它 BS 通过退出或切换,例如可以将其它低优先级的 BS 下的无线 backhaul link 退出其所占用的 TVWS 频谱资源,或者,对于具有多个可用 TVWS 频谱资源的 BS 下的无线 backhaul link,可以将其切换到其它可用 TVWS 频谱资源上,而让出正在使用的 TVWS 频谱资源,将其分配给发出申请的 BS,并将分配结果发送给相关 BS。如果协商后仍无可用的 TVWS 频谱资源,则向基站返回失败响应,此时基站将不会进行下面的操作,该无线 backhaul link 继续使用原授权频谱资源。

[0091] 步骤 106:BS 根据其下属 AP 上报的信息和得到的 TVWS 频谱资源,确定与其相连 backhaul link 所使用的无线资源;

[0092] 步骤 107:工作频谱发生变化的无线 backhaul link 实施重配,切换至新频谱资源上进行通信;

[0093] 其中,所述工作频谱发生变化的无线 backhaul link 包括新接入节点和基站之间的无线 backhaul link,还包括 CCP 进行协商的退出或切换的其它 BS 与其接入节点之间的无线 backhaul link。

[0094] 步骤 108:BS 向 CCP 发送资源分配更新信息,CCP 反馈确认消息;

[0095] 步骤 109:CCP 根据资源分配情况更新 TVWS 使用信息及可用 TVWS 信息。

[0096] 实施例二

[0097] 如图 4 所示,本实施例的无线回程链路的资源分配方法具体描述如下:

[0098] 步骤 201:CCP 获取 TVDB 中 TVWS 信息,结合 CCP 中存储着 TVWS 被系统占用情况信息,维护相应的可用 TVWS 信息;

[0099] 其中,CCP 获取 TVWS 信息的方式可以是 CCP 周期访问 TVDB,或 CCP 按需访问 TVDB,或 TVDB 主动通知 CCP,或其组合。

[0100] 步骤 202:AP 开启,并工作于原授权频谱;

[0101] 步骤 203:AP 上报信息,包括但不限于最大发射功率、支持的工作频段、位置信息、接入终端的能力等;

[0102] 步骤 204:BS 根据 AP 上报的信息,若 BS 存在之前 CCP 分配给它的预留 TVWS 频谱资源,将为该 AP 与其之间的无线 backhaul link 分配预留 TVWS 频谱资源;

[0103] 与前述实施例一中 BS 只按 AP 的实际需求向 CCP 发起 TVWS 资源请求不同,本实施例中 BS,在第一次向 CCP 申请 TVWS 频谱资源时,根据前期小区业务量统计,申请资源中有一定的预留量,以便随后新开启 AP 时,直接对其进行预留 TVWS 资源分配。相应的这种情况下,BS 需要维护这部分预留资源,以保证其为可用 TVWS 资源。如果 BS 中无预留 TVWS 资源,则可按照实施例一中的操作进行 TVWS 频谱资源申请。

[0104] 步骤 205:工作频谱发生变化的无线 backhaul link 实施重配,切换至新资源上进行通信;

[0105] 步骤 206:BS 向 CCP 发送资源分配更新信息,CCP 反馈确认消息;

[0106] 步骤 207:CCP 根据资源分配情况更新 TVWS 使用信息及可用 TVWS 信息。

[0107] 以上仅为本发明的优选实施案例而已,并不用于限制本发明,本发明还可有其他多种实施例,在不背离本发明精神及其实质的情况下,熟悉本领域的技术人员可根据本发明做出各种相应的改变和变形,但这些相应的改变和变形都应属于本发明所附的权利要求的保护范围。

[0108] 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。

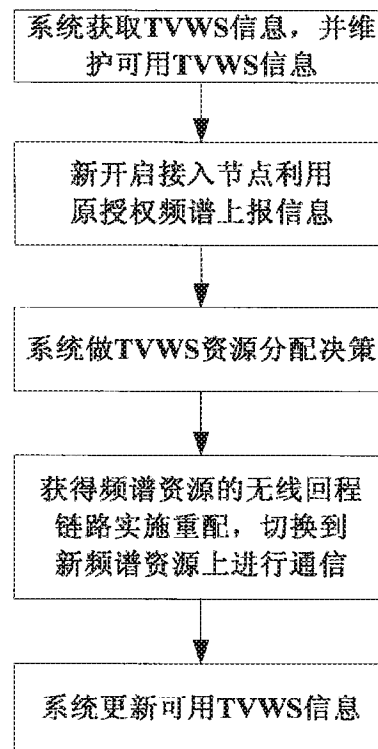


图 1

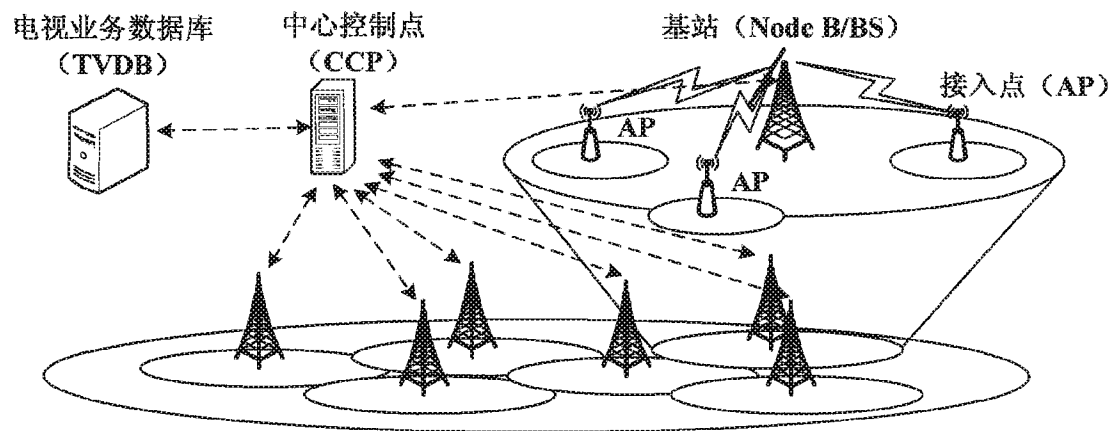


图 2

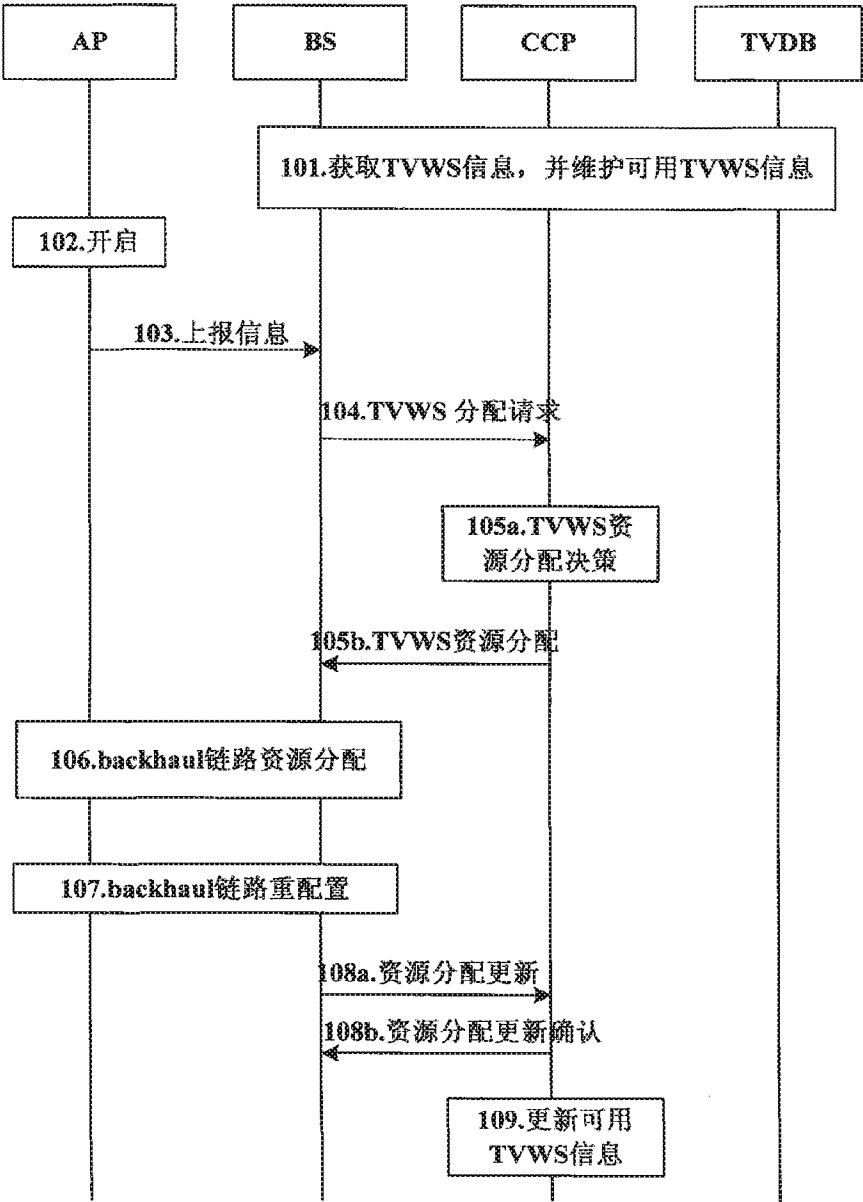


图 3

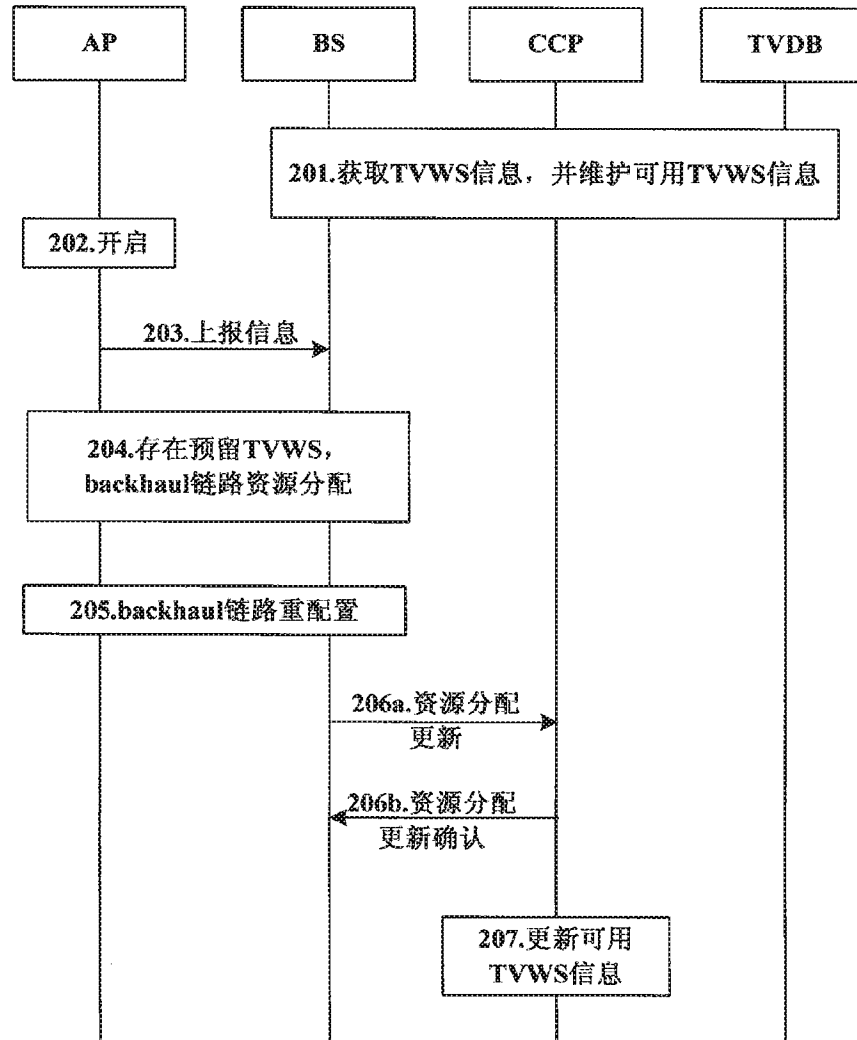


图 4



Espacenet

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Method and system for evaluating a wireless service network

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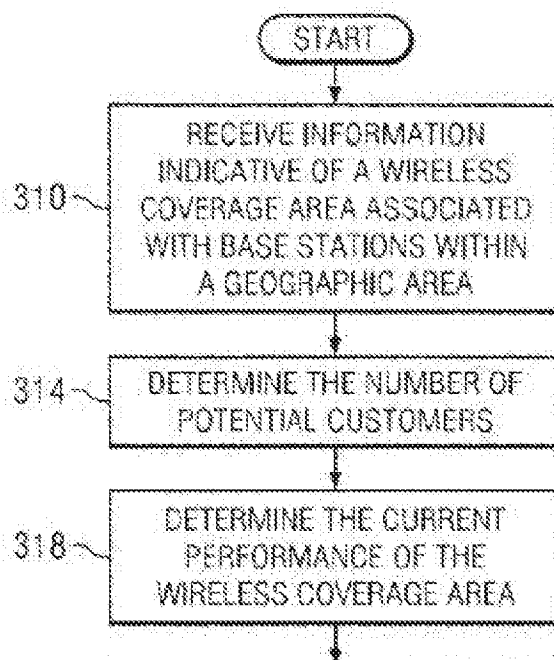
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US8718656 (B2) less

Abstract of CN102740306 (A)

A method for evaluating a wireless service network includes receiving information indicative of a wireless coverage area associated with each of a plurality of base stations within a geographic area. The method also includes determining a threshold performance requirement within the geographic area. The method additionally includes simulating a deployment of at least one femto base station within the geographic area. The method further includes determining at least a first performance parameter based on the simulated deployment of the at least one femto base station within the geographic area. The method further includes generating a deployment



recommendation based on at least the first performance parameter and the threshold performance requirement. The deployment recommendation may indicate whether to deploy the at least one femto base station within the geographic area.

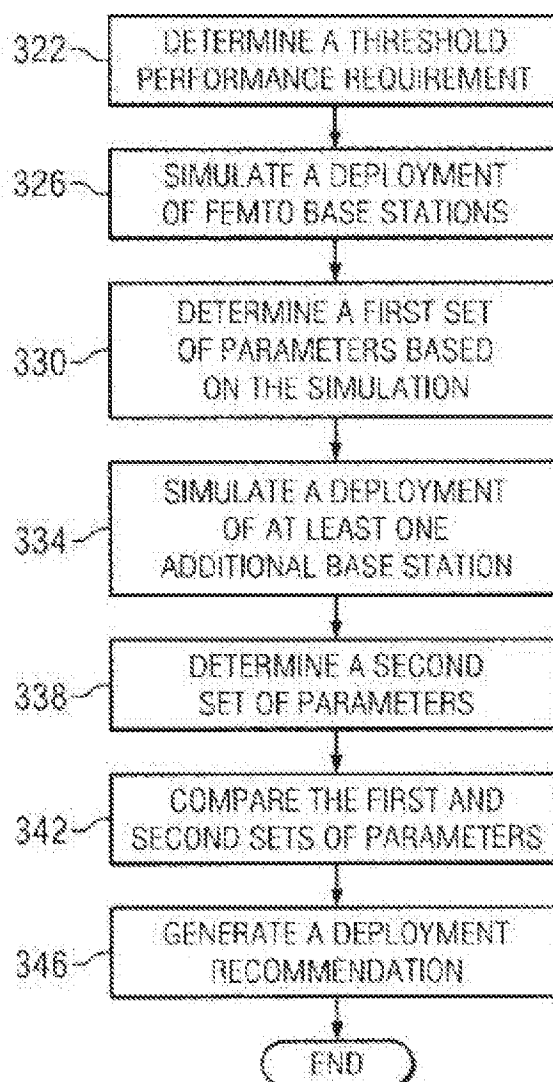


FIG. 3

Notice

This translation is machine-generated. It cannot be guaranteed that it is intelligible, accurate, complete, reliable or fit for specific purposes. Critical decisions, such as commercially relevant or financial decisions, should not be based on machine-translation output.

DESCRIPTION CN102740306

The present invention relates to a method and system for evaluating a wireless service network. A method for evaluating a wireless service network is provided, the method comprising receiving information indicative of a wireless coverage area associated with each of a plurality of base stations within a geographic area. The method also includes determining a threshold performance requirement within the geographic area. The method additionally includes simulating deployment of the at least one femto base station within the geographic area. The method also includes determining at least a first performance parameter based on the simulated deployment of the at least one femto base station within the geographic area. The method also includes generating a deployment recommendation based on at least the first performance parameter and the threshold performance requirement. The deployment suggestion can indicate whether at least one femto base station is deployed within the geographic area.

Method and system for evaluating a wireless service network

Technical field

The present disclosure generally relates to methods and systems for evaluating a wireless service network.

Background technique

Various wireless technologies (eg, 3G, 4G, 3GPP Long Term Evolution (LTE), LTE-Advanced (LTE-A), WiMAX, etc.) leave room for the use of smaller, user-installed base stations, which are commonly referred to herein. It is a femto base station (fBS) (for example, a femtocell in WiMAX, or a home node-B in 3GPP). The

fBS is provided to the user by the wireless service provider. The user or the wireless service provider's technician installs the fBS in the user's home or office (herein referred to as a home or home location) to increase the signal quality and strength of the local wireless coverage. The backhaul connection of the fBS to the wireless service provider's network (WSPN) is provided via the user's home network access (e.g., DSL). The fBS operates in a wireless manner similar to other base stations (e.g., macro base stations (MBS) and/or relay stations (RS)) of the wireless service provider (e.g., using the same licensed band). The fBS may allow handover from the MBS to the fBS to be completed without requiring user notification (eg, similar to switching from one MBS to another).

Essentially, an endpoint can treat an fBS as another base station. Thus, any endpoint that utilizes the same wireless service may be able to establish a connection through the fBS. However, the owner of the fBS may not want to make their fBS available to the public, whereby the owner can set the fBS to only allow access from members of the Closed Subscriber Group (CSG) designated by the owner.

Summary of the invention

The teachings of the present disclosure relate to methods and systems for evaluating a wireless service network. For example, a method for evaluating a wireless service network can include the step of receiving information indicative of a wireless coverage area associated with each of a plurality of base stations within a geographic area. The method can also include the step of determining a threshold performance requirement within the geographic area. The method can additionally include the step of simulating deployment of at least one femto base station within the geographic area. The method can also include the step of determining at least a first performance parameter based on the simulated deployment of the at least one femto base station within the geographic area. The method can also include the step of generating a deployment recommendation based on at least the first performance parameter and the threshold performance requirement. The deployment suggestion can indicate whether at least one femto base station is deployed within the geographic area.

The technical advantages of a particular embodiment include the ability to evaluate a wireless network that provides femtocell services and fBS. Another advantage of certain embodiments is that the wireless service provider can determine whether to deploy the femtocell service within a geographic area. Another advantage of certain embodiments is that the wireless service provider is also able to determine the price of the femtocell service within the geographic area. Another advantage of certain embodiments is that the wireless service provider can determine the spectrum utilization policy of the fBS within the geographic area. Other technical advantages will be readily apparent to those of ordinary skill in the art in view of the appended claims. Moreover, although specific advantages have been enumerated above, various embodiments may include all, some, or none of the enumerated advantages.

DRAWINGS

For a more complete understanding of the specific embodiments and their advantages, the following description will be described with reference to the accompanying drawings in which:

Figure 1 illustrates a communication system including various communication networks in accordance with a particular embodiment;

2 illustrates a network including a more detailed view of a computer, in accordance with a particular embodiment;

3 illustrates a method for evaluating a wireless service network within a geographic area, in accordance with a particular embodiment;

4 illustrates a method for boosting a femtocell service, in accordance with a particular embodiment;

Figure 5 illustrates a method for determining installation configuration parameters for a femto base station, in accordance with a particular embodiment.

detailed description

FIG. 1 illustrates a communication system including various communication networks in accordance with a particular embodiment. Communication system 100 can be comprised of multiple networks 110. Each network 110 can be any of a variety of communication networks designed to facilitate one or more different services, either independently or in combination with other networks. For example, network 110 may facilitate Internet access, wireless access (eg, via LTE or WiMAX wireless services), online gaming, data downloading, file sharing, peer-to-peer file sharing (P2P), Voice over Internet Protocol (VoIP) calls, IP A video call, or any other type of functionality typically provided by the network. Network 110 may utilize any of a variety of protocols for wired or wireless communication to provide their respective services. For example, network 110a may include an 802.16 wireless network (eg, 802.16j), commonly referred to as WiMAX, which may include, in addition to other portions, a macro base station (MBS) (eg, base station 120) and a femto base station (fBS). (eg fBS 190).

For simplicity and ease of discussion, the remainder of this specification may use simplified naming for the various entities, components, and networks discussed herein. "Home location" may refer to a location where a user has access to a home network to an external network such as the Internet. The home location is not limited to only the user's home, which may include, for example, the user's office. "Home network access" may refer to any of a variety of methods and/or techniques for accessing one or more external networks, such as the Internet, from a user's home location. For example, home network access may include: cable modems, DSL modems, xDSL modems, and the like. "Home network" may refer to a local area network (LAN) that is placed within the user's home location. The LAN can include both wired and wireless connections. The term "Internet" is not limited to the Internet, but includes any type of network, including public and private networks. An "Internet Service Provider" (ISP) may refer to an entity that provides users with access to their home network. "Wireless service" may refer to any of a variety of methods and/or techniques used by a wireless service provider to provide wireless access to an endpoint over a large geographic area. A Wireless Service Provider (WSP) can refer to an entity that provides wireless services. Although such a nomenclature is used for simplicity, it does not represent the full scope of all possible embodiments and/or circumstances. For example, an ISP can also be a WSP. As another example, an ISP may not provide Internet access directly to a user (eg, an ISP may provide Internet access to a building, which may then provide Internet access to fBS users).

The embodiment depicted in FIG. 1 includes an fBS 190. fBS 190 may essentially be a small base station that a user purchases (or rents) from their WSP. Once installed, the fBS 190 can provide a geographically small coverage area that can be used to enhance signal coverage within the user's home location. In some embodiments, fBS 190 can use the same wireless service as surrounding base station 120. For example, in a particular embodiment, fBS 190 may use the same licensed spectrum as other local base stations 120 of WSP (e.g., MBS, pico base station (pBS) (not depicted), and/or RS (not depicted) (For example, the spectrum licensed by the user's WSP). Depending on the situation, the user can share the coverage of his fBS with other unknown users (eg, the fBS is a public fBS), which he can limit to known/authorized users (eg, the fBS is a private fBS), or above Some combination. Known/authorized users may be referred to as CSGs. Because every fBS user can operate their own corresponding fBS, all of them can prefer to use their fBS in a CSG type configuration.

Although the exemplary communication system 100 of FIG. 1 includes six different networks, the networks 110a-110f, the term "network" should be interpreted to generally define the ability to transmit signals, data, and/or messages (including through web pages, email, text chat, Any network or combination of networks of Voice over IP (VoIP) and instant messaging (signal, data, or messaging). Depending on the scope, size, and/or configuration of the network, any of the networks 110a-110f can be implemented as a LAN, WAN, MAN, PSTN, WiMAX network, a global distribution network such as the Internet, an intranet, an extranet, or Any other form of wireless or wired networking.

Network 110 may include any number of wired links 160, wireless connections 150, nodes 170, and/or endpoints 140, and combinations thereof. For purposes of illustration, and by way of example only, network 110a is a MAN

that may be implemented at least in part via WiMAX or LTE; network 110b is a PSTN; network 110c is a LAN; network 110d is a WAN such as the Internet; network 110e may be responsible for The network 110a is a WSPN that operates with a WSP operated by a wireless service (e.g., WiMAX); and the network 110f is an Internet service provider network that can be operated by an ISP responsible for providing home network access (including Internet access) to its users (ISP). Although not depicted in Figure 1, the ISP network 110f may include servers, modems, gateways, and any other components that may be required to provide their respective services.

Although network 110 has been depicted as six separate networks, depending on the situation, any two or more of these networks may be a single network. For example, the WSP and ISP can be the same business entity that can maintain the necessary components for both services on the same network, thereby combining the ISP network 110f and the WSPN network 110e into a single network. Moreover, the interconnections between the plurality of networks 110 can be different than the interconnections depicted in FIG. For example, if a user uses a Digital Subscriber Line (DSL) for his Internet access, his network access device 180 can connect to the PSTN 110b.

In general, network 110 is provided for communication of packets, units, frames, or other portions of information (referred to herein as packets) between endpoints 140 and/or nodes 170. In a particular embodiment, networks 110a and 110c-110f may be IP networks. The IP network transmits data by placing data in the packet and individually transmitting each packet to the selected destination along one or more communication paths. Network 110b may be, for example, a PSTN, which may include a switching station, a central office, a mobile telephone switching office, a paging exchange, remote terminals, and other related telecommunications equipment throughout the world. Network 110d can be coupled to network 110b through a gateway. According to an embodiment, the gateway may be part of network 110b and/or 110d (e.g., nodes 170e and/or 170c may include a gateway). The gateway may allow the PSTN 110b to communicate with a non-PSTN network, such as any of the networks 110a or 110c-110f.

Any of the networks 110a or 110c-110f may be coupled to other IP networks including, but not limited to, the Internet. Because IP networks share a common method of transmitting data, signals can be sent between devices located on different and interconnected IP networks. In addition to being coupled to other IP networks, any of the networks 110a or 110c-110f may also be coupled to a non-IP network by using an interface or a component such as a gateway. Similarly, PSTN 110b may be capable of connecting to other networks, including connecting to an IP network via an interface or gateway.

The networks 110 can be connected to each other and to other networks via a plurality of wired links 160, wireless connections 150, and nodes 170. Not only the wired link 160, the wireless connection 150, and the node 170 connect various networks, but they are also interconnected with the endpoints 140 and with any other

components or any portion of any of the networks 110 that are coupled to the endpoints 140. The interconnection of network 110 may enable endpoints 140 to transmit data and control signaling between each other and allow any intermediate component or device to transmit data and control signals. Thus, a user of endpoint 140 may be able to transmit and receive data and control signals between and among network components coupled to one or more networks 110.

In the depicted embodiment, wireless connections 150f and 150g may represent, for example, a wireless connection between end point 140 of WiMAX and base station 120 or fBS 190. In other embodiments, wireless connection 150 may use other wireless technologies and/or protocols, such as LTE, or LTE-A. In some cases, WiMAX, LTE, or LTE-AMBS, along with an extended range of one or more relay stations, pBSs, and/or fBSs, may allow network 110a to cover a larger geographic area associated with the MAN.

Node 170 can include any combination of: network components, modems, session border controllers, gatekeepers, ISPN gateways, WSPN gateways, security gateways, operations management and maintenance and provisioning (OAM&P) servers, network access providers (NAP) server, base station, conference bridge, router, hub, switch, gateway, endpoint, or any other hardware, software, or embedding that implements any number of communication protocols that permit the exchange of packets in communication system 100. Logic. For example, node 170e can include a gateway. As a gateway, node 170e may allow network 110b, PSTN networks to transmit and receive communications from other non-PSTN networks, such as network 110d, IP networks. In some cases, as a gateway, node 170e can switch communications between the various protocols used by networks 110b and 110d.

In particular embodiments, network 110e may include various servers, gateways, switches, routers, and other nodes used in providing one or more wireless services. For example, WSPN 110e includes: a mobility management entity (MME) 130b, a security gateway 130a, a serving gateway 130d, and a home node gateway 130c. The MME 130b may be responsible for storing, organizing, and/or maintaining bindings received from various endpoints. Security gateway 130a may include multiple, logically separate security gateways. Although gateways can be logically separated, they can be physically juxtaposed or separated. The secure gateway 130a may provide security to the WSPN 110e for access to the WSPN 110e via the Internet and/or to the fBS accessing the WSPN 110e. In a particular embodiment, this security can be provided by two logically separate security gateways. For example, a security gateway can be responsible for an internet-based connection, while a second separate security gateway can be responsible for an fBS-based connection.

The home node gateway 130c can be used as a concentrator for the control plane (eg, S1-MME interface). In some embodiments, the home node gateway 130c may terminate the user plane towards the home node gateway 130c and toward the serving gateway 130d. The home node gateway 130c may provide a relay function for relaying user plane data between the home node gateway 130c and the serving gateway 130d. In some

embodiments, the home node gateway 130c can support a NAS node selection function (NNSF). Although specific components have been described and depicted within WSPN 110e, WSPNs may include different, fewer, or additional components.

Network access device 180 may provide home network to fBS 190 by hardware, software embedded in a computer readable medium, and/or any combination of encoding logic (e.g., firmware) incorporated into or otherwise stored in hardware. Access. In some embodiments, network access device 180 can be provided by a user's ISP. For example, if the user's ISP is a cable company, the ISP can provide a cable modem as the network access device 180. As another example, if the user's ISP is a telephone company, the ISP can provide an xDSL modem as the network access device 180. As can be appreciated, network access device 180 can provide home network access to components other than fBS 190. For example, a user can connect his personal computer to the network access device 180 to access the Internet.

Endpoints 140 and/or nodes 170 may provide data to a user via hardware, software embedded in a computer readable medium, and/or any combination of encoding logic (eg, firmware) incorporated into or otherwise stored in hardware. Or web service. For example, any one of the endpoints 140 can be a cellular telephone, an IP telephone, a computer, a video monitor, a video camera, a personal digital assistant, or any other hardware or software that supports the use of one or more networks 110 to transmit packets (or frames). And / or coding logic. Endpoints 140 may also include unattended or automated systems, gateways, other intermediate components, or other devices that can transmit or receive data and/or signals.

Although FIG. 1 illustrates a particular number and configuration of endpoints, connections, links, and nodes, communication system 100 also contemplates any number or arrangement of such components for communicating data. Additionally, elements of communication system 100 may include components that are centrally located (partially) relative to one another or distributed throughout communication system 100.

2 illustrates a network including a more detailed view of a computer, in accordance with a particular embodiment. The depicted network 200 is a simplified illustration of a computer 210, a network 220, and storage areas 230a-230c. Computer 210 may include one or more portions of one or more computer systems. In particular embodiments, one or more of these computer systems can perform one or more steps of one or more methods described or exemplified herein. In particular embodiments, one or more computer systems can provide the functions described or exemplified herein. In some implementations, encoding software running on one or more computer systems can perform one or more steps of one or more methods described or illustrated herein, or can be described or illustrated herein. The function.

The components of computer 210 may include any suitable physical form, configuration, number, type, and/or

layout. By way of example and not limitation, computer 210 may comprise an embedded computer system, a system on a chip (SOC), a single board computer system (SBC) (for example, a computer on a module (COM) or a system on a module (SOM)), desktop computer system, laptop or notebook computer system, interactive query system (kiosk), mainframe, computer system network, mobile phone, mobile phone, personal digital assistant (PDA), server, or these A combination of two or more. Where appropriate, computer 210 may include one or more computer systems; single or distributed; span multiple locations; span multiple machines; or reside in one or more networks including one In the cloud of more or more cloud components. In one example, computer 210 can be a radio system level simulator or a commercial radio planning tool.

Where appropriate, computer 210 may perform one or more steps of one or more methods described or exemplified herein without significant spatial or temporal limitations. By way of example and not limitation, computer 210 may perform one or more steps of one or more methods described or exemplified herein. One or more computers may perform one or more steps of one or more methods described or illustrated herein at different times or at different locations, where appropriate.

In the depicted embodiment, computer 210 can include processor 211, memory 213, storage 215, interface 217, and bus 212. These components can work together to plan, design, and evaluate a wireless network that can include fBS, as discussed below. Although a particular network is depicted as having a particular number of specific components in a particular arrangement, this disclosure contemplates any suitable network 200 having any suitable number of any suitable components in any suitable arrangement. For the sake of simplicity, only the components of computer 210 are depicted. Other devices in network 200 may have one or more of the various components described below for computer 210.

Processor 211 can be a microprocessor, controller, or any other suitable computing device, resource, or combination of hardware, software, and/or coded logic operable to separate or in combination with other components (eg, memory 213) To provide the ability to plan, design, and evaluate a wireless network that can include fBS. Such functionality may include providing various features discussed herein. For example, processor 211 can identify one or more potential deployment customers to which to deploy an fBS. Additional examples and functions provided at least in part by processor 211 are discussed below.

In particular embodiments, processor 211 may include hardware for executing instructions, such as instructions that constitute a computer program. As an example, and not by way of limitation, the processor 211 may retrieve (or extract) instructions from internal registers, internal cache, memory 213, or storage 215 for execution of instructions; decode and execute them; and then The more or more results are written to the internal register, the internal cache, the memory 213, or the storage 215.

In particular embodiments, processor 211 may include one or more internal caches for data, instructions or addresses. Where appropriate, the present disclosure contemplates processor 211 including any suitable number of any suitable internal cache memories. As an example, and not by way of limitation, the processor 211 can include one or more instruction caches, one or more data caches, and one or more translation look-aside buffers (TLBs). The instructions in the instruction cache may be copies of instructions in memory 213 or storage 215. The instruction cache can be used by the processor 211 to speed up the retrieval of those instructions. The data in the data cache may be: a copy of the data in memory 213 or storage 215, operating on instructions executed at processor 211; previously performed at processor 211 for subsequent processing The instructions at 211 are executed for execution, or for writing to memory 213 or storage 215; or other suitable data. The data cache can be accelerated by the processor 211 for read or write operations. The TLB can speed up virtual address translation for the processor 211. In particular embodiments, processor 211 may include one or more internal registers for data, instructions or addresses. Depending on the implementation, processor 211 may include any suitable number of any suitable internal registers, where appropriate. Processor 211 may, where appropriate, include one or more arithmetic logic units (ALUs); may be multi-core processors; may include one or more processors 211; or be any other suitable processor.

The memory 213 can be any form of volatile or non-volatile memory including, but not limited to, magnetic media, optical media, random access memory (RAM), read only memory (ROM), flash memory, removable media. Or any other suitable local or remote memory component or multiple local or remote memory components. Memory 213 can store any suitable data or information utilized by computer 210, including software embedded in a computer readable medium, and/or encoding logic (e.g., firmware) incorporated into or otherwise stored in hardware. In a particular implementation, memory 213 may include a main memory for storing instructions executed by processor 211 or data operated by processor 211. By way of example and not limitation, computer 210 may load instructions from storage 215 or another source (e.g., another computer system, storage area 230, or remote transceiver) to memory 213. Processor 211 can then load the instructions from memory 213 into an internal register or internal cache. To execute these instructions, processor 211 can retrieve these instructions from internal registers or internal cache and decode them. During or after execution of these instructions, processor 211 may write one or more results (which may be intermediate or final results) to an internal or internal cache. Processor 211 can then write one or more of those results to memory 213. In particular embodiments, processor 211 may execute only one or more internal registers or instructions in internal cache or memory 213 (as opposed to storage portion 215 or elsewhere), and may only be one or more Data is manipulated in a plurality of internal registers or internal caches or in memory 213 (as opposed to storage portion 215 or elsewhere).

Bus 212 may comprise hardware, any software embedded in a computer readable medium, and/or any combination of encoding logic (e.g., firmware) incorporated in or otherwise stored in hardware to couple components of computer 210 to each other. As an example, and not by way of limitation, the bus 212 may include: an accelerated graphics port (AGP) or other graphics bus, an enhanced industry standard architecture (EISA) bus, a front side bus (FSB), a hypertransport (HT) Connection, Industry Standard Architecture (ISA)

bus, INFINIBAND interconnect, low-pin-count (LPC) bus, memory bus, microchannel architecture (MCA) bus, peripheral component interconnect (PCI) bus, PCI Expansion (PCI-X) bus, Serial Advanced Technology Attachment (SATA) bus, Video Electronics Standards Association Local Area (VLB) bus, or any other suitable bus or combination of two or more of these buses. Bus 212 may include any number, type, and/or configuration of bus 212, where appropriate. In a particular embodiment, one or more buses 212 (which may include an address bus and a data bus) may couple processor 211 to memory 213. Bus 212 can include one or more memory buses, as described below. In particular embodiments, one or more memory management units (MMUs) may reside between processor 211 and memory 213 and facilitate access to memory 213 as requested by processor 211. In a particular implementation, memory 213 can include random access memory (RAM). The RAM can be a volatile memory, where appropriate. The RAM may be dynamic RAM (DRAM) or static RAM (SRAM), where appropriate. Moreover, the RAM may be a single port or multi-port RAM, or any other suitable type of RAM or memory, where appropriate. The memory 213 may include one or more memories 213, where appropriate.

In particular embodiments, storage 215 can include a mass storage for data or instructions. As an example, and not by way of limitation, the storage portion 215 may include: an HDD, a floppy disk drive, a flash memory, an optical disk, a magneto-optical disk, a magnetic tape, or a universal serial bus (USB) drive or two or more of these. The combination. The storage portion 215 may include a removable or non-removable (or fixed) medium, where appropriate. The storage portion 215 may be internal or external to the computer 210, where appropriate. In a particular implementation, storage 215 can be a non-volatile, solid state memory. In a particular embodiment, storage 215 can include a read only memory (ROM). Where appropriate, the ROM may be a mask programming ROM, a programmable ROM (PROM), an erasable PROM (EPROM), an electrically erasable ROM (EEPROM), an electrically rewritable ROM (EAROM), or a flash. Memory or a combination of two or more of these. Storage 215 can take any suitable physical form and can include any suitable number or type of storage. The storage section 215 may include one or more storage control units that are easily communicated between the processor 211 and the storage section 215, where appropriate.

In particular embodiments, interface 217 can include one or more interfaces for one or more I/O devices. One or more of these I/O devices may be capable of enabling communication between a person and the computer 210. As an example, and not by way of limitation, the I/O device can include: a keyboard, a keypad, a microphone, a monitor, a mouse, a printer, a scanner, a speaker, a still camera, a stylus, a tablet, a touch screen, a trackball, a video A camera, another suitable I/O device, or a combination of two or more of these. The I/O device can include one or more sensors. Particular embodiments may include any suitable type and/or number of I/O devices, and any suitable type and/or number of interfaces 117 for these I/O devices. Interface 117 may include one or more devices or encoding software drivers that enable processor 211 to drive one or more of these I/O devices, where appropriate. Interface 117 may include one or more interfaces 117, where appropriate.

Herein, a reference to a computer readable storage medium encompasses one or more tangible computer

readable storage medium processing structures. As an example, and not as a limitation, the computer readable storage medium may include semiconductor-based or other integrated circuits (ICs), such as, for example, Field Programmable Gate Array (FPGA) or dedicated, where appropriate, IC (ASIC), hard disk, HDD, hybrid hard drive (HDD), optical disk, optical disk drive (ODD), magneto-optical disk, magneto-optical drive, floppy disk, floppy disk drive (FDD), magnetic tape, holographic storage medium, solid state drive (SSD) A RAM drive, a secure digital card, a secure digital drive, a flash memory card, a flash memory drive, or any other suitable computer readable storage medium or a combination of two or more of these. Here, references to computer readable storage media exclude any medium that does not meet the patent protection conditions under 35 U.S.C. § 101. Here, references to computer readable storage media exclude temporary forms of signal transmission (e.g., propagating electrical or electromagnetic signals themselves) from the point that they do not comply with the patent protection conditions under 35 U.S.C. § 101.

Particular embodiments may include one or more non-transitory computer readable storage media that implement any suitable storage. In a particular embodiment, the computer readable storage medium implements one or more portions of processor 211 (eg, such as one or more internal registers or caches), memory 213, where appropriate. One or more portions, one or more portions of the storage portion 215, or a combination of these. In a particular embodiment, a computer readable storage medium implements a RAM or ROM. In a particular embodiment, a computer readable storage medium implements a volatile or persistent memory. In a particular embodiment, the one or more computer readable storage media specifically comprise encoding software.

Here, where appropriate, references to encoding software may encompass one or more applications, bytecodes, one or more computer programs, one or more that have been stored or encoded in a computer readable storage medium. Multiple executable programs, one or more instructions, logic, machine code, one or more scripts, or source code, and vice versa. In a particular embodiment, the encoding software includes one or more application programming interfaces (APIs) stored or encoded in a computer readable storage medium. Particular embodiments may use any suitable encoding software that is stored or encoded in any suitable type or number of computer readable storage media, written or otherwise expressed in any suitable programming language or combination of programming languages. In a particular embodiment, the encoding software can be expressed as source code or object code. In a particular embodiment, the encoding software is expressed in a high level programming language (for example, such as C, Perl, or a suitable extension thereof). In a particular embodiment, the encoding software is expressed in a low level programming language such as assembly language (or machine code). In a particular embodiment, the encoding software is expressed in JAVA. In a particular embodiment, the encoding software is expressed in Hypertext Markup Language (HTML), Extensible Markup Language (XML), or other suitable markup language.

Computer 210 is coupled to network 220. Network 220 can include hardware, software, coding logic, or any combination thereof. The term "network" should be interpreted to generally define a signal, data, and/or message (including, but not limited to, signals, data, or messages transmitted via web pages, email, text chat, voice over IP

(VoIP), and instant messaging). Any network or combination of multiple networks. Depending on the scope, size, and/or configuration, network 220 (or any of its component networks) can be implemented as a LAN, WAN, MAN, PSTN, global distribution network such as the Internet, an intranet, an extranet, or any other form. Wireless or wired networking. In general, network 220 provides communication of packets, units, frames, or other portions of information (referred to herein as packets) between various components. More specifically, network 220 can couple computer 210 to one or more storage areas 230 such that computer 210 can access any information stored in storage area 230.

In particular embodiments, storage area 230 may include a mass storage portion of data or instructions. As an example, and not by way of limitation, the storage area 230 may include: an HDD, a floppy disk drive, a flash memory, an optical disk, a magneto-optical disk, a magnetic tape, or a universal serial bus (USB) or two or more of these. combination. Storage area 230 may include removable or non-removable (or fixed) media, where appropriate. In a particular implementation, storage area 230 can be a non-volatile, solid state memory. In a particular embodiment, storage area 230 can include read only memory (ROM). Where appropriate, the ROM may be a mask programming ROM, a programmable ROM (PROM), an erasable PROM (EPROM), an electrically erasable ROM (EEPROM), an electrically rewritable ROM (EAROM), or a flash. Memory or a combination of two or more of these. The storage area 230 can take any suitable physical form and can include any suitable number or type of storage. In particular embodiments, storage area 230 may refer to a database accessible by computer 210. In a particular implementation, storage area 230 may store any suitable data for planning, designing, and evaluating a wireless network that may include an fBS. For example, storage area 230 may store: demographic information associated with the geographic area (eg, population density, revenue, subscription status, etc.), geographic information associated with the geographic area (city, county, state, building, etc.), Terrain information associated with the geographic area (eg, altitude, vegetation, etc.), current top information of the service provided by the service provider, current licensed spectrum information for the wireless network, information about the spectrum available for licensing, and licensing License cost information associated with available spectrum, deployment cost information associated with deploying fBS within a geographic area (eg, installation cost, site lease cost, spectrum license cost, etc.), data throughput associated with deploying fBS within a geographic area Changes in volume information, information about expected fees to be collected for deployment of fBS in a geographic area (eg, normal customer charges, promotional customer charges, etc.), and/or during planning, design, and evaluation of wireless networks that may include fBS Any other suitable information used or created.

So far, several different implementations and features have been proposed. Particular embodiments may combine one or more of these features depending on operational needs and/or component constraints. This can allow the network 200 to be highly adaptable to the needs of various organizations and users. Some embodiments may include additional or different features. In particular embodiments, the functionality of computer 210 may be provided by additional or different means.

In accordance with certain embodiments, the teachings of the present disclosure relate to planning, designing, and evaluating a wireless network that can include an fBS. Traditionally, wireless service providers have not been able to efficiently plan, design, or evaluate wireless networks that provide femtocell services and fBS. In particular, for femtocell services and fBS, various barriers have made planning, designing, and evaluating wireless networks impractical. For example, unlike traditional base stations (e.g., MBS, pBS, RS, etc.) where the wireless service provider controls the deployment of the base station, the wireless service provider has little or no control over the deployment of the fBS. Specifically, because the fBS is owned or leased by a separate client, the wireless service provider does not know which home locations will deploy the fBS. Moreover, the wireless service provider may have less control over where the fBS may be located within the customer's home location. Therefore, since the number of potential fBS site locations is significantly larger than that of a conventional base station, it is not feasible to evaluate all possible combinations of fBS locations. As another example, the wireless coverage of an fBS is significantly smaller than a conventional base station. In particular, although the wireless coverage of the MBS can be several square miles, the wireless coverage of the fBS is limited to relatively small areas (eg, surrounding a house). Thus, planning, designing, and evaluating networks that include fBS is traditionally not feasible.

In one embodiment, planning, designing, and evaluating a wireless network may include three phases of processing: (1) a "pre-planning" phase (FIG. 3), which may be an auxiliary service provision prior to initiating a femtocell service within a particular geographic region. The party makes a strategic decision; (2) the "promotion" phase (Figure 4), which can assist the service provider to promote the femtocell service to a specific customer base, and the subscription of the femtocell service for that particular customer group may benefit the service provider. And (3) the "Operation" phase (Figure 5), which can assist the service provider in determining installation configuration parameters for faster and more successful deployment of the fBS. In some embodiments, depending on the situation, the pre-planning phase may occur during deployment of a planned new wireless service, after a traditional wireless network has been planned (eg, a wireless network including MBS, pBS, RS, etc.) but not fully deployed. In the case of a network, or after a traditional wireless network has been deployed in a geographic area. In some embodiments, the promotion phase can occur after the wireless service has been initiated by the service provider. In another embodiment, the operational phase may occur after the wireless service has been initiated by the service provider and/or at any time when the potential deployment customer is identified (e.g., a request for the fBS has been received from the potential deployment customer).

Each of Figures 3-5 discussed below may relate to the deployment of an fBS. In one embodiment, the deployment of the fBS may include any suitable action for providing the femtocell service to the client. For example, the deployment of the fBS may include providing the fBS device to the client, providing the femto cell service to the fBS, configuring the fBS to operate, or any other suitable action associated with deploying the fBS.

Moreover, each of Figures 3-5 discussed below may relate to "potential deployment customers." In one embodiment, the potential deployment customer may include any suitable individual, institution, company, or any other suitable group that may potentially deploy the fBS. In another embodiment, the potential deployment

customer may include: an existing customer of the wireless service provider who has not subscribed to the wireless service provider for the femtocell service (eg, they may subscribe to other wireless provided by the wireless service provider) Service), or a person or group (eg, a non-customer) who has neither subscribed to the wireless service provider nor subscribed to the wireless service provider for the femtocell service.

Figure 3 illustrates a method for evaluating a wireless service network within a geographic area, in accordance with a particular embodiment. In a particular embodiment, the method may allow the wireless service provider to make a policy decision regarding the deployment of the fBS in a geographic area. For example, based on the determinations performed in the method, the wireless service provider is able to understand at a high level the performance of the wireless service network and how the incorporated fBS may affect the performance. Specifically, the wireless service provider can determine how the fBS affects wireless capacity, backhaul capacity, latency, traffic (such as traffic redirected from MBS to fBS), and revenue. Thus, the wireless service provider can determine whether to deploy the femtocell service within a geographic area and also be able to determine the price of the femtocell service within the geographic area.

In one embodiment, the method of FIG. 3 may be performed by a computer such as computer 210 of FIG. Likewise, the method of Figure 3 can be performed by a radio system level simulator or a commercial radio planning tool.

The method begins at step 310 where the computer receives information indicative of a wireless coverage area associated with a base station within a geographic area. This information can be associated with base stations that have been deployed or are planned to be deployed in the future. In those cases where the wireless coverage area information is based on a planned deployment of the base station, the information may be based on a simulation of the deployment of the base station. Where the wireless coverage area information is based on actual deployment to the base station, the information may be based on measurements made within the geographic area, a simulation of the deployed base station, or some combination of the two. In one embodiment, the wireless coverage associated with the base station may include wireless coverage associated with any suitable type of base station. For example, these base stations may include: MBS, pBS, RS, or any other suitable base station. The wireless coverage area information can be used in particular to determine the current capacity of the wireless network and/or to identify locations within the geographic area that the wireless coverage does not satisfy one or more performance thresholds. For example, the identified location may be an area within the geographic area where the wireless signal strength is weak or there is insufficient available bandwidth.

At step 314, the computer determines the number of potential customers within the geographic area. In one embodiment, the computer can determine the number of potential customers based on demographic information. For example, a computer can receive demographic information associated with the geographic area. Such demographic information may include: current population level, address associated with the population,

expected population growth, information about the current customer of the wireless service provider, age distribution, household income, education level, or related to the geographic information. Any other suitable demographic information. This demographic information can also include U.S. Any accessible information of the Census Bureau.

Once demographic information is received, the computer can identify a subset of the population within the geographic region. The subset may be identified based on the identified location where the wireless signal was not performed as required, an analysis of any suitable demographic factors, or a combination of the above. For example, a computer can identify subsets based on family income ranges, age ranges, education level ranges, and the like. After identifying a subset of the population, the computer can then determine the number of potential customers by multiplying the subset of the population by the probability of ordering. The probability of ordering may be based on historical data provided by the wireless service provider, e.g., based on previous deployments, deployments of other wireless service providers, other sources that have historically employed wireless services, or some combination of the above. In some embodiments, the probability of ordering may be based on a function of the household income range, age range, education level, etc. of the population within the geographic region.

In some embodiments, the computer can determine the number of potential customers based on a list of previous customers, such as customers who have subscribed to previously generated wireless services provided by the wireless service provider. Similarly, the number of potential customers can be determined using an existing customer database accessible to the wireless service provider.

In particular embodiments, potential deployment customers may be identified based on the number of potential customers. In some embodiments, potential deployment customers may also be identified based on market share maintained by wireless service providers within the geographic area. For example, a computer can multiply the total number of potential customers (eg. people living in the geographic area) by market share (the percentage of people in the geographic area that are already customers of the wireless service provider) to calculate potential A subset of customers. In this example, the market share can be determined by the computer or can be entered into the computer by the user. In some embodiments, if demographic information is utilized to calculate the number of potential customers, the computer can randomly select an address from among all addresses within the geographic area. In another embodiment, if the previous customer list is utilized to calculate the number of potential customers, the computer can randomly select an address from among the addresses on the list.

At step 318, the computer determines the current performance of the wireless coverage area. In one embodiment, the computer determines current performance based on information indicative of the wireless coverage area received by the computer in step 310. In one embodiment, the current performance of the wireless coverage area may refer to coverage and throughput provided by base stations within the geographic area. This current

performance may also refer to the cost of providing wireless coverage (eg, maintenance, operations, etc.). The current performance of the wireless system can be determined in any suitable manner using any suitable information.

At step 322, the computer determines a threshold performance requirement. This threshold performance requirement can include any suitable wireless performance requirements. For example, the threshold performance requirement can include the total wireless capacity required within the geographic area during peak usage time. As another example, the threshold performance requirement may include the total wireless capacity required within the geographic area during the average usage time. In one embodiment, the threshold performance requirement can provide an indication of the extent to which the wireless system network can be expected to receive. In some embodiments, the threshold performance requirement can be based on a desired future performance requirement to reflect an expected increase in the number of customers. This expected increase can be based on the number of potential customers and/or the probability of the order discussed above. The threshold can be based on usage, capacity, cost, or any other metric that is recognized by the wireless service provider.

This threshold performance requirement can be determined in any suitable manner. In one embodiment, the threshold performance requirement may be determined based on an estimate of the wireless usage requirements of current and/or potential deployment customers. For example, when a wireless service provider enters a new market, each potential deployment customer can be associated with a wireless subscription plan for wireless services. In such an example, this association can be made based on the probability of the order discussed above. In another embodiment, such association may be based on any other information obtained during the above steps. In one embodiment, after the computer associates the potential deployment customer with the wireless subscription plan for the wireless service, the computer can estimate the threshold performance requirements based on the potential deployment customers and their associated subscription plans. In another embodiment, the estimate can be made based on any other suitable factor, such as typical wireless usage during peak periods.

At step 326, the computer simulates an fBS deployment within the geographic area. In one embodiment, the simulation can include a computer simulation of the wireless coverage generated by the fBS deployed (e.g., installed and operated) within the geographic area. As such, the simulation can include wireless coverage provided by both existing base stations within the geographic area and also by the added fBS. In one embodiment, this combination of existing base stations (MBS, pBS, RS, etc.) and fBS may be referred to as a "heterogeneous environment."

In one embodiment, the simulation can include deploying fBSs to cause them to operate in a particular mode. For example, the simulation can include one or more of a plurality of fBSs operating in CSG, OSG, or HSG.

In one embodiment, the simulation can include deploying any suitable number of fBSs. For example, during a simulation, only a single fBS can be deployed, or multiple fBSs can be deployed. In another embodiment, the number of fBSs deployed during the simulation may be based on the percentage of potential deployed customers. For example, the number of fBSs can be ten percent of the number of potential deployed customers, twenty percent of the number of potential deployed customers, or any other suitable percentage.

In one embodiment, the simulation can include deploying the fBS to a particular location within the geographic area. For example, an fBS can be deployed to a specific address within a geographic area. As another example, the fBS can be deployed to any address of a potential deployment customer. In one embodiment, the selection of the address may be random. For example, the selection of an address can be based on the probability of ordering as discussed above. As another example, the selection of the address may be based on a uniform random distribution. In another embodiment, the selection of the address can be based on any suitable algorithm. In yet another embodiment, the number of addresses at which the femto base station is deployed may be based on a percentage of the address of the potential deployment client.

At step 330, the computer determines a first set of parameters based on the simulated deployment of the fBS. In some embodiments, the first set of parameters can include a first performance parameter. The first performance parameter can include any indication of the wireless coverage produced by the simulation. For example, the first performance parameter can be based on bandwidth, coverage area, signal quality, wireless capacity, backhaul capacity, any other parameters related to the wireless network, or some combination of the above. In some embodiments, the first set of parameters can also include a first cost parameter. The first cost parameter may include capital expenditures (such as equipment costs for fBS, security gateways, femtocell gateways, etc.) and operational costs associated with deploying fBS (eg, maintenance, technical support, customer support, providing another channel for fBS operation, cost of providing additional bandwidth, etc.). Likewise, the first cost parameter can include the total cost associated with deploying the fBS.

At step 334, the computer simulates the deployment of additional base stations within the geographic area. In an embodiment, the additional base station may not include an fBS. For example, the additional base station may only include base stations of the type already existing in the geographic area, such as MBS, pBS, RS, and the like. In a particular embodiment, such a deployment can be simulated to compare with the simulation of the deployment of the fBS. For example, the deployment can be simulated to determine if the added additional MBS, pBS, RS, and/or any other suitable type of base station already present in the geographic area can result in better performance than deploying the fBS.

In one embodiment, the simulation of step 334 may include a computer simulation of the wireless coverage generated by deploying (e.g., installing and operating) additional base stations within the geographic area.

Likewise, the simulation can include wireless coverage provided by both existing base stations within the geographic area and also by added base stations. Moreover, in one embodiment, the simulation performed by the computer at step 334 may not include any fBS from steps 326 and 346. Likewise, the simulation may only include base stations of the same type as the base stations already present in the geographic area. In one embodiment, this may be referred to as a different "isomorphic environment."

In one embodiment, the simulation of step 334 may include deploying any suitable number of additional base stations. For example, during a simulation, only a single additional base station may be deployed, or multiple additional base stations may be deployed. In one embodiment, the number of additional base stations can be determined in any suitable manner. In another embodiment, the simulation of step 334 can include deploying the additional base stations to specific locations within the geographic area. In one embodiment, the location at which additional base stations are deployed may be determined in any suitable manner.

At step 338, the computer determines a second set of parameters based on the simulated deployment of the additional base stations. In one embodiment, the second set of parameters can include a second performance parameter. The second performance parameter can include any indication of the wireless coverage generated by the simulation at step 334. For example, the second performance parameter can be based on bandwidth, coverage area, signal quality, wireless capacity, backhaul capacity, any other parameters related to the wireless network, or some combination of the above. In one embodiment, the second set of parameters can include a second cost parameter. The second cost parameter may include capital expenditures (e.g., equipment costs for additional base stations, security gateways, etc.) and operational costs (e.g., maintenance costs) associated with deploying additional base stations. Likewise, the second cost parameter can include the total cost associated with deploying the additional base station.

In particular embodiments, the information used by the computer and used in the simulations performed in steps 326 and 334 may include any number of different types that may or may affect the wireless network and/or any associated cost thereof. Any combination of appropriate information. For example, the information can include geographic or terrain data associated with the geographic area. This data can be included from U.S. City, county, and/or state boundaries, building size and location, terrain, elevation, and land cover data received by the Geological Survey (USGS). The data may also include any information that may relate to the physical location of the base station or fBS and/or the range that may affect its wireless signals.

This information may include infrastructure data associated with providing coverage areas. The infrastructure data may include any suitable data regarding antennas, cellular towers, base stations, cabling, switching or routing offices, site leases (e.g., leased land or building space), or any other suitable infrastructure data. For example, the infrastructure data may include location data for any aspect of the infrastructure (eg, the location of any base station, antenna, or cell tower within the geographic area), performance data for any aspect of the infrastructure,

and infrastructure-specific Any aspect of cost (eg, acquisition, rent, maintenance, upgrades, etc.) data, or any other suitable infrastructure data. The infrastructure data may include any suitable infrastructure data that is stored and maintained by the wireless service provider or by the Federal Communications Commission (FCC).

The information may also include spectrum information related to the availability of the wireless spectrum (e.g., the wireless spectrum available to the wireless service provider for lease and/or current lease). The spectral information may relate to available frequencies, bandwidth, costs associated with licensed available spectrum, any other features or components related to the available spectrum, or some combination of the above.

This information can also include capacity data. This capacity data can be associated with the cumulative capacity of the base station or fBS deployed or to be deployed, or the individual capacity of a single base station or fBS. In addition, the capacity can be associated with wireless capacity, wired capacity, backhaul capacity, switched capacity, processing capacity, or the capacity of any other component or service required to provide wireless coverage.

This information can also include currency information. The currency information may include the fees currently charged to the current customer, or an estimated fee that may be charged when deploying an fBS or other base station. The currency information can include: promotional pricing, promotional discounts, or incentives. The currency information can include the costs associated with deploying the base station or fBS. This cost can relate to initial deployment costs (eg, purchasing new hardware, installing hardware, configuring hardware, acquiring site space, renting spectrum, etc.) and recurring costs (eg, site rental fees, spectrum license renewals, utilities, maintenance, etc.)).

At step 342, the computer compares the first and second sets of parameters. The comparison can include one or more of the first and second performance parameters and the first and second cost parameters. This comparison can be used to help decide between deploying an fBS within the geographic area or deploying additional base stations. In some embodiments, the first and/or second performance parameters can be compared to a threshold to determine if any of the simulations result in a parameter that is sufficiently improved (e.g., a parameter that meets or exceeds the threshold performance determined at step 322). In some embodiments, the computer can determine if additional simulations are to be performed. In some cases, the determination can be made based on input from an operator of the computer. Depending on the particular implementation, determining that additional simulations are to be performed may enable the computer to simulate additional ways in which threshold performance requirements may be met.

At step 346, a deployment suggestion is generated. In one embodiment, the deployment suggestion can indicate whether the fBS should be deployed within the geographic area. For example, based on one or more of the

simulations at steps 326 and 334 and the threshold performance requirements determined at step 322, the computer can determine whether deploying the fBS within the geographic area is desirable or undesirable. As another example, based on one or more of the simulations at steps 326 and 334 and the threshold performance requirements determined at step 322, the computer can determine whether deploying the additional base within the geographic area is desirable or undesirable. In some embodiments, the computer can determine that it is desirable to deploy a combination of fBS and base stations. In some embodiments, the computer can determine that deploying an fBS or base station is disadvantageous. This may occur, for example, when neither of the simulations produces a performance parameter that exceeds the threshold determined at step 322. In yet another embodiment, the deployment suggestion can indicate performance parameters and/or cost parameters that may be expected with or without the deployment of the fBS.

In one embodiment, the computer can generate a deployment suggestion based at least on the first performance parameter. For example, it may be desirable for the computer to determine that deploying an fBS within the geographic area when the first performance parameter meets the threshold performance requirement.

In another embodiment, the computer can generate a deployment suggestion based on a comparison of the first performance parameter to the second performance parameter. For example, based on a comparison of the first performance parameter to the second performance parameter, the computer can determine that the heterogeneous system (which includes the fBS) produces better performance than the homogeneous system (which does not include the fBS). Likewise, the computer can generate deployment recommendations indicating that fBS should be deployed within the geographic area.

In another embodiment, the computer can generate a deployment suggestion based on a comparison of the first cost parameter to the second cost parameter. For example, based on a comparison of the first cost parameter to the second cost parameter, the computer can determine that the heterogeneous system (which includes the fBS) produces a lower cost than the homogeneous system (which does not include the fBS). Likewise, the computer can generate deployment recommendations indicating that fBS should be deployed within the geographic area.

In yet another embodiment, the computer can generate a deployment suggestion based on the comparison of the first and second performance parameters and the first and second cost parameters. For example, based on a comparison of the first and second performance parameters and the first and second cost parameters, the computer can determine that the heterogeneous system (which includes the fBS) produces better performance and/or performance than the homogeneous system (which does not include the fBS) Lower cost. Similarly, the computer can generate deployment recommendations indicating that fBS should be deployed within the geographic region.

In one embodiment, generating a deployment suggestion may also cause the computer to make additional determinations. In particular, the computer can determine one or more deployment policies (eg, spectrum usage policies) for the fBS. For example, the computer can determine if the fBS and other base stations (MBS, pBS, RS, etc.) should share the wireless channel or determine whether to dedicate the wireless channel to the fBS. As another example, the computer can determine one or more operational modes (CSG, OSG, HSG, etc.) for the fBS. As yet another example, the computer can determine the bandwidth of the fBS channel. In one embodiment, these determinations can be made based on a comparison of the first and second performance parameters and/or the first and second cost parameters.

In one embodiment, the step of generating a deployment suggestion can further include the computer generating a pricing policy associated with deploying the fBS within the geographic area. Specifically, the pricing strategy can be based on capital expenditures and savings (eg, for equipment, site leases, security gateways, femtocell gateways, backhaul connections, etc.), operating costs, and savings (eg, for maintenance, technical support, customers) Information on support, spectrum, etc., marketing inputs (such as how many potential deployment customers may be willing to pay for femtocell services), and/or any other suitable information. In one embodiment, the computer can generate a pricing policy in any suitable manner. For example, pricing strategies can be based on device cost, additional channel cost (as when fBS receives their own dedicated channel), and base station channel bandwidth cost. As another example, the pricing policy may be based on an operating mode of the fBS (CSG, OSG, HSG, etc.). In one embodiment, the computer can generate a pricing policy such that the wireless service provider can determine the price at which the potential deployment customer may be subscribed to subscribe to the femtocell service. According to this embodiment, the price may be a national price, a local price for a femtocell service, or some other price (eg, having a partial promotional discount that expires after a certain amount of time (eg, 6 months)) National price).

In another embodiment, the step of generating a deployment suggestion may further comprise the computer determining a profit margin for deploying the fBS. For example, the price that a wireless service provider can charge a customer for a wireless service utilizing an fBS can be compared to the cost for the wireless service provider to operate the fBS (eg, the cost of providing a service and maintaining the service) so that Determine the profit rate. Moreover, the computer can determine how to adjust the pricing strategy and/or the performance of the wireless network to maximize profit margins. In addition, the computer can determine how to adjust pricing strategies and/or profit margins in order to increase the performance of the wireless service network.

Although the embodiment depicted in Figure 3 includes a particular number of steps depicted in a particular order, it should be understood that other embodiments may have more, fewer, or different steps, and the steps may be rearranged. For example, in some embodiments, a computer can generate a deployment proposal without the need to simulate deploying additional base stations. As another example, in some embodiments, the simulation steps 326 and/or 334 may be repeated multiple times, with the number and/or placement of base stations and/or fBS changing each time. This repetition can be used to better identify the best deployment.

4 illustrates a method for promoting a femto service, in accordance with a particular embodiment. In one embodiment, the method of Figure 4 can provide wireless service providers with the ability to identify locations and/or potentially deploy customers if the deployment fBS can provide the greatest benefit to the wireless service provider's network. In another example, the method of FIG. 4 may be provided to a potential deployment customer in such a manner as to provide wireless service providers with enhanced overall wireless system performance, increased individual services for customers, and/or may increase revenue for wireless service providers. The ability of femtocell services. For example, by adding additional customers, the benefits of wireless service providers can increase. Moreover, traffic can be redirected from the existing base station to the fBS by adding additional fBS to the network at the location where the fBS can bring the greatest benefit to the wireless service network. This can reduce the traffic load on existing base stations in the wireless network, thereby allowing higher quality of service to be provided to customers. Moreover, by redirecting traffic from an existing base station to an fBS, the wireless service provider can reduce the cost of maintaining its backhaul connection to an existing base station. In some cases, wireless service providers can use fBS to offer discount rates to customers to encourage their use.

In one embodiment, the method of FIG. 4 may be performed by a computer such as computer 210 of FIG. As such, the method of Figure 4 can be performed by a radio system level simulator or a commercial radio planning tool.

The method begins at step 410 where the computer receives information indicative of a wireless coverage area associated with a base station within a geographic area. In one embodiment, the information may be any suitable information indicative of a wireless coverage area. For example, the information can be similar to the information of step 310 of FIG. As another example, the information can include any information that is received, used, or determined during the methods of Figures 3 and/or 5. As another example, the information may be a selection of a wireless coverage area within the geographic area and/or a selection of the geographic area.

At step 414, the computer identifies potential deployment customers to deploy the fBS for these potential deployment customers. In a particular embodiment, the computer can identify potential deployment customers in any suitable manner. In one embodiment, potential deployment customers can be identified by receiving an indication from a potential deployment customer. For example, a potential deployment customer may contact a wireless service provider to learn about femtocell services or install femtocell services. As another example, a computer can identify potential deployment customers by randomly selecting addresses from a subset of potential customers. The address of a subset of potential customers can be retrieved in any suitable way, such as by U.S. Information from the Census Bureau, or through detailed maps such as those available from online map resources. In one embodiment, the random selection of the address may be based on the probability of the order discussed above. In another embodiment, the random selection of addresses may be based on a uniform random

distribution of femto cell subscriptions. The random selection can be limited to a particular location within the geographic area (e.g., where there is a weak wireless signal).

In one embodiment, the computer can identify potential deployment customers based on wireless usage data. For example, potential deployment customers may include existing customers with high capacity wireless service usage in locations where fBS may be deployed. In particular, potential deployment customers may have high capacity (e.g., high traffic or long term use) indoor usage of wireless services within the customer's home, office, or any other suitable location where the fBS can be deployed. In one embodiment, by deploying fBS to a location where existing customers have high capacity indoor wireless service usage, a significant portion of the customer's wireless usage can be redirected through the fBS. This can reduce the amount of traffic directed through existing base stations, thereby increasing the performance of the wireless service. Moreover, because a significant portion of the customer's wireless usage can now be redirected through the fBS (which uses the customer's network access for the backhaul connection of the corresponding fBS, without using the wireless service provider's network access), the wireless The service provider is able to offer discounted prices to customers.

In one embodiment, any suitable method can be used to identify potential deployment customers based on wireless usage data. For example, a computer can access and search for one or more databases that include information about wireless usage data for existing customers. In one embodiment, the method of Figure 4 may also include the step of computer generating information stored in these databases.

In another embodiment, the computer can identify potential deployment customers based on wireless performance data. For example, a potential deployment customer may include an existing customer who is subject to frequent drops of wireless service within a location where the fBS can be deployed. In particular, potential deployment customers may experience frequent drops of wireless service in the customer's home, office, or any other suitable location where the fBS can be deployed. In one embodiment, deploying fBS to these locations may improve wireless signal reception as potential deployment customers may experience frequent drops of wireless service within a particular location.

In one embodiment, any suitable method can be used to identify potential deployment customers based on wireless performance data. For example, a computer can access and search for one or more databases that include information about wireless performance data for existing customers. In such an example, these databases may include information about measurements of the customer's wireless service, or may include a log of the number of times the wireless service has declined for each customer. In one embodiment, the method of Figure 4 may also include the step of computer generating information stored in these databases.

In another embodiment, potential deployment customers can be identified by identifying potential deployment

locations within the geographic area. For example, a potential deployment customer may include an existing customer associated with an address that falls within a location of a wireless coverage area where the wireless service is unsatisfactory (e.g., the address is the address of their home, office, etc.). In one embodiment, deploying fBS to these locations may improve wireless signal reception because potential deployment customers may be located in areas that may prevent them from receiving sufficient wireless service.

In one embodiment, any suitable method can be used to identify these potential deployment customers. For example, a wireless coverage area within a geographic area can be evaluated to identify locations where wireless coverage provides unsatisfactory wireless service. In particular, the wireless zone can be evaluated to determine locations with weak wireless signals, no wireless signals, and/or have insufficient wireless bandwidth. In one embodiment, by identifying such locations, the computer can identify potential deployment locations. Moreover, once a potential deployment location is identified, in one embodiment, the computer can identify potential deployment customers based on a comparison of potential deployment locations with location data associated with current customers within the geographic region. For example, the computer can compare potential deployment locations (eg, locations with weak wireless signals, no wireless signals, and/or locations with insufficient wireless bandwidth) to the customer's address. In this example, if the customer's address falls within a potential deployment location, the customer can be identified as a potential deployment customer.

In one embodiment, to identify potential deployment customers based on potential deployment locations, the computer can access and search for one or more databases that include information about wireless coverage areas within the geographic area. For example, such a database may include performance parameters determined in the method of Figure 3. As another example, these databases may include any other suitable information determined in the method of FIG. In yet another embodiment, to identify potential deployment customers based on potential deployment locations, the computer can access and search for one or more databases including address information. For example, such a database can include a list of existing customers (including addresses). As another example, such a database may include a list of addresses of people and communities that are not current customers (e.g., non-clients) of the wireless service provider, as included from U.S. A database of information from the Census Bureau. In this example, the computer can compare these addresses to potential deployment locations to identify these non-customers as potential deployment customers.

Once the potential deployment customer is identified, the method moves to step 418. At step 418, the computer determines initial configuration parameters for deploying the fBS. In one embodiment, the initial configuration parameters may include an operational mode of the fBS, such as OSG, CSG, HSG, and the like. Other parameters may include one or more constraints (e.g., transmit power, available spectrum, and/or channel, etc.) for the wireless signals used by the fBS based on the fBS deployed for the identified potential deployment customers. According to one embodiment, the computer can determine these initial configuration parameters based on the likely deployment locations of the fBS. For example, if the fBS is to be deployed in the vicinity of other wireless service users (such as other wireless users other than the customer who subscribes to the femto cell

service), the computer can determine that the fBS should work in accordance with the CSG to prevent other wireless service users from passing the fBS to receive their wireless service. As another example, if the fBS is to be deployed in a commercial location (e.g., a coffee shop where all customers receive free wireless access), the computer can determine that the fBS is operating as an OSG. In this way, customers of the store can easily access the wireless services provided by the fBS.

In another embodiment, the initial configuration parameters may include whether the fBS can be deployed at all. For example, if an fBS is to be deployed too close to another base station (e.g., MBS), the fBS may interfere with the wireless service provided by the base station and vice versa. In this way, the computer can determine that the fBS cannot be deployed in this location.

In one embodiment, the method may end when it is determined that the fBS cannot be deployed. In another embodiment, upon determining that the fBS cannot be deployed, the computer can determine an alternate location (eg, an alternate location at the same address) for the fBS to be deployed, or the computer can determine another suitable solution (eg, identification can It is set to the fBS in the vicinity of the OSG or the base station is deployed).

At step 422, the computer generates a promotional bid. In one embodiment, the promotional offer is more specific to potential deployment customers. For example, if the potential deployment customer is a premium data user, the promotional bid can include a specific price discount to encourage potential deployment customers to sign up for the femtocell service. The amount of price discount can be based in part on the amount of data used by potential deployment customers. In one embodiment, the computer can generate promotional bids in any suitable manner. For example, the computer can use any suitable algorithm for generating promotional bids. As another example, a computer may generate a promotional bid based on input from a user of the computer or based on one or more online sources.

In one embodiment, generating a promotional bid may also include the computer determining a pricing policy for use in the promotional bid. In a particular embodiment, the computer can determine a pricing policy based on the circumstances of each potential deployment customer. For example, if a computer identifies a potential deployment customer based on the high data usage of a potential deployment customer, the computer can determine a pricing strategy that takes into account high data usage. In this example, unlike existing base stations (such as MBS), potential deployment customers can receive discounts on wireless data sent over the fBS. As another example, the computer can determine the pricing policy based on the mode of operation of the fBS. For example, the pricing of fBSs operating on CSG may be more expensive than fBS operating on HSG or OSG.

In one embodiment, generating the promotional bid may also include prioritizing the potential deployment

customer prior to generating the promotional bid. For example, in one embodiment, potential deployment customers may be prioritized based on the extent to which the potential deployment customer's subscription to the femto cell service may benefit the wireless service provider. In this example, if the subscription to the femtocell service can be redirected by the fBS to a large portion of the data, unlike the existing base station, the wireless service provider can be pressured from the wireless service provided by the existing base station. The reduction is reduced to receive greater benefits. In this example, the potential deployment customer can receive a higher priority than another potential deployment customer that benefits the subscription to the femtocell service, which is beneficial to the wireless service provider. In one embodiment, by prioritizing potential deployment customers, a higher priority potential deployment customer may first receive a promotional bid for the femtocell service. In one embodiment, the differentiation of potential deployment customer prioritization may also include the computer determining and comparing the benefits that the wireless service provider may receive from the potential deployment customer's subscription to the femtocell service.

In one embodiment, generating the promotional bid may also include contacting the potential deployment customer to provide the promotional bid. In one embodiment, the potential deployment customer can be contacted by the computer in any suitable manner. For example, a computer can generate an email message to send to a potential deployment customer. As another example, a computer can generate a voicemail message for delivery to a potential deployment customer. In another embodiment, potential deployment customers can contact directly without a computer. For example, a computer can generate a notification about a promotional offer and can also provide the notification to a wireless service provider employee. In this example, after receiving the notification, the wireless service provider employee can contact the potential deployment customer. As another example, a promotional bid may be transmitted to a potential deployment customer via an advertisement posted to the address of the potential deployment customer.

Although the embodiment depicted in Figure 4 includes a particular number of steps depicted in a particular order, it should be understood that other embodiments may have more, fewer, or different steps, and the steps may be rearranged.

FIG. 5 illustrates a method for determining installation configuration parameters for an fBS, in accordance with a particular embodiment. In one embodiment, the method can be reduced to the amount of time that may be required to successfully deploy the fBS. For example, deploying fBS typically takes up to a full day. In one embodiment, the method may allow for faster installation (and/or prior to deployment of the fBS) to determine installation configuration parameters. As a result, the time required to successfully deploy (via the wireless service provider's technicians, or even through the actual customer) fBS can be reduced.

In one embodiment, the method of FIG. 5 can be performed by a computer such as computer 210 of FIG. As such, the method of Figure 5 can be performed by a radio system level simulator or a commercial radio planning

tool.

The method begins at step 510, where the computer receives a request to deploy an fBS. The request can be any suitable type of request to deploy the fBS. For example, the request may be in the form of a potential deployment customer accessing a wireless service provider's store or retail center, a phone call, an email message, a request via mail, an online ordering request, or any other suitable type of request. The request may also be a request for any suitable question associated with deploying the fBS. For example, the request may relate to potential deployment customers having difficulty installing the fBS, potential deployment customers wanting to subscribe to the femtocell service, potential deployment client requesting information about the femtocell service, or any other suitable associated with deploying the fBS request. In one embodiment, the computer can receive the request in any suitable manner. For example, the request can be received directly or indirectly by a computer, via an online submission of a potential deployment customer. As another example, a wireless service provider employee can enter the request into a computer after receiving a request from a potential deployment customer (e.g., during a telephone call with the potential deployment customer).

At step 514, the computer determines if the fBS can be deployed. The computer can make this determination based on any suitable information. For example, a request to deploy an fBS may include address information for a potential deployment customer. Thus, based on the address information, the computer can determine that the fBS is not allowed to be deployed at the address or at a particular location associated with the address. In particular, if the fBS is deployed too close to another base station (e.g., MBS), thereby causing interference, the fBS may not be allowed to be deployed. As another example, the request to deploy a femto base station may include information about Internet services and/or wireless connections available or ordered by potential deployment customers. Similarly, the computer can determine that potential deployment customers are not able to receive Internet access (or sufficient Internet access) for fBS operations. As another example, the computer can make a determination as to whether to allow the fBS based on one or more simulations (as discussed below for step 518).

In one embodiment, the method may end when it is determined that the fBS may not be allowed. In another embodiment, upon determining that the fBS may not be allowed, the computer may determine an alternate location (eg, an alternate location at the same address) for the fBS to deploy, or the computer may determine another suitable solution (eg, identification) It can be set to fBS near the OSG).

On the other hand, when it is determined that the fBS is allowed (or if the computer does not have enough information to make an appropriate determination), the method moves to step 518. At step 518, the computer determines the installation configuration parameters for the fBS. The installation configuration parameters can include any suitable configuration parameters for successfully deploying the fBS at a particular location. For example, the installation configuration parameters may include an operational mode of the fBS (CSG, OSG,

HSG, etc.). Moreover, the installation configuration parameters can include wireless parameters based on characteristics of the wireless coverage area, such as any suitable physical layer (PHY) and/or medium access control layer (MAC) configuration parameters. Additionally, the installation configuration parameters may include parameters for backhaul connections to the air interface or fBS.

The computer can use any suitable method to determine the installation configuration. In one embodiment, the computer may be based on on-site access to a location where the fBS can be deployed, such as a residential, office, or commercial enterprise potentially deploying a customer (which may require more than one fBS to provide satisfactory wireless service). To determine the installation configuration parameters. During a live visit, the wireless service provider's technician can create a video recording of the location, such as the indoor environment and layout at that location. Moreover, the wireless service provider's technicians can also take detailed measurements of the location. The computer can then utilize video recording and/or measurement to create a three-dimensional layout of the location using any suitable computer program, such as computer vision. In another embodiment, the three-dimensional layout of the location can be created independently of the computer and can then be entered into the computer. Once the computer has a three-dimensional layout of the location, the computer can run one or more simulations that deploy the fBS. In one embodiment, these simulations may include simulations of propagating wireless signals to and from the fBS in the three dimensional layout. In one embodiment, the computer can then combine the simulation (and the data collected from the simulation) with detailed measurements taken by the wireless service provider's technician during the live visit. In one embodiment, based on the combination, the computer can determine the installation configuration parameters and placement of the fBS. Once these installation configuration parameters have been determined by the computer, the wireless service provider's technician can return to the location of the potential deployment customer and utilize the installation configuration parameters to properly deploy the fBS at that location, or the potential deployment customer can use the installation configuration parameters. Successfully deployed fBS.

In another embodiment, the computer can determine installation configuration parameters based on empirical modeling. Empirical modeling can include modeling performed using a spatial channel model (SCM) or any other suitable empirical modeling method.

In one embodiment, to utilize empirical modeling to determine initial configuration parameters, the computer can create various templates for use in simulating the deployment of fBS. These templates can be created for various types of locations and various types of environments. For example, the template may be created for large buildings, small buildings, high altitude locations, low altitude locations, locations close to existing base stations, and/or any other suitable type of location or environment. In a particular embodiment, these templates may represent a general type of location or environment. In one embodiment, these templates may utilize geographic information such as three-dimensional measurements of a particular location, and also utilize detailed details such as RayTracing and/or Finite-Difference Time-Domain (FDTD). Modeling methods to create. Because these detailed modeling methods are time consuming methods, these templates can be pre-created for computers

that need them to determine initial configuration parameters.

After creating these templates, you can use empirical modeling to train these templates. This empirical modeling can result in the determination of the modeling parameters for each template (resulting in the determination of the modeling parameters for each of the different location types and different environmental types exhibited by these templates). In one embodiment, training the template can include empirical modeling of a template multiple times. In such an embodiment, the modeling parameters generated during each empirical modeling period can be averaged to determine more realistic modeling parameters for these templates.

Once these templates have been created and trained, they can be stored, such as in a database accessible to the computer. In one embodiment, storing the templates may include classifying the templates based on geographic information (e.g., three-dimensional location information, terrain, land coverage, etc.). This type of classification allows for the classification of these templates based on different location types and different environment types.

In one embodiment, to utilize empirical modeling to determine initial configuration parameters, the computer may select one or more of these templates for use in simulating the deployment of the fBS. In one embodiment, geographic information (eg, three-dimensional location information, terrain, terrestrial coverage, etc.) and/or geometric information (eg, building structure, floor plan, etc.) associated with the location of the femto base station to be deployed may be utilized. To choose a template. This information can be determined in any suitable manner. For example, the computer can determine this information based on the address of the location where the fBS is to be deployed. In particular embodiments, this may include extracting three-dimensional information from online map resources such as Google Maps or Bing Maps. In one embodiment, the geographic and/or geometric information may simply be geographic and/or geometric information associated with the outdoor layout of the location rather than the indoor layout. In one embodiment, it may be associated only with an indoor layout or with both indoor and outdoor layouts.

Using the geographic information and/or geometric information associated with the location where the fBS is to be deployed, the computer can select a template to use as a model for that location. In particular embodiments, such selection may include determining which template's geographic and/or geometric information is most similar to the geographic and/or geometric information of the location where the fBS is to be deployed. This determination can be made by searching for the classification in the database in which these templates are stored.

After selecting the appropriate template, the computer can then simulate the deployment of the fBS based on the template and the modeling parameters of the template. In one embodiment, the computer can determine installation configuration parameters based on the simulation. For example, a computer may utilize various operational modes (CSG, OSG, HSG, etc.) of a femto base station, various wireless parameters (such as any

suitable PHY and/or MAC parameters), and/or various air or backhaul connections. Parameters to simulate the deployment of fBS. In one embodiment, the simulation can include another empirical modeling.

In one embodiment, determining configuration installation parameters based on empirical modeling and templates may result in more accurate installation configuration parameters than installation configuration parameters that would typically result from empirical modeling itself. For example, empirical modeling is not as detailed as ray tracing and FDTD modeling techniques. However, empirical modeling is faster than those with more detailed modeling techniques. Thus, by combining empirical modeling with templates that are created using detailed modeling of general location and environment types, an accurate set of installation configuration parameters can be determined in a short amount of time.

As explained above, Figure 5 illustrates steps 514 and 518 that occur after the computer receives a request to deploy an fBS. Such an embodiment of Figure 5 may be referred to as "online operation." According to one embodiment of the online operation, one or more steps of FIG. 5 may occur when a potential deployment client waits for the outcome of the method. For example, potential deployment customers can call a customer service representative after encountering difficulties with deploying fBS. The customer service representative can then direct the computer to perform one or more of steps 514-518 while the potential deployment customer is still talking to the customer service representative. Once these steps are completed, the customer service representative can use the determinations of steps 514-518 to explain to the potential deployment customer how to successfully deploy the fBS.

In another embodiment of the online operation, one or more of the steps in Figure 5 may occur after the computer receives a request to deploy the fBS. For example, a potential deployment customer can submit a request for a femtocell service. Based on the request, one or more of steps 514-518 can be performed. The results of one or more of the steps in Figure 5 can then be transmitted to potential deployment customers at a later time. This transmission may take the form of an email message, a return telephone call, or any other suitable form of transmission. The results of one or more of the steps in Figure 5 can be used to configure the fBS prior to shipping the fBS or otherwise delivering it to a potential deployment customer.

In another embodiment, steps 514-518 of Figure 5 may be performed by the computer before the computer receives a request to deploy the fBS. Such an embodiment of Figure 5 may be referred to as "offline operation." According to one embodiment of the offline operation, one or more of steps 514-518 of Figure 5 may occur before the potential deployment client provides a request to deploy the fBS. For example, a computer can assume that a potential deployment customer intends to ultimately subscribe to a femto cell service. Based on this assumption, the computer can perform one or more of steps 514-518 of Figure 5 such that the results of these steps may have been known before the time when the potential deployment client actually provided the request to deploy the fBS.

In one embodiment of offline operation, the computer can use various databases to determine potential deployment customers to perform the steps of Figure 5. Such a database may include an existing customer database, a previous customer database, a non-customer database, or any other suitable database that may include information about potential deployment customers. In one embodiment, the computer can utilize any suitable method to identify potential deployment customers. For example, a computer may use a potential deployment customer identified or determined in Figures 3 and/or 4. As another example, a computer can identify potential deployment customers by randomly selecting potential deployment customers from any suitable database.

In one embodiment, after the computer identifies the potential deployment customer, the computer can use any suitable information associated with the potential deployment customer (eg, the address of the potential deployment customer) to determine whether the fBS is allowed to be associated with the potential deployment customer. At the location, and also determine the installation configuration parameters for the fBS (according to steps 514-518). Once these determinations are made by the computer, these determinations can be stored (e.g., stored at a computer or at a computer accessible database). Thus, as discussed in step 510, when the computer receives a request to deploy the fBS, the computer can retrieve the stored determinations and provide these determinations so that the deployment of the fBS can be performed more quickly.

In another embodiment, the method of FIG. 5 may also include the step of a computer determining a pricing policy for the fBS. For example, based on the installation configuration parameters, the computer can determine a more accurate pricing strategy for potential deployment customers. As such, when a potential deployment customer requests to deploy an fBS, a more accurate price can be provided to the potential deployment customer.

Although the embodiment depicted in Figure 5 includes a particular number of steps depicted in a particular order, it should be understood that other embodiments may have more, fewer, or different steps, and the steps may be rearranged.

In one embodiment, each of the methods illustrated in Figures 3-5 can be a separate, independent method. In another embodiment, each of the methods of Figures 3-5 can be performed in combination with each other. As an example, one or more steps of one of the various methods illustrated in Figures 3-5 can be performed with one or more of any of the other methods of Figures 3-5. In particular, the steps of the method of Figure 3 can be performed prior to the steps of the method of Figures 4-5. Once the steps of Figure 3 have been performed, the computer can perform the steps of the method shown in Figure 4. Moreover, after the computer has performed the steps of the method of Figure 4, the computer can then perform the steps of the method of Figure 5. In

another embodiment, after the computer performs the steps of the method of FIG. 3, the computer can move directly to the steps of the method of FIG. 5, thereby bypassing the method of FIG. 4. In another embodiment, the computer may return to any of the other methods of Figures 3-5 after one or more of the methods of Figures 3-5 have been performed. For example, after the computer performs the steps in the method of FIG. 5, the computer can return to one or more of the methods of FIG. 4 to further promote the femtocell service.

A person skilled in the art can determine many other variations, substitutions, variations, changes and modifications of the inventions.

Notice

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CLAIMS CN102740306

1.

A method comprising the steps of:

Receiving information indicative of a wireless coverage area associated with each of a plurality of base stations within the geographic area;

Determining threshold performance requirements within the geographic area;

Simulating deployment of at least one femto base station within the geographic area;

Determining at least a first performance parameter based on a simulated deployment of the at least one femto base station within the geographic area;

A deployment suggestion is generated based at least on the first performance parameter and the threshold performance requirement, the deployment suggestion indicating whether the at least one femto base station is deployed within the geographic area.

2.

The method of claim 1 wherein the step of generating a deployment suggestion comprises the step of comparing

the first performance parameter to the threshold performance requirement, the deployment suggestion indicating;

Deploying the at least one femto base station if the first performance parameter is greater than the threshold performance requirement;

The at least one femto base station is not deployed if the first performance parameter is less than the threshold performance requirement.

3.

The method of claim 1

The method also includes the following steps:

Simulating deployment of at least one additional base station within the geographic area, the at least one additional base station not being a femto base station;

Determining at least a second performance parameter based on the simulated deployment of the at least one additional base station within the geographic area;

Comparing at least the first performance parameter and the second performance parameter;

The generating the deployment suggestion is further based on comparing the first performance parameter with the second performance parameter.

4.

The method of claim 3,

The method also includes the following steps:

Simulating at least a first cost parameter for deployment of the at least one femto base station within the geographic area;

Determining at least a second cost parameter based on the simulated deployment of the at least one additional base station within the geographic area;

Comparing at least the first cost parameter and the second cost parameter;

The generating the deployment proposal is further based on comparing the first cost parameter with the second cost parameter.

5.

The method of claim 1 wherein the step of determining a threshold performance requirement within the geographic area comprises the steps of:

Receiving demographic information associated with the geographic area;

The threshold performance requirement is determined based at least on the demographic information associated with the geographic area.

6.

The method of claim 1 further comprising the step of determining whether to share one or more of said at least one femto base station with one or more base stations deployed within said geographic area Wireless channel.

7.

The method of claim 1 further comprising the step of generating at least one pricing policy associated with deploying said at least one femto base station within said geographic area.

8.

A device comprising:

An interface configured to receive information indicative of a wireless coverage area associated with each of a plurality of base stations within the geographic area; and

a processor coupled to the interface and configured to:

Determining threshold performance requirements within the geographic area;

Simulating deployment of at least one femto base station within the geographic area;

Simulating at least the first performance parameter for the deployment of the at least one femto base station within the geographic area;

A deployment suggestion is generated based at least on the first performance parameter and the threshold performance requirement, the deployment suggestion indicating whether the at least one femto base station is deployed within the geographic area.

9.

The apparatus of claim 8, wherein the processor configured to generate a deployment suggestion is further configured to compare the first performance parameter to the threshold performance requirement, the deployment suggestion indicating:

Deploying the at least one femto base station if the first performance parameter is greater than the threshold performance requirement;

The at least one femto base station is not deployed if the first performance parameter is less than the threshold performance requirement.

10.

The apparatus of claim 8 wherein said processor is further configured to:

Simulating deployment of at least one additional base station within the geographic area, the at least one

additional base station being not a femto base station;

Determining at least a second performance parameter based on the simulated deployment of the at least one additional base station within the geographic area;

Comparing at least the first performance parameter and the second performance parameter;

The processor configured to generate the deployment suggestion is further configured to generate the deployment suggestion based on a comparison of the first performance parameter and the second performance parameter.

11.

The apparatus of claim 10 wherein said processor is further configured to

Determining at least a first cost parameter based on the simulated deployment of the at least one femto base station within the geographic area;

Determining at least a second cost parameter based on the simulated deployment of the at least one additional base station within the geographic area;

Comparing at least the first cost parameter and the second cost parameter;

The processor configured to generate the deployment suggestion is further configured to generate the deployment proposal based on a comparison of the first cost parameter and the second cost parameter.

12.

The apparatus of claim 8 wherein said processor arranged to determine a threshold performance requirement within said geographic area is further configured to:

Receiving demographic information associated with the geographic area;

The threshold performance requirement is determined based at least on the demographic information associated with the geographic area.

13.

The apparatus of claim 8, wherein the processor is further configured to determine whether to share one or between the at least one femto base station and one or more base stations deployed within the geographic area More wireless channels.

14.

The apparatus of claim 8, wherein the processor is further configured to generate at least one pricing policy associated with deploying the at least one femto base station within the geographic area.

15.

One or more computer readable non-transitory storage media comprising software, the software being arranged to be executed by a processor:

Receiving information indicative of a wireless coverage area associated with each of a plurality of base stations within the geographic area;

Determining threshold performance requirements within the geographic area;

Simulating deployment of at least one femto base station within the geographic area;

Determining at least a first performance parameter based on a simulated deployment of the at least one femto base station within the geographic area;

A deployment suggestion is generated based at least on the first performance parameter and the threshold performance requirement, the deployment suggestion indicating whether the at least one femto base station is deployed within the geographic area.

16.

The medium of claim 15, wherein the software configured to generate a deployment suggestion upon execution is further configured to compare the first performance parameter to the threshold performance requirement when executed, the deployment suggestion Instructions:

Deploying the at least one femto base station if the first performance parameter is greater than the threshold performance requirement;

The at least one femto base station is not deployed if the first performance parameter is less than the threshold performance requirement.

17.

The medium of claim 15 wherein said software is further configured to, when executed,

Simulating deployment of at least one additional base station within the geographic area, the at least one additional base station being not a femto base station;

Determining at least a second performance parameter based on the simulated deployment of the at least one additional base station within the geographic area;

Comparing at least the first performance parameter and the second performance parameter;

Wherein the software configured to generate the deployment suggestion upon execution is further configured to generate the deployment suggestion based on a comparison of the first performance parameter and the second performance parameter when executed.

18.

The medium of claim 17 wherein said software is further configured to, when executed,

Determining at least a first cost parameter based on the simulated deployment of the at least one femto base station within the geographic area;

Determining at least a second cost parameter based on the simulated deployment of the at least one additional base station within the geographic area;

Comparing at least the first cost parameter and the second cost parameter;

The software configured to generate the deployment suggestion upon execution is further configured to generate the deployment suggestion based on a comparison of the first cost parameter and the second cost parameter when executed.

19.

The medium of claim 15 wherein said software arranged to determine a threshold performance requirement within said geographic area is further arranged to be executed:

Receiving demographic information associated with the geographic area;

The threshold performance requirement is determined based at least on the demographic information associated with the geographic area.

20.

The medium of claim 15 wherein the software is further configured to, upon execution, determine whether to share between the at least one femto base station and one or more base stations deployed within the geographic area One or more wireless channels.

21.

The medium of claim 15 wherein the software is further configured to, when executed, generate at least one pricing policy associated with deploying the at least one femto base station within the geographic area.



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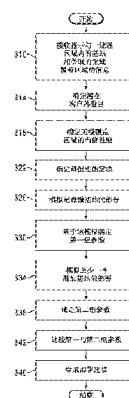
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(54) 发明名称

用于评估无线服务网络的方法和系统

(57) 摘要

本发明涉及用于评估无线服务网络的方法和系统。提供了一种用于评估无线服务网络的方法，该方法包括接收指示与地理区域内的多个基站中的每一个基站相关联的无线覆盖区域的信息。该方法还包括确定该地理区域内的阈值性能需求。该方法附加地包括在该地理区域内模拟对至少一个毫微微基站的部署。该方法还包括基于模拟的在该地理区域内对至少一个毫微微基站的部署来至少确定第一性能参数。该方法还包括：至少基于第一性能参数和阈值性能需求来生成部署建议。该部署建议可以指示是否在该地理区域内部署至少一个毫微微基站。



1. 一种方法,该方法包括以下步骤:

接收指示与地理区域内的多个基站中的每一个基站相关联的无线覆盖区域的信息;

确定所述地理区域内的阈值性能需求;

模拟在所述地理区域内对至少一个毫微微基站的部署;

基于模拟的在所述地理区域内对所述至少一个毫微微基站的部署来至少确定第一性能参数;以及

至少基于所述第一性能参数和所述阈值性能需求来生成部署建议,所述部署建议指示是否在所述地理区域内部署所述至少一个毫微微基站。

2. 根据权利要求1所述的方法,其中,生成部署建议的步骤包括将所述第一性能参数与所述阈值性能需求进行比较的步骤,所述部署建议指示:

如果所述第一性能参数大于所述阈值性能需求,则部署所述至少一个毫微微基站;而

如果所述第一性能参数小于所述阈值性能需求,则不部署所述至少一个毫微微基站。

3. 根据权利要求1所述的方法,

所述方法还包括以下步骤:

模拟在所述地理区域内对至少一个附加基站的部署,所述至少一个附加基站不是毫微微基站;

基于模拟的在所述地理区域内对所述至少一个附加基站的部署来至少确定第二性能参数;以及

至少比较所述第一性能参数与所述第二性能参数;

其中,生成所述部署建议还基于所述第一性能参数与所述第二性能参数的比较。

4. 根据权利要求3所述的方法,

所述方法还包括以下步骤:

基于模拟的在所述地理区域内对所述至少一个毫微微基站的部署来至少确定第一成本参数;

基于模拟的在所述地理区域内对所述至少一个附加基站的部署来至少确定第二成本参数;以及

至少比较所述第一成本参数与所述第二成本参数;

其中,生成所述部署建议还基于所述第一成本参数与所述第二成本参数的比较。

5. 根据权利要求1所述的方法,其中,确定所述地理区域内的阈值性能需求的步骤包括以下步骤:

接收与所述地理区域相关联的人口统计信息;以及

至少基于与所述地理区域相关联的所述人口统计信息来确定所述阈值性能需求。

6. 根据权利要求1所述的方法,所述方法还包括以下步骤:确定是否在所述至少一个毫微微基站与部署在所述地理区域内的一个或多个基站之间共享一个或多个无线信道。

7. 根据权利要求1所述的方法,所述方法还包括以下步骤:生成与在所述地理区域内部署所述至少一个毫微微基站相关联的至少一个定价策略。

8. 一种装置,该装置包括:

接口,该接口被设置成接收指示与地理区域内的多个基站中的每一个基站相关联的无

线覆盖区域的信息 ;和

处理器,该处理器耦接至所述接口,并且被设置成 :

确定所述地理区域内的阈值性能需求 ;

模拟在所述地理区域内对至少一个毫微微基站的部署 ;

基于模拟的在所述地理区域内对所述至少一个毫微微基站的部署来至少确定第一性能参数 ;以及

至少基于所述第一性能参数和所述阈值性能需求来生成部署建议,所述部署建议指示是否在所述地理区域内部署所述至少一个毫微微基站。

9. 根据权利要求 8 所述的装置,其中,被设置成生成部署建议的所述处理器还被设置成,将所述第一性能参数与所述阈值性能需求进行比较,所述部署建议指示 :

如果所述第一性能参数大于所述阈值性能需求,则部署所述至少一个毫微微基站 ;而

如果所述第一性能参数小于所述阈值性能需求,则不部署所述至少一个毫微微基站。

10. 根据权利要求 8 所述的装置,其中,所述处理器还被设置成 :

模拟在所述地理区域内对至少一个附加基站的部署,所述至少一个附加基站不是毫微微基站 ;

基于模拟的在所述地理区域内对所述至少一个附加基站的部署来至少确定第二性能参数 ;以及

至少比较所述第一性能参数与所述第二性能参数 ;

其中,被设置成生成所述部署建议的所述处理器还被设置成,基于所述第一性能参数与所述第二性能参数的比较来生成所述部署建议。

11. 根据权利要求 10 所述的装置,其中,所述处理器还被设置成,

基于模拟的在所述地理区域内对所述至少一个毫微微基站的部署来至少确定第一成本参数 ;

基于模拟的在所述地理区域内对所述至少一个附加基站的部署来至少确定第二成本参数 ;以及

至少比较所述第一成本参数与所述第二成本参数 ;

其中,被设置成生成所述部署建议的所述处理器还被设置成,基于所述第一成本参数与所述第二成本参数的比较来生成所述部署建议。

12. 根据权利要求 8 所述的装置,其中,被设置成确定所述地理区域内的阈值性能需求的所述处理器还被设置成 :

接收与所述地理区域相关联的人口统计信息 ;以及

至少基于与所述地理区域相关联的所述人口统计信息来确定所述阈值性能需求。

13. 根据权利要求 8 所述的装置,其中,所述处理器还被设置成,确定是否在所述至少一个毫微微基站与部署在所述地理区域内的一个或多个基站之间共享一个或多个无线信道。

14. 根据权利要求 8 所述的装置,其中,所述处理器还被设置成,生成与在所述地理区域内部署所述至少一个毫微微基站相关联的至少一个定价策略。

15. 一种或更多种包含软件的计算机可读非暂时性存储介质,该软件被设置成在由处理器执行时 :

接收指示与地理区域内的多个基站中的每一个基站相关联的无线覆盖区域的信息；
确定所述地理区域内的阈值性能需求；
模拟在所述地理区域内对至少一个毫微微基站的部署；
基于模拟的在所述地理区域内对所述至少一个毫微微基站的部署来至少确定第一性能参数；以及

至少基于所述第一性能参数和所述阈值性能需求来生成部署建议，所述部署建议指示是否在所述地理区域内部署所述至少一个毫微微基站。

16. 根据权利要求 15 所述的介质，其中，被设置成在执行时生成部署建议的所述软件还被设置成在执行时，比较所述第一性能参数与所述阈值性能需求，所述部署建议指示：

如果所述第一性能参数大于所述阈值性能需求，则部署所述至少一个毫微微基站；而
如果所述第一性能参数小于所述阈值性能需求，则不部署所述至少一个毫微微基站。

17. 根据权利要求 15 所述的介质，其中，所述软件还被设置成在执行时，

模拟在所述地理区域内对至少一个附加基站的部署，所述至少一个附加基站不是毫微微基站；

基于模拟的在所述地理区域内对所述至少一个附加基站的部署来至少确定第二性能参数；以及

至少比较所述第一性能参数与所述第二性能参数；

其中，被设置成在执行时生成所述部署建议的所述软件还被设置成在执行时，基于所述第一性能参数与所述第二性能参数的比较来生成所述部署建议。

18. 根据权利要求 17 所述的介质，其中，所述软件还被设置成在执行时，

基于模拟的在所述地理区域内对所述至少一个毫微微基站的部署来至少确定第一成本参数；

基于模拟的在所述地理区域内对所述至少一个附加基站的部署来至少确定第二成本参数；以及

至少比较所述第一成本参数与所述第二成本参数；

其中，被设置成在执行时生成所述部署建议的所述软件还被设置成在执行时，基于所述第一成本参数与所述第二成本参数的比较来生成所述部署建议。

19. 根据权利要求 15 所述的介质，其中，被设置成确定所述地理区域内的阈值性能需求的所述软件还被设置成在执行时：

接收与所述地理区域相关联的人口统计信息；以及

至少基于与所述地理区域相关联的所述人口统计信息来确定所述阈值性能需求。

20. 根据权利要求 15 所述的介质，其中，所述软件还被设置成在执行时，确定是否在所述至少一个毫微微基站与部署在所述地理区域内的一个或多个基站之间共享一个或多个无线信道。

21. 根据权利要求 15 所述的介质，其中，所述软件还被设置成在执行时，生成与在所述地理区域内部署所述至少一个毫微微基站相关联的至少一个定价策略。

用于评估无线服务网络的方法和系统

技术领域

[0001] 本公开总体上涉及用于评估无线服务网络的方法和系统。

背景技术

[0002] 各种无线技术（例如，3G、4G、3GPP 长期演进（LTE）、LTE- 高级（LTE-A）、WiMAX 等）为使用较小的、用户安装的基站留有余地，这种基站在此通称为毫微微基站（femto base station, fBS）（例如，WiMAX 中的毫微微小区（femtocell），或 3GPP 中的家庭 node-B）。该 fBS 由无线服务提供方提供给用户。用户或无线服务提供方的技术人员将 fBS 安装在用户的家中或办公室中（在此通称为家庭或家庭位置），以增加局部无线覆盖的信号质量和强度。fBS 到无线服务提供方的网络（WSPN）的回程连接经由用户的家庭网络接入（例如，DSL）来提供。fBS 以与无线服务提供方的其它基站（例如，宏基站（MBS）和 / 或中继站（RS））相似的无线方式工作（例如，使用相同的许可频带）。fBS 可以允许在不需要用户通知的情况下完成从 MBS 向 fBS 的切换（例如，与从一个 MBS 向另一 MBS 的切换类似）。

[0003] 本质上，端点可以将 fBS 视为另一基站。由此，利用相同的无线服务的任何端点可以能够通过 fBS 建立连接。然而，fBS 的拥有者可能不想使他们的 fBS 可用于公众，由此，拥有者可以将 fBS 设置成仅允许来自该拥有者所指定的闭合用户组（CSG）的成员的接入。

发明内容

[0004] 本公开的教导涉及用于评估无线服务网络的方法和系统。例如，用于评估无线服务网络的方法可以包括以下步骤：接收指示与地理区域内的多个基站中的每一个基站相关联的无线覆盖区域的信息。该方法还可以包括以下步骤：确定该地理区域内的阈值性能需求。该方法可以附加地包括以下步骤：模拟在该地理区域内对至少一个毫微微基站的部署。所述方法还可以包括以下步骤：基于模拟的在该地理区域内对至少一个毫微微基站的部署来至少确定第一性能参数。所述方法还可以包括以下步骤：至少基于第一性能参数和阈值性能需求来生成部署建议。该部署建议可以指示是否在该地理区域内部署至少一个毫微微基站。

[0005] 特定实施方式的技术优点包括评估提供毫微微小区服务和 fBS 的无线网络的能力。特定实施方式的另一优点是，无线服务提供方能够确定是否在一地理区域内部署毫微微小区服务。特定实施方式的另一优点是，无线服务提供方还能够确定该地理区域内的毫微微小区服务的价格。特定实施方式的另一优点是，无线服务提供方能够确定地理区域内的 fBS 的频谱利用策略。根据下面的附图、描述以及权利要求书，其它技术优点对本领域普通技术人员将容易变得明显。而且，虽然上面已经列举了具体优点，但各种实施方式可以包括所列举优点的全部、一些，或者不包括所列举优点。

附图说明

[0006] 为了对特定实施方式和它们的优点的更完全的理解，下面，结合附图，对下面的说

说明书进行描述,附图中:

- [0007] 图 1 例示了根据一特定实施方式的、包括各种通信网络的通信系统;
- [0008] 图 2 例示了根据一特定实施方式的、包括计算机的更详细视图的网络;
- [0009] 图 3 例示了根据一特定实施方式的、用于评估一地理区域内的无线服务网络的方法;
- [0010] 图 4 例示了根据一特定实施方式的、用于提升毫微微小区服务的方法;以及
- [0011] 图 5 例示了根据一特定实施方式的、用于确定毫微微基站的安装配置参数的方法。

具体实施方式

[0012] 图 1 例示了根据一特定实施方式的、包括各种通信网络的通信系统。通信系统 100 可以由多个网络 110 组成。每一个网络 110 可以是设计成独立地或者结合其它网络来便于一种或更多种不同服务的多种通信网络中的任一种。例如,网络 110 可以便于因特网接入、无线接入(例如,经由 LTE 或 WiMAX 无线服务)、在线游戏、数据下载、文件共享、对等文件共享(P2P)、因特网协议语音(VoIP)呼叫、IP 视频呼叫,或者通常由网络提供的任何其它类型的功能。网络 110 可以利用用于有线或无线通信的多种协议中的任一种来提供它们相应的服务。例如,网络 110a 可以包括俗称为 WiMAX 的 802.16 无线网络(例如,802.16j),该 802.16 无线网络除了包括其它部分外,还可以包括宏基站(MBS)(如基站 120)和毫微微基站(fBS)(如 fBS 190)。

[0013] 为简单和容易讨论起见,本说明书的其余部分可以针对在此讨论的各种实体、组件以及网络使用简化的命名。“家庭位置”可以指用户具有到诸如因特网的外部网络的家庭网络接入的地点。家庭位置不限于仅用户的住宅,其例如可以包括用户的办公室。“家庭网络接入”可以指用于从用户的家庭位置接入一个或多个诸如因特网的外部网络的多种方法和/或技术中的任一种。例如,家庭网络接入可以包括:电缆调制解调器、DSL 调制解调器、xDSL 调制解调器等。“家庭网络”可以指设置在用户的家庭位置内的局域网(LAN)。LAN 可以包括有线和无线连接两者。术语“互联网”不是仅限于因特网,而是包括任何类型的网络,包括公共和私有网络。“因特网服务提供方”(ISP)可以指为用户提供他的家庭网络接入的实体。“无线服务”可以指由无线服务提供方所使用的、以在较大地理区域上为端点提供无线接入的多种方法和/或技术中的任一种。“无线服务提供方”(WSP)可以指提供无线服务的实体。虽然出于简化而使用了这种命名,但其不表示所有可能的实施方式和/或情况的全部范围。例如,ISP 也可以是 WSP。作为另一示例,ISP 可以不直接向用户提供互联网接入(例如,ISP 可以向建筑物提供互联网接入,该建筑物接着可以向 fBS 用户提供互联网接入)。

[0014] 图 1 中描绘的实施方式包括 fBS 190。fBS 190 本质上可以是用户从其 WSP 购买(或租用)的小型基站。一旦安装,fBS 190 可以提供地理上小的覆盖区域,该小的覆盖区域可以被用于增强用户的家庭位置内的信号覆盖。在一些实施方式中,fBS 190 可以使用和周围基站 120 相同的无线服务。例如,在特定实施方式中,fBS 190 可以使用和 WSP 的其它局部基站 120(例如,MBS、微微基站(pBS)(未描绘出),和/或 RS(未描绘出))相同的许可频谱(例如,经用户的 WSP 许可的频谱)。根据情况,用户可以与其他未知用户共享他

的 fBS 的覆盖 (例如, 该 fBS 是公共 fBS), 他可以将其限制于已知 / 经授权用户 (例如, 该 fBS 是私有 fBS), 或者以上的某种组合。已知 / 经授权用户可以被称为 CSG。因为每一个 fBS 用户都可以操作他们自己相应的 fBS, 所有他们可以更倾向于以 CSG 类型的配置使用他们的 fBS。

[0015] 尽管图 1 的示例性通信系统 100 包括六种不同网络, 网络 110a-110f, 术语“网络”应被解释为通常限定能够发送信号、数据和 / 或消息 (包括通过网页、电子邮件、文本聊天、IP 语音 (VoIP) 以及即时消息发送的信号、数据或消息) 的任何网络或多个网络的组合。根据该网络的范围、尺寸和 / 或配置, 网络 110a-110f 中的任一个网络都可以被实现为 LAN、WAN、MAN、PSTN、WiMAX 网络、诸如因特网的全球分布网络、内联网、外联网或任何其它形式的无线或有线联网。

[0016] 网络 110 可以包括任何数目的有线链路 160、无线连接 150、节点 170 以及 / 或端点 140 和它们的组合。出于例示的目的, 并且仅作为示例, 网络 110a 是可以至少部分地经由 WiMAX 或 LTE 实现的 MAN; 网络 110b 是 PSTN; 网络 110c 是 LAN; 网络 110d 是诸如互联网的 WAN; 网络 110e 是可以由负责向网络 110a 提供无线服务 (例如, WiMAX) 的 WSP 来操作的 WSPN; 而网络 110f 是可以由负责向其用户提供家庭网络接入 (包括互联网接入) 的 ISP 来操作的互联网服务提供方网络 (ISPN)。尽管图 1 中未描绘出, 但 ISPN 网络 110f 可以包括: 服务器、调制解调器、网关以及可能被需要提供他们相应的服务的任何其它组件。

[0017] 虽然网络 110 已经被描绘为六种分离的网络, 但根据情况, 这些网络中的任两种或更多种可以是单个网络。例如, WSP 和 ISP 可以是同一商业实体, 其可以在同一网络上保持针对两种服务的必要组件, 由此将 ISPN 网络 110f 和 WSPN 网络 110e 合并成单个网络。而且, 多个网络 110 之间的互连可以不同于图 1 中所描绘的互联。例如, 如果用户使用数字用户线路 (DSL) 用于他的互联网接入, 则他的网络接入装置 180 可以连接至 PSTN 110b。

[0018] 一般来说, 网络 110 为端点 140 和 / 或节点 170 之间的包、单元、帧或信息的其它部分 (在此通称为包) 的通信而设置。在特定实施方式中, 网络 110a 以及 110c-110f 可以是 IP 网络。IP 网络通过在包中放置数据并沿一个或多个通信路径向选定的目的地单独地发送每一个包来发送数据。网络 110b 例如可以是 PSTN, 其可以包括交换站、中央局、移动电话交换局、寻呼交换局、远程终端以及遍布世界各地的其它相关电信设备。网络 110d 可以通过网关耦接至网络 110b。根据实施方式, 网关可以是网络 110b 和 / 或 110d 的一部分 (例如, 节点 170e 和 / 或 170c 可以包括网关)。网关可以允许 PSTN 110b 能够与诸如网络 110a 或 110c-110f 中的任一种的非 PSTN 网络进行通信。

[0019] 网络 110a 或 110c-110f 中的任一种可以耦接至其它 IP 网络, 该其它 IP 网络包括但不限于因特网。因为 IP 网络共享发送数据的公共方法, 所以可以在位于不同且互连的 IP 网络上的装置之间发送信号。除了耦接至其它 IP 网络, 网络 110a 或 110c-110f 中的任一种还可以通过使用接口或诸如网关的组件而耦接至非 IP 网络。类似地, PSTN 110b 可以能够连接至其它网络, 包括经由接口或网关连接至 IP 网络。

[0020] 网络 110 可以彼此连接, 并经由多个有线链路 160、无线连接 150 以及节点 170 与其它网络连接。不仅有有线链路 160、无线连接 150 以及节点 170 连接各种网络, 而且它们还与端点 140 彼此互连和利用所耦接至的任何其它组件或网络 110 中任何网络的一部分与端点 140 互连。网络 110 的互连可以使得端点 140 能够传输数据并控制彼此之间的信令, 并

允许任何中间组件或装置传输数据和控制信号。因此,端点 140 的用户可以能够在耦接至一个或多个网络 110 的各网络组件之间和当中发送和接收数据和控制信号。

[0021] 在所描绘的实施方式中,无线连接 150f 和 150g 可以表示例如利用 WiMAX 的端点 140 与基站 120 或 fBS 190 之间的无线连接。在其它实施方式中,无线连接 150 可以使用其它无线技术和 / 或协议,如 LTE,或 LTE-A。在某些情况下,WiMAX、LTE、或 LTE-AMBS,连同同一个或多个中继站、pBS 和 / 或 fBS 的扩展范围可以允许网络 110a 覆盖与 MAN 相关联的更大的地理区域。

[0022] 节点 170 可以包括以下的任何组合:网络组件、调制解调器、会话边界控制器、网守 (gatekeeper)、ISPN 网关、WSPN 网关、安全网关、操作管理维护和供应 (OAM&P) 服务器、网络接入提供方 (NAP) 服务器、基站、会议电话桥接器 (conference bridge)、路由器、集线器、交换机、网关、端点、或者实现允许通信系统 100 中包的交换的任何数目的通信协议的任何其它硬件、软件或嵌入式逻辑。例如,节点 170c 可以包括网关。作为网关,节点 170c 可以允许网络 110b、PSTN 网络能够发送和接收来自诸如网络 110d、IP 网络的其它非 PSTN 网络的通信。在一些情况下,作为网关,节点 170c 可以在由网络 110b 和 110d 所使用的各种协议之间转换通信。

[0023] 在特定实施方式中,网络 110c 可以包括:各种服务器、网关、交换机、路由器,以及在提供一个或多个无线服务中所使用的其它节点。例如,WSPN 110e 包括:移动管理实体 (MME) 130b、安全网关 130a、服务网关 130d 以及家庭节点网关 130c。MME 130b 可以负责存储、组织和 / 或维持从各种端点接收到的绑定。安全网关 130a 可以包括多个、逻辑地分离的安全网关。虽然网关可以逻辑地分离,但它们可以物理地并置或分离。安全网关 130a 可以针对经由互联网接入 WSPN 110e 的端点和 / 或针对接入 WSPN 110e 的 fBS 而向 WSPN 110c 提供安全性。在特定实施方式中,这种安全性可以由两个逻辑地分离的安全网关来提供。例如,一个安全网关可以负责基于互联网的连接,而第二分离的安全网关可以负责基于 fBS 的连接。

[0024] 家庭节点网关 130c 可以用作用于控制面的集中器 (例如,S1-MME 接口)。在一些实施方式中,家庭节点网关 130c 可以终止朝向家庭节点网关 130c 和朝向服务网关 130d 的用户面。家庭节点网关 130c 可以提供用于在家庭节点网关 130c 与服务网关 130d 之间中继用户面数据的中继功能。在一些实施方式中,家庭节点网关 130c 可以支持 NAS 节点选择功能 (NNSF)。虽然已经描述了并在 WSPN 110e 内描绘了特定组件,但 WSPN 可以包括不同的、更少的或附加的组件。

[0025] 网络接入装置 180 可以通过硬件、嵌入在计算机可读介质中的软件和 / 或并入到硬件中的或以其它方式存储的编码逻辑 (例如,固件) 的任何组合来向 fBS 190 提供家庭网络接入。在一些实施方式中,网络接入装置 180 可以由用户的 ISP 来提供。例如,如果用户的 ISP 是电缆公司,则 ISP 可以提供电缆调制解调器,作为网络接入装置 180。作为另一示例,如果用户的 ISP 是电话公司,则 ISP 可以提供 xDSL 调制解调器,作为网络接入装置 180。如可以清楚的是,网络接入装置 180 可以向除了 fBS 190 以外的组件提供家庭网络接入。例如,用户可以将他的个人计算机连接至网络接入装置 180 以接入互联网。

[0026] 端点 140 和 / 或节点 170 可以通过硬件、嵌入在计算机可读介质中的软件和 / 或并入到硬件中的或以其它方式存储的编码逻辑 (例如,固件) 的任何组合来向用户提供数

据或网络服务。例如,任何一个端点 140 可以是蜂窝电话、IP 电话、计算机、视频监控器、摄像机、个人数字助理,或者支持使用一种或更多种网络 110 来传输包(或帧)的任何其它硬件、软件和/或编码逻辑。端点 140 还可以包括无人监视或自动系统、网关、其它中间组件、或者可以发送或接收数据和/或信号的其它装置。

[0027] 尽管图 1 例示了特定数量和配置的端点、连接、链路以及节点,但通信系统 100 也考虑任何数量或排布的这种组件用于传递数据。另外,通信系统 100 的元件可以包括相对彼此居中定位(局部)的或者遍及通信系统 100 分布的组件。

[0028] 图 2 例示了根据一特定实施方式的、包括计算机的更详细视图的网络。所描绘的网络 200 是包括计算机 210、网络 220 以及存储区域 230a-230c 的简化情况。计算机 210 可以包括一个或更多个计算机系统的一个或更多个部分。在特定实施方式中,这些计算机系统中的一个或更多个可以执行在此描述或例示的一种或更多种方法的一个或更多个步骤。在特定实施方式中,一个或更多个计算机系统可以提供在此描述或例示的功能。在一些实施方式中,运行在一个或更多个计算机系统上的编码软件可以执行在此描述或例示的一种或更多种方法的一个或更多个步骤,或者可以提供在此描述或例示的功能。

[0029] 计算机 210 的组件可以包括任何合适的物理形式、配置、数量、类型和/或布局。作为一示例,而非以限制的方式,计算机 210 可以包括嵌入式计算机系统、芯片上系统(SOC)、单板计算机系统(SBC)(举例来说,如模块上计算机(COM)或模块上系统(SOM))、台式计算机系统、膝上型或笔记本计算机系统、交互式查询系统(kiosk)、大型机、计算机系统网、移动电话、移动电话、个人数字助理(PDA)、服务器,或这些中的两个或更多个的组合。在合适的情况下,计算机 210 可以包括一个或更多个计算机系统;单式或分布式的;跨越多个位置;跨越多个机器;或者驻留在可以在一个或更多个网络中包括一个或更多个云组件的云中。在一个示例中,计算机 210 可以是无线电系统级模拟器或商用无线电规划工具。

[0030] 在合适的情况下,计算机 210 可以在没有显著的空间或时间限制的情况下,执行在此描述或例示的一种或更多种方法的一个或更多个步骤。作为一示例,而非以限制的方式,计算机 210 可以实时地或者以成批的方式,执行在此描述或例示的一种或更多种方法的一个或更多个步骤。在合适的情况下,一个或更多个计算机可以在不同时间或者在不同位置,执行在此描述或例示的一种或更多种方法的一个或更多个步骤。

[0031] 在所描绘的实施方式中,计算机 210 可以包括:处理器 211、存储器 213、存储部 215、接口 217 以及总线 212。这些组件可以一起工作以规划、设计以及评估可以包括 fBS 的无线网络,如下所讨论的。尽管将特定网络描绘为具有按特定排布的特定数量的特定组件,但本公开考虑具有按任何合适排布结构的任何合适数量的任何合适组件的任何合适网络 200。为简单起见,仅描绘了计算机 210 的组件。网络 200 中的其它装置可以具有下面针对计算机 210 描述的多个组件中的一个或更多个组件。

[0032] 处理器 211 可以是微处理器,控制器,或者任何其它合适的计算装置,资源,或硬件、软件以及/或编码逻辑的组合,其可操作用于单独地或者结合其它组件(例如,存储器 213)来提供用于规划、设计以及评估可以包括 fBS 的无线网络的能力。这种功能可以包括提供在此讨论的各种特征。例如,处理器 211 可以识别要向其部署 fBS 的一个或更多个潜在部署客户。下面将对附加例和至少部分地由处理器 211 提供的功能进行讨论。

[0033] 在特定实施方式中,处理器 211 可以包括用于执行指令(如构成计算机程序的指

令)的硬件。作为一示例,而非以限制的方式,为执行指令,处理器 211 可以从内部寄存器、内部高速缓冲存储器、存储器 213 或存储部 215 检索(或提取)指令;解码并执行它们;并接着将一个或多个结果写入至内部寄存器、内部高速缓冲存储器、存储器 213 或者存储部 215。

[0034] 在特定实施方式中,处理器 211 可以包括用于数据、指令或地址的一个或多个内部高速缓冲存储器。在合适的情况下,本公开考虑包括任何合适数量的任何合适的内部高速缓冲存储器的处理器 211。作为一示例,而非作为限制,处理器 211 可以包括:一个或多个指令高速缓冲存储器、一个或多个数据高速缓冲存储器,以及一个或多个转译后备缓冲器(TLB)。指令高速缓冲存储器中的指令可以是存储器 213 或存储部 215 中的指令的拷贝。指令高速缓冲存储器可以通过处理器 211 加速对那些指令的检索。数据高速缓冲存储器中的数据可以是:存储器 213 或存储部 215 中的数据的拷贝,针对在处理器 211 处执行的指令而进行操作;先前在处理器 211 处执行的、用于通过随后在处理器 211 处的指令执行而存取的、或者用于写入至存储器 213 或存储部 215 的结果;或者其它合适数据。数据高速缓冲存储器可以通过处理器 211 加速读取或写入操作。TLB 针对处理器 211 可以加速虚拟地址转换。在特定实施方式中,处理器 211 可以包括用于数据、指令或地址的一个或多个内部寄存器。根据实施方式,在合适的情况下,处理器 211 可以包括任何合适数量的任何合适的内部寄存器。在合适的情况下,处理器 211 可以包括一个或多个算术逻辑单元(ALU);可以为多核处理器;可以包括一个或多个处理器 211;或者为任何其它合适的处理器。

[0035] 存储器 213 可以是任何形式的易失性或非易失性存储器,包括但不限于,磁介质、光介质、随机存取存储器(RAM)、只读存储器(ROM)、闪存存储器、可移动介质,或者任何其它合适的本地或远程存储器组件或多个本地或远程存储器组件。存储器 213 可以存储计算机 210 所利用的任何合适的数据或信息,包括嵌入在计算机可读介质中的软件,和/或并入硬件中或者以其它方式存储的编码逻辑(例如,固件)。在特定实施方式中,存储器 213 可以包括用于存储处理器 211 执行的指令或者处理器 211 操作的数据的主存储器。作为一示例,而非作为限制,计算机 210 可以将来自存储部 215 或另一源(举例来说,如另一计算机系统、存储区域 230,或远程收发器)的指令加载至存储器 213。处理器 211 接着可以将来自存储器 213 的指令加载至内部寄存器或内部高速缓冲存储器。为执行这些指令,处理器 211 可以从内部寄存器或内部高速缓冲存储器检索这些指令,并对它们进行解码。在执行这些指令期间或之后,处理器 211 可以将一个或多个结果(其可以是中间或最终结果)写入至内部寄存器或内部高速缓冲存储器。处理器 211 接着可以将那些结果中的一个或多个写入至存储器 213。在特定实施方式中,处理器 211 可以仅执行一个或多个内部寄存器或内部高速缓冲存储器中的或者存储器 213(与存储部 215 相对或在别处)中的指令,并且可以仅对一个或多个内部寄存器或内部高速缓冲存储器中的或者存储器 213(与存储部 215 相对或在别处)中的数据进行操作。

[0036] 总线 212 可以包括硬件、嵌入在计算机可读介质中的软件和/或并入硬件中的或以其它方式存储的编码逻辑(例如,固件)的任何组合,以将计算机 210 的组件彼此耦接。作为一示例,而非作为限制,总线 212 可以包括:加速图形端口(AGP)或其它图形总线、增强的工业标准架构(EISA)总线、前端总线(FSB)、超传输(HYPERTRANSPORT)(HT)互连、工业标

准架构 (ISA) 总线、INFINIBAND 互连、低引脚数 (low-pin-count, LPC) 总线、存储器总线、微通道架构 (MCA) 总线、周边组件互连 (PCI) 总线、PCI 扩展 (PCI-X) 总线、串行高级技术附件 (SATA) 总线、视频电子标准协会局域 (VLB) 总线, 或者任何其它合适的总线或这些总线中的两种或更多种的组合。在合适的情况下, 总线 212 可以包括任何数量、类型和 / 或配置的总线 212。在特定实施方式中, 一个或更多个总线 212 (其皆可以包括地址总线 and 数据总线) 可以将处理器 211 耦接至存储器 213。总线 212 可以包括一个或更多个存储器总线, 如下所述。在特定实施方式中, 一个或更多个存储器管理单元 (MMU) 可以驻留在处理器 211 与存储器 213 之间, 并且便于接入由处理器 211 请求的存储器 213。在特定实施方式中, 存储器 213 可以包括随机存取存储器 (RAM)。在合适的情况下, 该 RAM 可以是易失性存储器。在合适的情况下, 该 RAM 可以是动态 RAM (DRAM) 或静态 RAM (SRAM)。而且, 在合适的情况下, 该 RAM 可以是单端口或多端口 RAM, 或者任何其它合适类型的 RAM 或存储器。在合适的情况下, 存储器 213 可以包括一个或更多个存储器 213。

[0037] 在特定实施方式中, 存储部 215 可以包括用于数据或指令的大容量存储部。作为一示例, 而非作为限制, 存储部 215 可以包括: HDD、软盘驱动器、闪速存储器、光盘、磁光盘、磁带, 或者通用串行总线 (USB) 驱动器或这些当中的两种或更多种的组合。在合适的情况下, 存储部 215 可以包括可移动或不可移动 (或固定) 介质。在合适的情况下, 存储部 215 可以处于计算机 210 内部或外部。在特定实施方式中, 存储部 215 可以是非易失性的、固态存储器。在特定实施方式中, 存储部 215 可以包括只读存储器 (ROM)。在合适的情况下, 该 ROM 可以是掩模编程 ROM、可编程 ROM (PROM)、可擦除 PROM (EPROM)、电可擦除 ROM (EEPROM)、电可改写 ROM (EAROM), 或者闪速存储器或这些当中的两个或更多个的组合。存储部 215 可以采取任何合适的物理形式, 并且可以包括任何合适数量或类型的存储部。在合适的情况下, 存储部 215 可以包括易于在处理器 211 与存储部 215 之间通信的一个或更多个存储控制单元。

[0038] 在特定实施方式中, 接口 217 可以包括用于一个或更多个 I/O 装置的一个或更多个接口。这些 I/O 装置中的一个或更多个可以能够实现人与计算机 210 之间的通信。作为一示例, 而非作为限制, I/O 装置可以包括: 键盘、小键盘、麦克风、监视器、鼠标、打印机、扫描仪、扬声器、静态照相机、触笔、写字板、触摸屏、轨迹球、视频摄像机、另外合适的 I/O 装置或这些当中的两种或更多种的组合。I/O 装置可以包括一个或更多个传感器。特定实施方式可以包括任何合适类型和 / 或数量的 I/O 装置, 和用于这些 I/O 装置的任何合适类型和 / 或数量的接口 117。在合适的情况下, 接口 117 可以包括使得处理器 211 能够驱动这些 I/O 装置中的一个或更多个的一个或更多个装置或编码软件驱动器。在合适的情况下, 接口 117 可以包括一个或更多个接口 117。

[0039] 在此, 对计算机可读存储介质的引用涵盖一个或更多个有形计算机可读存储介质处理结构。作为一示例, 而非作为限制, 在合适的情况下, 计算机可读存储介质可以包括: 基于半导体的或其它的集成电路 (IC) (举例来说, 如现场可编程门阵列 (FPGA) 或专用 IC (ASIC))、硬盘、HDD、混合硬驱动器 (HDD)、光盘、光盘驱动器 (ODD)、磁光盘、磁光驱动器、软盘、软盘驱动器 (FDD)、磁带、全息存储介质、固态驱动器 (SSD)、RAM 驱动器、安全数字卡、安全数字驱动器、闪速存储卡、闪速存储器驱动器, 或者任何其它合适的计算机可读存储介质或这些当中的两种或更多种的组合。在此, 对计算机可读存储介质的引用排除不符合

35U. S. C. § 101 下的专利保护条件的任何介质。在此,对计算机可读存储介质的引用从它们不符合 35U. S. C. § 101 下的专利保护条件的方面来说,排除了信号传送的暂时形式(如传播电或电磁信号本身)。

[0040] 特定实施方式可以包括实现任何合适的存储部的一种或更多种非暂时计算机可读存储介质。在特定实施方式中,在合适的情况下,计算机可读存储介质实现处理器 211 的一个或更多个部分(举例来说,如一个或更多个内部寄存器或高速缓冲存储器)、存储器 213 的一个或更多个部分、存储部 215 的一个或更多个部分,或者这些的组合。在特定实施方式中,计算机可读存储介质实现 RAM 或 ROM。在特定实施方式中,计算机可读存储介质实现易失性或持久性存储器。在特定实施方式中,一个或更多个计算机可读存储介质具体包含编码软件。

[0041] 在此,在合适的情况下,对编码软件的引用可以涵盖已经存储或编码在计算机可读存储介质中的一个或更多个应用、字节码、一个或更多个计算机程序、一个或更多个可执行程序、一个或更多个指令、逻辑、机器码、一个或更多个脚本、或源代码,反之亦然。在特定实施方式中,编码软件包括存储或编码在计算机可读存储介质中的一个或更多个应用编程接口(API)。特定实施方式可以使用在任何合适类型或数量的计算机可读存储介质中存储或编码的、按任何合适的编程语言或多种编程语言的组合编写或以其它方式表达的任何合适的编码软件。在特定实施方式中,编码软件可以表达为源代码或目标代码。在特定实施方式中,编码软件采用高级编程语言(举例来说,如 C、Perl,或其合适的扩展)来表达。在特定实施方式中,编码软件采用低级编程语言(如汇编语言(或机器码))来表达。在特定实施方式中,编码软件采用 JAVA 来表达。在特定实施方式中,编码软件采用超文本标记语言(HTML)、可扩展标记语言(XML),或其它合适的标记语言来表达。

[0042] 计算机 210 耦接至网络 220。网络 220 可以包括:硬件、软件、编码逻辑,或它们的任何组合。术语“网络”应被解释为通常限定能够发送信号、数据和/或消息(包括但不限于,通过网页、电子邮件、文本聊天、IP 语音(VoIP)以及即时消息发送的信号、数据或消息)的任何网络或多个网络的组合。根据范围、尺寸和/或配置,网络 220(或其成分网络中的任一种)可以被实现为 LAN、WAN、MAN、PSTN、诸如因特网的全球分布网络、内联网、外联网或任何其它形式的无线或有线连网。一般来说,网络 220 在各种组件之间提供包、单元、帧或信息的其它部分(在此通称为包)的通信。更具体地说,网络 220 可以将计算机 210 耦接至一个或更多个存储区域 230,以使得计算机 210 可以存取存储在存储区域 230 中的任何信息。

[0043] 在特定实施方式中,存储区域 230 可以包括数据或指令的大容量存储部。作为一示例,而非作为限制,存储区域 230 可以包括:HDD、软盘驱动器、闪速存储器、光盘、磁光盘、磁带,或者通用串行总线(USB)或这些中的两种或更多种的组合。在合适的情况下,存储区域 230 可以包括可移动或不可移动(或固定)介质。在特定实施方式中,存储区域 230 可以是非易失性、固态存储器。在特定实施方式中,存储区域 230 可以包括只读存储器(ROM)。在合适的情况下,该 ROM 可以是掩模编程 ROM、可编程 ROM(PROM)、可擦除 PROM(EPROM)、电可擦除 ROM(EEPROM)、电可改写 ROM(EAROM),或者闪速存储器或这些当中的两个或更多个的组合。存储区域 230 可以采取任何合适的物理形式,并且可以包括任何合适数量或类型的存储部。在特定实施方式中,存储区域 230 可以指计算机 210 可访问的数据库。在特定实

施方式中,存储区域 230 可以存储用于规划、设计以及评估可以包括 fBS 的无线网络的任何合适数据。例如,存储区域 230 可以存储:与地理区域相关联的人口统计信息(例如,人口密度、收入、订购状态等)、与地理区域相关联的地理信息(城市、县、州、建筑物等)、与地理区域相关联的地形信息(例如,海拔、植被等)、由服务提供方所提供的服务的当前顶户信息、无线网络的当前许可频谱信息、关于可用于许可的频谱的信息、与许可可用频谱相关联的许可成本信息、与在地理区域内部署 fBS 相关联的部署成本信息(例如,安装成本、站点租用成本、频谱许可成本等)、与在地理区域内部署 fBS 相关联的数据吞吐量信息的变化、关于在地理区域内部署 fBS 要收取的预期费用的信息(例如,正常客户收费、促销式客户收费等),以及/或在规划、设计以及评估可以包括 fBS 的无线网络期间所使用或创建的任何其它合适的信息。

[0044] 至此,已经提出了几个不同实施方式和特征。特定实施方式可以根据操作需要和/或组件限制来组合这些特征中的一个或多个。这可以允许网络 200 针对各种组织和用户的需要的极大适应性。一些实施方式可以包括附加的或不同的特征。在特定实施方式中,计算机 210 的功能可以通过附加的或不同的装置来提供。

[0045] 根据特定实施方式,本公开的教导涉及规划、设计以及评估可以包括 fBS 的无线网络。传统地,无线服务提供方未能有效地规划、设计或评估提供毫微微小区服务和 fBS 的无线网络。具体来说,对于毫微微小区服务和 fBS 来说,各种障碍已经致使规划、设计以及评估无线网络不可行。例如,与由无线服务提供方来控制基站的部署的传统基站(如 MBS、pBS、RS 等)不同,无线服务提供方很少或不控制 fBS 的部署。具体来说,因为 fBS 被单独的客户拥有或租用,所以无线服务提供方不知道哪些家庭位置将部署 fBS。而且,无线服务提供方对于 fBS 可能位于客户的家庭位置内的什么地方可能具有更少的控制。因此,因为潜在 fBS 站点位置的数量显著大于传统基站,所以评估 fBS 位置的所有可能的组合是不可行的。作为另一示例,fBS 的无线覆盖范围显著小于传统基站。具体来说,虽然 MBS 的无线覆盖范围可以是几平方英里,但 fBS 的无线覆盖范围被限制于相对小的区域(例如,包围一栋房子)。由此,规划、设计以及评估包括 fBS 的网络传统上不可行。

[0046] 在一个实施方式中,规划、设计以及评估无线网络可以包括三个阶段的处理:(1)“预规划”阶段(图 3),其可以在于特定地理区域内启动毫微微小区服务之前辅助服务提供方作出策略决定;(2)“推广”阶段(图 4),其可以辅助服务提供方向特定客户群推广毫微微小区服务,该特定客户群的对毫微微小区服务的订购可能有益于服务提供方;以及(3)“操作”阶段(图 5),其可以辅助服务提供方确定用于更快速成功地部署 fBS 的安装配置参数。在一些实施方式中,根据情况,预规划阶段可以出现在部署规划新无线服务期间、在已经规划了传统无线网络之后(例如,包括 MBS、pBS、RS 等的无线网络)但未完全部署传统无线网络的情况下,或者已经在某一地理区域内部署了传统无线网络之后。在某些实施方式中,推广阶段可以出现在已经由服务提供方启动了无线服务之后。在另一实施方式中,操作阶段可以出现在已经由服务提供方启动了无线服务之后和/或在识别出潜在部署客户的任何时间(例如,已经从潜在部署客户接收到对 fBS 的请求)。

[0047] 下面讨论的图 3-5 中的每一个都可以涉及 fBS 的部署。在一个实施方式中,fBS 的部署可以包括用于向客户提供毫微微小区服务的任何合适的动作。例如,fBS 的部署可以包括向客户提供 fBS 设备、向 fBS 提供毫微微小区服务、配置 fBS 以操作,或者与部署 fBS 相

关联的任何其它合适的动作。

[0048] 而且,下面讨论的图 3-5 中的每一个都可以涉及“潜在部署客户”。在一个实施方式中,潜在部署客户可以包括:任何合适的个人、机构、公司,或可以潜在地部署 fBS 的任何其它合适的团体。在另一实施方式中,潜在部署客户可以包括:无线服务提供方的、未向该无线服务提供方订购毫微微小区服务的现有客户(例如,他们可以订购该无线服务提供方提供的其它无线服务)、或者既未向无线服务提供方订购无线服务也未向该无线服务提供方订购毫微微小区服务的人或团体(例如,非客户)。

[0049] 图 3 例示了根据一特定实施方式的、用于评估一地理区域内的无线服务网络的方法。在特定实施方式中,该方法可以允许无线服务提供方作出有关在一地理区域内部署 fBS 的策略决定。例如,基于在该方法中执行的确定,无线服务提供方能够高水平地理解无线服务网络的性能以及并入的 fBS 可能如何影响该性能。具体来说,无线服务提供方能够确定 fBS 如何影响无线容量、回程容量、等待时间、通信量(如重定向为从 MBS 到 fBS 的通信量)流量,以及收益。因此,无线服务提供方能够确定是否在一地理区域内部署毫微微小区服务,并且还能够确定该地理区域内的毫微微小区服务的价格。

[0050] 在一个实施方式中,图 3 的方法可以由诸如图 2 的计算机 210 之类的计算机来执行。同样地,图 3 的方法可以由无线电系统级模拟器或商用无线电规划工具来执行。

[0051] 该方法在步骤 310 开始,其中,计算机接收指示与一地理区域内的基站相关联的无线覆盖区域的信息。该信息可以与已经部署的或者规划为将来要部署的基站相关联。在无线覆盖区域信息是基于对基站的规划部署的那些情况下,该信息可以基于对基站的部署的模拟。在无线覆盖区域信息是基于对基站的实际部署的那些情况下,该信息可以基于在该地理区域内进行的测量,对所部署的基站的模拟,或者这两者的某种组合。在一个实施方式中,与基站相关联的无线覆盖可以包括与任何合适类型的基站相关联的无线覆盖。例如,这些基站可以包括:MBS、pBS、RS,或者任何其它合适的基站。无线覆盖区域信息尤其可以被用于确定无线网络的当前容量和/或识别该地理区域内的、无线覆盖不满足一个或多个性能阈值的位置。例如,所识别的位置可以是该地理区域内的、无线信号强度较弱或者存在不足的可用带宽的区域。

[0052] 在步骤 314,计算机确定该地理区域内的潜在客户的数目。在一个实施方式中,计算机可以基于人口统计信息来确定潜在客户的数目。例如,计算机可以接收与该地理区域相关联的人口统计信息。这种人口统计信息可以包括:当前人口水平、与人口相关联的地址、期望人口增长、关于无线服务提供方的当前客户的信息、年龄分布、家庭收入、教育水平,或者与该地理信息有关的任何其它合适的人口统计信息。这种人口统计信息还可以包括来自 U. S. 人口调查局的任何可访问的信息。

[0053] 一旦接收到人口统计信息,计算机就可以识别该地理区域内人口的子集。该子集可以基于所识别的没有按照要求执行无线信号的位置、对任何合适的人口统计因素的分析,或者以上的组合来被识别。例如,计算机可以基于家庭收入范围、年龄范围、教育水平范围等来识别子集。在识别了人口的子集之后,计算机接着可以通过将该人口的子集乘以订购的概率来确定潜在客户的数目。订购的概率可以基于由无线服务提供方例如基于之前的部署、其它无线服务提供方的部署、历史上采用无线服务的其它源,或者以上的某种组合而提供的历史数据。在某些实施方式中,订购的概率可以基于该地理区域内人口的家庭收入

范围、年龄范围、教育水平等的函数。

[0054] 在一些实施方式中,计算机可以基于先前的客户(如已经订购由无线服务提供方所提供的先前生成的无线服务的客户)的列表来确定潜在客户的数目。同样地,潜在客户的数目可以利用无线服务提供方访问的现有的客户数据库来确定。

[0055] 在特定实施方式中,可以基于潜在客户的数目来识别潜在部署客户。在一些实施方式中,还可以基于由地理区域内的无线服务提供方所保持的市场份额来识别潜在部署客户。例如,计算机可以将潜在客户(例如生活在该地理区域内的人们)的总数目乘以市场份额(该地理区域内的、已经是该无线服务提供方的客户的人们的百分数),以便计算潜在客户的子集。在这种示例中,市场份额可以由计算机来确定,或者可以由用户输入到计算机中。在某些实施方式中,如果利用人口统计信息来计算潜在客户的数目,则计算机可以从该地理区域内的全部地址当中随机地选择地址。在另一实施方式中,如果利用先前的客户列表来计算潜在客户的数目,则计算机可以从该列表上的地址当中随机地选择地址。

[0056] 在步骤 318,计算机确定无线覆盖区域的当前性能。在一个实施方式中,计算机基于在步骤 310 中由计算机接收到的指示无线覆盖区域的信息来确定当前性能。在一个实施方式中,无线覆盖区域的当前性能可以指由该地理区域内的基站所提供的覆盖和吞吐量。该当前性能还可以指提供无线覆盖的成本(例如,维护、操作等)。无线系统的当前性能可以利用任何合适的信息按任何合适的方式来确定。

[0057] 在步骤 322,计算机确定阈值性能需求。该阈值性能需求可以包括任何合适的无线性能需求。例如,该阈值性能需求可以包括在峰值使用时间期间该地理区域内所需的总的无线容量。作为另一示例,该阈值性能需求可以包括在平均使用时间期间该地理区域内所需的总的无线容量。在一个实施方式中,该阈值性能需求可以提供对无线系统网络可以被期望接收的使用程度的指示。在某些实施方式中,该阈值性能需求可以基于期望的将来性能需求,以反映客户数的预期增长。该预期增长可以基于潜在客户的数目和/或上面讨论的订购的概率。该阈值可以基于使用率、容量、成本,或由无线服务提供方所识别的任何其它度量。

[0058] 该阈值性能需求可以按任何合适的方式来确定。在一个实施方式中,该阈值性能需求可以基于对当前和/或潜在部署客户的无线使用需求的估计来确定。例如,当无线服务提供方进入新的市场时,每一个潜在部署客户都可以与无线服务的无线订购计划相关联。在这种示例中,这种关联可以基于上面讨论的订购的概率来进行。在另一实施方式中,这种关联可以基于在上述步骤期间获得的任何其它信息来进行。在一个实施方式中,在计算机将潜在部署客户与无线服务的无线订购计划相关联之后,计算机可以基于潜在部署客户和他们的相关联的订购计划来估计阈值性能需求。在另一实施方式中,该估计可以基于诸如高峰期期间的典型无线使用率之类的任何其它合适的因素来进行。

[0059] 在步骤 326,计算机模拟在该地理区域内的 fBS 部署。在一个实施方式中,该模拟可以包括对在该地理区域内部署(例如,安装和操作)的 fBS 而产生的无线覆盖的计算机模拟。同样地,该模拟可以包括由该地理区域内的现有基站并且还由添加的 fBS 两者所提供的无线覆盖。在一个实施方式中,现有基站(MBS、pBS、RS 等)和 fBS 的这种组合可以被称为“异构环境”。

[0060] 在一个实施方式中,该模拟可以包括部署 fBS,以使它们按特定模式操作。例如,该

模拟可以包括按 CSG、OSG 或 HSG 操作的多个 fBS 中的一个或更多个。

[0061] 在一个实施方式中,该模拟可以包括部署任何合适数目的 fBS。例如,在模拟期间,可以仅部署单个 fBS,或者可以部署多个 fBS。在另一实施方式中,在模拟期间部署的 fBS 的数目可以基于潜在部署客户的百分比。例如,fBS 的数目可以是潜在部署客户的数目的百分之十,潜在部署客户的数目的百分之二十,或者任何其它合适的百分比。

[0062] 在一个实施方式中,该模拟可以包括将 fBS 部署至地理区域内的特定位置。例如,可以将 fBS 部署至地理区域内的特定地址。作为另一示例,可以将 fBS 部署至潜在部署客户的任何地址。在一个实施方式中,对地址的选择可以是随机的。例如,对地址的选择可以基于上面讨论的订购的概率。作为另一示例,对地址的选择可以基于均匀随机分布。在另一实施方式中,对地址的选择可以基于任何合适的算法。在又一实施方式中,部署毫微微基站的地址的数目可以基于潜在部署客户的地址的百分比。

[0063] 在步骤 330,计算机基于对 fBS 的模拟部署来确定第一组参数。在某些实施方式中,第一组参数可以包括第一性能参数。第一性能参数可以包括对由模拟而产生的无线覆盖的任何指示。例如,第一性能参数可以基于带宽、覆盖区域、信号质量、无线容量、回程容量、与无线网络有关的任何其它参数,或者以上的某种组合。在一些实施方式中,第一组参数还可以包括第一成本参数。第一成本参数可以包括资本支出(如用于 fBS、安全网关、毫微微小区网关等的设备成本)和与部署 fBS 相关联的操作成本(如维护、技术支持、客户支持、提供另一通道供 fBS 操作、提供附加带宽等的成本)。同样地,第一成本参数可以包括与部署 fBS 相关联的总成本。

[0064] 在步骤 334,计算机模拟在该地理区域内对附加基站的部署。在一个实施方式中,该附加基站可以不包括 fBS。例如,该附加基站可以仅包括在该地理区域内已经存在的类型的基站,如 MBS、pBS、RS 等。在特定实施方式中,可以模拟这种部署,以与对 fBS 的部署的模拟相比较。例如,可以模拟该部署,以便确定添加的附加 MBS、pBS、RS 和 / 或已经存在于该地理区域中的任何其它适当类型的基站是否可以导致比部署 fBS 更好的性能。

[0065] 在一个实施方式中,步骤 334 的模拟可以包括对在该地理区域内部署(例如,安装和操作)附加基站而产生的无线覆盖的计算机模拟。同样地,该模拟可以包括由该地理区域内的现有基站并且还由添加的基站两者所提供的无线覆盖。而且,在一个实施方式中,在步骤 334 由计算机执行的模拟可以不包括来自步骤 326 和 346 的任何 fBS。同样地,该模拟可以仅包括与该地理区域内已经存在的基站相同类型的基站。在一个实施方式中,这可以被称为不同的“同构环境”。

[0066] 在一个实施方式中,步骤 334 的模拟可以包括部署任何合适数目的附加基站。例如,在模拟期间,可以仅部署单个附加基站,或者可以部署多个附加基站。在一个实施方式中,附加基站的数目可以按任何合适的方式来确定。在另一实施方式中,步骤 334 的模拟可以包括将这些附加基站部署至该地理区域内的特定位置。在一个实施方式中,部署附加基站的位置可以按任何合适的方式来确定。

[0067] 在步骤 338,计算机基于对附加基站的模拟部署来确定第二组参数。在一个实施方式中,第二组参数可以包括第二性能参数。第二性能参数可以包括对由在步骤 334 的模拟而产生的无线覆盖的任何指示。例如,第二性能参数可以基于带宽、覆盖区域、信号质量、无线容量、回程容量、与无线网络有关的任何其它参数,或者以上的某种组合。在一个实施方

式中,第二组参数可以包括第二成本参数。第二成本参数可以包括资本支出(如用于附加基站、安全网关等的设备成本)和与部署附加基站相关联的操作成本(如维护成本)。同样地,第二成本参数可以包括与部署附加基站相关联的总成本。

[0068] 在特定实施方式中,由计算机接收的并且在步骤 326 和 334 执行的模拟中所使用的信息可以包括可能涉及、或者可能影响无线网络和 / 或其任何相关联的成本的任何数目的不同类型的适当信息的任何组合。例如,该信息可以包括与该地理区域相关联的地理或地形数据。该数据可以包括从 U. S. 地质勘探局 (USGS) 接收到的城市、县和 / 或州边界、建筑物尺寸和位置、地形、海拔,以及陆地覆盖数据。该数据还可以包括可能涉及基站或 fBS 的物理位置和 / 或可能影响其无线信号的范围的任何信息。

[0069] 该信息可以包括与提供覆盖区域相关联的基础设施数据。该基础设施数据可以包括关于天线、蜂窝塔、基站、敷设电缆、交换或路由局、站点租用(例如,租用的陆地或建筑物空间)的任何合适的的数据,或者任何其它合适的基础设施数据。例如,该基础设施数据可以包括:针对基础设施的任何方面的位置数据(如该地理区域内的任何基站、天线或蜂窝塔的位置)、针对基础设施的任何方面的性能数据、针对基础设施的任何方面的成本(例如,获取、租金、维护、升级等)数据,或者任何其它合适的基础设施数据。该基础设施数据可以包括由无线服务提供方或者由联邦通信委员会 (FCC) 存储和保持的任何合适的基础设施数据。

[0070] 该信息还可以包括与无线频谱(例如,由无线服务提供方用于租用的和 / 或当前租用的无线频谱)的可用性有关的频谱信息。该频谱信息可以涉及可用频率、带宽、与许可可用频谱有关的成本、与可用频谱有关的任何其它特征或组件,或者以上的某种组合。

[0071] 该信息还可以包括容量数据。该容量数据可以与部署的或要部署的基站或 fBS 的累积容量,或单个基站或 fBS 的单独容量相关联。另外,该容量可以与无线容量、有线容量、回程容量、交换容量、处理容量,或提供无线覆盖所需的任何其它组件或服务的容量相关联。

[0072] 该信息还可以包括货币信息。该货币信息可以包括目前向当前客户收取的费用,或者估计的在部署 fBS 或其它基站时可以收取的费用。该货币信息可以包括:促销定价、促销折扣或刺激。该货币信息可以包括与部署基站或 fBS 相关联的成本。该成本可以涉及最初部署成本(例如,购买新硬件、安装硬件、配置硬件、获取站点空间、租用频谱等)和续生成本(例如,站点的租金费用、频谱许可续订、公共事业、维护等)。

[0073] 在步骤 342,计算机比较第一组与第二组参数。该比较可以包括第一和第二性能参数以及第一和第二成本参数中的一个或更多个。该比较可以被用于帮助在该地理区域内部署 fBS 或部署附加基站之间进行决定。在一些实施方式中,第一和 / 或第二性能参数可以与阈值进行比较,以确定任一模拟是否导致足够改进的参数(例如,满足或超出在步骤 322 确定的阈值性能的参数)。在一些实施方式中,计算机可以确定是否要进行附加模拟。在某些情况下,该确定可以基于来自计算机的操作者的输入来进行。根据特定实施方式,确定要进行附加模拟可以使得计算机能够模拟可以满足阈值性能需求的附加途径。

[0074] 在步骤 346,生成部署建议。在一个实施方式中,该部署建议可以指示是否应当在该地理区域内部署 fBS。例如,基于在步骤 326 和 334 的一个或更多个模拟和在步骤 322 确定的阈值性能需求,计算机可以确定在该地理区域内部署 fBS 是合乎要求的还是不合

乎要求的。作为另一示例,基于在步骤 326 和 334 的一个或多个模拟和在步骤 322 确定的阈值性能需求,计算机可以确定在该地理区域内部署附加基站是合乎要求的还是不合乎要求的。在一些实施方式中,计算机可以确定部署 fBS 和基站的组合是合乎要求的。在某些实施方式中,计算机可以确定部署 fBS 或基站是不利的。这例如可能在两个模拟都没有生成超出步骤 322 所确定的阈值的性能参数时出现。在又一实施方式中,该部署建议可以指示在部署或不部署 fBS 的情况下可能期望的性能参数和 / 或成本参数。

[0075] 在一个实施方式中,计算机可以至少基于第一性能参数来生成部署建议。例如,计算机可以在第一性能参数满足阈值性能需求时确定在该地理区域内部署 fBS 是合乎要求的。

[0076] 在另一实施方式中,计算机可以基于第一性能参数与第二性能参数的比较来生成部署建议。例如,基于第一性能参数与第二性能参数的比较,计算机可以确定异构系统 (其包括 fBS) 产生比同构系统 (其不包括 fBS) 更好的性能。同样地,计算机可以生成指示应当在该地理区域内部署 fBS 的部署建议。

[0077] 在另一实施方式中,计算机可以基于第一成本参数与第二成本参数的比较来生成部署建议。例如,基于第一成本参数与第二成本参数的比较,计算机可以确定异构系统 (其包括 fBS) 产生比同构系统 (其不包括 fBS) 更低的成本。同样地,计算机可以生成指示应当在该地理区域内部署 fBS 的部署建议。

[0078] 在又一实施方式中,计算机可以基于第一与第二性能参数和第一与第二成本参数的比较来生成部署建议。例如,基于第一与第二性能参数和第一与第二成本参数的比较,计算机可以确定异构系统 (其包括 fBS) 产生比同构系统 (其不包括 fBS) 更好的性能和 / 或更低的成本。同样地,计算机可以生成指示应当在该地理区域内部署 fBS 的部署建议。

[0079] 在一个实施方式中,生成部署建议还可以导致计算机作出附加确定。具体来说,计算机可以确定针对 fBS 的一个或多个部署策略 (如频谱使用策略)。例如,计算机可以确定 fBS 和其它基站 (MBS、pBS、RS 等) 是否应当共享无线信道,或者确定是否将无线信道专用于 fBS。作为另一示例,计算机可以确定用于 fBS 的一个或多个可操作模式 (CSG、OSG、HSG 等)。作为又一示例,计算机可以确定 fBS 信道的带宽。在一个实施方式中,这些确定可以基于第一与第二性能参数和 / 或第一与第二成本参数的比较来作出。

[0080] 在一个实施方式中,生成部署建议的步骤还可以包括,计算机生成与在该地理区域内部署 fBS 相关联的定价策略。具体来说,该定价策略可以基于关于资本支出和储蓄 (如用于设备、站点租用、安全网关、毫微微小区网关、回程连接等)、操作成本和储蓄 (如用于维护、技术支持、客户支持、频谱等)、营销输入 (如多少潜在部署客户可能愿意为毫微微小区服务支付) 的信息,和 / 或任何其它合适的信息来生成。在一个实施方式中,计算机可以按任何合适的方式来生成定价策略。例如,定价策略可以基于设备成本、附加信道成本 (如在 fBS 接收到它们自己的专用信道时),以及基站信道带宽成本。作为另一示例,该定价策略可以基于 fBS 的操作模式 (CSG、OSG、HSG 等)。在一个实施方式中,计算机可以生成定价策略,使得无线服务提供方可以确定可能吸引潜在部署客户订购毫微微小区服务的价格。根据该实施方式,该价格可以是全国性的价格、针对毫微微小区服务的局部价格,或者某种其它价格 (例如,具有在特定时间量 (例如,6 个月) 之后期满的局部促销折扣的全国性价格)。

[0081] 在另一实施方式中,生成部署建议的步骤还可以包括,计算机确定用于部署 fBS 的利润率。例如,无线服务提供方可以针对利用 fBS 的无线服务而向客户收费的价格可以与针对无线服务提供方用于操作 fBS 的成本(举例来说,如提供服务和维护服务的成本)相比较,以便确定利润率。而且,计算机可以确定如何调节定价策略和/或无线网络的性能,以便使利润率最大化。另外,计算机可以确定如何调节定价策略和/或利润率,以便增加无线服务网络的性能。

[0082] 虽然图 3 中描绘的实施方式包括按特定次序描绘的特定数目的步骤,但应当明白,其它实施方式可以具有更多、更少或不同步骤,并且可以重新排列这些步骤。例如,在一些实施方式中,计算机可以在不需要模拟部署附加基站的情况下生成部署建议。作为另一示例,在一些实施方式中,模拟步骤 326 和/或 334 可以重复多次,其中,基站和/或 fBS 的数目和/或布置每次改变。该重复可以用于更好地识别最佳部署。

[0083] 图 4 例示了根据一特定实施方式的、用于推广毫微微服务的方法。在一个实施方式中,图 4 的方法可以在部署 fBS 可以为无线服务提供方的网络带来最大利益的情况下向无线服务提供方提供识别位置和/或潜在部署客户的能力。在另一示例中,图 4 的方法可以向无线服务提供方提供以增强总体无线系统性能、增加针对客户的单独服务以及/或可能增加无线服务提供方的收益的这种方式向潜在部署客户推广毫微微小区服务的能力。例如,通过添加附加客户,无线服务提供方的收益可以增加。而且,通过在 fBS 可以为无线服务网络带来最大利益的位置处将附加 fBS 添加至网络,可以将通信量从现有基站重新定向至 fBS。这可以降低无线网络中的现有基站上的通信量负荷,由此,允许向客户提供更高的服务质量。而且,通过将通信量从现有基站重新定向至 fBS,无线服务提供方能够减少维护其针对现有基站的回程连接的花费。在一些情况下,无线服务提供方可以利用 fBS 向客户提供折扣率,以鼓励他们的使用。

[0084] 在一个实施方式中,图 4 的方法可以由诸如图 2 的计算机 210 之类的计算机来执行。同样地,图 4 的方法可以由无线电系统级模拟器或商用无线电规划工具来执行。

[0085] 该方法在步骤 410 开始,其中,计算机接收指示与一地理区域内的基站相关联的无线覆盖区域的信息。在一个实施方式中,该信息可以是指示无线覆盖区域的任何合适的信息。例如,该信息可以类似于图 3 的步骤 310 的信息。作为另一示例,该信息可以包括在图 3 和/或图 5 的方法期间接收的、使用的或者确定的任何信息。作为另一示例,该信息可以是对该地理区域内的无线覆盖区域的选择和/或对该地理区域的选择。

[0086] 在步骤 414,计算机识别潜在部署客户,以为这些潜在部署客户部署 fBS。在特定实施方式中,计算机可以按任何合适的方式来识别潜在部署客户。在一个实施方式中,可以通过接收来自潜在部署客户的指示而识别潜在部署客户。例如,潜在部署客户可能联系无线服务提供方,以便获知毫微微小区服务或者安装毫微微小区服务。作为另一示例,计算机可以通过从潜在客户的子集随机选择地址来识别潜在部署客户。潜在客户的子集的地址可以按任何合适的方式来检索到,如通过来自 U.S. 人口调查局的信息,或者通过例如可从在线地图资源得到的详细地图。在一个实施方式中,对地址的随机选择可以基于上面讨论的订购的概率。在另一实施方式中,对地址的随机选择可以基于毫微微小区订购的均匀随机分布。该随机选择可以受限于该地理区域内的特定位置(例如,存在弱的无线信号的地方)。

[0087] 在一个实施方式中,计算机可以基于无线使用数据来识别潜在部署客户。例如,潜在部署客户可以包括在可能部署 fBS 的位置中具有高容量无线服务使用率的现有客户。具体来说,潜在部署客户可以在客户的住宅、办公室或可以部署 fBS 的任何其它合适位置内具有无线服务的高容量(例如,高通信量或长期使用)的室内使用率。在一个实施方式中,通过将 fBS 部署至现有客户具有高容量的室内无线服务使用率的位置,可以通过 fBS 来重新定向客户的无线使用率的相当大的部分。这可以减少通过现有基站定向的通信量,由此增加无线服务的性能。而且,因为客户的无线使用了的相当大的部分现在可以通过 fBS(其使用客户的针对相应 fBS 的回程连接的网络接入,而不使用无线服务提供方的网络接入)重新定向,所以无线服务提供方能够向客户提供折扣价格。

[0088] 在一个实施方式中,任何合适的方法都可以用于基于无线使用率数据来识别潜在部署客户。例如,计算机可以访问并搜索包括关于现有客户的无线使用率数据的信息的一个或多个数据库。在一个实施方式中,图 4 的方法还可以包括计算机生成存储在这些数据库中的信息的步骤。

[0089] 在另一实施方式中,计算机可以基于无线性能数据来识别潜在部署客户。例如,潜在部署客户可以包括在可以部署 fBS 的位置内遭受频繁下降的无线服务的现有客户。具体来说,潜在部署客户在客户的住宅、办公室,或者可以部署 fBS 的任何其它合适的位置内可能遭受频繁下降的无线服务。在一个实施方式中,由于潜在部署客户在特定位置内可能遭受频繁下降的无线服务,所以将 fBS 部署至这些位置可以改进无线信号接收。

[0090] 在一个实施方式中,任何合适的方法都可以被用于基于无线性能数据来识别潜在部署客户。例如,计算机可以访问并搜索包括关于现有客户的无线性能数据的信息的一个或多个数据库。在这种示例中,这些数据库可以包括关于对客户的无线服务的测量的信息,或者可以包括无线服务针对每一个客户已经下降的次数的日志。在一个实施方式中,图 4 的方法还可以包括计算机生成存储在这些数据库中的信息的步骤。

[0091] 在另一实施方式中,可以通过识别该地理区域内的潜在部署位置来识别潜在部署客户。例如,潜在部署客户可以包括与落入无线服务不令人满意的无线覆盖区域的位置内的地址(例如,该地址是他们的住宅、办公室等的地址)相关联的现有客户。在一个实施方式中,因为潜在部署客户可能位于可能阻碍他们接收足够的无线服务的区域中,所以将 fBS 部署至这些位置可以改进无线信号接收。

[0092] 在一个实施方式中,任何合适的方法都可以用于识别这些潜在部署客户。例如,可以评估一地理区域内的无线覆盖区域,以便识别无线覆盖提供不令人满意的无线服务的位置。具体来说,可以评估无线区域,以确定具有弱的无线信号、没有无线信号,和/或具有不足的无线带宽的位置。在一个实施方式中,通过识别这种位置,计算机可以识别潜在部署位置。而且,一旦识别了潜在部署位置,在一个实施方式中,计算机就可以基于潜在部署位置与和该地理区域内的当前客户相关联的位置数据的比较来识别潜在部署客户。例如,计算机可以将潜在部署位置(例如,具有弱的无线信号、没有无线信号,以及/或具有不足的无线带宽的位置)与客户的地址进行比较。在这种示例中,如果客户的地址落入潜在部署位置内,则客户可以被识别为潜在部署客户。

[0093] 在一个实施方式中,为了基于潜在部署位置来识别潜在部署客户,计算机可以访问并搜索包括关于该地理区域内的无线覆盖区域的信息的一个或多个数据库。例如,这

种数据库可以包括在图 3 的方法中确定的性能参数。作为另一示例,这些数据库可以包括在图 3 的方法中确定的任何其它合适的信息。在又一实施方式中,为了基于潜在部署位置来识别潜在部署客户,计算机可以访问并搜索包括地址信息的一个或更多个数据库。例如,这种数据库可以包括现有客户的列表(包括地址)。作为另一示例,这种数据库可以包括不是无线服务提供方的当前客户(例如,非客户)的人和团体的地址的列表,如包括来自 U. S. 人口调查局的信息的数据库。在这种示例中,计算机可以将这些地址与潜在部署位置进行比较,以便将这些非客户识别为潜在部署客户。

[0094] 一旦识别了潜在部署客户,该方法移动至步骤 418。在步骤 418,计算机确定用于部署 fBS 的初始配置参数。在一个实施方式中,初始配置参数可以包括 fBS 的操作模式,如 OSG、CSG、HSG 等。其它参数可以包括基于为识别的潜在部署客户部署的 fBS 的、对由 fBS 使用的无线信号的一个或更多个约束(例如,发送功率、可用频谱和/或信道等)。根据一个实施方式,计算机可以基于 fBS 的可能的部署位置来确定这些初始配置参数。例如,如果要将 fBS 部署在其它无线服务用户(如除了订购毫微微小区服务的客户以外的其它无线用户)附近,则计算机可以确定该 fBS 应当按 CSG 来工作,以防止其它无线服务用户通过该 fBS 来接收他们的无线服务。作为另一示例,如果 fBS 要部署在商业位置(如所有客户接收免费无线接入的咖啡店),则计算机可以确定该 fBS 按 OSG 工作。这样,该商店的客户可以容易地接入由该 fBS 提供的无线服务。

[0095] 在另一实施方式中,初始配置参数可以包括是否根本可以部署 fBS。例如,如果要太靠近另一基站(如 MBS)部署 fBS,则该 fBS 可能干扰由该基站提供的无线服务,反之亦然。这样,计算机可以确定不能在这种位置部署 fBS。

[0096] 在一个实施方式中,在确定不能部署 fBS 时,该方法可以结束。在另一实施方式中,在确定不能部署 fBS 时,计算机可以为要部署的 fBS 确定另选位置(如同一地址处的另选位置),或者计算机可以确定另一合适的解决方案(如识别可以被设置成 OSG 的附近的 fBS 或者部署基站)。

[0097] 在步骤 422,计算机生成促销出价。在一个实施方式中,该促销出价更特定于潜在部署客户。例如,如果潜在部署客户是高级数据用户,则促销出价可以包括特定价格折扣,以鼓励潜在部署客户签约毫微微小区服务。价格折扣的量可以部分地基于由潜在部署客户使用的数据的量。在一个实施方式中,计算机可以按任何合适的方式来生成促销出价。例如,计算机可以使用用于生成促销出价的任何合适的算法。作为另一示例,计算机可以基于来自该计算机的用户的输入或者基于一个或更多个在线源来生成促销出价。

[0098] 在一个实施方式中,生成促销出价还可以包括计算机确定定价策略以在促销出价中使用。在特定实施方式中,计算机可以基于每一个潜在部署客户的情况来确定定价策略。例如,如果计算机基于潜在部署客户的高数据使用率识别出潜在部署客户,则该计算机可以确定考虑了数据高使用率的定价策略。在这种示例中,与现有基站(如 MBS)不同,潜在部署客户可以接收对通过 fBS 发送的无线数据的折扣。作为另一示例,计算机可以基于 fBS 的操作模式来确定定价策略。例如,对按 CSG 操作的 fBS 的定价可能比按 HSG 或 OSG 操作的 fBS 更昂贵。

[0099] 在一个实施方式中,生成促销出价还可以包括计算机在生成促销出价之前将潜在部署客户区分优先次序。例如,在一个实施方式中,可以基于潜在部署客户对毫微微小区服

务的订购可能有益于无线服务提供方的程度而将潜在部署客户区分优先次序。在这种示例中,如果与现有基站不同,潜在部署客户对毫微微小区服务的订购可以通过 fBS 重新定向数据的大部分,则无线服务提供方可以从现有基站所提供的无线服务方面压力的减小而接收更大的益处。在这个示例中,与对毫微微小区服务的订购不那么有益于无线服务提供方的另一潜在部署客户相比,该潜在部署客户可以接收更高的优先级。在一个实施方式中,通过将潜在部署客户区分优先次序,更高优先级的潜在部署客户首先可以接收对毫微微小区服务的促销出价。在一个实施方式中,对潜在部署客户优先次序的区分还可以包括,计算机确定并比较无线服务提供方可以从潜在部署客户对毫微微小区服务的订购接收的益处。

[0100] 在一个实施方式中,生成促销出价还可以包括,联系潜在部署客户以提供该促销出价。在一个实施方式中,潜在部署客户可以由计算机按任何合适的方式来进行联系。例如,计算机可以生成电子邮件消息以发送至潜在部署客户。作为另一示例,计算机可以生成语音邮件消息以递送至潜在部署客户。在另一实施方式中,潜在部署客户可以不通过计算机直接联系。例如,计算机可以生成关于促销出价的~~通知~~,并且还可以向无线服务提供方员工提供该通知。在这种示例中,在接收到该通知之后,无线服务提供方员工可以联系潜在部署客户。作为另一示例,促销出价可以经由邮往潜在部署客户的地址的广告而传送至潜在部署客户。

[0101] 虽然图 4 中描绘的实施方式包括按特定次序描绘的特定数目的步骤,但应当明白,其它实施方式可以具有更多、更少或不同的步骤,并且可以重新排列这些步骤。

[0102] 图 5 例示了根据一特定实施方式的、用于确定 fBS 的安装配置参数的方法。在一个实施方式中,该方法可以缩减为成功部署 fBS 而可能需要的时间量。例如,部署 fBS 通常需要多达一整天的时间。在一个实施方式中,该方法可以允许更快速地(和/或在部署 fBS 之前)确定安装配置参数。由此,可以缩减成功地部署(通过无线服务提供方的技术人员,或者甚至通过实际客户)fBS 所需的时间。

[0103] 在一个实施方式中,图 5 的方法可以由诸如图 2 的计算机 210 之类的计算机来执行。同样地,图 5 的方法可以通过无线电系统级模拟器或商用无线电规划工具来执行。

[0104] 该方法在步骤 510 开始,其中,计算机接收部署 fBS 的请求。该请求可以是部署该 fBS 的任何合适类型的请求。例如,该请求可以以潜在部署客户访问无线服务提供方的商店或零售中心、电话呼叫、电子邮件消息、通过邮件的订购请求、在线订购请求,或任何其它合适类型的请求的形式。该请求还可以是关于与部署 fBS 相关联的任何合适的问题的请求。例如,该请求可以涉及潜在部署客户在安装 fBS 时有困难、潜在部署客户想要订购毫微微小区服务、潜在部署客户请求有关毫微微小区服务的信息,或者与部署 fBS 相关联的任何其它合适的请求。在一个实施方式中,计算机可以按任何合适的方式来接收该请求。例如,该请求可以由计算机、通过潜在部署客户的在线提交而直接地或间接地接收。作为另一示例,无线服务提供方员工可以在接收到来自潜在部署客户的请求之后(如在与该潜在部署客户的电话通话期间)将该请求输入到计算机中。

[0105] 在步骤 514,计算机确定是否可以部署 fBS。计算机可以基于任何合适的信息来做出该确定。例如,部署 fBS 的请求可以包括针对潜在部署客户的地址信息。这样,基于该地址信息,计算机可以确定不允许在该地址或者在与该地址相关联的特定位置处部署 fBS。具体来说,如果要太靠近另一基站(如 MBS)而部署 fBS,由此造成干扰,则可能不允许部署该

fBS。作为另一示例,部署毫微微基站请求可以包括有关由潜在部署客户可用或者订购的因特网服务和/或无线连接的信息。同样地,计算机可以确定潜在部署客户不可以接收fBS操作的因特网接入(或足够的因特网接入)。作为另一示例,计算机可以基于一个或更多个模拟(如下面针对步骤518讨论的模拟)来做出有关是否允许fBS的确定。

[0106] 在一个实施方式中,在确定不可以允许fBS时,该方法可以结束。在另一实施方式中,在确定不可以允许fBS时,计算机可以为要部署的fBS确定另选位置(如同一地址处的另选位置),或者计算机可以确定另一合适的解决方案(如识别可以被设置成OSG的附近的fBS)。

[0107] 另一方面,在确定允许fBS时(或者在计算机尚未具有足够信息来做出恰当确定的情况下),该方法移动至步骤518。在步骤518,计算机确定fBS的安装配置参数。该安装配置参数可以包括用于在特定位置成功部署fBS的任何合适的配置参数。例如,安装配置参数可以包括fBS的可操作模式(CSG、OSG、HSG等)。而且,安装配置参数可以包括基于无线覆盖区域的特征的无线参数,如任何合适的物理层(PHY)和/或介质接入控制层(MAC)配置参数。另外,安装配置参数可以包括针对空中接口或fBS的回程连接的参数。

[0108] 计算机可以利用任何合适的方法来确定安装配置事宜。在一个实施方式中,计算机可以基于对可以部署fBS的位置(如潜在部署客户的住宅、办公室或商业企业(其可能需要一个以上的fBS,以便提供令人满意的无线服务))的现场访问,来确定安装配置参数。在现场访问期间,无线服务提供方的技术人员可以创建该位置的视频记录,如该位置的室内环境和布局。而且,无线服务提供方的技术人员还可以对该位置采取详细测量。计算机接着可以利用任何合适的计算机程序(如计算机视觉)利用视频记录和/或测量来创建该位置的三维布局。在另一实施方式中,该位置的三维布局可以不依赖于计算机来创建,并接着可以将该三维布局输入到计算机中。一旦计算机具有该位置的三维布局,计算机就可以运行部署fBS的一个或更多个模拟。在一个实施方式中,这些模拟可以包括对该三维布局中向fBS和从fBS传播无线信号的模拟。在一个实施方式中,计算机接着可以将该模拟(和根据该模拟收集的数据)与在现场访问期间由无线服务提供方的技术人员采取的详细测量相组合。在一个实施方式中,基于该组合,计算机可以确定fBS的安装配置参数和布置。一旦这些安装配置参数已经被计算机确定,无线服务提供方的技术人员就可以返回至潜在部署客户的位置并且利用该安装配置参数在该位置恰当地部署fBS,或者潜在部署客户可以使用该安装配置参数成功地部署fBS。

[0109] 在另一实施方式中,计算机可以基于经验建模来确定安装配置参数。经验建模可以包括利用空间信道模型(SCM)或任何其它合适的经验建模方法执行的建模。

[0110] 在一个实施方式中,为了利用经验建模来确定初始配置参数,计算机可以创建各种模板,以在模拟fBS的部署时使用。这些模板可以针对各种类型的位置和各种类型的环境而创建。例如,模板可以针对大型建筑物、小型建筑物、高海拔位置、低海拔位置、靠近现有基站的位置,以及/或任何其它合适类型的位置或环境来创建。在特定实施方式中,这些模板可以表示一般类型的位置或环境。在一个实施方式中,这些模板可以利用诸如特定位置的三维测量的地理信息,并且还利用诸如光线跟踪(Ray Tracing)和/或有限差分域(Finite-Difference Time-Domain(FDTD))的详细的建模方法来创建。由于这些详细的建模方法是耗时的方法,所以可以对需要他们以确定初始配置参数的计算机预先创建这些模

板。

[0111] 在创建这些模板之后,可以利用经验建模来训练这些模板。该经验建模可以导致对每一个模板的建模参数的确定(导致对这些模板展现的不同位置类型和不同环境类型中每一个的建模参数的确定)。在一个实施方式中,对模板的训练可以包括多次对一模板进行经验建模。在这种实施方式中,可以将由各个经验建模期间产生的建模参数进行平均,以便确定针对这些模板的更实际的建模参数。

[0112] 一旦创建并训练了这些模板,就可以将这些模板进行存储,如存储在计算机可访问的数据库中。在一个实施方式中,存储这些模板可以包括基于地理信息(如三维位置信息、地形、陆地覆盖等)分类这些模板。这种类型的分类可以允许基于不同位置类型和不同环境类型来分类这些模板。

[0113] 在一个实施方式中,为了利用经验建模来确定初始配置参数,计算机可以选择这些模板中的一个或更多个,以在模拟 fBS 的部署时使用。在一个实施方式中,可以利用与要部署的毫微微基站的位置相关联的地理信息(如三维位置信息、地形、陆地覆盖等)和/或几何信息(如建筑物结构、楼面平面图等)来选择模板。该信息可以按任何合适的方式来确定。例如,计算机可以基于要部署 fBS 的位置的地址来确定该信息。在特定实施方式中,这可以包括从诸如 Google 地图或 Bing 地图之类的在线地图资源提取三维信息。在一个实施方式中,该地理和/或几何信息可以仅仅是与该位置的室外布局而非室内布局相关联的地理和/或几何信息。在一个实施方式中,其可以仅仅与室内布局相关联或者与室内和室外布局两者相关联。

[0114] 利用与要部署 fBS 的位置相关联的地理信息和/或几何信息,计算机可以选择模板以用作该位置的模型。在特定实施方式中,这种选择可以包括确定哪个模板的地理和/或几何信息与要部署 fBS 的位置的地理和/或几何信息最相似。该确定可以通过搜索存储有这些模板的数据库中的分类来做出。

[0115] 在选择了恰当模板之后,计算机可以接着基于该模板和该模板的建模参数来模拟 fBS 的部署。在一个实施方式中,计算机可以基于该模拟来确定安装配置参数。例如,计算机可以利用毫微微基站的各种可操作模式(CSG、OSG、HSG 等)、各种无线参数(如任何合适的 PHY 和/或 MAC 参数),以及/或各种空中接口或回程连接参数来模拟 fBS 的部署。在一个实施方式中,该模拟可以包括另一经验建模。

[0116] 在一个实施方式中,与通常由经验建模本身会产生的安装配置参数相比,基于经验建模和模板确定安装配置参数可以导致更准确的安装配置参数。例如,经验建模不如光线跟踪和 FDTD 建模技术详细。然而,经验建模比那些更详细的建模技术更快。因此,通过组合经验建模与模板(其利用一般位置和环境类型的详细建模来创建),可以按较短时间量来确定准确的一组安装配置参数。

[0117] 如上所说明的,图 5 例示了在计算机接收到部署 fBS 的请求之后发生的步骤 514 和 518。图 5 的这种实施方式可以被称为“在线操作”。根据在线操作的一个实施方式,图 5 的一个或更多个步骤可以在潜在部署客户等待该方法的结果时发生。例如,在部署 fBS 遇到困难之后,潜在部署客户可以呼叫客户服务代表。客户服务代表可以接着引导计算机执行步骤 514-518 中的一个或更多个步骤,同时潜在部署客户仍在与客户服务代表通话。一旦完成这些步骤,客户服务代表就可以使用步骤 514-518 的确定,来向潜在部署客户解释

怎样成功部署 fBS。

[0118] 在在线操作的另一实施方式中,图 5 中的一个或多个步骤可以在计算机接收到部署 fBS 的请求之后发生。例如,潜在部署客户可以提交对毫微微小区服务的请求。基于该请求,可以执行步骤 514-518 中的一个或多个。图 5 中的一个或多个步骤的结果可以接着在稍后时间传送至潜在部署客户。这种传送可以采用电子邮件消息、返回电话呼叫,或者任何其它合适形式的传送形式。图 5 中的一个或多个步骤的结果可以用于在将 fBS 运送、或者以其它方式递送至潜在部署客户之前配置该 fBS。

[0119] 在另一实施方式中,图 5 中的步骤 514-518 可以在计算机接收到部署 fBS 的请求之前由该计算机执行。图 5 的这种实施方式可以被称为“离线操作”。根据离线操作的一个实施方式,图 5 的步骤 514-518 中的一个或多个步骤可以在潜在部署客户提供部署 fBS 的请求之前发生。例如,计算机可以假定潜在部署客户打算最终订购毫微微小区服务。基于该假定,计算机可以执行图 5 的步骤 514-518 中的一个或多个步骤,使得这些步骤的结果在潜在部署客户实际上提供部署 fBS 的请求的时间之前就可能已经被获知。

[0120] 在离线操作的一个实施方式中,计算机可以使用各种数据库来确定潜在部署客户,以执行图 5 的步骤。这种数据库可以包括:现有的客户数据库、以前的客户数据库、非客户数据库,或者可以包括关于潜在部署客户的信息的任何其它合适的数据库。在一个实施方式中,计算机可以利用任何合适的方法来识别潜在部署客户。例如,计算机可以使用在图 3 和 / 或图 4 中识别或确定的潜在部署客户。作为另一示例,计算机可以通过从任何合适的数据库随机选择潜在部署客户来识别潜在部署客户。

[0121] 在一个实施方式中,在计算机识别潜在部署客户之后,计算机可以使用与潜在部署客户(如潜在部署客户的地址)相关联的任何合适的信息,以确定是否允许 fBS 处于与该潜在部署客户相关联的位置处,并且还确定 fBS 的安装配置参数(根据步骤 514-518)。一旦由计算机做出了这些确定,就可以将这些确定进行存储(如存储在计算机处或者计算机可访问的数据库处)。因此,如在步骤 510 中讨论的,当计算机接收到用于部署 fBS 的请求时,计算机可以检索所存储的确定,并且提供这些确定,使得可以更快速地进行 fBS 的部署。

[0122] 在另一实施方式中,图 5 的方法还可以包括计算机确定 fBS 的定价策略的步骤。例如,基于安装配置参数,计算机可以确定针对潜在部署客户的更准确的定价策略。照此,当潜在部署客户请求部署 fBS 时,可以将更准确的价格提供给该潜在部署客户。

[0123] 虽然图 5 中描绘的实施方式包括按特定次序描绘的特定数目的步骤,但应当明白,其它实施方式可以具有更多、更少或不同的步骤,并且可以重新排列这些步骤。

[0124] 在一个实施方式中,图 3-5 中所示每一种方法都可以是单独的、独立方法。在另一实施方式中,图 3-5 中的每一种方法都可以彼此组合地执行。作为一示例,图 3-5 中所示多种方法中的一种方法的一个或多个步骤可以与图 3-5 的其它任何方法中的一个或多个步骤一起执行。具体来说,图 3 的方法的步骤可以在图 4-5 的方法的步骤之前执行。一旦已经执行了图 3 的步骤,计算机就可以执行图 4 中所示方法的步骤。而且,在计算机已经执行了图 4 的方法的步骤之后,计算机可以接着执行图 5 的方法的步骤。在另一实施方式中,在计算机执行图 3 的方法的步骤之后,该计算机可以直接移动至图 5 的方法中的步骤,由此绕过图 4 的方法。在另一实施方式中,在已经执行了图 3-5 的一种方法中的一个或更

多个步骤之后,计算机可以返回至图 3-5 的其它方法中的任一种方法。例如,在计算机执行图 5 的方法中的步骤之后,该计算机可以返回至图 4 的方法中的一个或多个步骤,以使进一步促销毫微微小区服务。

[0125] 本领域技术人员可以确定许多其它改变、替换、变型、改变以及修改,并且本公开旨在涵盖如落入所附权利要求书的精神和范围内的所有这些改变、替换、变型、改变以及修改。

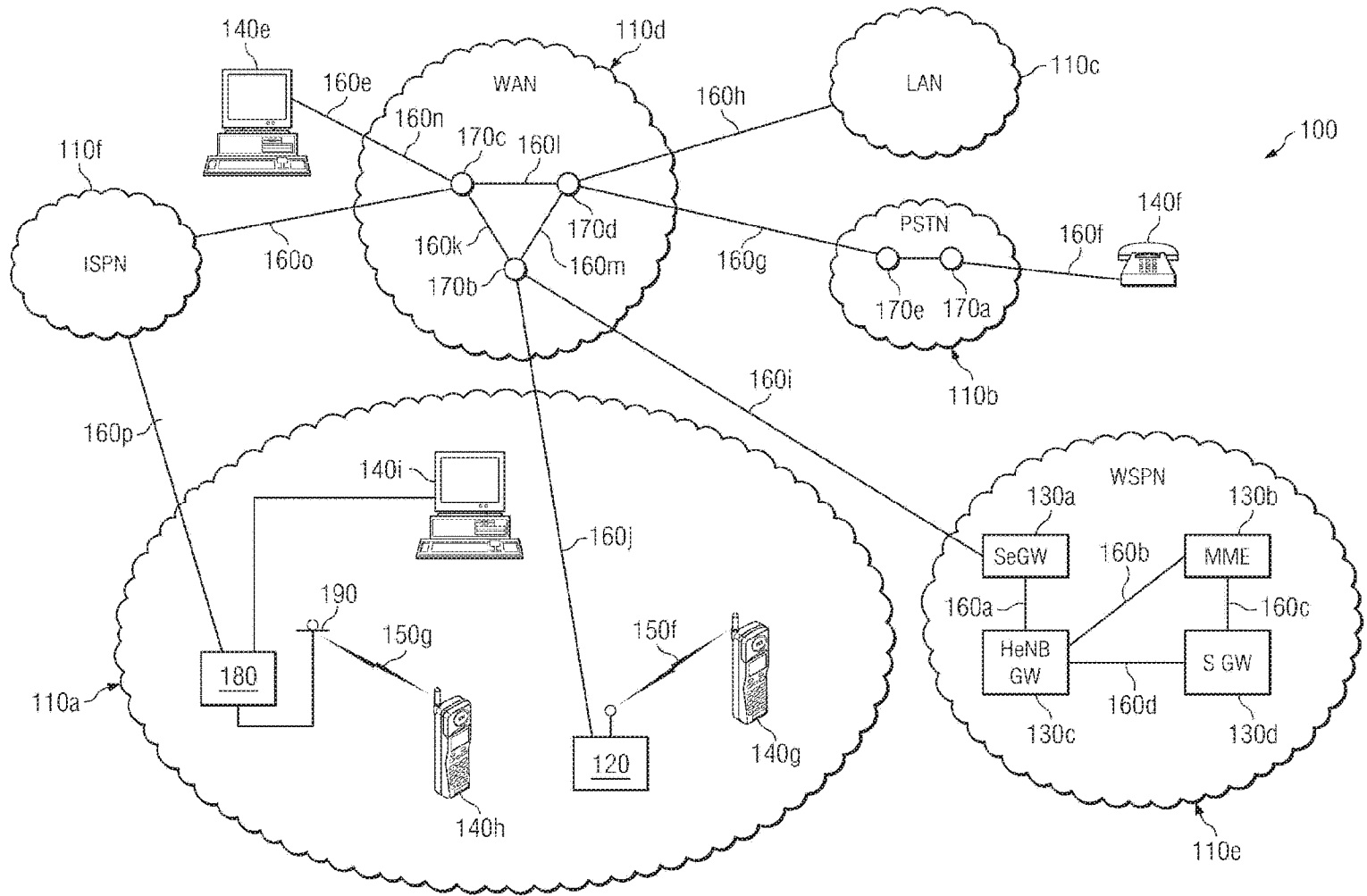


图 1

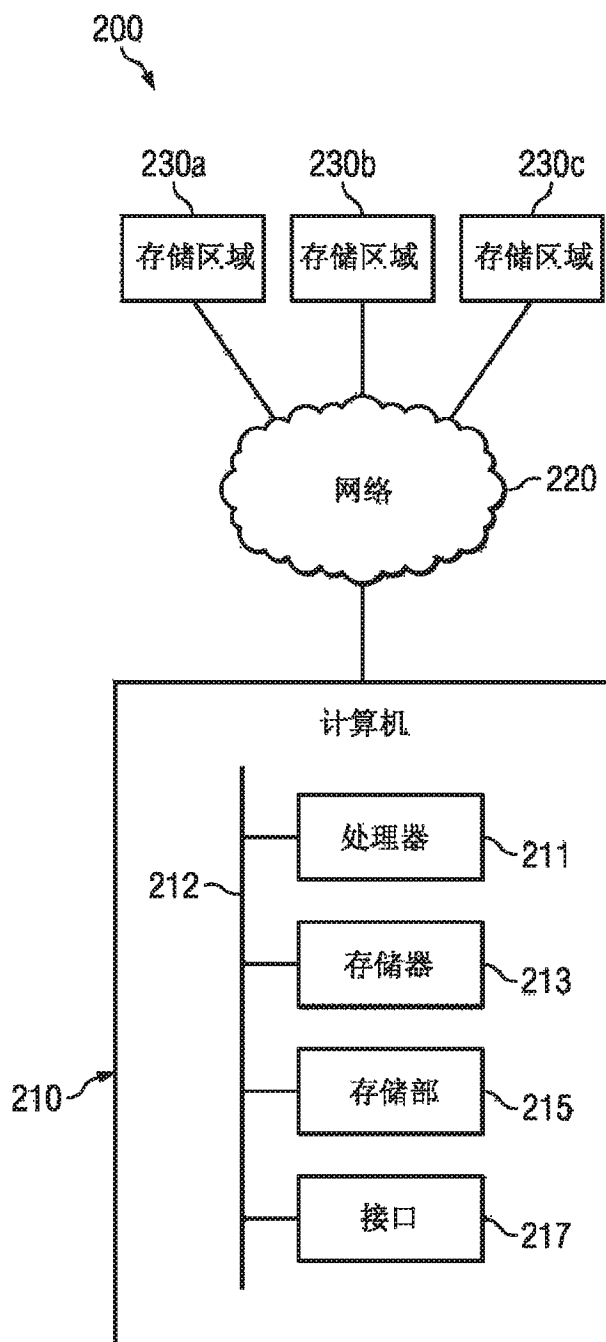


图 2

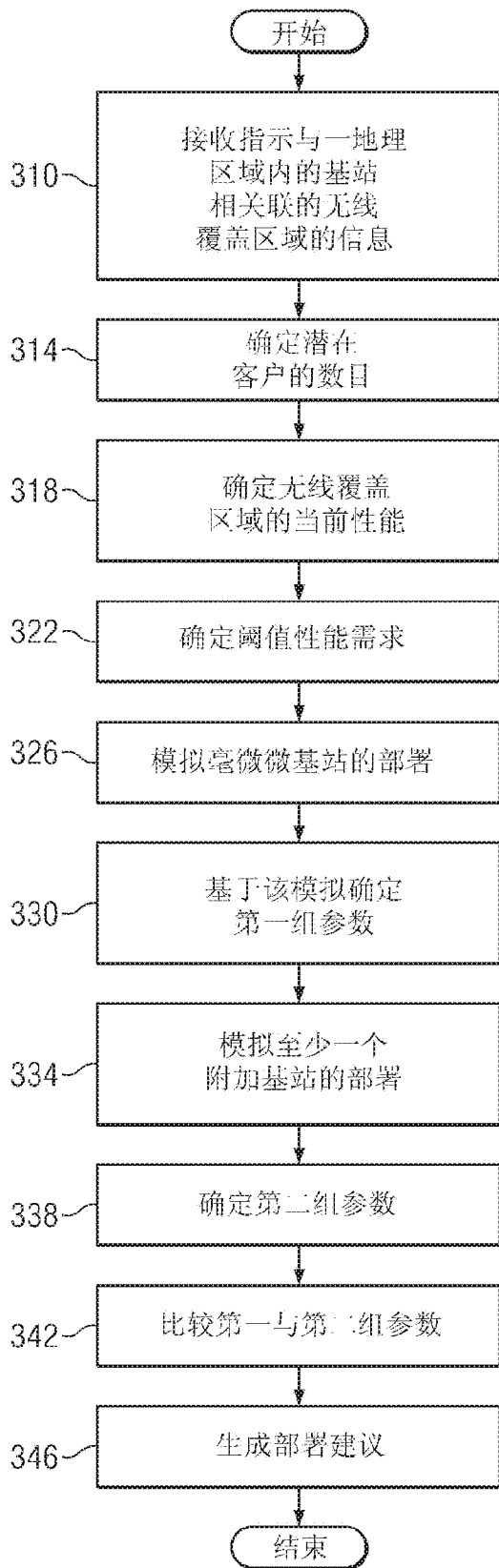


图 3

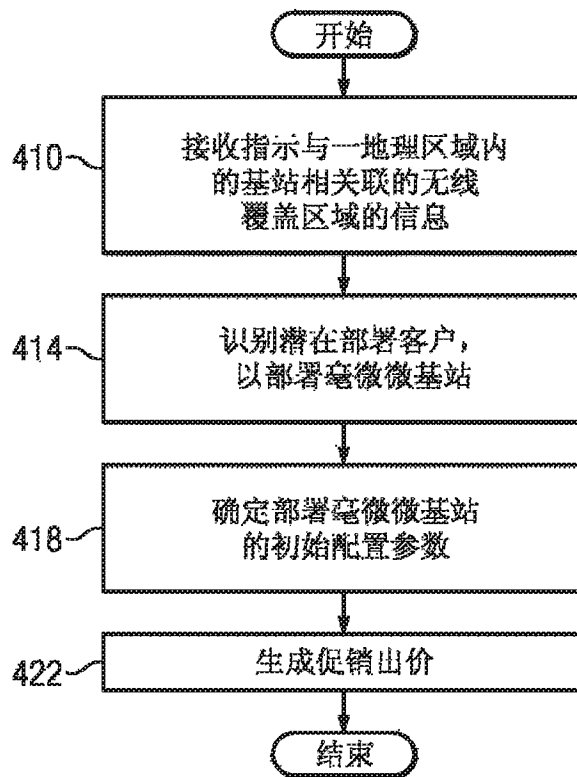


图 4

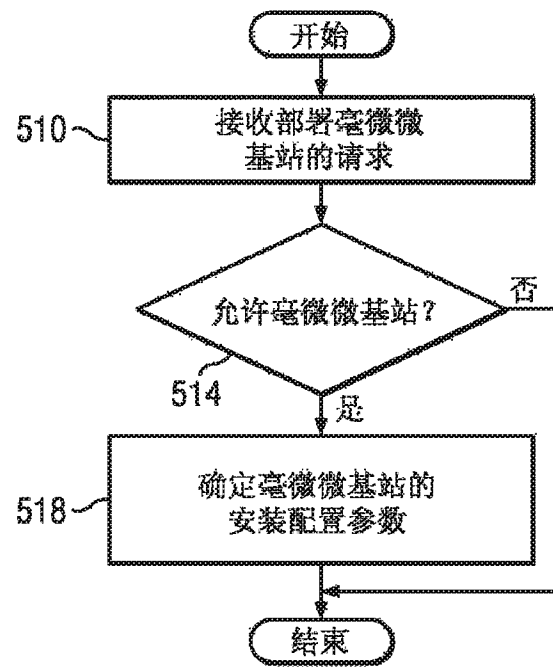


图 5



Espacenet

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Method, apparatus, and system for connecting a mobile client to wireless networks

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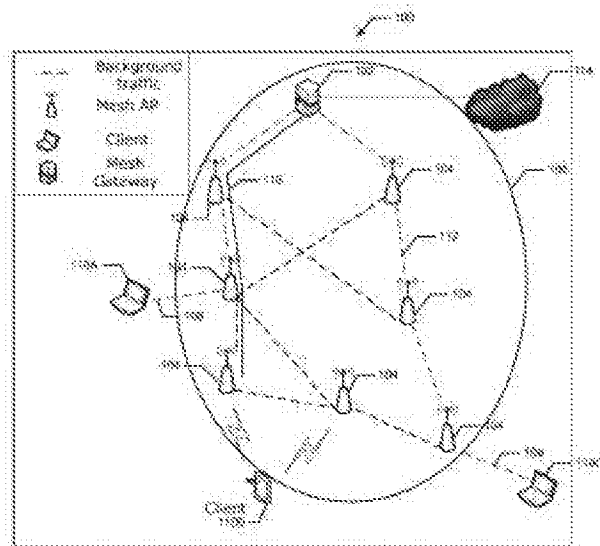
Application number: CN20118024785 20110601 Global Dossier

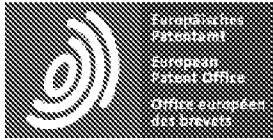
Priority number(s): WO2011EP02721 20110601 ; US20100793387 20100603

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Abstract of CN102907141 (A)

A method for connecting a mobile client to a wireless network includes periodically triggering an access point scanning process so as to monitor an access point density of a wireless network. A frequency of the triggering is adjusted in response to a change in the access point density.





Notice

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DESCRIPTION CN102907141

The present disclosure relates to methods, apparatus, and systems for connecting a mobile client to a wireless network. A method for connecting a mobile client to a wireless network includes periodically triggering an access point scanning process to monitor the access point density of the wireless network. The frequency of the trigger is adjusted in response to changes in the density of the access points.

Method, device and system for connecting mobile client to wireless network

Technical field

The present invention relates generally to wireless networking and, more particularly, to methods, apparatus, and systems for providing wireless connectivity to mobile clients to optimize power savings, wireless access opportunities, and end-to-end performance.

Background technique

With the growing popularity of Internet-enabled mobile devices and the excess of mobile web applications in use, data consumption on smartphones has skyrocketed in the past few years. Many carriers have reported an alarming increase in mobile data traffic. Although in countries including the US, the flat rate plan helps with the largest data limits, users around the world continue to join the usage-based program.

Wi-Fi-based wireless mesh networks offer high bandwidth and are often cheaper, and are another option for

mobile Internet users, and are a good choice for service providers to offload mobile data traffic. For a satisfying user experience, mobile Internet applications like latency-sensitive IP telephony need to guarantee seamless connectivity within areas with wireless coverage. However, due to the reconnection required for user mobility and the short transmission range of the Wi-Fi network, this is a burden on the battery of the mobile phone. Specifically, in order to maximize the use of Wi-Fi opportunities, the mobile host must (i) frequently scan the ISM spectrum band for a list of available Wi-Fi networks, and (ii) proactively probe the wireless link to identify the most Good access networks or access points (APs), and (iii) proactively migrate their current associations to other APs that provide high throughput. All of these tasks are critical to the battery life and connectivity of mobile hosts.

There are several inherent challenges to maximizing Wi-Fi usage for battery-limited mobile client utilization. Periodic scanning of Wi-Fi networks can help identify available networks. Determining the optimal scan frequency for optimizing battery life and Wi-Fi connection opportunities is challenging. Cell-assisted range-based scanning provided by existing cellular service providers suffers from the unpredictability of cellular signals or the density of changes in cell towers. Some existing devices use Received Signal Strength (RSS) based scanning, which relies on fixed thresholds when triggering AP scans and is not flexible enough to take advantage of the variable Wi-Fi provided by wireless mesh networks. Access opportunities. There are also some existing devices that utilize history-based scanning and correlation control, which requires energy-intensive computing and position tracking.

In a wireless mesh network (WMN), a mobile client can receive signals from a plurality of mobile APs belonging to the network and can select one of the APs to access the WMN. Therefore, it is desirable to choose an AP that provides the best user experience or performance for the mobile client. Existing systems primarily utilize a signal strength based mechanism to classify APs, where the mobile client is associated with an AP that provides maximum received signal strength (RSS) at the client.

However, simply selecting an AP based on signal strength can result in an increase in congestion on the selected AP, thereby causing poor performance for the end user. Moreover, signal strength is not an accurate indication of channel conditions in a wireless network. Therefore, even if the signal strength received from one AP is high, this may not correctly indicate the current performance level of the AP.

Summary of the invention

It is an object of the present invention to overcome the above mentioned deficiencies.

The present invention provides a method for providing a wireless connection to a mobile client. The method includes periodically triggering an access point scanning process to monitor an access point density of the wireless network and adjusting the frequency of the trigger in response to changes in the density of the access point.

The method can also include the steps of decreasing the trigger frequency in response to a decrease in access point density and/or increasing the trigger frequency in response to an increase in access point density.

Advantageously, the method can include the step of monitoring at least one motion of the mobile client and adjusting the trigger frequency in response to at least one motion of the mobile client.

Preferably, the method includes the step of determining a speed of the at least one motion of the mobile client; and increasing the trigger frequency in response to the increasing speed.

In a preferred embodiment, the method includes the step of reducing the trigger frequency in response to a decrease in speed.

Preferably, the method includes the step of detecting the motion of the mobile client by an accelerometer placed in the mobile client.

Advantageously, the method further comprises the steps of:

Detecting one or more access points in the area in which the mobile client is located;

Monitoring at least link quality and load characteristics of the wireless network;

In response to at least the link quality and load characteristics of the wireless network, one of the detected one or more access points is selected to connect the mobile client to the wireless network.

In a preferred embodiment, the wireless network is a wireless mesh network comprising a plurality of access points, wherein another network entity is connected to one of the plurality of access points, and wherein one or

more of the detected Each of the access points is associated with a path connecting the corresponding access point and another network entity over the wireless mesh network, each path having one or more nodes selected from the plurality of access points;

The method also includes:

Determining connection quality and load characteristics of each path associated with each of the detected one or more access points over the wireless mesh network;

The access point is selected according to the connection quality and load characteristics of the path.

Preferably, the method comprises the steps of:

Ranking the detected one or more access points based on their connection quality and load characteristics of the associated path through the wireless mesh network; and

The access point is selected according to the rating.

The above mentioned technical problem is also solved by a computer readable medium having computer readable code stored thereon, which when the code is executed by one or more digital processors, indicates that the one or more digital processors are mobile The client provides a wireless connection, the computer readable code comprising:

An instruction that periodically triggers an access point scanning process to monitor the access point density of the wireless network; and

An instruction to adjust the trigger frequency in response to a change in the density of the access point.

Preferably, the computer code further comprises:

An instruction to monitor at least one motion of the mobile client; and

An instruction to adjust the trigger frequency in response to a change in at least one motion of the mobile client.

Advantageously, the computer code may further comprise:

An instruction to receive a motion signal from an accelerometer placed in the mobile client; and

An instruction to move at least one motion of the mobile client is determined from the motion signal.

In a preferred embodiment, the computer code further includes:

An instruction to detect one or more access points in an area in which the mobile client is located;

An instruction to measure at least link quality and load characteristics of a wireless network; and

The one of the detected one or more access points is selected to connect the mobile client to the wireless network based on at least the link quality and load characteristics of the wireless network to maximize end-to-end performance of the wireless connection.

The above mentioned technical problem is further solved by a mobile client connected to the wireless network through one or more access points. The mobile client includes:

a scanning module configured to periodically trigger an access point scanning process to monitor an access point density of the wireless network; and

The adjustment module is configured to adjust the frequency of the trigger in response to a change in the density of the access points.

Preferably, the mobile client further includes:

a sensor configured to generate a motion signal indicative of at least one motion of the mobile client; and

a mobility monitor configured to monitor at least one motion of the mobile client by the motion signal,

The adjustment module is further configured to adjust the frequency of the trigger in response to a change in the at least one motion of the mobile client.

Advantageously, the mobile client can include an association module configured to monitor at least link quality and load characteristics of the wireless network and to select an access point based on at least the link quality and load characteristics of the wireless network, To connect mobile clients to the wireless network to maximize end-to-end performance of wireless connectivity.

Preferably, the scanning module is configured to monitor the received signal strength of the wireless signal received by the mobile client, wherein the mobile client may further include:

a migration module configured to migrate the mobile client from the first access point to the second access in response to at least one of a change in motion of the mobile client, a change in density of the access point, and a change in received signal strength point.

The above mentioned technical problem is further solved by a system for providing a mobile client with a wireless connection to a wireless network. The system includes:

Multiple access points distributed over a wireless network; and

A mobile client configured to periodically trigger an access point scanning process to monitor an access point density in an area in which the mobile client is located, the mobile client being further configured to respond to changes in access point density And adjust the frequency of the trigger.

Preferably, the mobile client is configured to monitor at least one motion of the mobile client and is configured to

adjust the frequency of the trigger in response to changes in the movement of the mobile client.

Advantageously, each of said plurality of access points is configured to measure at least link quality and load characteristics of the wireless network and is configured to transmit measurements indicative of said link quality and load characteristics to the mobile client end.

In a preferred embodiment, the mobile client is configured to receive measurements of link quality and load characteristics, and when the mobile client detects one or more access points of the wireless network, the mobile client is configured Depending on the measurement of the link quality and load characteristics of the wireless network, one of the detected one or more access points is selected to maximize the end-to-end performance of the wireless connection.

DRAWINGS

1 depicts a wireless network environment in which various embodiments of the present invention are practiced;

2A is a schematic diagram showing an embodiment of the mobile client shown in FIG. 1;

2B is a schematic diagram showing another embodiment of the mobile client shown in FIG. 1;

3 is a schematic diagram showing an embodiment of the wireless access point shown in FIG. 1;

4A depicts a flow diagram of a method for triggering an access point sensing process at a mobile client;

4B illustrates another embodiment of a method of triggering an access point sensing process when a mobile client disconnects from a wireless network;

4C depicts another embodiment of a method of triggering an access point sensing process when a mobile client connects to a wireless network;

5A depicts a flow diagram of a method of selecting an access point to access the wireless network depicted in FIG. 1;

Figure 5B illustrates another embodiment of the method depicted in Figure 4B;

Figure 6 depicts the power consumption of a periodic access point scan with an adjustable trigger interval T_s ;

Figure 7 depicts a performance comparison between a fixed threshold access point scan and an adaptable threshold AP scan;

Figure 8A depicts the average number of new access points detected by the access point scanning process as the mobile client moves;

8B depicts data samples collected from a built-in accelerometer on one embodiment of a mobile client with a 20% duty cycle under different motion behaviors;

Figure 8C depicts the measurement results according to the present invention, which shows that the AP arrival interval is accurately approximated as an exponential distribution;

9A depicts an optimal scan interval (T_s) suitable for mobile client motion speed and AP density in accordance with the present invention;

Figure 9B depicts the threshold distance of an AP scan as a function of the average AP density for each probability value ξ in accordance with the present invention;

Figure 9C depicts the energy savings provided by the motion based scan in accordance with the present invention when compared to conventional fixed frequency triggering with a fixed trigger interval (T_s);

Figure 10 depicts the accuracy provided by passive probe estimation of link bandwidth in accordance with the present invention;

Figure 11 depicts an outdoor test bench topology for practicing embodiments of the present invention;

Figure 12A depicts performance improvements provided by one embodiment of the present invention as compared to conventional fixed frequency scanning;

Figure 12B depicts energy savings provided by an embodiment of the present invention as compared to conventional fixed frequency scanning;

Figure 12C depicts the performance of density based scanning with different thresholds;

Figure 13 depicts throughput improvements provided by an embodiment of the present invention as compared to conventional access point selection strategies;

Figure 14 depicts a round trip delay improvement provided by an embodiment of the present invention as compared to a conventional access point selection strategy;

Figure 15 depicts the effect of weight values w_1 and w_2 on throughput performance in accordance with the present invention;

Figure 16 depicts throughput and round-trip delay performance provided by an embodiment of the present invention practiced in an indoor test bed as the number of mobile clients changes;

Figure 17 depicts the throughput and round-trip delay performance provided by an embodiment of the present invention practiced on an outdoor test bed as the number of mobile clients changes;

Figure 18 depicts the impact of traditional AP selection strategies on network throughput.

detailed description

In some embodiments, the present invention provides an access point sensing (scanning) technique that maximizes wireless access opportunities for mobile clients while providing optimal power savings. Unlike existing systems that rely on expensive positioning mechanisms (eg, GPS) or war-driving, the present invention provides low power sensors placed in mobile clients to maximize the use of wireless networks. The present invention also provides an AP selection technique that selects an access point for a mobile client to maximize end-to-end performance to provide an optimal user experience.

According to another embodiment, the method includes detecting one or more access points within an area in which the mobile client is located, monitoring at least link quality and load characteristics of the wireless network, and responsive to at least the wireless network Link quality and load characteristics, selecting one of the detected one or more access points to connect the mobile client to the wireless network to maximize end-to-end performance of the wireless connection.

According to some alternative embodiments, a computer readable medium having stored thereon computer readable code is provided. When the computer readable code is executed by one or more digital processors, the one or more digital processors are instructed to provide a wireless connection to the mobile client. The computer readable code includes instructions for periodically triggering an access point scanning process for monitoring an access point density of a wireless network and for adjusting a trigger frequency in response to a change in access point density to maximize a mobile client Instructions for energy saving and access opportunities.

In accordance with another embodiment, the computer code further includes instructions for detecting one or more access points within a region in which the mobile client is located, instructions for measuring at least link quality and load characteristics of the wireless network, and Selecting an access point from the detected one or more access points based on at least the link quality and load characteristics of the wireless network to connect the mobile client to the wireless network to maximize end-to-end wireless connectivity Performance instructions.

In still other alternative embodiments, a mobile client connected to a wireless network through one or more access points is provided. The mobile client includes a scanning module configured to periodically trigger an access point scanning process for monitoring wireless network access point density, configured to adjust a trigger frequency in response to a change in access point density to maximize An adjustment module for energy saving and access opportunities for mobile clients.

In another embodiment, the mobile client includes an association module configured to monitor at least link quality and load characteristics of the wireless network, and select one interface according to at least the link quality and load characteristics of the wireless network Incoming points to connect mobile clients to the wireless

network to maximize end-to-end performance of wireless connections.

According to still further alternative embodiments, a system for connecting a mobile client to a wireless network is provided. The system includes a plurality of access points distributed in a wireless network and a mobile client configured to periodically trigger an access point scanning process for monitoring the density of access points within the area in which the mobile client is located. The mobile client is also configured to adjust the frequency of the trigger in response to changes in the density of the access points.

In another embodiment, each of the plurality of access points is configured to measure at least link command and load characteristics of the wireless network and configured to transmit measurements indicative of the link quality and load characteristics to the mobile client.

In still another embodiment, the mobile client is configured to receive measurements of link quality and load characteristics, and when the mobile client detects one or more access points of the wireless network, the mobile client is configured to select one of the detected one or more access points based on measurements of link quality and load characteristics of the wireless network.

The various embodiments of the invention are described with reference to the drawings, in which the same reference numerals are used to identify the same elements. The scope of the invention is not limited by the scope of the invention, and the scope of the invention is limited only by the scope of the appended claims. In addition, any examples set forth in this specification are not intended to be limiting, but merely to illustrate some of the many possible embodiments of the claimed invention. The invention may be embodied as a method or apparatus. Accordingly, the present invention can be implemented in an entirely hardware embodiment, an entirely software implementation, or a combination of software and hardware. Therefore, the following detailed description should not be construed in a limiting sense.

Throughout the specification and claims, the following terms are to be used in the meanings As used herein, the phrase "in one embodiment" does not necessarily mean the same embodiment, although it may be. The term "or" as used herein is an inclusive "or" operator and is equivalent to the term "and/or" unless the context clearly dictates otherwise. The terms "partially based on", "based at least in part on" or "based on" are not exclusive and are permitted to be based on additional factors not described, unless the context clearly dictates otherwise. In addition, throughout the specification, the meaning of "a" and "an" includes plural meaning. The meaning of "in" includes "in" and "on".

Briefly, methods, apparatus and systems for connecting a mobile client to a wireless network are provided. Here, wireless networks include, but are not limited to, Wi-Fi networks, Bluetooth networks, WiMAX networks, or

any wireless network that conforms to industry standards such as IEEE 802.11, which is hereby incorporated by reference in its entirety. Alternatively, the wireless network may be a proprietary network that provides data communication through multiple access points.

In general, the methods described herein provide access point sensing processes (e.g., scanning and association) by considering the motion and behavior of the mobile client and the density of access points within the mobile client's transmission range.

In particular, the mobile client periodically scans the channel to discover available wireless access points. Because wireless access opportunities are subject to spatial variations, such as mobile client motion and access point density, the scanning frequency of the access point sensing process is adapted based on spatial variations to conserve energy and maximize access opportunities. . Provides mobile clients with access point density and fine-grained mobility information for sensing access points to maintain optimal power savings and wireless access opportunities.

Moreover, the method also provides energy efficient access point sensing by optimizing a trade-off metric, wherein the trade-off metric can be defined as the energy spent on wireless network discovery and communication and transmitted to the mobile client. The ratio of all bits.

In addition, due to the unbalanced nature of wireless access opportunities, the methods described herein use information about access network conditions and AP density at a given location, which allows mobile clients to discover new access points, Wi-Fi networks. . For example, in a highly dense area with high average received signal strength (RSS) where wireless access points are densely distributed, the mobile client can increase the migration threshold to find better APs, while in sparsely distributed areas, They can reduce migration thresholds to avoid migration overhead. Here, a migration, also referred to as handover, refers to the process of disconnecting a mobile client from an existing access point and connecting the mobile client to another access point when certain conditions are met.

Mobile clients include, but are not limited to, portable computers, cellular phones, PDAs, and smart phones with the ability to access wireless networks. The method includes periodically triggering an access point scanning process for monitoring wireless network access point density and adjusting a frequency of triggering in response to changes in access point density to maximize energy savings and access opportunities for the mobile client.

Illustrative operating environment

Figure 1 illustrates components of one embodiment of an environment in which the present invention may be practiced. The invention is not necessarily required to all of the components, and variations in the arrangement and type of components may be made without departing from the spirit or scope of the invention. As shown, the system 100 of FIG. 1 includes a wireless network 106 including a plurality of access points 104 and one or more mobile clients 110A-C. In some embodiments, the wireless network 106 also includes an edge gateway 102 that connects the wireless network 106 to an external network 114, such as the Internet, a local area network/wide area network, a telephone network, or a cellular network.

In general, access points 104 are interconnected via a wireless link 112, and each link may include one or more wireless channels centered at different transmission frequencies, such as 900 MHz or 2.5 GHz. Each link 112 can provide one-way or two-way data transmission over one or more wireless channels. Moreover, as data is transmitted from one access point to another, data passes through the wireless network 106 through a wireless path, such as path 116, where the wireless network 106 is formed by one or more access points (nodes) . As shown in FIG. 1, path 116, which is an exemplary embodiment of a wireless network path, may include one or more hops, each hop being defined by a pair of neighboring nodes along the path. Data can be transmitted across the entire wireless path over the same wireless channel. Alternatively, the wireless channel used to transmit data may vary from one hop to the next along the wireless path.

The edge gateway 102 provides an interface to the external network 114 in addition to functions similar to those provided by the access point 104. These interfaces provide address translation and data conversion and encapsulation, which are well known in the art.

When a mobile client, such as 110A-C, enters the transmission range of access point 104, access point 104 can provide a wireless connection 108 between the wireless client and wireless network 106. Once the initial connection is made, the access point may require authentication from the wireless client. Once the mobile client is authenticated, it is allowed to move within the wireless network 106 without additional authentication.

Each of the mobile clients 110A-C is configured to periodically scan an area within the transmission range of the wireless signal to determine if there are any access points within the transmission range. The mobile client can select one of the detected access points to access the wireless network 106. When the mobile client moves, the network topology changes or the environment changes, and the mobile client can migrate from one access point to another.

In general, mobile client 110 may actually include any mobile computing device capable of receiving data over a network, such as wireless network 110. Such devices include portable devices such as cellular phones, smart

phones, radio frequency (RF) devices, infrared devices, personal digital assistants (PDAs), handheld computers, laptops, wearable computers, tablets, and the like. An integrated device of one or more devices, and the like.

Illustrative mobile client devices 110A, 110B, and 110C

FIG. 2A illustrates one embodiment of a mobile client device 200 that can be included in a system 100 embodying the present invention. Device 200 may include more or fewer components than those shown in Figure 2A. However, the illustrated components are sufficient to implement the illustrative embodiments for practicing the invention. For example, device 200 can represent one implementation of at least one of mobile clients 110A, 110B, and 110C of FIG.

As shown in the figure, device 200 includes a processing unit (CPU) 222 that communicates with mass storage 230 via bus 224. The device 200 also includes a power source 226, one or more network interfaces 250, an audio interface 252, a display 254, a keypad 256, a luminaire 258, and an input/output interface 260. Power source 226 powers device 200. A charged or non-rechargeable battery can be used to supply power. Power can also be provided by an external power source, such as an AC adapter or a charging dock that replenishes the battery and/or charges the battery.

Device 200 can communicate with another computing device either directly or via wired/wireless network interface 250. Network interface 250 includes circuitry for coupling device 200 to one or more networks and for use with one or more communication protocols and techniques, including, but not limited to Global System for Mobile Communications (GSM), Code Division Multiple Access (CDMA), Time Division Multiple Access (TDMA), User Datagram Protocol (UDP), Transmission Control Protocol/Internet Protocol (TCP/IP), SMS, General Packet Radio Any of the services (GPRS), WAP, Ultra Wide Band (UWB), IEEE 802.11 Wi-Fi, IEEE 802.16 Worldwide Interoperability for Microwave Access (WiMAX), SIP/RTP, or a variety of other wireless communication protocols. Network interface 250 is sometimes referred to as a transceiver, transceiver device, or network interface card (NIC).

The audio interface 252 is arranged to generate and receive an audio signal, such as a human voice. For example, the audio interface 252 can be coupled to a speaker and a microphone such that it can talk to other people and/or generate an audio confirmation of an action. Display 254 can be a liquid crystal display (LCD), a gas plasma, a light emitting diode (LED), or any other type of display used with computing devices. Display 254 may also include a touch sensitive screen arranged to receive input from an object such as a stylus or a human finger.

Keypad 256 can include any input device that arranges to receive input from a user. For example, keypad 256 can

include a button numeric dial, or a keyboard. Keypad 256 may also include command buttons associated with selecting and transmitting images. Illuminator 258 can provide status indications and/or provide light.

Illuminator 258 can remain active for a specific period of time or in response to an event. For example, when the illuminator 258 is active, it can illuminate the buttons on the keypad 256 from the back and remain in this state while the device is powered. Moreover, when performing a particular action, such as dialing another device, the illuminator 258 can illuminate the buttons from behind in various modes. Illuminator 258 can also illuminate a light source located in a transparent or translucent housing of the device in response to an action.

Device 200 also includes an input/output interface 260 for communicating with an external device, such as a headset. Input/output interface 260 can utilize one or more communication technologies such as USB, infrared, Bluetooth <TM>, and the like.

In terms of capabilities and features, the range of devices 200 is generally broad. For example, a cell phone can have a numeric keypad and a few lines of monochrome LCD display on which only text can be displayed. In another example, a web-enabled mobile device, such as a PDA, can have a touch-sensitive screen, a stylus, and a few lines of color LCD display in which both text and graphics can be displayed. In yet another example, a multimedia enabled mobile device, such as laptop 110A, can include a multimedia application, such as a video playback application, configured to render images, video through a multimedia interface such as a color LCD or LED screen or microphone. Stream, audio signal, etc. In still another example, device 200 can also include a browser application configured to receive and display graphics, text, multimedia, etc., the browser application can in fact employ any web-based language, including wireless application protocol messages (WAP). Wait. For example, enabling browser applications to use Handheld Device Markup Language (HDML), Wireless Markup Language (WML), WMLScript, JavaScript, Standard Generalized Markup Language (SMGL), Hypertext Markup Language (HTML), Extensible Markup Language (XML) Wait to display and send information.

As depicted in FIG. 2, device 200 also includes a sensor 262 for monitoring the motion of the mobile client as a result of user motion, such as walking, running, or cycling. In general, sensor 262 can generate a signal that reflects the motion of the mobile client. Sensor 262 can convert the signal to digital data, which is then stored in data storage portion 244 of the memory or provided to CPU 222 for practicing the present invention. Sensor 262 can take many forms of accelerometers and is typically embedded in a mobile client.

Device 200 also includes a mobility monitor 246 that is configured to detect motion of the mobile client from data generated by sensor 262. For example, the mobility monitor 246 can divide the data into a plurality of classes including walking, running, and cycling and calculate the travel distance of the mobile device based on the classified athletic data.

The device 200 also includes a scanning module 247 that can periodically trigger an access point scanning process to detect if there are currently and how many access points are within the transmission range.

The device 200 also includes an access point association module 248 that can select an access point to connect the mobile client to the wireless network 106. The access point association module 248 can select an access point based on various criteria, such as the link quality and load characteristics of the wireless network 106. The association module 248 can also provide for the migration of mobile clients from one access point to another based on similar criteria.

In FIG. 2A, mobility monitor 246, scanning module 247, and access point association module 248 are implemented as one or more computer programs including computer readable code stored in application portion 242 of the memory. These computer programs can be implemented by programming languages such as C, C++, Java, and the like.

Alternatively, the various modules described above can also be implemented as hardware modules, as depicted in Figure 2B. In this embodiment, the device 280 that can also be used for the mobile client 110 includes a user interface 281, a memory 282, a CPU 283, a sensor 288, a network interface 289, and an additional mobility monitor 284, a scanning module 285, and an associated module. 286 and migration module 287. According to this embodiment, the modules are hardware components that include one or more circuits, which may be dedicated circuits or general purpose programmable logic devices.

Illustrative network node 104

FIG. 3 illustrates one embodiment of an access point 300 that can be used in the wireless network 106 of FIG. Access point 300 can include more or fewer components than those shown. However, the illustrated components are sufficient to disclose illustrative embodiments for practicing the invention.

In particular, network device 300 includes a processing unit 312, a mass storage device, and one or more network interface units 310A, 310B, and 310C (collectively referred to as "wireless interface unit 310"), all of which are in communication with each other via bus 322. The mass storage typically includes RAM 316, ROM 332, and one or more permanent mass storage devices, such as hard drives, tape drives, optical drives, and/or floppy drives. The mass storage stores an operating system 320 for controlling the operation of the access point 300. Any general purpose operating system can be used. A basic input/output system ("BIOS") 318 for controlling low level operation of network device 300 is also provided.

As illustrated in FIG. 3, network device 300 can also communicate with other access points 104 or mobile clients 110 via wireless network interface units 310A, 310B, and 310C, with wireless network interface units 310A, 310B, and 310C being intended to include Various communication protocols such as TCP/IP, Wi-Fi, Bluetooth, etc. are used together. Wireless network interface units 310A, 310B, and 310C are sometimes referred to as wireless transceivers, transceiver devices, or network interface cards (NICs). Each of the wireless units 310A, 310B, and 310C can operate in the same or different frequency ranges, such as 900 MHz, 2.5 GHz, or 5 GHz.

When the wireless interface unit 310 is in communication with another access point 104, it acts as a network router for routing data through the wireless network 106. On the other hand, when the wireless interface unit 310 is in communication with the mobile client 110, it acts as an access point to allow the connected mobile client to access the wireless network 106. Thus, through the wireless interface units 310A, 310B, and 310C, the device 300 can act as both a wireless router and an access point.

The mass storage as described above illustrates another type of computer readable medium, i.e., a computer storage medium. As used herein, such computer readable storage medium refers to a physical, tangible device. The computer readable storage medium can include volatile, nonvolatile, removable and non-removable media for information storage, such as computer readable instructions, data structures, programs, implemented in any method or technology. Module or other data. Examples of computer readable storage media include RAM, ROM, EEPROM, flash memory or other memory technology, CD-ROM, digital versatile disk (DVD) or other optical storage, magnetic tape cassette, magnetic tape, magnetic disk storage or other magnetic storage A device, or any other physical device that can be used to store desired information and that can be accessed by a computing device.

RAM 316 may include one or more data stores, which may be used by access point 300 to store applications 350 and/or other data. RAM 316 can also be used to store database information. The mass storage also stores program code and data. One or more applications 350 are loaded into mass storage and run by central processing unit 312 on operating system 320. Examples of applications include link quality monitor 354 and utilization monitor 356, customizable user interface programs, IPSec applications, encryption programs, security programs, and the like.

The operation of link quality monitor 354 and utilization monitor 356 will be further described below.

Generalized operation of system 100

Due to the unplanned deployment of access points (APs) and their small coverage, mobile users are frequently disconnected from the AP, and therefore there is a need to actively discover wireless access opportunities. Even if there are many open wireless APs 104 in a given area, there are black spots in the coverage area or throughput at some locations is not very good for a satisfactory user experience. In order to discover wireless access opportunities, mobile clients 110A, 110B, and 110C (collectively referred to as "mobile clients 110") periodically trigger an access point scanning process.

However, the access point scan consumes a significant amount of energy in the mobile client 110. Figure 6 shows the power consumption of the Wi-Fi scanning process in the GOOGLE G1 phone. The data shown in Figure 6 was measured experimentally at 20 samples per second using an Agilent 34410A digital multimeter. During the experiment, all other applications and background services were turned off, so the energy consumption of the AP scanning process was reflected in the data. As shown in the figure, the AP scan is expensive, about 1.1 J per scan (ie, 00 mW x 1.3 seconds), mainly because it needs to scan the complete set of ISM channels and receive from all neighboring APs. Multiple beacons. Due to its high energy consumption, the scanning process is triggered periodically, which leads to energy spikes. The time interval T_s between each of the two peaks is determined by the frequency of the trigger.

In accordance with an embodiment of the present invention, in order to maximize power savings (ie, reduce power consumption) while maintaining wireless access opportunities (ie, reducing scan errors), provision is made based on various conditions, such as density or movement of access points. The motion of the client to adjust the trigger frequency.

In another embodiment, when the mobile clients 110A-C are exposed to a plurality of access points 104, the present invention also provides a method of estimating network conditions to select the best AP. This also leads to energy efficient data transmission. In particular, to provide estimation and association selection, system 100 allows mobile clients 110A-C to collect information regarding wireless last hop (ie, client to AP) and mesh backhaul (AP to gateway) conditions. Since a large number of data packets are sent to and from the AP, the prior art utilizing active probing strategies is energy intensive. Unlike the prior art, mobile clients 110A-C in system 100 are allowed to utilize the data collected from AP 104 to monitor network conditions without proactive provisioning.

On the connection, the mobile host experiences link condition fluctuations, especially for the last hop of the wireless, and they are subject to false triggering of AP sensing (eg, mobile hosts located in multiple AP boundaries). Even in the absence of user movement, the state of the last hop of the wireless fluctuates with the user's movements or new obstacles. This often results in AP sensing being triggered more than it should be triggered, resulting in frequent network probing and re-association. The reactive triggering of AP sensing can save the associated overhead, but delayed sensing increases the chance of omission.

According to another embodiment, system 100 provides a mechanism to trigger an AP scan based on a mobile client's trigger probability (Pscan) and received signal strength (RSS) threshold. The trigger probability is updated in response to the motion of the mobile client. The RSS threshold is updated in response to the density of the AP. Triggering based on trigger probability reduces false triggering caused by RSS fluctuations due to fading.

In areas with densely deployed wireless APs and high average RSS, mobile client 110 preemptively senses new and/or better wireless access opportunities and performs migration to improve energy efficiency and end-to-end in data transmission End performance.

Unlike existing systems that only trigger sensing and migration when the received signal strength (RSS) is below a certain predetermined threshold, the mobile client 110A-C triggers in response to the motion of the mobile client and network conditions such as AP density. Measurement and migration. In one embodiment of the invention, the threshold for triggering the migration is adapted in response to at least one of motion and AP density. The threshold can be adapted continuously or with discrete values.

Figure 7 illustrates a comparison between an embodiment of system 100 and a migration performance of an embodiment of an existing system using a fixed RSS threshold. The embodiment shown here uses two discrete values (-75 dBm and -85 dBm) to fit the RSS threshold, while the fixed threshold system uses -75 dBm as the RSS threshold. In the exemplary embodiment, the RSS threshold is changed for different AP densities (high and low density). The mobile client triggers the migration only when the RSS from the current AP becomes lower than the RSS threshold. Figure 7 shows the average RSS from the associated AP as the mobile client moves around the indoor test rig, where the test rig has a high AP density area 712 and a low AP density area 714. As shown in the figure, in the high AP density region 712, the exemplary embodiments of the conventional system and system 100 all produce a higher achievable user RSS with less migration overhead. On the other hand, in the low AP density region 714, conventional systems using high thresholds (-75 dBm) result in significant energy costs and disruptions due to increased number of migrations, while an exemplary embodiment of the system 100 with adaptable RSS thresholds A relatively high RSS can be achieved with significantly less energy costs due to reduced number of migrations.

In accordance with the embodiments as depicted in Figures 2A and 2B, various modules are provided for mobile client 200 to scan, probe, correlate, and migrate across multiple wireless access points 104 of wireless network 106 to maximize Wireless access opportunities while saving energy costs per bit.

In particular, to discover wireless access opportunities, the mobile client 200 uses fine-grained motion information extracted from a low power sensor, such as an accelerometer, placed thereon. This mobile-centric mobility detection helps avoid triggering expensive position tracking or war driving. The mobile client 200 provides a disconnection sensing process that adjusts the AP scan frequency as the mobile client 200 disconnects from any AP, thereby maximizing the discovery of network opportunities with reduced energy costs. Mobile client 200 also provides a connection sensing process that preemptively identifies and migrates mobile clients from one access point to another to maximize wireless access opportunities. Also, the mobile client 200 uses both network status information and motion information to reduce erroneous association/migration triggers.

The mobile client 200 can be implemented on many different platforms, such as the Android framework using Google's G1 Android Development Phone (ADP) or Apple's iPhone or Microsoft's Windows Phone. According to another embodiment, the modules depicted in Figures 2A-B can be implemented as a middleware program that utilizes information from low power sensors located in mobile client 200 and interacts with other components.

When executed by the mobile client 200, the program provides energy efficiency improvements in three aspects of always-on wireless connectivity. First, sensor-assisted adaptive AP scanning reduces the number of scans while significantly reducing missed access opportunities. Second, network-aware association control saves exploration overhead and further improves the accuracy of AP selection. Third, mobility-based adaptive migration helps the mobile client 110 speculatively determine the optimal migration time.

Under the direction of this program, the mobile client 200 provides energy efficient AP discovery through the following features.

Motion-aware access point sensing: The mobile client 200 collects information about its own physical motion and combines this information with network conditions to optimize the AP sensing frequency or timing and trigger or suppress AP sensing operations.

Use of low power sensors: Unlike existing motion detection methods based on GPS or cell tower IDs, which are typically energy intensive or subject to inaccuracies, mobile client 200 uses onboard low power sensors such as Accelerometer to infer motion and determine the trigger point.

Sensing when connected or disconnected: The mobile client 200 not only identifies the wireless access opportunity when it is disconnected from the network, but also preemptively searches for better access when it connects to the existing access point. opportunity.

Dynamic AP Sensing: The mobile client 200 spatially monitors the non-uniformity of wireless access opportunities and dynamically changes its sensing parameters to improve network opportunity discovery and improve energy efficiency.

Energy efficient access point sensing

As noted above, the physical location and motion of the mobile client 110 relative to the wireless network 106 affects the discovery of connection opportunities. Figure 8A shows the average number of new APs detected by the AP scan when the user carrying the mobile client stands, walks and runs for five minutes along the urban roadside. As shown in the figure, increasing mobility translates into a higher number of discovered wireless access opportunities (i.e., the number of APs detected within an area within a time frame). In one embodiment, the mobile client 200 adaptively changes its sensing frequency depending on its motion. For example, when the onboard sensor 262 or 288 of the mobile client 110 detects that its user is not moving, the AP sensing is triggered less frequently or even when the mobile client is not connected to any wireless network. The AP sensing process is triggered more often when the sensor 262 or 288 detects that the user has walked through an area with a dense AP distribution.

In another embodiment, user mobility is monitored in an energy efficient manner by onboard sensors. Furthermore, the motion information detected by the onboard sensors becomes available in real time to detect access opportunities. In particular, sensor 262 or 288 includes a low power accelerometer sensor that detects user motion. Such low power accelerometers are similar to those available in existing systems such as Apple's iPhone and GOOGLE's G1 handset. Compared to high-power GPS sensors, low-power accelerometers require much less energy for proper operation. Moreover, during monitoring of the motion of client 110, sensor 262 or 288 does not require external information, such as cellular radio or Bluetooth signals, thereby providing several benefits including controllability, accuracy, and less power consumption.

In operation, the mobility monitor 246 or 284 periodically monitors the accelerometer values and classifies the behavior of the user at a given time into classes such as walking, running, or standing. This behavior-based mobility estimation allows mobile clients to infer meaningful user behavior based on sensor readings, including standing, walking, running, cycling, and driving.

FIG. 8B illustrates an exemplary embodiment of an accelerometer-based behavior classification collected from a GOOGLE G1 phone. The motion matrix (x, y, z) is calculated by the mobility monitor 246 or 284 when the mobile client is placed in a pocket and performs different behaviors (eg, standing, walking, and running), where

x, y, and z Represents accelerometer values along three axes based on accelerometer samples. In particular, the accelerometer is periodically turned on (eg, 1 second off for 4 seconds) and calculates the average of the samples obtained during that time interval. As shown in the figure, the motion estimation generated by the mobility monitor 246 or 284 accurately detects the user's behavior. In another embodiment, the user behavior classification is based on a non-patent entitled "An algorithm for the evaluation of finite trigonometric series" by G. Goertzel, vol. 65, pp. 34-35, 1958, Mathematical Monthly, 1958. The Goertzel method described in the literature is hereby incorporated by reference in its entirety.

According to another embodiment depicted in FIG. 4A, a method 400 of connecting a mobile client to a wireless network is provided. In such an embodiment, the mobile client periodically triggers an access point transmission process for monitoring the access point density (402 and 404) of the wireless network. Within each sensing interval, the mobile client further measures its motion (406). The frequency (sensing interval) is then dynamically adjusted based on the motion of the mobile client and the AP density to maximize power savings and wireless access opportunities (408). When each transmission process is completed, the mobile client determines if any APs are available (410). If no AP is available, the mobile client continues to the next trigger loop. Conversely, if at least one AP is available, the mobile client selects an AP to access the wireless network (412) and proceeds to the next trigger cycle. Alternatively, at step 412, if the current mobile client is connected to an AP, the mobile client determines if migration is necessary to maximize end-to-end performance. If the migration conditions are met, the mobile client migrates from the existing AP to the selected AP.

According to another embodiment, the mobile client 110 operates in a disconnected and connected mode. Based on the mode of operation, the mobile client 110 triggers different AP sensing processes as shown in Figures 4B and 4C.

Access point sensing in disconnected mode

When disconnected from the wireless network 106, the scanning module 247 or 285 periodically triggers the mobile client 110 to perform an AP scanning process to discover any access options. The AP scanning process advantageously uses statistical observations from the wireless network. Based on the scan results obtained in the past time window, the mobile client 110 can estimate the local AP density and adapt the scan interval T_s (or trigger frequency), thereby minimizing the detection of delays in the available wireless access points while reducing the number of scans, thereby maximizing energy savings.

In designing a scanning technique that provides the advantages discussed above, two assumptions are made regarding the behavior of wireless network conditions. First, the AP distribution follows the point Poisson process, which has an average density ρ , ie, the number of APs per square meter, as written by D. Qiu et al. in

Stanford University Technical Report February 2009, entitled "Physical Pseudo Random Function in Radio Frequency Sources for Security, which is incorporated herein by reference in its entirety.

Second, as described in the non-patent literature entitled "Joint Effects of Radio Channels and Node Mobility on Link Dynamics in Wireless Networks" by W. Wang et al., Proc. of IEEE Infocom, April 2008. This document is hereby incorporated by reference in its entirety, assuming that the client-to-AP connection lifetime, that is, the physical distance between the client and the AP is less than the time span of the effective transmission range, can be approximated as an exponential distribution, ie, $\frac{R}{v}$ where v is the average speed of the mobile client, and R is the common transmission range of the AP, assuming that the common transmission range of the AP is a unit disc model well known in the art.

Given these assumptions, the average arrival rate of the new AP is derived. Consider a mobile client that moves at an average speed v . Then, the expected area covered by the mobile host during the time period (t_1, t_2) is approximately $v(t_2 - t_1)$. Then, according to the assumption of the Poisson-distributed AP, the average arrival rate of the new AP is $\rho v(t_2 - t_1)$ where ρ is the average AP density.

Figure 8C shows the cumulative distribution function (CDF) of the AP arrival interval. The figure clearly indicates that this function can be approximated as an exponential distribution, thereby confirming the assumptions discussed above. The gap between the experience and the approximation curve can be explained as follows. In practice, APs can be highly aggregated and may not follow the Poisson distribution inaccurately. Irregularities in mobile client motion measurements can also cause such gaps. Based on the assumptions, the availability of an access point can be modeled as a Markov model with two states, a disconnect (D) and a connect (C) state. The disconnected state means that there is no available AP that the mobile client 110 can connect to, otherwise it will be connected. It should be noted that, according to the assumption, the AP arrival and departure rates are given as λ_c and λ_d , respectively. Thus, the state transition probability for such a two-state model can be easily derived as $\lambda_{d \rightarrow c} = \lambda_d$ and $\lambda_{c \rightarrow d} = \lambda_c$, where $\lambda_{d \rightarrow c}$ and $\lambda_{c \rightarrow d}$ are state transition probabilities for $D \rightarrow C$ and $C \rightarrow D$, respectively.

Optimal scan interval (frequency)

Based on the connectivity model above, it may be determined to minimize missed wireless access opportunities while maximizing the optimal scan interval (T_s) for optimally energy efficient scan intervals. The missing access opportunity is defined as the average score of the number of access times that are not detected by the mobile client 110.

In particular, for missed wireless access opportunities, consider a mobile client 110 that is disconnected from the wireless network 106 and periodically scans the spectrum at intervals T_s . Let $T_{m,d}(T_s)$ denote the chance of missing with the scan interval T_s (until an available AP is found). So, it can be shown as:

Among them, and

To this end, let $T_{m,d}(t)$ denote the average missing AP connection opportunity within the time period $(\tau, \tau + t)$ (by time). When there is no AP available at time τ , the opportunity to connect (ie, AP association) occurs only when an available AP arrives within time period t . Therefore, for the time period $(\tau, \tau + t)$, the expected number of missed opportunities can be expressed as:

Similarly,

By using the Laplace transform, the expected number of missed opportunities $T_{m,d}$ can be solved in the frequency domain, ie

Based on these Laplace transforms, the expected missing opportunity $T_{m,d}(s)$ is given as follows:

The connection and disconnection periods for the exponential distribution are given as follows:

$$f_d(t) = \lambda e^{-\lambda t} \text{ and } f_c(t) = \mu e^{-\mu t}.$$

Thus, the Laplace transform is given as follows:

with

Substituting these into equation (2) and using the inverse Laplace transform yields equation (1).

Equation (1) indicates that the missed opportunity increases with increasing scan interval T_s . From this formula, the missing access opportunities show the following behavior:

When $t \rightarrow \infty$,

This confirmation shows that as the scan interval increases, the mobile client misses detecting all access opportunities. It should be noted that in the analysis, it is assumed that the scanning process is pulsating, so that missed access opportunities due to scanning can be ignored.

Based on this analysis, the optimal scan interval (T_s) can be determined to minimize the ratio of the energy spent on the AP scan to the total transfer position within the scan interval T_s . Here, it is assumed that the energy consumption for data transmission is negligible. When the mobile client scans the AP at a fixed interval T_s , it detects that the time fraction of the access opportunity is $1 - T_d - T_m/d(T_s)$, where $d(T_s)$ is the average of the disconnected state. fraction. Thus, the optimal scan interval is given as follows:

Where T_{max} is the maximum scan interval, which is a predetermined parameter. For example, for a mobile client running a delay sensitive application (eg, an IP phone), T_{max} can be set to a small value and vice versa. In equation (3), the expected achievable data rate is expressed as $E[R]$ and it depends on the AP associated with the client. The AP association policy is described in further detail later in this application.

Hereinafter, it is further shown that the optimal scanning interval of the minimum formula (3) is:

Where d is the average speed, ρ is the average AP density, and R is the transmission range of the AP (for example, 200m).

To do this, the indication is the objective function in the formula (***), that is, the energy spent scanning each transmitted data bit. Assuming that the energy consumption E_{scan} for scanning and the average achievable data rate $E[R]$ are given as constants, the process of finding the optimal scanning interval T_s in equation (3) is equivalent to finding the maximum $G(T_s)$ of (T_s) , which can be found as follows: Obviously, $G(T_s)$ is a monotonically increasing function of T_s in d . Therefore, the optimal value of T_s is given as d . Therefore, the formula (4) is subsequently performed. Equation (4) implies that the optimal scan period depends on the average moving speed d and average AP density (ρ) of the mobile client. For example, when the user moves quickly, the AP arrival rate (λ_d) will increase, and the user is encouraged to scan more frequently, and it is expected that the available AP will be detected quickly, and vice versa. FIG. 9A shows an optimum scanning interval (T_s) for different user speeds assuming the transmission range of the AP is $R=200$ m.

Access point sensing

According to one embodiment, a motion based AP scanning method is provided based on the analysis performed above. In such an embodiment, the AP scan is triggered based on the distance traveled by the mobile client 110 since the last scan. Rather than relying on a power-efficient position tracking system like GPS, this distance can be estimated using the motion sensing techniques described above. Specifically, the distance traveled can be estimated as:

Where K is a set of user behaviors that can be classified based on accelerometer readings as described above, and v_k is the average speed corresponding to the behavior $k \in K$. After each AP scan, the travel distance is reset to zero so that inaccuracies in the system do not accumulate.

According to another embodiment, the AP scanning process is triggered when the mobile client 110 travels more than a threshold distance d_{th} , which is defined as the user finding at least a probability ξ (in the range of 0 to 1) The minimum distance that an available AP needs to move, ie,

Where n_{ap} is the number of available APs detected by the previous scan. The last formula is based on the relationship $E[n_{ap}] \approx \pi R \sqrt{\lambda} > \rho$ and $[\text{image}]$ which can be estimated using the exponentially weighted moving average (EWMA) well known in the art. Figure 9B shows the threshold distance for different AP densities in equation (5). For example, if the average number of APs is 2 and ξ is set to 0.3, the threshold distance is 56 m.

For a mobile client operating in the disconnect mode as shown in Figure 4B, a scan decision is made in each epoch including three sequential cycles. First, within the motion estimation period (T_m), the mobile client turns on the accelerometer at a given duty cycle ratio (eg, 1 second every 10 seconds). Once the mobile host estimates the user's behavior, it updates the distance $[\text{image}]$ and decides whether to trigger an AP scan within the scan decision period (T_d). Once it detects a group of APs, it selects an AP based on the selection criteria and associates it with the selected AP, otherwise it will update the AP density and repeat the process.

To understand the impact of the distance threshold on energy consumption, analyze the number of scans required for the fixed period and motion-based triggering methods before the AP is detected. In the motion-based triggering method, the AP scan is triggered only when the mobile host moves a certain distance, and the fixed period trigger method triggers the AP scan at predetermined time intervals.

The number of scans required for the fixed-cycle trigger method is given as follows:

[image]

The number of scans required for a motion-based triggering method is given as follows:

[image]

Where t_{still} is the amount of time the user is stationary, and $d = \sum_k d_k$ is the distance traveled until the new AP is detected, and where d_k is the distance traveled by the behavior k (eg, walking or running).

Figure 9C shows the total number of scans when the mobile client 110 repeats walking and pausing (still) until an available AP is found. Assume that the distance of the AP from the break point is $d=500\text{m}$ and $d_{\text{th}}=80\text{m}$. The figure shows that the number of scans required for a fixed-cycle trigger increases because the mobile client remains stationary for multiple times. In contrast, motion-based triggering is not affected by static immobility time because it only triggers a scan when the motion of the mobile client exceeds a threshold distance. It should be noted that the motion algorithm triggers a scan every [image] while the user is walking.

Access point sensing in connected mode

Figure 4C depicts an AP sensing method that controls scanning, probing, and migration when the mobile client is operating in connected mode.

To take advantage of the diverse Wi-Fi access opportunities, the sensing process adaptively changes the RSS threshold based on the local AP density estimated using the moving average. When the AP density is high, by setting a high RSS threshold, the mobile client 110 becomes more actively triggering the AP scanning process, thereby expecting to find a better AP at the expense of scanning overhead. In order to avoid high false trigger rates due to RSS fluctuations caused by fading even when the mobile client is stationary, the mobile client triggers the scan in a probabilistic manner based on its motion. Specifically, the triggering probability (i.e., P_{scan} of line 18 in Fig. 4C) is increased based on the distance [image] of the mobile client from the most recent scan. Here, in our experiment, Δ is set to 0.1 and the unit distance (d_{unit}) is 10 meters.

Once the sensing is triggered, if the mobile client scans for any available APs, it is associated with one of the available APs that provides the highest estimated bandwidth. Conversely, if no available APs are found, the mobile client switches to the disconnect mode depicted in Figure 4B.

According to this embodiment, when the mobile client is currently connected to an AP of the wireless network 106, it still preemptively searches for other or better wireless access opportunities to maintain connectivity. For example, when a mobile user walks in an urban area, there are many access points therein and their performance is uneven. Thus, the mobile client can identify and use (or migrate to) such opportunities in an energy efficient manner.

The AP sensing process in connected mode consists of three main parts (ie, scanning, probing, and selection). In particular, to exploit multiple access opportunities while minimizing false triggers, the scan trigger threshold (received signal strength threshold) is dynamically adapted based on the motion or motion history of the mobile client and the local AP density. For example, when the user is stationary, the mobile client avoids triggering the AP sensing process even if the RSS is low due to temporary link quality changes. However, when the mobile client has moved a certain distance (eg, 20m), it not only observes the degraded RSS but also expects to find more APs, thus triggering the AP sensing process.

Access point selection

Once the mobile host is scanned to find a set of available APs, it selects one of the APs based on the performance-based AP selection policy, where the performance-based AP selection policy seeks to provide optimal end-to-end throughput performance for the mobile client. . Access point selection is provided by association module 248 or 286.

In general, mobile client 110 estimates end-to-end bandwidth by utilizing quality and load information available in the network. In a wireless mesh network, the throughput that a mobile host can achieve depends on the quality of the client-to-AP link and the mesh backhaul link. Here, the quality of the client-to-AP link is more dependent on the user's mobility, and the mesh backhaul performance is closely related to the network traffic condition. Therefore, the available bandwidth of the last hop (client-to-AP link) and mesh backhaul is estimated separately. The EAB is estimated by identifying a bottleneck link along the path from the client to the mesh gateway. Specifically, each AP and mesh router periodically measures the available bandwidth of their outgoing links, and each AP collects information measured along its own path to the gateway and then derives the EAB. This information is then passed to the mobile client for easy selection of the best AP to associate.

Estimation of available bandwidth for mesh backhaul

In order to avoid additional measurement overhead, AP sensing uses existing measurements in a passive manner.

Consider link i and denote the source node for downstream traffic with m . Then, node m can estimate the available on link i by passively monitoring the measurement period $(t, t+T)$ packet transmission time (t_{tx}) , link busy time (t_{busy}) , and link idle time (t_{idle}) . Communication time (airtime), where $T = t_{tx} + t_{busy} + t_{idle}$. Thus, the bandwidth available on link i can be estimated as:

Where $R_{m,i}$ is the maximum data transfer rate that node m can support on link i , which can be calculated by performing a simple calibration experiment to calculate a prior value. The estimated available bandwidth calculated above includes the effects of channel contention between adjacent links operating on the same channel. Each mesh node maintains the available link bandwidth by taking a moving average.

Estimated available bandwidth for the client-to-AP link

Next, in order to calculate the available client-to-AP bandwidth, the AP keeps estimating their own link utilization as:

Where C is the set of clients associated with AP a , $L_{a,c}$ is the load (ie, traffic) generated by user $c \in C$ on AP a , and $R_{a,c}$ is the maximum achievable transmission rate of user c (when there is no competition). The AP can estimate the load $L_{a,c}$ by monitoring the total number of bytes per second transmitted to each client associated with it. Here, the utilization U_a can be interpreted as an estimate of the portion of the AP capacity used to service an existing client associated with the AP. Thus, the remaining capacity is available for the new client n , which is given by:

$$AB_{a,n} = (1 - U_a) \times R_{a,n}$$

Where $R_{a,n}$ is the transmission rate between AP a and the new client, which can be estimated during the AP scanning process.

Figure 10 shows the available link bandwidth (indicated by the solid line) estimated for single-hop, two-hop, three-hop, and four-hop connections compared to the actual bandwidth measured by the method of Thrulay (represented by dotted lines), where The method of Thrulay is available at <http://shlang.com/thrulay>, which is incorporated herein by reference in its entirety. Figure 10 indicates that a simple estimation method provides reasonable and accurate results with less than 10% error while eliminating the need for active probing (and its overhead).

Access point selection based on link quality and load balancing

According to another embodiment, the mobile client 110 takes into account the link quality and load balancing of the backhaul wireless network 106 into an access point selection policy.

Specifically, there are three separate measurement components combined into the AP selection strategy, including:

Channel quality between the client 110 and each available AP;

If the client 110 attempts to access the external network 114, it is the performance of the backhaul path between the desired AP and the mesh gateway 102 in the wireless network 106, or if the client attempts to access another network entity in the wireless network 106. Is the performance of the backhaul path between the desired AP in the wireless network 106 and another access point; and

Information on the load characteristics of the wireless network 106.

An access point that has a more congested route to the gateway node should be given a lower priority by the AP selection policy, where the congestion route is not always reflected by the performance or quality parameters.

The following description assumes that the mobile client 110 seeks a network connection to the external network 114 through the edge gateway 102. The AP selection technique can be easily adapted to access an internal network entity in the wireless network 106.

In order to select an AP based on the performance and load characteristics of the backhaul wireless network 106, the client 110 is configured to estimate the channel conditions between itself and the available APs and the network performance in the mesh backhaul 106. In addition, client 110 collects the required information as efficiently as possible while introducing as little overhead as possible. The measurement process should not significantly affect network resources, nor cause excessive power consumption of client devices. On the other hand, in order to load balance network traffic and avoid congestion, the wireless network 106 itself facilitates the AP selection process, thereby improving overall network performance and utilization.

In one embodiment, the APs detected by the client 110 provide the client with link quality information reflecting their routing performance to the mesh gateway 102. In order to avoid the overhead of implementing the measurement framework, link quality metrics that can be obtained from the underlying routing protocol are used for this purpose. In addition, to avoid unbalanced load distribution and routing congestion, network load information is further integrated into the decision making process. These two factors are considered by each client 110 together with the channel quality of the client-to-AP link before making an AP selection decision. This approach is also supported by the new IEEE 802.11k draft, which is available at <http://www.ietf.org/rfc/rfc3626.txt>, which is hereby incorporated by reference in its entirety. In addition, for multi-radio multi-channel wireless mesh networks, the effects of channel diversity are also incorporated into the AP selection process.

As depicted in FIG. 1, after scanning and detecting an available AP using the AP scanning method, the new client 110B needs to be associated with one of several possible options for the AP. From the perspective of the end user, an AP that can provide the best end-to-end throughput or latency would be the best choice. However, from the perspective of network 106, it is also desirable to distribute network traffic (or load) across networks 106 to achieve better network utilization. To help the client make the right decision, the network 106 provides the client 110B with the necessary metrics, such as the throughput expected by the client, the load of the available backhaul path, and others. Based on these, client device 110B calculates a score associated with each AP that indicates a measure of expected performance that can be achieved if client 110B is associated with that AP. Client 110B then uses this score to rank each AP and associate with the best available AP.

In this embodiment, each AP only allows the client device to obtain the necessary network statistics and leave the final AP selection decision to the client. Unlike existing systems, in this embodiment network 106 does not provide association control, where network 106 does not determine which AP the client 110B can associate with, or forces client 110B to roam in order to search for a better AP.

The AP selection technology has the following characteristics:

Network-assisted AP selection: In a wireless network 106, typically a wireless mesh network, each client 110 needs to be aware of the condition of the mesh backhaul in order to make a reliable AP selection decision. Rather than having client 110 perform this end-to-end proactive exploration, this information is very expensive in terms of network resources and power consumption, but system 100 utilizes network 106 to provide the client with the necessary information.

Low overhead network monitoring: To reduce the overhead associated with measurements, the network 106 performs passive measurements to gather the necessary information. This information is then exchanged between the various mesh nodes or APs for distributed AP selection policies or reported to a centralized controller.

Load balancing in mesh backhaul: Several metrics such as estimated throughput, packet loss rate, and others are used to estimate the performance of the mesh backhaul. However, such metrics tend to favor APs with higher throughput, which results in uneven traffic distribution in the mesh network and reduces overall system performance. The AP selection techniques described herein incorporate some form of load balancing metric in the AP selection process.

Impact of hop count and channel diversity: In order to properly integrate the performance of the mesh backhaul into the AP selection process, the number of hops and the impact of channel diversity on user performance should be considered. The AP selection metrics described herein illustrate these two parameters.

According to another embodiment, when AP selection is performed, the new client 110B determines various metrics that indicate the connection performance and load characteristics of the backhaul wireless network 106. These metrics include channel quality metrics for the wireless link between the client and the AP, performance metrics for backhaul routing between the AP and the edge gateway, and load balancing metrics for the backhaul wireless network. Each of these metrics is further described below.

Channel quality between the client and the AP

This metric indicates the performance of the first wireless hop between the client device 110B and the mesh AP. In one embodiment, it is assumed that most of the traffic flows from the mesh AP to the client in the downlink direction. Thus, only the downlink channel quality from the AP to the client is estimated. Alternatively, both downlink and uplink channel quality can be considered.

In general, the link quality between the client 110B and the desired AP is measured by the estimated throughput

metric. In particular, consider the AP a with a set of clients U associated with it. Let $L_{a,u}$ be the load generated by each client $u \in U$ on AP a per unit time. If $R_{a,u}$ is the maximum transmission rate achieved by each client, the utilization of AP a is defined as:

$$\text{For all } u \in U, \mu_a = \sum (L_{a,u} / R_{a,u}).$$

This utilization is an estimate of the portion of the AP capacity used to serve existing clients. Thus, the remaining capacity is available to the new client 110B and can be used to estimate the downlink throughput between the AP and the client. If R indicates the transmission rate between the AP and the new client, the estimated downlink throughput is given by:

$$\text{Thr downlink} = (1 - \mu_a) \times R \quad (6)$$

During the scanning process, the corresponding AP makes this value available to client 110B.

Backhaul routing performance between AP and gateway

System 110 provides a network performance metric that indicates the performance of the client stream in mesh backhaul network 106. By combining this metric, system 100 considers a situation where even if the client-to-AP link is good, the route between the AP and the gateway node may suffer from poor link quality and thereby assign a lower priority to the corresponding AP.

Unlike existing strategies that rely on a measurement framework involving additional measurement and communication overhead that can adversely affect end user performance, system 100 utilizes an underlying routing protocol for wireless mesh network 106 that has employed some form of link quality estimation. For example, this metric can be an expected transmit count (ETX) metric in the Optimal Link Condition Routing Protocol (OLSR) available at <http://www.ietf.org/rfc/rfc3626.txt> or in the IEEE 802.11s standard. Recommended communication time metrics, which are hereby incorporated by reference in their entirety. When the network 106 exposes these metrics to the client 110, the client can utilize the wireless network 106 to estimate the performance of the backhaul path and incorporate it into the AP selection process.

In one embodiment, the wireless network 106 utilizes the OLSR routing protocol and exposes the ETX metrics to the client device 110. Each AP maintains a track of the cumulative path ETX value for its route to the gateway

node. In addition, in order to include channel diversity, the accumulated ETX is modified. As shown in FIG. 1, for path 116 through wireless network 106, the accumulated ETX is defined as follows:

Where N is the total number of hops on P and N_j is the number of different channels used by hops on path P . The score N/N_j acts as a weight assigned to each path. If two paths have the same number of hops, the path with better channel diversity will give a lower weight. This is because if multiple hops along a path are on the same channel, then only one hop can access the channel at the same time. Thus, even though individual links may have good ETX values, the effective throughput of that path will decrease. The cumulative ETX value of such a path is penalized with a larger weight. Alternatively, the wireless network 106 may use a routing protocol having metrics that already include channel diversity information, such as the title written by R. Draves et al. on pages 114-128 of the 2004 International Conference on Mobile Computing and Networks. The weighted cumulative expected transmission time (WCETT) described in the non-patent literature of "Routing in Multi-Radio, Multi-Hop Wireless Mesh Networks" is hereby incorporated by reference in its entirety.

Load characteristic metric

Different APs in the network 106 provide different hierarchical performance for the client 110. Existing systems that prefer APs that provide higher throughput paths for clients cause load imbalances in the mesh network. To avoid such load imbalances, system 100 uses node utilization as an indication of network load in wireless network 106. A bottleneck jump is estimated for a given path between the AP and the gateway 102.

Specifically, consider a mesh node (access point) m having n backhaul links. Let $L_{m,i}$ be the load generated by node m per unit time on link i , and $C_{m,i}$ is the maximum transmission capacity. Thus, the utilization of node m is defined as:

Depending on the current modulation rate of that node, $C_{m,i}$ is constant for each node. A priori values are calculated by performing a simple calibration experiment. $L_{m,i}$ is estimated by monitoring the total amount of data currently transmitted by the node. Each node in the wireless network 106 maintains a moving average of its respective utilization values with respect to time. Now, for a given path 116 through the wireless network 106, it is assumed that one of the k available channels is allocated for each hop. Thus, U_j is defined as:

$$U_j = \sum_{i=1}^k \mu_i$$

Jump i on channel j .

Thus, U_j is the sum of the utilization of all nodes on the same channel j on path 116. Thus, for path 116, we define bottleneck utilization as:

$$\text{For all } j \in (1 \dots k) \quad U_p = \max U_j \quad (8)$$

Thus, if different hops on a path use different channels, the hop with the highest utilization will be a bottleneck hop. However, if multiple hops on a path use the same channel, the transmissions on these hops will interfere with each other (except for very long hops). In this case, client 110 adds a single utilization of all hops on the same channel on the path. The path with the lowest bottleneck utilization U_p will give the highest preference as this will help achieve a more load balanced network.

AP selection score

Once the metric is determined, the client 110 combines the above three parameters into a single score, based on which the client can rank and make decisions for different APs. Each client 110 uses the following three ratings, which are associated with the three parameters to be measured.

Rank AP: For each AP detected by the client, the client assigns a rating to it based on the estimated downlink throughput from each AP. Assign the highest rating to APs that can provide maximum downlink throughput. The estimation of downlink throughput involves both the load on the AP and the current channel status or link quality (in terms of the transmission rate used). Thus, it provides an accurate estimate of the quality of the downlink channel.

Rank path: For each AP, the client 110 will also obtain the performance of the backhaul path from the AP to the mesh gateway. In this embodiment, this performance is based on the value of the modified ETX metric described in equation (7). By selecting the AP with the lowest cumulative path ETX value, client 110B effectively selects the AP with high throughput backhaul routing. This approach allows the client 110 to select backhaul performance parameters independently of the routing protocol. For example, if the underlying protocol uses some other link quality metric, such as the recommended communication time metric in the IEEE 802.11s protocol, then each AP can calculate the cumulative communication time required to transfer user traffic from the AP to the mesh gateway. And report it to the client 110.