

14.

A method according to any of the claims 1 to 12, characterized in that any radio cell having a much smaller coverage area than the macro cell comprises a public "pico cell", a residential femto cell, Or a Wifi access point that defines a small cell.

15.

A system comprising a database system, characterized in that the method of any one of claims 1-14 is implemented.



(12) 发明专利申请

(10) 申请公布号 CN 104854901 A

(43) 申请公布日 2015.08.19

(21) 申请号 201380063411.9

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(22) 申请日 2013.11.21

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(30) 优先权数据

12196130.4 2012.12.07 EP

(51) Int. Cl.

H04W 24/02(2006.01)

(85) PCT国际申请进入国家阶段日

H04W 84/04(2006.01)

2015.06.04

(86) PCT国际申请的申请数据

PCT/EP2013/074355 2013.11.21

(87) PCT国际申请的公布数据

W02014/086586 EN 2014.06.12

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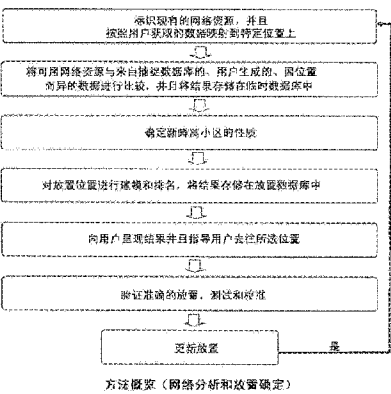
权利要求书2页 说明书12页 附图7页

(54) 发明名称

用于指导新的小型蜂窝小区的放置的方法

(57) 摘要

一种用于指导新的小型蜂窝小区的放置的方法,其中小型蜂窝小区是具有比宏蜂窝小区小得多的覆盖区域的无线电蜂窝小区站,包括一个或多个现有的无线蜂窝小区、具有已知位置和应用使用和上下文的一个或多个移动设备、处理器和数据库系统、新的小型蜂窝小区、用于指导用户放置新的小型蜂窝小区的设备,所述方法包括以下步骤:在数据库系统中随时间记录和存储取决于位置的测得网络特性和移动设备的取决于位置的上下文数据需求;数据库系统中的内容被用于确定可能将来的因位置而异的网络需求,以使得此信息连同新的小型蜂窝小区的特性一起被用于确定该新的小型蜂窝小区的放置坐标;以及使用该放置坐标、通过用于指导用户的设备来指导用户放置该新的小型蜂窝小区。



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1. 一种用于指导新的小型蜂窝小区的放置的方法, 其中小型蜂窝小区是具有比宏蜂窝小区小得多的覆盖区域的无线电蜂窝小区站, 包括一个或多个现有的无线蜂窝小区、具有已知位置和应用使用和上下文的一个或多个移动设备、处理器和数据库系统、新的小型蜂窝小区、用于指导用户放置新的小型蜂窝小区的设备, 所述方法包括以下步骤:

- 在数据库系统中随时记录 and 存储取决于位置的测得网络特性和移动设备的取决于位置的上下文数据需求;

- 所述数据库系统中的内容被用于确定可能将来的因位置而异的网络需求, 以使得此信息连同新的小型蜂窝小区的特性一起被用于确定所述新的小型蜂窝小区的放置坐标,

- 以及使用所述放置坐标、通过所述用于指导用户的设备来指导用户放置所述新的小型蜂窝小区。

2. 如权利要求 1 所述的方法, 其特征在于, 所述放置位置是通过以下操作来确定的:

- a) 在由用户在所述移动设备上执行的应用的上下文中确定所述移动设备的跨区域使用的因位置而异的需求,

- b) 跨此区域测量所述网络特性

其中信息 a) 和 b) 被用于建立映射, 所述映射示出现有的网络资源如何良好地满足因位置而异的上下文应用需求, 并且因此能够最佳地放置具有已定义特性的新蜂窝小区。

3. 如权利要求 2 所述的方法, 其特征在于, 所述方法包括:

- (a) 确定和表征所述移动设备的取决于位置的数据需求, 反映应用使用,

- (b) 确定特定位置处或者跨区域、尤其是跨所述新蜂窝小区的潜在影响区域的现有网络资源的可用性,

- (c) 在所述新蜂窝小区的至少容量、带宽、功率和等待时间方面表征所述新蜂窝小区,

- (d) 将 (a) 与 (b) 进行比较以确定取决于位置的上下文需求,

- (e) 将 (c) 与 (d) 进行比较并且计算结果以鉴于可能的位置地点确定所述新蜂窝小区的最佳位置, 以及最后

- (f) 指导运营商或用户放置所述新的小型蜂窝小区。

4. 如权利要求 3 所述的方法, 其特征在于, 迭代地、尤其是在放置了新蜂窝小区之后确定所述移动设备的跨区域使用的因位置而异的需求。

5. 如权利要求 1-4 中任一项所述的方法, 其特征在于, 所述移动设备的位置是通过使用由所述移动设备和 / 或网络采集的数据以确定用户位置的方式来确定的, 所述移动设备采集测量并且将所述测量传递给所述数据库系统,

和 / 或

在所述移动设备上使用 GPS (全球定位系统),

和 / 或

使用来自 CSR 的 SiRFusion 产品范围以使得能够通过将输出数据与数种不同的地理定位技术融合在一起来计算所述移动设备的位置, 所述地理定位技术包括三角测量或 GPS。

6. 如权利要求 1-5 中任一项所述的方法, 其特征在于, 所述应用和相关联的数据需求被存储在所述数据库系统中, 包括以下字段中的一个或多个: 应用的名称、协议类型、带宽、IP 分组丢失、传输的等待时间、QoS (服务质量)、QoE (体验质量)、收到的信号强度和方向、连通的蜂窝小区和上下文使用信息。

7. 如权利要求 1-6 中任一项所述的方法, 其特征在于, 在没有网络连接或者网络连接很少的情形中, 所述取决于位置的测得网络特性和所述移动设备的取决于位置的上下文数据需求被离线地记录和存储, 并且在较佳连接可用时被上传至所述数据库系统。

8. 如权利要求 1-7 中任一项所述的方法, 其特征在于, 所述用于指导的设备包括取向传感器, 所述取向传感器可以辅助小型蜂窝小区信息的采集和 / 或定位。

9. 如权利要求 1-8 中任一项所述的方法, 其特征在于, 在确定了所述移动设备的位置之后, 确定当前位置是否被视为新的小型蜂窝小区的经规划放置的潜在影响区域, 如果用户当前位置在所述潜在影响区域内, 则所述方法进行至确定小型蜂窝小区的位置。

10. 如权利要求 9 所述的方法, 其特征在于, 所述新的小型蜂窝小区的经规划放置的潜在影响区域是根据以下步骤中的一个或多个来确定的:

- 网络运营商或用户向所述数据库系统标记他们希望将所述小型蜂窝小区安装在要放置小型蜂窝小区的位置处;

基于随时间采集到的数据, 所述数据库系统提议要放置所述小型蜂窝小区的位置。

11. 如权利要求 1-10 中任一项所述的方法, 其特征在于, 所述用于指导用户的设备使用视觉、听觉或其他装置来指导用户去往所述位置。

12. 如权利要求 11 所述的方法, 其特征在于, 对用户的指导是使用包括以下的办法中的一个或多个来达成的:

(i) 若可用则使用建筑物测绘数据并且在地图上标绘期望位置并指引用户,

(ii) 使用无线指纹信息并使用基于文本 / 音频的命令来指导用户,

(iii) 检测期望位置附近其他连通设备的存在并且形成与它们的关联。

13. 如权利要求 1-12 中任一项所述的方法, 其特征在于, 在定位了所述新的小型蜂窝小区之后, 通过使用三角测量或其他位置估计技术并且测试和校准所述蜂窝小区以及优选向用户提供状态更新, 来监督准确的放置。

14. 如权利要求 1-12 中任一项所述的方法, 其特征在于, 具有比宏蜂窝小区小得多的覆盖区域的任何无线电蜂窝小区, 包括公共“微微蜂窝小区”、住宅毫微微蜂窝小区、或者 Wifi 接入点, 定义小型蜂窝小区。

15. 一种包括数据库系统的系统, 其特征在于实现如权利要求 1-14 中任一项所述的方法。

用于指导新的小型蜂窝小区的放置的方法

发明领域

[0001] 本发明涉及用于无线通信的小型蜂窝小区在建筑物或其他受限制区域内的定位。

[0002] 发明背景

[0003] 随着移动网络快速演进,广泛预测将有大量连通设备和相关联的蜂窝小区。除了常规的宏蜂窝小区之外,许多“小型蜂窝小区”将以低能量水平工作并且被设计成与紧邻的本地区域中的设备通信。在此文献中,小型蜂窝小区被定义为具有比常规的“宏”蜂窝小区小得多的覆盖区域的任何无线电蜂窝小区,包括公共“微微蜂窝小区”、住宅毫微微蜂窝小区、或者 WiFi 接入点。

[0004] 小型蜂窝小区的当前示例为毫微微蜂窝小区。毫微微蜂窝小区是通常使用被许可频谱的由消费者部署的便携式单元。与传统的基站不同,至无线通信网络的回程是经由消费者提供的分组数据 (IP) 连接 (例如,DSL 连接) 的而不是在第一代和第二代蜂窝系统中使用的专用或者租用线路的电路交换回程。由于被设计成用于室内覆盖,因而毫微微蜂窝小区无线电功率输出名义上在 0.5 瓦到 1 瓦的范围内。在第三代伙伴项目 (3GPP) 长期演进 (LTE) 或演进型 UTRAN (eUTRAN) 项目中,毫微微蜂窝小区亦被称为“家庭演进型 B 节点”。

[0005] 将小型蜂窝小区用作用于向无线通信网络添加覆盖和容量的低成本办法导致本发明的实施例试图解决的一些困难。便宜的小型无线电蜂窝小区的放置通常不能通过常规的蜂窝小区位置规划方法来实施。然而,小型蜂窝小区的位置极其重要,因为小型蜂窝小区的位置可能是对于具有特定数据需求 (高带宽、低等待时间等) 或者位于在用户与其他网络蜂窝小区之间造成具有挑战性的接收条件的建筑物中的移动用户而言是唯一可用的连接。不正确的位置可能对较宽网络的性能具有关键影响 (例如,在干扰的意义下),并且这对于成功的部署而言是要解决的关键问题。

[0006] 归因于有可能在将来的移动通信网络中使用的蜂窝小区类型的数目,这些移动通信网络具有不同的能力、支持不同的网络技术并且具有不同的带宽能力和应用需求的多样性,因而辅助小型蜂窝小区的放置是有利的,以使得最优地满足网络需求,并且还在网络资源的取决于其位置的使用的上下文中最优地满足用户需求。

[0007] 更多信息可以在“US2010120394(A1)——通过代理方法的毫微微蜂窝小区定位”中找到。

[0008] 当前的蜂窝小区位置规划方法一般不适于小型蜂窝小区的受指导放置 (这些小型蜂窝小区的放置可以由网络运营商或者消费者来承担),并且已在现有技术中发现的其他放置方法不考虑用户移动设备使用的上下文本质。因此,目前不存在允许以考虑因位置而异的应用需求的方式来对小型蜂窝小区进行消费者放置的放置方法或装置。

[0009] 具体限制包括:

[0010] (i) 小型蜂窝小区的放置应当与其中用户正在利用网络以及可从其他毗邻蜂窝小区获得的网络资源的上下文一致。例如,用户可能在特定位置中需要非常高带宽、低等待时间连接。高带宽、低等待时间连接可能仅在建筑物的一部分 (其具有来自新的宏蜂窝小区的良好覆盖) 中可用,但是建筑物的其他部分 (其仅具有来自先前生成蜂窝小区的覆盖)

可能与用户正常位置重合——这导致对相关的应用的效率的限制。显然,在该实例中,小型蜂窝小区应当被放置成满足用户的因上下文位置而异的需求,这是本发明的主题。换言之,蜂窝小区的位置必须考虑现有覆盖和用户的取决于位置的要求两者,而这两者是彼此独立的。因此,如果是用户所需要的,则取决于用户的需求,小型蜂窝小区可以与较差覆盖的区域重合,或者可以与可用的良好覆盖的区域重合(但是例如宏蜂窝网络的低容量)。

[0011] (ii) 虽然蜂窝小区位置规划或参与感测方法可以标识来自周围蜂窝小区的较低或较强信号强度的区域,但是已知的办法不考虑物体(诸如石壁)在应用需求的上下文中如何跨频率范围衰减信号。由于以范围从 GHz 到 THz 的不同频率操作的通信链路的部署,这对于高级移动通信网络而言有可能变得日益重要,其中这些通信链路可以是全向的或者是单向的(例如如果使用自适应波束成形)。如果在小型蜂窝小区的放置中不考虑这点,则可能产生次优的链路,因为该小型蜂窝小区的放置将不充分反映该区域中的其他蜂窝小区的位置和因位置而异的信号衰减。

[0012] US2010120394 (A1)——通过代理方法的毫微微蜂窝小区定位

[0013] 由消费者部署的小型毫微微蜂窝小区的位置不能通过通常的站点调查方法来确定。所附连的移动台的位置允许毫微微蜂窝小区的代理位置,该代理位置可随后用于无线网络规划,包括:为毫微微蜂窝小区提供所计算出的默认紧急服务位置。

[0014] 该文献公开了一种由无线定位系统(WLS)用来定位在无线通信系统中操作的毫微微蜂窝小区设备的方法,包括:

[0015] 发现和发起毫微微蜂窝小区设备的位置;确定由该毫微微蜂窝小区设备服务的移动站(MS)的标识;确定MS的位置;以及使用MS的位置来确定毫微微蜂窝小区设备的位置。

[0016] 因此,公开了使用基于移动站的位置的代理方法来确定消费者部署的毫微微蜂窝小区的位置。

[0017] US2008151777 (A1)——用于核心网拓扑路由器放置规划的系统和方法

[0018] 提供了用于核心网拓扑路由器放置规划的系统和方法。这些系统和方法可以使用现有的网络数据来创建数据集并且使用该数据集来针对路由器的放置优化网络。

[0019] 1. 一种方法,包括:

[0020] 标识网络拓扑;从该网络拓扑计算电路位置;从该网络拓扑和该电路位置创建数据集;以及求解该数据集以确定指示该网络拓扑中的一个或多个路由器的所提议放置的至少一个输出。

[0021] 概述:使用网络拓扑来计算放置位置

[0022] US2008279552 (A1)——用于在网络中放置可重新配置的光学添加/丢弃复用器(ROADMS)的方法

[0023] 可以通过包括模拟分布式网络中的数据话务的路由的方法来设计包括至少两个可重新配置的光学添加/丢弃复用器(ROADMs)的分布式网络。该方法还可以包括至少部分地基于所模拟的数据话务的路由来标识用于放置第一ROADM的第一位置。该方法还可以包括模拟包括第一位置处的第一ROADM在内的分布式网络中的数据话务的重新路由。该方法可以进一步包括至少部分地基于所模拟的数据话务的重新路由来标识用于放置第二ROADM的第二位置。

[0024] 该文献公开了一种方法,包括:

[0025] 至少部分地基于分布式网络中的数据话务的初始模拟路由来标识多个候选位置；

[0026] 至少部分地基于成本来选择该多个候选位置中的至少一个候选位置以用于放置可重新配置的光学添加 / 丢弃复用器 (ROADM)；以及

[0027] 模拟包括该至少一个所选择的候选位置处的该至少一个 ROADM 在内的分布式网络中的数据话务的重新路由。

[0028] 该文献使用路由数据的模拟来辅助复用器的放置。

[0029] WO02071781 (A1)——用于蜂窝移动网络中的蜂窝小区站点位置的方法

[0030] 通过包括以下步骤的方法来标识固定的发射蜂窝小区站点在蜂窝移动电话网络中的位置：借助移动测试电话来推导网络的调查数据测量；将在驾驶路线上推导出的调查数据测量编组到个体子集中；借助多个三角测量计算来标识关于发射蜂窝小区站点位置的第一站点群集数据和第二站点群集数据，其中在三角测量计算中，每个个体点关于测试电话的接收机的地理位置数据与每个其他的个体点配对以在每一情形中提供一对位置，其与发射蜂窝小区站点位置的距离是从相应的定时提前数据来确定的；以及确定第一站点和第二站点群集数据中的哪一个具有最大的群集密度并且将该站点的重心确定为标识固定的发射蜂窝小区站点的位置。调查数据测量包括测试电话的接收机的地理位置数据；提供固定的发射蜂窝小区站点与测试电话的接收机之间的距离的定时提前数据；以及蜂窝小区身份字段数据。调查数据测量的每个子集对应于属于同一固定的发射蜂窝小区站点的测量。

[0031] 该文献公开了一种用于标识固定的发射蜂窝小区站点在蜂窝移动电话网络中的位置的方法，包括以下步骤：借助移动测试电话来推导网络的调查数据测量，该调查数据测量包括：测试电话的接收机的地理位置数据；提供固定的发射蜂窝小区站点与测试电话的接收机之间的距离的定时提前数据；以及蜂窝小区身份字段数据；将在驾驶路线上推导出的调查数据测量编组到个体子集中，其中每个子集对应于属于同一固定的发射蜂窝小区站点的测量；借助多个三角测量计算来标识关于发射蜂窝小区站点位置的第一站点群集数据和第二站点群集数据，其中在三角测量计算中，每个个体点关于测试电话的接收机的地理位置数据与每个其他的个体点配对以在每一情形中提供一对位置，其与发射蜂窝小区站点位置的距离是从相应的定时提前数据来确定的；以及确定第一站点和第二站点群集数据中的哪一个具有最大的群集密度并且将该站点的重心确定为标识固定的发射蜂窝小区站点的位置。

[0032] 该文献使用站点调查数据作为用于在蜂窝网络内定位蜂窝小区的方法的一部分。

[0033] US2010309790 (A1)——毫微微基站以及用于操作毫微微基站的方法

[0034] 本文中描述的毫微微基站和方法抑制对外部 GPS 天线和电缆的需要，而同时仍然向网络服务供应商提供获得期望的 GPS 位置坐标的能力，并且向用户提供在家庭内在其选择的位置处放置毫微微蜂窝小区而不管 GPS 信号强度如何的灵活性。

[0035] 该美国申请包括一种用于在无线网络中操作毫微微基站的方法，该方法包括：

[0036] 在毫微微基站处决定位置信息信号是否可用；

[0037] 在毫微微基站处确定存储在毫微微基站处的存储器中的锚位置信息是否有效，如果决定步骤决定位置信息信号不可用，则锚位置信息指示毫微微基站的锚位置；以及

[0038] 如果确定步骤确定所存储的锚位置信息是有效的，则标识毫微微基站的网络配置

参数。

发明内容

[0039] 本发明被呈现为一种用于基于可能的覆盖、使用的上下文、以及现有无线网络连接的容量和位置来指导移动网络运营商或用户放置小型蜂窝小区的方式。

[0040] 本发明包括一种用于指导新的小型蜂窝小区的放置的方法，其中小型蜂窝小区是具有比宏蜂窝小区小得多的覆盖区域的无线电蜂窝小区站，包括一个或多个现有的无线蜂窝小区、具有已知位置和应用使用和上下文的一个或多个移动设备、处理器和数据库系统、新的小型蜂窝小区、用于指导用户放置新的小型蜂窝小区的设备，所述方法包括以下步骤：

[0041] - 在数据库系统中随时间记录和存储取决于位置的测得网络特性和移动设备的取决于位置的上下文数据需求；

[0042] - 数据库系统中的内容被用于确定可能将来的因位置而异的网络需求，以使得此信息连同新的小型蜂窝小区的特性一起被用于确定该新的小型蜂窝小区的放置坐标，

[0043] - 以及使用该放置坐标、通过用于指导用户的设备来指导用户放置该新的小型蜂窝小区。

[0044] 在此上下文中，具有比宏蜂窝小区小的覆盖区域的任何无线电蜂窝小区或接入点定义小型蜂窝小区。因此，小型蜂窝小区可以是公共的“微微蜂窝小区”、住宅毫微微蜂窝小区、WiFi 接入点或者其中输出功率比宏蜂窝小区低的收发机被部署为通信网络的一部分的任何其他布置。

[0045] 在一优选实施例中，数据库系统是位于因特网或者用户的本地网络中的服务器，并且从应当被优化的网络中的蜂窝小区、移动设备和其他网络组件接收信息。例如，在智能电话上运行一应用，该应用传送其位置、取向、正在运行的应用以及带宽或响应时间需求。此外，现有的蜂窝小区还可以传送连接质量、带宽、丢失的分组数目、协议类型等。扫描网络的其他设备也可以被用于采集导入到数据库系统中的数据。此信息随后被存储在数据库系统中作为一系列字段和记录，这些字段和记录包括用于采集此信息的数据库文件。

[0046] 在一优选实施例中，放置位置是通过以下操作来确定的：

[0047] a) 在由用户在移动设备上执行的应用的上下文中确定移动设备的跨区域使用的因位置而异的需求，

[0048] b) 跨此区域测量网络特性

[0049] 其中信息 a) 和 b) 被用于建立映射，该映射示出现有的网络资源如何良好地满足因位置而异的上下文应用需求并且因此可以最佳地放置具有已定义特性的新蜂窝小区。

[0050] 位置信息还可以结合至移动设备的蜂窝小区的连接状态的传送来使用。该设备可以向数据库服务器通知其位置以及检测到的基站。

[0051] 在一优选实施例中，该方法

[0052] (a) 确定和表征移动设备的取决于位置的数据需求，这些数据需求反映移动设备的应用使用和应用需求。这可以包括例如响应时间、数据传输带宽、丢失的分组、分组的等待时间等。

[0053] (b) 确定特定位置处或者跨区域、尤其是跨新蜂窝小区的潜在影响区域的现有网

络资源的可用性。这是通过分析数据库系统的数据库或者通过采集移动设备的提供至蜂窝小区的连接状态的信息、或者通过手动输入来达成的。

[0054] (c) 在新蜂窝小区的至少容量、带宽、功率和等待时间方面表征该新蜂窝小区。在此实例中,假定该表征将针对预先存在的蜂窝小区。然而,其他实施例可以表征被要求确定应当获取的特定蜂窝小区类型的新蜂窝小区。

[0055] (d) 将 (a) 与 (b) 进行比较以确定网络的取决于位置的上下文需求。这是为地理坐标来计算的,该地理坐标表示新蜂窝小区要被放置于其中(建筑物、办公室、酒店等内)的已定义边界区域。例如,如果建筑物具有多个楼层,则该地理坐标可以是二维或三维的。在一些实施例中,安装若干蜂窝小区以符合用户的需求可能是必需的。

[0056] (e) 将 (c) 与 (d) 进行比较以及计算结果以鉴于可能的位置地点确定新蜂窝小区的最佳位置。新蜂窝小区的最佳位置是通过 (i) 检索来自 (d) 的对网络数据的取决于位置的上下文需求来计算的。这提供了网络连接需求(带宽、等待时间等)相对于特定的位置坐标的映射。(ii) 在边界区域内的多个位置处模拟在 (c) 中表征的新蜂窝小区,并且 (d) 优化算法被用于标识其中应当放置新蜂窝小区以最优地满足网络需求的 X、Y(可任选的 Z) 坐标。

[0057] 替换地,如果新的小型蜂窝小区是蜂窝小区(与无线接入点不同),则可以按无线蜂窝小区或无线接入点最优地交叠的方式来进行计算。最优位置可以通过模拟或者通过其他优化规程来计算。

[0058] (f) 指导运营商或用户放置新的小型蜂窝小区。

[0059] 在一优选实施例中,迭代地、尤其是在放置了新蜂窝小区之后确定移动设备的跨区域使用的因位置而异的需求。通过这个办法,可以执行新蜂窝小区的成功且可能的重定位。

[0060] 在一优选实施例中,通过将由移动设备和/或网络采集的数据用于确定用户位置来确定移动设备的位置,移动设备采集测量并且将这些测量传递给数据库系统,和/或在移动设备上使用 GPS(全球定位系统),和/或使用来自 CSR 的 SiRFusion 产品范围,以使得能够通过将输出数据与数种不同的地理定位技术(包括三角测量或 GPS)融合在一起来计算移动设备的位置。

[0061] 在一优选实施例中,应用和相关联的数据需求被存储在数据库系统中,包括以下字段中的一个或多个:应用的名称、协议类型、带宽、IP 分组丢失、传输的等待时间、QoS(服务质量)、QoE(体验质量)、收到信号强度和方向、连通的蜂窝小区以及上下文使用信息。

[0062] 该信息由在移动设备上运行的应用采集,并且在后台通过网络自动地传输至数据库系统。在一优选实施例中,该应用是安装在智能电话上的 app。网络站也可以提供该信息。该信息优选仅在移动设备位于其中应当安装新的小型蜂窝小区的区域内时才被采集。

[0063] 在一优选实施例中,确定当前位置是否被视为新的小型蜂窝小区的经规划放置的潜在影响区域,如果用户当前位置位于潜在影响区域内,则该方法行进至确定小型蜂窝小区的位置。这意味着仅在相关区域的情形中才执行该方法。

[0064] 新的小型蜂窝小区的经规划放置的潜在影响区域是根据以下步骤中的一个或多个来确定的:网络运营商或用户向数据库系统标记他们希望将该小型蜂窝小区安装在要放

置小型蜂窝小区的位置处；基于随时间采集到的数据，数据库系统提议要放置该小型蜂窝小区的位置。

[0065] 在没有网络连接或者网络连接很少的情形中，取决于位置的测得网络特性和移动设备的取决于位置的上下文数据需求被离线地记录和存储，并且在较佳连接可用时被上传至数据库系统。

[0066] 在一优选实施例中，用于指导的设备包括取向传感器，该取向传感器辅助小型蜂窝小区信息的采集和/或定位。在一优选实施例中，在移动设备或智能电话上运行的应用可以实现用于指导的设备。特别是智能电话包括位置传感器，该位置传感器可被用于指导用户去往新的小型蜂窝小区的最优位置。

[0067] 用于指导用户的设备使用视觉、听觉或其他手段来指导用户去往该位置。

[0068] 对用户的这种指导可以使用以下办法中的一个或多个来达成，包括：

[0069] (i) 使用建筑物测绘数据（若可用）并且在地图上标绘期望位置来指引用户，

[0070] (ii) 使用无线指纹信息并使用基于文本/音频的命令来指导用户，

[0071] (iii) 检测期望位置附近其他连通设备的存在并且形成与它们的关联。

[0072] 在定位了新的小型蜂窝小区之后，通过使用三角测量或其他位置估计技术并且测试和校准该蜂窝小区以及优选向用户提供状态更新来监督准确的放置。

[0073] 本发明的另一部分是一种包括数据库系统的系统，其特征在于实现权利要求 1 到 14 之一所述的方法。

[0074] 与每个区别技术特征有关的本发明的优点如下：

[0075] 本发明可以确定和表征移动设备的取决于位置的数据需求，反映应用使用。这种办法允许表征至特定位置的通信链路所需要的性质。

[0076] 本发明可以确定特定位置处或者跨区域（“新蜂窝小区的潜在影响区域”）的现有网络资源的可用性。这种办法允许找到可能已经连接至一位置的链路的性质。

[0077] (a) 本发明可以在新蜂窝小区的至少容量、带宽、功率和等待时间方面表征该新蜂窝小区。这种办法允许确定要放置的新蜂窝小区的性质。

[0078] (b) 本发明可以将 (a) 与 (b) 进行比较以确定取决于位置的上下文需求。这种办法允许计算所需要的资源。

[0079] (c) 本发明可以将 (c) 与 (d) 进行比较并且计算结果以鉴于可能的位置地点确定新蜂窝小区的最佳位置。这种办法允许确定所要求的用于放置的位置。

[0080] (d) 本发明可以指导运营商或用户放置蜂窝小区。这种办法允许新蜂窝小区的最优定位。

附图说明

[0081] 图 1 示出移动设备架构。

[0082] 图 2 示出示例网络处理器架构。

[0083] 图 3 示出方法的流程图。

[0084] 图 4 示出移动设备上的方法的流程图。

[0085] 图 5 和 6 示出在该方法之前和之后小型蜂窝小区在公寓内的位置。

[0086] 图 7 示出具有新站点位置的示例性推导的移动网络情景。

具体实施方式

[0087] 良好的放置位置可以通过以下操作来确定：

[0088] (i)a) 确定在由用户执行的应用的上下文中移动设备的跨区域使用的因位置而异的需求（例如，实时流送视频具有截然不同的文件下载需求），

[0089] (ii) 跨此区域测量网络特性。

[0090] 此信息 (i 和 ii) 允许建立映射，该映射示出现有的网络资源如何良好地满足因位置而异的上下文应用需求并且因此可以最佳地放置（具有已定义特性）的新蜂窝小区。

[0091] 通常基于预测和 / 或感测信号强度、使用网络映射和表征数据以及容量规划工具的现有的蜂窝小区位置规划办法不考虑用户的因位置而异的使用上下文。随着用户数据和应用使用的演进，这将变得日益重要。例如，在等待时间和带宽方面，对所流送的 YouTube UHD 视频的数据需求与 Skype 实时视频链接非常不同。部分地由于（将纳入旧式网络资源的）高级通信网络下大量的蜂窝小区和可能的链路，可以预想在现有网络资源（诸如宏蜂窝小区）可以满足一些应用的数据需求时，其他应用的数据需求（由于带宽或等待时间需求）特别是在还考虑容量约束的情况下可能不能得到满足。

[0092] 因此，本发明的负责优点的关键要素为对由用户在不同位置中执行的应用及其各自的数据需求的迭代发现，并且关于可能已在用户位置处可用的现有网络资源来考虑这些需求。这是使用上下文的一个示例，但是显然可以有其他示例。

[0093] (i) 确定因位置而异的应用需求。在假定移动设备在蜂窝小区的范围内的情况下，这可以通过使用由移动设备和 / 或网络采集的数据来求解。为了确定用户位置，移动设备采集（例如，接收自邻近的基站的信号的相对定时的）测量并且将它们传递给网络，该网络随后计算移动设备的位置并且将该位置传递给外部应用服务器。替换地，诸设备（诸如来自 CSR 的 SiRFusion 产品范围）允许通过将输出数据与数种不同的地理定位技术（包括三角测量或 GPS）融合在一起来计算移动设备的位置。在确定了移动设备的位置之后，这可以与时变应用使用相关。一旦表征了位置和应用以及相关的数据需求，就可以将结果得到的数据传达给在其中存储该数据以供未来使用的服务器。由于这些步骤与新蜂窝小区的放置相关联，因而可能的情形是，在其潜在位置的区域中，没有现有蜂窝小区的覆盖或者现有蜂窝小区的覆盖很少，这意味着不能执行期望的应用。结果，这些数据将不通过以上步骤来记录。在此实例中，可以采纳以下办法：(i) 通过跟踪用户移动设备位置来理解哪些用户进入了新蜂窝小区的潜在影响区域（若必要，则这可以通过存储历史位置并且在连接变得可用时上传这些历史位置来“离线地”达成）。描绘在新蜂窝小区的潜在影响区域中的一个或多个用户，以确定他们在其他区域中的可以合理地预期延及新蜂窝小区的潜在影响区域的历史应用使用。（这可以例如通过交叉引用所有物的地理位置来确定其类型（家庭、办公室、站等）并且随后使用该类型来表征与用户已访问的相同类型的其他位置相比这些用户在此位置的可能使用来达成）。

[0094] (ii) 确定可能已经可用的网络资源。类似于 (i)，这可以通过采用使用移动设备的参与感测办法或者 (ii) 通过已使用站点调查或其他现有方法开发出的现有网络模型来确定。

[0095] 因此，本发明的一些区别技术特征在于，

[0096] (a) 确定和表征移动设备的取决于位置的数据需求,这些数据需求反映应用使用,并且如所需要的那样重复。

[0097] (b) 确定特定位置处或者跨区域(“跨新蜂窝小区的潜在影响的区域”)的现有网络资源的可用性,

[0098] (c) 在新蜂窝小区的至少容量、带宽、功率和等待时间方面表征该新蜂窝小区,

[0099] (d) 将(a)与(b)进行比较以确定取决于位置的上下文需求,

[0100] (e) 将(c)与(d)进行比较并且计算结果以鉴于可能的位置地点确定新蜂窝小区的最佳位置,以及最后(f)指导运营商或用户放置新的小型蜂窝小区。

[0101] 应用注意,本发明具有大量可能的实施例,说明书不旨在限制此范围。本文给出一个可能的实施例并且使用基于移动设备的实现。未解说其他可能的实施例,例如使用基于网络的实现(以上提到了其中的一些实现)。

[0102] 所描述的系统可以在移动设备上实现的功能(其中这些功能的结果被传达给基于网络的处理系统/数据库系统)与本身在基于网络的处理系统(该处理系统可以例如形成网络架构的一部分)上实现的功能之间进行划分。图1中示出示例移动设备架构的概览,并且图2中示出(涉及与本发明有关的)示例网络架构。

[0103] 图1表示包括用于确定其在建筑物内部和外部的位置的装置的移动设备。还可以包括其他传感器以例如确定其取向,这可以辅助蜂窝小区放置信息的采集。还纳入了显示装置,并且附加地还可包括其他输出设备以帮助将用户指引至蜂窝小区放置地点。例如,这些设备可以包括触觉设备、或者听觉指令。

[0104] 图2表示示例网络处理器架构/数据库系统。由移动设备采集的数据被写入到由处理器控制的三个数据库之一,该处理器能够访问本地存储器以及允许其至移动设备的通信的接口。

[0105] 在网络处理器和移动设备架构中的每一者上实现方法。以下给出由图4表示的用于移动设备架构的方法。

[0106] 第一步骤使用已知的各种地理定位技术之一来确定移动设备的位置,诸如如果移动设备在建筑物的外部则使用GPS,或者如果移动设备在建筑物的内部则使用三角测量和诸如(例如在来自CSR的SiRFusion设备上实现的)惯性估计之类的其他技术的组合。

[0107] 因此,输入是用户的物理位置,并且输出使用户坐标的数字表示。

[0108] 第二步骤将用户当前位置与被视为新的小型蜂窝小区的经规划放置的“潜在影响区域”作比较。如果用户当前位置在潜在影响区域内,则该方法继续,否则返回到开始。

[0109] 新的小型蜂窝小区的经规划放置的潜在影响区域可以如下确定:

[0110] - 网络运营商或用户向系统标记他们希望安装小型蜂窝小区

[0111] - 网络运营商或用户指示他们何时在要放置该蜂窝小区的位置(例如,建筑物中)

[0112] - 该区域随后被定义为潜在影响区域。

[0113] 替换地,移动设备方法可以在允许在一段时间上针对所有位置采集数据以得到最佳结果的所有已定义移动设备上执行,或者产生相似结果的等效办法可以在网络资源上执行(然而,应当注意,这可能具有相关联的用户隐私问题)。如果采取这种办法,则可以删除第二步骤。

[0114] 因此,输入是用户位置和潜在干扰区域定义,并且输出继续返回到开始循环。

[0115] 第三步骤确定用户位置处的连接的性质,并且可以包括诸如 QoS(服务质量)、QoE(体验质量)、收到信号强度和方向、连通的蜂窝小区和上下文使用信息之类的参数。

[0116] 特别注意:由于这个步骤与新蜂窝小区的放置相关联,因而可能的情形是,在其潜在位置的区域中,没有现有蜂窝小区的覆盖或者现有蜂窝小区的覆盖很少,这意味着不能执行期望的应用。结果,它们将不被记录。在此实例中,可以采纳以下办法:(i) 通过跟踪用户移动设备位置来理解哪些用户进入了新蜂窝小区的潜在影响区域(若必要,则这可以通过存储历史位置并且在连接变得可用时上传这些历史位置来“离线地”达成)。

[0117] (ii) 描绘在新蜂窝小区的潜在影响区域中的一个或多个用户以确定他们在其他区域中的可以合理地预期延及至新蜂窝小区的潜在影响区域的历史应用使用。(这可以例如通过交叉引用所有物的地理位置来确定其类型(家庭、办公室、站等)并且随后使用该类型来表征与用户已访问的相同类型的其他位置相比这些用户在此位置的可能使用来达成)。

[0118] 因此,输入是用户位置,并且输出是用上下文连接性质作标记的用户位置。

[0119] 第四步骤将用上下文连接性质作标记的用户位置传达给网络处理系统,并且将其记录为捕捉数据库中的记录。

[0120] 因此,输入是用上下文连接性质作标记的用户位置,并且输出是存储在捕捉数据库中的记录。

[0121] 在用于移动设备架构的方法之后,以下给出由图 3 表示的用于网络架构的方法。

[0122] 第一步骤通过利用可从移动网络运营商获取的关于宏网络的知识(站点位置、可用技术、技术参数……)来标识潜在影响区域的现有网络资源,并且将此数据加载到本地存储器中。

[0123] 因此,输入是新蜂窝小区放置的潜在影响区域,并且输出是跨潜在影响区域的现有网络资源的性质。

[0124] 第二步骤将来自步骤 1 的输出与捕捉数据库的内容作比较。实际上,这是将可用网络资源与所要求的资源作比较。计算差异并且将该差异存储为临时数据库中的表示。

[0125] 因此,输入是捕捉数据库、现有网络的性质,并且输出是现有网络资源与在给定移动设备的因位置而异的上下文使用的情况下最优地需要的那些资源之间的差异。

[0126] 第三步骤直接或间接地确定新的小型蜂窝小区的性质,并且将这些性质存储在本地存储器中。

[0127] 因此,输入是产品参考码(例如),并且输出是蜂窝小区/接入点性质。

[0128] 第四步骤使用来自临时数据库的信息来对新蜂窝小区的影响建模,并且计算将(为用户、网络运营商等)达成期望的放置特性的蜂窝小区的放置位置。期望地,此时还应当考虑反映建筑物结构的测绘数据,以便确保能以功率可用性等来达到放置位置。可能的放置位置可被排名,并且存储在放置数据库中。

[0129] 因此,输入是新蜂窝小区信息、因位置和上下文而异的网络需求(临时数据库),并且输出是经排名的放置位置。

[0130] 第五步骤向用户呈现结果并且使用视觉、听觉或其他装置来指导用户去往该位置。可以通过使用数种办法来达成用户指导,包括(i) 使用建筑物测绘数据(若可用)并且在地图上标绘期望位置来指导用户,(ii) 使用(来自 wifi 等的)无线指纹信息并且使用

基于文本 / 音频的命令来指导用户, (iii) 检测期望位置附近其他连通设备的存在并且与它们形成关联, 这可以例如导致通知用户将消费者蜂窝小区放置到“HP8500 打印机”旁边。

[0131] 因此, 输入是经排名的放置结果, 并且输出是用于定位放置位置的用户指令。

[0132] 第六步骤通过使用三角测量或其他位置估计技术来验证准确的地点并且测试和校准蜂窝小区, 以及向用户提供状态更新。

[0133] 因此, 输入是蜂窝小区放置位置, 并且输出是状态更新。

[0134] 最后一个步骤是在网络或用户要求已改变时或者在蜂窝小区的物理位置被用户任意地改变的情况下对要被更新的位置预作安排。

[0135] 因此, 输入是可能的变化, 并且输出是过程的迭代。

[0136] 以下将描述一使用情形。

[0137] 在第一步骤中, 捕捉信息。如图 5 中可见, 建筑物被宏蜂窝基站 BS1 覆盖。大多数用户体验到良好的覆盖, 然而, 被厚墙部分地阻挡的会议室遭受高水平的信号衰减。因此, 希望运行要求较高的应用 (与要求较低的语音呼叫不同) 的用户 (例如, UE1) 经受非常差的 QoE。这被捕捉并且被存储在捕捉数据库中, 并且还反映在临时数据库中。

[0138] 在第二步骤中, 确定新蜂窝小区的放置。如图 6 中可见, 新的小型蜂窝小区 BS2 被放置在其中位于会议室中的 UE1 经受较小的信号衰减的位置中。该蜂窝小区是作为已被执行的计算的结果而被放置在此位置中的, 其中经排名的结果被存储在放置数据库中。作为 (使用上下文应用信息来定位的) 新蜂窝小区的最优放置的结果, 可以达成 UE1 的较高水平的 QoE 以及其他网络优点。

[0139] 以下提供附加详情:

[0140]

现场传入数据			
地理位置 (设备)	诸位置处的可能服务	所使用的服务	无线电规划信息 (例如, 平均 SNR)
位置1 (UE1)	HTTP、视频呼叫、视频	HTTP、视频呼叫、视频	1 dB
位置2 (UE2)	HTTP、视频呼叫、视频	HTTP、视频呼叫、视频	10 dB
位置3 (UE3)	HTTP、视频呼叫、视频	HTTP	11 dB
位置4 (UE4)	HTTP、视频呼叫、视频	HTTP	7 dB

[0141]

数据库/统计数据/历史			
地理位置	成功使用的服务	不成功使用的服务	无线电规划信息 (例如, 平均 SINR)
位置1 (UE1)	3x HTTP, 4x 视频	4x 视频呼叫	1dB
位置2 (UE2)	2x 视频呼叫, 2x 视频	无	10dB
位置3 (UE3)	3 x HTTP	无	11dB
位置4 (UE4)	3x HTTP	无	7dB

[0142] 新站点的推导

[0143] 在位置 1 处发生由用户 (UE1) 在位置 1 处要求的服务不成功的概率较高较差的 SINR(4 种情形中的一种)

[0144] 基于在位置 1 处标识的需求、以及包括功率接入、固定线路可用性、评价位置和建筑物规划的站点信息来推导新站点

[0145] 图 7 中描述了另一使用情形。

[0146] 解说了具有通常由六边形表示的理想覆盖区域的两个基站。BS1 服务 3 个终端 (UE5、UE6、UE7) 并且 BS2 服务 4 个终端 (UE1、UE2、UE3、UE4)。虽然 BS1 中所指派的终端正经历良好的链路质量 (例如, UE5 具有 10dB SINR), 但是 BS2 处的 4 个终端中的 3 个终端由于其出现在网络中的蜂窝小区边缘处或者蜂窝小区边缘处的室内而具有较差的链路质量 (例如, UE1 具有 0dB SINR)。

[0147] 每个终端正使用服务并且需要一定量的无线电资源来获得令人满意的体验质量。如果例如住在所描绘的房屋内的用户在尝试进行视频呼叫时总是经历较差的质量, 则他将有可能在一会儿之后不再次尝试。在该示例中, 出现在蜂窝小区边缘或室内的终端使用 http 服务。另外, 具有良好无线电链路的 UE4 由于蜂窝小区可能过载的问题而仅能够使用令人满意的 http 服务。这可能来自其他受服务终端由于较差的无线电链路而需要较大数量的资源来满足所使用的服务的要求的问题。每个单个用户的信息被存储在中央数据库中, 该中央数据库采集每个所出现位置的统计数据。这将导致巨量数据, 所需要的新站点位置的定位可以基于这些数据来推导。在该示例中示出在 7 个位置中的 4 个位置中成功地使用了 http 服务。在那 7 个位置中的 3 个位置中已出现较差的 SINR。因此, 在位置 1、2 和 3 处, 不会以良好的体验来使用具有较高质量要求的任何服务另外, 在这些位置处, 无线电链路条件较差。基于这些位置的组合信息, 可以推导出新站点位置 (例如, 那 3 个位置的平均位置或者满足附加要求 (诸如固定的线路和功率接入) 的附近位置)。

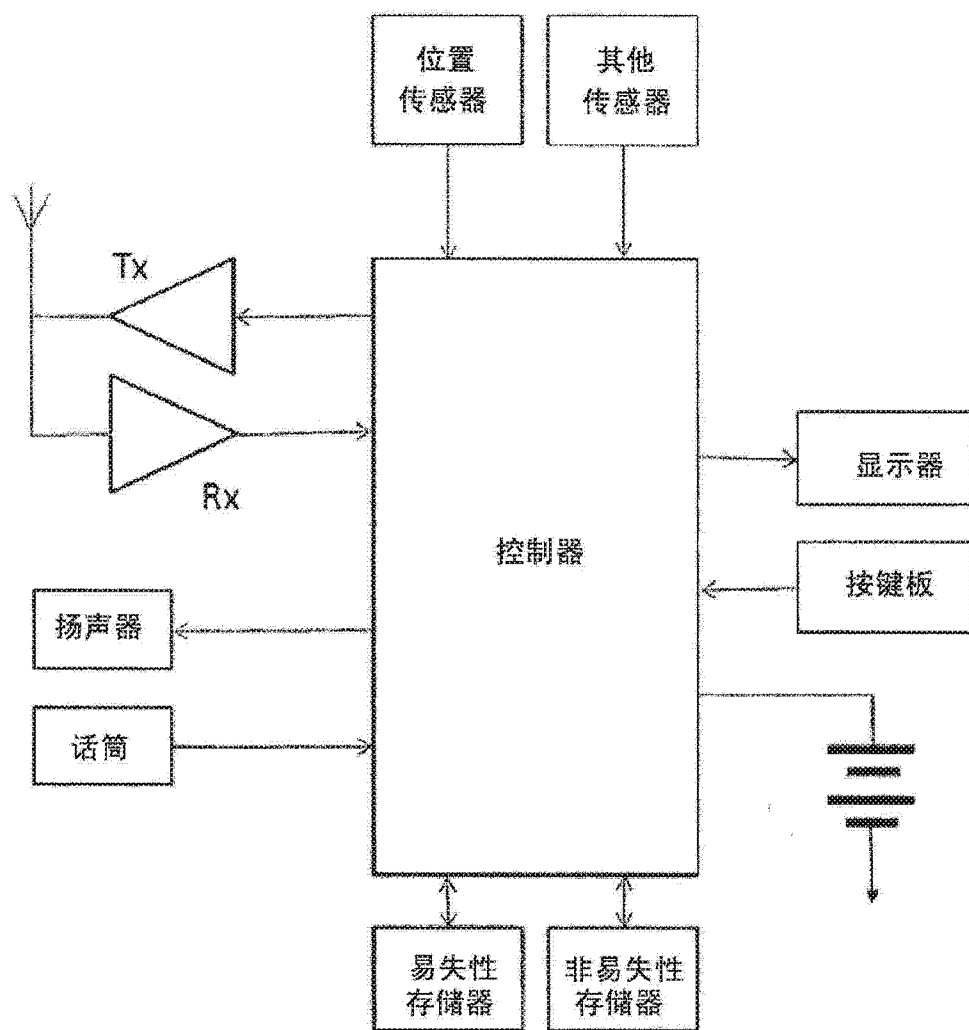
现有技术

[0148] [1]US2010120394(A1) ——通过代理方法的毫微微蜂窝小区定位

[0149] [2]*背景技术文本基于来自“US2010120394(A1) ——通过代理方法的毫微微蜂窝

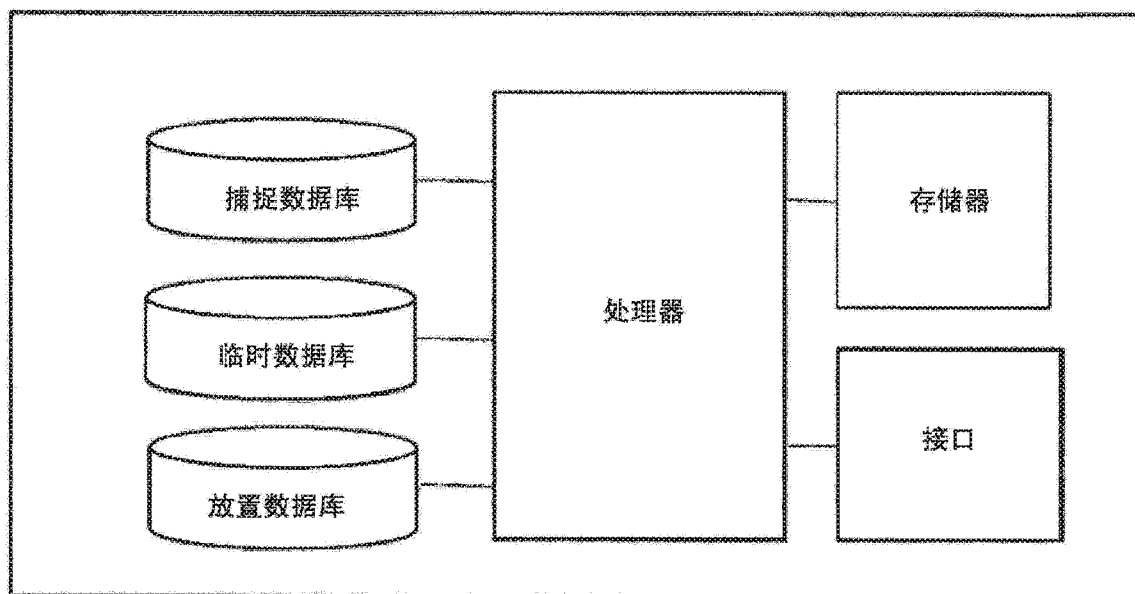
小区定位”的摘录

- [0150] [3]US2010120394(A1)——通过代理方法的毫微微蜂窝小区定位
- [0151] [4]US2008151777(A1)——用于核心网拓扑路由器放置规划的系统和方法
- [0152] [5]US2008279552(A1)——用于在网络中放置可重新配置的光学添加 / 丢弃复用器 (ROADMS) 的方法
- [0153] [6]W002071781(A1)——用于蜂窝移动网络中的蜂窝小区站点位置的方法
- [0154] [7]US2010309790(A1)——毫微微基站以及用于操作毫微微基站的方法



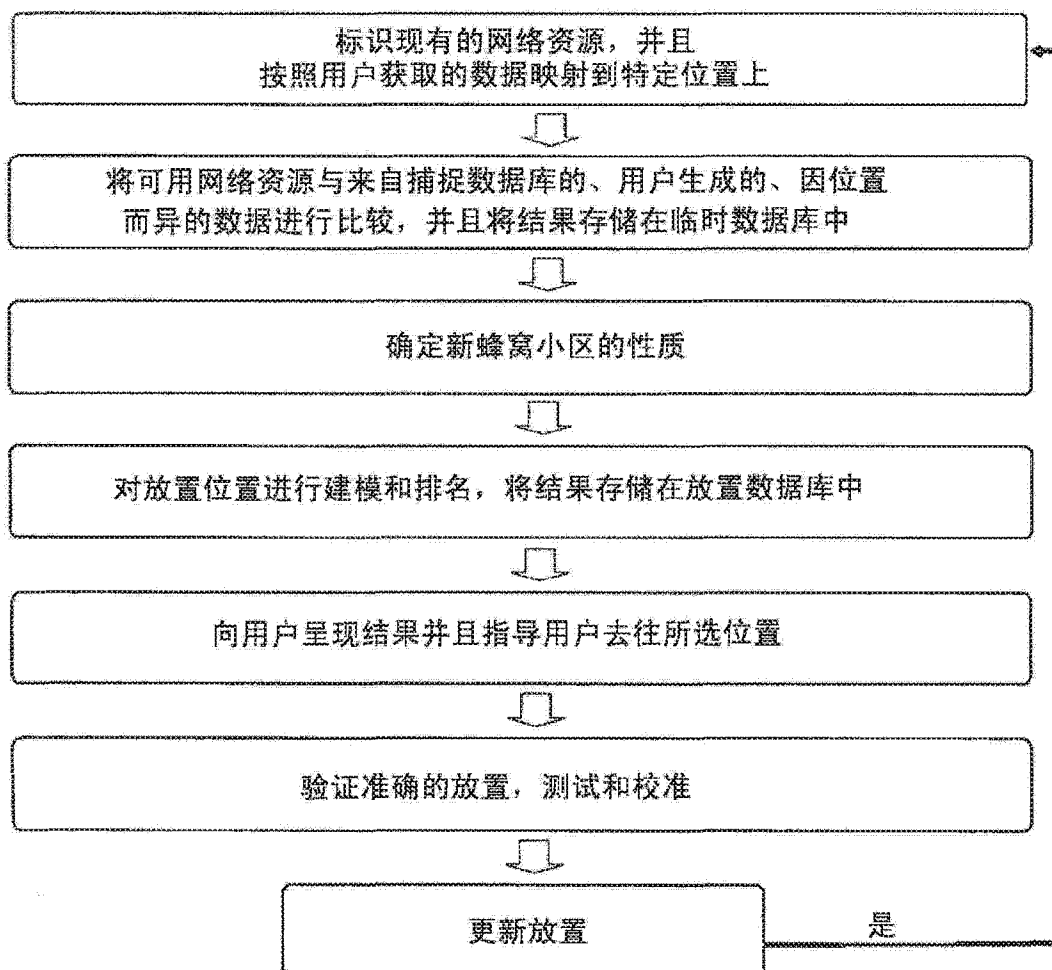
示例移动设备架构

图 1



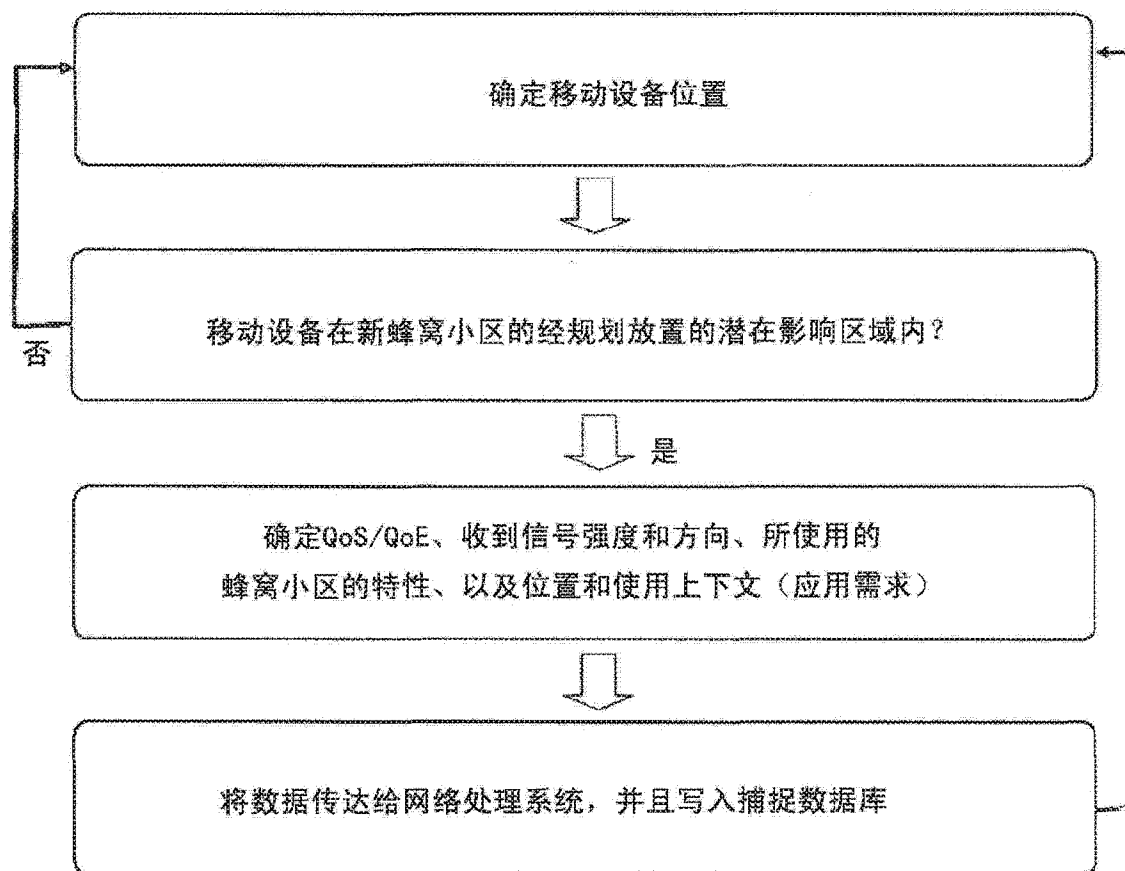
示例网络处理器架构

图 2



方法概览（网络分析和放置确定）

图 3



方法概览（移动设备捕捉）

图 4

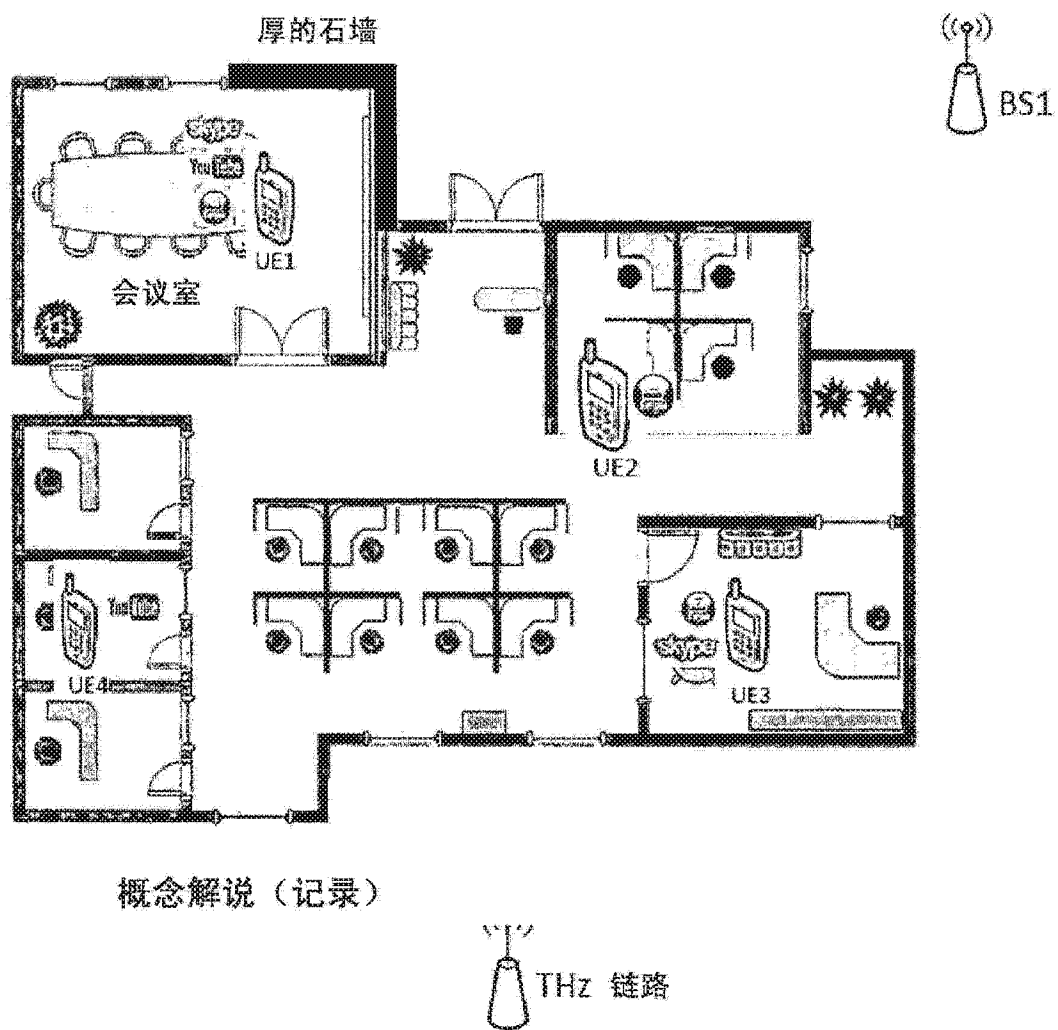


图 5

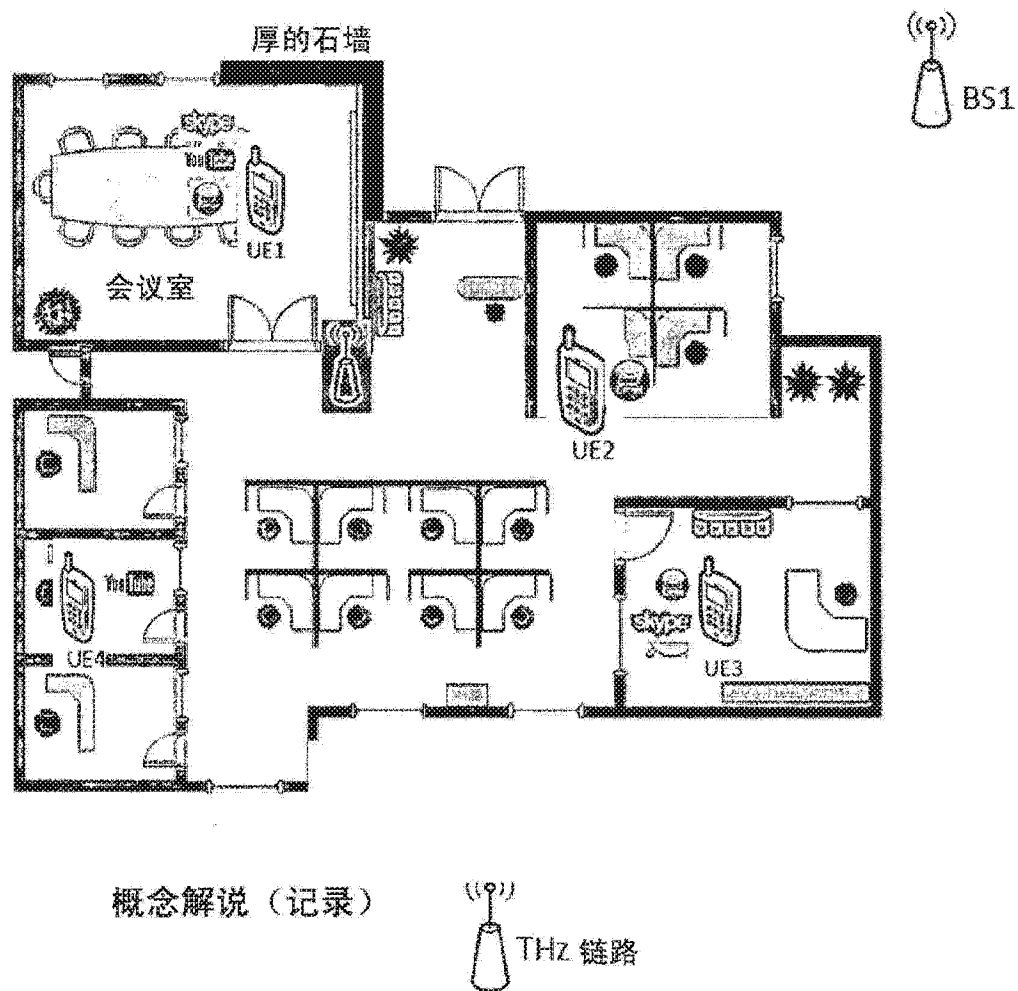


图 6

本发明的示例情形

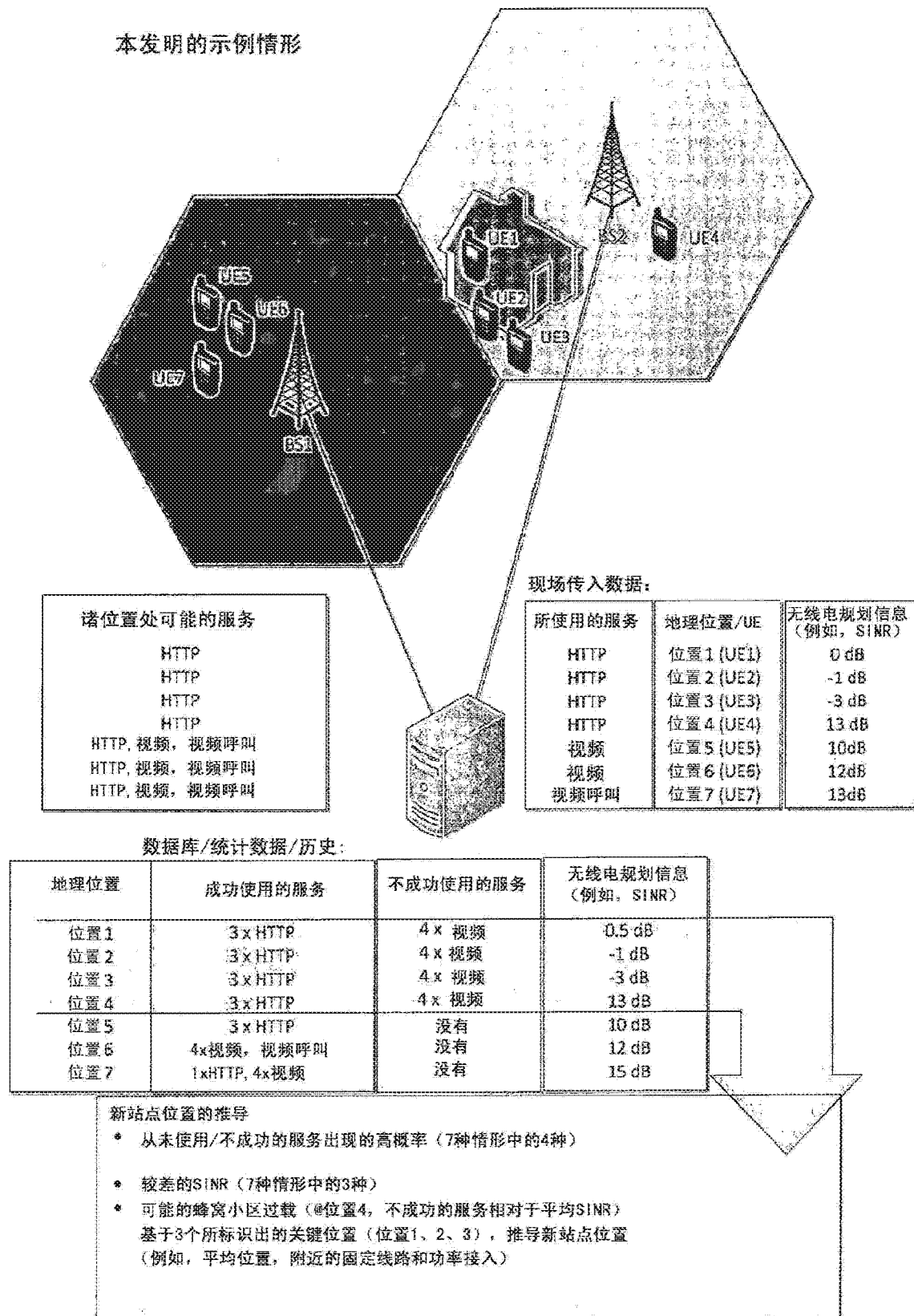


图 7



Espacenet

Bibliographic data: CN104885378 (A) — 2015-09-02

Apparatus, system and method of wireless backhaul communication between wireless communication nodes

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Classification: - international: **H04B7/04; H04B7/24**
- cooperative: **H04W72/0406 (EP, US); H04W84/045 (EP, US);**
H04W88/06 (EP, US); H04W92/20 (EP, US)

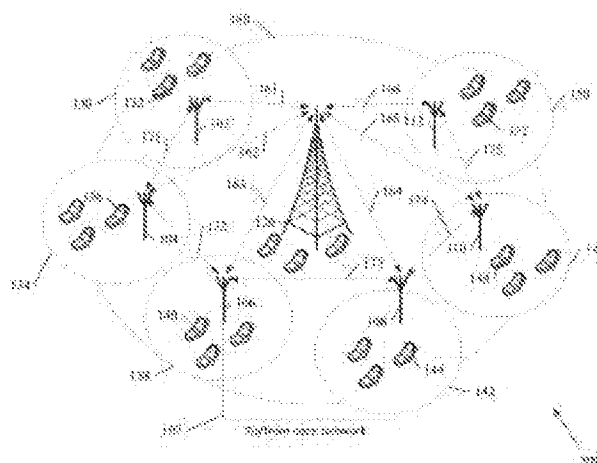
Application number: CN20148003566 20140122 Global Dossier

Priority number(s): WO2014US12477 20140122 ; US201313865625 20130418 ;
US201361756302P 20130124

Also published as: CN104885378 (B) EP2949056 (A1) EP2949056 (A4)
EP2949056 (B1) TW201434342 (A) TWI571081 (B)
US2014206368 (A1) US9326273 (B2) WO2014116657 (A1) less

Abstract of CN104885378 (A)

Some demonstrative embodiments include apparatuses, systems and/or methods of wireless backhaul communication between wireless communication nodes. For example, a wireless communication controller may control a wireless communication node to communicate with one or more other wireless communication nodes via one or more backhaul links of a backhaul network over a first frequency band, and to communicate with a control station via a control link over a second frequency band, the first frequency band is higher than the second frequency band.



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CLAIMS CN104885378

1.

A device that includes:

a wireless communication controller that controls the wireless communication node to communicate with one or more other wireless communication nodes via one or more backhaul links of the backhaul network on the first frequency band, and via the second frequency band The control link is in communication with the control station, the first frequency band being higher than the second frequency band.

2.

The apparatus of claim 1, wherein the wireless communication controller controls the wireless communication node to receive control information from the control station via the control link, the control information defining the backhaul link and A routing map via the backhaul link, wherein the wireless communication controller controls the wireless communication node to establish the backhaul link based on the control information.

3.

The apparatus of claim 2 wherein said wireless communication controller controls said wireless communication node to receive a request for connectivity information from said control station via said control link, said connectivity information and The wireless communication node is associated with an ability to connect to the one or more other wireless communication nodes, wherein the wireless communication controller controls the wireless communication node to transmit the connectivity information on the control link To the control station, and wherein control information from the control station is based on the connectivity information.

4.

The device of claim 1, wherein the backhaul link comprises a link for transmitting backhaul traffic between the one or more other wireless communication nodes and a core network.

5.

The apparatus of claim 4 wherein said wireless communication node comprises a backhaul endpoint node to communicate over said core network.

6.

The apparatus of claim 4 wherein said wireless communication controller controls said wireless communication node to transmit traffic between said core network and one or more mobile devices of a wireless communication cell.

7.

The apparatus of claim 4 wherein said wireless communication controller controls said communication node to transmit said backhaul traffic on a backhaul link between said wireless communication node and said control station.

8.

Apparatus according to any of the claims 1-7, wherein the wireless communication node communicates with one or more mobile devices of a wireless communication cell via one or more access links.

9.

The apparatus of any of claims 1-7, wherein the wireless communication controller controls the wireless communication node to simultaneously communicate on the first frequency band and the second frequency band.

10.

The apparatus of any of claims 1-7, wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

11.

The apparatus of claim 10 wherein said second frequency band comprises a cellular frequency band.

12.

A system comprising:

a wireless communication device, the wireless communication device comprising:

One or more antennas;

At least one transceiver, the at least one transceiver communicating on a first frequency band and a second frequency band, the first frequency band being higher than the second frequency band;

a wireless communication controller that controls the wireless communication device to transmit control information between a wireless communication node of the plurality of wireless communication nodes and the control station via the control link, the control information defining the wireless communication One or more backhaul links between the node and one or more other wireless communication nodes of the plurality of wireless communication nodes, the backhaul link including a link on the first frequency band to Traffic is transmitted between the wireless communication node and the core network, the control information defining a route map for routing the traffic via the backhaul link, the control link further including a link on the second frequency band.

13.

The system of claim 12, wherein said wireless communication controller transmits a request for connectivity information from said control station via said control link, said connectivity information being coupled to said wireless communication node Relating to the capabilities of the one or more other wireless communication nodes, wherein the wireless communication controller transmits the connectivity information to the control station over the control link, and wherein, from the control station The control information is based on the connectivity information.

14.

A system according to claim 12 or claim 13 wherein said wireless communication controller controls said wireless communication node to transmit said traffic on a backhaul link between said wireless communication node and said control station.

15.

A method of wireless communication, the method comprising:

Transmitting control information between a wireless communication node of the plurality of wireless communication nodes and the control station via the control link, the control information defining one or more other wireless of the wireless communication node and the plurality of wireless communication nodes One or more backhaul links between the communication nodes, the backhaul links including links on the first frequency band to transmit traffic between the wireless communication nodes and the core network, the control information defining via the A backhaul link routes a route map for the traffic, the control link including a link on a second frequency band, wherein the first frequency band is higher than the second frequency band.

16.

The method of claim 15 comprising transmitting said control information from said control station to said wireless communication node.

17.

The method of claim 16 comprising receiving said control information from said control station and establishing said backhaul link based on said control information.

18.

A product comprising a non-transitory storage medium having stored thereon instructions that, when executed by a machine, cause the following operations to be performed:

Communicating between the wireless communication node and one or more other wireless communication nodes via one or more backhaul links of the backhaul network on the first frequency band;

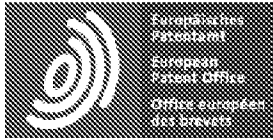
The first frequency band is higher than the second frequency band by communication between the wireless communication node and a control station via a control link on a second frequency band.

19.

The product of claim 18, wherein the instructions cause an operation to be received from the control station via the control link, the control information defining the backhaul link and via the backhaul a route map of the link; and establishing the backhaul link based on the control information.

20.

The product of claim 18 or 19, wherein the instructions cause an operation to receive a request for connectivity information from the control station via the control link, the connectivity information Relating to a capability of the wireless communication node to connect to the one or more other wireless communication nodes; and transmitting the connectivity information to the control station via the control link, wherein control information from the control station is Based on the connectivity information.



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 CN104885378

Some illustrative embodiments include devices, systems, and/or methods for wireless backhaul communication between wireless communication nodes. For example, the wireless communication controller can control the wireless communication node to communicate with one or more other wireless communication nodes via one or more backhaul links of the backhaul network on the first frequency band, and via a control chain on the second frequency band. The road communicates with the control station, the first frequency band being higher than the second frequency band.

Apparatus, system and method for wireless backhaul communication between wireless communication nodes

cross reference

This application claims the application date of January 24, 2013, entitled "Millimeter Wave Backhauling System for Small Cells with Central Control From a Macro Base Station" (millimeter wave backhaul system with small cells from the central control of the macro base station)" The interest and priority of U.S. Provisional Patent Application Serial No. 61/756,302, the entire disclosure of which is incorporated herein by reference.

Technical field

Embodiments described herein relate generally to wireless communication between wireless communication nodes.

Background technique

Some wireless communication units may be deployed in accordance with a wireless network topology involving multiple small cells, and multiple small cells may be used to exchange information with mobile users. This small cell can greatly increase the overall network capacity.

However, deployments involving a large number of small cells may require a very sophisticated backhaul infrastructure to provide proper core network access. This backhaul infrastructure is large and/or expensive.

DRAWINGS

For the sake of simplicity and clarity of the description, elements shown in the drawings are not necessarily drawn to scale. For example, the size of some of the elements may be exaggerated relative to other elements for clarity. Further, reference numerals may be repeated among the drawings to indicate corresponding or similar elements. The figures are listed below:

1 is a schematic block diagram illustrating the deployment of a multi-cell wireless communication system, in accordance with some demonstrative embodiments.

2 is a schematic block diagram illustrating another deployment of a multi-cell wireless communication system, in accordance with some demonstrative embodiments.

3 is a schematic block diagram illustrating another deployment of a multi-cell wireless communication system, in accordance with some demonstrative embodiments.

4 is a schematic block diagram illustrating a wireless communication device in accordance with some demonstrative embodiments.

FIG. 5 is a schematic diagram illustrating a modular antenna array in accordance with some demonstrative embodiments.

6 is a schematic flow diagram illustrating a method of wireless backhaul communication, in accordance with some demonstrative embodiments.

FIG. 7 is a schematic diagram illustrating the manufacture of a product, in accordance with some demonstrative embodiments.

detailed description

In the following detailed description, numerous specific details are set forth. However, it will be understood by those of ordinary skill in the art that the embodiments may be practiced without the specific details. In other instances, well-known methods, procedures, components, units and/or circuits have not been described in detail so as not to obscure the discussion.

The use of terms such as "processing," "calculating," "determining," "establishing," "analysing," "inspecting," or the like, refers to a computer, computing platform, computing system, or other electronic device. The operation(s) of the computing device and/or processing(s), which are to be represented as physical (eg, electronic) amounts of data manipulation within registers and/or memory of the computer. And/or other data transformed into physical quantities within other information storage media that are similarly represented as computer registers and/or memories or that can store instructions for performing operations and/or processing.

The term "plurality" and "a plurality" as used herein includes, for example, "many" or "two or more." For example, "multiple projects" includes two or more projects.

References to "one embodiment", "an embodiment", "an illustrative embodiment", "a variety of embodiments" and the like are intended to include a particular feature, structure, or characteristic, but not every embodiment. Includes specific features, structures, and characteristics. In addition, the repeated use of the phrase "in one embodiment" does not necessarily mean the same embodiment, although it may refer to the same embodiment.

As used herein, the use of ordinal adjectives "first", "second", "third", etc., to describe a common object merely indicates that different instances of similar objects are being referred to, and are not intended to imply such use. The described object must be in a given sequence in time, space, level, or in any other way.

Some embodiments may be utilized in connection with various devices and systems such as personal computers

(PCs), desktop computers, mobile computers, laptop computers, notebook computers, tablet computers, Ultrabooks, computers, server computers. Handheld computer, handheld device, personal digital assistant (PDA) device, handheld PDA device, on-board device, off-site device, hybrid device, in-vehicle device, off-vehicle device, mobile or portable device, consumer device, non-mobile Or a non-portable device, a wireless communication station, a wireless communication device, a wireless access point (AP), a wired router or wireless router, a cable modem or wireless modem, a video device, an audio device, an audiovisual (A/V) device, a wired network, or Wireless network, wireless area network, wireless video area network (WVAN), local area network (LAN), wireless LAN (WLAN), personal area network (PAN), wireless PAN (WPAN), and the like.

Some embodiments may be used in conjunction with the following devices and/or networks: according to the existing Wireless-Gigabit-Alliance (WGA) specification (Wireless Gigabit Alliance WiGig MAC and PHY Specification Version 1.1, April 2011, Apparatus and/or network operating in the final specification) and/or its future versions and/or derivative versions; according to the existing IEEE 802.11 standard (IEEE 802.11-2012, IEEE standard for information technology - System Local Area Network and Metropolitan Area Network Communication and information exchange - Specific requirements - Part 11: Wireless LAN medium access control (MAC) and physical layer (PHY) specification, March 29, 2012; IEEE 802.11 task group ac (TGac) ("IEEE802.11-09/0308r12-TGac channel model appendix"); IEEE802.11 task group ad (TGad) (IEEE P802.11ad standard for information technology - Telecommunications and information exchange between systems - specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications - Amendments to the very high throughput enhancements in the 3.60 GHz band) and/or its future versions and/or derivative versions of the device and/or Or network; according to the existing Long Term Evolution (LTE) specification (Including ETSI TS 136 300 V11.3.0 (2012-11): LTE; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); General Description; Phase 2 (3GPP TS 36.300 version 11.3.0 11th Edition), 2012) and/or its future versions and/or derivative versions of devices and/or networks operating; according to existing WirelessHD <TM> specifications and/or its future versions and/or derivatives The device and/or network in which the version operates; is a unit and/or device of a part of the above network.

Some embodiments may be used in conjunction with one-way and/or two-way radio communication systems, cellular radio-mobile telephone communication systems, mobile telephones, cellular telephones, wireless telephones, personal communication system (PCS) devices, including wireless communication devices. PDA device, mobile or portable global positioning system (GPS) device, device containing GPS receiver or transceiver or chip, device containing FRID component or chip, multiple input multiple output (MIMO) transceiver or device, single input A multiple output (SIMO) transceiver or device, a device having one or more internal and/or external antennas, a digital video broadcasting (DVB) device or system, a multi-standard radio or system, a wired or wireless handheld device (eg, Smart phone), Wireless Application Protocol (WAP) device, etc.

Some embodiments may be used in conjunction with one or more types of wireless communication signals

and/or systems, such as radio frequency (RF), infrared (IR), frequency division multiplexing (FDM), orthogonal FDM (OFDM), single carrier. Frequency Division Multiple Access (SC-FDMA), Time Division Multiplexing (TDM), Time Division Multiple Access (TDMA), Extended TDMA (E-TDMA), General Packet Radio Service (GPRS), Extended GPRS, Code Division Multiple Access (CDMA) Wideband CDMA (WCDMA), CDMA 2000, single carrier CDMA, multi-carrier CDMA, multi-carrier modulation (MDM), discrete multi-tone (DMT), Bluetooth [image], global positioning system (GPS), wireless fidelity (Wi-Fi), Wi-Max, ZigBee <TM>, Ultra Wide Band (UWB), Global System for Mobile Communications (GSM), Second Generation (2G), 2.5G, 3G, 3.5G, 4G, 5G (5G) Mobile Network, 3GPP, Long Term Evolution (LTE), Upgraded LTE, Enhanced Data Rate (EDGE) for GSM Evolution, and more. Other embodiments may be used in a variety of other devices, systems, and/or networks.

The term "wireless device" as used herein includes, for example, a device having wireless communication capability, a communication device having wireless communication capability, a communication station having wireless communication capability, a portable device having wireless communication capability, or a non-portable device or the like. In some demonstrative embodiments, a wireless device may be or may include a peripheral of a computer integrated with a computer or a peripheral attached to a computer. In some demonstrative embodiments, the term "wireless device" may optionally include a wireless service.

The term "communicating" as used herein with respect to wireless communication signals includes transmitting wireless communication signals and/or receiving wireless communication signals. For example, a wireless communication unit capable of communicating wireless communication signals can include a wireless transmitter to transmit wireless communication signals to at least one other wireless communication unit, and/or a wireless communication receiver to receive wireless from at least one other wireless communication unit Communication signal.

Some illustrative embodiments are described herein with respect to LTE cellular networks. However, other embodiments may be implemented in any other suitable cellular network (e.g., 3G cellular network, 4G cellular network, 5G cellular network, WiMax cellular network, etc.).

Some illustrative embodiments may be used in conjunction with a WLAN. Other embodiments may be utilized in connection with, for example, a wireless area network, "piconet", WPAN, WVAN, etc., any other suitable wireless communication network.

Some illustrative embodiments may be utilized in connection with a wireless communication network that communicates over a frequency band of 60 GHz. However, other embodiments may be implemented using any other suitable wireless communication band, such as: Very High Frequency (EHF) band (millimeter wave band),

such as bands in the band between 20 GHz and 300 GHz; WPAN band Wireless Gigabit (WiGig) band, such as according to the WGA specification; WiFi band; band according to the IEEE 802.11 standard, such as the band according to IEEE 802.11ad ("802.11ad band"), and the like.

The phrase "peer-to-peer (PTP or P2P) communication" as used herein may relate to device-to-device communication over a wireless link ("peer-to-peer link") between a pair of devices. P2P communication may include, for example, wireless communication over a direct link within a QoS Basic Service Set (BSS), wireless communication over a Tunnel Direct Link Setup (TDLS) link, and an Independent Basic Service Set (IBSS) STA to STA communication, etc.

The term "antenna" as used herein may include any suitable configuration, structure, and/or arrangement of one or more antenna elements, components, units, components, and/or arrays. In some embodiments, the antenna can use separate transmit antenna elements and receive antenna elements to implement transmit and receive functions. In some embodiments, the antennas can implement transmit and receive functions using common and/or integrated transmit/receive elements. The antenna may include, for example, a phased array antenna, a single element antenna, a beam switching antenna group, and/or the like.

The phrase "millimeter wave band" as used herein may relate to a frequency band above 20 GHz, for example, a frequency band between 20 GHz and 300 GHz.

The phrases "directional multi-gigabit (DMG)" and "directional band (DBand)" as used herein may refer to a frequency band in which the channel start frequency is higher than 40 GHz.

The phrases "DMG STA" and "millimeter wave STA (mSTA)" may relate to STAs having radio transmitters that are operating on channels within the millimeter wave or DMG band.

The term "beamforming" as used herein may refer to a spatial filtering mechanism that may be used at a transmitter and/or receiver to improve one or more attributes, such as the received signal power at a predetermined receiver or Signal to noise ratio (SNR).

The term "cell" as used herein may include a combination of network resources, such as downlink and optional uplink resources. Resources may be controlled and/or distributed, for example, by wireless communication nodes (also referred to as "nodes" or "base stations"), and the like. The link between the carrier frequency of the downlink resource and the carrier frequency of the uplink resource may be indicated in the system information

transmitted on the downlink resource.

Reference is now made to Fig. 1, which is a block diagram that schematically illustrates the deployment of a multi-cell wireless communication system 100, in accordance with some demonstrative embodiments.

In some demonstrative embodiments, system 100 may include one or more wireless communication devices capable of transmitting content, data, information, and/or signals via a wireless medium (WM). The wireless medium can include, for example, a radio channel, a cellular channel, an RF channel, a wireless fidelity (WiFi) channel, a WiGig channel, a millimeter wave channel, an IR channel, and the like. One or more components of system 100 are selectively capable of communicating over any suitable wired communication link.

In some demonstrative embodiments, system 100 may be deployed as a network comprising a plurality of cells (e.g., small cells) configured to, for example, deliver data to/from a mobile user, for example, to substantially increase throughput throughout the network. the amount.

In some demonstrative embodiments, a cell may include a wireless communication node that may be configured to overlay and/or serve multiple users, such as mobile devices (eg, user equipment (UE)), and the like. A wireless communication node may include or perform functions of a base station (BS), an access point (AP), an LTE node, an LTE evolved Node B (eNB), and the like. The deployment of small cells can provide, for example, high speed wireless access that enables many users to communicate simultaneously.

In some demonstrative embodiments, the size of the small cell may be configured to enable, for example, a wireless communication node to cover a small cell. In one example, a small cell may have a coverage of about 10 to 100 meters, or any other range.

In some demonstrative embodiments, a relatively large number of small cell base stations are deployed to cover a relatively large area, such as a city or a number of blocks in a city. In one example, elements of system 100 can be deployed, for example, in an outdoor space (eg, a street, a sports field, etc.) and/or a large indoor area (eg, a meeting room, etc.).

In some demonstrative embodiments, system 100 may include a plurality of wireless communication nodes configured to communicate with one or more mobile devices of one or more wireless communication cells (eg, small cells).

For example, as shown in FIG. 1, system 100 includes a wireless communication node 102 in communication with one or more mobile devices 132 of wireless communication cell 130; a wireless communication node in communication with one or more mobile devices 136 of wireless communication cell 134, 104; a wireless communication node 106 in communication with one or more mobile devices 140 of the wireless communication cell 138; a wireless communication node 108 in communication with one or more mobile devices 144 of the wireless communication cell 142; and one or A wireless communication node 110 in which a plurality of mobile devices 148 communicate; and/or a wireless communication node 112 in communication with one or more mobile devices 152 of the wireless communication cell 150.

In some demonstrative embodiments, nodes 102, 104, 106, 108, 110, and/or 112 may include or be executable BSs, macro BSs, micro BSs, APs, WiFi nodes or stations, WiGig nodes or stations, Wimax nodes, or Functions of stations, cellular nodes, evolved Node Bs (eNBs), pico eNBs, LTE nodes, stations, hotspots, network controllers, and the like.

In some demonstrative embodiments, for example, as described below with respect to FIG. 4, nodes 102, 104, 106, 108, 110, and/or 112 may include wireless communication devices including one or more antennas and a Or multiple wireless communication transceivers.

In some demonstrative embodiments, mobile devices 132, 136, 140, 144, 148, and/or 152 may include, for example, user equipment (UE), mobile computers, laptop computers, notebook computers, tablet computers, Ultrabooks < TM > Computers, mobile internet devices, handheld computers, handheld devices, storage devices, PDA devices, handheld PDA devices, on-board devices, field devices, hybrid devices (eg, combined cellular phone functions and PDA device functions), consumer devices , in-vehicle devices, off-board devices, portable devices, mobile phones, cellular phones, PCS devices, mobile or portable GPS devices, DVB devices, relatively small computing devices, non-desktop computers, "Carry Small Live Large" , CSLL)" device, Super Mobile Device (UMD), Super Mobile PC (UMPC), Mobile Internet Network Device (MID), "Origami" device or computing device, video device, audio device, A/V device, Game devices, media players, smart phones, etc.

In some demonstrative embodiments, a sophisticated backhaul infrastructure may be used to connect wireless communication nodes 102, 104, 106, 108, 110, and/or 112 to a core network.

In some demonstrative embodiments, for example, as described below, wireless communication nodes 102, 104, 106, 108, 110, and/or 112 may be configured to communicate over multiple wireless backhaul links.

In some demonstrative embodiments, the wireless backhaul link may include a high throughput link.

In some demonstrative embodiments, for example, as described below, a wireless backhaul link may include a wireless communication link over a high frequency band, such as a millimeter wave link over a millimeter wave band. In one example, the millimeter wave link may include a DMG link, a link according to the WiGig specification ("WiGig Link"), a link according to the IEEE 802.11ad specification ("802.11ad link"), and the like. In other embodiments, the wireless backhaul link can include any other wireless communication video band and/or any other wireless communication link in accordance with any other wireless communication standard and/or specification.

In some demonstrative embodiments, the backhaul network may require advanced routing and/or scheduling algorithms to be implemented, for example, with device recovery and/or device failure management. It is difficult to implement a backhaul network using only millimeter wave links between wireless communication nodes.

In some demonstrative embodiments, for example, as described in detail below, system 100 can be configured in accordance with a dual band backhaul scheme that includes transmitting backhaul traffic on a first frequency band and transmitting on a second frequency band Control information.

In some demonstrative embodiments, the dual-band backhaul scheme allows for implementation to transmit control functionality (eg, for controlling backhaul links) at relatively low speed and/or throughput, for example, and at relatively high speeds and/or Or throughput to transmit backhaul traffic.

In some demonstrative embodiments, the first frequency band may be greater than the second frequency band.

In some demonstrative embodiments, the first frequency band may include a millimeter wave band and the second frequency band may include a non-millimeter wave band.

In one example, the first frequency band can include a DMG frequency band, eg, a 60 gigahertz (GHz) frequency band; and the second frequency band can include a cellular frequency band, eg, an LTE frequency band (eg, a 2.4 GHz frequency band). In other embodiments, the second and second frequency bands can include any other combination of frequency bands.

In some demonstrative embodiments, for example, as described in detail below, system 100 can include a control

station 120 that is configured to control wireless communication nodes 102, 104, 106, 108, 110, and/or 112.

In some demonstrative embodiments, for example, as described below with respect to FIG. 4, control station 120 can include a wireless communication device that includes one or more antennas and one or more wireless communication transceivers.

In some demonstrative embodiments, control station 120 may be configured to communicate with wireless communication nodes 102, 104, 106, 108, 110, and/or 112 over a second frequency band. For example, as described below, control node 120 is configured to communicate with wireless communication nodes 102, 104, 106, 108, 110, and/or 112 over a plurality of control links on a second frequency band.

In some demonstrative embodiments, control station 120 may include or may be implemented as part of a cellular base station (e.g., an LTE base station). In one embodiment, control station 120 may perform the functions of an eNB (e.g., a macro cell eNB) or any other cellular node or base station.

In some demonstrative embodiments, control station 120 (also referred to as a "macro base station") may be implemented as a dedicated entity, such as an entity separate from nodes 102, 104, 106, 108, 110, and/or 112.

In other embodiments, control station 120 can be implemented as part of 102, 104, 106, 108, 110, and 112 wireless communication nodes. In accordance with these embodiments, control station 120 can be configured to perform the functions of control station 120 and wireless communication nodes of nodes 102, 104, 106, 108, 110, and 112. For example, as described below, control station 120 can be configured to communicate over one or more backhaul links on a first frequency band.

In some demonstrative embodiments, for example, as described below, wireless communication nodes 102, 104, 106, 108, 110, and 112 may be configured to operate as backhaul nodes that may be formed for use in wireless communication nodes A backhaul network that transmits backhaul traffic between 102, 104, 106, 108, 110, and 112.

In some demonstrative embodiments, control station 120 may communicate with backhaul nodes over multiple control links. For example, control station 120 can communicate with wireless communication node 102 via control link 161; control station 120 can communicate with wireless communication node 104 via control link 162; control station 120 can communicate with wireless communication node 106 via control link 163; control station 120 can communicate with wireless communication node 108 via control link 164; control station 120 can communicate with wireless communication node 110 via control link 165; control station 120 can communicate with wireless communication node 112 via control link 166.

164; control station 120 can communicate with wireless communication node 110 via control link 165; control station 120 can communicate with wireless communication node 112 via control link 166.

In some demonstrative embodiments, control links 161, 162, 163, 164, 165, and/or 166 may include links on a second frequency band (eg, on a non-millimeter wave band). In one example, control links 161, 162, 163, 164, 165, and/or 166 can include links on an LTE frequency band (eg, the 2.4 GHz band) or any other frequency band.

In some demonstrative embodiments, control links 161, 162, 163, 164, 165, and/or 166 may be configured to be at control station 120 and wireless communication nodes 102, 104, 106, 108, 110, and/or 112 Transfer control information. For example, as described below, control station 120 can communicate control information with wireless communication nodes 102, 104, 106, 108, 110, and/or 112 to set up and/or control at wireless communication nodes 102, 104, Communication over the backhaul network between 106, 108, 110, and/or 112.

In some demonstrative embodiments, the backhaul network may include multiple backhaul wireless communication links formed between wireless communication nodes 102, 104, 106, 108, 110, and/or 112. For example, wireless communication node 102 can transmit backhaul traffic with wireless communication node 104 over wireless backhaul link 171; wireless communication node 104 can transmit backhaul traffic with wireless communication node 106 over wireless backhaul link 172; wireless communication node 106 Backhaul traffic may be transmitted over wireless backhaul link 173 with wireless communication node 108; wireless communication node 108 may transmit backhaul traffic with wireless communication node 110 over wireless backhaul link 174; and/or wireless communication node 110 may be in a wireless backhaul chain The backhaul traffic is transmitted on the way 175 with the wireless communication node 112. Any other additional or alternative wireless backhaul links may be formed by any other pair of backhaul nodes.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may include links on a first frequency band (eg, a millimeter wave band).

In some demonstrative embodiments, wireless communication node 102 may communicate with mobile device 132 of cell 130 over a plurality of wireless communication links ("access links"); wireless communication node 104 may communicate with multiple access links Mobile device 136 of cell 134 communicates; wireless communication node 106 can communicate with mobile device 140 of cell 138 over a plurality of access links; wireless communication node 108 can communicate with mobile device 144 of cell 142 over a plurality of access links; The wireless communication node 110 can communicate with the mobile device 148 of the cell 146 over a plurality of access links; and/or the wireless communication node 112 can communicate with the mobile device 152 of the cell 150 over a plurality of access links. The access link may include a downlink for transmitting

downlink data from the wireless communication node to the mobile device, and/or an uplink for transmitting uplink data from the mobile device to the wireless communication node.

In some demonstrative embodiments, the access link may include a wireless communication link (eg, a millimeter wave link) on the first frequency band. In other embodiments, the access link may include a wireless communication link in a second frequency band or any other frequency band.

Reference herein to wireless communication configured to perform functions of a backhaul node (e.g., for communicating over a backhaul network) and an access node (e.g., a cell base station) (e.g., for communicating with a mobile device of a wireless communication cell) Wireless communication nodes of nodes (e.g., nodes 102, 104, 106, 108, 110, and/or 112) describe some illustrative embodiments. For example, in accordance with these embodiments, a wireless communication node can be implemented as part of a small cell base station. The small base station is capable of communicating with the mobile device over the access link, communicating with other backhaul nodes over the backhaul link, and communicating with the control station over the control link.

However, in other embodiments, the backhaul node and the access node may be implemented as two separate entities. For example, a wireless communication node (e.g., wireless communication node 102, 104, 106, 108, 110, and/or 112) can perform the functions of a backhaul node (e.g., for communicating over a backhaul network); and separate access A node can be used to communicate with a mobile device of a wireless communication cell. For example, in accordance with these embodiments, a small cell base station can communicate with a mobile device over an access link, and a backhaul node can communicate with other backhaul nodes over a backhaul link and with the control station over a control link. According to this example, the backhaul node can interface between the small cell base station and the backhaul network.

In some demonstrative embodiments, the backhaul node can communicate, for example, on both the backhaul link and the control link. For example, wireless communication node 102 can simultaneously communicate over control link 161 and backhaul link 171; wireless communication node 104 can simultaneously communicate over control link 162 and backhaul links 171 and/or 172; wireless communication node 106 Communication can occur over control link 163 and backhaul links 172 and/or 173 at the same time; wireless communication node 108 can simultaneously communicate over control link 164 and backhaul links 173 and/or 174; wireless communication node 110 can simultaneously control Link 165 and backhaul links 174 and/or 175 communicate; and/or wireless communication node 112 can communicate over control link 166 and backhaul link 175 simultaneously.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may be used for direct or indirect communication between wireless communication nodes 102, 104, 106, 108, 110, and/or 112.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may be used to communicate between a wireless communication node and a core network.

In some demonstrative embodiments, system 100 may include one or more backhaul nodes ("source/aggregation nodes") connected to a core network. For example, a source/aggregation node may perform one or more "endpoints" at which wireless traffic is concentrated and delivered to/from a core (wired/fiber) network. The core network may include, for example, a telephone network, the Internet, a local area network (LAN), and the like.

In some demonstrative embodiments, at least one of the wireless communication nodes 102, 104, 106, 108, 110, and/or 112 may be connected to a core network, and one or more other wireless communication nodes may be connected through a wireless backhaul link Core network communication.

For example, as shown in FIG. 1, wireless communication node 106 can include at least one network interface 107 that is configured to communicate over one or more wired and/or wireless connections (eg, via wires, cables, fiber optics, light) Connections, etc.) communicate with at least one core network. For example, network interface 107 can include a modulator-demodulator (modem), a cable modem, a router, and the like.

In some demonstrative embodiments, the core network may be selectively configured to enable communication, for example, between one or more elements of the backhaul network over a wired connection.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may include high throughput links configured to be at node 60 at wireless communication nodes 102, 104, 106, 108, 110 And/or 112 transmits high throughput data to and from the core network.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may be used, for example, for systems that include relatively high density nodes per unit area, for example, for a large number of cells (eg, small cells) Deployment.

In some demonstrative embodiments, control station 120 may be implemented as a cellular node having a relatively large coverage area ("macro coverage area") 180 (eg, an elliptical area as shown in FIG. 1 or any other coverage area) Part of (eg, eNB). A plurality of small cells (eg, cells 130, 134, 138, 142, 146, and 150) may be

deployed within the coverage area 180.

In some demonstrative embodiments, control station 120 may control wireless communication nodes 102, 104, 106, 108, 110, and/or in a centralized manner, such as by control links 161, 162, 163, 164, 165, and/or 166. 112.

In some demonstrative embodiments, control station 120 may control wireless communication nodes 102, 104, 106, 108, 110, and/or in a centralized manner, such as by control links 161, 162, 163, 164, 165, and/or 166. 112, to form wireless backhaul links 171, 172, 173, 174, and/or 175 according to any backhaul scheme ("backhaul connectivity map" and "routing map"). For example, as described below, the backhaul routing map may define and/or configure one or more backhaul links formed by the backhaul nodes.

In some demonstrative embodiments, control station 120 may, for example, be defined and/or configured based on communication between control station 120 and one or more of wireless communication nodes 102, 104, 106, 108, 110, and/or 112. The backhaul route map, for example, through control links 161, 162, 163, 164, 165, and/or 166.

In some demonstrative embodiments, control station 120 may transmit a request for connectivity information corresponding to a wireless communication node with a wireless communication node (e.g., wireless communication node 102) over a control link (e.g., control link 161). Connectivity information may include, for example, capabilities for wireless communication nodes to connect to one or more other wireless communication nodes (e.g., wireless communication nodes 104) over one or more backhaul links (e.g., backhaul link 171), wireless communication nodes Information about the capabilities of the connection to the core network, information about the coverage of the wireless communication node, information about the ability of the wireless communication node to communicate on the first frequency band, with respect to the wireless communication node being able to form a backhaul link (eg, a beamforming chain) Information on the number of routes, information about the location of the wireless communication node, and/or any other information.

In some demonstrative embodiments, control station 120 may define a backhaul connectivity map based on, for example, connectivity information received from wireless communication nodes 102, 104, 106, 108, 110, and/or 112. For example, as shown in FIG. 1, control station 120 can define a backhaul connectivity map to include backhaul links 171, 172, 173, 174, and/or 175.

In some demonstrative embodiments, control station 120 may define a backhaul connectivity map such that a wireless communication node (eg, each of nodes 102, 104, 106, 108, 110, and/or 112) can The backhaul traffic is transmitted to the core network via at least one backhaul path (route) between the wireless communication node

and the core network. The backhaul path can be formed by one or more wireless backhaul links ("hops"). One or more wireless communication nodes may be connected to the core network via a single backhaul link ("single hop"), and/or one or more wireless communication nodes may be connected to the core via multiple backhaul links ("multiple hops") The internet.

For example, as shown in FIG. 1, wireless communication node 102 can communicate with a core network via a backhaul path including backhaul links 171 and 172 and backhaul interface 107; wireless communication node 104 can include backhaul link 172 and backhaul interface 107 via The backhaul path communicates with the core network; the wireless communication node 106 can communicate directly with the core network via the backhaul interface 107; the wireless communication node 108 can communicate with the core network via a backhaul path including the backhaul link 173 and the backhaul interface 107; the wireless communication node 110 The core network can be communicated via a backhaul path including backhaul links 174 and 173 and backhaul interface 107; and/or wireless communication node 112 can communicate with the core network via a backhaul path including backhaul links 175, 174 and 173 and backhaul interface 107. .

In some demonstrative embodiments, for example, as described below with respect to FIG. 2, the backhaul routing map may define more than one backhaul route for the wireless communication node. For example, if one or more of the backhaul links are blocked, lost, or corrupted, connecting the wireless communication node to the core network via multiple backhaul paths may provide redundancy to, for example, enable maintaining backhaul connections.

In some demonstrative embodiments, control station 120 may communicate control information with a wireless communication node (e.g., wireless communication node 102) over a control link (e.g., control link 161). Control information may include, for example, defining information to be formed on one or more backhaul links between the wireless communication node and one or more other wireless communication nodes in accordance with the routing map. For example, control station 120 can transmit control information to control node 161 to wireless communication node 102 that defines the wireless communication node to establish backhaul traffic and/or transmit backhaul traffic on backhaul link 171.

In some demonstrative embodiments, control station 120 may utilize various optimization algorithms for traffic routing and scheduling the transmission of backhaul traffic over the wireless backhaul link. For example, the control station 120 can configure the connectivity map to optimize the total throughput on the backhaul network and/or to optimize any other metrics (eg, quality of service (QoS) metrics). Different QoS metrics can be applied with respect to different small cells.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may be included for non-

simultaneously in both directions between a pair of wireless communication nodes (eg, only one direction at a time) Upper) Half-duplex link for transport traffic. In one example, communication over a half-duplex link can be managed according to a suitable time division multiplexing (TDD) scheme or any other half-duplex scheme.

In some demonstrative embodiments, backhaul links 171, 172, 173, 174, and/or 175 may include full-duplex links for transmitting traffic between a pair of wireless communication nodes, for example, simultaneously in both directions. In one example, communication over a full duplex link can be managed according to a suitable frequency division multiplexing (TDD) scheme or any other full duplex scheme.

In some demonstrative embodiments, system 100 may include a control station (eg, control station 120) configured to control a plurality of backhaul nodes (eg, nodes 102, 104, 106, 108, 110, and/or 112) These nodes may communicate over a backhaul network formed by wireless backhaul links (e.g., backhaul links 171, 172, 173, 174, and/or 175) between the backhaul nodes.

In some demonstrative embodiments, for example, as described below with respect to FIG. 2, for example, if the control station is capable of communicating on the first frequency band, the control station can be configured to also perform the backhaul node or the backhaul source/aggregation node Features.

In some demonstrative embodiments, the system (system 100) may include a source/aggregation backhaul node (eg, backhaul node 106) configured to be between the core network and one or more other backhaul nodes Make an interface connection.

In some demonstrative embodiments, for example, as described below with respect to FIG. 3, the system may include more than one source/aggregation backhaul node.

2 is a schematic block diagram illustrating another deployment of a multi-cell wireless communication system 200, in accordance with some demonstrative embodiments.

In some demonstrative embodiments, system 200 may include a control station 220 having a relatively large coverage area ("macro coverage area") 280. A plurality of small cells (e.g., cell 230) can be deployed within coverage area 280.

In some demonstrative embodiments, control station 220 may perform the functions of a cellular base station,

such as an eNB (e.g., a macro cell eNB), or any other cellular node.

In some demonstrative embodiments, system 200 may include multiple backhaul nodes 210 deployed within small cell 230. In one example, for example, as described above, backhaul node 210 can be implemented as part of a small cell base station of cell 230. For example, backhaul node 210 can be implemented as part of a pico eNB or any other cellular base station.

In some demonstrative embodiments, backhaul node 210 may transmit backhaul data over a backhaul network (eg, a dual band backhaul network) including a plurality of backhaul links 270 between backhaul nodes 210, eg, on a first frequency band. And a plurality of control links 260 on the second frequency band between the control station 220 and the backhaul node 210.

In some demonstrative embodiments, backhaul link 270 may perform the functions of the wireless backhaul link described above with respect to FIG. 1, and/or control link 260 may perform the functions of the wireless control link described above with respect to FIG. .

In some demonstrative embodiments, control station 220 may be configured to transmit backhaul traffic with backhaul node 210, for example, via one or more of backhaul links 270 of the backhaul network. For example, control station 220 can communicate on a first frequency band (eg, a millimeter wave band). In accordance with these embodiments, in addition to the functionality of the control station, the control station 220 can, for example, also perform the functions of the backhaul node 210.

In some demonstrative embodiments, control station 220 may perform the functions of a source/aggregation backhaul node. For example, as described above, control station 210 can include a network interface 207 to connect control station 220 to a core network.

In some demonstrative embodiments, for example, as described with reference to FIG. 1, control station 220 may communicate with backhaul node 210, for example, via control link 260 to define a backhaul connectivity map; and may, for example, be via control link 260 The backhaul node 210 is controlled to establish a wireless backhaul link 270 based on the backhaul connectivity map.

In some demonstrative embodiments, one or more of the backhaul nodes 210 may transmit backhaul traffic to the core network via a single hop (eg, via a direct backhaul link 270 with the control station).

In some demonstrative embodiments, one or more of the backhaul nodes 210 may transmit backhaul traffic to the core network by multiple hops (eg, via one or more backhaul links with one or more other backhaul nodes 210).

In some demonstrative embodiments, as shown in FIG. 2, backhaul node 210 may communicate with the core network via more than one backhaul path (eg, via a single hop backhaul path and one or more multiple hop backhaul paths).

In some demonstrative embodiments, control station 220 may configure a connectivity map to define one or more alternate backhaul paths for backhaul node 210, which may be used, for example, as a backhaul path used by backhaul node 210 ("current path" ") alternate path. For example, an alternate path may be used in the event that one or more backhaul links 270 and/or backhaul nodes 210 along the current path fail.

FIG. 3 is a schematic block diagram illustrating another deployment of multi-cell wireless communication system 300, in accordance with some demonstrative embodiments.

In some demonstrative embodiments, for example, as described above, system 300 can include control station 320 to control, for example, a plurality of backhaul nodes 310 of a plurality of small cells that can be deployed within a coverage area of the control station .

In some demonstrative embodiments, control station 320 may perform the functions of a cellular base station, such as an eNB (e.g., a macro cell eNB), or any other cellular node.

In some demonstrative embodiments, backhaul node 310 may transmit backhaul data over a backhaul network (eg, a dual band backhaul network) including a plurality of backhaul links between backhaul nodes 310, eg, on a first frequency band 370, and a plurality of control links 360 on the second frequency band between the control station 320 and the backhaul node 310.

In some demonstrative embodiments, backhaul link 370 may perform the functions of the wireless backhaul link described above with respect to FIG. 1, and/or control link 360 may perform the wireless control link described above with respect to FIG. The function.

In some demonstrative embodiments, system 300 can include multiple source/aggregation backhaul nodes. For example, as shown in FIG. 3, system 300 can include a source/aggregation backhaul node 306 having a connection 307 to a core network, and a source having a connection 308 to a core network (eg, the same core network or a different core network). / Convergence backhaul node 316.

In some demonstrative embodiments, multiple source/aggregation backhaul nodes may be used, for example, to optimize one or more attributes of the backhaul network.

In some demonstrative embodiments, multiple source/aggregation backhaul nodes may be used to form multiple backhaul subnetworks.

In one example, the first backhaul subnetwork 302 can include a first plurality of backhaul nodes 310 that can be connected to the source/aggregation backhaul node 316 via a backhaul link 370. The second backhaul subnetwork 304 can include a second plurality of backhaul nodes 310 that can be connected to the source/aggregation backhaul node 306 via the backhaul link 370.

In some demonstrative embodiments, for example, as described above, control station 320 may define a backhaul subnetwork in a centralized manner.

In some demonstrative embodiments, the control station may transmit control information defining the backhaul link 370 according to the connectivity map of the sub-network 302 to the backhaul node of the sub-network 302, for example, via the control link 360. The control station may transmit control information defining the backhaul link 370 according to the connectivity map of the sub-network 304 to the backhaul node of the sub-network 304, for example, via the control link 360.

In some demonstrative embodiments, control station 320 may assign backhaul node 310 to more than one backhaul subnetwork. In accordance with these embodiments, control station 320 can provide control information defining backhaul link 370 to backhaul node 310 on two sub-networks 302 and 304.

Referring to Figure 4, Figure 4 schematically illustrates a wireless communication device 400 in accordance with some demonstrative embodiments.

In some demonstrative embodiments, for example, as described above, wireless communication device 400 can

include a transceiver module 404 to perform wireless communication between wireless communication device 400 and one or more other wireless communication devices.

In some demonstrative embodiments, wireless communication device 400 may perform wireless communication nodes (eg, nodes 102, 104, 106, 108, 110, and/or 112 (FIG. 1), backhaul node 210 (FIG. 2), and/or The function of the backhaul node 310 (Fig. 3)).

In accordance with these embodiments, the transceiver module 404 can include being configured to communicate on a first frequency band (e.g., to communicate over a wireless backhaul link) and to communicate on a second frequency band (e.g., on a control link with a control station) Dual band transceiver for communication).

In one example, the transceiver module 404 can include: at least one low-band transceiver 410, for example, to communicate on a second frequency band; and at least one high-band transceiver 412 to communicate on a first frequency band. For example, transceiver 410 can perform the functions of a cellular transceiver (eg, an LTE transceiver) to communicate on a non-millimeter wave band (eg, the 2.4 GHz band) or any other frequency band. For example, transceiver 412 can perform the functionality of a millimeter wave transceiver (eg, a WiGig or IEEE 802.11 ad transceiver) to communicate over a millimeter wave band (eg, the 60 GHz band) or any other frequency band.

In some demonstrative embodiments, wireless communication device 400 may perform the functions of a control station (eg, control station 120 (FIG. 1), control station 220 (FIG. 2), and/or control station 320 (FIG. 3)).

In some demonstrative embodiments, wireless communication device 400 may perform the functions of a control station (e.g., control station 120 (FIG. 1), or control station 320 (FIG. 3)) capable of communicating over a control link. In accordance with these embodiments, the transceiver module 404 can include a low band transceiver 410 to communicate over a first frequency band, for example, to communicate over a control link.

In some demonstrative embodiments, wireless communication device 400 may perform the functions of a control station (e.g., control station 220 (FIG. 2)) capable of communicating over a backhaul link. In accordance with these embodiments, the transceiver module 404 can include a dual band transceiver module configured to communicate over a first frequency band (eg, to communicate over a wireless backhaul link) and in a second frequency band Communication (eg, to communicate with the control station over the control link). In one example, transceiver module 404 can include both low-band transceiver 410 and high-band transceiver 412, for

example, as described above.

In some demonstrative embodiments, transceivers 404, 410, and/or 412 may include one or more radios, including, for example, capable of transmitting and/or receiving wireless communication signals, RF signals, frames, blocks, transport streams, packets. One or more wireless transmitters, receivers, and/or transceivers of messages, data items, and/or data.

In some demonstrative embodiments, transceiver module 404 may include one or more antennas or may be associated with one or more antennas. In one example, transceiver 410 can be associated with one or more antennas 406; and/or transceiver 412 can be associated with one or more antennas 408.

Antennas 406 and/or 408 may include any type of antenna suitable for transmitting and/or receiving wireless communication signals, blocks, frames, transport streams, packets, messages, and/or data. For example, antennas 406 and/or 408 can include any suitable configuration, structure, and/or arrangement of one or more antenna elements, components, units, assemblies, and/or arrays. Antennas 406 and/or 408 may include, for example, antennas suitable for directional communication, such as using beamforming techniques. For example, antenna 408 can include a phased array antenna, a multi-element antenna, a beam-converted antenna set, and/or the like. In some embodiments, antennas 406 and/or 408 can implement transmit and receive functions using separate transmit and receive antenna elements. In some embodiments, antennas 406 and/or 408 can implement transmit and receive functions using common and/or integrated transmit/receive elements.

In some demonstrative embodiments, wireless communication device 400 also includes a wireless communication controller 402 that is configured to control transceiver module 404, for example, according to the functionality of wireless communication device 400.

In one example, controller 402 can control transceiver module 404 to execute a control station (eg, control station 120 (FIG. 1), control station 220 (FIG. 2), and/or control station 320, for example, as described above. (Figure 3)) features.

In another example, for example, as described above, the controller 402 can control the transceiver module 404 to perform the functions of a wireless communication node (eg, a backhaul node), such as nodes 102, 104, 106, 108, 110 and/or 112 (FIG. 1), backhaul node 210 (FIG. 2), and/or backhaul node 310 (FIG. 3).

In some demonstrative embodiments, wireless communication device 400 may also include, for example, one or

more of processor 416, memory unit 418, and storage unit 420. Wireless communication device 400 can optionally include other suitable hardware components and/or software components. In some demonstrative embodiments, some or all of the components of wireless communication device 400 may be enclosed in a common housing or package and may be interconnected or operatively associated using one or more wired or wireless links. In other embodiments, the components of wireless communication device 400 can be distributed between multiple or separate devices.

The processor 416 includes, for example, a central processing unit (CPU), a digital signal processor (DSP), one or more processor cores, a single core processor, a dual core processor, a multi-core processor, a microprocessor, a host processor. Controller, multiple processors or controllers, chips, microchips, one or more circuits, circuitry, logic units, integrated circuits (ICs), application specific ICs (ASICs), or any other suitable multi-purpose or specialized processing Or controller. Processor 416 executes, for example, an operating system (OS) of wireless communication device 400 and/or instructions of one or more suitable applications.

The memory unit 418 includes, for example, a random access memory (RAM), a read only memory (ROM), a dynamic RAM (DRAM), a synchronous DRAM (SD-RAM), a flash memory, a volatile memory, a nonvolatile memory, a cache memory, a buffer, a short-term memory unit, a long-term memory unit, or other suitable memory unit. The storage unit 420 includes, for example, a hard disk drive, a floppy disk drive, a compact disk (CD) drive, a CD-ROM drive, a DVD drive, or other suitable removable or non-removable storage unit. Memory unit 418 and/or storage unit 420, for example, can store data processed by wireless communication device 400.

In some demonstrative embodiments, as described below, wireless communication device 400 can utilize a common antenna (eg, a common antenna array) to communicate over multiple wireless communication links (eg, multiple wireless backhaul circuits).

In some demonstrative embodiments, antenna 408 may include an antenna array that includes a plurality of antenna elements. The plurality of antenna elements of the antenna array can be configured, for example, to generate a plurality of highly oriented antenna patterns. The plurality of antenna elements include, for example, about 16-36 antenna elements or any other number of antenna elements that can be placed in a predefined geometry. For example, as described below, multiple antenna elements can be configured to form a plurality of highly oriented antenna patterns or beams that can be manipulated by setting the appropriate signal phase at the antenna elements.

In some demonstrative embodiments, controller 402 may be configured to control antenna 408 to generate and manipulate multiple beams to point to a number of other devices, such as other backhaul nodes. For example,

wireless communication device 400 can manipulate multiple beams to communicate with multiple wireless backhaul nodes via multiple wireless backhaul links on multiple beams formed by antennas 408. In one example, node 108 (FIG. 1) can include controller 402 to control antenna 408 to form a first beam directed to node 110 (FIG. 1) to communicate with node 110 on backhaul link 174 (FIG. 1) (FIG. 1) Communication, and forming a second beam directed to node 106 (FIG. 1) to communicate with node 106 (FIG. 1) on backhaul link 173 (FIG. 1).

In other embodiments, wireless communication device 400 can utilize multiple separate antennas (eg, antenna arrays) to communicate over multiple wireless communication links (eg, multiple wireless backhaul links).

The following is a description of a modular antenna array that can be utilized by wireless communication device 400 in accordance with some demonstrative embodiments. In other embodiments, any other suitable antenna array can be used. For example, a modular antenna array can perform the functions of antenna 408. In some demonstrative embodiments, the modular antenna array may also perform shared MIMO and/or beamforming processing for multiple beams.

In some demonstrative embodiments, the antenna array may include a modular architecture configured to synthesize a larger composite antenna array from smaller sub-array antenna modules. The combination of RF beamforming in a sub-array antenna module with central beamforming that can be implemented, for example, between baseband, intermediate frequency, and/or sub-array antenna modules in an RF chain can provide, for example, enhanced beamforming capabilities, for example, Beamwidth, gain, coverage, and beam steering. The antenna array can be configured to operate, for example, in a millimeter wave region of the RF spectrum, particularly, for example, in a 60 GHz region associated with the use of a wireless personal area network (WPAN) and a wireless local area network (WLAN) communication system.

Reference is now made to Fig. 5, which schematically illustrates a modular antenna array 500, in accordance with some demonstrative embodiments.

In some demonstrative embodiments, modular antenna array 500 may perform the functions of antenna 408 (FIG. 4).

In some demonstrative embodiments, modular antenna array 500 may include at least one antenna array 507 that includes a plurality of antenna elements 517. The plurality of antenna elements 517 can be configured to, for example, produce a highly directional antenna pattern. The plurality of antenna elements 517 include, for example, about 16 to 36 antenna elements or any other number of antenna elements that can be placed in a

predefined geometry. For example, as described below, multiple antenna elements 517 can be configured to form a plurality of highly oriented antenna patterns or beams that can be set by setting the appropriate signal phase at antenna element 517. Control.

In some demonstrative embodiments, antenna array 507 may include multiple antenna sub-arrays. For example, antenna array 507 can include a first antenna sub-array 535 and a second antenna sub-array 545. In other embodiments, antenna array 507 can include any other number of antenna sub-arrays. For example, more than two antenna sub-arrays.

The phrase "antenna subarray" as used herein may refer to a group of antenna elements of a plurality of antenna elements 517 that may be coupled to, for example, a common RF chain. In one example, antenna 507 can include an array of antennas that can be divided into a plurality of, for example, independent sub-arrays, each of which can independently generate directional beams. In another example, antenna 507 can include a plurality of different antenna arrays to generate a plurality of directional beams. In another example, antenna 507 can include two or more different antenna arrays. One or more of the different antenna arrays can be divided into two or more sub-arrays.

In some demonstrative embodiments, the first antenna sub-array 535 may include a first plurality of antenna elements of the plurality of antenna elements 517, the first plurality of antenna elements being configured to form a first orientation directed to the first direction 539 Beam 537.

In some demonstrative embodiments, the second antenna array 545 may include a second (eg, different) plurality of antenna elements of the plurality of antenna elements 517, the second plurality of antenna elements being configured to form a second direction 549 Second directional beam 547.

Some illustrative embodiments are described herein with respect to a modular antenna array (eg, modular antenna array 500) that includes two sub-arrays (eg, antenna sub-arrays 535 and 545) that are configured to form two directional beams . However, in other embodiments, the modular antenna array can include any other plurality of antenna sub-arrays to form any other plurality of directional beams.

In some demonstrative embodiments, modular antenna array 500 may include a plurality of radio frequency (RF) chains configured to control first plurality of antenna elements and second plurality of antenna elements of antenna sub-arrays 535 and 545 .

In some demonstrative embodiments, multiple RF chains may be coupled to multiple antenna sub-arrays. For example, modular antenna array 500 can include a first RF chain 530 coupled to first antenna sub-array 535 and a second RF chain 540 coupled to second antenna sub-array 545. In other embodiments, modular antenna array 500 can include any other number of RF chains coupled to any other number of antenna sub-arrays of the plurality of antenna sub-arrays, for example, two connected to more than two antenna sub-arrays Above RF chain.

In some demonstrative embodiments, RF chain 530 and/or 540 may comprise a radio frequency integrated circuit (RFIC) or may be included as part of a radio frequency integrated circuit (RFIC), which may pass through a plurality of feed lines 518 (eg, may It is a microstrip feed line) that is connected to antenna sub-arrays 535 and 545.

In some demonstrative embodiments, multiple RF chains may allow for processing of, for example, two or more independent RF signals carrying different data. For example, RF chain 530 can process RF signal 531 and RF chain 540 can process RF signal 541.

In some demonstrative embodiments, RF chain 530 may include a plurality of phase shifters 515 that are configured to adjust the phase of the antenna elements of antenna sub-array 535. For example, the phase shifters in phase shifter 515 can be configured to adjust corresponding antenna elements of antenna sub-array 535.

For example, the phase of the antenna elements of antenna sub-array 535 can be shifted, for example, by phase shifter 515 to provide constructive and/or destructive interference, and the phase shifter is configured to change the beamforming scheme of antenna sub-array 535 and change The direction of the directional beam 537.

In some demonstrative embodiments, RF chain 540 may include a plurality of phase shifters 514 that are configured to adjust the phase of the antenna elements of antenna sub-array 545. For example, the phase shifters in phase shifter 514 can be configured to adjust corresponding antenna elements of antenna sub-array 545.

For example, the phase of the antenna elements of antenna sub-array 545 can be shifted, for example, by phase shifter 514 to provide constructive or destructive interference, and the phase shifter is configured to change the beamforming scheme of antenna sub-array 545 and change the directional beam. Direction of 547.

Phase shifters 515 and/or 514 can be discrete, for example, configured to rotate the phase of the antenna elements of antenna sub-arrays 535 and/or 545 to a finite set of values, eg, 0 , $\pm \pi/2$, and π , allowing Only relatively

coarse beamforming is used to change the direction of directional beams 537 and/or 547.

In some demonstrative embodiments, RF chain 530 may include a summer/divider block 513 coupled to phase shifter 515, and/or RF chain 540 may include a summer coupled to phase shifter 514/ Splitter block 512.

In some demonstrative embodiments, summer/divider block 513 may include a splitter 534 (eg, a multiplexer) that may be configured to regenerate RF signal 531 and in antenna sub-array 535 The RF signal 531 is split between the antenna elements and the regenerated signal of the RF signal 531 is coupled to a phase shifter 515, for example, when the RF signal 531 is transmitted through the beam 537.

In some demonstrative embodiments, the summer/divider block 513 may include a summer 536 configured to sum the signals received from the antenna elements of the antenna sub-array into an RF signal 531, for example, When the RF signal 531 is received through the beam 537.

In some demonstrative embodiments, utilizing two or more RF chains may allow for baseband processing of, for example, two or more independent signals carrying different data. In contrast, utilizing a single RF chain may allow for baseband processing of only one signal, for example, even with a large number of antenna elements 517.

For example, RF chains 530 and 540 may allow for baseband processing (eg, independent baseband processing) of RF signals 531 and 541 transmitted through directional beams 537 and 547.

In some demonstrative embodiments, RF signal 531 may include a first wireless backhaul link (eg, backhaul link 174 (FIG. 1)) over beam 537 by a backhaul node (eg, node 108 (FIG. 1)) The transmitted data, and the RF signal 541 may include data transmitted by the backhaul node via a second wireless backhaul link (eg, backhaul link 173 (FIG. 1)) on beam 547.

In some demonstrative embodiments, for example, as described below, modular antenna array 500 may utilize two or more RF chains to perform diverse communications for beamforming.

The phrase "diversified communication of beamforming" as used herein may refer to any communication that utilizes multiple beams.

In some demonstrative embodiments, modular antenna array 500 may include a baseband 550 configured to control antenna sub-arrays 535 and 545 to form directional beams 537 and 547 pointing in directions 539 and 549 to transmit MIMO wireless transmissions.

In some demonstrative embodiments, baseband 550 may process input data 521 into MIMO wireless transmissions that will be transmitted using a MIMO beamforming scheme, for example, as described below.

In some demonstrative embodiments, input data 521 may include data to be transmitted over one or more backhaul links (eg, backhaul links 173 and/or 174 (FIG. 1)).

Some illustrative embodiments are described herein with reference to a wireless communication unit (e.g., modular antenna array 500) that is configured to perform transmission and reception of MIMO beamforming communications. Other embodiments include a wireless communication unit that is only capable of performing one of transmission and reception of MIMO beamforming communications.

Some illustrative embodiments are described herein with reference to a communication system (e.g., wireless communication system 500) in which both the TX side and the RX side utilize multiple antenna sub-arrays to transmit MIMO transmissions. However, it is possible to form a single-input multiple-output (SIMO) and/or multiple-input single-output (MISO) with respect to a system configured to transmit any other diverse communication letter (eg, where only one of the Tx side and the Rx side utilizes multiple antenna sub-arrays, for example) Other embodiments are implemented by outputting a system of (MISO) beamforming links. For example, one of the Tx side and the Rx side may utilize an omnidirectional antenna, and the other of the Tx and Rx sides may utilize a multi-array transceiver, such as modular antenna array 500.

In some demonstrative embodiments, modular antenna array 500 may include a plurality of baseband (BB) to RF (BB2RF) converters that interface between a plurality of RF chains and baseband 550. For example, modular antenna array 500 can include a BB2 RF converter 533 that interfaces between RF chain 530 and baseband 550, and a BB2 RF converter 543 that interfaces between RF chain 540 and baseband 550. In other embodiments, modular antenna array 500 can include any other number (eg, more than two) of BB2 RF converters connected between baseband 550 and any other number of RF chains.

In some demonstrative embodiments, BB2 RF converter 533 may convert RF signal 531 to baseband data signal 527 and vice versa, and/or BB2 RF converter 543 may convert RF signal 541 to baseband data signal 529 and vice versa .

In one example, for example, if modular antenna array 500 receives MIMO wireless transmissions via beams 537 and/or 547, BB2 RF converter 543 can convert RF signal 531 to baseband data signal 527, and/or BB2 RF converter 543 can The RF signal 541 is converted to a baseband data signal 529.

In another example, for example, if modular antenna array 500 receives MIMO wireless transmissions via beams 537 and/or 547, BB2 RF converter 533 can convert baseband data signals to 527 RF signals 531, and/or BB2 RF converter 543 can The baseband data signal 529 is converted to an RF signal 541.

In some demonstrative embodiments, for example, if modular antenna array 500 receives MIMO wireless transmissions, BB2 RF converters 533 and/or 543 may include a down-converter 532 that is configured to The RF signal is converted to a baseband data signal and the baseband data signal is provided to baseband 550.

For example, BB2 RF converter 533 can include a down converter 532 that is configured to downconvert RF signal 531 to data signal 527 and provide the data signal to baseband 550.

In some demonstrative embodiments, for example, if modular antenna array 500 transmits MIMO wireless transmissions, baseband to RF converters 533 and/or 543 may include an up-converter 538 that is configured To convert the baseband data signal to an RF signal, the RF signal is provided to the RF chain.

For example, BB2 RF converter 533 can include an upconverter 538 that is configured to upconvert data signal 527 to RF signal 531 and RF signal 531 to RF chain 530.

In some demonstrative embodiments, modular antenna array 500 may be configured to perform hybrid beamforming. For example, as described below, hybrid beamforming can include performing coarse beamforming in RF chains 530 and/or 540, for example, using phase shifters 539 and/or 549; and performing fine beamforming in baseband 550.

In one example, coarse and/or fine beamforming may be performed, for example, as part of a beamforming process for setting up a beamforming link.

In some demonstrative embodiments, fine beamforming may include diverse processing at baseband 550, such as

MIMO processing, MISO processing, and/or SIMO processing. For example, MIMO processing may include, for example, closed loop (CL) MIMO processing, open loop (OL) MIMO processing, spatial block coding (SBC) MIMO processing, (eg, space time block coding (STBC) MIMO processing, null Frequency block coding (SFBC) MIMO processing).

In some demonstrative embodiments, modular antenna array 500 may include a controller 522 configured to control RF chains 535 and 545 and baseband 550 to perform coarse beamforming and/or fine beamforming.

In some demonstrative embodiments, controller 522 may utilize control signal 528 to control antenna sub-arrays 535 and/or 545 that carry one or more phase shifts to be applied to phase shifters 515 and/or 514. The amount of phase shift on the device.

In some demonstrative embodiments, the phase shift adjustment of phase shifter 515 may determine and/or control the beamwidth, gain, and/or direction of directional beam 537 formed by antenna sub-array 535.

In some demonstrative embodiments, the phase shift adjustment of phase shifter 514 may determine and/or control the beamwidth, gain, and/or direction of directional beam 547 formed by antenna sub-array 545.

In some demonstrative embodiments, each phase shifter of the antenna elements of antenna sub-arrays 535 and/or 545 may perform local phase adjustment on the signals to produce a local phase distribution in the desired beam direction.

In some demonstrative embodiments, control signal 528 may include weighting coefficients that may be generated and/or derived from controller 522 that are configured to manipulate directional beams 537 and/or 547.

In some demonstrative embodiments, controller 522 may provide a first set of weighting coefficients to phase shifter 515 via control signal 528, which is configured to form one or more antenna elements of antenna sub-array 535. The local phase is adjusted such that beam 537 is directed to direction 539.

In some demonstrative embodiments, controller 522 may provide a second (eg, different) set of weighting coefficients to phase shifter 514 via controller 528, which is configured to form one of paired antenna sub-arrays 545. Or local phase adjustment of multiple antenna elements such that beam 547 is directed in direction 549.

In some demonstrative embodiments, multiple different signals may be transmitted over multiple beamforming links formed by multiple beamformed beams. Each beamforming link corresponding to an antenna sub-array in a plurality of antenna sub-arrays may, for example, transmit signals through a plurality of antenna elements of the antenna sub-array.

For example, a first signal (e.g., signal 527) may be transmitted over a first beamformed link formed by directional beam 537 generated by antenna sub-array 535, and may be passed through a directional beam generated by antenna sub-array 545. A second beamformed link formed by 547 transmits a second (eg, different) signal (eg, signal 529).

In some demonstrative embodiments, modular antenna array 500 may be utilized by nodes to form one or more independently directional communication beams. In one example, modular antenna array 500 can be utilized by node 108 (FIG. 1) to form a first directional beam to communicate on backhaul link 174 (FIG. 1) and form a second directional beam to be on backhaul link 173. (Figure 1) Communication on.

Referring to Figure 6, Figure 6 schematically illustrates a method of wireless backhaul communication in accordance with some demonstrative embodiments. For example, one or more of the operations of the method of FIG. 6 can be performed by a wireless communication system (eg, system 100), a wireless communication node (eg, nodes 102, 104, 106, 108, 110, 112 (FIG. 1), 210 (FIG. 2), and/or 310 (FIG. 3), control stations (eg, control station 120 (FIG. 1), 220 (FIG. 2), and/or 320 (FIG. 3)), And/or a wireless communication device (eg, wireless communication device 400 (FIG. 4)).

In some demonstrative embodiments, one or more of the operations of the method of FIG. 6 may implement a dual band backhaul network over a first frequency band and a second frequency band. For example, the first frequency band can be larger than the second frequency band. In one example, the first frequency band can include a millimeter wave band and the second frequency band can include a non-millimeter wave band, for example, as described above.

As indicated at block 602, the method can include communicating between the wireless communication node and the control station via the backhaul link over the second frequency band. For example, as described above, wireless communication node 102 (FIG. 1) can communicate with control station 120 (FIG. 1) via control link 161 (FIG. 1).

As indicated at block 604, the method can include communicating between the wireless communication node and one or more other wireless communication nodes over the first frequency band via one or more backhaul links of the backhaul network. For example, as described above, wireless communication node 102 (FIG. 1) can communicate with wireless communication node 104 (FIG. 1) via backhaul link 171 (FIG. 1).

As indicated at block 606, communication over the control link can include transmitting control information between the control station and the wireless communication node, the control information defining the wireless communication node in accordance with a routing map for routing backhaul traffic via the backhaul link. One or more backhaul links with one or more other wireless communication nodes. For example, as described above, control station 120 (FIG. 1) can transmit control information defining a routing map to node 102 (FIG. 1) on control link 161 (FIG. 1).

As indicated at block 608, transmitting control information can include transmitting connectivity information from a plurality of wireless communication nodes. For example, as described above, control station 120 (FIG. 1) may collect status information from a backhaul node, such as on/off status, millimeter wave band connectivity map information, traffic strength through a node, and the like.

As indicated at block 610, transmitting connectivity information may include instructing a backhaul node to perform a search for a peer backhaul node suitable for millimeter wave band communication. For example, as described above, control station 120 (FIG. 1) may, for example, instruct command node 102 (FIG. 1) via control link 161 (FIG. 1) to search for communication on one or more backhaul links. One or more other nodes (eg, node 104 (FIG. 1)).

As indicated at block 612, transmitting connectivity information may include requesting connectivity information from the backhaul node. For example, control station 120 (FIG. 1) may transmit a request for connectivity information from control station 120 (FIG. 1) to node 102 (FIG. 1) via control link 161 (FIG. 1). For example, as described above, connectivity information may include, for example, information regarding the ability of wireless communication node 102 (FIG. 1) to connect to one or more other wireless communication nodes on a backhaul link, and/or about wireless communication information on the capabilities of node 102 (FIG. 1) to the core network.

As indicated at 614, the transmission control information can include calculating and/or configuring or reconfiguring a connectivity map that defines a backhaul node to be established between the backhaul nodes. For example, control station 120 (FIG. 1) can configure a connectivity map between nodes 102, 104, 106, 108, 110, and/or 112 (FIG. 1) to include a particular node pair, eg, based on the collected connectivity information. Multiple backhaul links between, for example, to configure/optimize the millimeter wave backhaul network.

As indicated at block 616, transmitting control information can include instructing the backhaul node to configure the wireless backhaul link according to the connectivity map. For example, as described above, control station 120 (FIG. 1) may control node 102 (FIG. 1), eg, via control link 161 (FIG. 1), to establish a backhaul chain 171 with node 104 (FIG. 1). (figure 1).

Referring to Figure 7, Figure 7 schematically illustrates the manufacture of a product 700 in accordance with some illustrative embodiments. Product 700 can include a non-transitory machine readable storage medium 702 storing logic 704 that can be used, for example, to perform at least a portion of the functions of wireless communication nodes 102, 104, 106, 108, 110, and/or 112 (1), wireless communication node 210 (FIG. 2), wireless communication node 310 (FIG. 3), control station 120 (FIG. 1), control station 220 (FIG. 2), control station 320 (FIG. 3), and/or wireless Communication device 400 (Fig. 4); and/or one or more operations for performing the method of Fig. 6. The phrase "non-transitory machine readable medium" is intended to include all computer readable media, except for transient propagation signals.

In some demonstrative embodiments, product 700 and/or machine readable storage medium 702 can include one or more types of computer readable media capable of storing data, including: volatile memory, nonvolatile memory, Removable or non-removable memory, erasable or non-erasable memory, writable or non-writable memory, and the like. For example, machine-readable storage storage medium 702 can include RAM, DRAM, double data rate DRAM (DDR-DRAM), SDRAM, static RAM (SRAM), ROM, programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), high density disk ROM (CD-ROM), recordable high density disk (CD-R), rewritable high density disk (CD-RW), flash Memory (eg, NOR or NAND flash memory), content addressable memory (CAM), polymer memory, phase change memory, ferroelectric memory, silicon oxynitride (SONOS) memory, disk, floppy disk, hard disk drive, CD, disk, card, magnetic card, optical card, tape, cassette, etc. A computer readable storage medium may comprise any suitable medium involved in downloading or transmitting a computer program from a remote computer to a requesting computer via a communication link (eg, a modem, a radio connection, or a network connection), wherein the computer program is It is carried by a data signal embodied in a carrier wave or other propagation medium.

In some demonstrative embodiments, logic 704 may include instructions, data, and/or code that, if executed by a machine, cause a machine to perform the methods, processes, and/or operations described herein. The machine can include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, etc., and can be implemented using any suitable combination of hardware, software, firmware, and the like. .

In some demonstrative embodiments, logic 704 may include or be implemented as software, software modules, applications, programs, subroutines, instructions, sets of instructions, computing code, words, values, symbols, and the like. These instructions may include any suitable type of code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, and the like. These instructions may be implemented in accordance with a predetermined computer language, manner, or syntax to direct the processor to perform a certain function. These instructions can be implemented using any suitable advanced, low-level, object-oriented, visual, compiled, and/or interpreted programming language, for example, C, C++, Java, BASIC, Matlab, Pascal, Visual BASIC, Assembly Language, machine code, and more.

Example

The following examples are related to other embodiments.

Example 1 includes a wireless communication device including a wireless communication controller that controls one or more other wireless networks via one or more backhaul links of a backhaul network over a first frequency band. The communication node communicates and communicates with the control station via a control link on the second frequency band that is higher than the second frequency band.

Example 2 includes the subject matter of Example 1 and optionally wherein the wireless communication controller controls the wireless communication node to receive control information from the control station via the control link, the control information defining a backhaul link and a routing map via the backhaul link, wherein The wireless communication controller controls the wireless communication node to establish a backhaul link based on the control information.

Example 3 includes the subject matter of Example 2 and optionally wherein the wireless communication controller controls the wireless communication node to receive a request for connectivity information from the control station via the control link, the connectivity information being coupled to the wireless communication node to one or Related to the capabilities of a plurality of other wireless communication nodes, wherein the wireless communication controller controls the wireless communication node to transmit the connectivity information to the control station over the control link, and wherein the control information from the control station is based on connectivity information .

Example 4 includes the subject matter of Example 2 or 3 and optionally wherein the connectivity information relates to the ability of the wireless communication node to connect to the core network.

Example 5 includes the subject matter of any of Examples 1-4 and optionally wherein the backhaul link comprises a link that transmits backhaul traffic between one or more other wireless communication nodes and a core network.

Example 6 includes the subject matter of Example 5 and optionally wherein the wireless communication node includes a backhaul endpoint node to communicate over the core network.

Example 7 includes the subject matter of Example 5 or 6 and optionally wherein the wireless communication controller controls the wireless communication node to communicate traffic between the core network and one or more mobile devices of the wireless communication cell.

Example 8 includes the subject matter of any of Examples 5-7 and optionally wherein the wireless communication controller controls the communication node to transmit backhaul traffic on a backhaul link between the wireless communication node and the control station.

Example 9 includes the subject matter of any of Examples 1-8 and optionally wherein the control station comprises a node of one or more other wireless communication nodes.

Example 10 includes the subject matter of any of Examples 1-9 and optionally wherein the backhaul link comprises at least one half-duplex link.

Example 11 includes the subject matter of any of Examples 1-10 and optionally wherein the backhaul link comprises at least one full duplex link.

Example 12 includes the subject matter of any of Examples 1-11 and optionally wherein the wireless communication node communicates with one or more mobile devices of the wireless communication cell over one or more access links.

Example 13 includes the subject matter of Example 12 and optionally wherein the access link comprises a link on a frequency band selected from the group consisting of a first frequency band and a second frequency band.

Example 14 includes the subject matter of any of Examples 1-13 and optionally wherein the wireless communication controller controls the wireless communication node to communicate on both the first frequency band and the second frequency band.

Example 15 includes the subject matter of any of Examples 1-14 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 16 includes the subject matter of Example 15 and optionally wherein the second frequency band comprises a cellular frequency band.

Example 17 includes the subject matter of Example 16 and optionally wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 18 includes the subject matter of any of Examples 1-17 and optionally wherein the wireless communication node comprises an access point or a base station.

Example 19 includes the subject matter of any of Examples 1-18 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 20 includes a wireless communication device including a wireless communication controller that communicates control information between a wireless communication node of a plurality of wireless communication nodes and a control station via a control link, the control information defining wireless a backhaul link between the communication node and one or more other wireless communication nodes of the plurality of wireless communication nodes, the backhaul links including links on the first frequency band to communicate traffic between the wireless communication node and the core network. The control information defines a route map for routing the traffic via a backhaul link, the control link including a link on a second frequency band, wherein the first frequency band is higher than the second frequency band.

Example 21 includes the subject matter of Example 20 and optionally wherein the wireless communication controller controls the control station to transmit control information from the control station to the wireless communication node.

Example 22 includes the subject matter of Example 21 and optionally wherein the wireless communication controller controls the control station to communicate with one or more wireless communication nodes via one or more other control links to define including a plurality of wireless communication nodes A backhaul network between multiple backhaul links.

Example 23 includes the subject matter of Example 20 and optionally wherein the wireless communication controller controls the wireless communication node to receive control information from the control station and establish a backhaul link based on the control information.

Example 24 includes the subject matter of Example 20 and optionally wherein the wireless communication controller transmits a request for connectivity information from the control station over the control link, the connectivity information being coupled to the wireless communication node to one or more other wireless communications The capabilities of the node are related, wherein the wireless communication controller transmits connectivity information to the control station over the control link, and wherein the control information from the control station is based on connectivity information.

Example 25 includes the subject matter of Example 24 and, optionally, wherein the connectivity information is related to an ability of the wireless communication node to connect to the core network.

Example 26 includes the subject matter of any of Examples 20-25 and optionally wherein the wireless communication node comprises a backhaul endpoint node to communicate over the core network and pass between the core network and one or more other wireless communication nodes flow.

Example 27 includes the subject matter of any of Examples 20-26 and optionally wherein the wireless communication controller controls the communication node to transmit traffic on a backhaul link between the wireless communication node and the control station.

Example 28 includes the subject matter of any of Examples 20-27 and optionally wherein the backhaul link comprises at least one half-duplex link.

Example 29 includes the subject matter of any of Examples 20-28 and optionally wherein the backhaul link comprises at least one full duplex link.

Example 30 includes the subject matter of any of Examples 20-29 and optionally wherein the wireless communication controller controls the wireless communication node to communicate on both the first frequency band and the second frequency band.

Example 31 includes the subject matter of any of Examples 20-30 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 32 includes the subject matter of Example 31 and optionally wherein the second frequency band comprises a cellular frequency band.

Example 33 includes the subject matter of Example 32 and optionally wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 34 includes the subject matter of any of Examples 20-33 and optionally wherein the wireless communication node comprises an access point or a base station.

Example 35 includes the subject matter of any of Examples 20-34 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 36 includes a wireless communication system including: a wireless communication node including one or more antennas; at least one transceiver communicating on the first frequency band and the second frequency band, the first frequency band being higher than the second frequency band; a wireless communication controller that controls the wireless communication node to communicate with one or more other wireless communication nodes over one or more backhaul links of the backhaul network on the first frequency band and over the second frequency band. The control link communicates with the control station.

Example 37 includes the subject matter of Example 36 and, optionally, wherein the wireless communication controller controls the wireless communication node to receive control information from the control station via the control link, the control information defining a backhaul link and a route map via the backhaul link, Wherein, the wireless communication controller controls the wireless communication node to establish a backhaul link according to the control information.

Example 38 includes the subject matter of Example 37 and, optionally, wherein the wireless communication controller controls the wireless communication node to receive a request for connectivity information from the control station via the control link, the connectivity information being coupled to the wireless communication node to one or Related to the capabilities of a plurality of other wireless communication nodes, wherein the wireless communication controller controls the wireless communication node to transmit the connectivity information to the control station over the control link, and wherein the control information from the control station is based on connectivity information of.

Example 39 includes the subject matter of Example 37 or 38 and, optionally, wherein the connectivity information relates to a capability of the wireless communication node to connect to the core network.

Example 40 includes the subject matter of any of Examples 36-39 and optionally wherein the backhaul link comprises a link that passes backhaul traffic between one or more other wireless communication nodes and a core network.

Example 41 includes the subject matter of Example 40 and, optionally, wherein the wireless communication node includes a backhaul endpoint node to communicate over the core network.

Example 42 includes the subject matter of Example 40 or 41 and, optionally, wherein the wireless communication controller controls the wireless communication node to transmit traffic between the core network and one or more mobile devices of the wireless communication cell.

Example 43 includes the subject matter of any of Examples 40-42 and optionally wherein the wireless communication controller controls the communication node to transmit backhaul traffic over a backhaul link between the wireless communication node and the control station.

Example 44 includes the subject matter of any of Examples 36-43 and optionally wherein the control station includes a node of one or more other wireless communication nodes.

Example 45 includes the subject matter of any of Examples 36-44 and optionally wherein the backhaul link comprises at least one half-duplex link.

Example 46 includes the subject matter of any of Examples 36-45 and optionally wherein the backhaul link

comprises at least one full duplex link.

Example 47 includes the subject matter of any of Examples 36-46 and optionally wherein the wireless communication node communicates with one or more mobile devices of the wireless communication cell over one or more access links.

Example 48 includes the subject matter of Example 47 and, optionally, wherein the access link comprises a link on a frequency band selected from the group consisting of a first frequency band and a second frequency band.

Example 49 includes the subject matter of any of Examples 36-48 and optionally wherein the wireless communication controller controls the wireless communication node to communicate on both the first frequency band and the second frequency band.

Example 50 includes the subject matter of any of Examples 36-49 and optionally wherein the one or more antennas comprise an antenna array, and wherein the wireless communication controller is to control the antenna array to transmit the backhaul link over the plurality of directional beams .

Example 51 includes the subject matter of any of Examples 36-50 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 52 includes the subject matter of Example 51 and, optionally, wherein the second frequency band comprises a cellular frequency band.

Example 53 includes the subject matter of Example 52 and, optionally, wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 54 includes the subject matter of any of Examples 36-53 and optionally wherein the wireless communication node comprises an access point or a base station.

Example 55 includes the subject matter of any of Examples 36-54 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 56 includes a wireless communication system including: a wireless communication device including one or more antennas; at least one transceiver that communicates over a first frequency band and a second frequency band, the first frequency band being higher than a second frequency band; and a wireless communication controller that controls the wireless communication device to transmit control information between the wireless communication node of the plurality of wireless communication nodes and the control station via the control link, the control information defining wireless communication a backhaul link between the node and one or more other wireless communication nodes of the plurality of wireless communication nodes, the backhaul link including a link on the first frequency band to transmit information between the wireless communication node and the core network, The control information defines a route map for routing traffic over the backhaul link, the control link including the link on the second frequency band.

Example 57 includes the subject matter of Example 56 and, optionally, wherein the wireless communication controller controls the control station to transmit control information from the control station to the wireless communication node.

Example 58 includes the subject matter of Example 57 and, optionally, wherein the wireless communication controller controls the control station to communicate with one or more wireless communication nodes via one or more other control links to define including a plurality of wireless communication nodes A backhaul network between multiple backhaul links.

Example 59 includes the subject matter of Example 58 and optionally wherein the wireless communication controller controls the wireless communication node to receive control information from the control station and establish a backhaul link based on the control information.

Example 60 includes the subject matter of Example 59 and, optionally, wherein the wireless communication controller transmits a request for connectivity information from the control station over the control link, the connectivity information being coupled to the wireless communication node to one or more other wireless communications The capabilities of the node are related, wherein the wireless communication controller transmits connectivity information to the control station over the control link, and wherein the control information from the control station is based on connectivity information.

Example 61 includes the subject matter of Example 60 and, optionally, wherein the connectivity information relates to a capability of the wireless communication node to connect to the core network.

Example 62 includes the subject matter of any of Examples 56-61 and optionally wherein the wireless communication node comprises a backhaul endpoint node to communicate over the core network and transmit between the core network and one or more other wireless communication nodes flow.

Example 63 includes the subject matter of any of Examples 56-62 and optionally wherein the wireless communication controller controls the communication node to transmit traffic on a backhaul link between the wireless communication node and the control station.

Example 64 includes the subject matter of any of Examples 56-63 and optionally wherein the backhaul link comprises at least one half-duplex link.

Example 65 includes the subject matter of any of Examples 20-28 and optionally wherein the backhaul link comprises at least one full duplex link.

The example 66 includes the subject matter of any of the examples 56-64 and optionally wherein the wireless communication controller controls the wireless communication node to simultaneously communicate on the first frequency band and the second frequency band.

Example 67 includes the subject matter of any of Examples 56-65 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 68 includes the subject matter of Example 67 and, optionally, wherein the second frequency band comprises a cellular frequency band.

Example 69 includes the subject matter of Example 68 and, optionally, wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 70 includes the subject matter of any of Examples 56-69 and optionally wherein the wireless communication node comprises an access point or a base station.

Example 71 includes the subject matter of any of Examples 56-70 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 72 includes a wireless communication method, the method comprising: communicating between a wireless communication node and one or more other wireless communication nodes via one or more backhaul links of a backhaul network on a first frequency band; The control link on the second frequency band communicates between the wireless communication node and the control station, the first frequency band being higher than the second frequency band.

Example 73 includes the subject matter of Example 72 and optionally includes receiving control information from the control station via the control link, the control information defining a backhaul link and a routing map via the backhaul link; and establishing a backhaul link based on the control information.

Example 74 includes the subject matter of Example 73 and optionally includes receiving, via the control link, a request for connectivity information from a control station, the capability of the connectivity information to connect to a wireless communication node to one or more other wireless communication nodes And transmitting the connectivity information to the control station on the control link, wherein the control information from the control station is based on connectivity information.

Example 75 includes the subject matter of Example 73 or 74 and optionally wherein the connectivity information relates to the ability of the wireless communication node to connect to the core network.

Example 76 includes the subject matter of any of Examples 72-75 and optionally wherein the backhaul link comprises a link that passes backhaul traffic between one or more other wireless communication nodes and a core network.

Example 77 includes the subject matter of Example 76 and optionally wherein the wireless communication node includes a backhaul endpoint node to communicate over the core network.

Example 78 includes the subject matter of Example 76 or 77 and optionally includes transmitting traffic between the core network and one or more mobile devices of the wireless communication cell.

Example 79 includes the subject matter of any of Examples 76-78 and, optionally, includes transmitting backhaul

traffic on a backhaul link between the wireless communication node and the control station.

Example 80 includes the subject matter of any of Examples 72-79 and optionally wherein the control station includes a node of one or more other wireless communication nodes.

Example 81 includes the subject matter of any of Examples 72-80 and optionally wherein the backhaul link comprises at least one half-duplex link.

Example 82 includes the subject matter of any of Examples 72-81 and optionally wherein the backhaul link includes at least one full duplex link.

Example 83 includes the subject matter of any of Examples 72-83 and, optionally, includes communicating with one or more mobile devices of a wireless communication cell via one or more access links.

Example 84 includes the subject matter of Example 83 and optionally wherein the access link comprises a link on a frequency band selected from the group consisting of a first frequency band and a second frequency band.

Example 85 includes the subject matter of any of Examples 72-84 and optionally includes simultaneously communicating on the first frequency band and the second frequency band.

Example 86 includes the subject matter of any of Examples 72-85 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 87 includes the subject matter of Example 86 and, optionally, wherein the second frequency band comprises a cellular frequency band.

Example 88 includes the subject matter of Example 87 and, optionally, wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 89 includes the subject matter of any of Examples 72-88 and optionally wherein the wireless

communication node comprises an access point or a base station.

Example 90 includes the subject matter of any of Examples 72-89 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 91 includes a method of wireless communication, the method comprising: transmitting, via a control link, control information between a wireless communication node of a plurality of wireless communication nodes and a control station, the control information defining the wireless communication node and the plurality of wireless communications. One or more backhaul links between one or more other wireless communication nodes in the node, the backhaul links including links on the first frequency band for communicating traffic between the wireless communication nodes and the core network. The control information defines a route map for routing traffic via the backhaul links, the control links including links on the second frequency band, wherein the first frequency band is higher than the second frequency band.

Example 92 includes the subject matter of Example 91 and optionally includes transmitting control information from the control station to the wireless communication node.

Example 93 includes the subject matter of Example 92 and optionally includes communicating with one or more other wireless communication nodes via one or more other control links to define a plurality of backhaul links between the plurality of wireless communication nodes. Backhaul network.

Example 94 includes the subject matter of Example 91 and optionally includes receiving control information from a control station and establishing a backhaul link based on the control information.

Example 95 includes the subject matter of Example 94 and optionally includes transmitting, via a control link, a request for connectivity information from a control station, the connectivity information related to a capability of the wireless communication node to connect to one or more other wireless communication nodes. And transmitting the connectivity information to the control station over the control link, wherein the control information from the control station is based on the connectivity information.

Example 96 includes the subject matter of Example 95 and, optionally, wherein the connectivity information relates to a capability of the wireless communication node to connect to the core network.

Example 97 includes the subject matter of any of Examples 91-96 and optionally wherein the wireless communication node comprises a backhaul endpoint node to communicate over the core network and transmit between the core network and one or more other wireless communication nodes flow.

Example 98 includes the subject matter of any of Examples 91-97 and optionally includes transmitting traffic on a backhaul link between the wireless communication node and the control station.

Example 99 includes the subject matter of any of Examples 91-98 and optionally wherein the backhaul link comprises at least one half-duplex link.

The example 100 includes the subject matter of any of the examples 91-99 and optionally wherein the backhaul link comprises at least one full duplex link.

The example 101 includes the subject matter of any of the examples 91-100 and optionally includes simultaneously communicating on the first frequency band and the second frequency band.

The example 102 includes the subject matter of any of the examples 91-101 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 103 includes the subject matter of example 102 and, optionally, wherein the second frequency band comprises a cellular frequency band.

Example 104 includes the subject matter of Example 103 and, optionally, wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

The example 105 includes the subject matter of any of the examples 91-104 and optionally wherein the wireless communication node comprises an access point or a base station.

The example 106 includes the subject matter of any of the examples 91-105 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 107 includes a product comprising a non-transitory storage medium having stored thereon instructions that, when executed by a machine, cause an operation to be performed via one or more backhaul links of a backhaul network on a first frequency band Communicating between the wireless communication node and one or more other wireless communication nodes; and communicating between the wireless communication node and the control station via a control link on the second frequency band, the first frequency band being higher than the second frequency band.

The example 108 includes the subject matter of the example 107 and, optionally, wherein the instructions further cause the following operations to be performed: receiving control information from the control station via the control link, the control information defining backhaul links and routing via the backhaul links And establishing a backhaul link based on the control information.

The example 109 includes the subject matter of the example 108 and, optionally, wherein the instructions further cause an operation to receive a request for connectivity information from the control station via the control link, the connectivity information being coupled to the wireless communication node to Related to the capabilities of one or more other wireless communication nodes; and transmitting the connectivity information to the control station via a control link, wherein control information from the control station is based on the connectivity information.

The example 110 includes the subject matter of the example 108 or 109 and optionally wherein the connectivity information relates to the ability of the wireless communication node to connect to the core network.

The example 111 includes the subject matter of any of the examples 107-110 and optionally wherein the backhaul link includes a link for transmitting backhaul traffic between one or more other wireless communication nodes and a core network.

The example 112 includes the subject matter of the example 111 and optionally wherein the wireless communication node includes a backhaul endpoint node to communicate over the core network.

The example 113 includes the subject matter of the example 111 or 112 and, optionally, wherein the instructions further cause the following operations to be performed: transmitting traffic between the core network and one or more mobile devices of the wireless communication cell.

The example 114 includes the subject matter of any of the examples 111-113 and, optionally, wherein the instructions further cause the following operations to be performed: transmitting backhaul traffic over a backhaul link between the wireless communication node and the control station.

The example 115 includes the subject matter of any of the examples 107-114 and optionally wherein the control station includes a node of one or more other wireless communication nodes.

The example 116 includes the subject matter of any of the examples 107-115 and optionally wherein the backhaul link includes at least one half-duplex link.

The example 117 includes the subject matter of any of the examples 107-116 and optionally wherein the backhaul link includes at least one full duplex link.

The example 118 includes the subject matter of any of the examples 107-117 and optionally wherein the instructions further cause the following operations to be performed: communicating with one or more mobile devices of the wireless communication cell over the one or more access links .

Example 119 includes the subject matter of example 118 and optionally wherein the access link comprises a link on a frequency band selected from the group consisting of a first frequency band and a second frequency band.

The example 120 includes the subject matter of any of the examples 107-119 and, optionally, wherein the instructions further cause the following operations to be performed: simultaneously communicating on the first frequency band and the second frequency band.

The example 121 includes the subject matter of any of the examples 107-120 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 122 includes the subject matter of example 121 and optionally wherein the second frequency band comprises a cellular frequency band.

Example 123 includes the subject matter of example 122 and optionally wherein the second frequency band

comprises a Long Term Evolution (LTE) frequency band.

The example 124 includes the subject matter of any of the examples 107-123 and optionally wherein the wireless communication node comprises an access point or a base station.

The example 125 includes the subject matter of any of the examples 107-124 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 126 includes a product comprising a non-transitory storage medium having stored thereon instructions that, when executed by a machine, cause the following operations to be performed: a wireless communication node and a control station among a plurality of wireless communication nodes via a control link Transmitting control information between the wireless communication node and one or more other wireless communication nodes of the plurality of wireless communication nodes, the backhaul links including for use in the wireless communication node and the core network a link between the traffic on the first frequency band, the control information defining a route map for routing traffic over the backhaul link, the control link including a link on the second frequency band, wherein the first frequency band is high In the second frequency band.

Example 127 includes the subject matter of example 126 and, optionally, wherein the instructions cause the following operations to be performed: transmitting control information from the control station to the wireless communication node.

Example 128 includes the subject matter of Example 127 and, optionally, wherein the instructions cause the following operations to be performed: communicating with one or more other wireless communication nodes via one or more other control links to define including multiple wireless communications A backhaul network of multiple backhaul links between nodes.

The example 129 includes the subject matter of the example 126 and, optionally, wherein the instructions cause the following operations to be performed: receiving control information from the control station and establishing a backhaul link based on the control information.

The example 130 includes the subject matter of the example 126 and, optionally, wherein the instructions cause the following operations to be performed: transmitting a request for connectivity information from the control station over the control link, the connectivity information being coupled to the one or more wireless communication nodes The capabilities of the other wireless communication nodes are related; and the

connectivity information is transmitted to the control station via the control link, wherein the control information from the control station is based on the connectivity information.

The example 131 includes the subject matter of the example 130 and, optionally, wherein the connectivity information relates to a capability of the wireless communication node to connect to the core network.

The example 132 includes the subject matter of any of the examples 126-131 and optionally wherein the wireless communication node includes a backhaul endpoint node to communicate over the core network and transmit between the core network and one or more other wireless communication nodes flow.

The example 133 includes the subject matter of any of the examples 126-132 and optionally wherein the instructions cause the following operations to be performed: transmitting traffic over a backhaul link between the wireless communication node and the control station.

The example 134 includes the subject matter of any of the examples 126-133 and optionally wherein the backhaul link comprises at least one half-duplex link.

Example 135 includes the subject matter of any of Examples 126-134 and optionally wherein the backhaul link includes at least one full duplex link.

The example 136 includes the subject matter of any of the examples 126-135 and, optionally, wherein the instructions cause the following operations to be performed: simultaneously communicating on the first and frequency band second frequency bands.

Example 137 includes the subject matter of any of Examples 126-136 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 138 includes the subject matter of Example 137 and, optionally, wherein the second frequency band comprises a cellular frequency band.

Example 139 includes the subject matter of example 138 and, optionally, wherein the second frequency band

comprises a Long Term Evolution (LTE) frequency band.

The example 140 includes the subject matter of any of the examples 126-139 and optionally wherein the wireless communication node comprises an access point or a base station.

The example 141 includes the subject matter of any of the examples 126-140 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 142 includes a wireless communication device including: means for communicating with one or more other wireless communication nodes via one or more backhaul links of a backhaul network on a first frequency band; The means for communicating the control link on the second frequency band with the control station, the first frequency band being higher than the second frequency band.

Example 143 includes the subject matter of example 142 and optionally includes: means for receiving control information from a control station via a control link, the control information defining a backhaul link and a routing map via the backhaul link; and based on the control information Establish a backhaul link.

Example 144 includes the subject matter of example 143 and optionally includes means for receiving a request for connectivity information from a control station via a control link, the connectivity information being coupled to the wireless communication node to one or more other wireless communications The capabilities of the node are related; and means for transmitting the connectivity information to the control station over the control link, wherein control information from the control station is based on the connectivity information.

Example 145 includes the subject matter of example 143 or 144 and, optionally, wherein the connectivity information relates to the ability of the wireless communication node to connect to the core network.

The example 146 includes the subject matter of any of the examples 142-145 and optionally wherein the backhaul link includes a link for transmitting backhaul traffic between one or more other wireless communication nodes and a core network.

Example 147 includes the subject matter of example 146 and optionally wherein the wireless communication node includes a backhaul endpoint node to communicate over the core network.

Example 148 includes the subject matter of example 146 or 147 and optionally includes means for transmitting traffic between the core network and one or more mobile devices of the wireless communication cell.

Example 149 includes the subject matter of any of Examples 146-148 and optionally and optionally includes means for transmitting backhaul traffic over a backhaul link between the wireless communication node and the control station.

The example 150 includes the subject matter of any of the examples 142-149 and optionally wherein the control station includes a node of one or more other wireless communication nodes.

The example 151 includes the subject matter of any of the examples 142-149 and optionally wherein the backhaul link comprises at least one half-duplex link.

The example 152 includes the subject matter of any of the examples 142-149 and optionally wherein the backhaul link includes at least one full duplex link.

Example 153 includes the subject matter of any of Examples 142-152 and optionally includes: means for communicating with one or more mobile devices of a wireless communication cell over one or more access links.

The example 154 includes the subject matter of the example 153 and, optionally, wherein the access link comprises a link on a frequency band selected from the group consisting of the first frequency band and the second frequency band.

Example 155 includes the subject matter of any of Examples 142-154 and optionally includes means for communicating on both the first frequency band and the second frequency band.

The example 156 includes the subject matter of any of the examples 142-155 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 157 includes the subject matter of example 156 and, optionally, wherein the second frequency band comprises a cellular frequency band.

Example 158 includes the subject matter of Example 157 and optionally wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 159 includes the subject matter of any of Examples 142-158 and optionally wherein the wireless communication node comprises an access point or a base station.

The example 160 includes the subject matter of any of the examples 142-159 and optionally wherein the control station comprises an evolved Node B (eNB).

Example 161 includes a wireless communication device including: means for transmitting control information between a wireless communication node and a control station among a plurality of wireless communication nodes via a control link, the control information defining a plurality of wireless communication nodes Backhaul links between one or more of the other wireless communication nodes, the backhaul links including links on the first frequency band for transmitting traffic between the wireless communication node and the core network, control The information defines a route map for routing the traffic over the backhaul link, the control link including a link on the second frequency band, wherein the first frequency band is higher than the second frequency band.

Example 162 includes the subject matter of Example 161 and optionally includes means for transmitting control information from the control station to the wireless communication node.

Example 163 includes the subject matter of example 162 and optionally includes communicating with one or more other wireless communication nodes via one or more other control links to define a plurality of backhaul chains between the plurality of wireless communication nodes The device of the backhaul network of the road.

The subject matter of example 164, including example 161, can optionally include means for receiving control information from a control station and establishing a backhaul link based on the control information.

The subject matter of the example 165, including the example 161, optionally includes means for transmitting a request for connectivity information from the control station via the control link, the connectivity information

being coupled to the one or more other wireless communication nodes with the wireless communication node. The capability is related to; and means for transmitting the connectivity information to the control station over the control link, wherein the control information from the control station is based on connectivity information.

The example 166 includes the subject matter of the example 165 and, optionally, wherein the connectivity information relates to a capability of the wireless communication node to connect to the core network.

Example 167 includes the subject matter of any of Examples 161-166 and optionally wherein the wireless communication node comprises a backhaul endpoint node to communicate over the core network and to communicate traffic between the core network and one or more other wireless communication nodes .

Example 168 includes the subject matter of any of Examples 161-167 and optionally includes means for transmitting traffic on a backhaul link between the wireless communication node and the control station.

Example 169 includes the subject matter of any of Examples 161-168 and optionally wherein the backhaul link includes at least one half-duplex link.

The example 170 includes the subject matter of any of the examples 161-169 and optionally wherein the backhaul link includes at least one full duplex link.

The subject matter of the example 171, including any of the examples 161-170, optionally includes means for simultaneously communicating on the first frequency band and the second frequency band.

The example 172 includes the subject matter of any of the examples 161-117 and optionally wherein the first frequency band comprises a millimeter wave (mmWave) frequency band, and wherein the second frequency band comprises a non-millimeter wave frequency band.

Example 173 includes the subject matter of example 172 and optionally wherein the second frequency band comprises a cellular frequency band.

Example 174 includes the subject matter of example 173 and, optionally, wherein the second frequency band comprises a Long Term Evolution (LTE) frequency band.

Example 175 includes the subject matter of any of Examples 161-174 and optionally wherein the wireless communication node comprises an access point or a base station.

The example 176 includes the subject matter of any of the examples 161-175 and optionally wherein the control station comprises an evolved Node B (eNB).

The functions, operations, components and/or features described herein with reference to one or more embodiments can be combined or combined with one or more other functions, operations, components and/or features described herein with reference to one or more other embodiments. Use and vice versa.

Many modifications, substitutions, changes and equivalents are apparent to those skilled in the art. Therefore, it is to be understood that the appended claims are intended to cover all such modifications and



(12) 发明专利申请

(10) 申请公布号 CN 104885378 A

(43) 申请公布日 2015.09.02

(21) 申请号 201480003566.8

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有限责任公司 11258

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(30) 优先权数据

61/756,302 2013.01.24 US

13/865,625 2013.04.18 US

(51) Int. Cl.

H04B 7/24(2006.01)

H04B 7/04(2006.01)

(85) PCT国际申请进入国家阶段日

2015.06.17

(86) PCT国际申请的申请数据

PCT/US2014/012477 2014.01.22

(87) PCT国际申请的公布数据

WO2014/116657 EN 2014.07.31

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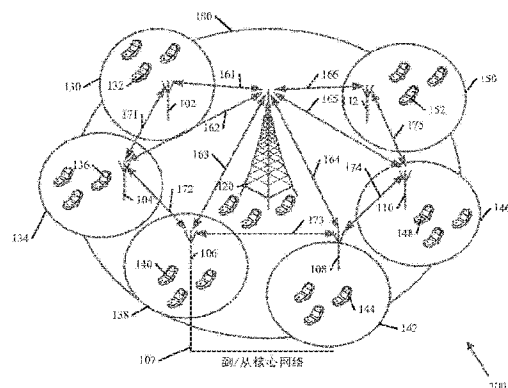
权利要求书2页 说明书30页 附图7页

(54) 发明名称

在无线通信节点间进行无线回程通信的设备、系统和方法

(57) 摘要

一些说明性实施例包括在无线通信节点间进行无线回程通信的设备、系统和/或方法。例如，无线通信控制器可控制无线通信节点以经由在第一频带上的回程网络的一个或多个回程链路与一个或多个其他无线通信节点通信，并且经由在第二频带上的控制链路与控制站通信，第一频带高于第二频带。



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1. 一种设备,包括:

无线通信控制器,该无线通信控制器控制无线通信节点以经由在第一频带上的回程网络的一个或多个回程链路与一个或多个其他无线通信节点通信,并且经由在第二频带上的控制链路与控制站通信,所述第一频带高于所述第二频带。

2. 根据权利要求 1 所述的设备,其中,所述无线通信控制器控制所述无线通信节点以经由所述控制链路从所述控制站接收控制信息,所述控制信息限定所述回程链路以及经由所述回程链路的路由图,其中,所述无线通信控制器控制所述无线通信节点以根据所述控制信息建立所述回程链路。

3. 根据权利要求 2 所述的设备,其中,所述无线通信控制器控制所述无线通信节点以经由所述控制链路接收来自所述控制站的对连通性信息的请求,所述连通性信息与所述无线通信节点连接至所述一个或多个其他无线通信节点的能力有关,其中,所述无线通信控制器控制所述无线通信节点以在所述控制链路上将所述连通性信息发送至所述控制站,并且其中,来自所述控制站的控制信息是基于所述连通性信息的。

4. 根据权利要求 1 所述的设备,其中,所述回程链路包括用于在所述一个或多个其他无线通信节点与核心网络之间传输回程流量的链路。

5. 根据权利要求 4 所述的设备,其中,所述无线通信节点包括回程端点节点,以在所述核心网络上通信。

6. 根据权利要求 4 所述的设备,其中,所述无线通信控制器控制所述无线通信节点以在所述核心网络与无线通信小区的一个或多个移动装置之间传输流量。

7. 根据权利要求 4 所述的设备,其中,所述无线通信控制器控制所述通信节点以在所述无线通信节点与所述控制站之间的回程链路上传输所述回程流量。

8. 根据权利要求 1-7 中的任一项所述的设备,其中,所述无线通信节点经由一个或多个接入链路与无线通信小区的一个或多个移动装置通信。

9. 根据权利要求 1-7 中的任一项所述的设备,其中,所述无线通信控制器控制所述无线通信节点以同时在所述第一频带和第二频带上通信。

10. 根据权利要求 1-7 的任一项所述的设备,其中,所述第一频带包括毫米波 (mmWave) 频带,并且其中,所述第二频带包括非毫米波频带。

11. 根据权利要求 10 所述的装置,其中,所述第二频带包括蜂窝频带。

12. 一种系统,包括:

无线通信装置,该无线通信装置包括:

一个或多个天线;

至少一个收发器,该至少一个收发器在第一频带和第二频带上通信,所述第一频带高于所述第二频带;以及

无线通信控制器,该无线通信控制器控制所述无线通信装置以经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传输控制信息,所述控制信息限定所述无线通信节点与所述多个无线通信节点中的一个或多个其他无线通信节点之间的一个或多个回程链路,所述回程链路包括在所述第一频带上的链路以在所述无线通信节点与核心网络之间传输流量,所述控制信息限定经由所述回程链路路由所述流量的路由图,所述控制链路还包括在所述第二频带上的链路。

13. 根据权利要求 12 所述的系统,其中,所述无线通信控制器经由所述控制链路传输来自所述控制站的对连通性信息的请求,所述连通性信息与所述无线通信节点连接至所述一个或多个其他无线通信节点的能力有关,其中,所述无线通信控制器在所述控制链路上将所述连通性信息传输至所述控制站,并且其中,来自所述控制站的控制信息是基于所述连通性信息的。

14. 根据权利要求 12 或 13 所述的系统,其中,所述无线通信控制器控制所述无线通信节点以在所述无线通信节点与所述控制站之间的回程链路上传输所述流量。

15. 一种无线通信的方法,所述方法包括:

经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传输控制信息,所述控制信息限定所述无线通信节点与所述多个无线通信节点中的一个或多个其他无线通信节点之间的一个或多个回程链路,所述回程链路包括在第一频带上的链路以在所述无线通信节点与核心网络之间传输流量,所述控制信息限定经由所述回程链路路由所述流量的路由图,所述控制链路包括在第二频带上的链路,其中,所述第一频带高于所述第二频带。

16. 权利要求 15 所述的方法,包括:将所述控制信息从所述控制站发送至所述无线通信节点。

17. 权利要求 16 所述的方法,包括:从所述控制站接收所述控制信息,并且基于所述控制信息来建立所述回程链路。

18. 一种包括上面存储有指令的非暂态存储介质的产品,所述指令在由机器执行时使得以下操作被执行:

经由在第一频带上的回程网络的一个或多个回程链路在无线通信节点与一个或多个其他无线通信节点之间通信;以及

经由在第二频带上的控制链路在所述无线通信节点与控制站之间通信,所述第一频带高于所述第二频带。

19. 根据权利要求 18 所述的产品,其中,所述指令使得以下操作被执行:经由所述控制链路从所述控制站接收控制信息,所述控制信息限定所述回程链路以及经由所述回程链路的路由图;以及根据所述控制信息来建立所述回程链路。

20. 根据权利要求 18 或 19 所述的产品,其中,所述指令使得以下操作被执行:经由所述控制链路接收来自所述控制站的对连通性信息的请求,所述连通性信息与所述无线通信节点连接至所述一个或多个其他无线通信节点的能力有关;以及经由所述控制链路将所述连通性信息发送至所述控制站,其中,来自所述控制站的控制信息是基于所述连通性信息的。

在无线通信节点间进行无线回程通信的设备、系统和方法

[0001] 交叉引用

[0002] 本申请要求申请日为 2013 年 1 月 24 日、题为“Millimeter Wave Backhauling System for Small Cells with Central Control From a Macro Base Station(具有来自宏基站的中央控制的小型小区的毫米波回程系统)”的美国临时专利申请 No. 61/756,302 的权益和优先权,其所有公开内容通过引用合并于此。

技术领域

[0003] 本文所述的实施例一般涉及无线通信节点之间的无线通信。

背景技术

[0004] 一些无线通信单元可根据涉及多个小型小区的无线网络拓扑进行部署,多个小型小区可被用于与移动用户交换信息。这种小型小区可大幅增加整个网络容量。

[0005] 然而,涉及大量小型小区的部署可能需要非常完善的回程基础设施以提供恰当的核心网络接入。这种回程基础设施很庞大且 / 或很昂贵。

附图说明

[0006] 为了说明的简单和清楚,附图中示出的元件不一定按比例绘制。举例来说,为呈现清楚,一些元件的大小相对于其他元件可进行夸张展示。此外,参考数字在附图间可被重复以指示对应或类似的元件。下面列出了附图:

[0007] 图 1 是根据一些说明性实施例说明多小区无线通信系统的部署的示意性框图。

[0008] 图 2 是根据一些说明性实施例说明多小区无线通信系统的另一部署的示意性框图。

[0009] 图 3 是根据一些说明性实施例说明多小区无线通信系统的另一部署的示意性框图。

[0010] 图 4 是根据一些说明性实施例说明无线通信装置的示意性框图。

[0011] 图 5 是根据一些说明性实施例说明模块化天线阵的示意图。

[0012] 图 6 是根据一些说明性实施例说明无线回程通信的方法的示意性流程图。

[0013] 图 7 是根据一些说明性实施例说明制造产品的示意图。

具体实施方式

[0014] 在下面的详细描述中,阐述了众多具体细节以便提供对一些实施例的透彻理解。然而,本领域的一般技术人员应该理解,可在没有这些具体细节的情况下实践一些实施例。在其他实例中,未详细描述熟知的方法、过程、组件、单元和 / 或电路,以便不会使论述晦涩不清。

[0015] 本文中利用诸如“处理”、“计算”、“演算”、“判定”、“建立”、“分析”、“检查”或其他类似的词语的论述是指计算机、计算平台、计算系统或其他电子计算装置的(一个或多个)

操作和 / 或 (一个或多个) 处理, 这些操作和 / 或处理将被表示为计算机的寄存器和 / 或存储器内的物理 (例如, 电子) 量的数据操纵和 / 或变换成被类似地表示为计算机寄存器和 / 或存储器或者可存储用以执行操作和 / 或处理的指令的其他信息存储介质内的物理量的其他数据。

[0016] 如本文所使用的“多个”(“plurality”和“a plurality”)一词包括例如“许多”或“两个或两个以上”。举例来说,“多个项目”包括两个或两个以上项目。

[0017] 提及“一个实施例”、“实施例”、“说明性实施例”、“各种实施例”等指示如此描述的实施例可包括特定特征、结构或特性, 但并非每一个实施例都必定包括特定特征、结构和特性。另外, 短语“在一个实施例中”的重复使用不一定是指同一实施例, 尽管它可以指同一实施例。

[0018] 如本文所使用, 除非另有说明, 否则使用序数形容词“第一”、“第二”、“第三”等来描述常见对象仅指示相似对象的不同实例正被提及, 且不意欲暗示如此描述的对象必须在时间、空间上、在等级上或以任何其他方式按给定序列。

[0019] 一些实施例可以结合各种装置及系统来使用, 这些装置和系统例如是个人计算机 (PC)、台式计算机、移动计算机、膝上型计算机、笔记本计算机、平板计算机、Ultrabook™ 计算机、服务器计算机、手持计算机、手持装置、个人数字助理 (PDA) 装置、手持式 PDA 装置、车上装置、场外装置、混合式装置、车载装置、非车载装置、移动或便携装置、消费者装置、非移动或非便携式装置、无线通信站、无线通信装置、无线接入点 (AP)、有线路由器或无线路由器、有线调制解调器或无线调制解调器、视频装置、音频装置、视听 (A/V) 装置、有线网络或无线网络、无线区域网络、无线视频区域网络 (WVAN)、局域网 (LAN)、无线 LAN (WLAN)、个人区域网络 (PAN)、无线 PAN (WPAN) 等。

[0020] 一些实施例可结合如下装置和 / 或网络来使用: 根据现有无线千兆联盟 (Wireless-Gigabit-Alliance, WGA) 规范 (无线千兆联盟公司 WiGig MAC 及 PHY 规范版本 1.1, 2011 年 4 月, 最终规范) 和 / 或其未来版本和 / 或衍生版本进行操作的装置和 / 或网络; 根据现有 IEEE802.11 标准 (IEEE802.11-2012, 信息技术的 IEEE 标准 — 系统局域网与城域网之间的通信和信息交换 — 具体要求 — 第 11 部分: 无线 LAN 介质访问控制 (MAC) 和物理层 (PHY) 规范, 2012 年 3 月 29 日; IEEE802.11 任务群组 ac (TGac) (“IEEE802.11-09/0308r12-TGac 信道模型附录文献”); IEEE802.11 任务群组 ad (TGad) (信息技术的 IEEE P802.11ad 标准 — 系统之间的电信和信息交换 — 具体要求 — 第 11 部分: 无线 LAN 介质访问控制 (MAC) 及物理层 (PHY) 规范 — 修正 3: 60GHz 频带中极高吞吐量的增强)) 和 / 或其未来版本和 / 或衍生版本进行操作的装置和 / 或网络; 根据现有长期演进 (Long Term Evolution, LTE) 规范 (包括 ETSI TS 136 300 V11.3.0 (2012-11): LTE; 演进型通用陆地无线电接入 (E-UTRA) 及演进型通用陆地无线电接入网络 E-UTRAN); 总体描述; 阶段 2 (3GPP TS 36.300 版本 11.3.0 第 11 版), 2012) 和 / 或其未来版本和 / 或衍生版本进行操作的装置和 / 或网络; 根据现有 WirelessHD™ 规范和 / 或其未来版本和 / 或衍生版本进行操作的装置和 / 或网络; 是以上网络的部分的单元和 / 或装置等。

[0021] 一些实施例可结合如下各项来使用: 单向和 / 或双向无线电通信系统、蜂窝无线电 — 移动电话通信系统、移动电话、蜂窝电话、无线电话、个人通信系统 (PCS) 装置、包含无线通信装置的 PDA 装置、移动或便携性全球定位系统 (GPS) 装置、包含 GPS 接收器或收发器

或芯片的装置、包含 FRID 元件或芯片的装置、多输入多输出 (MIMO) 收发器或装置、单输入多输出 (SIMO) 收发器或装置、具有一个或多个内部天线和 / 或外部天线的装置、数字视频广播 (DVB) 装置或系统、多重标准无线电装置或系统、有线或无线手持装置 (例如, 智能电话)、无线应用协议 (WAP) 装置等。

[0022] 一些实施例可结合一种或多种类型的无线通信信号和 / 或系统使用, 例如, 射频 (RF)、红外线 (IR)、频分复用 (FDM)、正交 FDM (OFDM)、单载波频分多址 (SC-FDMA)、时分复用 (TDM)、时分多址 (TDMA)、扩展 TDMA (E-TDMA)、通用分组无线电业务 (GPRS)、扩展 GPRS、码分多址 (CDMA)、宽带 CDMA (WCDMA)、CDMA 2000、单载波 CDMA、多载波 CDMA、多载波调制 (MDM)、离散多音调 (DMT)、蓝牙 (Bluetooth®)、全球定位系统 (GPS)、无线保真 (Wi-Fi)、Wi-Max、ZigBee™、超宽带 (UWB)、全球移动通信系统 (GSM)、第二代 (2G)、2.5G、3G、3.5G、4G、第五代 (5G) 移动网络、3GPP、长期演进 (LTE)、升级 LTE、GSM 演进的增强型数据速率 (EDGE) 等等。其他实施例可用于各种其他装置、系统和 / 或网络中。

[0023] 本文所使用的术语“无线装置”例如包括具有无线通信能力的装置、具有无线通信能力的通信装置、具有无线通信能力的通信站、具有无线通信能力的便携式装置或非便携式装置等。在一些说明性实施例中, 无线装置可以是或可包括与计算机相集成计算机的外设或附接至计算机计算机的外设。在一些说明性实施例中, 术语“无线装置”可选择性包括无线服务。

[0024] 本文中关于无线通信信号所使用的术语“传输 (communicating)”包括: 发送无线通信信号和 / 或接收无线通信信号。举例来说, 能够传递无线通信信号的无线通信单元可包括无线发送器以将无线通信信号发送到至少一个其他无线通信单元, 和 / 或包括无线通信接收器以从至少一个其他无线通信单元接收无线通信信号。

[0025] 本文中关于 LTE 蜂窝网络描述了一些说明性实施例。然而, 其他实施例可以在任意其他适当的蜂窝网络 (例如, 3G 蜂窝网络、4G 蜂窝网络、5G 蜂窝网络、WiMax 蜂窝网络等等) 中被实施。

[0026] 一些说明性实施例可结合 WLAN 来使用。其他实施例可结合例如无线区域网络、“微微网 (piconet)”、WPAN、WVAN 等任何其他合适无线通信网络来使用。

[0027] 一些说明性实施例可结合在 60GHz 的频带上通信的无线通信网络来使用。然而, 其他实施例可利用任何其他合适无线通信频带来实施, 这些频带例如是: 极高频率 (EHF) 频带 (毫米波 (mmwave) 频带), 如 20GHz 和 300GHz 间的频带内的频带; WPAN 频带; 无线千兆 (WiGig) 频带, 如根据 WGA 规范; WiFi 频带; 根据 IEEE802.11 标准的频带, 如根据 IEEE802.11ad 的频带 (“802.11ad 频带”) 等。

[0028] 本文中所使用的短语“对等 (PTP 或 P2P) 通信”可涉及通过一对装置之间的在无线链路 (“对等链路”) 的装置到装置通信。P2P 通信可包括: 例如, 通过 QoS 基本服务集 (BSS) 内的直接链路的无线通信、遂穿 (tunnel) 直接链路设置 (TDLS) 链路的无线通信、独立基本服务集 (IBSS) 中的 STA 到 STA 通信等。

[0029] 本文所使用的术语“天线”可以包括对一个或多个天线元件、部件、单元、组件和 / 或阵列的任意适当的配置、结构和 / 或安排。在一些实施例中, 天线可使用分开的发送天线元件和接收天线元件来实现发送和接收功能。在一些实施例中, 天线可使用共同和 / 或集成的发送 / 接收元件来实现发送和接收功能。天线例如可以包括相控阵天线、单一元件天

线、波束转换天线组和 / 或其类似。

[0030] 本文中所使用的短语“毫米波频带”可涉及 20GHz 以上的频带,例如,20GHz 与 300GHz 之间的频带。

[0031] 本文中所使用的短语“定向多千兆 (DMG)”及“定向频带 (DBand)”可涉及其中信道起始频率高于 40GHz 的频带。

[0032] 短语“DMG STA”及“毫米波 STA (mSTA)”可涉及具有无线电发送器的 STA,该无线电发送器正在处于毫米波或 DMG 频带内的信道上运作。

[0033] 本文中所使用的术语“波束成形”可涉及空间滤波机制,其可在发送器和 / 或接收器处被用于改进一个或多个属性,例如,预定接收器处的所接收的信号功率或信噪比 (SNR)。

[0034] 本文中所使用的术语“小区”可包括网络资源的组合,例如,下行链路和可选上行链路资源。资源例如可通过无线通信节点 (也被称为“节点”或“基站”) 等来控制和 / 或分配。下行链路资源的载波频率与上行链路资源的载波频率之间的链接可以在下行链路资源上传输的系统信息中被指示。

[0035] 现参考图 1,图 1 根据一些说明性实施例示意性地示出了多小区无线通信系统 100 的部署的方框图。

[0036] 在一些说明性实施例中,系统 100 可包括能够经由无线介质 (WM) 传输内容、数据、信息和 / 或信号的一个或多个无线通信装置。无线介质可包括:例如,无线电信道、蜂窝信道、RF 信道、无线保真 (WiFi) 信道、WiGig 信道、毫米波信道、IR 信道等。系统 100 的一个或多个元件可选择性地能够在任何合适的有线通信链路上通信。

[0037] 在一些说明性实施例中,系统 100 可被部署为包括多个小区 (例如,小型小区) 的网络,该小区被配置为例如向 / 从移动用户递送数据,例如,为了大幅提高整个网络的吞吐量。

[0038] 在一些说明性实施例中,小区可包括无线通信节点,该无线通信节点可被配置为覆盖和 / 或服务于多个用户,例如,移动装置 (例如用户设备 (UE)) 等。无线通信节点可包括或执行基站 (BS)、接入点 (AP)、LTE 节点、LTE 演进型节点 B (eNB) 等的功能。小型小区的部署可提供例如使许多用户同时进行通信的高速无线接入。

[0039] 在一些说明性实施例中,小型小区的大小可被配置为例如使无线通信节点能够覆盖小型小区。在一个实例中,小型小区可具有约 10 至 100 米的覆盖范围,或任何其他范围。

[0040] 在一些说明性实施例中,相对大量的小型小区基站被部署为覆盖相当大的区域,比如,城市或城市中的若干街区。在一个实例中,系统 100 的元件可被部署例如在室外空间 (例如,街道、运动场等) 和 / 或大型室内区域 (例如,会议室等) 中。

[0041] 在一些说明性实施例中,系统 100 可包括多个无线通信节点,这些无线通信节点被配置为与一个或多个无线通信小区 (例如,小型小区) 的一个或多个移动装置通信。

[0042] 例如,如图 1 所示,系统 100 包括:与无线通信小区 130 的一个或多个移动装置 132 通信的无线通信节点 102;与无线通信小区 134 的一个或多个移动装置 136 通信的无线通信节点 104;与无线通信小区 138 的一个或多个移动装置 140 通信的无线通信节点 106;与无线通信小区 142 的一个或多个移动装置 144 通信的无线通信节点 108;与无线通信小区 146 的一个或多个移动装置 148 通信的无线通信节点 110;和 / 或与无线通信小区 150 的一

个或多个移动装置 152 通信的无线通信节点 112。

[0043] 在一些说明性实施例中,节点 102、104、106、108、110 和 / 或 112 可包括或可执行 BS、宏 BS、微 BS、AP、WiFi 节点或站、WiGig 节点或站、Wimax 节点或站、蜂窝节点、演进型节点 B(eNB)、微微 eNB、LTE 节点、站、热点、网络控制器等的功能。

[0044] 在一些说明性实施例中,例如,如下文参考图 4 所述,节点 102、104、106、108、110 和 / 或 112 可包括无线通信装置,该无线通信装置包括一个或多个天线及一个或多个无线通信收发器。

[0045] 在一些说明性实施例中,移动装置 132、136、140、144、148 和 / 或 152 可包括:例如,用户设备 (UE)、移动计算机、膝上型计算机、笔记本计算机、平板计算机、Ultrabook™ 计算机、移动互联网装置、手持计算机、手持装置、存储装置、PDA 装置、手持 PDA 装置、车上装置、外场装置、混合式装置 (例如,组合蜂窝电话功能与 PDA 装置功能)、消费者装置、车载装置、非车载装置、便携式装置、移动电话、蜂窝电话、PCS 装置、移动或便携性 GPS 装置、DVB 装置、相对较小的计算装置、非台式计算机、“畅享生活 (Carry Small Live Large, CSL)” 装置、超级移动装置 (UMD)、超级移动 PC (UMPC)、移动互联网网络装置 (MID)、“折纸 (Origami)” 装置或计算装置、视频装置、音频装置、A/V 装置、游戏装置、媒体播放器、智能电话等。

[0046] 在一些说明性实施例中,完善的回程基础设施可被用于将无线通信节点 102、104、106、108、110 和 / 或 112 连接至核心网络。

[0047] 在一些说明性实施例中,例如,如下文所述,无线通信节点 102、104、106、108、110 和 / 或 112 可被配置为在多个无线回程链路上通信。

[0048] 在一些说明性实施例中,无线回程链路可包括高吞吐量链路。

[0049] 在一些说明性实施例中,例如,如下文所述,无线回程链路可包括在高频带上的无线通信链路,例如,毫米波频带上的毫米波链路。在一个示例中,毫米波链路可包括 DMG 链路、根据 WiGig 规范的链路 (“WiGig 链路”)、根据 IEEE 802.11ad 规范的链路 (“802.11ad 链路”) 等。在其他实施例中,无线回程链路可包括在任何其他无线通信视频频带和 / 或根据任何其他无线通信标准和 / 或规范的任何其他无线通信链路。

[0050] 在一些说明性实施例中,回程网络可要求例如与装置恢复和 / 或装置故障管理一起实施高级路由和 / 或调度算法。仅使用无线通信节点之间的毫米波链路来实施回程网络是困难的。

[0051] 在一些说明性实施例中,例如,如下文详细描述,系统 100 可根据双频带回程方案进行配置,该双频带回程方案包括在第一频带上传输回程讯务,并在第二频带上传输控制信息。

[0052] 在一些说明性实施例中,双频带回程方案允许实施例如,以相对较低速度和 / 或吞吐量传输控制功能性 (例如,用于控制回程链路),及以相对较高的速度和 / 或吞吐量传输回程流量。

[0053] 在一些说明性实施例中,第一频带可大于第二频带。

[0054] 在一些说明性实施例中,第一频带可包括毫米波频带,且第二频带可包括非毫米波频带。

[0055] 在一个示例中,第一频带可包括 DMG 频带,例如,60 千兆赫 (GHz) 频带;且第二频

带可包括蜂窝频带,例如,LTE 频带(例如,2.4GHz 频带)。在其他实施例中,第二及第二频带可包括频带的任何其他组合。

[0056] 在一些说明性实施例中,例如,如下文所详细描述,系统 100 可包括控制站 120,该控制站被配置为控制无线通信节点 102、104、106、108、110 和 / 或 112。

[0057] 在一些说明性实施例中,例如,如下文参考图 4 所述的,控制站 120 可包括无线通信装置,该无线通信装置包括一个或多个天线及一个或多个无线通信收发器。

[0058] 在一些说明性实施例中,控制站 120 可被配置为在第二频带上与无线通信节点 102、104、106、108、110 和 / 或 112 通信。举例来说,例如,如下文所述的,控制节点 120 被配置为通过第二频带上的多个控制链路与无线通信节点 102、104、106、108、110 和 / 或 112 通信。

[0059] 在一些说明性实施例中,控制站 120 可包括或可被实施为蜂窝基站(例如 LTE 基站)的部分。在一个实施例中,控制站 120 可执行 eNB(例如,宏小区 eNB)或任何其他蜂窝节点或基站的功能。

[0060] 在一些说明性实施例中,控制站 120(也被称为“宏基站”)可被实施为专用实体,例如,与节点 102、104、106、108、110 和 / 或 112 分离的实体。

[0061] 在其他实施例中,控制站 120 可作为 102、104、106、108、110 和 112 无线通信节点的部分来实施。根据这些实施例,控制站 120 可被配置为执行控制站 120 以及节点 102、104、106、108、110 和 112 的无线通信节点的功能。举例来说,例如,如下文所述的,控制站 120 可被配置为通过第一频带上的一个或多个回程链路通信。

[0062] 在一些说明性实施例中,例如,如下文所述的,无线通信节点 102、104、106、108、110 及 112 可被配置为作为回程节点运作,这些回程节点可形成用于在无线通信节点 102、104、106、108、110 及 112 之间传输回程流量的回程网络。

[0063] 在一些说明性实施例中,控制站 120 可在多个控制链路上与回程节点通信。举例来说,控制站 120 可通过控制链路 161 与无线通信节点 102 通信;控制站 120 可通过控制链路 162 与无线通信节点 104 通信;控制站 120 可通过控制链路 163 与无线通信节点 106 通信;控制站 120 可通过控制链路 164 与无线通信节点 108 通信;控制站 120 可通过控制链路 165 与无线通信节点 110 通信;控制站 120 可通过控制链路 166 与无线通信节点 112 通信。

[0064] 在一些说明性实施例中,控制链路 161、162、163、164、165 和 / 或 166 可包括在第二频带上(例如,在非毫米波频带上)的链路。在一个实例中,控制链路 161、162、163、164、165 和 / 或 166 可包括在 LTE 频带(例如,2.4GHz 频带)或任何其他频带上的链路。

[0065] 在一些说明性实施例中,控制链路 161、162、163、164、165 和 / 或 166 可被配置为在控制站 120 与无线通信节点 102、104、106、108、110 和 / 或 112 之间传输控制信息。举例来说,例如,如下文所述,控制站 120 可与无线通信节点 102、104、106、108、110 和 / 或 112 传输控制信息,以设置和 / 或控制在无线通信节点 102、104、106、108、110 和 / 或 112 之间的回程网络上的通信。

[0066] 在一些说明性实施例中,回程网络可包括形成于无线通信节点 102、104、106、108、110 和 / 或 112 之间的多个回程无线通信链路。举例来说,无线通信节点 102 可在无线回程链路 171 上与无线通信节点 104 传输回程流量;无线通信节点 104 可在无线回程链路 172 上与无线通信节点 106 传输回程流量;无线通信节点 106 可在无线回程链路 173 上与无线

通信节点 108 传输回程流量；无线通信节点 108 可在无线回程链路 174 上与无线通信节点 110 传输回程流量；和 / 或无线通信节点 110 可在无线回程链路 175 上与无线通信节点 112 传输回程流量。任何其他额外或替代无线回程链路可由任何其他回程节点对来形成。

[0067] 在一些说明性实施例中，回程链路 171、172、173、174 和 / 或 175 可包括在第一频带上（例如，毫米波频带）上的链路。

[0068] 在一些说明性实施例中，无线通信节点 102 可通过多个无线通信链路（“接入链路”）与小区 130 的移动装置 132 通信；无线通信节点 104 可通过多个接入链路与小区 134 的移动装置 136 通信；无线通信节点 106 可通过多个接入链路与小区 138 的移动装置 140 通信；无线通信节点 108 可通过多个接入链路与小区 142 的移动装置 144 通信；无线通信节点 110 可通过多个接入链路与小区 146 的移动装置 148 通信；和 / 或无线通信节点 112 可通过多个接入链路与小区 150 的移动装置 152 通信。接入链路可包括用于将下行链路数据从无线通信节点传输至移动装置的下行链路，和 / 或用于将上行链路数据从移动装置传输至无线通信节点的上行链路。

[0069] 在一些说明性实施例中，接入链路可把包括在第一频带上的无线通信链路（例如，毫米波链路）。在其他实施例中，接入链路可包括在第二频带或任何其他频带上的无线通信链路。

[0070] 本文中参考被配置为执行回程节点（例如，用于在回程网络上进行通信）和接入节点（例如，小区基站）（例如，用于与无线通信小区的移动装置通信）的功能的无线通信节点（例如，节点 102、104、106、108、110 和 / 或 112）的无线通信节点描述了一些说明性实施例。举例来说，根据这些实施例，无线通信节点可作为小型小区基站的部分被实施。小型基站能够在接入链路上与移动装置通信，通过回程链路与其他回程节点通信，且通过控制链路与控制站通信。

[0071] 然而，在其他实施例中，回程节点和接入节点可实施为两个分离实体。举例来说，无线通信节点（例如，无线通信节点 102、104、106、108、110 和 / 或 112）可执行回程节点的功能（例如，用于在回程网络上通信）；且分离的接入节点可被用于与无线通信小区的移动装置通信。举例来说，根据这些实施例，小型小区基站能够在接入链路上与移动装置通信，回程节点能够通过回程链路与其他回程节点通信，且通过控制链路与控制站通信。根据此示例，回程节点可在小型小区基站与回程网络之间进行接口连接（interface）。

[0072] 在一些说明性实施例中，回程节点能够例如同时在回程链路及控制链路上通信。举例来说，无线通信节点 102 可同时在控制链路 161 及回程链路 171 上通信；无线通信节点 104 可同时在控制链路 162 及回程链路 171 和 / 或 172 上通信；无线通信节点 106 可同时在控制链路 163 及回程链路 172 和 / 或 173 上通信；无线通信节点 108 可同时在控制链路 164 及回程链路 173 和 / 或 174 上通信；无线通信节点 110 可同时在控制链路 165 及回程链路 174 和 / 或 175 上通信；和 / 或无线通信节点 112 可同时在控制链路 166 及回程链路 175 上通信。

[0073] 在一些说明性实施例中，回程链路 171、172、173、174 和 / 或 175 可用于无线通信节点 102、104、106、108、110 和 / 或 112 之间的直接或间接通信。

[0074] 在一些说明性实施例中，回程链路 171、172、173、174 和 / 或 175 可用于在无线通信节点与核心网络之间进行通信。

[0075] 在一些说明性实施例中,系统 100 可包括连接至核心网络的一个或多个回程节点 (“源 / 汇聚节点”)。举例来说,源 / 汇聚节点可执行一个或多个“端点”的功能,在这些端点处无线流量被集中并被向 / 从核心 (有线 / 光纤) 网络递送。核心网络可包括:例如,电话网络、互联网、局域网 (LAN) 等。

[0076] 在一些说明性实施例中,无线通信节点 102、104、106、108、110 和 / 或 112 中至少一个可被连接至核心网络,且一个或多个其他无线通信节点可通过无线回程链路与核心网络通信。

[0077] 举例来说,如图 1 所示,无线通信节点 106 可包括至少一个网络接口 107,网络接口 107 被配置为通过一个或多个有线和 / 或无线连接 (例如,通过导线、电缆、光纤、光连接等) 与至少一个核心网络通信。举例来说,网络接口 107 可包括调制器 - 解调器 (调制解调器)、线缆调制解调器、路由器等。

[0078] 在一些说明性实施例中,核心网络可选择性地被配置为使得例如能够通过有线连接在回程网络的一个或多个元件之间进行通信。

[0079] 在一些说明性实施例中,回程链路 171、172、173、174 和 / 或 175 可包括高吞吐量链路,其被配置为经由节点 106 在无线通信节点 102、104、106、108、110 和 / 或 112 与核心网络之间传输高吞吐量数据。

[0080] 在一些说明性实施例中,回程链路 171、172、173、174 和 / 或 175 可用于例如每单位面积包括相对较高密度的节点的系统,例如,用于大量小区 (例如,小型小区) 的部署。

[0081] 在一些说明性实施例中,控制站 120 可被实施为具有相对较大的覆盖区域 (“宏覆盖区域”) 180 (例如,图 1 所示的椭圆形区域或任何其他覆盖区域) 的蜂窝节点 (例如, eNB) 的部分。多个小型小区 (例如,小区 130、134、138、142、146 及 150) 可被部署在覆盖区域 180 内。

[0082] 在一些说明性实施例中,控制站 120 可例如通过控制链路 161、162、163、164、165 和 / 或 166 以集中式方式控制无线通信节点 102、104、106、108、110 和 / 或 112。

[0083] 在一些说明性实施例中,控制站 120 可例如通过控制链路 161、162、163、164、165 和 / 或 166 以集中式方式控制无线通信节点 102、104、106、108、110 和 / 或 112,以根据任意回程方案 (“回程连通性图”和“路由图”) 来形成无线回程链路 171、172、173、174 和 / 或 175。举例来说,例如,如下文所述,回程路由图可限定和 / 或配置由回程节点形成的一个或多个回程链路。

[0084] 在一些说明性实施例中,控制站 120 可例如,基于控制站 120 和无线通信节点 102、104、106、108、110 和 / 或 112 中的一个或多个之间的通信限定和 / 或配置回程路由图,例如,通过控制链路 161、162、163、164、165 和 / 或 166。

[0085] 在一些说明性实施例中,控制站 120 可通过控制链路 (例如,控制链路 161) 与无线通信节点 (例如,无线通信节点 102) 传输对与无线通信节点相对应的连通性信息的请求。连通性信息可包括例如关于无线通信节点通过一个或多个回程链路 (例如,回程链路 171) 连接至一个或多个其他无线通信节点 (例如,无线通信节点 104) 的能力、无线通信节点连接至核心网络的能力的信息,关于无线通信节点的覆盖范围的信息,关于无线通信节点在第一频带上进行通信的能力的信息,关于无线通信节点能够形成回程链路 (例如,波束成形链路) 的数目的信息,关于无线通信节点的位置的信息,和 / 或任何其他信息。

[0086] 在一些说明性实施例中,控制站 120 可例如基于从无线通信节点 102、104、106、108、110 和 / 或 112 接收到的连通性信息来限定回程连通性图。举例来说,如图 1 所示,控制站 120 可限定回程连通性图以包括回程链路 171、172、173、174 和 / 或 175。

[0087] 在一些说明性实施例中,控制站 120 可限定回程连通性图,以使得无线通信节点(例如,节点 102、104、106、108、110 和 / 或 112 中的每个无线通信节点)能够例如经由无线通信节点与核心网络之间的至少一个回程路径(路线)与核心网络传输回程流量。回程路径可由一个或多个无线回程链路(“跳跃(hop)”)形成。一个或多个无线通信节点可经由单一回程链路(“单一跳跃”)连接至核心网络,和 / 或一个或多个无线通信节点可经由多个回程链路(“多重跳跃”)连接至核心网络。

[0088] 举例来说,如图 1 所示,无线通信节点 102 可经由包括回程链路 171 和 172 以及回程接口 107 的回程路径与核心网络通信;无线通信节点 104 可经由包括回程链路 172 及回程接口 107 的回程路径与核心网络通信;无线通信节点 106 可经由回程接口 107 直接与核心网络通信;无线通信节点 108 可经由包括回程链路 173 及回程接口 107 的回程路径与核心网络通信;无线通信节点 110 可经由包括回程链路 174 及 173 及回程接口 107 的回程路径与核心网络通信;和 / 或无线通信节点 112 可经由包括回程链路 175、174 和 173 及回程接口 107 的回程路径与核心网络通信。

[0089] 在一些说明性实施例中,例如,如下文参考图 2 所述的,回程路由图可限定无线通信节点的不止一个回程路线。例如,若回程链路中的一个或多个被阻断、丢失或破坏,则经由多个回程路径将无线通信节点连接至核心网络可提供冗余,以例如使得维持回程连接成为可能。

[0090] 在一些说明性实施例中,控制站 120 可在控制链路(例如,控制链路 161)上与无线通信节点(例如,无线通信节点 102)传输控制信息。控制信息可包括例如根据路由图限定待形成于无线通信节点与一个或多个其他无线通信节点之间的一个或多个回程链路的信息。举例来说,控制站 120 可在控制链路 161 上向无线通信节点 102 发送控制信息,该控制信息限定无线通信节点以在回程链路 171 上建立回程流量和 / 或传输回程流量。

[0091] 在一些说明性实施例中,控制站 120 可利用各种优化演算法进行流量路由及调度无线回程链路上的回程流量的传输。举例来说,控制站 120 可配置连通性图以使回程网络上的总吞吐量最优化,和 / 或使任何其他量度(例如,服务质量(QoS)量度)最优化。可关于不同小型小区应用不同的 QoS 量度。

[0092] 在一些说明性实施例中,回程链路 171、172、173、174 和 / 或 175 可包括用于在一对无线通信节点之间非同时地在双方向上(例如,在一个时刻仅在一个方向上)传输流量的半双工链路。在一个示例中,可根据合适的时分复用(TDD)方案或任何其他半双工方案来管理半双工链路上的通信。

[0093] 在一些说明性实施例中,回程链路 171、172、173、174 和 / 或 175 可包括用于在一对无线通信节点之间例如同时在两个方向上传输流量的全双工链路。在一个实例中,可根据合适的频分复用(FDD)方案或任何其他全双工方案来管理全双工链路上的通信。

[0094] 在一些说明性实施例中,系统 100 可包括控制站(例如,控制站 120),该控制站被配置为控制多个回程节点(例如,节点 102、104、106、108、110 和 / 或 112),这些节点可在由回程节点之间的无线回程链路(例如,回程链路 171、172、173、174 和 / 或 175)形成的回程

网络上通信。

[0095] 在一些说明性实施例中,例如,如下文参考图 2 所述的,例如,若控制站能够在第一频带上通信,那么控制站可被配置为也执行回程节点或回程源/汇聚节点的功能。

[0096] 在一些说明性实施例中,系统(系统 100)可包括源/汇聚回程节点(例如,回程节点 106),该源/汇聚回程节点被配置为在核心网络与一个或多个其他回程节点之间进行接口连接。

[0097] 在一些说明性实施例中,例如,如下文参考图 3 所述的,系统可包括不止一个源/汇聚回程节点。

[0098] 图 2 为根据一些说明性实施例图示多小区无线通信系统 200 的另一部署的示意框图。

[0099] 在一些说明性实施例中,系统 200 可包括具有相对较大的覆盖区域(“宏覆盖区域”)280 的控制站 220。多个小型小区(例如,小区 230)可被部署在覆盖区域 280 内。

[0100] 在一些说明性实施例中,控制站 220 可执行例如 eNB(例如,宏小区 eNB)的蜂窝基站或任何其他蜂窝节点的功能。

[0101] 在一些说明性实施例中,系统 200 可包括部署在小型小区 230 内的多个回程节点 210。在一个示例中,例如,如上文所述,回程节点 210 可被实施为小区 230 的小型小区基站的部分。举例来说,回程节点 210 可被实施为微微 eNB 或任何其他蜂窝基站的部分。

[0102] 在一些说明性实施例中,回程节点 210 可在回程网络(例如,双频带回程网络)上传输回程数据,回程网络包括回程节点 210 之间的例如在第一频带上的多个回程链路 270,以及在控制站 220 与回程节点 210 之间的在第二频带上的多个控制链路 260。

[0103] 在一些说明性实施例中,回程链路 270 可执行上文参考图 1 描述的无线回程链路的功能,和/或控制链路 260 可执行上文参考图 1 描述的无线控制链路的功能。

[0104] 在一些说明性实施例中,控制站 220 可被配置为例如经由回程网络的回程链路 270 中的一个或多个与回程节点 210 传输回程流量。举例来说,控制站 220 能够在第一频带(例如,毫米波频带)上通信。根据这些实施例,除控制站的功能外,控制站 220 例如还可执行回程节点 210 的功能。

[0105] 在一些说明性实施例中,控制站 220 可执行源/汇聚回程节点的功能。举例来说,例如,如上文所述,控制站 210 可包括网络接口 207 以将控制站 220 连接至核心网络。

[0106] 在一些说明性实施例中,例如,如参考图 1 所述的,控制站 220 可例如经由控制链路 260 与回程节点 210 通信以限定回程连通性图;且可例如,经由控制链路 260 来控制回程节点 210 以根据回程连通性图建立无线回程链路 270。

[0107] 在一些说明性实施例中,回程节点 210 中的一个或多个可经由单一跳跃(例如,经由与控制站的直接回程链路 270)与核心网络传输回程流量。

[0108] 在一些说明性实施例中,回程节点 210 中的一个或多个可由多重跳跃(例如,经由与一个或多个其他回程节点 210 的一个或多个回程链路)与核心网络传输回程流量。

[0109] 在一些说明性实施例中,如图 2 所示,回程节点 210 可经由不止一个回程路径(例如,经由单一跳跃回程路径及一个或多个多重跳跃回程路径)与核心网络通信。

[0110] 在一些说明性实施例中,控制站 220 可配置连通性图以针对回程节点 210 限定一个或多个替代回程路径,该回程路径可用作例如,回程节点 210 所使用的回程路径(“当前

路径”)的备用路径。例如,在沿当前路径的一个或多个回程链路 270 和 / 或回程节点 210 发生故障的状况下可使用备用路径。

[0111] 图 3 为根据一些说明性实施例图示多小区无线通信系统 300 的另一部署的示意图。

[0112] 在一些说明性实施例中,例如,如上文所述,系统 300 可包括控制站 320 以控制例如多个小型小区的多个回程节点 310,多个小型小区可被部署在控制站的覆盖区域内。

[0113] 在一些说明性实施例中,控制站 320 可执行例如 eNB(例如,宏小区 eNB)的蜂窝基站或任何其他蜂窝节点的功能。

[0114] 在一些说明性实施例中,回程节点 310 可在回程网络(例如,双频带回程网络)上传输回程数据,该回程网络包括回程节点 310 之间的例如在第一频带上的多个回程链路 370,及在控制站 320 与回程节点 310 之间的在第二频带上的多个控制链路 360。

[0115] 在一些说明性实施例中,回程链路 370 可执行上文参考图 1 所述的无线回程链路的功能,和 / 或控制链路 360 可执行上文参考图 1 所述的无线控制链路的功能。

[0116] 在一些说明性实施例中,系统 300 可包括多个源 / 汇聚回程节点。举例来说,如图 3 所示,系统 300 可包括具有至核心网络的连接 307 的源 / 汇聚回程节点 306,及具有至核心网络(例如,同一核心网络或不同核心网络)的连接 308 的源 / 汇聚回程节点 316。

[0117] 在一些说明性实施例中,多个源 / 汇聚回程节点可用于例如,使回程网络的一个或多个属性最优化。

[0118] 在一些说明性实施例中,多个源 / 汇聚回程节点可用于形成多个回程子网络。

[0119] 在一个实例中,第一回程子网络 302 可包括第一多个回程节点 310,其可经由回程链路 370 连接至源 / 汇聚回程节点 316。第二回程子网络 304 可包括第二多个回程节点 310,其可经由回程链路 370 被连接至源 / 汇聚回程节点 306。

[0120] 在一些说明性实施例中,例如,如上文所述,控制站 320 可用集中式方式限定回程子网络。

[0121] 在一些说明性实施例中,控制站可例如经由控制链路 360 将根据子网络 302 的连通性图限定回程链路 370 的控制信息传输至子网络 302 的回程节点。控制站可例如经由控制链路 360 将根据子网络 304 的连通性图限定回程链路 370 的控制信息传输至子网络 304 的回程节点。

[0122] 在一些说明性实施例中,控制站 320 可将回程节点 310 分配给不止一个回程子网络。根据这些实施例,控制站 320 可在两个子网络 302 及 304 上向回程节点 310 提供限定回程链路 370 的控制信息。

[0123] 参考图 4,图 4 根据一些说明性实施例示意性地图示无线通信装置 400。

[0124] 在一些说明性实施例中,例如,如上文所述,无线通信装置 400 可包括收发器模块 404 以执行无线通信装置 400 与一个或多个其他无线通信装置之间的无线通信。

[0125] 在一些说明性实施例中,无线通信装置 400 可执行无线通信节点(例如,节点 102、104、106、108、110 和 / 或 112(图 1),回程节点 210(图 2),和 / 或回程节点 310(图 3))的功能。

[0126] 根据这些实施例,收发器模块 404 可包括被配置为在第一频带上通信(例如,在无线回程链路上进行通信)并在第二频带上通信(例如,在控制链路上与控制站进行通信)

的双频带收发器。

[0127] 在一个实例中,收发器模块 404 可包括:至少一个低频带收发器 410 例如,以在第二频带上通信;及至少一个高频带收发器 412 以在第一频带上通信。举例来说,收发器 410 可执行蜂窝收发器(例如,LTE 收发器)的功能以在非毫米波频带(例如,2.4GHz 频带)或任何其他频带上通信。举例来说,收发器 412 可执行毫米波收发器(例如,WiGig 或 IEEE802.11ad 收发器)的功能以在毫米波频带(例如,60GHz 频带)或任何其他频带上通信。

[0128] 在一些说明性实施例中,无线通信装置 400 可执行控制站(例如,控制站 120(图 1)、控制站 220(图 2)、和/或控制站 320(图 3))的功能。

[0129] 在一些说明性实施例中,无线通信装置 400 可执行能够在控制链路上通信的控制站(例如,控制站 120(图 1)、或控制站 320(图 3))的功能。根据这些实施例,收发器模块 404 可包括低频带收发器 410 以在第一频带上通信,例如,以在控制链路上通信。

[0130] 在一些说明性实施例中,无线通信装置 400 可执行能够在回程链路上通信的控制站(例如,控制站 220(图 2))的功能。根据这些实施例,收发器模块 404 可包括双频带收发器模块,该双频带收发器模块被配置为在第一频带上通信(例如,以在无线回程链路上通信),并且在第二频带上通信(例如,以在控制链路上与控制站通信)。在一个实例中,例如,如上文所述,收发器模块 404 可既包括低频带收发器 410 也包括高频带收发器 412。

[0131] 在一些说明性实施例中,收发器 404、410 和/或 412 可包括一个或多个无线电装置,例如包括能够发送和/或接收无线通信信号、RF 信号、帧、区块、传输流、分组、消息、数据项、和/或数据的一个或多个无线发送器、接收器、和/或收发器。

[0132] 在一些说明性实施例中,收发器模块 404 可包括一个或多个天线,或可与一个或多个天线相关联。在一个示例中,收发器 410 可与一个或多个天线 406 相关联;和/或收发器 412 可与一个或多个天线 408 相关联。

[0133] 天线 406 和/或 408 可包括适用于发送和/或接收无线通信信号、区块、帧、传输流、分组、消息、和/或数据的任何类型的天线。举例来说,天线 406 和/或 408 可包括一个或多个天线元件、组件、单元、装配、和/或阵列的任何合适配置、结构和/或安排。天线 406 和/或 408 可包括例如适用于使用波束成形技术的定向通信的天线。举例来说,天线 408 可包括相控阵列天线、多元件天线、波束转换天线组、和/或其类似物。在一些实施例中,天线 406 和/或 408 可使用分离的发送和接收天线元件来实施发送和接收功能。在一些实施例中,天线 406 和/或 408 可使用共同和/或集成的发送/接收元件来实施发送和接收功能。

[0134] 在一些说明性实施例中,无线通信装置 400 还包括被配置为例如根据无线通信装置 400 的功能控制收发器模块 404 的无线通信控制器 402。

[0135] 在一个示例中,例如,如上文所述,控制器 402 可控制收发器模块 404 来执行控制站(例如,控制站 120(图 1)、控制站 220(图 2)、和/或控制站 320(图 3))的功能。

[0136] 在另一示例中,例如,如上文所述,控制器 402 可控制收发器模块 404 来执行无线通信节点(例如,回程节点)的功能,无线通信节点比如是节点 102、104、106、108、110 和/或 112(图 1),回程节点 210(图 2),和/或回程节点 310(图 3)。

[0137] 在一些说明性实施例中,无线通信装置 400 还可包括例如,处理器 416、存储器单

元 418、及存储单元 420 中的一个或多个。无线通信装置 400 可选择性地包括其他合适的硬件组件 / 或软件组件。在一些说明性实施例,无线通信装置 400 的组件中的一些或全部可封闭于共同外壳或封装中,且可使用一个或多个有线或无线链路来互连或可操作地关联。在其他实施例中,无线通信装置 400 的组件可分布于多个或分离的装置之间。

[0138] 处理器 416 包括:例如,中央处理单元 (CPU)、数字信号处理器 (DSP)、一个或多个处理器核心、单核处理器、双核处理器、多核处理器、微处理器、主机处理器、控制器、多个处理器或控制器、芯片、微型芯片、一个或多个电路、电路系统、逻辑单元、集成电路 (IC)、专用 IC (ASIC)、或任何其他合适多用途或专门处理器或控制器。处理器 416 执行例如,无线通信装置 400 的操作系统 (OS) 和 / 或一个或多个合适应用的指令。

[0139] 存储器单元 418 包括:例如,随机访问存储器 (RAM)、只读存储器 (ROM)、动态 RAM (DRAM)、同步 DRAM (SD-RAM)、闪速存储器、易失存储器、非易失存储器、缓存存储器、缓冲器、短期存储器单元、长期存储器单元、或其他合适的存储器单元。存储单元 420 包括:例如,硬盘驱动、软盘驱动、光盘 (CD) 驱动、CD-ROM 驱动、DVD 驱动、或其他合适可移除或非可移除存储单元。存储器单元 418 和 / 或存储单元 420 例如可储存由无线通信装置 400 处理的数据。

[0140] 在一些说明性实施例中,如下文所述,无线通信装置 400 可利用共同天线 (例如,共同天线阵列) 在多个无线通信链路 (例如,多个无线回程电路) 上通信。

[0141] 在一些说明性实施例中,天线 408 可包括天线阵列,该天线阵列包括多个天线元件。天线阵列的多个天线元件例如可被配置为产生多个高度定向的天线方向图 (antenna pattern)。多个天线元件包括例如可被放置在预定义几何形状中的约 16-36 个天线元件或任何其他数目的天线元件。例如,如下文所述,多个天线元件可被配置为形成多个高度定向的天线方向图或波束,这些高度定向的天线方向图或波束可通过设定天线元件处的恰当信号相位来操控。

[0142] 在一些说明性实施例中,控制器 402 可被配置为控制天线 408 以生成并操控多个波束以指向多个其他装置,例如,其他回程节点。举例来说,无线通信装置 400 可操控多个波束以经由在由天线 408 形成的多个波束上的多个无线回程链路与多个无线回程节点通信。在一个示例中,节点 108 (图 1) 可包括控制器 402 以控制天线 408 来形成指向节点 110 (图 1) 的第一波束以在回程链路 174 (图 1) 上与节点 110 (图 1) 通信,以及形成指向节点 106 (图 1) 的第二波束以在回程链路 173 (图 1) 上与节点 106 (图 1) 通信。

[0143] 在其他实施例中,无线通信装置 400 可利用多个分离天线 (例如,天线阵列) 来在多个无线通信链路 (例如,多个无线回程链路) 上通信。

[0144] 下文是根据一些说明性实施例的可由无线通信装置 400 利用的模块化天线阵列的描述。在其他实施例中,可以使用任何其他适合的天线阵列。举例来说,模块化天线阵列可执行天线 408 的功能。在一些说明性实施例中,模块化天线阵列还可执行针对多个波束的共享 MIMO 和 / 或波束成形处理。

[0145] 在一些说明性实施例中,天线阵列可包括模块化架构,该模块化架构被配置为从较小子阵列天线模块合成较大的复合天线阵列。子阵列天线模块中的 RF 波束成形与可实施于例如基带、中间频率、和 / 或 RF 链中的子阵列天线模块之间的中心波束成形的组合可提供例如增强的波束成形能力,例如,在波束宽度、增益、覆盖范围及波束操控方面。天

线阵列可被配置为例如在 RF 频谱的毫米波区域运行,特别地,例如,在无线个人区域网络 (WPAN) 及无线局域网 (WLAN) 通信系统的使用相关联的 60GHz 区域运行。

[0146] 现参考图 5,图 5 根据一些说明性实施例示意性图示模块化天线阵列 500。

[0147] 在一些说明性实施例中,模块化天线阵列 500 可执行天线 408(图 4)的功能。

[0148] 在一些说明性实施例中,模块化天线阵列 500 可包括至少一个天线阵列 507,该天线阵列包括多个天线元件 517。多个天线元件 517 可被配置为例如产生高度定向天线方向图。多个天线元件 517 包括例如可放置在预定义几何形状中的约 16 至 36 个天线元件或任何其他数目个天线元件。例如,如下文所述,多个天线元件 517 可被配置为形成多个高度定向的天线方向图或波束,这些高度定向的天线方向图或波束可通过设定天线元件 517 处的适当信号相位来操控。

[0149] 在一些说明性实施例中,天线阵列 507 可包括多个天线子阵列。举例来说,天线阵列 507 可包括第一天线子阵列 535 及第二天线子阵列 545。在其他实施例中,天线阵列 507 可包括任何其他数目个天线子阵列。例如,两个以上天线子阵列。

[0150] 如本文所用的短语“天线子阵列”可涉及多个天线元件 517 的天线元件群组,该天线元件群组可被耦合到例如共同 RF 链。在一个示例中,天线 507 可包括可被分成多个例如独立子阵列的天线阵列,每个子阵列都能独立地生成定向波束。在另一示例中,天线 507 可包括多个不同天线阵列以生成多个定向波束。在另一示例中,天线 507 可包括两个或更多个不同天线阵列。不同天线阵列中的一个或多个可被分成两个或更多个子阵列。

[0151] 在一些说明性实施例中,第一天线子阵列 535 可包括多个天线元件 517 中的第一多个天线元件,第一多个天线元件被配置为形成指向第一方向 539 的第一定向波束 537。

[0152] 在一些说明性实施例中,第二天线阵列 545 可包括多个天线元件 517 的第二(例如,不同的)多个天线元件,第二多个天线元件被配置为形成指向第二方向 549 的第二定向波束 547。

[0153] 本文中关于包括两个子阵列(例如,天线子阵列 535 及 545)的模块化天线阵列(例如,模块化天线阵列 500)描述了一些说明性实施例,这些子阵列被配置为形成两个定向波束。然而,其他实施例,模块化天线阵列可包括任何其他多个天线子阵列以形成任何其他多个定向波束。

[0154] 在一些说明性实施例中,模块化天线阵列 500 可包括多个射频(RF)链,这些 RF 链被配置为控制天线子阵列 535 及 545 的第一多个天线元件及第二多个天线元件。

[0155] 在一些说明性实施例中,多个 RF 链可被耦合至多个天线子阵列。举例来说,模块化天线阵列 500 可包括连接至第一天线子阵列 535 的第一 RF 链 530,及连接至第二天线子阵列 545 的第二 RF 链 540。在其他实施例中,模块化天线阵列 500 可包括耦合于多个天线子阵列中的任何其他数目个天线子阵列的任何其他数目个 RF 链,例如,连接至两个以上天线子阵列的两个以上 RF 链。

[0156] 在一些说明性实施例中,RF 链 530 和 / 或 540 可包括射频集成电路(RFIC)或可被包括作为射频集成电路(RFIC)的部分,射频集成电路可通过多个馈线 518(例如,可以是微带馈线)被连接至天线子阵列 535 及 545。

[0157] 在一些说明性实施例中,多个 RF 链可允许实现对例如携带不同数据的两个或两个以上独立 RF 信号的处理。举例来说,RF 链 530 可处理 RF 信号 531,且 RF 链 540 可处理

RF 信号 541。

[0158] 在一些说明性实施例中, RF 链 530 可包括多个移相器 515, 这些移相器 515 被配置为调整天线子阵列 535 的天线元件的相位。举例来说, 移相器 515 中的移相器可配置为调整天线子阵列 535 的对应天线元件。

[0159] 举例来说, 天线子阵列 535 的天线元件的相位可例如由移相器 515 移位以提供相长和 / 或相消干扰, 移相器被配置为改变天线子阵列 535 的波束成形方案并改变定向波束 537 的方向。

[0160] 在一些说明性实施例中, RF 链 540 可包括多个移相器 514, 这些移相器 514 被配置为调整天线子阵列 545 的天线元件的相位。举例来说, 移相器 514 中的移相器可被配置为调整天线子阵列 545 的对应天线元件。

[0161] 举例来说, 天线子阵列 545 的天线元件的相位可例如由移相器 514 移位以提供相长或相消干扰, 移相器被配置为改变天线子阵列 545 的波束成形方案并改变定向波束 547 的方向。

[0162] 移相器 515 和 / 或 514 可为离散的, 例如, 被配置将天线子阵列 535 和 / 或 545 的天线元件的相位旋转至值的有限集, 例如, 0 、 $\pm \pi/2$ 及 π , 允许仅相对粗略的波束成形用于改变定向波束 537 和 / 或 547 的方向。

[0163] 在一些说明性实施例中, RF 链 530 可包括耦合至移相器 515 的求和器 / 分路器区块 513, 和 / 或 RF 链 540 可包括耦合于移相器 514 的求和器 / 分路器区块 512。

[0164] 在一些说明性实施例中, 求和器 / 分路器区块 513 可包括分路器 534 (例如, 多路复用器), 其可被配置为重新生成 RF 信号 531 并在天线子阵列 535 的天线元件之间对 RF 信号 531 进行分路, 并且将 RF 信号 531 的重新生成的信号耦合到移相器 515, 例如, 在通过波束 537 传输 RF 信号 531 时。

[0165] 在一些说明性实施例中, 求和器 / 分路器区块 513 可包括求和器 536, 其被配置为把从天线子阵列的天线元件接收到的信号求和成 RF 信号 531, 例如, 在通过波束 537 接收 RF 信号 531 时。

[0166] 在一些说明性实施例中, 利用两个或两个以上 RF 链可允许实现对例如携带不同数据的两个或更多个独立信号的基带处理。相比之下, 利用单一 RF 链可允许实现对仅一个信号的基带处理, 例如, 即使在利用大量天线元件 517 的情况下亦然。

[0167] 举例来说, RF 链 530 及 540 可允许实现对通过定向波束 537 及 547 传输的 RF 信号 531 及 541 的基带处理 (例如, 独立基带处理)。

[0168] 在一些说明性实施例中, RF 信号 531 可包括由回程节点 (例如, 节点 108 (图 1)) 经由在波束 537 上的第一无线回程链路 (例如, 回程链路 174 (图 1)) 传输的数据, 且 RF 信号 541 可包括由回程节点经由在波束 547 上的第二无线回程链路 (例如, 回程链路 173 (图 1)) 传输的数据。

[0169] 在一些说明性实施例中, 例如, 如下文所述, 模块化天线阵列 500 可利用两个或更多个 RF 链来执行波束成形的多样化通信。

[0170] 本文中所使用短语“波束成形的多样化通信”可涉及利用多个波束的任何通信。

[0171] 在一些说明性实施例中, 模块化天线阵列 500 可包括基带 550, 其被配置为控制天线子阵列 535 和 545 以形成指向方向 539 和 549 的定向波束 537 和 547, 以传送 MIMO 无线

传输。

[0172] 在一些说明性实施例中,例如,如下文所述,基带 550 可将输入数据 521 处理成将利用 MIMO 波束成形方案来传送的 MIMO 无线传输。

[0173] 在一些说明性实施例中,输入数据 521 可包括将在一个或多个回程链路(例如,回程链路 173 和 / 或 174(图 1))上传输的数据。

[0174] 在本文中参考无线通信单元(例如,模块化天线阵列 500)描述了一些说明性实施例,该无线通信单元被配置为执行 MIMO 波束成形通信的发送及接收。其他实施例中包括仅能够执行 MIMO 波束成形通信的发送和接收中的一者的无线通信单元。

[0175] 本文中参考通信系统(例如,无线通信系统 500)描述了一些说明性实施例,其中 TX 侧及 RX 侧都利用多个天线子阵列来传送 MIMO 传输。然而,可关于被配置为传输任何其他多样通信的系统(例如,其中 Tx 侧和 Rx 侧中仅一者利用多个天线子阵列例如来形成单输入多输出(DIMO)和 / 或多输入单输出(MISO)波束成形链路的系统)来实施其他实施例。举例来说,Tx 侧和 Rx 侧之一可利用全向天线,且 Tx 和 Rx 侧中的另一侧可利用多阵列收发器,例如模块化天线阵列 500。

[0176] 在一些说明性实施例中,模块化天线阵列 500 可包括在多个 RF 链与基带 550 之间进行接口连接的多个基带(BB)到 RF(BB2RF)转换器。举例来说,模块化天线阵列 500 可包括在 RF 链 530 与基带 550 之间进行接口连接的 BB2RF 转换器 533,及在 RF 链 540 与基带 550 之间进行接口连接的 BB2RF 转换器 543。在其他实施例中,模块化天线阵列 500 可包括连接在基带 550 与任何其他数目个 RF 链之间的任何其他数目个(例如,两个以上)BB2RF 转换器。

[0177] 在一些说明性实施例中,BB2RF 转换器 533 可将 RF 信号 531 转换成基带数据信号 527 且反之亦然,和 / 或 BB2RF 转换器 543 可将 RF 信号 541 转换成基带数据信号 529 且反之亦然。

[0178] 在一个示例中,例如,若模块化天线阵列 500 经由波束 537 和 / 或 547 接收 MIMO 无线传输,则 BB2RF 转换器 543 可将 RF 信号 531 转换成基带数据信号 527,和 / 或 BB2RF 转换器 543 可将 RF 信号 541 转换成基带数据信号 529。

[0179] 在另一示例中,例如,若模块化天线阵列 500 经由波束 537 和 / 或 547 接收 MIMO 无线传输,则 BB2RF 转换器 533 可将基带数据信号转换成 527RF 信号 531,和 / 或 BB2RF 转换器 543 可将基带数据信号 529 转换成 RF 信号 541。

[0180] 在一些说明性实施例中,例如,若模块化天线阵列 500 接收 MIMO 无线传输,则 BB2RF 转换器 533 和 / 或 543 可包括下转换器(down-converter)532,该下转换器被配置为将 RF 信号转换成基带数据信号,并将基带数据信号提供给基带 550。

[0181] 举例来说,BB2RF 转换器 533 可包括下转换器 532,其被配置为将 RF 信号 531 下转换成数据信号 527,并将数据信号提供给基带 550。

[0182] 在一些说明性实施例中,例如,如果模块化天线阵列 500 发送 MIMO 无线传输,则基带至 RF 转换器 533 和 / 或 543 可包括上转换器(up-converter)538,该上转换器被配置为将基带数据信号转换成 RF 信号,并将 RF 信号提供给 RF 链。

[0183] 举例来说,BB2RF 转换器 533 可包括上转换器 538,其被配置为将数据信号 527 上转换成 RF 信号 531,并将 RF 信号 531 提供给 RF 链 530。

[0184] 在一些说明性实施例中,模块化天线阵列 500 可被配置为执行混合波束成形。例如,如下文所述,混合波束成形可包括例如使用移相器 539 和 / 或 549 在 RF 链 530 和 / 或 540 中执行粗略波束成形;以及在基带 550 中执行精细波束成形。

[0185] 在一个示例中,粗略和 / 或精细波束成形可例如,作为用于设置波束成形链路的波束成形过程的部分来执行。

[0186] 在一些说明性实施例中,精细波束成形可包括在基带 550 处的多样化处理,例如,MIMO 处理、MISO 处理和 / 或 SIMO 处理。举例来说,MIMO 处理可包括:例如,闭环 (CL)MIMO 处理、开环 (OL)MIMO 处理、空间区块编码 (SBC)MIMO 处理、(例如,空时区块编码 (STBC)MIMO 处理、空频区块编码 (SFBC)MIMO 处理) 等。

[0187] 在一些说明性实施例中,模块化天线阵列 500 可包括控制器 522,其被配置为控制 RF 链 535 和 545 以及基带 550 以执行粗略波束成形和 / 或精细波束成形。

[0188] 在一些说明性实施例中,控制器 522 可利用控制信号 528 来控制天线子阵列 535 和 / 或 545,控制信号 528 携带待施加至移相器 515 和 / 或 514 中的一个或多个移相器上的相移量。

[0189] 在一些说明性实施例中,对移相器 515 的相移调整可判定和 / 或控制由天线子阵列 535 形成的定向波束 537 的波束宽度、增益和 / 或方向。

[0190] 在一些说明性实施例中,对移相器 514 的相移调整可判定和 / 或控制由天线子阵列 545 形成的定向波束 547 的波束宽度、增益和 / 或方向。

[0191] 在一些说明性实施例中,天线子阵列 535 和 / 或 545 的天线元件的每个移相器可对信号执行局部相位调整,以产生在期望的波束方向上的局部相位分布。

[0192] 在一些说明性实施例中,控制信号 528 可包括可从控制器 522 生成和 / 或导出的加权系数,该加权系数被配置为操控定向波束 537 和 / 或 547。

[0193] 在一些说明性实施例中,控制器 522 可经由控制信号 528 将第一组加权系数提供给移相器 515,移相器 515 被配置为形成对天线子阵列 535 的一个或多个天线元件的局部相位调整,从而使波束 537 指向方向 539。

[0194] 在一些说明性实施例中,控制器 522 可经由控制信号 528 将第二(例如,不同)加权系数集合提供给移相器 514,移相器 514 被配置为形成对天线子阵列 545 的一个或多个天线元件的局部相位调整,从而使波束 547 指向方向 549。

[0195] 在一些说明性实施例中,可通过由多个波束成形的波束形成的多个波束成形链路传输多个不同信号。对应于多个天线子阵列中的天线子阵列的每一波束成形链路可例如,通过天线子阵列的多个天线元件传输信号。

[0196] 举例来说,可通过由天线子阵列 535 产生的定向波束 537 所形成的第一波束成形的链路来传输第一信号(例如,信号 527),且可通过由天线子阵列 545 生成的定向波束 547 形成的第二波束成形的链路来传输第二(例如,不同)信号(例如,信号 529)。

[0197] 在一些说明性实施例中,模块化天线阵列 500 可由节点利用以形成一个或多个独立定向通信波束。在一个示例中,模块化天线阵列 500 可由节点 108(图 1)利用以形成第一定向波束以在回程链路 174(图 1)上通信,并形成第二定向波束以在回程链路 173(图 1)上通信。

[0198] 参考图 6,图 6 根据一些说明性实施例示意性地图示无线回程通信的方法。举例

来说,图 6 的方法的操作中的一个或多个可由如下各项来执行:无线通信系统(例如,系统 100)、无线通信节点(例如,节点 102、104、106、108、110、112(图 1)、210(图 2)、和/或 310(图 3))、控制站(例如,控制站 120(图 1)、220(图 2)和/或 320(图 3))、和/或无线通信装置(例如,无线通信装置 400(图 4))。

[0199] 在一些说明性实施例中,图 6 的方法的操作中的一个或多个可以实施在第一频带及第二频带上的双频带回程网络。举例来说,第一频带可大于第二频带。在一个示例中,第一频带可包括毫米波频带,且第二频带可包括非毫米波频带,例如,如上文所述。

[0200] 如框 602 处所指示的,该方法可包括在第二频带上经由回程链路在无线通信节点与控制站之间通信。举例来说,例如,如上文所述,无线通信节点 102(图 1)可经由控制链路 161(图 1)与控制站 120(图 1)通信。

[0201] 如框 604 处所指示的,该方法可包括在第一频带上经由回程网络的一个或多个回程链路在无线通信节点与一个或多个其他无线通信节点之间通信。举例而言,例如,如上文所述,无线通信节点 102(图 1)可经由回程链路 171(图 1)与无线通信节点 104(图 1)通信。

[0202] 如框 606 处所指示的,在控制链路上进行的通信可包括在控制站与无线通信节点之间传输控制信息,该控制信息根据用于经由回程链路路由回程流量的路由图限定无线通信节点与一个或多个其他无线通信节点之间的一个或多个回程链路。举例来说,例如,如上文所述,控制站 120(图 1)可在控制链路 161(图 1)上将限定路由图的控制信息传输至节点 102(图 1)。

[0203] 如框 608 处所指示的,传输控制信息可包括传输来自多个无线通信节点的连通性信息。举例来说,例如,如上文所述,控制站 120(图 1)可从回程节点收集状态信息,例如,接通/关断状态、毫米波频带连通性图信息、通过节点的流量强度等。

[0204] 如框 610 处所指示的,传输连通性信息可包括指令回程节点执行对适合于毫米波频带通信的对等回程节点进行搜索。举例来说,例如,如上文所述,控制站 102(图 1)可例如,经由控制链路 161(图 1)指令节点 102(图 1)搜索适合于在一个或多个回程链路上通信的一个或多个其他节点(例如,节点 104(图 1))。

[0205] 如框 612 处所指示的,传输连通性信息可包括向回程节点请求连通性信息。举例来说,控制站 120(图 1)可经由控制链路 161(图 1)将来自控制站 120(图 1)的对连通性信息的请求传输至节点 102(图 1)。例如,如上文所述,连通性信息可包括:例如,关于无线通信节点 102(图 1)在回程链路上连接至一个或多个其他无线通信节点的能力的信息,和/或关于无线通信节点 102(图 1)连接至核心网络的能力的信息。

[0206] 如图 614 处所指示的,传输控制信息可包括演算和/或配置或重新配置连通性图,该连通性图限定将在回程节点之间建立的回程节点。举例来说,控制站 120(图 1)可例如基于所收集的连通性信息配置节点 102、104、106、108、110 和/或 112(图 1)之间的连通性图以包括具体节点对之间的多个回程链路,例如以配置/最优化毫米波回程网络。

[0207] 如框 616 处所指示的,传输控制信息可包括指令回程节点根据连通性图来配置无线回程链路。举例来说,例如,如上文所述,控制站 120(图 1)可例如经由控制链路 161(图 1)控制节点 102(图 1),以建立与节点 104(图 1)的回程链 171(图 1)。

[0208] 参考图 7,图 7 根据一些说明性实施例示意性的图示了制造产品 700。产品 700 可

包括储存逻辑 704 的非暂态机器可读存储介质 702, 该逻辑可用以例如执行如下各项的功能的至少一部分: 无线通信节点 102、104、106、108、110 和 / 或 112 (图 1), 无线通信节点 210 (图 2), 无线通信节点 310 (图 3), 控制站 120 (图 1), 控制站 220 (图 2), 控制站 320 (图 3), 和 / 或无线通信装置 400 (图 4); 和 / 或用于执行图 6 的方法的一个或多个操作。短语“非暂态机器可读介质”旨在包括所有计算机可读介质, 仅暂态传播信号除外。

[0209] 在一些说明性实施例中, 产品 700 和 / 或机器可读存储介质 702 可包括能够存储数据的一种或多种类型的计算机可读介质, 包括: 易失性存储器、非易失性存储器、可移除或非可移除存储器、可擦除或非可擦除存储器、可写入或非可写入存储器等。举例来说, 机器可读储存存储介质 702 可包括 RAM、DRAM、双数据速率 DRAM (DDR-DRAM)、SDRAM、静态 RAM (SRAM)、ROM、可编程 ROM (PROM)、可擦除可编程 ROM (EPROM)、电可擦除可编程 ROM (EEPROM)、高密度盘 ROM (CD-ROM)、可录高密度磁盘 (CD-R)、可重写高密度磁盘 (CD-RW)、闪速存储器 (例如, NOR 或 NAND 闪速存储器)、内容可寻址存储器 (CAM)、聚合物存储器、相变存储器、铁电存储器、硅氧化氮氧化硅 (SONOS) 存储器、盘、软盘、硬盘驱动、光盘、磁盘、卡、磁卡、光卡、磁带、盒式磁带等。计算机可读存储介质可以包括在通过通信链路 (例如, 调制解调器、无线电连接或网络连接) 将计算机程序从远程计算机下载或传送到请求计算机时所涉及到的任意适当的介质, 其中该计算机程序由体现于载波或其他传播介质中的数据信号来携带。

[0210] 在一些说明性实施例中, 逻辑 704 可包括指令、数据和 / 或代码, 如果这些指令、数据和 / 或代码被机器执行, 则可以使得机器执行本文所述的方法、处理和 / 或操作。该机器可包括: 例如, 任意适当的处理平台、计算平台、计算设备、处理设备、计算系统、处理系统、计算机、处理器等, 并且可使用硬件、软件、固件等的任意适当的组合来实施。

[0211] 在一些说明性实施例中, 逻辑 704 可包括或可被实施为: 软件、软件模块、应用、程序、子程序、指令、指令集、计算代码、词、值、符号等。这些指令可包括任意适当类型的代码, 例如, 源代码、编译代码、解译代码、可执行代码、静态代码、动态代码等。这些指令可根据预定的计算机语言、方式或语法来实现, 以指导处理器执行某一功能。这些指令可使用任意合适的高级、低级、面向对象的、可视的、编译的和 / 或解译的编程语言来实现, 例如, C、C++、Java、BASIC、Matlab、Pascal、Visual BASIC、汇编语言、机器代码等等。

[0212] 示例

[0213] 下面的示例与其他实施例有关。

[0214] 示例 1 包括一种无线通信设备, 该设备包括无线通信控制器, 该无线通信控制器控制无线通信节点经由在第一频带上的回程网络的一个或多个回程链路与一个或多个其他无线通信节点通信, 并且经由在第二频带上的控制链路与控制站通信, 该第一频带高于第二频带。

[0215] 示例 2 包括示例 1 的主题且可选择地, 其中, 无线通信控制器控制无线通信节点以经由控制链路从控制站接收控制信息, 控制信息限定回程链路及经由回程链路的路由图, 其中, 无线通信控制器控制无线通信节点以根据控制信息建立回程链路。

[0216] 示例 3 包括示例 2 的主题且可选择地, 其中, 无线通信控制器控制无线通信节点以经由控制链路接收来自控制站的对连通性信息的请求, 连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关, 其中, 无线通信控制器控制无线通信节点以在

控制链路上将该连通性信息发送至控制站,且其中来自控制站的控制信息是基于连通性信息的。

[0217] 示例 4 包括示例 2 或 3 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0218] 示例 5 包括示例 1-4 中任一示例的主题且可选择地,其中,回程链路包括在一个或多个其他无线通信节点与核心网络之间传输回程流量的链路。

[0219] 示例 6 包括示例 5 的主题且可选择地,其中,无线通信节点包括回程端点节点以在核心网络上通信。

[0220] 示例 7 包括示例 5 或 6 的主题且可选择地,其中,无线通信控制器控制无线通信节点以在核心网络与无线通信小区的一个或多个移动装置之间传递流量。

[0221] 示例 8 包括示例 5-7 中任一示例的主题且可选择地,其中,无线通信控制器控制通信节点以在无线通信节点与控制站之间的回程链路上传输回程流量。

[0222] 示例 9 包括示例 1-8 中任一示例的主题且可选择地,其中,控制站包括一个或多个其他无线通信节点中的节点。

[0223] 示例 10 包括示例 1-9 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0224] 示例 11 包括示例 1-10 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0225] 示例 12 包括示例 1-11 中任一示例的主题且可选择地,其中,无线通信节点通过一个或多个接入链路与无线通信小区的一个或多个移动装置通信。

[0226] 示例 13 包括示例 12 的主题且可选择地,其中,接入链路包括在选自由第一频带和第二频带组成的群组的频带上的链路。

[0227] 示例 14 包括示例 1-13 中任一示例的主题且可选择地,其中,无线通信控制器控制无线通信节点以同时在第一频带和第二频带上通信。

[0228] 示例 15 包括示例 1-14 中任一示例的主题且可选择地,其中,第一频带包括毫米波(mmWave)频带,且其中第二频带包括非毫米波频带。

[0229] 示例 16 包括示例 15 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0230] 示例 17 包括示例 16 的主题且可选择地,其中,第二频带包括长期演进(LTE)频带。

[0231] 示例 18 包括示例 1-17 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0232] 示例 19 包括示例 1-18 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B(eNB)。

[0233] 示例 20 包括一种无线通信设备,该设备包括无线通信控制器,该无线通信控制器经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传递控制信息,控制信息限定无线通信节点与多个无线通信节点中的一个或多个其他无线通信节点之间的回程链路,这些回程链路包括在第一频带上的链路以在无线通信节点与核心网络之间传递流量,该控制信息限定经由回程链路路由该流量的路由图,该控制链路包括在第二频带上的链路,其中第一频带高于第二频带。

[0234] 示例 21 包括示例 20 的主题且可选择地,其中,无线通信控制器控制控制站以将控制信息从控制站传输至无线通信节点。

[0235] 示例 22 包括示例 21 的主题且可选择地,其中,无线通信控制器控制控制站以经由一个或多个其他控制链路来与一个或多个无线通信节点通信,以限定包括多个无线通信节点之间的多个回程链路的回程网络。

[0236] 示例 23 包括示例 20 的主题且可选择地,其中,无线通信控制器控制无线通信节点以从控制站接收控制信息,并且基于该控制信息来建立回程链路。

[0237] 示例 24 包括示例 20 的主题且可选择地,其中,无线通信控制器通过控制链路传输来自控制站的对连通性信息的请求,连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关,其中,无线通信控制器通过控制链路将连通性信息传输至控制站,并且其中,来自控制站的控制信息是基于连通性信息的。

[0238] 示例 25 包括示例 24 的主题且可选择地,其中,连通性信息是与无线通信节点连接至核心网络的能力有关。

[0239] 示例 26 包括示例 20-25 中任一示例的主题且可选择地,其中,无线通信节点包括回程端点节点,以在核心网络上通信且在核心网络与一个或多个其他无线通信节点之间传递流量。

[0240] 示例 27 包括示例 20-26 中任一示例的主题且可选择地,其中,无线通信控制器控制通信节点以在无线通信节点与控制站之间的回程链路上传输流量。

[0241] 示例 28 包括示例 20-27 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0242] 示例 29 包括示例 20-28 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0243] 示例 30 包括示例 20-29 中任一示例的主题且可选择地,其中,无线通信控制器控制无线通信节点以同时在第一频带和第二频带上通信。

[0244] 示例 31 包括示例 20-30 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中,第二频带包括非毫米波频带。

[0245] 示例 32 包括示例 31 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0246] 示例 33 包括示例 32 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频带。

[0247] 示例 34 包括示例 20-33 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0248] 示例 35 包括示例 20-34 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0249] 示例 36 包括一种无线通信系统,该系统包括:包括一个或多个天线的无线通信节点;在第一频带和第二频带上通信的至少一个收发器,第一频带高于第二频带;以及无线通信控制器,该无线通信控制器控制无线通信节点以通过在第一频带上的回程网络的一个或多个回程链路与一个或多个其他无线通信节点通信,并且通过在第二频带上的控制链路与控制站通信。

[0250] 示例 37 包括示例 36 的主题且可选择地,其中,无线通信控制器控制无线通信节点

以经由控制链路从该控制站接收控制信息,控制信息限定回程链路及经由回程链路的路由图,其中,无线通信控制器控制无线通信节点以根据控制信息建立回程链路。

[0251] 示例 38 包括示例 37 的主题且可选择地,其中,无线通信控制器控制无线通信节点以经由控制链路接收来自控制站的对连通性信息的请求,连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关,其中,无线通信控制器控制无线通信节点以在控制链路上将该连通性信息发送至控制站,并且其中,来自控制站的控制信息是基于连通性信息的。

[0252] 示例 39 包括示例 37 或 38 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0253] 示例 40 包括示例 36-39 中任一示例的主题且可选择地,其中,回程链路包括在一个或多个其他无线通信节点与核心网络之间传递回程流量的链路。

[0254] 示例 41 包括示例 40 的主题且可选择地,其中,无线通信节点包括回程端点节点以在核心网络上通信。

[0255] 示例 42 包括示例 40 或 41 的主题且可选择地,其中,无线通信控制器控制无线通信节点以在核心网络与无线通信小区的一个或多个移动装置之间传输流量。

[0256] 示例 43 包括示例 40-42 中任一示例的主题且可选择地,其中,无线通信控制器控制通信节点以在无线通信节点与控制站之间的回程链路上传输回程流量。

[0257] 示例 44 包括示例 36-43 中任一示例的主题且可选择地,其中,控制站包括一个或多个其他无线通信节点中的节点。

[0258] 示例 45 包括示例 36-44 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0259] 示例 46 包括示例 36-45 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0260] 示例 47 包括示例 36-46 中任一示例的主题且可选择地,其中,无线通信节点通过一个或多个接入链路与无线通信小区的一个或多个移动装置通信。

[0261] 示例 48 包括示例 47 的主题且可选择地,其中,接入链路包括在选自由第一频带及第二频带组成的群组的频带上的链路。

[0262] 示例 49 包括示例 36-48 中任一示例的主题且可选择地,其中,无线通信控制器控制无线通信节点以在同时第一频带和第二频带上通信。

[0263] 示例 50 包括示例 36-49 中任一示例的主题且可选择地,其中,一个或多个天线包括天线阵列,并且其中无线通信控制器将控制天线阵列以在多个定向波束上传输回程链路。

[0264] 示例 51 包括示例 36-50 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中第二频带包括非毫米波频带。

[0265] 示例 52 包括示例 51 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0266] 示例 53 包括示例 52 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频带。

[0267] 示例 54 包括示例 36-53 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0268] 示例 55 包括示例 36-54 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0269] 示例 56 包括一种无线通信系统,该系统包括:包括一个或多个天线的无线通信装置;至少一个收发器,该至少一个收发器在第一频带及第二频带上通信,第一频带高于第二频带;以及无线通信控制器,该无线通信控制器控制无线通信装置以经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传输控制信息,该控制信息限定无线通信节点与多个无线通信节点中的一个或多个其他无线通信节点之间的回程链路,回程链路包括在第一频带上的链路以在无线通信节点与核心网络之间传输信息,该控制信息限定经由回程链路路由流量的路由图,控制链路包括在第二频带上的链路。

[0270] 示例 57 包括示例 56 的主题且可选择地,其中,无线通信控制器控制该控制站以将控制信息从控制站发送至无线通信节点。

[0271] 示例 58 包括示例 57 的主题且可选择地,其中,无线通信控制器控制该控制站以经由一个或多个其他控制链路来与一个或多个无线通信节点通信以限定包括多个无线通信节点之间的多个回程链路的回程网络。

[0272] 示例 59 包括示例 58 的主题且可选择地,其中,无线通信控制器控制无线通信节点以从控制站接收控制信息,并且基于该控制信息来建立回程链路。

[0273] 示例 60 包括示例 59 的主题且可选择地,其中,无线通信控制器通过控制链路传输来自控制站的对连通性信息的请求,连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关,其中,无线通信控制器在控制链路上将连通性信息传输至控制站,并且其中来自控制站的控制信息是基于连通性信息的。

[0274] 示例 61 包括示例 60 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0275] 示例 62 包括示例 56-61 中任一示例的主题且可选择地,其中,无线通信节点包括回程端点节点,以在核心网络上通信并且在核心网络与一个或多个其他无线通信节点之间传输流量。

[0276] 示例 63 包括示例 56-62 中任一示例的主题且可选择地,其中,无线通信控制器控制通信节点以在无线通信节点与控制站之间的回程链路上传输流量。

[0277] 示例 64 包括示例 56-63 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0278] 示例 65 包括示例 20-28 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0279] 示例 66 包括示例 56-64 中任一示例的主题且可选择地,其中,无线通信控制器控制无线通信节点以同时第一频带和第二频带上通信。

[0280] 示例 67 包括示例 56-65 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中第二频带包括非毫米波频带。

[0281] 示例 68 包括示例 67 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0282] 示例 69 包括示例 68 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频带。

[0283] 示例 70 包括示例 56-69 中任一示例的主题且可选择地,其中,无线通信节点包括

接入点或基站。

[0284] 示例 71 包括示例 56-70 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0285] 示例 72 包括一种无线通信方法,该方法包括:经由在第一频带上的回程网络的一个或多个回程链路在无线通信节点与一个或多个其他无线通信节点之间通信;以及经由在第二频带上的控制链路在无线通信节点与控制站之间通信,第一频带高于第二频带。

[0286] 示例 73 包括示例 72 的主题且可选择地包括:经由控制链路从控制站接收控制信息,该控制信息限定回程链路和经由回程链路的路由图;以及根据该控制信息建立回程链路。

[0287] 示例 74 包括示例 73 的主题且可选择地包括:经由该控制链路接收来自控制站的对连通性信息的请求,该连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关;以及在控制链路上将该连通性信息传输至控制站,其中,来自控制站的控制信息是基于连通性信息的。

[0288] 示例 75 包括示例 73 或 74 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0289] 示例 76 包括示例 72-75 中任一示例的主题且可选择地,其中,回程链路包括在一个或多个其他无线通信节点与核心网络之间传递回程流量的链路。

[0290] 示例 77 包括示例 76 的主题且可选择地,其中,无线通信节点包括回程端点节点,以在核心网络上通信。

[0291] 示例 78 包括示例 76 或 77 的主题且可选择地包括:在核心网络与无线通信小区的一个或多个移动装置之间传输流量。

[0292] 示例 79 包括示例 76-78 中任一示例的主题且可选择地,包括在无线通信节点与控制站之间的回程链路上传输回程流量。

[0293] 示例 80 包括示例 72-79 中任一示例的主题且可选择地,其中,控制站包括一个或多个其他无线通信节点中的节点。

[0294] 示例 81 包括示例 72-80 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0295] 示例 82 包括示例 72-81 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0296] 示例 83 包括示例 72-83 中任一示例的主题且可选择地,包括经由一个或多个接入链路与无线通信小区的一个或多个移动装置通信。

[0297] 示例 84 包括示例 83 的主题且可选择地,其中,接入链路包括在选自由第一频带和第二频带组成的群组的频带上的链路。

[0298] 示例 85 包括示例 72-84 中任一示例的主题且可选择地包括:同时在第一频带和第二频带上通信。

[0299] 示例 86 包括示例 72-85 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中第二频带包括非毫米波频带。

[0300] 示例 87 包括示例 86 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0301] 示例 88 包括示例 87 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频

带。

[0302] 示例 89 包括示例 72-88 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0303] 示例 90 包括示例 72-89 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0304] 示例 91 包括一种无线通信方法,该方法包括:经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传输控制信息,该控制信息限定该无线通信节点与多个无线通信节点中的一个或多个其他无线通信节点之间的一个或多个回程链路,这些回程链路包括用于在这些无线通信节点与核心网络之间传递流量的在第一频带上的链路,该控制信息限定用于经由这些回程链路路由流量的路由图,这些控制链路包括在第二频带上的链路,其中,第一频带高于第二频带。

[0305] 示例 92 包括示例 91 的主题且可选择地包括:将控制信息从控制站发送至无线通信节点。

[0306] 示例 93 包括示例 92 的主题且可选择地包括:经由一个或多个其他控制链路来与一个或多个其他无线通信节点通信,以限定包括多个无线通信节点之间的多个回程链路的回程网络。

[0307] 示例 94 包括示例 91 的主题且可选择地包括:从控制站接收控制信息,并且基于该控制信息建立回程链路。

[0308] 示例 95 包括示例 94 的主题且可选择地包括:经由控制链路传输来自控制站的对连通性信息的请求,该连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关;以及在控制链路上将该连通性信息传输至控制站,其中,来自控制站的控制信息是基于该连通性信息的。

[0309] 示例 96 包括示例 95 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0310] 示例 97 包括示例 91-96 中任一示例的主题且可选择地,其中,无线通信节点包括回程端点节点,以在核心网络上通信并且在核心网络与一个或多个其他无线通信节点之间传输流量。

[0311] 示例 98 包括示例 91-97 中任一示例的主题且可选择地包括:在无线通信节点与控制站之间的回程链路上传输流量。

[0312] 示例 99 包括示例 91-98 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0313] 示例 100 包括示例 91-99 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0314] 示例 101 包括示例 91-100 中任一示例的主题且可选择地包括:同时在第一频带和第二频带上通信。

[0315] 示例 102 包括示例 91-101 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中第二频带包括非毫米波频带。

[0316] 示例 103 包括示例 102 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0317] 示例 104 包括示例 103 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频

带。

[0318] 示例 105 包括示例 91-104 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0319] 示例 106 包括示例 91-105 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0320] 示例 107 包括一种包括上面存储有指令的非暂态存储介质的产品,这些指令在由机器执行时使得以下操作被执行:经由在第一频带上的回程网络的一个或多个回程链路在无线通信节点与一个或多个其他无线通信节点之间通信;以及经由在第二频带上的控制链路在无线通信节点与控制站之间通信,第一频带高于第二频带。

[0321] 示例 108 包括示例 107 的主题且可选择地,其中,这些指令还使得以下操作被执行:经由控制链路接收来自控制站的控制信息,该控制信息限定回程链路和经由这些回程链路的路由图;以及根据该控制信息来建立回程链路。

[0322] 示例 109 包括示例 108 的主题且可选择地,其中,这些指令还使得以下操作被执行:经由该控制链路接收来自控制站的对连通性信息的请求,该连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关;以及经由控制链路将该连通性信息发送至该控制站,其中,来自控制站的控制信息是基于该连通性信息的。

[0323] 示例 110 包括示例 108 或 109 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0324] 示例 111 包括示例 107-110 中任一示例的主题且可选择地,其中,回程链路包括用于在一个或多个其他无线通信节点与核心网络之间传输回程流量的链路。

[0325] 示例 112 包括示例 111 的主题且可选择地,其中,无线通信节点包括回程端点节点,以在核心网络上通信。

[0326] 示例 113 包括示例 111 或 112 的主题且可选择地,其中,这些指令还使得以下操作被执行:在核心网络与无线通信小区的一个或多个移动装置之间传输流量。

[0327] 示例 114 包括示例 111-113 中任一示例的主题且可选择地,其中,这些指令还使得以下操作被执行:在无线通信节点与控制站之间的回程链路上传输回程流量。

[0328] 示例 115 包括示例 107-114 中任一示例的主题且可选择地,其中,控制站包括一个或多个其他无线通信节点中的节点。

[0329] 示例 116 包括示例 107-115 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0330] 示例 117 包括示例 107-116 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0331] 示例 118 包括示例 107-117 中任一示例的主题且可选择地,其中,这些指令还使得以下操作被执行:通过一个或多个接入链路与无线通信小区的一个或多个移动装置通信。

[0332] 示例 119 包括示例 118 的主题且可选择地,其中,接入链路包括在选自由第一频带和第二频带组成的群组的频带上的链路。

[0333] 示例 120 包括示例 107-119 中任一示例的主题且可选择地,其中,这些指令还使得以下操作被执行:同时在第一频带和第二频带上通信。

[0334] 示例 121 包括示例 107-120 中任一示例的主题且可选择地,其中,第一频带包括毫

米波 (mmWave) 频带, 并且其中第二频带包括非毫米波频带。

[0335] 示例 122 包括示例 121 的主题且可选择地, 其中, 第二频带包括蜂窝频带。

[0336] 示例 123 包括示例 122 的主题且可选择地, 其中, 第二频带包括长期演进 (LTE) 频带。

[0337] 示例 124 包括示例 107-123 中任一示例的主题且可选择地, 其中, 无线通信节点包括接入点或基站。

[0338] 示例 125 包括示例 107-124 中任一示例的主题且可选择地, 其中, 控制站包括演进型节点 B (eNB)。

[0339] 示例 126 包括一种包括上面存储有指令的非暂态存储介质的产品, 这些指令在由机器执行时使得以下操作被执行: 经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传输控制信息, 该控制信息限定无线通信节点与多个无线通信节点中的一个或多个其他无线通信节点之间的回程链路, 这些回程链路包括用于在无线通信节点与核心网络之间传输流量的在第一频带上的链路, 该控制信息限定用于经由回程链路路由流量的路由图, 这些控制链路包括在第二频带上的链路, 其中, 第一频带高于第二频带。

[0340] 示例 127 包括示例 126 的主题且可选择地, 其中, 这些指令使得以下操作被执行: 将控制信息从控制站传输至无线通信节点。

[0341] 示例 128 包括示例 127 的主题且可选择地, 其中, 这些指令使得以下操作被执行: 经由一个或多个其他控制链路来与一个或多个其他无线通信节点通信, 以限定包括多个无线通信节点之间的多个回程链路的回程网络。

[0342] 示例 129 包括示例 126 的主题且可选择地, 其中, 这些指令使得以下操作被执行: 从控制站接收控制信息, 并且基于该控制信息建立回程链路。

[0343] 示例 130 包括示例 126 的主题且可选择地, 其中, 这些指令使得以下操作被执行: 通过控制链路传输来自控制站的对连通性信息的请求, 连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关; 以及通过该控制链路将该连通性信息传输至控制站, 其中, 来自控制站的控制信息是基于连通性信息的。

[0344] 示例 131 包括示例 130 的主题且可选择地, 其中, 连通性信息与无线通信节点连接至核心网络的能力有关。

[0345] 示例 132 包括示例 126-131 中任一示例的主题且可选择地, 其中, 无线通信节点包括回程端点节点, 以在核心网络上通信并且在核心网络与一个或多个其他无线通信节点之间传输流量。

[0346] 示例 133 包括示例 126-132 中任一示例的主题且可选择地, 其中, 这些指令使得以下操作被执行: 在无线通信节点与控制站之间的回程链路上传输流量。

[0347] 示例 134 包括示例 126-133 中任一示例的主题且可选择地, 其中, 回程链路包括至少一个半双工链路。

[0348] 示例 135 包括示例 126-134 中任一示例的主题且可选择地, 其中, 回程链路包括至少一个全双工链路。

[0349] 示例 136 包括示例 126-135 中任一示例的主题且可选择地, 其中, 这些指令使得以下操作被执行: 同时在第一频带第二频带上通信。

[0350] 示例 137 包括示例 126-136 中任一示例的主题且可选择地, 其中, 第一频带包括毫

米波 (mmWave) 频带, 并且其中第二频带包括非毫米波频带。

[0351] 示例 138 包括示例 137 的主题且可选择地, 其中, 第二频带包括蜂窝频带。

[0352] 示例 139 包括示例 138 的主题且可选择地, 其中, 第二频带包括长期演进 (LTE) 频带。

[0353] 示例 140 包括示例 126-139 中任一示例的主题且可选择地, 其中, 无线通信节点包括接入点或基站。

[0354] 示例 141 包括示例 126-140 中任一示例的主题且可选择地, 其中, 控制站包括演进型节点 B (eNB)。

[0355] 示例 142 包括一种无线通信设备, 该设备包括: 用于经由在第一频带上的回程网络的一个或多个回程链路与一个或多个其他无线通信节点通信的装置; 以及用于经由在第二频带上的控制链路与控制站通信的装置, 第一频带高于第二频带。

[0356] 示例 143 包括示例 142 的主题且可选择地包括: 用于经由控制链路从控制站接收控制信息的装置, 该控制信息限定回程链路和经由回程链路的路由图; 以及根据该控制信息来建立回程链路。

[0357] 示例 144 包括示例 143 的主题且可选择地包括: 用于经由控制链路接收来自控制站的对连通性信息的请求的装置, 该连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关; 以及用于在控制链路上将该连通性信息传输至该控制站的装置, 其中, 来自该控制站的控制信息是基于该连通性信息的。

[0358] 示例 145 包括示例 143 或 144 的主题且可选择地, 其中, 连通性信息与无线通信节点连接至核心网络的能力有关。

[0359] 示例 146 包括示例 142-145 中任一示例的主题且可选择地, 其中, 回程链路包括用于在一个或多个其他无线通信节点与核心网络之间传输回程流量的链路。

[0360] 示例 147 包括示例 146 的主题且可选择地, 其中, 无线通信节点包含回程端点节点, 以在核心网络上通信。

[0361] 示例 148 包括示例 146 或 147 的主题且可选择地包括: 用于在核心网络与无线通信小区的一个或多个移动装置之间传输流量的装置。

[0362] 示例 149 包括示例 146-148 中任一示例的主题且可选择地且可选择地包括: 用于在无线通信节点与控制站之间的回程链路上传输回程流量的装置。

[0363] 示例 150 包括示例 142-149 中任一示例的主题且可选择地, 其中, 控制站包括一个或多个其他无线通信节点中的节点。

[0364] 示例 151 包括示例 142-149 中任一示例的主题且可选择地, 其中, 回程链路包括至少一个半双工链路。

[0365] 示例 152 包括示例 142-149 中任一示例的主题且可选择地, 其中, 回程链路包括至少一个全双工链路。

[0366] 示例 153 包括示例 142-152 中任一示例的主题且可选择地包括: 用于通过一个或多个接入链路与无线通信小区的一个或多个移动装置通信的装置。

[0367] 示例 154 包括示例 153 的主题且可选择地, 其中, 接入链路包括在选自第一频带及第二频带组成的频带的频带上的链路。

[0368] 示例 155 包括示例 142-154 中任一示例的主题且可选择地包括: 用于在同时第一

频带和第二频带上通信的装置。

[0369] 示例 156 包括示例 142-155 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中第二频带包括非毫米波频带。

[0370] 示例 157 包括示例 156 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0371] 示例 158 包括示例 157 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频带。

[0372] 示例 159 包括示例 142-158 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0373] 示例 160 包括示例 142-159 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0374] 示例 161 包括一种无线通信设备,该设备包括:用于经由控制链路在多个无线通信节点中的无线通信节点与控制站之间传输控制信息的装置,该控制信息限定无线通信节点与多个无线通信节点中的一个或多个其他无线通信节点之间的回程链路,这些回程链路包括用于在无线通信节点与核心网络之间传输流量的在第一频带上的链路,控制信息限定用于经由回程链路路由该流量的路由图,该控制链路包括在第二频带上的链路,其中,第一频带高于第二频带。

[0375] 示例 162 包括示例 161 的主题且可选择地包括:用于将控制信息从控制站传输至无线通信节点的装置。

[0376] 示例 163 包括示例 162 的主题且可选择地包括:用于经由一个或多个其他控制链路来与一个或多个其他无线通信节点通信以限定包括多个无线通信节点之间的多个回程链路的回程网络的装置。

[0377] 示例 164 包括示例 161 的主题可选择地包括:用于从控制站接收控制信息并基于该控制信息来建立回程链路的装置。

[0378] 示例 165 包括示例 161 的主题可选择地包括:用于经由控制链路传输来自控制站的对连通性信息的请求的装置,该连通性信息与无线通信节点连接至一个或多个其他无线通信节点的能力有关;以及用于在控制链路上将该连通性信息传输至控制站的装置,其中,来自控制站的控制信息是基于连通性信息的。

[0379] 示例 166 包括示例 165 的主题且可选择地,其中,连通性信息与无线通信节点连接至核心网络的能力有关。

[0380] 示例 167 包括示例 161-166 中任一示例的主题且可选择地,其中,无线通信节点包括回程端点节点以在核心网络上通信并且在核心网络与一个或多个其他无线通信节点之间传输流量。

[0381] 示例 168 包括示例 161-167 中任一示例的主题且可选择地包括:用于在无线通信节点与控制站之间的回程链路上传输流量的装置。

[0382] 示例 169 包括示例 161-168 中任一示例的主题且可选择地,其中,回程链路包括至少一个半双工链路。

[0383] 示例 170 包括示例 161-169 中任一示例的主题且可选择地,其中,回程链路包括至少一个全双工链路。

[0384] 示例 171 包括示例 161-170 中任一示例的主题可选择地包括:用于同时在第一频

带和第二频带上通信的装置。

[0385] 示例 172 包括示例 161-171 中任一示例的主题且可选择地,其中,第一频带包括毫米波 (mmWave) 频带,并且其中第二频带包括非毫米波频带。

[0386] 示例 173 包括示例 172 的主题且可选择地,其中,第二频带包括蜂窝频带。

[0387] 示例 174 包括示例 173 的主题且可选择地,其中,第二频带包括长期演进 (LTE) 频带。

[0388] 示例 175 包括示例 161-174 中任一示例的主题且可选择地,其中,无线通信节点包括接入点或基站。

[0389] 示例 176 包括示例 161-175 中任一示例的主题且可选择地,其中,控制站包括演进型节点 B (eNB)。

[0390] 本文参照一个或多个实施例描述的功能、操作、组件和 / 或特征可与本文参照一个或多个其他实施例描述的一个或多个其他功能、操作、组件和 / 或特征相结合或结合使用,反之亦然。

[0391] 虽然本文中已说明并描述了本发明的某些特征,但本领域的技术人员可以想到许多修改、替换、改变和等同物。因此,应该理解的是,所附权利要求意在覆盖落入本发明的真正精神内的所有这样的修改和改变。

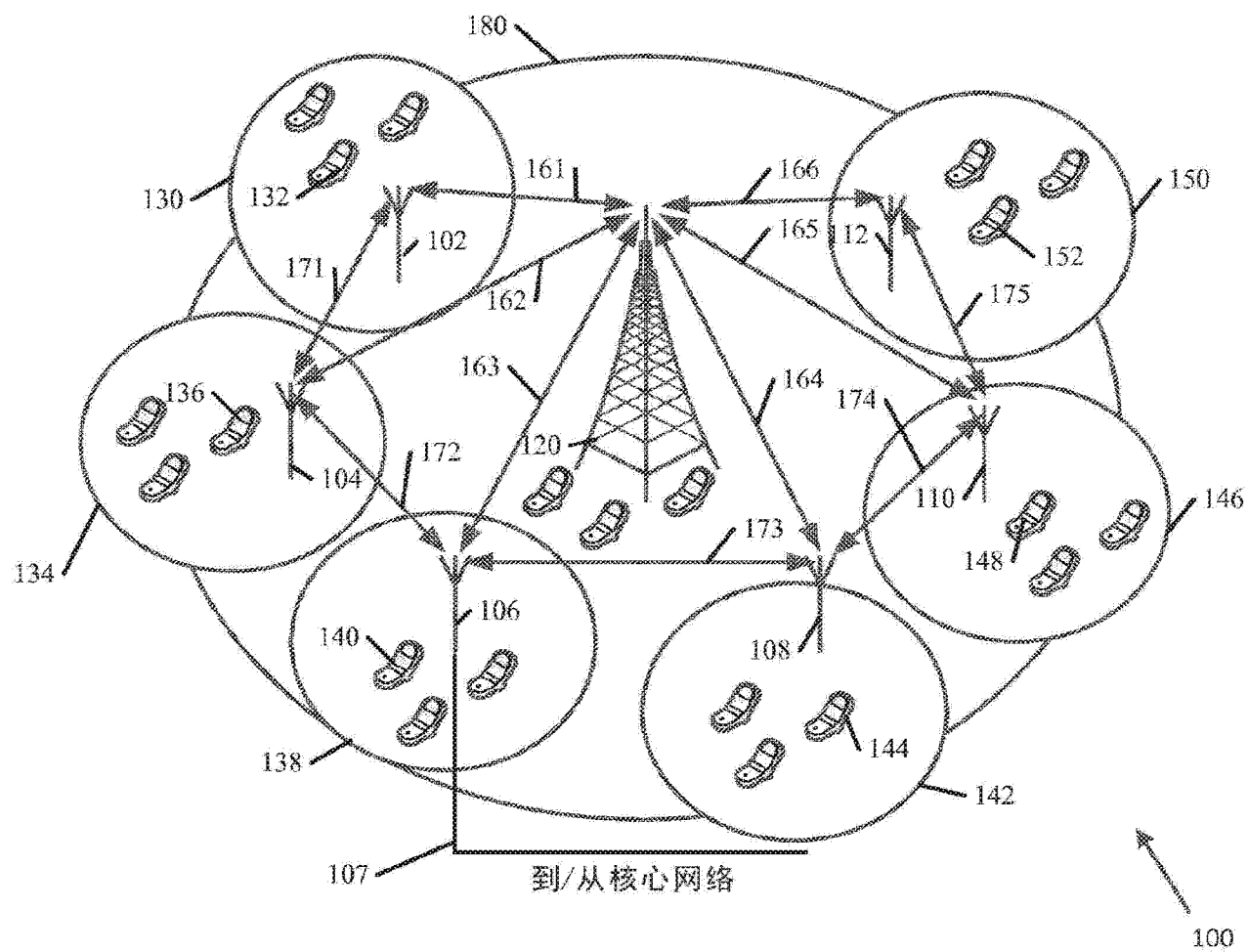


图 1

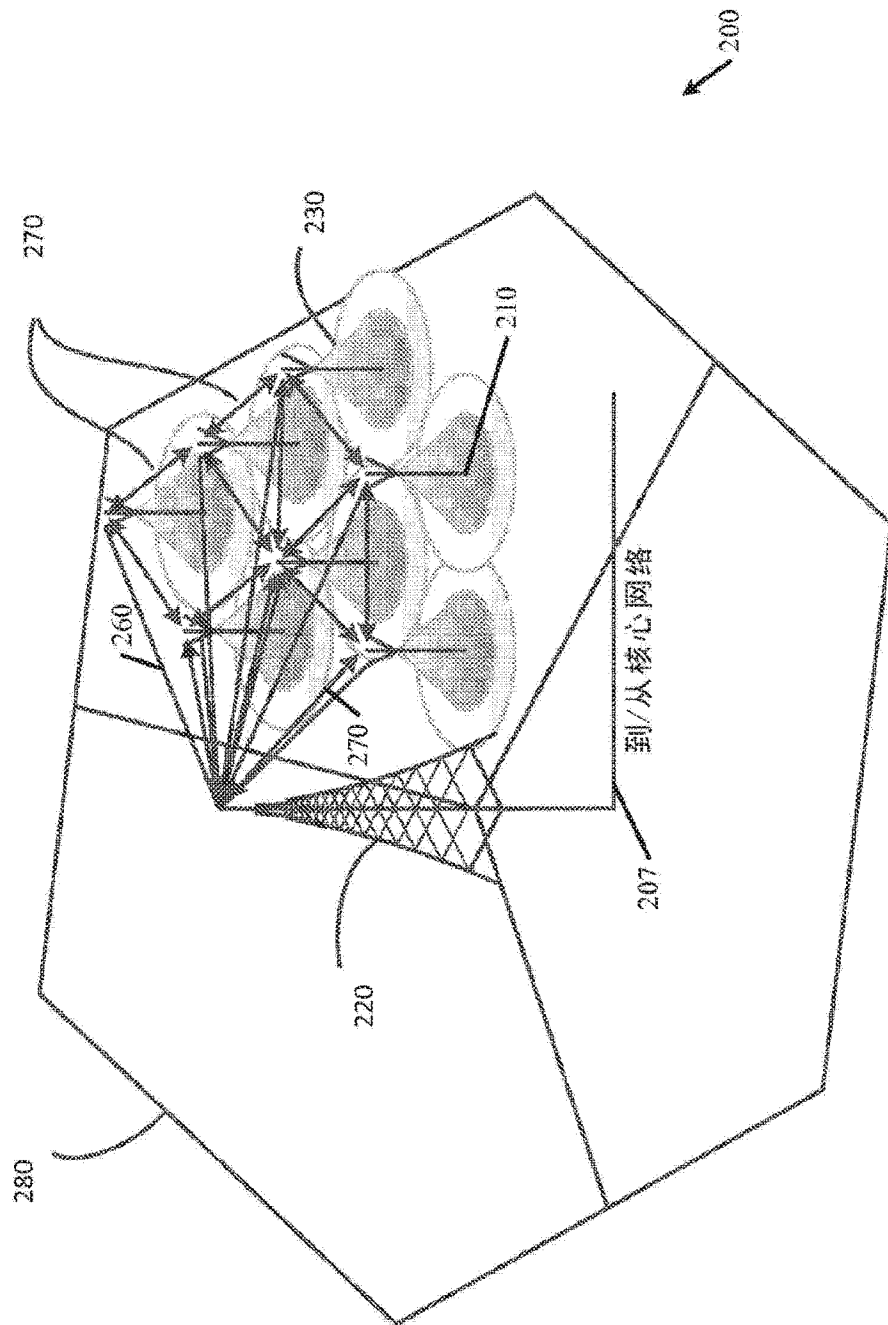


图 2

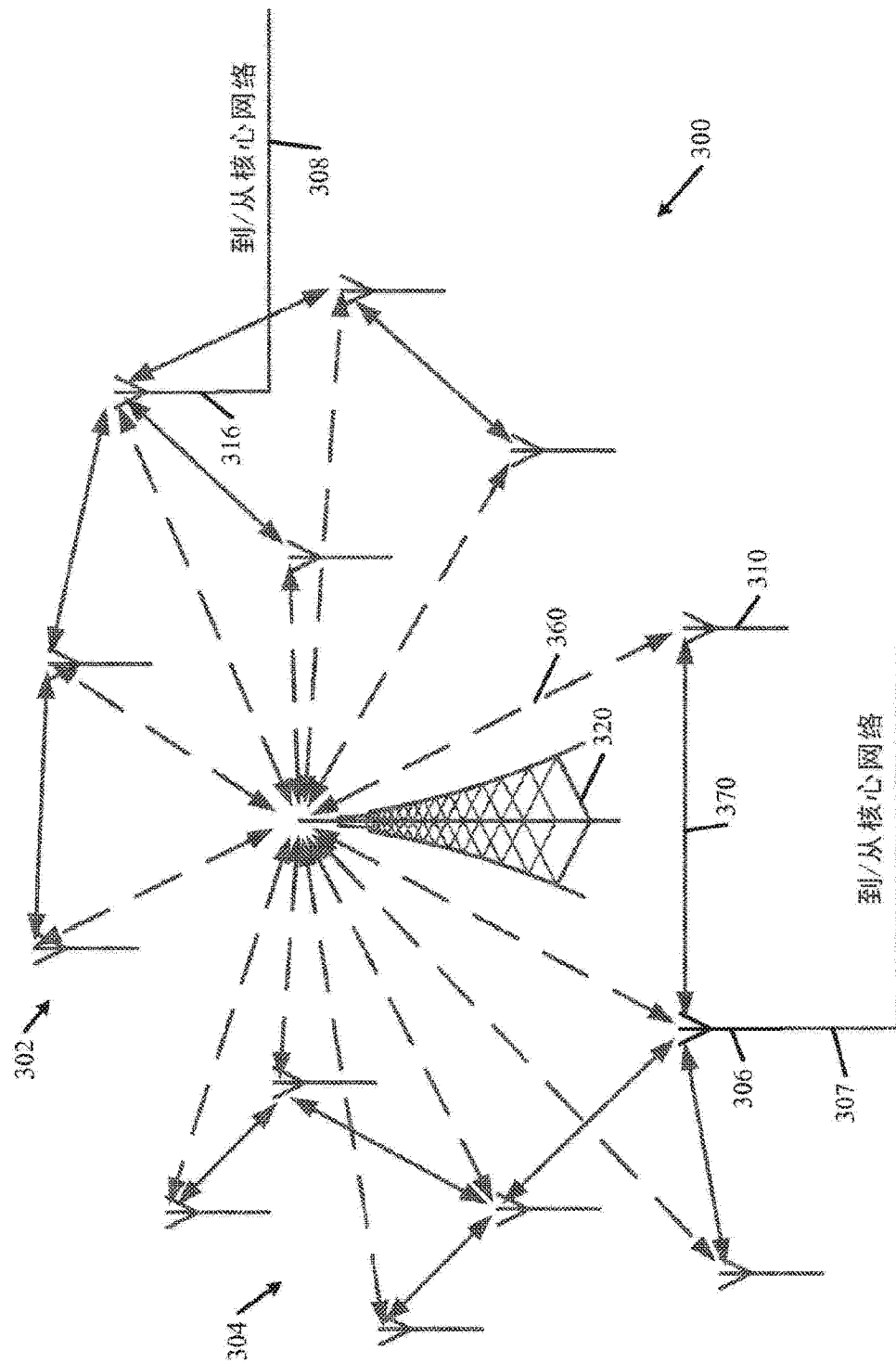


图 3

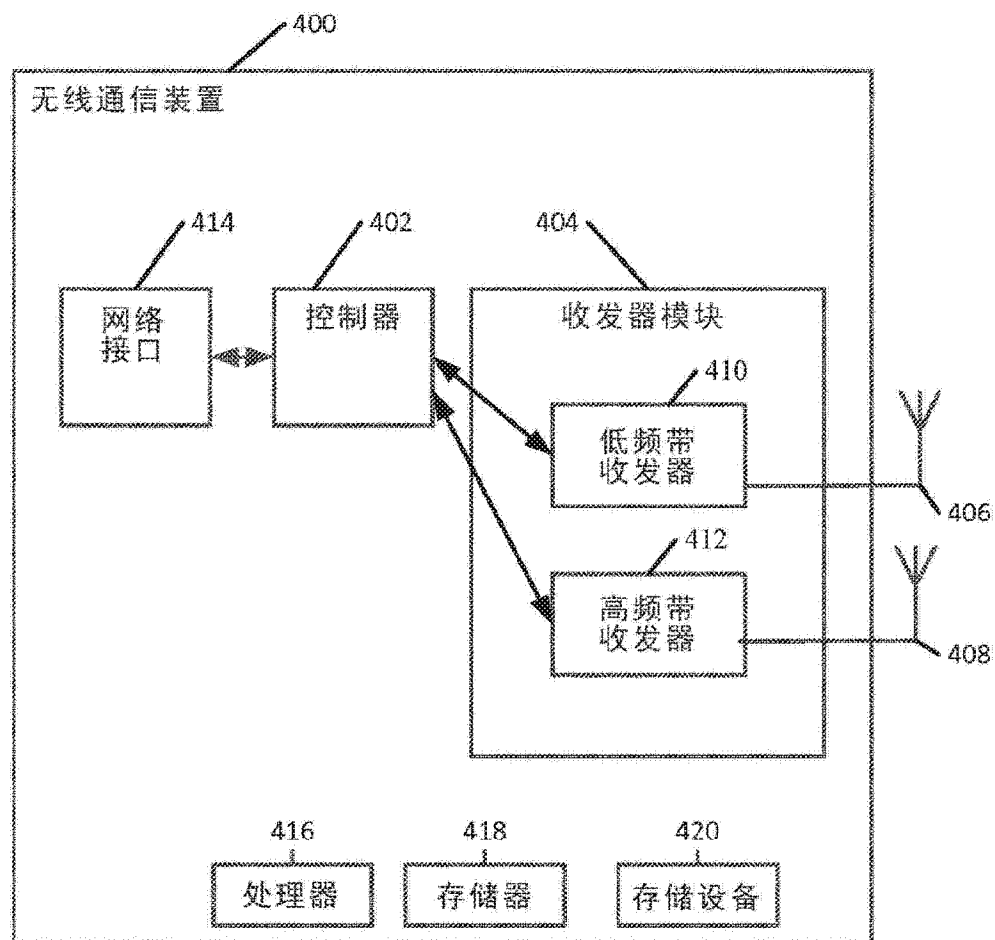
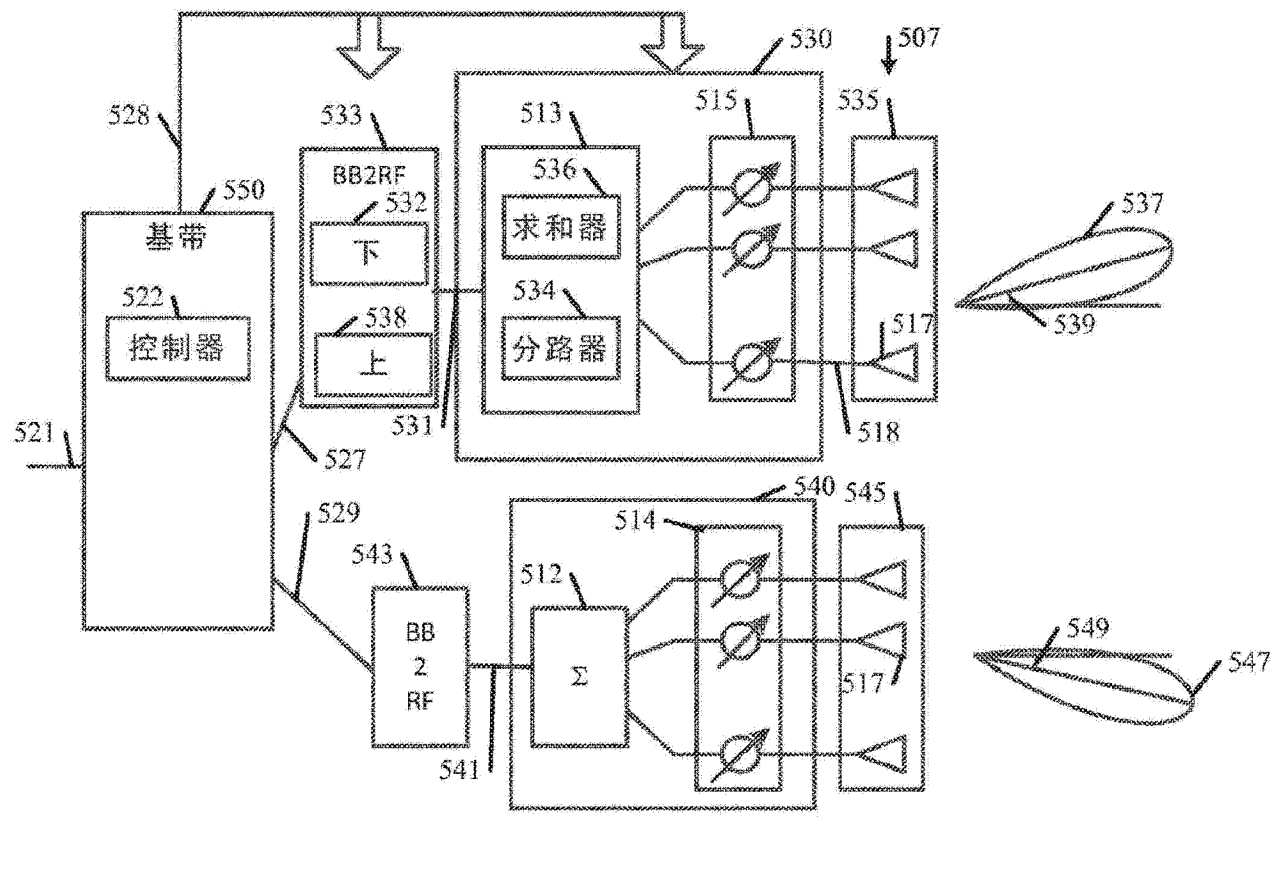


图 4

图 5



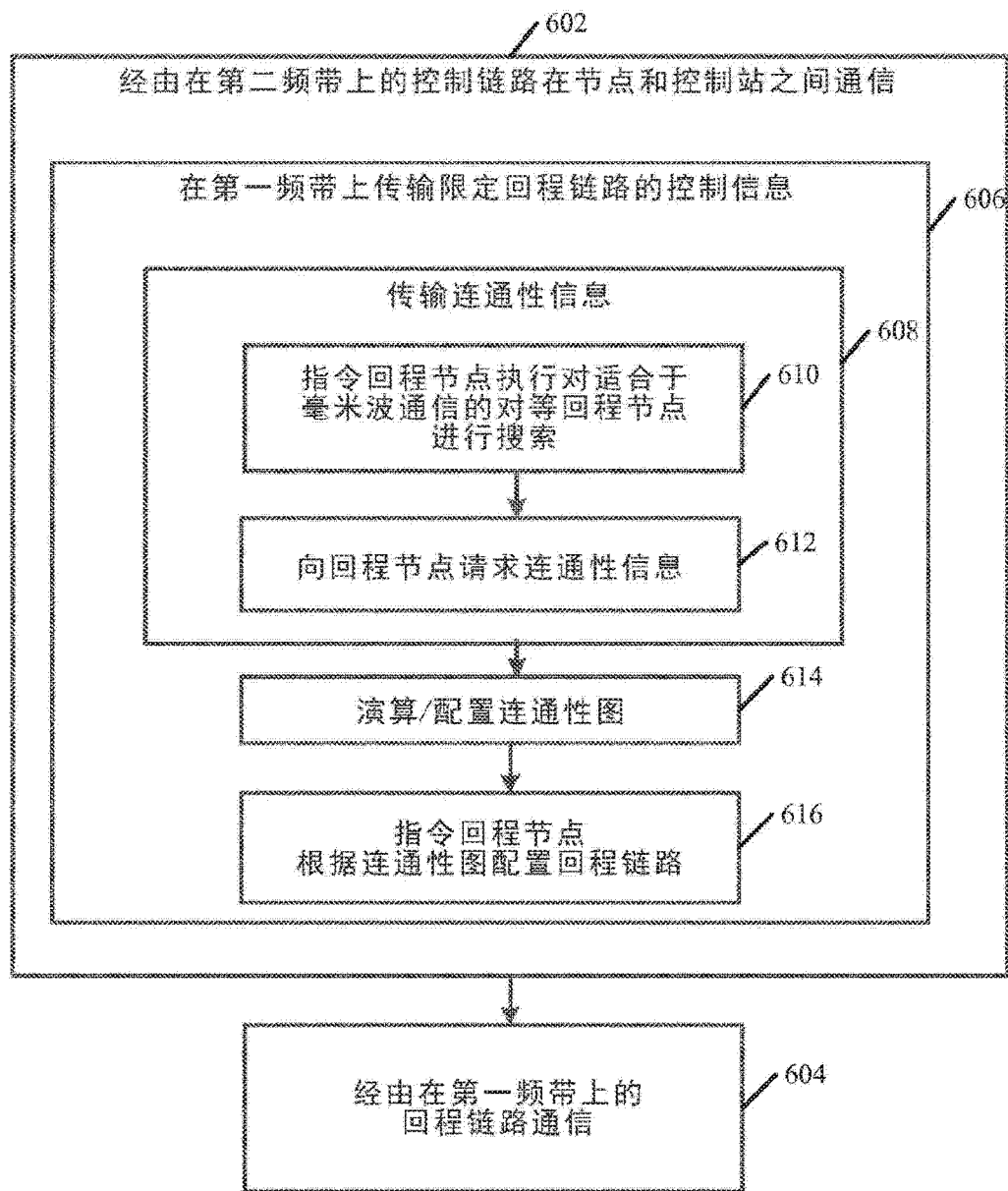


图 6

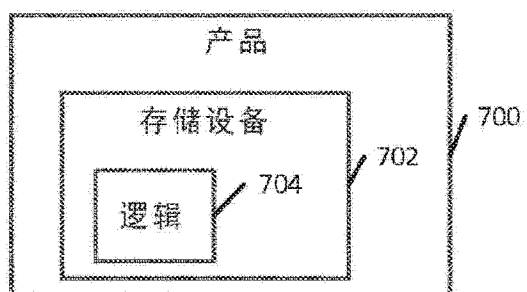


图 7



Espacenet

Bibliographic data: CN105027604 (A) — 2015-11-04

A protection system for wireless NLOS backhaul

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Classification: - international: H04B7/15; H04W24/04; H04W72/04; H04W84/04; H04W92/04
- cooperative: H04W24/04 (EP, US); H04W24/08 (EP); H04W72/085 (US); H04W72/10 (US); H04B7/15542 (EP, US); H04W24/10 (EP, US); H04W72/0406 (EP, US)

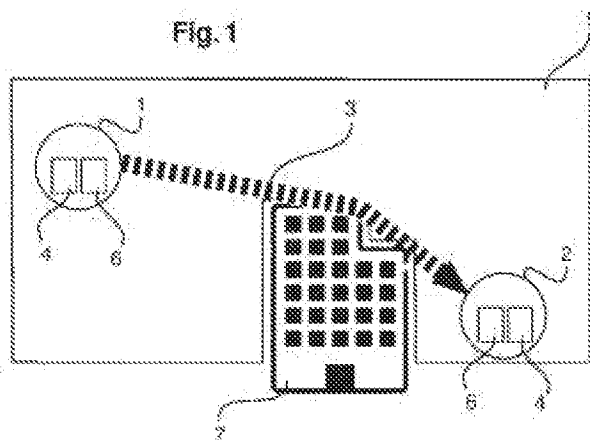
Application number: CN20138071747 20130130 Global Dossier

Priority number (s): WO2013EP51792 20130130

Also published as: EP2952033 (A1) MX2015008734 (A) MX344766 (B) PH12015501413 (A1) US10306653 (B2) US2015365959 (A1) WO2014117832 (A1) less

Abstract of CN105027604 (A)

The invention relates to a protection system, configured for switching between backhaul technologies for upholding a communication in a wireless backhaul network, to a main node, to a dependent node, and to a method for switching between backhaul technologies for upholding a communication. The protection system (5) comprises a main node (1) and a dependent node (2), wherein the main node (1) and the dependent node (2) are configured for communicating with each other via a backhaul channel (3), and a switching unit (4) configured for selecting a backhaul technology for a communication via the backhaul



channel (3), wherein at least one of the main node (1) and the dependent node (2) are further configured for measuring a quality parameter of the backhaul channel (3), wherein the switching unit (4) is further configured for switching the backhaul technology selected for the communication via the backhaul channel (3) to a predefined backhaul technology dependent on the quality parameter measured. In this way, the availability of a wireless backhaul network is increased and, hence, the outage probability of backhauling decreased in connection with providing a more robust backhauling.

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DESCRIPTION CN105027604

The present invention relates to a protection system configured to switch between backhaul technologies for supporting communication in a wireless backhaul network, a master node, a slave node, and a type for supporting communication The method of switching between backhaul technologies. The protection system (5) comprises: a master node (1) and a slave node (2), wherein the master node (1) and the slave node (2) are configured to communicate with each other via a backhaul channel (3); and a switching unit (4) a backhaul technique configured to select communications for the backhaul channel (3), wherein at least one of the master node (1) and the slave node (2) is further configured to measure the backhaul channel (3) A quality parameter, wherein the switching unit (4) is further configured to switch the backhaul technology selected for communication via the backhaul channel (3) to a predefined backhaul technique depending on the measured quality parameter. In this way, the availability of the wireless backhaul network is increased, and thus, the outage probability of backhaul transmission is reduced and a more robust backhaul transmission is provided.

Protection system for wireless NLOS backhaul

Technical field

The present invention relates to a protection system configured to switch between backhaul technologies for supporting communications in a wireless backhaul network.

Background technique

Wireless backhaul systems for small cells are likely to operate in a non-line of sight (NLOS) environment.

Conventionally, most wireless backhaul systems are designed for microwave communication in a line of sight (LOS) environment that ensures high availability of the desired data rate through the communication link or link, respectively. The LOS operation also guarantees a very low probability of outage, ie the link is never interrupted in principle, which is important when designing a wireless backhaul system for transporting user data and controlling data traffic between radio base stations (RBS).

It is desirable that the wireless backhaul system operating in NLOS should also guarantee high availability and therefore very low probability of outage. However, this is difficult to achieve when using microwave frequencies (eg, microwave frequencies greater than 10 GHz) for backhauling in NLOS. A general consensus in the wireless industry today is that the capabilities offered in existing cellular radio access networks based on macro cells do not meet the requirements for future mobile broadband services, except at specific locations (such as in hotspots, cells). Capacity increases at the edge and indoor locations). One way to increase the capacity at these locations is to deploy a low power radio base station, such as a pico RBS, in a heterogeneous network that covers smaller cells within the coverage area of the macro cell. Assuming that each macro cell is supported by several small cells, the number of cells in the network and thus the number of required mobile backhaul (MBH) links will increase dramatically. Due to its small coverage area, it will be important that the small cell pico RBS is placed in the correct location without being limited by the availability of the broadband connection for the MBH. Further, the pico RBS will in many cases be placed or placed below the roof level of the building to prevent clear LOS between the pico RBS and the aggregation nodes co-located with the macro RBS above the roof. Typically, the macro RBS is placed on the roof of a building. Macro RBS is characterized by a large coverage area, high power and directional antennas. Depending on the desired application and environment, pico RBS is typically placed up to 6 meters above street level, such as on a building wall. In an NLOS environment, communication via a backhaul channel is primarily based on diffraction and/or reflection. Traditional MBH technologies (such as copper, fiber optic or LOS microwave links) may not always be suitable for such heterogeneous backhaul schemes, and therefore they need to be complemented by low cost wireless NLOS MBH links. NLOS propagation has traditionally been proposed only for carrier frequencies below 6 GHz. However, the wideband spectrum at these frequencies is a scarce resource, and if made available, the use of this spectrum for mobile broadband services in the Radio Access Network (RAN) becomes attractive.

Conventional fixed service LOS microwave point-to-point (PTP) links operate in licensed bands between 6 GHz and 42 GHz over a channel bandwidth ranging from 3.5 MHz up to 112 MHz. Due to the nature of the traffic carried by the MBH, the traditional PtP LOS link is required to be extremely highly available. However, if a small cell is within the coverage area of a macro cell in a heterogeneous deployment, the extremely high availability requirements for small cell backhaul may be debated. The requirement for small cell MBH is becoming an increasingly important topic discussed in the industry and is driven by the evolution towards a flexible and cost effective heterogeneous arrangement.

In the past few years, there has been an increased interest in higher frequency bands for MBH applications,

especially for the 9 GHz 60 GHz band including a bandwidth between 57 and 66 GHz and for a total of between 71 and 86 GHz. 70/80 GHz band of 10 GHz bandwidth. The bandwidth supplied in these bands is large compared to the 56 and 112 MHz channels available for conventional microwave links, which makes them attractive. The portion of the 60 GHz band is unlicensed, meaning that anyone can deploy the system within that band as long as the equipment meets predefined regulations. However, this frequency is of particular interest for small cell MBH applications because excess oxygen loss at this frequency band can attenuate interference from adjacent links, making efficient frequency reuse possible.

In cellular communications, mobile users are associated or connected to a cell. In a sense, the choice of cell is typically based on being connected to the best cell for a particular user. Due to the mobility of the user, the user may experience another cell as a replacement connection. The system can switch the user to another cell if needed. Conventionally, handovers are based on measurements of access links from different cells or base stations.

Microwave-based wireless backhaul systems operating in NLOS will have problems in ensuring high availability and low outage probability due to multiple problems associated with microwave propagation in urban NLOS. Some typical shortcomings and problems are described below: weather effects (such as rain and snow) will change the diffraction properties; because high frequency radio waves rely mainly on reflection and diffraction so there is no penetration of obstacles; trees and other objects may be moving in the wind; temporary obstacles, such as high vehicles passing close to small cell RBS installed at or slightly above the street level; long-term changes in urban topology, such as new buildings, commercial billboard signs, Etc.; unexpected multipath propagation due to strong reflections; and high gain antennas that become misaligned due to weather effects or vandalism, ie, parabolic antennas.

There is a need to provide high gain antennas for compensating for high path losses associated with high frequencies in NLOS environments. If the backhaul to/from a particular access point fails or is lost, the user connected to that particular access point can ideally switch to another access point with a functional backhaul. However, a failed backhaul connection means that the network has lost all its communications to/from the access point, making it impossible for the access point to request such handover by its users. Alternatively, this switch must be requested by the user themselves, which may mean that many users must make simultaneous switch requests quickly, which increases the likelihood of dropping the connection. This may be that the user may have a bad, very bad, or even non-existent connection to the replacement access point. For example, a user may be indoors and connected to an indoor access point that receives its backhaul connection via an outdoor or near-outdoor antenna solution.

Summary of the invention

It is an object of the present invention to provide a possibility for increasing the availability of a wireless backhaul network and reducing the outage probability of the backhaul link and for providing a more robust backhaul transmission.

This object is achieved by the subject matter of the independent claims. Preferred embodiments are defined in the subclaims.

According to a first aspect of the invention, this object is achieved by a protection system configured to switch between backhaul technologies for supporting communications in a wireless backhaul network, comprising: a master node and a slave node Wherein the master node and the slave node are configured to communicate with each other via a backhaul channel; and a switching unit configured to select a backhaul technique for communication via the backhaul channel, wherein at least one of the master node and the slave node is further A quality parameter is configured for measuring the backhaul channel, wherein the switching unit is further configured to switch the backhaul technology selected for communication via the backhaul channel to a predefined backhaul technique depending on the measured quality parameter.

Separately, the primary node preferably corresponds to a macro radio base station or macro cell, and the secondary node preferably corresponds to a pico radio base station or pico cell. The term "switching between backhaul technologies" means not only that it is switched to a backhaul technique or another backhaul technique, but also that there may be a mix between at least two backhaul technologies. This allows communication or simultaneous connection using multiple backhaul technologies to be supported at least during the handover procedure. The wireless backhaul network preferably corresponds to a wireless non-line-of-sight backhaul network. The term "communication" in its ordinary sense means that two nodes (ie, a first node and a second node) communicate with each other, eg, via a channel, wherein the first node preferably transmits information or data to the second node. The first node preferably comprises a radio transmitter and the second node preferably comprises a radio receiver. The first node and the second node are preferably arranged in a radio communication system.

Therefore, it is an idea of the present invention to allow a wireless backhaul connection to fall back to the macro RBS access as a backup solution in the event of an interruption, preferably by using microwave frequencies. Backhaul transmission using an access system can also be referred to as "in-band relay" or "out-of-band relay" as defined in 3GPP. Preferably, the small cell RBSs that are wirelessly backhauled, in other words, the pico RBSs, are preferably arranged in the coverage area of the macro cell or the macro RBS, respectively, in the normal international mobile telecommunication standard frequency band (IMT band). Take action. IMT represents the technical standard at the bottom of 3G mobile telecommunications, while 3G is just one of many examples of IMT technology. In this way, the total wireless backhaul connection becomes more robust due to system

diversity and/or due to technical diversity. Typically, in NLOS, less reliable wireless backhaul transmission using microwave technology may fail for different reasons, and then utilize the invention at hand, which can be via IMT technology (eg, using High Speed Packet Access (HSPA) Or Long Term Evolution (LTE) is communicated back to the macro RBS. In addition, control data and prioritized data traffic can still communicate via IMT technology. HSPA stands for Mobile Broadband Technology, and LTE is a standard for wireless communication technologies. Preferably, the macro RBS prioritizes scheduling of small cell RBS backhaul transmissions in the case of poor or lost microwave connections.

According to a preferred embodiment of the invention, the switching unit is further configured to request a status parameter of the backhaul channel, wherein the status parameter comprises a communication status from at least one of the primary node and the secondary node. The switching unit is preferably further configured to transmit the requested status parameters of the backhaul channel to the slave node and/or to the master node. Preferably, the quality parameters of the backhaul channel include a received signal strength (RSL) parameter, a channel quality indicator (CQI) parameter, a delay measurement parameter, and/or a repeated retransmission request, wherein the quality parameter is configured to indicate The performance of the backhaul channel. The predefined backhaul technology preferably includes mobile telecommunications technologies such as HSPA and LTE, microwave technology, and/or wireless local area network technologies such as Wi-Fi.

According to a preferred embodiment of the invention, the protection system comprises a diversity unit configured to receive state parameters of a backhaul channel transmitted from the handover unit, the handover unit being arranged at least partially within the master node and/or At least partially disposed within the slave node, wherein the diversity unit is further configured to control and prioritize data traffic between the master node and the slave node depending on the received state parameters and/or dependent on the quality parameters. The diversity unit is preferably at least partially arranged inside the master node and/or preferably at least partially arranged inside the slave node, the diversity unit being further configured to schedule depending on quality parameters and/or dependent on state parameters Data traffic towards the slave node and/or towards the master node. Preferably, the diversity unit, at least partially arranged inside the slave node, is further configured to send a prioritization request and/or a dispatch request to the master node.

In accordance with a preferred embodiment of the present invention, the predefined backhaul technology corresponds to HSPA and/or LTE and is based on a relay type of backhaul. Referring to 3GPP terminology, an LTE RBS is referred to as an enhanced node base station (eNB). 3A relay in GPP terminology is an eNB that is backhauled to another eNB using LTE technology. Therefore, it switches between the relay type backhaul and the microwave backhaul. The slave node is preferably arranged in a non-line of sight to the master node within a predefined coverage area of the master node.

According to a second aspect of the invention, the above mentioned object is achieved by a master node

configured to communicate in a protection system according to the first aspect of the invention, wherein the master node is configured A quality parameter for communicating over a backhaul channel and for measuring a backhaul channel. The master node preferably includes a switching unit configured to select a backhaul technique for communication via a backhaul channel, wherein the switching unit is further configured to be selected depending on quality parameters of the measured backhaul channel The backhaul technique for communication via the backhaul channel switches to a predefined backhaul technique.

According to a third aspect of the invention, the above mentioned object is achieved by a slave node configured for communication in a protection system according to the first aspect of the invention, wherein the slave node is configured A quality parameter for communicating over a backhaul channel and for measuring a backhaul channel. The slave node preferably comprises a handover unit configured to select a backhaul technique for communication via a backhaul channel, wherein the handover unit is further configured to be selected depending on quality parameters of the measured backhaul channel The backhaul technique for communication via the backhaul channel switches to a predefined backhaul technique.

According to a fourth aspect of the invention, the above mentioned object is achieved by a method for switching between backhaul techniques for supporting communication, the method comprising the steps of: a) selecting for use via a backhaul channel The backhaul technique of communication, b) measuring the quality parameters of the backhaul channel, and c) switching backhaul techniques selected for communication via the backhaul channel to a predefined backhaul technique, depending on the quality parameters measured in the previous steps.

According to a preferred embodiment of the invention, the method comprises the step of controlling the data traffic and prioritizing the data traffic depending on the measured quality parameters. Preferably, the method comprises the step of transmitting a prioritization request and/or transmitting a scheduling request via a backhaul channel.

Therefore, one idea of the present invention is that the backup based on IMT technology ensures high availability of data connections between the macro cell and the small cell RBS, enabling communication of at least control and prioritized data to/from the network. Furthermore, the backhaul network is more robust than the solution where the user connects to the small cell RBS and the user switches to another access point in the event of a backhaul outage. Thus, it is easier to make a single and network-controlled "backhaul" between two established technologies prepared for such situations, as compared to, for example, having multiple users make simultaneous handovers to another access point. Switch". With the invention at hand, the user remains connected to the small cell RBS. This is advantageously ensured in the case of poor, very inferior, or even in the absence of a connection to a replacement access point. For example, a user may be indoors and connected to an indoor access point that receives its backhaul connection via an outdoor or near-outdoor antenna solution.

Advantageously, it is ensured that it is always possible to check the status and to ensure that it is possible to communicate control signaling to the small cell/small cell even in the event of a microwave interruption, so that the network triggers an appropriate action to solve the problem. This results in higher availability regardless of, for example, weather effects, but also as a protection system or a diversity system for failures such as hardware failures.

DRAWINGS

Further objects and advantages of the present invention will become apparent from the following description of the preferred embodiments. In the drawing:

Figure 1 illustrates a protection system, a master node and a slave node in accordance with a first preferred embodiment of the present invention;

2 illustrates a NLOS backhaul solution in accordance with a second preferred embodiment of the present invention, in which microwaves are used as primary backhaul technology and IMT techniques are used for backup;

3 shows a scenario for a path loss model with diffraction through a building in accordance with a third preferred embodiment of the present invention;

4 illustrates additional path loss experienced at 32 GHz compared to 2.3 GHz in accordance with a third preferred embodiment of the present invention;

Figure 5 illustrates a method for switched backhaul diversity in accordance with a fourth preferred embodiment of the present invention;

Fig. 6 schematically illustrates the steps of a method for switching between backhaul techniques in accordance with a fifth preferred embodiment of the present invention.

Figure 1 shows a protection system 5 that is configured to switch between different backhaul technologies. The master node 1 is shown, which includes a switching unit 4 and a diversity unit 6. Furthermore, slave node 2 is shown, which also includes a switching unit 4 and a diversity unit 6. In this first preferred embodiment, the master node 1 and the slave node 2 correspond to the macro RBS and the pico RBS, respectively.

Communication between the macro RBS 1 and the pico RBS 2 occurs via the backhaul channel 3. Since the pico RBS 2 is in the NLOS leading to the macro RBS 1, the communication is based on reflections and diffraction that occur in the urban NLOS environment. In this first preferred embodiment, the urban NLOS environment is characterized by a building 7. The switching unit 4 of the pico RBS 2 selects a backhaul technique which is a microwave technique used for communication via the backhaul channel 3. Further, the macro RBS 1 measures the quality parameter of the backhaul channel 3, and thereafter directs the result of this measurement (i.e., the measured quality parameter) to the switching unit 4, which is arranged in this first preferred embodiment Inside the macro RBS 1. In this first preferred embodiment, the received signal level (RSL) is below a certain predefined value, and thus the backhaul technique is switched to a different backhaul technique, which is a mobile telecommunications technology, such as LTE.

In this first preferred embodiment, the switching unit 4 requests a status parameter of the backhaul channel 3, wherein the status parameter includes the communication status from the macro RBS 1 and from the pico RBS 2. The switching unit 4 transmits the status parameters of the requested backhaul channel 3 to the pico RBS 2 and to the macro RBS 1. According to other preferred embodiments of the invention, the node or RBS measures its own state and initiates a handover without any status reporting via the backhaul. In other words, if the node itself detects a backhaul problem, the node initiates a handover, which is preferably communicated to another node.

2 illustrates a NLOS backhaul solution in accordance with a second preferred embodiment of the present invention in which microwaves are used as primary backhaul technology and IMT techniques are used for backup. The narrow arrows illustrate the diffracted microwaves and the wide arrows illustrate the diffracted and reflected IMT radio waves. The macro RBS 1 communicates with the pico RBS 2 via the backhaul channel 3. In this second preferred embodiment, both the macro RBS 1 and the pico RBS 2 are arranged in an urban environment characterized by three buildings 7. The microwave frequency is in principle dependent on the roof diffraction to reach the pico RBS 2, while the IMT band based technique uses a multipath propagation with reflection and diffraction around the building 7 in the NLOS to have better propagation characteristics, which is in this The second preferred embodiment is illustrated by a wide arrow.

Figure 3 illustrates a path loss model with diffraction through a building in accordance with a third preferred embodiment of the present invention. The parameters used for the model are respectively given by h_1 equal to 5 m, h_2 equal to 20 m, H equal to 33 m, and D equal to 15 m. 4 illustrates additional path loss experienced by a

signal at a microwave frequency of 32 GHz compared to an IMT frequency of 2.3 GHz in accordance with a third preferred embodiment of the present invention. The relative attenuation in dB is illustrated on the hop length, which is given by the distance between the macro RBS 1 and the pico RBS 2 shown in FIG. The solid curve in Fig. 4 indicates the relative attenuation without rain, and the broken line curve illustrates the case for the rainfall intensity of 50 mm/hr. Figure 4 illustrates an example of numerical values considering only the roof diffraction above. Further, since the jump length varies from 100 m to 2000 m, a plurality of buildings arranged between the corresponding nodes are considered. At a hop length of 500 m, it can be seen how the 32 GHz channel suffers an additional path loss of 33 dB and 39 dB for no rain and rain, respectively. It can be noted how the curve with rain and the curve without rain differ differently with increasing hop length. Although the additional path loss decreases with increasing distance in the absence of rain, the additional path loss increases with increasing distance in the 50 mm/hr rainfall intensity. This is mainly due to the higher diffraction loss at 2.3 GHz than at 32 GHz, since at 2.3 GHz there are more obstacles in the first Fresnel zone, such as buildings. However, equivalent to a rain attenuation of approximately 12 dB/km at 32 GHz dominates the higher diffraction loss at 2.3 GHz, which causes the additional path loss to increase with increasing hop length in the rain. Thus, Figure 4 clearly illustrates the challenge when using microwave frequencies in NLOS compared to the IMT band. For distances up to 500 m, the extra path loss is at least 33 dB or more, which will have a noticeable effect on the achievable availability and the corresponding fade margin.

Figure 5 illustrates a method for switched backhaul diversity in accordance with a fourth preferred embodiment of the present invention. The received signal strength (RSL) is a measure of the quality of the channel. In the first step 13, it is checked whether the RSL is large and thus the channel quality is good, but if the RSL is small, the channel quality is inferior. The value of the design parameter P is a measure used to determine when to switch backhaul techniques. In the case of poor microwave backhaul, the prioritized backhaul information is rerouted back to the network via IMT technology, for example using 3GPP LTE radio access back to the 3GPP eNB. The microwave backhaul may be at an interruption or close to an interruption. If the RSL is large, the channel quality is good, but if the RSL is small, the channel quality is inferior. Alternatively, in the case where the RSL is small, an alert 14 can be sent to the macro RBS. In this case, 15 is always switched to in-band relay and 16 prioritized information is routed via IMT technology. This continues with 17 when the microwave backhaul is still poor, otherwise it is switched back to the 18 microwave backhaul again. This decision is based on the design parameter P. Preferably, P is greater than the minimum RSL required to operate for the backhaul to avoid an emergency. In the case of a backhaul interruption or whenever communication between the pico RBS and the macro RBS is desired, the macro RBS schedules the pico RBS in a manner similar to the user it schedules to connect to the macro RBS, but in a prioritized manner. This is achieved, for example, by in-band relaying according to 3GPP terminology.

According to another preferred embodiment of the invention, the microwave based connection in the NLOS provides a rate R_1 available at $T_1\%$ of the time, and further, the corresponding IMT based connection provides a rate available at $T_2\%$ of the time R_2 . For simplicity, a fixed rate is also assumed and thus $R_1 = R_2 = R$, which makes sense if the microwave connection has a wider bandwidth than the IMT connection but a worse path loss

in NLOS. Finally, assume that the two links show independent outage probabilities. Availability is defined as a minus the probability of outage. If and only if both the microwave-based backhaul and the IMT-based backhaul are both interrupted, the network is in an interrupt, which becomes a very low probability event, compared to covering other preferences for scenarios when using only a single backhaul technique. For the sake of the embodiment, this implies a higher availability of backhaul transmission. Using the above assumptions, the total availability T3 in % of the backhaul transmission in this preferred embodiment becomes:

And the corresponding availability can therefore be calculated by applying the formula mentioned above. Once the channel quality is good enough, a backhaul switch back to the microwave backhaul technique is initiated.

Figure 6 is a schematic illustration of the steps of a method for switching between backhaul techniques in a wireless backhaul network in accordance with a fifth preferred embodiment of the present invention. In a first step, selection 8 is directed to a backhaul technique for communication via a backhaul channel between the master node and the slave node. In a second step, the quality parameter of the backhaul channel is measured. In the final step, depending on the quality parameters measured in the previous step 9, the selected backhaul technique is switched 10 to a predefined backhaul technique for communication between the master node and the slave node. In a further step, data flow between the master node and the slave node is controlled 11 and prioritized using a predefined backhaul technique.

In accordance with another preferred embodiment of the present invention, the step of transmitting a prioritization request and/or transmitting a scheduling request via a backhaul channel is performed. According to still other preferred embodiments of the present invention, the step of transmitting a prioritization request or transmitting a scheduling request is not performed via a backhaul channel, but LTE is prioritized if it has been handed over to an alternate backhaul technique, such as handover to LTE. Round trip scheduling. For example, this can be done by 3GPP in-band relay, which includes resources reserved for in-band relay, ie if the backhaul is switched to in-band LTE, the LTE "backhaul" is prioritized for backhaul traffic.

The present invention has been illustrated and described in detail in the drawings and the foregoing description of the invention example.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art. In the claims, the term "comprises" does not indicate that the Any reference signs in the claims should not be construed as limiting.

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CLAIMS CN105027604

1.

A protection system (5) configured to switch between backhaul technologies for supporting communications in a wireless backhaul network, including:

a primary node (1) and a secondary node (2), wherein the primary node (1) and the secondary node (2) are configured to communicate with each other via a backhaul channel (3);

a switching unit (4) configured to select a backhaul technique for communication via the backhaul channel (3), wherein at least one of the master node (1) and the slave node (2) is further configured to measure a quality parameter for measuring the backhaul channel (3), wherein the switching unit (4) is further configured to be selected for use via the backhaul channel (3) depending on the measured quality parameter The backhaul technology of the communication switches to a predefined backhaul technique.

2.

The protection system according to claim 1, wherein said switching unit (4) is further configured to request a status parameter of said backhaul channel (3), wherein said status parameter comprises from said master node (1) and a communication state of at least one of the slave nodes (2).

3.

The protection system according to claim 2, wherein said switching unit (4) is further configured to transmit said backhaul channel (3) to said slave node (2) and/or to said master node (1) The requested status parameter.

4.

Protection system according to one of the preceding claims, wherein the quality parameters of the backhaul channel (3) comprise: received signal strength parameters, channel quality indicator parameters, time delay measurement parameters, and/or A repeated retransmission request, wherein the quality parameter is configured to indicate performance of the backhaul channel (3).

5.

A protection system according to one of the preceding claims, wherein the predefined backhaul technology comprises: mobile telecommunication technology such as HSPA and LTE, microwave technology, and/or wireless local area network technology such as Wi-Fi.

6.

A protection system according to one of claims 2 and 3 and claims 4 to 5, when dependent on claim 2, comprises a diversity unit (6) configured for Receiving the state parameters of the backhaul channel (3) transmitted from the switching unit (4), the switching unit (4) being at least partially arranged inside the master node (1) and/or at least partially Grounded within the slave node (2), wherein the diversity unit (6) is further configured to control and prioritize depending on the received state parameters and/or dependent on the quality parameters Data traffic between the primary node (1) and the secondary node (2).

7.

Protection system according to claim 6, wherein said diversity unit (6) is at least partially arranged inside said primary node (1) and/or at least partially arranged inside said secondary node (1) The diversity unit (6) is further configured to schedule towards the slave node (2) and/or towards the master node (1) depending on the quality parameter and/or depending on the state parameter Data traffic.

8.

A protection system according to claim 7, wherein said diversity unit (6) at least partially disposed inside said slave node (1) is further configured to send prioritization to said master node (1) Request and/or send a scheduling request.

9.

A protection system according to one of the preceding claims, wherein the predefined backhaul technology corresponds to HSPA and/or LTE and is based on a relay type of backhaul.

10.

Protection system according to one of the preceding claims, wherein the slave node (2) is arranged in the predefined coverage area of the master node (1) to the master node (1) Not in sight.

11.

A master node (1) configured to communicate in a protection system (5) according to one of claims 1 to 10, wherein the master node (1) is configured for a backhaul channel (3) communicating and measuring quality parameters of the backhaul channel (3).

12.

A master node (1) according to claim 11, comprising a switching unit (4) configured to select a backhaul technique for communication via the backhaul channel (3), wherein The switching unit (4) is further configured to rely on the measured quality parameter of the backhaul channel (3) to select the backhaul for the communication via the backhaul channel (3) The technology switches to a predefined backhaul technology.

13.

A slave node (2) configured to communicate in a protection system (5) according to one of claims 1 to 10, wherein the slave node (2) is configured for a backhaul channel (3) communicating and measuring quality parameters of the backhaul channel (3).

14.

A slave node (2) according to claim 13, comprising a switching unit (4) configured to select a backhaul technique for communication via the backhaul channel (3), wherein The switching unit (4) is further configured to rely on the measured quality parameter of the backhaul channel (3) to select the backhaul for the communication via the backhaul channel (3) The technology switches to a predefined backhaul technology.

15.

A method for switching between backhaul technologies for supporting communications, comprising the steps of:

a) selecting (8) a backhaul technique used for communication via the backhaul channel (3),

b) measuring (9) the quality parameters of the backhaul channel (3), and

c) Depending on the quality parameters measured in the preceding steps, the backhaul technology selected for the communication via the backhaul channel (3) is switched (10) to a predefined backhaul technique.

16.

The method of claim 15 including the step of controlling (11) data traffic and prioritizing (12) data traffic in dependence on the measured quality parameters.

17.

Method according to one of the claims 15 and 16, comprising the step of transmitting a prioritization request and/or transmitting a scheduling request via the backhaul channel (3).



(12) 发明专利申请

(10) 申请公布号 CN 105027604 A

(43) 申请公布日 2015. 11. 04

(21) 申请号 201380071747. X

(51) Int. Cl.

(22) 申请日 2013. 01. 30

H04W 24/04(2006. 01)

H04B 7/15(2006. 01)

(85) PCT国际申请进入国家阶段日
2015. 07. 29

H04W 72/04(2006. 01)

H04W 84/04(2006. 01)

(86) PCT国际申请的申请数据
PCT/EP2013/051792 2013. 01. 30

H04W 92/04(2006. 01)

(87) PCT国际申请的公布数据
WO2014/117832 EN 2014. 08. 07

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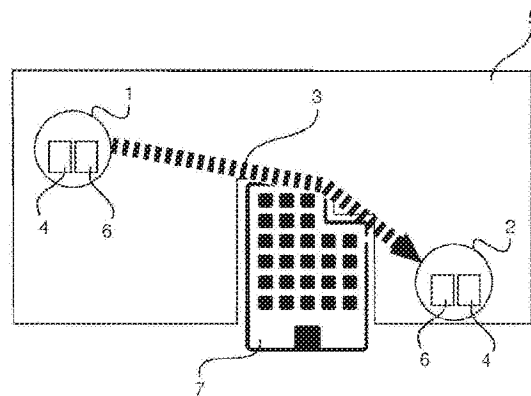
权利要求书2页 说明书7页 附图5页

(54) 发明名称

用于无线 NLOS 回程的保护系统

(57) 摘要

本发明涉及一种被配置用于在用于支持无线回程网络中的通信的回程技术之间进行切换的保护系统、一种主节点、一种从节点、以及一种用于在用于支持通信的回程技术之间进行切换的方法。该保护系统 (5) 包括：主节点 (1) 和从节点 (2)，其中主节点 (1) 和从节点 (2) 被配置用于经由回程信道 (3) 彼此进行通信；以及切换单元 (4)，被配置用于选择用于经由回程信道 (3) 的通信的回程技术，其中主节点 (1) 和从节点 (2) 中的至少一个进一步被配置用于测量回程信道 (3) 的质量参数，其中切换单元 (4) 进一步被配置用于依赖于所测量的质量参数来将被选择用于经由回程信道 (3) 的通信的回程技术切换到预定义的回程技术。以这种方式，增加了无线回程网络的可用性，并且因此，减少了回程传送的中断概率并且提供了更加稳健的回程传送。



1. 一种保护系统 (5), 被配置用于在用于支持无线回程网络中的通信的回程技术之间进行切换, 包括:

主节点 (1) 和从节点 (2), 其中所述主节点 (1) 和所述从节点 (2) 被配置用于经由回程信道 (3) 彼此进行通信; 以及

切换单元 (4), 被配置用于选择用于经由所述回程信道 (3) 的通信的回程技术, 其中所述主节点 (1) 和所述从节点 (2) 中的至少一个节点进一步被配置用于测量所述回程信道 (3) 的质量参数, 其中所述切换单元 (4) 进一步被配置用于依赖于所测量的质量参数来将被选择用于经由所述回程信道 (3) 的所述通信的所述回程技术切换到预定义的回程技术。

2. 根据权利要求 1 所述的保护系统, 其中所述切换单元 (4) 进一步被配置用于请求所述回程信道 (3) 的状态参数, 其中所述状态参数包括来自所述主节点 (1) 和所述从节点 (2) 中的至少一个节点的通信状态。

3. 根据权利要求 2 所述的保护系统, 其中所述切换单元 (4) 进一步被配置用于向所述从节点 (2) 和 / 或向所述主节点 (1) 传输所述回程信道 (3) 的所请求的状态参数。

4. 根据前述权利要求中的一项所述的保护系统, 其中所述回程信道 (3) 的所述质量参数包括: 所接收的信号强度参数、信道质量指示符参数、时延测量参数、和 / 或重复的重传请求, 其中所述质量参数被配置用于指示所述回程信道 (3) 的性能。

5. 根据前述权利要求中的一项所述的保护系统, 其中所述预定义的回程技术包括: 诸如 HSPA 和 LTE 的移动通信技术、微波技术、和 / 或诸如 Wi-Fi 的无线局域网技术。

6. 根据权利要求 2 和 3 以及权利要求 4 至 5 中的一项所述的保护系统, 当从属于权利要求 2 时, 包括多样性单元 (6), 所述多样性单元 (6) 被配置用于接收从所述切换单元 (4) 传输的所述回程信道 (3) 的所述状态参数, 所述切换单元 (4) 至少部分地被布置在所述主节点 (1) 内部和 / 或至少部分地被布置在所述从节点 (2) 内部, 其中所述多样性单元 (6) 进一步被配置用于依赖于所接收的所述状态参数和 / 或依赖于所述质量参数来控制并且优先化所述主节点 (1) 与所述从节点 (2) 之间的数据流量。

7. 根据权利要求 6 所述的保护系统, 其中所述多样性单元 (6) 至少部分地被布置在所述主节点 (1) 内部和 / 或至少部分地被布置在所述从节点 (1) 内部, 所述多样性单元 (6) 进一步被配置用于依赖于所述质量参数和 / 或依赖于所述状态参数来调度朝向所述从节点 (2) 和 / 或朝向所述主节点 (1) 的数据流量。

8. 根据权利要求 7 所述的保护系统, 其中至少部分地被布置在所述从节点 (1) 内部的所述多样性单元 (6) 进一步被配置用于向所述主节点 (1) 发送优先化请求和 / 或发送调度请求。

9. 根据前述权利要求中的一项所述的保护系统, 其中所述预定义的回程技术对应于 HSPA 和 / 或 LTE 并且基于中继类型的回程。

10. 根据前述权利要求中的一项所述的保护系统, 其中所述从节点 (2) 被布置在所述主节点 (1) 的预定义的覆盖区域内的通向所述主节点 (1) 的非视线中。

11. 一种主节点 (1), 被配置用于在根据权利要求 1 至 10 中的一项所述的保护系统 (5) 中进行通信, 其中所述主节点 (1) 被配置用于经由回程信道 (3) 进行通信并且用于测量所述回程信道 (3) 的质量参数。

12. 根据权利要求 11 所述的主节点 (1), 包括切换单元 (4), 所述切换单元 (4) 被配置

用于选择用于经由所述回程信道 (3) 的通信的回程技术, 其中所述切换单元 (4) 进一步被配置用于依赖于所测量的所述回程信道 (3) 的所述质量参数来将被选择用于经由所述回程信道 (3) 的所述通信的所述回程技术切换到预定义的回程技术。

13. 一种从节点 (2), 被配置用于在根据权利要求 1 至 10 中的一项所述的保护系统 (5) 中进行通信, 其中所述从节点 (2) 被配置用于经由回程信道 (3) 进行通信并且用于测量所述回程信道 (3) 的质量参数。

14. 根据权利要求 13 所述的从节点 (2), 包括切换单元 (4), 所述切换单元 (4) 被配置用于选择用于经由所述回程信道 (3) 的通信的回程技术, 其中所述切换单元 (4) 进一步被配置用于依赖于所测量的所述回程信道 (3) 的所述质量参数来将被选择用于经由所述回程信道 (3) 的所述通信的所述回程技术切换到预定义的回程技术。

15. 一种用于在用于支持通信的回程技术之间进行切换的方法, 包括步骤:

a) 选择 (8) 被使用用于经由回程信道 (3) 的通信的回程技术,

b) 测量 (9) 所述回程信道 (3) 的质量参数, 以及

c) 依赖于在前述步骤中测量的所述质量参数, 来将被选择用于经由所述回程信道 (3) 的所述通信的所述回程技术切换 (10) 到预定义的回程技术。

16. 根据权利要求 15 所述的方法, 包括步骤: 依赖于所测量的质量参数, 来控制 (11) 数据流量并且优先化 (12) 数据流量。

17. 根据权利要求 15 和 16 中的一项所述的方法, 包括步骤: 经由所述回程信道 (3) 来发送优先化请求和 / 或发送调度请求。

用于无线 NLOS 回程的保护系统

技术领域

[0001] 本发明涉及被配置用于在用于支持无线回程 (backhaul) 网络中的通信的回程技术之间进行切换的保护系统。

背景技术

[0002] 用于小型小区的无线回程系统很可能在非视线 (NLOS) 环境中进行操作。常规地, 大多数无线回程系统被设计用于在视线 (LOS) 环境中的微波通信, 视线环境保证了分别通过通信链路或链路的所期望的数据速率的高可用性。LOS 操作还保证了极低的中断概率, 即链路原则上从不中断, 这在设计在无线电基站 (RBS) 之间运输用户数据和控制数据流量的无线回程系统时是重要的。

[0003] 合意的是, 操作在 NLOS 中的无线回程系统还应当保证高可用性以及因此非常低的中断概率。然而, 当使用微波频率 (例如, 大于 10GHz 的微波频率) 用于 NLOS 中的回程传送 (backhauling) 时, 这是难以实现的。现今在无线行业内的一般共识是, 在基于宏小区的已有蜂窝无线电接入网络中所供应的能力不能满足对于未来移动宽带服务而言的要求, 除非在特定位置处 (诸如在热点、小区边缘和室内位置处) 实现容量提升。一种增加这些位置处的容量的方法是在异构网络中部署低功率无线电基站, 诸如微微 RBS, 覆盖宏小区覆盖区域内的较小小区。假设每个宏小区由几个小型小区来支持, 则网络中的小区的数目以及因此所要求的移动回程 (MBH) 链路的数目将急剧增加。归因于它的小型覆盖区域, 将重要的是, 小型小区微微 RBS 被布置在正确的位置而不被用于 MBH 的宽带连接的可用性所限制。进一步地, 微微 RBS 在许多情况下将被放置或布置在建筑物的屋顶水平以下, 以防止微微 RBS 与和屋顶以上的宏 RBS 共址的聚合节点之间的清楚 LOS。通常, 宏 RBS 被布置在建筑物的屋顶上。宏 RBS 的特征在于大的覆盖区域、高功率和定向天线。依赖于所期望的应用和环境, 微微 RBS 通常被布置在街道水平以上多至 6 米, 例如在建筑物墙壁上。在 NLOS 环境中, 经由回程信道的通信主要基于衍射和 / 或反射。传统的 MBH 技术 (诸如铜、光纤或 LOS 微波链路) 可能并不总是适合于这样的异构回程方案, 并且因此它们需要由低成本无线 NLOS MBH 链路来互补。NLOS 传播传统上仅被提议用于 6GHz 以下的载波频率。然而, 这些频率上的宽带频谱是稀缺资源, 并且如果使之可用, 则利用这一频谱用于无线电接入网络 (RAN) 中的移动宽带服务变得有吸引力。

[0004] 传统的固定服务 LOS 微波点对点 (PTP) 链路在从 3.5MHz 上至 112MHz 范围的信道带宽上的 6GHz 与 42GHz 之间的经许可频带中进行操作。归因于由 MBH 承载的流量的性质, 要求传统的 PtP LOS 链路具有极高的可用性。然而, 如果小型小区在异构部署中的宏小区的覆盖区域内, 则对小型小区回程的极高可用性要求可能受到争论。对于小型小区 MBH 的要求正在成为行业内所讨论的日益重要的主题, 并且由朝向灵活和成本有效的异构布置的演进来驱动它。

[0005] 在过去的几年里, 已经存在对于用于 MBH 应用的较高频带的增加的兴趣, 特别是对于包括 57 至 66GHz 之间的带宽的 9GHz 的 60GHz 频带以及对于包括 71 至 86GHz 之间的

总共 10GHz 带宽的 70/80GHz 频带。与可用于传统微波链路的 56 和 112MHz 信道相比,在这些频带中供应的带宽大,这使得它们有吸引力。该 60GHz 频带的部分是无需许可频谱,这意味着任何人都能够在该频带内部署系统,只要装备符合于预定义的规制。但是,这个频率对于小型小区 MBH 应用而言是特别令人感兴趣的,因为在这个频段处的过量氧损耗 (oxygen loss) 可以衰减来自相邻链路的干扰,使得高效的频率重用成为可能。

[0006] 在蜂窝通信中,移动用户被关联或连接到小区。在某种意义上,小区的选择通常基于被连接到对于特定用户而言的最好小区。归因于用户的移动性,用户可能经历另一小区作为替换连接。如果需要,则系统可以将用户切换到另一小区。常规地,切换基于对来自不同小区或基站的接入链路的测量。

[0007] 操作在 NLOS 中的基于微波的无线回程系统在保证高可用性和低中断概率上将具有难题,这归因于与城市 NLOS 中的微波传播有关的多个问题。下文中描述了一些典型的缺点和难题:天气效应(诸如雨和雪)将改变衍射属性;因为高频无线电波主要依赖于反射和衍射所以不存在对障碍物的穿透;树木和其他对象可能在风中移动;临时障碍物,例如高的车辆路过接近于被安装在街道水平或者略高于街道水平的小型小区 RBS;城市拓扑结构上的长期改变,例如新的建筑物、商业广告板标志,等等;归因于强反射的意外的多路径传播;以及归因于天气效应或者故意毁坏 (vandalism) 而变得不对齐的高增益天线,即笔形波束天线。

[0008] 存在提供高增益天线以用于补偿在 NLOS 环境中与高频相关联的高路径损耗的需要。如果去往/来自特定接入点的回程失效或丢失,则连接到该特定接入点的用户可以理想地切换到具有起作用的回程的另一接入点。然而,失效的回程连接意味着网络已经失去了它的去往/来自该接入点的所有通信,这使得对于该接入点而言不可能请求它的用户的这种切换。替代地,这一切换必须由用户他们自己来请求,这可能意味着许多用户必须快速地进行同时的切换请求,这增加了丢弃连接的可能性。这可能是用户可能具有通向替换接入点的不良的、非常不良的、或者甚至是不存在的连接。例如,用户可能在室内并且连接到经由室外的或者接近于室外的天线解决方案来接收它的回程连接的室内接入点。

发明内容

[0009] 本发明的目的是提供用于增加无线回程网络的可用性并且减少回程链路的中断概率以及用于提供更加稳健的回程传送的可能性。

[0010] 这一目的通过独立权利要求的主题来实现。子权利要求中限定了优选实施例。

[0011] 根据本发明的第一方面,这一目的由一种保护系统来实现,其被配置用于在用于支持无线回程网络中的通信的回程技术之间进行切换,其包括:主节点和从节点,其中主节点和从节点被配置用于经由回程信道彼此进行通信;以及切换单元,被配置用于选择用于经由回程信道的通信的回程技术,其中主节点和从节点中的至少一个进一步被配置用于测量回程信道的质量参数,其中切换单元进一步被配置用于依赖于所测量的质量参数来将被选择用于经由回程信道的通信的回程技术切换到预定义的回程技术。

[0012] 分别地,主节点优选地对应于宏无线电基站或者宏小区,而从节点优选地对应于微微无线电基站或者微微小区。术语“在回程技术之间进行切换”不仅意味着它被切换到一种回程技术或者另一种回程技术,而且还意味着可能存在至少两种回程技术之间的混合。

这允许优选地至少在切换过程期间支持同时使用多种回程技术的通信或者被连接。无线回程网络优选地对应于无线非视线回程网络。术语“通信”在其一般意义上是指，两个节点（即，第一节点和第二节点）例如经由信道而彼此进行通信，其中第一节点优选地将信息或数据传送给第二节点。第一节点优选地包括无线电发射机，并且第二节点优选地包括无线电接收机。第一节点和第二节点优选地被布置在无线电通信系统中。

[0013] 因此，本发明的一个思想是，优选地通过使用微波频率，而允许无线回程连接落回到宏 RBS 接入作为中断情况下的备份解决方案。使用接入系统的回程传送也能够被称为 3GPP 中所定义的“带内中继”或者“带外中继”。优选地，无线地被回程的小型小区 RBS，换言之微微 RBS，优选地分别被布置在宏小区或者宏 RBS 的覆盖区域内，宏小区或者宏 RBS 在普通的国际移动通信标准频带（IMT 频带）上进行操作。IMT 表示在 3G 移动通信底层的技术标准，而 3G 只是 IMT 技术的许多示例中的一个。以这种方式，归因于系统多样性和 / 或归因于技术多样性，总的无线回程连接变得更加稳健。典型地，在 NLOS 中，使用微波技术的更不可靠的无线回程传送可能由于不同的原因而失效，并且然后利用手边的本发明，这能够经由 IMT 技术（例如，使用高速分组接入（HSPA）或者长期演进（LTE））而被通信回到宏 RBS。此外，控制数据和优先化数据流量仍然能够经由 IMT 技术来通信。HSPA 表示移动宽带技术，而 LTE 是一种用于无线通信技术的标准。优选地，宏 RBS 在低劣的或者丢失的微波连接的情况下优先化对小型小区 RBS 回程传送的调度。

[0014] 根据本发明的优选实施例，切换单元进一步被配置用于请求回程信道的状态参数，其中状态参数包括来自主节点和从节点中的至少一个的通信状态。切换单元优选地进一步被配置用于向从节点和 / 或向主节点传输回程信道的所请求的状态参数。优选地，回程信道的质量参数包括所接收的信号强度（RSL）参数、信道质量指示符（CQI）参数、时延测量参数、和 / 或重复的重传请求，其中质量参数被配置用于指示回程信道的性能。预定义的回程技术优选地包括诸如 HSPA 和 LTE 的移动通信技术、微波技术、和 / 或诸如 Wi-Fi 的无线局域网技术。

[0015] 根据本发明的优选实施例，该保护系统包括多样性单元，该多样性单元被配置用于接收从切换单元传输的回程信道的状态参数，切换单元至少部分地被布置在主节点内部和 / 或至少部分地被布置在从节点内部，其中多样性单元进一步被配置用于依赖于所接收的状态参数和 / 或依赖于质量参数来控制并且优先化主节点与从节点之间的数据流量。多样性单元优选地至少部分地被布置在主节点内部和 / 或优选地至少部分地被布置在从节点内部，多样性单元进一步被配置用于依赖于质量参数和 / 或依赖于状态参数来调度朝向从节点和 / 或朝向主节点的数据流量。优选地，至少部分地被布置在从节点内部的多样性单元进一步被配置用于向主节点发送优先化请求和 / 或发送调度请求。

[0016] 根据本发明的优选实施例，预定义的回程技术对应于 HSPA 和 / 或 LTE 并且基于中继类型的回程。参考 3GPP 术语，LTE RBS 被称为增强型节点基站（eNB）。3GPP 术语中的中继是使用 LTE 技术被回程到另一 eNB 的 eNB。因此，它在中继类型的回程与微波回程之间进行切换。从节点优选地被布置在主节点的预定义的覆盖区域内的通向主节点的非视线中。

[0017] 根据本发明的第二方面，上面所提到的目的由一种主节点来实现，该主节点被配置用于在根据本发明的第一方面的保护系统中进行通信，其中该主节点被配置用于经由回程信道进行通信并且用于测量回程信道的质量参数。该主节点优选地包括切换单元，该切

换单元被配置用于选择用于经由回程信道的通信的回程技术,其中切换单元进一步被配置用于依赖于所测量的回程信道的质量参数来将被选择用于经由回程信道的通信的回程技术切换到预定义的回程技术。

[0018] 根据本发明的第三方面,上面所提到的目的由一种从节点来实现,该从节点被配置用于在根据本发明的第一方面的保护系统中进行通信,其中该从节点被配置用于经由回程信道进行通信并且用于测量回程信道的质量参数。该从节点优选地包括切换单元,该切换单元被配置用于选择用于经由回程信道的通信的回程技术,其中切换单元进一步被配置用于依赖于所测量的回程信道的质量参数来将被选择用于经由回程信道的通信的回程技术切换到预定义的回程技术。

[0019] 根据本发明的第四方面,上面所提到的目的由用于在用于支持通信的回程技术之间进行切换的方法来实现,该方法包括步骤:a) 选择被使用用于经由回程信道的通信的回程技术,b) 测量回程信道的质量参数,以及 c) 依赖于在前述步骤中所测量的质量参数来将被选择用于经由回程信道的通信的回程技术切换到预定义的回程技术。

[0020] 根据本发明的优选实施例,该方法包括步骤:依赖于所测量的质量参数来控制数据流量并且优先化数据流量。优选地,该方法包括步骤:经由回程信道来发送优先化请求和/或发送调度请求。

[0021] 因此,本发明的一个思想是,基于 IMT 技术的备份确保了宏小区与小型小区 RBS 之间的数据连接的高可用性,使得能够向网络/从网络来通信至少控制和被优先化的数据。此外,相比于用户连接到小型小区 RBS 并且在回程中断的情况下进行向另一接入点的用户切换的解决方案,回程网络更加稳健。因此,相比于例如让多个用户进行向另一接入点的同时切换的情况,更容易在针对这样的情况而准备的两种已经建立的技术之间进行单个的且网络控制的“回程切换”。利用手边的本发明,用户保持连接到小型小区 RBS。在低劣的、非常低劣的、或者甚至在不存在通向替换接入点的连接的情况下,这有利地被确保。例如,用户可能在室内并且连接到经由室外的或者接近于室外的天线解决方案来接收它的回程连接的室内接入点。

[0022] 有利地,确保了总是有可能检查状态,并且确保了有可能即使在微波中断的情况下向小型小区/从小型小区来通信控制信令,从而网络触发解决问题的适当动作。这导致了更高的可用性,而不论例如天气效应,而且也用作针对失效(诸如硬件失效)的保护系统或者多样性系统。

附图说明

[0023] 从以下对通过示例的方式参考附图给出的优选实施例的描述来看,本发明的进一步的优点和优点将变得明显。在附图中:

[0024] 图 1 图示了根据本发明的第一优选实施例的保护系统、主节点和从节点;

[0025] 图 2 图示了根据本发明的第二优选实施例的 NLOS 回程解决方案,其中微波被使用作为主回程技术并且 IMT 技术用于备份;

[0026] 图 3 示出了针对根据本发明的第三优选实施例的具有通过建筑物的衍射的路径损耗模型的场景;

[0027] 图 4 示出了根据本发明的第三优选实施例的相比于 2.3GHz 而言在 32GHz 处经历

的附加路径损耗；

[0028] 图 5 图示了根据本发明的第四优选实施例的用于已切换的回程多样性的方法；以及

[0029] 图 6 示意性地图示了根据本发明的第五优选实施例的用于在回程技术之间进行切换的方法的步骤。

具体实施方式

[0030] 图 1 示出了被配置用于在不同的回程技术之间进行切换的保护系统 5。主节点 1 被示出，其包括切换单元 4 和多样性单元 6。此外，从节点 2 被示出，其也包括切换单元 4 和多样性单元 6。在这个第一优选实施例中，主节点 1 和从节点 2 分别对应于宏 RBS 和微微 RBS。宏 RBS 1 与微微 RBS 2 之间的通信经由回程信道 3 而发生。因为微微 RBS 2 在通向宏 RBS 1 的 NLOS 中，所以通信基于在城市 NLOS 环境中发生的反射和衍射。在这个第一优选实施例中，城市 NLOS 环境的特征在于建筑物 7。微微 RBS 2 的切换单元 4 选择一种回程技术，该回程技术是被使用用于经由回程信道 3 的通信的微波技术。进一步地，宏 RBS 1 测量回程信道 3 的质量参数，并且此后将这一测量的结果（即，所测量的质量参数）定向到切换单元 4，切换单元 4 在这个第一优选实施例中布置在宏 RBS 1 内部。在这个第一优选实施例中，所接收的信号电平（RSL）低于某个预定义的值，并且因此回程技术被切换到一种不同的回程技术，该不同的回程技术是移动通信技术，诸如 LTE。

[0031] 在这个第一优选实施例中，切换单元 4 请求回程信道 3 的状态参数，其中该状态参数包括来自宏 RBS 1 和来自微微 RBS 2 的通信状态。切换单元 4 向微微 RBS 2 并且向宏 RBS 1 传输所请求的回程信道 3 的状态参数。根据本发明的其他优选实施例，节点或 RBS 测量它自己的状态，并且无需经由回程进行的任何状态报告而发起切换。换言之，如果节点它自身检测到回程问题，则该节点发起切换，该切换优选地被通信到另一节点。

[0032] 图 2 图示了根据本发明的第二优选实施例的 NLOS 回程解决方案，其中微波被使用作为主要回程技术并且 IMT 技术用于备份。窄箭头图示了衍射的微波，并且宽箭头图示了衍射的和反射的 IMT 无线电波。宏 RBS 1 经由回程信道 3 与微微 RBS 2 进行通信。在这个第二优选实施例中，宏 RBS 1 和微微 RBS 2 二者都被布置在以三个建筑物 7 为特征的城市环境中。微波频率原则上依赖于屋顶衍射以到达微微 RBS 2，而基于 IMT 频带的技术使用具有在 NLOS 中的建筑物 7 周围的反射和衍射的多路径传播而具有更好的传播特征，这在这个第二优选实施例中由宽箭头来图示。

[0033] 图 3 示出了根据本发明的第三优选实施例的具有通过建筑物的衍射的路径损耗模型。被使用用于该模型的参数分别由等于 5m 的 h_1 ，等于 20m 的 h_2 ，等于 33m 的 H ，以及等于 15m 的 D 给出。图 4 示出了根据本发明的第三优选实施例的相比于 2.3GHz 的 IMT 频率而言信号在 32GHz 的微波频率处经历的附加路径损耗。在跳长度 (hop length) 上图示了以 dB 为单位的相对衰减，跳长度由图 3 中所示出的宏 RBS 1 与微微 RBS 2 之间的距离给出。图 4 中的实线曲线表示没有雨的相对衰减，并且虚线曲线图示了针对 50mm/hr 的降雨强度的情形。图 4 图示了仅考虑上面的屋顶衍射的数值示例。进一步地，因为跳长度从 100m 多至 2000m 而变化，所以考虑了在对应节点之间被布置的多个建筑物。在 500m 的跳长度处，能够看到 32GHz 信道分别对于没有雨和有雨而言如何遭受 33dB 和 39dB 的附加路径损耗。

可注意到,有雨的曲线和没有雨的曲线如何随着增加的跳长度而不同地表现。尽管在没有雨时附加路径损耗随着增加的距离而减小,但是附加路径损耗在 50mm/hr 的降雨强度中随着增加的距离而增加。这主要归因于在 2.3GHz 处比在 32GHz 处更高的衍射损耗,因为在 2.3GHz 处,在第一菲涅耳区内存在更多的障碍物,诸如建筑物。然而,等同于在 32GHz 处大约 12dB/km 的下雨衰减主导了在 2.3GHz 处的较高衍射损耗,这使得附加路径损耗在雨中随着增加的跳长度而增加。因此,图 4 清楚地图示了在 NLOS 中相比于 IMT 频带而言当使用微波频率时的挑战。对于多至 500m 的距离而言,额外的路径损耗至少是 33dB 或者更多,这将对可达到的可用性和对应的衰落余量具有显而易见的影响。

[0034] 图 5 图示了根据本发明的第四优选实施例的用于已切换的回程多样性的方法。所接收的信号强度 (RSL) 是信道的质量的测度。在第一步骤 13 中,检查 RSL 是否为大并且因此信道质量是否良好,但是如果 RSL 为小,则信道质量低劣。设计参数 P 的值是用于决定何时切换回程技术的测度。在低劣的微波回程的情况中,被优先化的回程信息经由 IMT 技术而被重新路由回到网络,例如使用 3GPP LTE 无线电接入回到 3GPP eNB。微波回程可能处于中断或者接近于中断。如果 RSL 为大,则信道质量良好,但是如果 RSL 为小,则信道质量低劣。可选地,在 RSL 为小的情况中,能够向宏 RBS 发送 14 预警。在这种情况下,总是切换 15 到带内中继,并且经由 IMT 技术来路由 16 被优先化的信息。这在微波回程仍然低劣时继续 17,否则其再次被切换回到 18 微波回程。该决定基于设计参数 P。优选地,P 大于对于回程而言进行工作而避免突发事件所要求的最小 RSL。在回程中断的情况中或者每当期期望在微微 RBS 与宏 RBS 之间进行通信时,宏 RBS 以与它调度连接到宏 RBS 的用户相类似的方式来调度微微 RBS,但是以被优先化的方式,这例如通过根据 3GPP 术语的带内中继来实现。

[0035] 根据本发明的另一优选实施例,NLOS 中的基于微波的连接提供了在 T1% 的时间可用的速率 R_1 ,并且进一步地,对应的基于 IMT 的连接提供了在 T2% 的时间可用的速率 R_2 。为了简单,还假设了固定速率并且从而 $R_1 = R_2 = R$,如果相比于 IMT 连接而言微波连接具有更宽的带宽但是在 NLOS 中更差的路径损耗,则这是有意义的。最后,假设两个链路示出了独立的中断概率。可用性被定义为一减去中断概率。当且仅当基于微波的回程和基于 IMT 的回程二者同时处于中断时,网络才处于中断,这成为非常低概率的事件,相比于覆盖了当使用仅单个回程技术时的场景的其他优选实施例而言,这暗示了回程传送的更高可用性。利用上面的假设,在这个优选实施例中的以回程传送的 % 为单位的总可用性 T_3 成为:

$$[0036] \quad T_3 = \left(1 - \left(1 - \frac{T_1}{100} \right) \cdot \left(1 - \frac{T_2}{100} \right) \right) \cdot 100\%$$

[0037] 并且对应的可用性能够因此通过应用上面所提到的公式来计算。一旦信道质量足够好,就发起回到微波回程技术的回程切换。

[0038] 图 6 示意性地示出了根据本发明的第五优选实施例的用于在无线回程网络中的回程技术之间进行切换的方法的步骤。在第一步骤中,选择 8 针对经由主节点与从节点之间的回程信道的通信而使用的回程技术。在第二步骤中,测量 9 该回程信道的质量参数。在最后的步骤中,依赖于在先前步骤 9 中测量的质量参数,所选择的回程技术被切换 10 到预定义的回程技术,以用于主节点与从节点之间的通信。在进一步的步骤中,执行使用预定义的回程技术来控制 11 和优先化 12 主节点与从节点之间的数据流量。

[0039] 根据本发明的另一优选实施例,执行经由回程信道发送优先化请求和 / 或发送调度请求的步骤。根据本发明的再其他的优选实施例,不经由回程信道来执行发送优先化请求或者发送调度请求的步骤,而是假如它已经被切换到替换的回程技术,诸如切换到 LTE,则 LTE 来优先化回程调度。例如,这能够由 3GPP 带内中继来进行,其包括为带内中继预留的资源,即假如回程被切换到带内 LTE,则 LTE “回程”来优先化回程流量。

[0040] 虽然在附图和前述描述中已经详细地图示和描述了本发明,但是这样的图示和描述被考虑为是说明性的或者示例性的而不是局限性的;本发明不限于所公开的实施例。

[0041] 从对附图、本公开内容和所附权利要求的研究,在实践要求保护的本发明中的本领域的技术人员能够理解和影响所公开的实施例的其他变型。在权利要求中,词语“包括”不排除其他的元件或步骤,并且不定冠词“一”或“一个”不排除多个。某些措施被记载在彼此不同的从属权利要求中的仅有事实并不指示这些措施的组合不能被使用以获利。权利要求中的任何参考标记不应当被解释为限制范围。

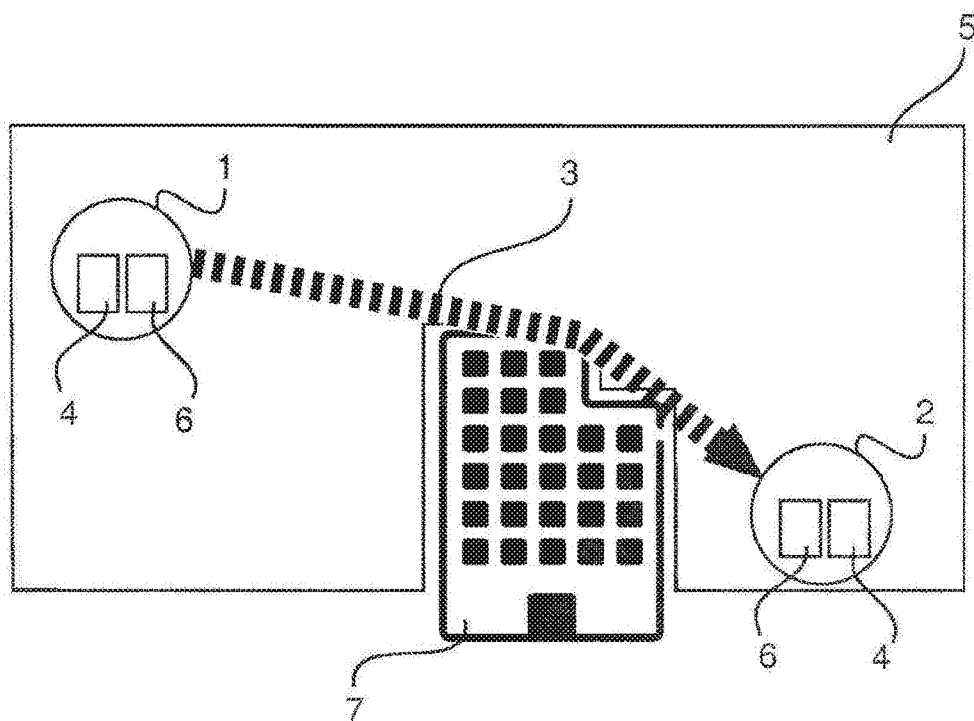


图 1

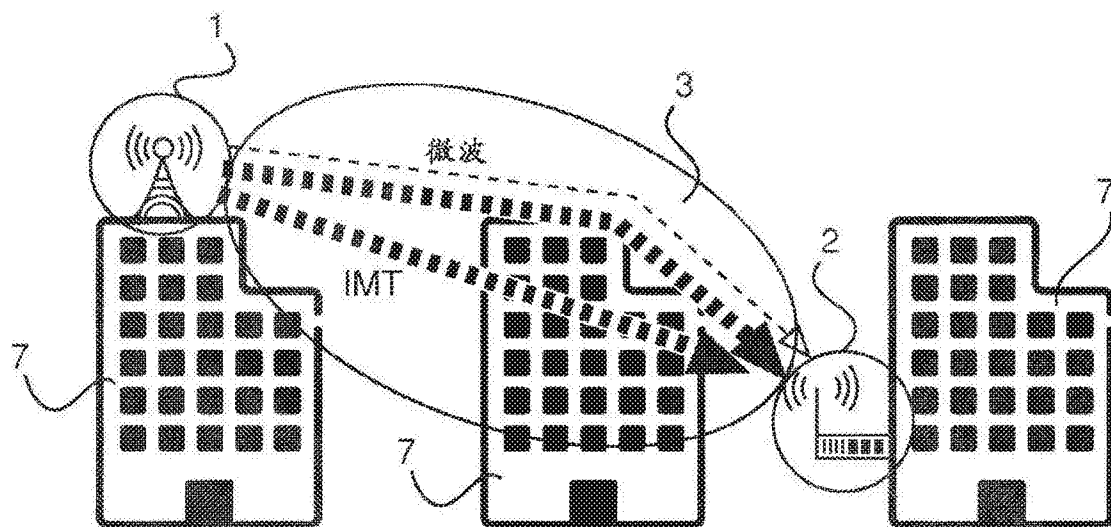


图 2

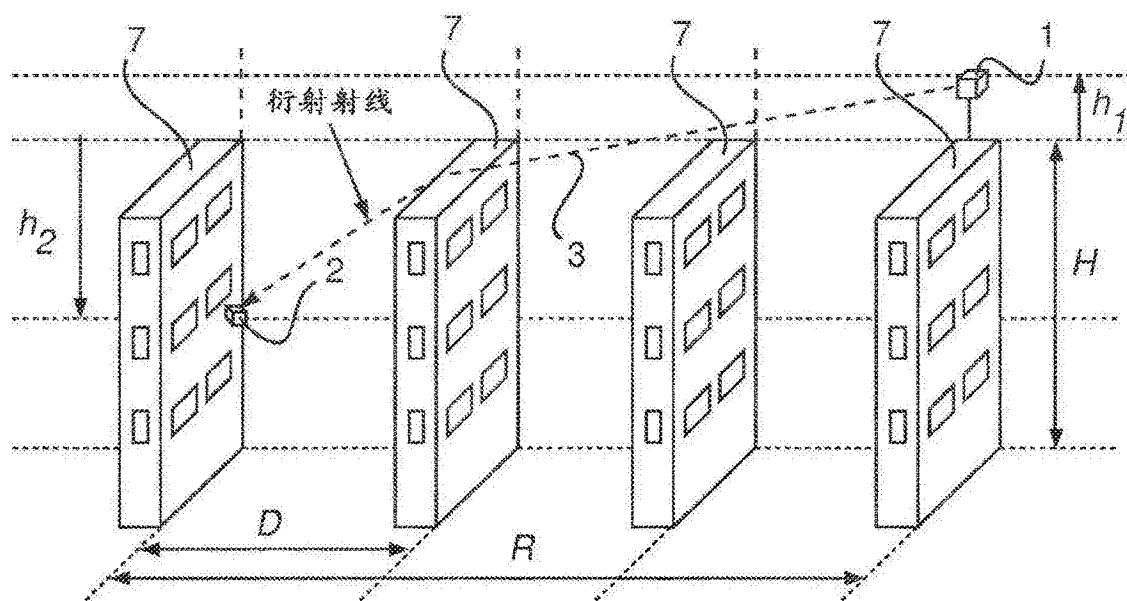


图 3

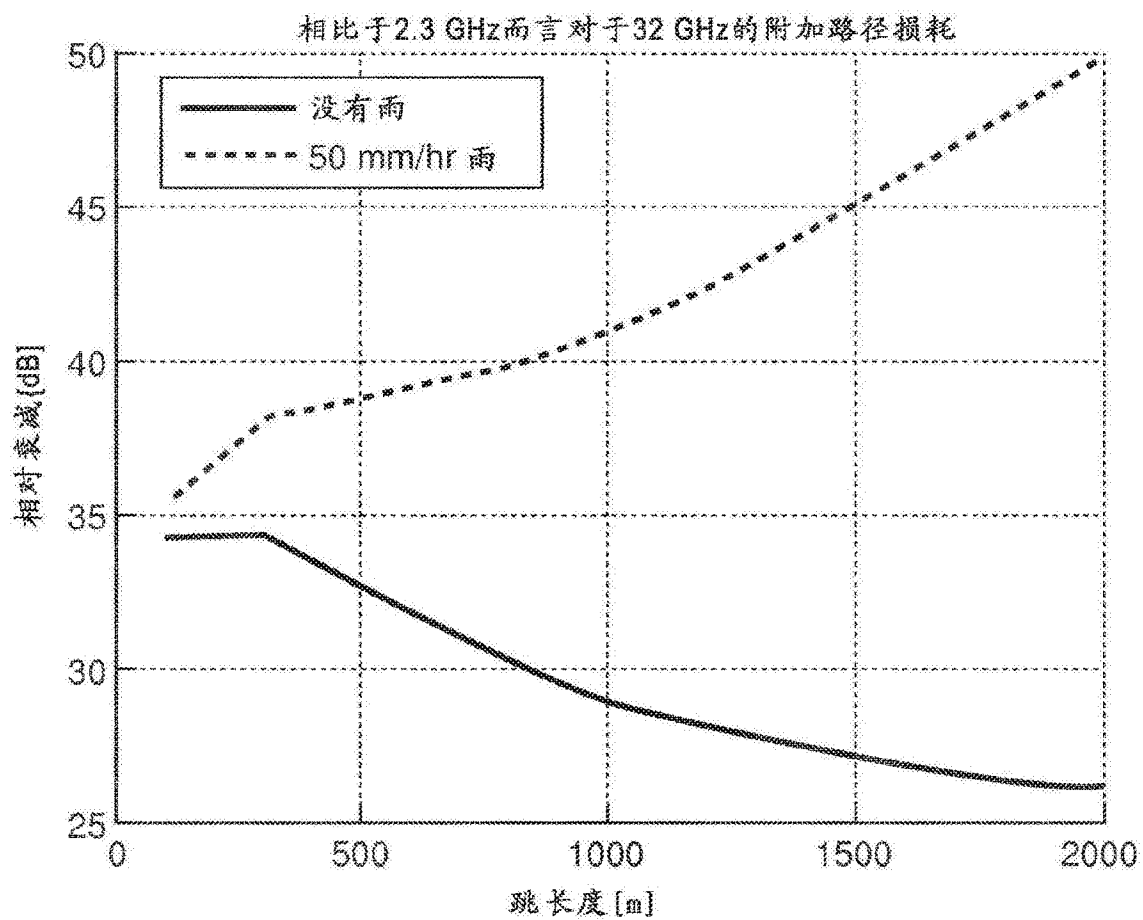


图 4

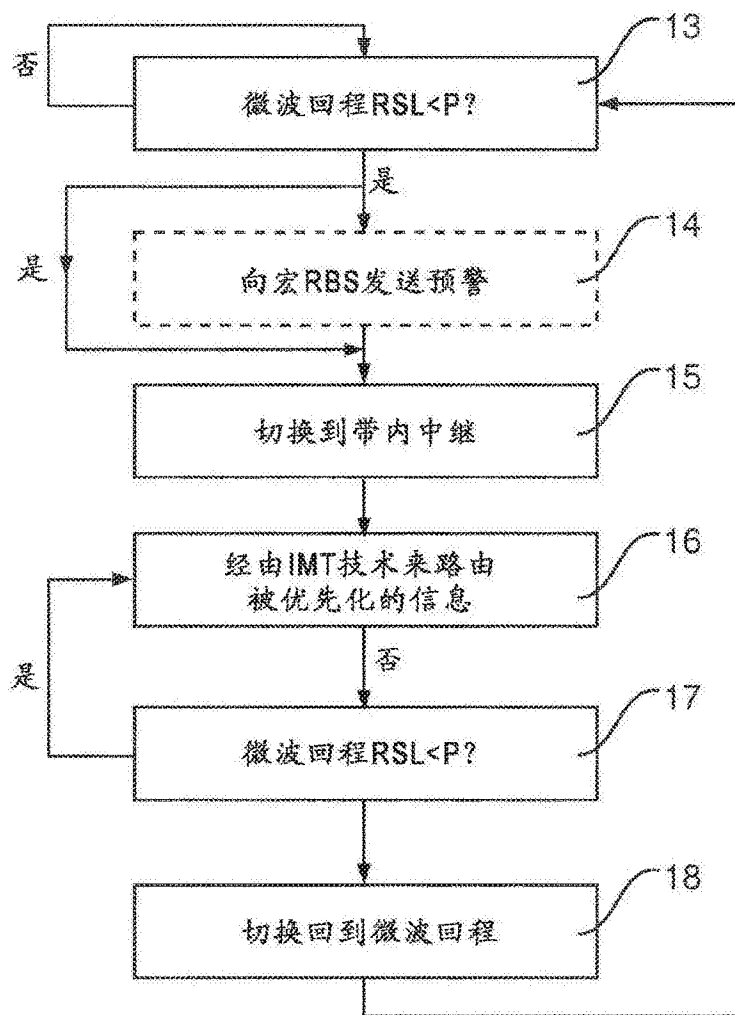


图 5

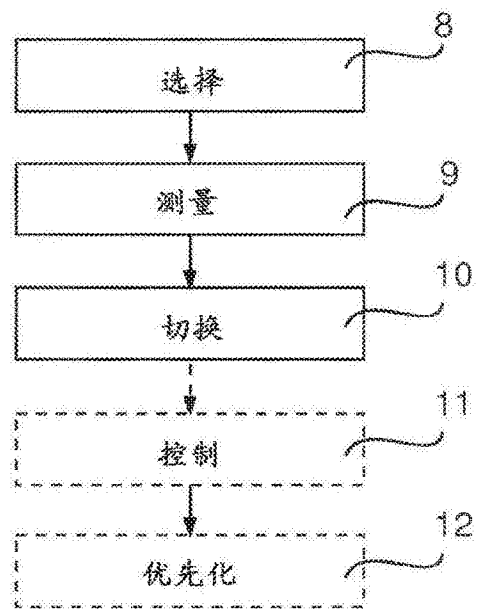


图 6

(10) International Publication Number
WO 2016/125055 A1(43) International Publication Date
11 August 2016 (11.08.2016)

(51) International Patent Classification:

H04W 24/06 (2009.01) H04W 84/12 (2009.01)
H04W 36/08 (2009.01) A61B 5/00 (2006.01)

(21) International Application Number:

PCT/IB2016/050447

(22) International Filing Date:

29 January 2016 (29.01.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/112,694 6 February 2015 (06.02.2015) US

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Building 5, 5656 AE Eindhoven (NL).(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a
patent (Rule 4.17(ii))

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD FOR TESTING CLIENT ROAMING

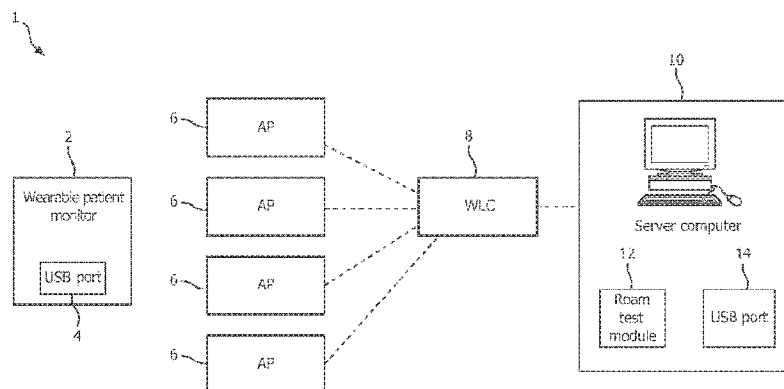


FIG. 1

(57) Abstract: The following relates to roam test systems and methods. By way of illustrative example, in a wireless network, a device under test (DUT) may be connected to an access point (AP). The DUT may switch which AP the DUT is connected to, thereby triggering a roam event. It is desirable to gather large amounts of data related to roam events. In the systems described herein, a plurality of roam events may be triggered to gather such data. Roam events may be triggered by, for example, deactivating all but an active AP of a plurality of APs, or by reducing or increasing a transmit power of an AP or APs, or so forth.

METHOD FOR TESTING CLIENT ROAMING

BACKGROUND

The following relates to the wireless device testing arts, wireless communication network arts, device roaming arts, and related arts.

In a typical wireless electronic communication network, a device may be connected to a network through a wireless access point (AP) in the network. APs are typically controlled by a wireless local area network controller (WLC). In order to cover a sizable area, such as a floor or several floors of a building, the network may have many APs, and the APs are often wireless routers. As the device travels geographically farther away from an AP that the device is connected to (for example, because a person carrying the device is walking), the connection between the device and the AP may become weaker, and may eventually be lost. Therefore, in certain circumstances, a device may switch from being connected to one AP to another, which is called roaming; and the event in which a device switches from one AP to another is called a roam event (sometimes also referred to as “handoff” of the device from one AP to another).

However, as a practical matter, technical problems are known to occur during roaming (e.g. due to a chip defect or so forth). Additionally, even in networks where roaming normally occurs without error, there may be problems during a small percentage of roam events. The performance of roaming may be improved by setting various configuration parameters of the wireless device and/or the APs. Therefore, to detect intrinsic defects, to optimize configuration parameters, or so forth, it is desired to gather test data related to roaming.

Roaming system reliability is of particular importance in the context of wireless medical monitoring devices. An example of such a device is the IntelliVue MX40™ wearable patient monitor (available from Koninklijke Philips N.V., Eindhoven, the Netherlands). The MX40™ is worn by a patient, for example in a pouch that is hung around the patient’s neck, and supports patient physiological sensors including electrocardiograph (ECG) and pulse oximetry (SpO₂) sensors. The wireless connectivity of the MX40™ allows the patient to be ambulatory while remaining continuously monitored at the nurses’ station or another central monitoring location. Due to the life-critical nature of ECG and other physiological sensors, a loss of wireless connectivity with the patient monitor (for example, due to a failed roam event) may set off an alarm at the nurses’ station calling for the patient

be quickly located to assess whether a medically significant event is occurring. Maintaining reliable (ideally failure-free) wireless communication with the wireless medical monitor is made more difficult by the challenging wireless environment of a typical hospital, which commonly includes multiple wireless networks for various purposes which are connected with myriad wireless devices. Accordingly, communications testing of the wireless medical monitor should be rigorous, including acquiring statistics for a large number of roam events. For example, a typical stress test preferably includes several thousand roam events.

One known method for testing a device while roaming, known as the “walk-around” test, is to physically walk the device through the network. However, this is time consuming and does not provide very much data. Stress testing the device using walk-around testing is particularly challenging. Other test methods employ special equipment to force or simulate a roam event. For example, a shield or antenna attenuator may be used to weaken the signal of an AP, thereby triggering a roam event. However, this requires additional special equipment, is time consuming, and again does not provide very much data.

SUMMARY

In accordance with one aspect, a non-transitory storage medium storing instructions readable and executable by a computer in communication with a wireless local area network controller (WLC) controlling a plurality of wireless access points (APs) to perform a roam test method including the operations of: (i) deactivating all but an active AP of the plurality of APs; (ii) connecting a wireless medical device under test (DUT) with the active AP; and (iii) triggering a roam event by operations including: connecting the DUT with a second AP that is different from the active AP of operation (i); and making the second AP the active AP.

In accordance with another aspect, a roaming test method, comprising: (i) deactivating all but an active wireless access point (AP) of a plurality of APs; (ii) connecting a wireless medical device under test (DUT) with the active AP; and (iii) triggering a roam event including: connecting the DUT with a second AP of the plurality of APs that is different from the active AP of operation (i); and deactivating the active AP of operation (i) thereby making the second AP the active AP.

In accordance with yet another aspect, a wireless medical communication test system comprising: a plurality of wireless access points (APs); a wireless medical device under test (DUT) configured to send and receive information via the plurality of APs using Institute of Electrical and Electronic Engineers (IEEE) 802.11 compliant communication, and

further configured to log roam information; a wireless local area network controller (WLC) configured to control the plurality of APs; and a computer configured to control the WLC to perform operations including: through the WLC, deactivate all APs of the plurality of APs except an active AP of the plurality of APs whereby the DUT connects with the active AP; 5 through the WLC, controlling the APs to trigger a roam event in which the DUT hands off from the active AP to a second AP different from the active AP; and storing information on the triggered roam event acquired from at least one of the DUT and the WLC.

One advantage of the approaches described herein is to gather roaming test data without the use of special equipment and without moving the wireless mobile device 10 under test.

Another advantage is that large amounts of data may be gathered. Put another way, data for stress testing (e.g. where data for several thousand roam events is desired) may be gathered.

Yet another advantage is gathering data in a short period of time.

15 The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 diagrammatically shows a wireless medical communication test 20 system in the context of a medical facility.

FIGURE 2 diagrammatically shows an example of a roam test method performed using the test system of FIGURE 1.

DETAILED DESCRIPTION

25 Disclosed herein are approaches for testing the roaming characteristics of a wireless medical device under test (DUT) operating in a wireless communication system. The disclosed approaches advantageously do not require any special equipment, such as radio frequency shields or antenna attenuators, and do not entail moving the DUT from proximity to one wireless access point (AP) to proximity to another AP. Rather, the disclosed 30 approaches are readily computer-implementable, and entail controlling the wireless local area network (LAN) controller (WLC) in order to selectively activate and deactivate APs in order to cause handoff of the DUT from one AP to another. The activation/deactivation of an AP can be performed by enablement/disablement, in which the AP is effectively turned on/off.

Alternatively, the activation/deactivation of an AP can be performed by adjusting transmit power of the AP. By reducing transmit power of the AP, movement of the DUT away from the AP is simulated (although the DUT actually remains stationary). Conversely, by increasing transmit power of the AP movement of the DUT toward the AP is simulated (although again, the DUT actually remains stationary). This approach to performing the roaming testing therefore enables testing of the impact of DUT and AP configuration parameters on the roaming performance – for example, it can be determined at what power level (or relative power level) a handoff is triggered, or at what power level communication is completely lost.

The disclosed approaches can be implemented by a computer in communication with the WLC (for example, the server computer controlling the WLC) in order to control the APs. Under conventional wireless electronic data communication protocols such as the IEEE 802.11 standard, data on the roam events is conventionally stored in wireless communication logs – at both the WLC and the DUT. These logs are suitably acquired by the computer, via its communication link with the WLC or by physically connecting the DUT with the computer during or after the roam testing (e.g. using a physical USB cable) in order to acquire roam statistics or the like.

It should be noted that the disclosed techniques generally cannot be performed in an operational hospital setting, because the APs cannot be used for normal wireless communication traffic during the testing, and it is usually not practical to take the APs of a hospital network offline to perform the testing. However, the disclosed techniques can be used in a “testbed” setting, for example to test performance of the wireless communication sub-system of a wireless medical device using a dedicated “testbed” wireless network. The disclosed techniques are also contemplated to be employed in an actual hospital setting, either at a time when the hospital is not actively operating (e.g. testing the wireless communication network of a new hospital before it begins serving patients) or by taking a portion of the hospital network offline (e.g., it is envisioned to test the wireless network of a single floor, care unit, or the like using the disclosed techniques by taking only the APs of that single floor, care unit, etc. offline for the testing).

With reference to FIGURE 1, medical facility network 1 includes wearable patient monitor 2. The wearable patient monitor 2 is capable of wirelessly connecting to any of a plurality of wireless access points (APs) 6. The wearable patient monitor 2 gathers data of a patient, for example, physiological data such as electrocardiogram (ECG) data, SpO₂ data, or so forth may be gathered. The wearable patient monitor 2 may also include a

touchscreen to enable easy viewing of the gathered data, as well as other information such as alarm history and alarm settings. It is contemplated for the wearable patient monitor 2 to provide other functionality, such as audio or audio/video communication with a nurses' station (e.g. enabling the patient to press a "talk" button to talk with his or her nurse). The wearable patient monitor 2 optionally includes a USB port 4 or other physical data communication port(s) for the purpose of transferring data (e.g. to a server computer 10 through a USB cable, not shown, connecting USB port 4 of the wearable patient monitor 2 with USB port 14 of the computer 10). An example of wearable patient monitor 2 is the IntelliVue MX40™ (available from Koninklijke Philips N.V., Eindhoven, the Netherlands).

By way of the MX40™ as an illustrative example, patient monitor 2 is designed to be placed in a pouch supported from the patient's neck, and can be connected with various patient monitoring sensors (e.g. ECG electrodes). The patient monitor 2 communicates with a central station (usually the nurses' station) wirelessly using a proprietary wireless network or using an available wireless local area network (WLAN) (e.g., an Institute of Electrical and Electronics Engineers (IEEE) 802.11 wireless network). Because life-critical data are being communicated, the communication link needs to be reliable. If the wireless link drops out, the patient monitor 2 alarms and an alarm issues at the nurses' station, and the ambulatory patient must be tracked down to determine the cause of the alarm. Accordingly, it is desirable to thoroughly test the wireless communication system including the patient monitor 2 and its connection with the APs 6. Since roam event anomalies are a common failure mode in distributed wireless communication systems, it is of particular value to test roaming performance, preferably including performing so-called "stress tests" in which many roam events, e.g. 2000-3000 roam events in some test protocols, are performed in order to collect sufficient statistics.

Returning to FIGURE 1, the plurality of APs 6 are controlled by a wireless local area network (LAN) controller (WLC) 8. The WLC 8 is in turn controlled by the server computer 10. For example, in a typical hospital setting, electronic hospital services (e.g. admissions records, electronic patient records, and so forth) are maintained on the hospital server 10, and communication amongst personal computers, tablet or slate computers, or other devices throughout the hospital connect with the server 10 via the LAN by wireless connectivity provided by the wireless LAN comprising the APs 6 and WLC 8. Additionally, some stationary devices such as desktop computers may additionally or alternatively connect with the server computer 10 via a wired LAN such as a wired Ethernet (not shown in FIGURE 1). The diagrammatically indicated server computer 10 may actually comprise

various configurations or architectures of interconnected/distributed computing resources. For example, the server may be partially or wholly cloud-based, comprising computers interconnected via the LAN and possibly also via the Internet. Conventionally, Information Technology (IT) personnel maintain the wireless local area network, including operations
5 such as configuring parameters of the APs 6 and WLC 8, by interaction with the WLC 8 via the server computer 10.

To implement the disclosed roam testing techniques, the server computer 10 further includes a roam test module 12, which may for example comprise a script or other software readable and executable by the server computer 10 to perform the roam testing
10 method described in FIGURE 2. It is alternatively contemplated to implement the roam test module 12 on another computer (not shown) that is in communication with the WLC 8, either directly or indirectly via connection with the server computer. The computer running the roam test module 12 (whether the server computer 10 as illustrated, or another computer in communication with the WLC 8) is capable of controlling the WLC 8 in order to control the
15 APs 6, for example by turning APs on or off (also referred to herein as “enabling” or “disabling” the APs), and/or by setting transmit power for an AP. It is also contemplated for the control to extend to other parameters of the wireless communication system such as setting the operating frequency used by an AP, setting other communication protocol parameters, or so forth.

20 With reference to FIGURE 2, an illustrative roam testing method is described, which is suitably performed by the system of FIGURE 1, and in particular by execution of the script or other software implementing the roam test module 12 in order to control the WLC 8 to control the APs 6. In preparation for the roam testing, the DUT 2 is brought into sufficient proximity to the set of APs 6 so that, if any AP is operating normally it could
25 communicate with the DUT 2. In other words, the DUT 2 is within the effective communication range of each AP 6 that is to participate in the roam testing. For effective testing, there must be at least two APs thusly capable of communicating with the DUT 2. During the testing, the DUT 2 is not moved about, but instead remains stationary. The DUT 2 is also set up to be able to communicate wirelessly via the 802.11 compliant wireless protocol
30 or other communication protocol whose roam characteristics are to be tested. This means that the DUT 2 is taken out of so-called “airplane” mode (if it has such), has its wireless communication activated, is logged into the wireless communication system comprising the APs 6 and WLC 8 including performing any password-based login or other authentication needed to enable communication with the APs 6. After these preparatory operations are

complete, in an operation 20, the roam test module 12 is started. Next, in an operation 22, all but one of the APs 6 are disabled; this controls which AP 6 the wearable patient monitor 2 is connected to because it forces connection to the only available AP 6. Next, in an operation 24 performed at the connected AP 6 and/or the WLC 8, the connection between the wearable patient monitor 2 and the AP 6 is estimated. This estimation includes, at a minimum, recording successful establishment of the connection (or lack thereof, e.g. if a roam event fails). Optionally, the estimation of the connection may include recording other parameters such as transmit power, communication frequency, or other settings of the connected AP, signal strength from the DUT 2 at the AP, data rate for test data communication, or so forth.

At the same time, at the DUT 2 the connection is also logged in a device under test (DUT) log 30 in an operation 32. The DUT log records, at a minimum, successful establishment of the connection (or lack thereof) and an identification of the connected AP. The log at the DUT may record other information such as transmit power, communication frequency, or other settings of the wireless communication interface of the DUT 2, strength of the AP signal at the DUT 2, data rate for test data communication, or so forth.

For explanatory purposes, the AP of the set of APs 6 that is active and connected with the DUT in the operation 22 is referred to as the “active AP.” The operations 24, 32 record characteristics of this connection at the AP 6/WLC 8 and at the DUT 2, respectively. It should be noted that while both logs 24, 32 are preferably acquired, it is alternatively contemplated to acquire only one of these logs as the data collected by the roam test: either acquiring only the AP/WLC log 24, or only the DUT log 32.

Next, in an operation 26, a roam event is triggered by deactivating the active AP that was connected in the operation 22 and activating a second AP (referred to hereafter as the “second AP”) that is different from the active AP that was connected in operation 22. The activation/deactivation operations can be performed in various ways. In one approach, the roam event is triggered by disabling the currently active AP and concurrently enabling the second AP 6 (this approach is referred to herein as a “forced roam” event). In another trigger approach, the active AP is left enabled, but its transmit (Tx) power is lowered and/or the Tx power of the “roam target”, i.e. second AP, is raised until the patient monitor 2 switches to the stronger signal provided by the second AP (this approach is referred to herein as an “opportunistic roam” event). Besides the forced roam and opportunistic roam, a skilled artisan will appreciate that other approaches to trigger roam events are possible.

The operation 26 produces a roam event, i.e. a handoff of the DUT 2 from the active AP connected in operation 22 to the second AP, because the deactivation of the former

and activation of the latter causes the DUT 2 to switch to the only available AP with sufficient signal in accordance with the automated roaming architecture of the IEEE 802.11 compliant wireless communication protocol (or in accordance with automated roaming architecture of another distributed wireless communication protocol under test). No other AP is active (as per operation 22), so the handoff is necessarily from the active AP of operation 22 which is now deactivated to the second AP which is now activated. Moreover, this handoff is caused entirely by the computer 10 controlling the APs 6 via the WLC 8, and does not entail either physically moving the DUT 2 or utilizing ancillary equipment such as RF shielding or antenna attenuators. The handoff of the wearable patient monitor 2 from the active AP of operation 22 to the second AP is logged as a new roam connection in the DUT log 30 in an operation 34, and is also logged at the AP/WLC in an operation analogous to the operation 24. It should be noted that the login operations 24, 32, 34 are typically performed automatically by the respective devices. For example, an existing feature of most 802.11-equipped mobile devices running Linux is the WPA_CLI front-end which maintains an event log of all roam events. Wireless 802.11 compliant communication interfaces running other operating systems typically include analogous wireless communication logging processes.

If more roam tests are desired then, in an operation 28, the method may return to operation 22. This entails disabling all APs except the current active AP, which is the AP labeled the “second AP” in describing operation 26. Alternatively, if the operation 26 entails disabling the previous active AP (that is, disabling the AP that was activated in the operation 22) then the state of the system at completion of the operation 26 is that precisely one AP is active (namely the AP labeled as the “second AP” when describing trigger operation 26) and so process flow could go directly back to the operation 26 to perform the next roam event. After all roam events to be tested are performed, the patient monitor 2 is connected with the computer via a USB port and the WPA_CLI event log (or other DUT wireless communication log) is read (operation 40) and time synchronized with WLC events recorded in the AP/WLC log or with the instructions sent to the AP by the roam test module 12 (operation 42). This results in a detailed record of the roaming test including both the operations performed by the APs 6 under control of the WLC and the responses generated at the mobile patient monitor. As an alternative to a USB connection, any other type of connection (e.g. wireless) may be used. This produces the roam testing results in an operation 44. In one aspect, both the DUT log 30 and the WLC log are each individually sufficient to analyze the roaming test results.

The roaming test systems described herein can be implemented entirely in software, as a script running on, for example, the computer 10 in communication with the WLC 8. The patient monitor is left stationary. Additionally, the roaming test systems described herein can be used for various purposes, such as stress tests (performing thousands of roam events and recording statistics), testing performance of a new 802.11 chipset, determining relative AP signal strengths at the DUT required to trigger a handoff, and so forth. Particularly, a stress test may involve 3,000-4,000 roam events. Its use in a hospital setting would typically involve taking the 802.11 wireless network off-line, since script operation disables most APs during the testing. Although the above descriptions have been made with reference to an 802.11 wireless network, it will be appreciated that the systems and methods described herein are applicable to any other types of networks and protocols. Similarly, while the illustrative examples pertain to a medical device, e.g. the illustrative wireless patient monitor 2, the disclosed techniques could also be used to test wireless communication including roaming of other wireless devices, such as portable computers, tablet or slate computers, or so forth.

It will be further appreciated that the systems and methods disclosed herein may be embodied by a non-transitory storage medium storing instructions readable and executable by an electronic data processing device (such as the computer 10) to perform the disclosed techniques. Such a non-transitory storage medium may comprise a hard drive or other magnetic storage medium, an optical disk or other optical storage medium, a cloud-based storage medium such as a RAID disk array, flash memory or other non-volatile electronic storage medium, or so forth.

Of course, modifications and alterations will occur to others upon reading and understanding the preceding description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.

CLAIMS:

1. A non-transitory storage medium storing instructions readable and executable by a computer (10) in communication with a wireless local area network controller (WLC) (8) controlling a plurality of wireless access points (APs) (6) to perform a roam test method including the operations of:
- (i) deactivating all but an active AP of the plurality of APs (6);
 - (ii) connecting a wireless medical device under test (DUT) (2) with the active AP; and
 - (iii) triggering a roam event by operations including:
 - connecting the DUT (2) with a second AP that is different from the active AP of operation (i); and
 - making the second AP the active AP.
2. The non-transitory storage medium of claim 1, wherein the triggering operation (iii) further includes:
- enabling the second AP; and
 - disabling the active AP.
3. The non-transitory storage medium of claim 1, wherein the triggering operation (iii) further includes:
- increasing transmit power of the second AP; and
 - reducing transmit power of the active AP.
4. The non-transitory storage medium of any of claims 1-3, wherein the DUT (2) logs connection events and roam events and the roam test method includes the further operation of:
- receiving log information of the roam event from the DUT at the computer executing the stored instructions.
5. The non-transitory storage medium of any of claims 1-4, wherein the AP activation and deactivation operations are performed by controlling the WLC (8) to control the plurality of APs (6).

6. The non-transitory storage medium of any of claims 1-5, wherein the roam test method further includes repeating the operation (iii) to perform a plurality of roam events.

5 7. The non-transitory storage medium of any of claims 1-5, wherein the roam test method further includes performing a plurality of roam events by activating and deactivating APs (6).

10 8. The non-transitory storage medium of any of claims 1-7, wherein the connecting operations comprise connecting the DUT (2) with the active AP in operation (ii), and with the second AP in operation (iii), via an Institute of Electrical and Electronic Engineers (IEEE) 802.11 compliant wireless communication.

15 9. The non-transitory storage medium of any of claims 1-8, wherein the operations (i), (ii), and (iii) are performed by controlling the WLC (8) using the computer executing the instructions and are not performed by moving the DUT (2).

20 10. The non-transitory storage medium of claim 9, wherein the DUT (2) is configured to connect to an AP based on the transmit power of the AP, and the operations (i), (ii), and (iii) are performed by adjusting transmit powers of the APs of the plurality of APs (6).

25 11. The non-transitory storage medium of any of claims 1-10, wherein the DUT (2) is stationary

12. A roaming test method, comprising:
(i) deactivating all but an active wireless access point (AP) of a plurality of APs (6);
(ii) connecting a wireless medical device under test (DUT) (2) with the active AP; and
(iii) triggering a roam event including:
30 connecting the DUT with a second AP of the plurality of APs (6) that is different from the active AP of operation (i); and
deactivating the active AP of operation (i) thereby making the second AP the active AP.

13. The roaming test method of claim 12, wherein the triggering includes:
prior to connecting the DUT (2) with the second AP, enabling the second AP; and
disabling the active AP (6).

5 14. The roaming test method of claim 12, wherein the triggering includes:
increasing transmit power of the second AP; and
reducing transmit power of the active AP of operation (i);
wherein the increasing and the reducing are effective to cause handoff of the DUT (2)
from the active AP of operation (i) to the second AP.

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15. The roaming test method of any of claims 12-14, wherein the DUT (2) is
stationary throughout the performing of operations (i), (ii), and (iii).

16. The roaming test method of any of claims 12-15, further comprising:
15 repeating operation (iii) to perform a plurality of roam events.

17. The roaming test method of claim 16 wherein the operations (i), (ii), and (iii)
are performed by a computer (10) communicating with a wireless local area network
controller (WLC) (8) to control the plurality of APs (6), and the roaming test method further
20 comprises:

after performing the plurality of roam events, downloading a record of the plurality of
roam events in a wireless communication log of the DUT (2) to the computer.

18. A wireless medical communication test system comprising:
25 a plurality of wireless access points (APs) (6);
a wireless medical device under test (DUT) (2) configured to send and receive
information via the plurality of APs (6) using Institute of Electrical and Electronic Engineers
(IEEE) 802.11 compliant communication, and further configured to log roam information;
a wireless local area network controller (WLC) (8) configured to control the plurality
30 of APs (6); and

a computer (10) configured to control the WLC to perform operations including:
through the WLC, deactivate all APs of the plurality of APs (6) except
an active AP of the plurality of APs (6) whereby the DUT connects with the
active AP,

through the WLC, controlling the APs to trigger a roam event in which the DUT hands off from the active AP to a second AP different from the active AP; and
storing information on the triggered roam event acquired from at least one of the DUT
5 and the WLC.

19. The wireless medical communication test system of claim 18 wherein the roam event is triggered by deactivating the active AP and activating the second active AP.

10 20. The wireless medical communication test system of any of claims 18-19 wherein the roam event is triggered by reducing transmit power of the active AP and increasing transmit power of the second AP.

21. The wireless medical communication test system of any of claims 18-20
15 wherein the triggering of a roam event is repeated between 2,000 and 3,000 to create a roam event log (30) comprising the stored information on the triggered roam events.

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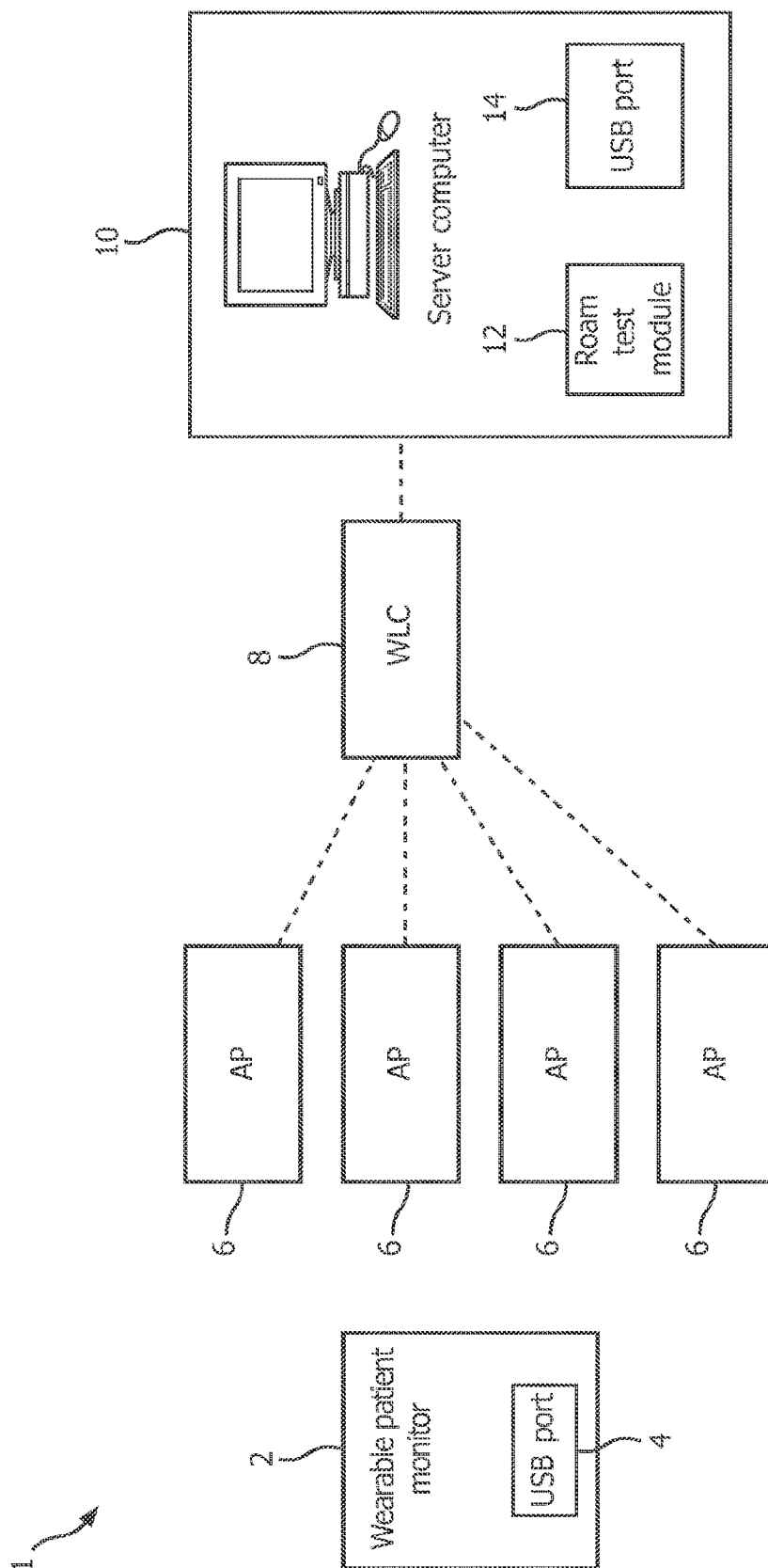


FIG. 1

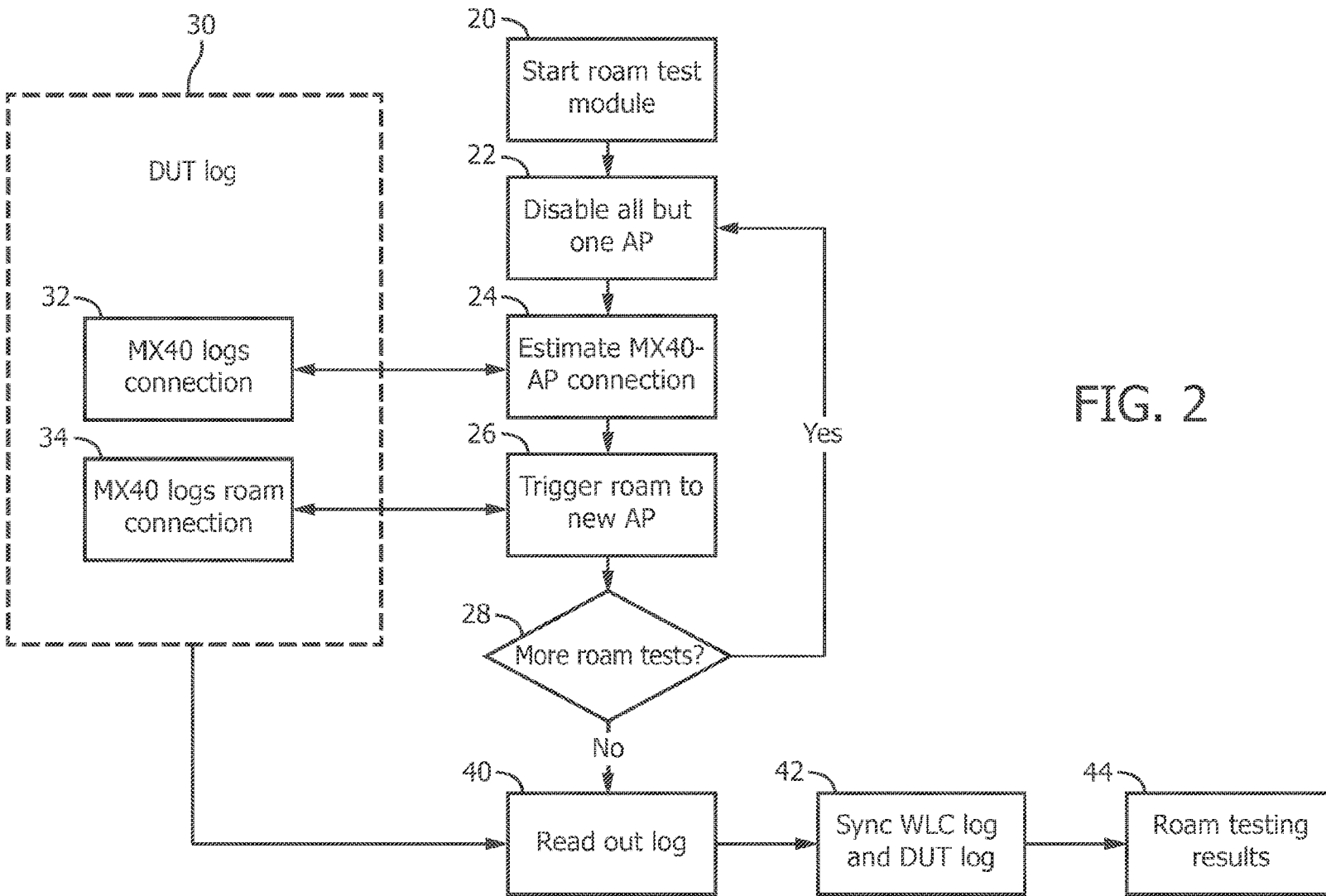


FIG. 2

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/050447

A. CLASSIFICATION OF SUBJECT MATTER INV. H04W24/06 ADD. H04W36/08 H04W84/12 A61B5/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04W H04L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data, INSPEC		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
X	US 2008/026748 A1 (ALEXANDER THOMAS [US] ET AL) 31 January 2008 (2008-01-31) abstract paragraphs [0003] - [0009], [0012] - [0014], [0021], [0031], [0032], [0035], [0037] - [0042], [0046] - [0048], [0050] - [0053], [0063], [0064] figures 1,3,5,6	1-21
X	US 2007/270195 A1 (LIANG YING-MING [TW]) 22 November 2007 (2007-11-22) abstract paragraphs [0002], [0006], [0014] - [0017], [0019], [0020], [0022] - [0025], [0035], [0037], [0040] figures 1,4 ----- -/-	1,3,6, 9-12, 14-16, 18,20
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 21 March 2016		Date of mailing of the international search report 30/03/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Dutrieux, Yann

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/050447

(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/172244 A1 (MLINARSKY I FANNY [US] ET AL) 8 July 2010 (2010-07-08) abstract paragraphs [0005] - [0008], [0027] - [0029], [0031] - [0034] figure 2A -----	1,3, 8-12,14, 15,18,20
A	US 2008/020746 A1 (ALEXANDAR THOMAS [US] ET AL) 24 January 2008 (2008-01-24) abstract paragraphs [0002], [0004], [0006] - [0010], [0013], [0014], [0022], [0040] - [0043], [0045], [0046], [0048], [0050], [0051], [0056], [0091], [0092], [0094] figure 1 -----	1-21
A	US 2013/338958 A1 (SHANISHCHARA KUNAL [US] ET AL) 19 December 2013 (2013-12-19) abstract paragraphs [0032] - [0035], [0077] - [0080], [0088], [0089], [0099] - [0101], [0106], [0136] -----	4,17,18, 21
A	US 2012/170474 A1 (PEKARSKE MATTHEW R [US]) 5 July 2012 (2012-07-05) abstract paragraphs [0002] - [0005], [0007], [0012] - [0014] figure 3 -----	1-21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2016/050447

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008026748 A1	31-01-2008	NONE	
US 2007270195 A1	22-11-2007	TW I315146 B US 2007270195 A1	21-09-2009 22-11-2007
US 2010172244 A1	08-07-2010	US 2006239198 A1 US 2010172244 A1	26-10-2006 08-07-2010
US 2008020746 A1	24-01-2008	NONE	
US 2013338958 A1	19-12-2013	NONE	
US 2012170474 A1	05-07-2012	GB 2487120 A US 2012170474 A1	11-07-2012 05-07-2012

Electronic Patent Application Fee Transmittal

Application Number:	15940890			
Filing Date:	29-Mar-2018			
Title of Invention:	DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE			
First Named Inventor/Applicant Name:	Joseph Amalan Arul EMMANUEL			
Filer:	Han-Wei Chen/Christine Dunn			
Attorney Docket Number:	110729-8058.US02			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	1806	1	240	240
Total in USD (\$)				240

Electronic Acknowledgement Receipt

EFS ID:	37577155
Application Number:	15940890
International Application Number:	
Confirmation Number:	8990
Title of Invention:	DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE
First Named Inventor/Applicant Name:	Joseph Amalan Arul EMMANUEL
Customer Number:	22918
Filer:	Han-Wei Chen/Christine Dunn
Filer Authorized By:	Han-Wei Chen
Attorney Docket Number:	110729-8058.US02
Receipt Date:	28-OCT-2019
Filing Date:	29-MAR-2018
Time Stamp:	13:38:42
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$240
RAM confirmation Number	E20190RD39150409
Deposit Account	500665
Authorized User	Christine Dunn

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:
37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	2019-10-28-IDS-110729-8058US02.pdf	1035521	no	5
			214b68c66d407473092ad1951757a8605252df9e		
Warnings:					
Information:					
2	Foreign Reference	CN_101523809.pdf	5594006	no	65
			6e02415a0ef15b4d22e2ce55c509677bfc259a3b		
Warnings:					
Information:					
3	Foreign Reference	CN_101610558.pdf	2262646	no	36
			e399903ed37a71846dc3c2ea078018dba87dbd80		
Warnings:					
Information:					
4	Foreign Reference	CN_101796869.pdf	2537840	no	36
			b6f73d2da02edfe376fe7e815ade274ce927f5ee		
Warnings:					
Information:					
5	Foreign Reference	CN_102387553.pdf	2243846	no	34
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Warnings:					
Information:					
6	Foreign Reference	CN_102740306.pdf	6337190	no	72
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Warnings:					
Information:					

7	Foreign Reference	CN_102907141.pdf	8404077	no	99
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Warnings:					
Information:					
8	Foreign Reference	CN_104301957.pdf	1617852	no	24
			26d81a7555ac4d83af9cb20b486c8ec4206d8bb7		
Warnings:					
Information:					
9	Foreign Reference	EP_2844020.pdf	598278	no	20
			7719d42c4552dbd790fa548a1a04efc65f18539a		
Warnings:					
Information:					
10	Foreign Reference	CN_104703193.pdf	2873119	no	39
			48cedda3d5ef2673c7ce90aa9ee3a956cb3a3abf		
Warnings:					
Information:					
11	Foreign Reference	CN_104756474.pdf	4099602	no	59
			1d84f54877739cc347e9331eeeb9d954f02c1a8		
Warnings:					
Information:					
12	Foreign Reference	CN_104854901.pdf	3953553	no	49
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Warnings:					
Information:					
13	Foreign Reference	CN_104885378.pdf	7529314	no	101
			0354d829c5af8e685928442a8b35d84a95d8a42b		
Warnings:					
Information:					

14	Foreign Reference	CN_105027604.pdf	2589129 da1008d357b276a7a74b9e57e4850b1143 a64ac4	no	31
Warnings:					
Information:					
15	Foreign Reference	WO_2016125055.pdf	2227805 b49f2854a939a81f0e21586fbf7f0cb548d 8b5d	no	19
Warnings:					
Information:					
16	Fee Worksheet (SB06)	fee-info.pdf	30595 5838d7c315f825beb3f75182b088b1e8c7d ea11b	no	2
Warnings:					
Information:					
Total Files Size (in bytes):			53934373		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 15/940,890		Filing Date 03/29/2018		☐ To be Mailed			
ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO											
APPLICATION AS FILED - PART I											
		(Column 1)		(Column 2)							
FOR		NUMBER FILED		NUMBER EXTRA		RATE (\$)		FEE (\$)			
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A		N/A		N/A					
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))		N/A		N/A		N/A					
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A		N/A		N/A					
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 = *				x \$100 =					
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 = *				x \$460 =					
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).									
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))											
* If the difference in column 1 is less than zero, enter "0" in column 2.						TOTAL					
APPLICATION AS AMENDED - PART II											
		(Column 1)		(Column 2)		(Column 3)					
AMENDMENT	10/25/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 22	Minus	** 22	= 0			x \$100 =		0	
	Independent (37 CFR 1.16(h))	* 2	Minus	*** 3	= 0			x \$460 =		0	
	☐ Application Size Fee (37 CFR 1.16(s))										
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))										
								TOTAL ADD'L FEE		0	
		(Column 1)		(Column 2)		(Column 3)					
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	*	Minus	**	=			x \$0 =			
	Independent (37 CFR 1.16(h))	*	Minus	***	=			x \$0 =			
	☐ Application Size Fee (37 CFR 1.16(s))										
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))										
								TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.								LIE			
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".								/VIOLA D ROGERS/			
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".											
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.											

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.



UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

22918 7590 01/28/2020
PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247

EXAMINER

PATEL, JAY P

ART UNIT

PAPER NUMBER

2466

DATE MAILED: 01/28/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	03/29/2018	Joseph Amalan Arul EMMANUEL	110729-8058.US02	8990

TITLE OF INVENTION: DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	04/28/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

22918 7590 01/28/2020
PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	03/29/2018	Joseph Amalan Arul EMMANUEL	110729-8058.US02	8990

TITLE OF INVENTION: DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	04/28/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
PATEL, JAY P	2466	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

1 _____

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	03/29/2018	Joseph Amalan Arul EMMANUEL	110729-8058.US02	8990
22918	7590	01/28/2020	EXAMINER	
PERKINS COIE LLP - PAO General			PATEL, JAY P	
P.O. BOX 1247			ART UNIT	
SEATTLE, WA 98111-1247			PAPER NUMBER	
			2466	
DATE MAILED: 01/28/2020				

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

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

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

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

Notice of Allowability	Application No. 15/940,890	Applicant(s) EMMANUEL et al.	
	Examiner JAY P PATEL	Art Unit 2466	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 10/25/2019.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-22. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. ____.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ____. 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material ____. 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date ____.	5. ☐ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other ____.
---	---

/JAY P PATEL/
Primary Examiner, Art Unit 2466

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

Claims 1-22 are allowed.

The following is an examiner's statement of reasons for allowance:

In regards to the claims, they are allowable in view of the remarks filed on 10/25/2019. In particular, the remarks concerning switching for a mesh wireless network backhaul communication, upon detection that the received signal strength of the first backhaul channel is below a threshold.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to JAY P PATEL whose telephone number is (571)272-3086. The examiner can normally be reached on M-F 9:30-6.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Faruk Hamza can be reached on 571-272-7969. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <https://ppair-my.uspto.gov/pair/PrivatePair>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/JAY P PATEL/
Primary Examiner, Art Unit 2466

Notice of References Cited	Application/Control No. 15/940,890		Applicant(s)/Patent Under Reexamination EMMANUEL et al.	
	Examiner JAY P PATEL		Art Unit 2466	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20090029645-A1	01-2009	Leroudier; Frederic	H04B7/2606	455/7
*	B	US-20100234071-A1	09-2010	Shabtay; Ophir	H04B7/0408	455/562.1
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

<i>Index of Claims</i> 	Application/Control No. 15/940,890	Applicant(s)/Patent Under Reexamination EMMANUEL et al.
	Examiner JAY P PATEL	Art Unit 2466

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	04/25/2019	01/16/2020							
	1	✓	=							
	2	✓	=							
	3	✓	=							
	4	✓	=							
	5	✓	=							
	6	✓	=							
	7	✓	=							
	8	✓	=							
	9	✓	=							
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	18	✓	=							
	19	✓	=							
	20	✓	=							
	21	✓	=							
	22	✓	=							

Search Notes 	Application/Control No. 15/940,890	Applicant(s)/Patent Under Reexamination EMMANUEL et al.
	Examiner JAY P PATEL	Art Unit 2466

CPC - Searched*		
Symbol	Date	Examiner
(H04W72/0453 or H04W76/15 or H04L12/44 or H04L43/16 or H04W40/12 or H04W24/06 or H04W36/36 or H04W36/30 or H04W24/08 or H04W4/023 or H04L43/10 or H04L43/0894 or H04L43/0888 or H04L45/20 or H04W76/10 or H04W72/085 or H04W24/04 or H04W84/12 or H04W84/18);PLUS TEXT	04/24/2019	JPP

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

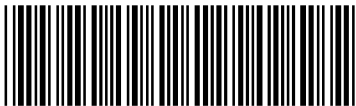
Search Notes		
Search Notes	Date	Examiner
EAST (USPAT, USPGPUB, USOCR, FPRS, EPO, JPO, DERWENT, IBM_TDB);PLUS TEXT	04/24/2019	JPP
EAST INVENTORSHIP SEARCH	04/24/2019	JPP
IP.COM SEARCH FOR CHOOSING BACKHAUL CHANNELS BASED ON SIGNAL STRENGTHS AND USING THE FRONT HAUL CHANNEL AS LAST RESORT	04/25/2019	JPP
EAST (USPAT, USPGPUB, USOCR, FPRS, EPO, JPO, DERWENT, IBM_TDB);PLUS TEXT	01/16/2020	JPP

/JAY P PATEL/ Primary Examiner, Art Unit 2466	
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<i>Search Notes</i> 	Application/Control No. 15/940,890	Applicant(s)/Patent Under Reexamination EMMANUEL et al.
	Examiner JAY P PATEL	Art Unit 2466

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	EAST Interference Search	01/16/2020	JPP

/JAY P PATEL/ Primary Examiner, Art Unit 2466	
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Issue Classification 	Application/Control No. 15/940,890	Applicant(s)/Patent Under Reexamination EMMANUEL et al.	
	Examiner JAY P PATEL	Art Unit 2466	

CPC						
Symbol					Type	Version
H04W	/	72	/	0453	F	2013-01-01
H04W	/	76	/	15	I	2018-02-01
H04L	/	12	/	44	I	2013-01-01
H04L	/	43	/	16	I	2013-01-01
H04L	/	45	/	20	I	2013-01-01
H04W	/	4	/	023	I	2013-01-01
H04W	/	24	/	08	I	2013-01-01
H04W	/	36	/	30	I	2013-01-01
H04W	/	36	/	36	I	2013-01-01
H04L	/	43	/	0888	I	2013-01-01
H04L	/	43	/	0894	I	2013-01-01
H04L	/	43	/	10	I	2013-01-01
H04W	/	24	/	06	I	2013-01-01
H04W	/	40	/	12	I	2013-01-01
H04W	/	24	/	04	A	2013-01-01
H04W	/	72	/	085	A	2013-01-01
H04W	/	76	/	10	A	2018-02-01
H04W	/	84	/	18	A	2013-01-01
H04W	/	84	/	12	A	2013-01-01

CPC Combination Sets				
Symbol	Type	Set	Ranking	Version
/				

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 22	
/JAY P PATEL/ Primary Examiner, Art Unit 2466 (Primary Examiner) _____ (Date) _____		O.G. Print Claim(s) 1	O.G. Print Figure 5

<i>Issue Classification</i> 	Application/Control No. 15/940,890	Applicant(s)/Patent Under Reexamination EMMANUEL et al.
	Examiner JAY P PATEL	Art Unit 2466

INTERNATIONAL CLASSIFICATION			
CLAIMED			
H04W	/	72	/ 04
NON-CLAIMED			
/	/		

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	22	
/JAY P PATEL/ Primary Examiner, Art Unit 2466 (Primary Examiner)	16 January 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 5

Issue Classification 	Application/Control No. 15/940,890	Applicant(s)/Patent Under Reexamination EMMANUEL et al.
	Examiner JAY P PATEL	Art Unit 2466

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47															
CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 22	
/JAY P PATEL/ Primary Examiner, Art Unit 2466 (Primary Examiner) _____ (Date) 16 January 2020		O.G. Print Claim(s) 1	O.G. Print Figure 5

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)

Application Number	15940890
Filing Date	2018-03-29
First Named Inventor	Joseph Amalan Arul Emmanuel
Art Unit	2466
Examiner Name	Jay P. Patel
Attorney Docket Number	110729-8058.US02

U.S.PATENTS

Remove

Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7113134	B1	2006-09-26	BERKMAN	
	2	8451752	B2	2013-05-28	LU	

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Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20120230206	A1	2012-09-13	BALIGA, et al.	
	2	20170251429	A1	2017-08-31	KAPOOR, et al.	

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FOREIGN PATENT DOCUMENTS

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Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²ⁱ	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1	101523809	CN	A	2009-09-02	QUALCOMM INC.		

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
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Application Number		15940890
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First Named Inventor	Joseph Amalan Arul Emmanuel	
Art Unit	2466	
Examiner Name	Jay P. Patel	
Attorney Docket Number	110729-8058.US02	

2	101610558	CN	A	2009-12-23	HONGFUJIN PRECISION INDUSTRY (SHENZHEN) CO., LTD.		
3	101796869	CN	A	2010-08-04	QUALCOMM INC.		
4	102387553	CN	A	2012-03-21	ZTE CORPORATION		
5	102740306	CN	A	2012-10-17	FUJITSU LTD.		
6	102907141	CN	A	2013-01-30	DEUTSCHE TELEKOM AG		
7	104301957	CN	A	2015-01-21	HANGZHOU H3C TECHNOLOGIES CO., LTD.		
8	2844020	EP	A1	2015-03-04	ITRON, INC.		
9	104703193	CN	A	2015-06-10	HANGZHOU H3C TECHNOLOGIES CO., LTD.		
10	104756474	CN	A	2015-07-01	ADAPTIVE SPECTRUM AND SIGNAL ALIGNMENT, INC.		
11	104854901	CN	A	2015-08-19	DEUTSCHE TELEKOM AG		
12	104885378	CN	A	2015-09-02	INTEL CORPORATION		

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15940890
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First Named Inventor	Joseph Amalan Arul Emmanuel
Art Unit	2466
Examiner Name	Jay P. Patel
Attorney Docket Number	110729-8058.US02

13	105027604	CN	A	2015-11-04	TELEFONAKTIEBOLAG ET LM ERICSSON		
14	2016125055	WO	A1	2016-08-11	KONINKLIJKE PHILIPS N.V.		

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵
	1		

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/JAY P PATEL/	Date Considered	01/16/2020
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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15940890
Filing Date	2018-03-29
First Named Inventor	Joseph Amalan Arul Emmanuel
Art Unit	2466
Examiner Name	Jay P. Patel
Attorney Docket Number	110729-8058.US02

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

- ✓ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.
- ✓ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Han-Wei Chen/	Date (YYYY-MM-DD)	2019-10-25
Name/Print	Han-Wei Chen	Registration Number	75350

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

Privacy Act Statement

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

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

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

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	5	mesh and (backhaul\$3 same (RSSI or (signal adj2 strength\$3))) and ((prioritiz\$4 or rank\$4) with (RSSI or (signal adj2 strength\$3)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/01/16 15:52
L2	2	L1 and (@rlad<"20151110" or @ad<"20151110")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/01/16 15:52
S50	4	("20120230206" "20170251429" "7113134" "8451752").PN.	US-PGPUB; USPAT	OR	OFF	2020/01/10 10:37
S51	2	S50 and backhaul\$3	US-PGPUB; USPAT	OR	OFF	2020/01/10 10:51
S52	8	"2016125055"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/01/10 11:39
S53	4	"20160125055"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/01/10 11:39
S54	5	"WO 2016125055"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/01/10 11:40
S55	1	S50 and backhaul\$3 and threshold	US-PGPUB; USPAT	OR	OFF	2020/01/10 11:48

1/ 16/ 2020 4:22:40 PM

C:\Users\jpatel1\Documents\EAST\Workspaces\15940890.wsp

Bibliographic Data

Application No: 15/940,890

Foreign Priority claimed: ☐ Yes ☒ No

35 USC 119 (a-d) conditions met: ☐ Yes ☒ No ☐ Met After Allowance

Verified and Acknowledged:

/JAY P PATEL/

JPP

Examiner's Signature

Initials

Title:

DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/29/2018	370	2466	110729-8058.US02
RULE			

APPLICANTS

NETGEAR, INC., San Jose, CA,

INVENTORS

Joseph Amalan Arul EMMANUEL Cupertino, CA, UNITED STATES

Peiman AMINI Mountain View, CA, UNITED STATES

CONTINUING DATA

This application is a CON of 15271912 09/21/2016 PAT 9967884

15271912 has PRO of 62336503 05/13/2016

15271912 has PRO of 62253540 11/10/2015

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

04/24/2018

STATE OR COUNTRY

UNITED STATES

ADDRESS

PERKINS COIE LLP - PAO General

P.O. BOX 1247

SEATTLE, WA 98111-1247

UNITED STATES

FILING FEE RECEIVED

\$1,720

EAST Search History

EAST Search History (I nterference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L5	1	(mesh and (backhaul\$3 same (RSSI or (signal adj2 strength\$3))) and ((prioritiz\$4 or rank\$4) with (RSSI or (signal adj2 strength\$3))))).clm.	US-PGPUB; USPAT	OR	OFF	2020/01/16 16:23

1/ 16/ 2020 4:23:38 PM

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Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 22918

Jan 28, 2020 03:34:20 AM

Dear PAIR Customer:

PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 22918 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

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Application	Document	Mailroom Date	Attorney Docket No.
15940890	NOA	01/28/2020	110729-8058.US02
	892	01/28/2020	110729-8058.US02
	1449	01/28/2020	110729-8058.US02

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If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

EMMANUEL et al.

Customer No.: 22918

Application No.: 15/940,890

Confirmation No.: 8990

Filed: March 29, 2018

Art Unit: 2466

For: DEDICATED BACKHAUL FOR WHOLE
HOME COVERAGE

Examiner: Jay P. Patel

AMENDMENT AFTER ALLOWANCE UNDER 37 C.F.R. §1.312

MAIL STOP ISSUE FEE

Commissioner for Patents

P.O. Box 1450

Alexandria, Virginia 22313-1450

Sir:

Please enter the following amendment prior to issuing the present application as a patent. The Notice of Allowance and Issue Fee due was mailed on January 28, 2020:

Amendments to the Specification begin on page **2** of this paper.

Remarks begin on page **3** of this paper.

AMENDMENTS TO THE SPECIFICATION:

Please amend page one, paragraph one of the specification as follows:

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation (CON) application of U.S. utility patent application no. 15/271,912, entitled DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE (Attorney Docket No. 110729-8058.US01), filed September 21, 2016, now U.S. Patent No. 9,967,884, which claims priority to U.S. provisional patent application no. 62/253,540, entitled METHOD AND APPARATUS FOR WHOLE HOME WI-FI COVERAGE (Attorney Docket No. 110729-8045.US00), filed November 10, 2015, and to U.S. provisional patent application no. 62/336,503, entitled DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE (Attorney Docket No. 110729-8058.US00), filed May 13, 2016; all of which are incorporated herein in their entirety by this reference thereto.

REMARKS

Please enter the above amendments to the specification prior to issuing the present application as a patent.

Applicant submits that these amendments do not introduce new matter or raise any new issues, but instead, are made to place the present application in better form and are not necessary to comply with any statutory requirement of patentability.

If there are any additional charges, please charge Deposit Account No. **50-0665** under Order No. **110729-8058.US02**, from which the undersigned is authorized to draw.

Dated: 3/26/2020

Respectfully submitted,

By /Han-Wei Chen/
Han-Wei Chen
Registration No.: 75,350
PERKINS COIE LLP
P.O. Box 1247
Seattle, WA 98111-1247
Phone: (650) 838-4300
Fax: (206) 359-7198
Attorney for Applicant

Electronic Acknowledgement Receipt

EFS ID:	38997312
Application Number:	15940890
International Application Number:	
Confirmation Number:	8990
Title of Invention:	DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE
First Named Inventor/Applicant Name:	Joseph Amalan Arul EMMANUEL
Customer Number:	22918
Filer:	Han-Wei Chen/Christine Dunn
Filer Authorized By:	Han-Wei Chen
Attorney Docket Number:	110729-8058.US02
Receipt Date:	27-MAR-2020
Filing Date:	29-MAR-2018
Time Stamp:	19:26:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		2020-03-27_After_Allowance_Amdt_110729-8058US02.pdf	89260	yes	3
			0e8d12bdc8e6dc80b872addbac18b7aec40543c3		

Multipart Description/PDF files in .zip description			
Document Description	Start	End	
Amendment after Notice of Allowance (Rule 312)	1	1	
Specification	2	2	
Applicant Arguments/Remarks Made in an Amendment	3	3	

Warnings:

Information:

Total Files Size (in bytes):	89260
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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

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

New International Application Filed with the USPTO as a Receiving Office
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PRINTER RUSH
(PTO ASSISTANCE)

Application: 15940890

Examiner: Patel

GAU: 2466

From:

Location: RTFM

Creation Date: 03/30/2020

Week Date: 1/27/2020

<u>DOC CODE</u>	<u>DOC DATE</u>	<u>MISCELLANEOUS</u>
☐ 1449 ☐ IDS ☐ CLM ☐ IIFW/FWCLM ☐ SRFW ☐ DRW ☐ OATH ☒ 312 ☐ SPEC	<u>03/27/2020</u>	☐ Continuing Data ☐ Foreign Priority ☐ Document Legibility ☐ Fees ☐ Petition (TC) ☐ Other

[RUSH] Message:

Please respond to the 3-27-20 A.NA

[XRUSH] Response:

Initials: _____



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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	03/29/2018	Joseph Amalan Arul EMMANUEL	110729-8058.US02	8990
22918	7590	04/10/2020		
PERKINS COIE LLP - PAO General			EXAMINER	
P.O. BOX 1247			PATEL, JAY P	
SEATTLE, WA 98111-1247				
			ART UNIT	PAPER NUMBER
			2466	
			NOTIFICATION DATE	DELIVERY MODE
			04/10/2020	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

patentprocurement@perkinscoie.com

Notice of Allowability	Application No. 15/940,890	Applicant(s) EMMANUEL et al.	
	Examiner JAY P PATEL	Art Unit 2466	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to amendment to spec. filed on 3/27/2020.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-22. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)	5. ☐ Examiner's Amendment/Comment
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.	6. ☐ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.	7. ☐ Other _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.	

/JAY P PATEL/ Primary Examiner, Art Unit 2466	
--	--

PRINTER RUSH
(PTO ASSISTANCE)

Application: 15940890

Examiner: Patel

GAU: 2466

From:

Location: RTFM

Creation Date: 03/30/2020

Week Date: 1/27/2020

<u>DOC CODE</u>	<u>DOC DATE</u>	<u>MISCELLANEOUS</u>
☐ 1449 ☐ IDS ☐ CLM ☐ IIFW/FWCLM ☐ SRFW ☐ DRW ☐ OATH ☒ 312 ☐ SPEC	<u>03/27/2020</u>	☐ Continuing Data ☐ Foreign Priority ☐ Document Legibility ☐ Fees ☐ Petition (TC) ☐ Other

[RUSH] Message:

Please respond to the 3-27-20 A.NA

[XRUSH] Response:

The amendment to the specification
that now includes the US Patent
number of the parent application
has been entered.

Initials: JPP

To: patentprocurement@perkinscoie.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 22918

Apr 10, 2020 04:07:42 AM

Dear PAIR Customer:

PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247
UNITED STATES

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Application	Document	Mailroom Date	Attorney Docket No.
15940890	NOA	04/10/2020	110729-8058.US02

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Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE
PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15940890
	Filing Date	2018-03-29
	First Named Inventor	Joseph Amalan Arul Emmanuel
	Art Unit	2464
	Examiner Name	Jay P. Patel
	Attorney Docket Number	110729-8058.US02

U.S.PATENTS						Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Patent citation information please click the Add button.

Add

U.S.PATENT APPLICATION PUBLICATIONS						Remove
Examiner Initial*	Cite No	Publication Number	Kind Code ¹	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20150373611	A1	2015-12-24	LIU, et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button.

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FOREIGN PATENT DOCUMENTS							Remove	
Examiner Initial*	Cite No	Foreign Document Number ³	Country Code ²ⁱ	Kind Code ⁴	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T ⁵
	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button

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NON-PATENT LITERATURE DOCUMENTS			Remove
Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T ⁵

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15940890
Filing Date	2018-03-29
First Named Inventor	Joseph Amalan Arul Emmanuel
Art Unit	2464
Examiner Name	Jay P. Patel
Attorney Docket Number	110729-8058.US02

1	
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EXAMINER SIGNATURE

Examiner Signature		Date Considered	
--------------------	--	-----------------	--

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**
(Not for submission under 37 CFR 1.99)

Application Number	15940890
Filing Date	2018-03-29
First Named Inventor	Joseph Amalan Arul Emmanuel
Art Unit	2464
Examiner Name	Jay P. Patel
Attorney Docket Number	110729-8058.US02

CERTIFICATION STATEMENT

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

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

OR

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

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Lena Petrovic/	Date (YYYY-MM-DD)	2020-04-24
Name/Print	Lena Petrovic	Registration Number	72128

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

Privacy Act Statement

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

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

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

Electronic Patent Application Fee Transmittal

Application Number:	15940890			
Filing Date:	29-Mar-2018			
Title of Invention:	DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE			
First Named Inventor/Applicant Name:	Joseph Amalan Arul EMMANUEL			
Filer:	Lena Petrovic/Christine Dunn			
Attorney Docket Number:	110729-8058.US02			
Filed as Large Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1000	1000

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1000

Electronic Acknowledgement Receipt

EFS ID:	39264139
Application Number:	15940890
International Application Number:	
Confirmation Number:	8990
Title of Invention:	DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE
First Named Inventor/Applicant Name:	Joseph Amalan Arul EMMANUEL
Customer Number:	22918
Filer:	Lena Petrovic/Christine Dunn
Filer Authorized By:	Lena Petrovic
Attorney Docket Number:	110729-8058.US02
Receipt Date:	24-APR-2020
Filing Date:	29-MAR-2018
Time Stamp:	19:10:44
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 1000
RAM confirmation Number	E20204NJ11080356
Deposit Account	500665
Authorized User	Christine Dunn

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:
37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	2020-04-24_Issue_Fee_110729-8058US02.pdf	1244157	no	1
			31779160bc62922c92f57cf69f3deeb0d0503a0a		
Warnings:					
Information:					
2	Post Allowance Communication - Incoming	Comments_on_Reasons_for_Allowance_110729-8058US02.pdf	77220	no	2
			985bc08285c2f2b549a4291050b8b66844922fb3		
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	2020-04-24_IDS_110729-8058US02.pdf	1034782	no	4
			6ed1c10f2da0655e21707e680a5743d658550a7b		
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30604	no	2
			9f7a7bef28180af0cbb721635875cba3081661eb		
Warnings:					
Information:					
Total Files Size (in bytes):			2386763		

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New Applications Under 35 U.S.C. 111

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

22918 7590 01/28/2020
PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Christine Dunn	(Typed or printed name)
/Christine Dunn/	(Signature)
04/24/2020	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	03/29/2018	Joseph Amalan Arul EMMANUEL	110729-8058.US02	8990

TITLE OF INVENTION: DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	\$1000	\$0.00	\$0.00	\$1000	04/28/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
PATEL, JAY P	2466	370-329000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Perkins Coie LLP

2

3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY AND STATE OR COUNTRY)

NETGEAR, INC.

SAN JOSE, CALIFORNIA

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 500665

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Lena Petrovic/

Date 4/24/20

Typed or printed name Lena Petrovic

Registration No. 72,128

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor	:	Joseph Amalan Arul EMMANUEL
Serial No.	:	15/940,890
Filed	:	March 29, 2018
Art Unit	:	2466
Confirmation Number	:	8990
Examiner	:	Jay P. Patel
Title	:	DEDICATED BACKHAUL FOR WHOLE HOME COVERAGE
Attorney Docket No.	:	110729-8058.US02

Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Dear Commissioner:

In the Notice of Allowance, mailed January 28, 2020, the Examiner provided Reasons for Allowance (hereinafter referred to as “Reasons”). Applicant believes the Reasons, to the extent understood, may be misconstrued and, as such, are incomplete. Applicant submits that indeed, the claims of the instant application, individually or in combination with other claims (via dependency), describe the patentable subject matter of Applicant’s invention(s). Accordingly, the Reasons in no way bind or affect the interpretation, infringement, validity and/or enforceability of any claim(s) or patent(s) resulting from, or relating to this application.

Applicant does not believe any fees are due with this submission. However, the commissioner is hereby authorized to charge any fees due or credit any overpayments to Deposit Account 500665 (Order No. 110729-8058.US02).

Dated: 4/24/20

Respectfully submitted,

By /Lena Petrovic/
Lena Petrovic
Registration No.: 72,128
PERKINS COIE LLP
P.O. Box 1247
Seattle, WA 98111-1247
Phone: (650) 838-4300
Fax: (206) 359-7198
Attorney for Applicant



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	03/29/2018	Joseph Amalan Arul EMMANUEL	110729-8058.US02	8990
7590 04/29/2020 PERKINS COIE LLP - PAO General P.O. BOX 1247 SEATTLE, WA 98111-1247			EXAMINER PATEL, JAY P	
			ART UNIT 2466	PAPER NUMBER
			NOTIFICATION DATE 04/29/2020	DELIVERY MODE ELECTRONIC

NOTICE OF NON-COMPLIANT INFORMATION DISCLOSURE STATEMENT

An Information Disclosure Statement (IDS) filed 4.24.2020 in the above-identified application fails to meet the requirements of 37 CFR 1.97(d) for the reason(s) specified below. Accordingly, the IDS will be placed in the file, but the information referred to therein has not been considered.

The IDS is not compliant with 37 CFR 1.97(d) because:

- ☒ The IDS lacks a statement as specified in 37 CFR 1.97(e).
- ☐ The IDS lacks the fee set forth in 37 CFR 1.17(p).
- ☐ The IDS was filed after the issue fee was paid. Applicant may wish to consider filing a petition to withdraw the application from issue under 37 CFR 1.313(c) to have the IDS considered. See MPEP 1308.

/ N.HORNE /

For:

571-272-4200 or 1-888-786-0101
Application Assistance Unit
Office of Data Management

To: patentprocurement@perkinscoie.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 22918

Apr 29, 2020 03:44:21 AM

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PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247
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Application	Document	Mailroom Date	Attorney Docket No.
15940890	M327	04/29/2020	110729-8058.US02

To view your correspondence online or update your email addresses, please visit us anytime at <https://portal.uspto.gov/secure/myportal/privatepair>.

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/940,890	06/09/2020	10681698	110729-8058.US02	8990

22918 7590 05/20/2020
PERKINS COIE LLP - PAO General
P.O. BOX 1247
SEATTLE, WA 98111-1247

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

NETGEAR, INC., San Jose, CA
Joseph Amalan Arul EMMANUEL, Cupertino, CA;
Peiman AMINI, Mountain View, CA;

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To: patentprocurement@perkinscoie.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 22918

May 21, 2020 08:50:42 AM

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Application	Document	Mailroom Date	Attorney Docket No.
15940890	ISSUE.NTF	05/20/2020	110729-8058.US02

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