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PASSWORD-LESS CONTINUOUS MULTIFACTOR AUTHENTICATION (CFMA) FOR WIRELESS NETWORKS

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WIRELESS LINK AGGREGATION TO PROVIDE AN EFFICIENT AND SMOOTH MULTI-PROTOCOL DATA LINK

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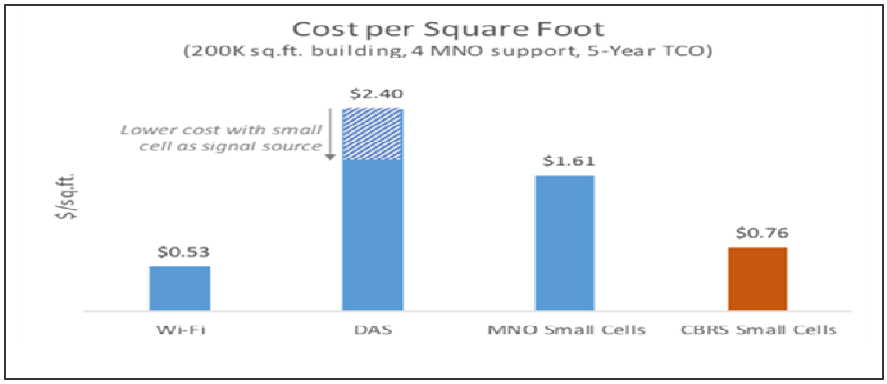
ABSTRACT

When connected to a cellular (e.g., 5G) network a device can receive/transmit Internet Protocol (IP) traffic via the packet data protocol (PDP). When connected to a Wi-Fi network a device can receive/transmit IP traffic via the Institute of Electrical and Electronics Engineers (IEEE) 802.11 protocol. This proposal provides for combining the capabilities of both cellular and Wi-Fi via a Wireless Link Aggregation (WLA) technique that allows for seamless roaming, no IP address change and no gateway change for a mobile device that is switched between access links, and enhanced experiences for users..

DETAILED DESCRIPTION

Cellular 5G access is a very powerful technology, but its main drawback is that it relies primarily on macro cell coverage, which often does not offer proper coverage for indoor environments. One could argue that such coverage could be offered through a Distributed Antenna System (DAS) deployment but the price per square for such a deployment is well beyond that of a comparable Wi-Fi system, as shown below in Table 1.

TABLE 1: Cost per Square Foot of Various Access Network Technologies



Private cellular access (e.g., private 4G/Long Term Evolution (LTE), 5G, etc.) as exemplified by Citizen Broadband Radio Service (CBRS) may provide one potential solution to bring deployment cost down to a more reasonable level but this also presents several challenges including:

- Challenges involved in the deployment of an Evolved Packet Core (EPC)/5G core, which is quite different from current enterprise Information Technology (IT) systems;
- Consideration of complex national spectrum regulations that allocate different bands and frequencies; and
- Challenges involved in sourcing equipment able to operate in the different regulated bands and frequencies.

When connected to a cellular (e.g., 5G) network a device can receive/transmit IP traffic via PDP and when connected to Wi-Fi network a device can receive/transmit IP traffic via the IEEE 802.11 protocol. A potential issue for a client device to utilize both accesses, however, is that most of the time IP subnets for the accesses are not the same and the access gateways are not the same, which creates a challenge to provide seamless roaming among different wireless links and protocols without managing routes on a client device. Any IP changes for the client device can have an impact on user experience and/or application availability.

This proposal provides for the ability to create a Wireless Link Aggregation (WLA) link between a Wireless Link Aggregation Endpoint (WLAE) and a Wireless Link Aggregation Gateway (WLAG) that will allow seamless roaming for a client device, no IP changes for the client device, and no gateway changes. Figure 1, below, illustrates example details associated with a system in which the WLA technique can be implemented.

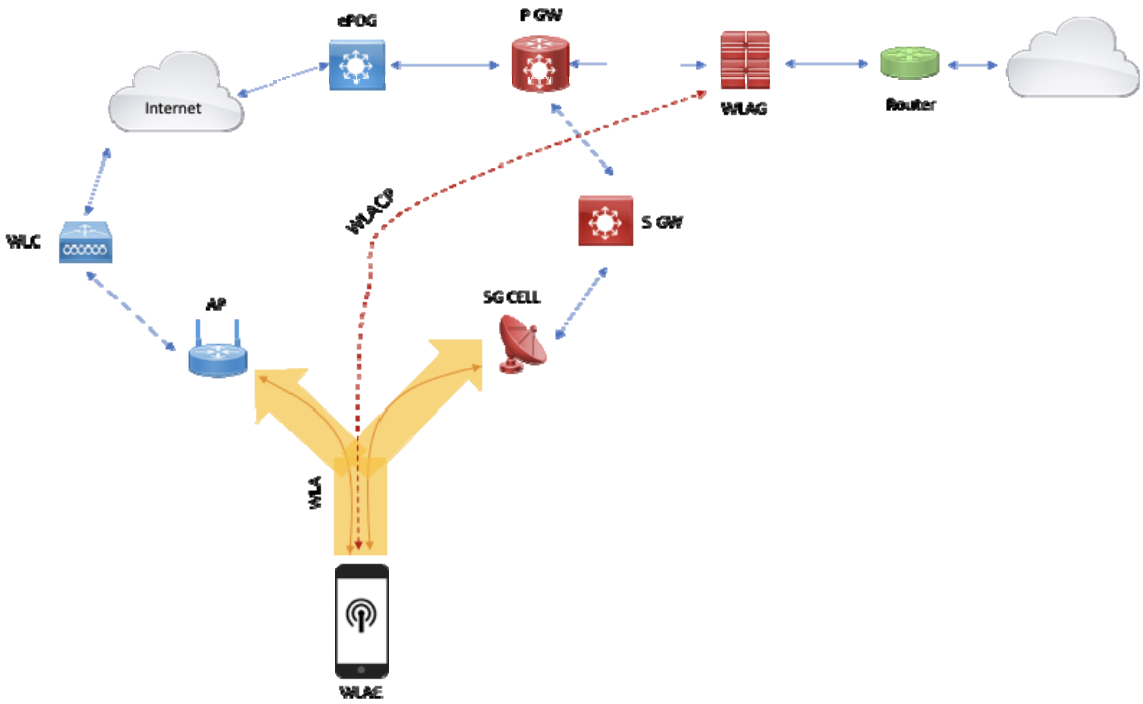


Figure 1: Wireless Link Aggregation System

As illustrated in Figure 1, a WLAE (client device) creates a WLA interface and attaches via several physical IP interfaces (e.g., one for each radio). The cellular operator can deploy a WLAG that will termination link aggregation. The WLA data plane can be implemented utilizing any tunneling protocol and the WLA control plane (WLACP) can monitor the performance of each physical link (e.g., Round-Trip-Time (RTT), jitter, packet loss, latency, etc.) and can balance packet flows for the WLAE based on the monitoring for both the WLAE and the WLAG. In one instance, the WLAE and WLAG via the WLA control plane can adapt the packet load balancer based on physical link characteristics and real-time statistics.

As compared to other technologies, such as Access Network Discovery and Selection Function (ANDSF), ANDSF focuses primarily on authentication and discovery and forces an access point that forwards traffic to communicate directly with a Packet Data Network (PDN) Gateway (PGW) or to use a Layer 3 (L3) gateway of a Wi-Fi/cellular connection, which will cause an IP address change. Further, performance is addressed only as a binary choice between Wi-Fi and cellular.

Advantageously, the system presented herein can leverage Access Network Query Protocol and/or OpenRoaming™ to facilitate service discovery and authentication. Additionally, wireless aggregation can be provided on top of one or more uplink underlays and is data link protocol agnostic. Such aggregation allows a stable, secure connection between a cellular node and the WLAG without involving any specific features for access points. Additionally, such aggregation allows for smart load balancing between several physical interfaces (e.g., cellular and/or Wi-Fi) to increase performance, which could be either throughput oriented or reliability oriented depending on the use case. Further, the IP address is maintained based on the underlay interface.

As compared to content centric networking solutions, techniques herein provide a mechanism to aggregate access links for a mobile device for throughput and reliability use cases and provide for maintaining unique IP addressing across multiple links with respect to the network at large.

In summary, a wireless link aggregation technique is presented herein that allows for seamless roaming, no IP address change and no gateway change for a mobile device that is switched between access links, and enhanced experiences for users.