

Multi-Channel, Multi-Radio Seamless Wireless Mesh Networks

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In an effort with JHU's Department of Computer Science, APL researchers developed a novel wireless mesh network, a communication network consisting of radio nodes organized in a mesh topology. Different from the cellular network, nodes in a wireless mesh network can

communicate with each other directly or through one or more intermediate nodes. A wireless mesh network is a special type of wireless ad hoc network in which the topology of the network is relatively static and nodes are with limited mobility (Fig. 1). Wireless mesh networks provide a unique architecture and extend the connectivity of mobile devices by using multiple access points connected to the Internet and other access networks.

They can provide many mobility applications such as client access, backhaul connection, seamless handoffs in heterogeneous networks, etc. Because of multi-hop transmissions with multiple contending and competing links, wireless mesh networks need more careful and improved design for optimized resource allocation. Furthermore, providing a seamless end-to-end connectivity transparently for mobile clients offers key advantages but has major challenges, especially if no changes are made to the mobile devices.

In this collaborative research project, researchers have been developing novel and improved network resource management and optimization in a wireless mesh network. The team developed a clique-based proportional fair scheduling algorithm with cooperative routing technique to address the throughput and fair-

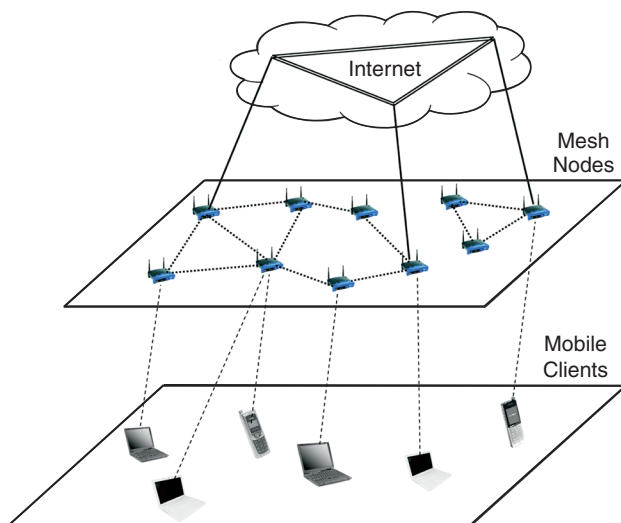


Figure 1. A multi-homed wireless mesh network.

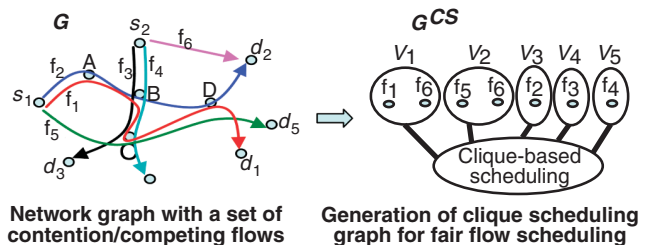


Figure 2. Clique-based proportional fair scheduling algorithm. (Reproduced with permission from Ref. 1 © 2009, IEEE.)

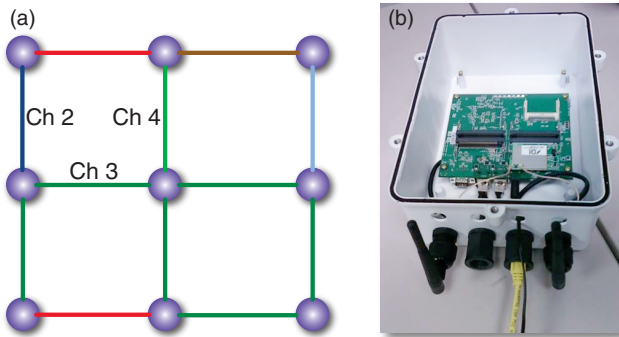


Figure 3. (a) Multiple channels on multiple radios enable a fully connected network. (b) Wireless router with multiple radios.

ness issues to maximize the network utility function (Fig. 2). First, the team developed an analytical model and derived a closed-form solution to quantify the throughput of links and end-to-end flows in a multi-hop network where links are proportionally fairly scheduled. Second, the team considered that each network node is equipped with multiple radio interfaces and is capable of operating among multiple channels (Fig. 3a). The team explored this multi-channel, multi-radio capability to reduce the collisions and interference caused by intra-flows and inter-flows, dramatically improving the network throughput and performance. The team has been developing a novel joint channel assignment and routing algorithm to optimize the network throughput and performance.

The team has developed a wireless research test bed at APL using the JHU-developed architecture and protocols called SMesh, the first transparent wireless mesh system that offers seamless, fast-handoff, real-time applications such as interactive Voice Over Internet Protocol (Fig. 4). In SMesh, the entire mesh network is seen by the mobile clients as a single, omnipresent access point, giving the mobile clients the illusion that they are sta-

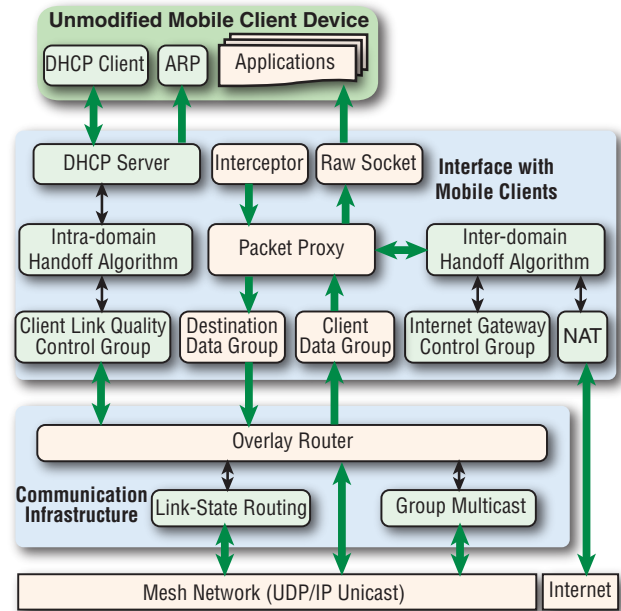


Figure 4. The SMesh architecture.

tionary. Multicast is used for coordination among the access points and involves more than one access point to handle the moving client during handoffs. SMesh provides a hybrid routing protocol that optimizes routes over wireless and wired links in a multi-homed environment. The team has shown experimental results on a fully deployed mesh network demonstrating the effectiveness of the SMesh architecture and its intra-domain and inter-domain handoff protocols. Furthermore, the team has built a research test bed based on the SMesh architecture to incorporate the network node with multiple radios operating at multiple channels (Fig. 3b). This research test bed provides a useful tool to demonstrate the effectiveness of resource management in a multi-channel, multi-radio wireless mesh network.

For further information on the work reported here, see the references below or contact qinqing.zhang@jhuapl.edu.

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