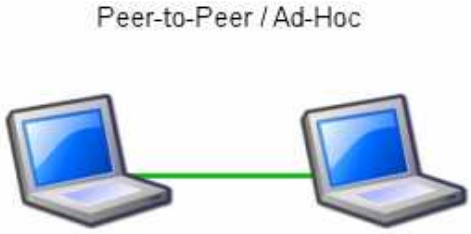
i250 Spring 2010
Christoph Boden

Urban Mesh Networks

Wireless urban mesh networks are large scale mesh networks that are deployed in metropolitan areas to provide internet access without having to rely on the ominous "last-mile" or to facilitate community networks that can provide educational resources or an open space for social and cultural exchange. This report first provides a short overview of the technology behind mesh networks and then gives brief overview of areas of application.

1. Overview of the Technology

The traditional of operating of a wireless LAN known as infrastructure node is given by multiple individual hosts (mobile units) connected to a central access point which serves as abridge to a wired network and frequently also as a gateway to the internet. But every WLAN device is also capable of what is called the ad-hoc mode. In this mode each host connects directly with other hosts within its range and transmission is done in a peer-to-peer fashion. In this decentralized layout, there are no routers and communication is limited to nodes that are within communication range of each others. To be able to communicate to more distant nodes, the devices also have to take over routing responsibilities. The resulting structure is called a wireless mesh network.



The central challenge in these networks is to find a feasible routing algorithm that performs well under the special conditions of wireless ad-hoc networks. One approach is known as the Optimized Linkstate Routing Protocol (OLSR), which is a proactive version of a linkstate routing protocol tuned to the needs of mesh networks. It is proactive in the sense, that each node proactively probes the topology of the network by sending "hello messages" uses this information to route packets along the shortest path. Unfortunately it turned out that this approach does not scale when trying to build large mesh networks. It becomes infeasible to keep a local copy of the topology in every host because the shortest path calculations become impractical. Furthermore the approach does not account for the quality of links, leading to the slightly ironic result, that the shortest path often runs along the longest individual links – which due to the physical nature of the wireless transmission have the poorest quality, thus leading to severe package loss.

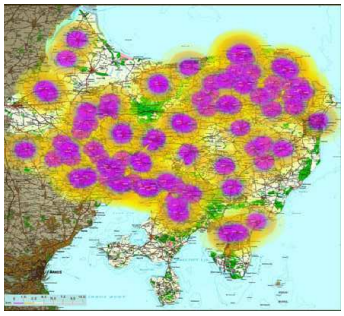
To address these issues a protocol called a "Better Approach To Mobile Ad-hoc Networking" or B.A.T.M.A.N has been developed. The central idea is to distribute the topological information of the network. Each node only contains a small amount of the information, essentially what nodes in the network can be reached via which direct neighbor. The route of a packet is thus determined by every single router along the way – and might not follow the shortest path. It seems to scale better than other approaches.

2. Applications

In a metropolitan environment, wireless mesh networks can be a viable alternative to a physical network infrastructure which comes with enormous costs of deployment. They might also be used in cases of emergencies as they can be rapidly deployed even after the existing infrastructure ceased to function.

As a possible business case one could imagine an Internet Service Provider that chooses to provide internet access via a mesh network rather than using physical communication networks and get drawn into the last-mile tussle. Also numerous initiatives aiming to provide open citywide community networks have formed worldwide – for example the “Freifunk” Community in Germany - a non commercial open initiative to support free radio networks in Germany. These communities rely mostly on volunteers and activists. They are also active contributors of open source developments in the area such as the OpenWRT router operating system or the already mentioned B.A.T.M.A.N protocol.

In Djursland, a remote rural area in Denmark for example 9 wireless community networks provide broadband access to the Internet at to more than 3.000 households. Large ISPs deemed investments in Infrastructure to provide Internet access as not economical and thus refrained from connecting them are to the internet. Only a local hospital was equipped with a T1 line. After it closed down, community activists started to develop a network based on this node and started the project.



References:

http://en.wikipedia.org/wiki/Wireless_mesh_network
http://en.wikipedia.org/wiki/Mobile_ad-hoc_network
http://de.wikipedia.org/wiki/Optimized_Link_State_Routing
http://en.wikipedia.org/wiki/B.A.T.M.A.N.
http://www.open-mesh.net/
http://wndw.net/pdf/wndw2-en/wndw2-ebook.pdf
https://www.opensourcepress.de/fileadmin/osp/pdf/mesh_leseprobe.pdf (in German)
http://bildungsserver-ohz.de/fileadmin/Docs/presentation_denmark.pdf
https://freifunk.net/ (in German)