EPM in WLAN paper analysis

Article 1. Investigating Depth-Fanout Trade-Off in WiMAX Mesh Networks

In a more recent release WiMAX (IEEE 802.16d),the standard has been extended, introducing the mesh mode to let Subscriber Stations (SSs) communicate through multi-hop transmissions. In its basic version, the mesh mode relies on a centralized approach that organizes all the nodes of a WiMAX network in a tree structure rooted at a particular node, namely the Base Station (BS).

The length of the links (in meters) significantly affects the bitrate.

We model the traffic demands of a WiMAX mesh tree architecture and we evaluate the trade-offs between the depth and the fanout of such a structure. Deeper trees have shorter links with higher bitrate.

Knowing the importance of allowing simultaneous transmissions in WiMAX mesh networks, we focus our work on exploring the impact of splitting direct long communications of fat trees (small depths) into multiple shorter ones (deep trees). We show by simulation that increasing the depth while reducing the fanout may increase, at least in some cases, the capacity of the WiMAX backbone even without allowing concurrent transmissions.

WiMAX mesh trade-offs

When mesh mode is employed, the network is still formed by a BS and many SSs.

The traffic can now occur directly between SSs and may be relayed by intermediate nodes (both uplink and downlink). The BS can also be the gateway between the WMN backbone and the Internet.

SS communicate with each other and transfer their neighbors' traffic through these links. Each SS must have at least one path towards the BS. In our study, we consider the WiMAX mesh tree on which the BS schedules the transmissions in a centralized manner. We suppose that all SSs are in the BS range and we study the depth-fanout trade-off of this architecture.

Increasing the depth (i.e., decreasing the fanout) reduces the distance and hence increases the bitrate on the different links. Moreover, it lowers the transmission power needed and hence interference decreases, which may improve spatial reuse for concurrent transmissions.

Reducing depth (i.e., increasing fanout) reduces the number of relay transmissions of the same data packet as well as control overhead.

Bitrate vs. Distance

IEEE 802.16 standard adapts different modulations and coding techniques on different transmissions, which implicitly implies different bitrates that can be attained. In other words, the data rate decreases as the link distance increases. On the other hand, increasing the tree depth means increasing the number of hops required to reach the BS, which in turn reduces the average hop distance (in km) leading to an increase in the average link bitrate. Moreover, it also affects the transmission power needed to attain the next hop, which becomes smaller reducing the interference.

The overall bitrate on some long links would be better if they are split, in other words, if the communications between sources and destinations on these links utilize intermediate SSs to rely their data.

Article 2. Hybrid WiFi-WiMAX Network Routing Protocol

Comparsion of WiFi and WiMAX

WiFi

WiFi's advantages include:

- its use of a non-licensed frequency band.
- its fewer international regulatory restrictions.
- its infrastructureless architecture that allowsfor ubiquitous functioning and dynamic growth.
- its low cost.
- its mobility without network connectionbreaks.

WiFi's disadvantages include:

- its use of the 2.4GHz spectrum, which is susceptible to interference.
- Its higher energy consumption when compared to other standards.

WiMAX

Some important characteristics of WiMAX include:

- its use of the microwave frequency band for wireless data transmission
- its high transmission speed over long distances.
- its use of OFDM (Orthogonal Frequency Division Multiplexing) to enable non-line-of-sight communication.
- its multi-channel support for TDD (Time Division Duplex) and FDD (Frequency Division Duplex)
- its flexible handling of channels in the 3.5MHz, 5MHz and 10MHz frequencies.

Some challenges for WiMAX include:

- reaching a coverage area of up to 10 miles.
- providing wireless broadband and dedicated links.
- making the technology more affordable.
- allowing access from more remote areas.

Some of the challenges facing WiMAX include:

- Элемент ненумерованного списка improving the signal propagation mechanism because using the atmosphere as the transmission medium has several problems.
- increasing the range of band frequencies to provide service to a larger number of users.
- providing adequate quality of service for a greater variety of applications.
- allowing for increased mobility either through roaming or handoff.
- meeting the demand for greater portability by lowering power consumption or increasing battery efficiency.
- offering improved security for devices that use different services.

Integration

Ali-Yahiya et al. propose an architecture where the WiFi and WiMAX networks and their traffic routes are separated by dedicated gateways to provide interconnectivity [6]. The main characteristic of this architecture is that it employs an overlapping area between a WLAN and a WMAN hotspot, where they interconnect at a BS and an AP. The WMAN coverage area expands using the WLAN hotspots. More than one AP can be located near the limit of the WMAN's coverage area. The authors assume that WiFi network APs are connected to the WiMAX network by means of a gateway that permits bidirectional interconnectivity. [6].

To better integrate WiFi and WiMAX technologies, it is important to identify the differences between them, including:

- Элемент ненумерованного списка WiFi channels use a specific band frequency while WiMAX permits users to select the channel requirements.
- WiMAX uses licensed frequencies while WiFi employs unlicensed ISM frequency bands.
- WiFi has a range of approximately 10m while WiMAX can cover several kilometers.
- WiMAX is a MAN protocol that provides an alternative to DSL and cable modem technologies, providing broadband access for the last mile as it acts as a backbone for WiFi hotspots.

The goal of our algorithm is to afford users of ad hoc network broadband service using devices that can select the best route in terms of bandwidth, battery residual energy and distance. Figure 2 shows how a WiFi node accesses a WiMAX network. The proposed protocol can carry out the necessary hops to send and receive data within a WiMAX network. If, a connection is broken, the algorithm is designed to automatically reconnect. Figure 3 provides an example of a service connection from a WiFi node physically located inside a MANET network that requests broadband services from the WiMAX network. The algorithm is based on the Ad-hoc On Demand Distance Vector (AODV) protocol modeled in OPNET. The following scenario presents a node that functions as a BS/AP gateway.

Article 3. Energy-aware WLAN scanning inintegrated IEEE 802.16e/802.11networks

Vertical handoff (VHO), i.e., handoff across heterogeneous access networks, is considered a key feature to bring the next-generation wireless communication era. Especially, along with the introduction of the 802.16e service,1 the interworking with WLANs, of which a commercial service has been operational for years, also attracts great interests.

Many of challenging issues are involved in VHO: target network discovery; VHO decision criteria; efficient IP-layer protocols for mobility management, and so on [7]. We in this paper focus on finding target networks. Espe- cially, assuming that the 802.16e network is always reachable anytime and anywhere,2 we just pay attention to the way how to find WLAN APs.

1. …mobile station (MSTA) always monitors the availability of nearby WLAN APs by attempting to detect the WLAN signal.
2. …an MSTA moves only within a specific region, where at least one of WLAN APs is reachable

…keeping the scan operation of WLAN without any guideline can be practically a bad idea in that MSTA is usually battery-powered. Since WLANs are of- ten deployed for hotspot services with spotty service coverages, keeping the WLAN interface turned on could often mean an inefficient use of energy [8].

A straightforward approach to resolving this issue is to make the MSTA informed of the existence of WLAN APs directly by the network side instead of relying solely on the individual scan operation of MSTA.

We propose a WLAN scanning algorithm, which uses the baseline scanning protocol specified by IEEE 802.11 standard [11] without an additional terminal module like GPS and enables the MSTA to manage the WLAN interface without human intervention. Especially, the proposed algorithm can statistically guarantee the scanning time needed until at least a WLAN AP is found.