Robustness in Wireless LAN

A SpectrumConsult white paper

Rev 1
The need for robust wireless LANs

Since many years, the use of wireless LANs has been expanding from the usual home and office networks. Instead of being just convenient, they have become business tools that frequently support mission critical applications. Frequently, the network performance required by a given mission critical application is expressed in a “service level agreement” or SLA which specifies such factors as throughput and availability. Mission critical applications may differ widely in their demands on the network – some require high throughput, others require extensive coverage. However, one requirement is common to all: robustness of the communications services provided by the wireless LAN. A robust network means that the services and connections provided will always be available and at an adequate level.

Factors that affect network robustness

The performance of any connection in a wireless network depends on a number of factors. These include the obvious ones such as non-wireless LAN interference, RF power, distances and obstacles. Equally important are the number of devices operating on the same channel and in range of each other, the transmission frame size, the minimally required transmission rate(s) and their related signal to noise + interference (SNIR) requirements, as well as asymmetries in RF visibility of devices on the same channel. The latter can hide nodes from some of the other nodes and so cause collisions. Non-wireless LAN interference may come from sources on the local premises or from external sources. The former can be managed; the latter have to be accommodated.

Another important factor is mixture of client devices. Adoption of smartphones and tablets as business tools and the emerging BYOD policies have resulted in a plethora of different devices being used concurrently. Wi-Fi technology is based on the unstated assumptions that all devices have the same RF properties and that the RF environment is basically flat – that is homogeneous in all directions. In today’s mission critical networks neither of these assumptions apply and therefore the robustness of wireless LANs is frequently impossible to maintain. A clear example is a hospital network that has to support heart monitoring devices, Wi-Fi phones and regular laptops and even desktops. Assuring that the heart monitoring applications always maintain connectivity is a challenge that is hard to meet.

Designing a robust wireless LAN

Many network vendors offer tools and management facilities to optimize the operation of a wireless LAN network. An example is the “clean air” technology and associated software offered by Cisco, including automatic optimization of RF channel settings. Other vendors have related offerings of various capabilities. Such capabilities may help understanding external interference conditions, but they fall short when it comes to optimization of the robustness of the network.
Commodity Wireless Technologies and Radio Regulations

and SLA assurance. The main reason is that vendors have little or no control over the actual deployment and operating conditions of the wireless LAN network, vendors are not in a position to offer any assurances related to network robustness nor SLAs.

A robust wireless LAN network delivers the performance required by the SLAs of the applications that use the network and under given conditions. A good network management tool will be designed to take all factors that impact actual network performance into account. This must be applied to every connection between any two wireless LAN devices so that the true performance of the wireless LAN network as a whole can be determined with confidence. Because the traffic sources are assumed to be fully buffered, the network performance so determined in fact provides a lower bound. At lower traffic loads, individual users will see a higher level of service.

Assessing network performance by trial and error is a time consuming effort fraught with risks and inconvenience to users. Ideally, a network management tool offers two assisted planning modes: automated planning of new deployments and deployment plan updating. The latter proceeds from the installed network. Assisted planning offers a number of optional criteria for optimizing network performance: highest overall throughput, highest minimum access point throughput, best coverage and least number of access points. Together with comprehensive reporting per access point and per network, the network manager gets detailed insight into the network’s estimated performance so that the feasibility of SLAs can be checked before the network is put into service.

Maintaining wireless LAN robustness
Network performance can be degraded by equipment failures and by interference. Access points may fail occasionally, neighbors may install or change a wireless LAN network and interference from other sources may impact all or part of a wireless LAN network. Manual checking network performance is time consuming and error prone. Therefore automated performance monitoring – also called auditing - is necessary. Ideally, a wireless network management tool provides a real-time performance audit and optimization capability. Auditing keeps track of actual performance and conditions of a network or subset thereof; optimization adjusts the network parameters so that performance is maintained or improved to meet service demands.

The audit can be performed by an overlay network of sensors which report to a central entity or it can leverage the reporting facilities built into many network controllers. In both cases data like signal levels transmission rates, channel loading and interference levels can be collected and used to check network performance against the requirements, including SLAs. In case of significant divergence network management staff can be alerted and remedial action proposed. As experience is gained with this type of capability, automated optimization action may be implemented. Thus, network related OPEX can be reduced and valuable expertise can be freed to address more productive matters.

Network Tuning with Channel management or RF Power management?
The choice of RF channels and RF power levels has a major impact on wireless LAN performance and knowing how they affect performance helps to maintain and tune the network’s performance. A common approach to planning a wireless LAN is to assure coverage of every bit of floor space by at least one access point at some level of RF power that is required for the
desired transmission speed. This assures that a client will always be able to connect at the desired speed but it says nothing about the actual throughput: Wi-Fi is built on channel sharing and therefore other activity on the channel determines actual throughput. Minimizing co-channel activity means avoiding multiple APs operating on the same channel and in range of the same clients.

In other words, keep neighboring APs from using the same channel and if the same channel has to be used the APs should be kept at distance from each other. The necessary distance goes up with the desired data rate: higher data rates mean a higher SNIR and therefore a lower interference tolerance. The difference in required SNIR between the lowest and the highest data rates can be as much as 20dB. That is easily achieved with channel separation – even co-located transmitters on adjacent channels are at least 28dB weaker than the wanted channel. Dropping RF power by that amount does not help because it drops the operating range to a few meters.

The question above is therefore easily answered: channel separation beats power reduction hands down. Therefore, wireless network tuning and optimization should focus on channelization; RF power management provides marginal benefits at best. This is borne out in practice as well as in simulations, e.g. using WiTuners’ Optimization function. The reference case is the lower floor of a hotel with a lobby, a restaurant and a few meeting rooms, by and large a fairly open, RF transparent environment. A wireless LAN with 7 APs serves this floor. As installed the network provides 72Mb/s. Dropping the RF power by a factor 10 – 10dBm increases the throughput to 84 Mb/s – about 16%. Keeping RF power at 20dBm and optimizing the channelization yields 106Mb/s – about 50% better than the reference case. Dropping RF power to 10dBm in this channel plan increases throughput to 143Mb/s – that is another 32% on top of the channel optimization and almost 100% on top of the reference case. A very similar result is obtained in a less transparent environment: channel optimization beats RF power optimization. RF power optimization based on throughput may very well result in a few areas being less well illuminated or even in coverage holes. If a wireless network doubles as a client location system than the RF power tuning is best based on coverage. The optimized RF channel plan will assure throughput performance.