Tech Note: Using DOT11 Monitor to Validate Wireless Network Design and Engage a Service Level Agreement

4-25-2008

Wireless networks are becoming ubiquitous. Emerging wireless standards (such as IEEE 802.11n) promise enterprise mobility with network access speeds comparable to wired networks. That promise will be broken if the wireless network is not properly designed. A component of the wireless design is a *physical site survey* or *simulation.* With a physical site survey, RF signal level measurements are made throughout the facility as an infrastructure access point is moved through the facility in a structured manner. With a simulation, building specific parameters are entered into the simulation software, which then predicts RF signal coverage based on propagation models. Accuracy of either approach is dependent upon the number of measurements made (for the physical site survey) or time spent on modeling the building (for the simulation software).

Once the design is complete, the infrastructure is “built-out”, and users are free to begin wirelessly connecting to the LAN. But how can the network “owner/operator” (network or system admin) validate the initial wireless network design? How can the owner monitor for RF coverage or interference problems during operation? Can the network owner request a coverage warranty from the wireless network designer, and more importantly, can the owner detect defects in the warranted design? Can the network owner request a Service Level Agreement (SLA) from the network designer or operator, and have a way of enforcing that service level agreement based on agreed upon metrics?

Many telecommunications companies offer an SLA that guarantees availability and data throughput for Internet services. These metrics can be measured at the point at which the telecommunication service reaches the premise. For the wireless LAN, with multiple dissimilar client devices running different O/Ss with different applications and hardware, quantifying uptime and throughput will be troublesome. But the network owner, using DOT11 Monitor, can monitor RF connectivity, signal level, and interference, and thereby has a means of quantifying operational availability and throughput.

As shown in figure 1, DOT11 Monitor queries the network infrastructure wireless access points for metrics, including the Received Signal Strength (RSS) from the client devices, and the Signal to Noise Ratio (SNR) for each client. DOT11 Monitor stores these values in a database, and can plot them against user-defined thresholds, over user-selected time-frames.

Other wireless LAN monitoring systems use overlay sensors, or laptop plug-in hardware and software for walk around spectrum analysis. These systems have their respective applications. The overlay sensors can be used for wireless Intrusion Detection Systems (IDS) to protect the network, and the walk around spectrum analysis tools can be used for the initial site survey and to find the location of interference sources. But for the purposes of monitoring operational wireless network connectivity over time, and generating concrete metrics of RF coverage, the DOT11 Monitor is the only available tool.

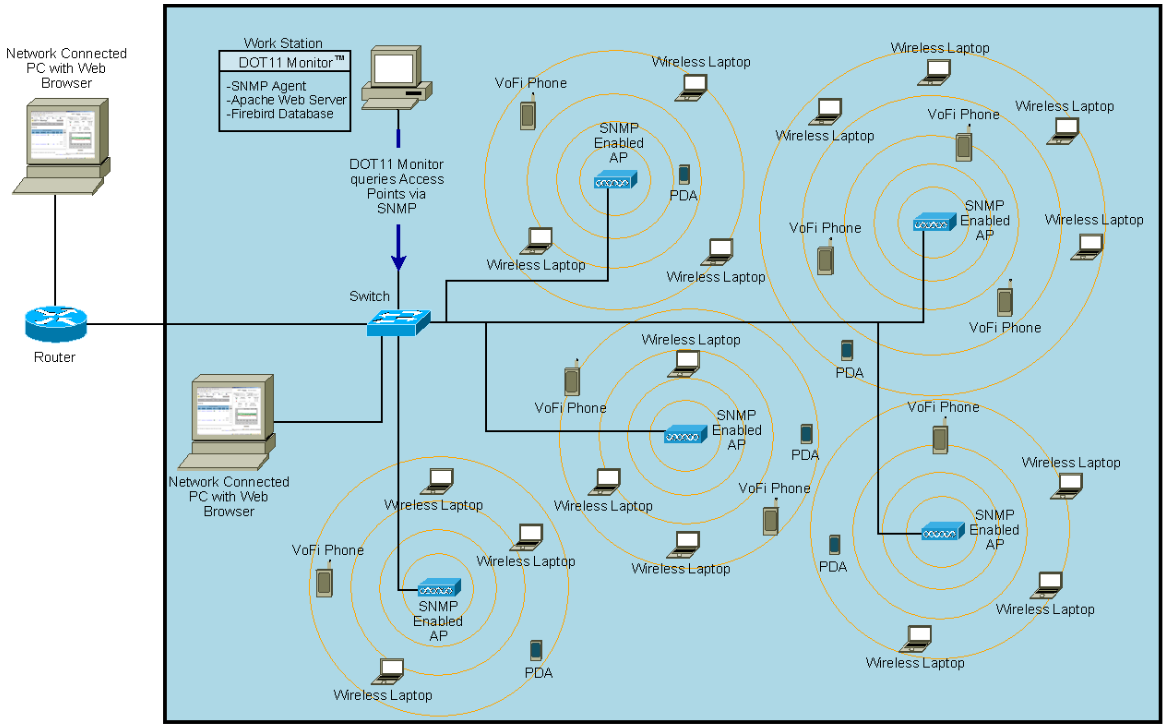

Figure 1 DOT 11 Monitor Architecture

Service Level Agreement for Wireless LAN

Typically, the wireless network owner will require an RF coverage warranty from the wireless network designer. The network owner should also require a service level agreement (SLA) from the wireless network designer or operator, if the operator is different from the owner. The SLA should be founded upon agreed upon, easily quantified statistical metrics. The SLA may have terms such as “the wireless network RF coverage shall provide an RSS equal to or greater than the (agreed upon) threshold at least 98% of the time (availability), and shall provide an SNR (which can be correlated to throughput) equal to or greater than the (agreed upon) threshold at least 98% of the time, over any 24 hour period”.

Since DOT11 Monitor is actually querying the infrastructure access points for these values, there is no better way to monitor network performance.

Service Level Agreement: Measuring Availability

Figure 2 shows the DOT11 Monitor report for RSS (availability) over the last 2 hours. One of the client devices (shown by the blue cross-hair) is commonly below the user-defined threshold, shown as a red line (the –70 dBm threshold “red-line” is the original network design parameter, which the network designer and operator have agreed upon). When a client device is below the threshold red-line, it has lost the desired RF connectivity, and is therefore considered “unavailable” (even though it may still be associated to the access point).

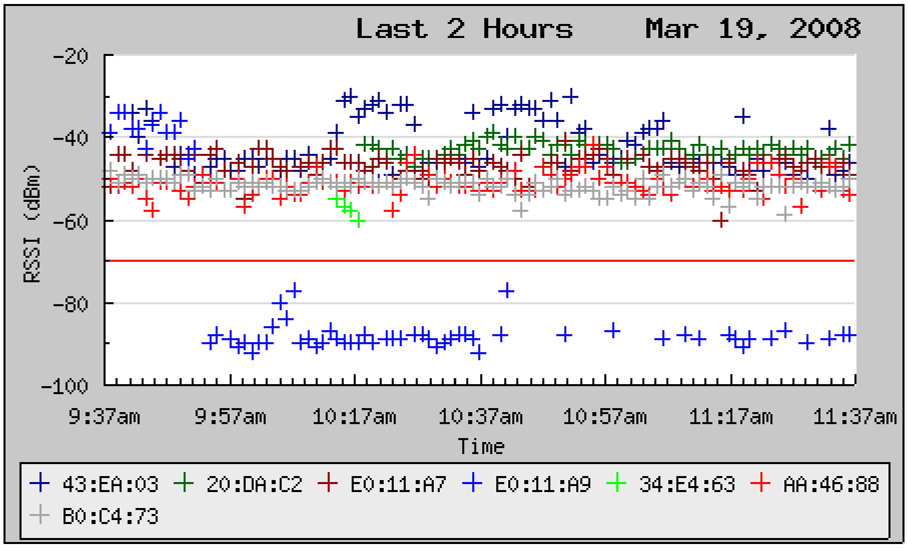

Figure 2 – Received Signal Strength (RSS) of 7 network connected client devices, the 7 device MAC addresses are in the legend

Since DOT11 Monitor has revealed that one client device appears to have poor RF connectivity, the network operator can have DOT11 Monitor compute the statistics of network availability over a longer period of time (up to 1 month). Figure 3 shows the RF availability (RSS) for the wireless network analyzed over a 24-hour period. RF availability is shown in the lower right-hand corner of the figure. Counts above the red threshold line are "available". Counts below the red threshold line are "unavailable", according to this design agreement. Over this 24 hour period, the RF availability is 4,055/ 4,161 = 97.47%. This is below the SLA of 98%, and the network operator would be warranted to have the network designer correct the problem. DOT11 Monitor has already revealed the client device which has the poor RF connectivity (in figure 2), so the network designer can address the identified client device to fix the problem.

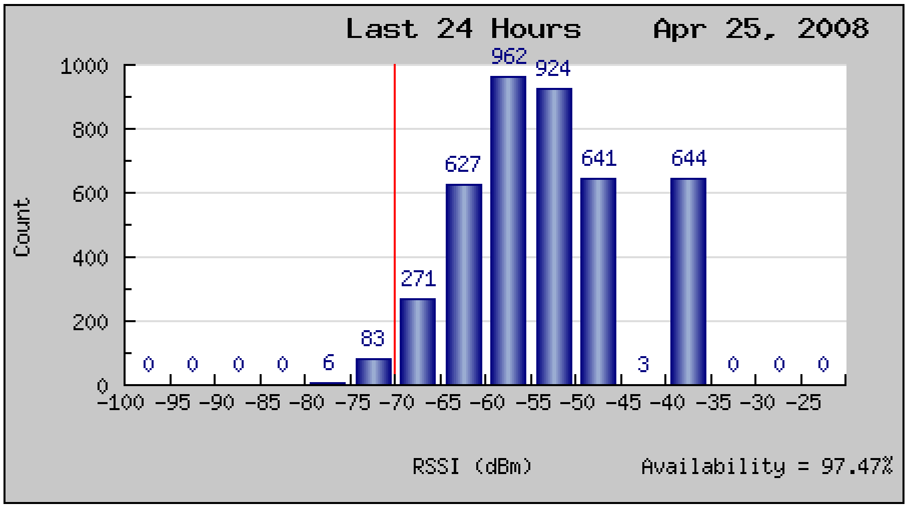

Figure 3 – Wireless network "availability" statistics

Service Level Agreement: A Quantifiable Data Throughput metric

Oberon's DOT11 Monitor is able to provide the network owner with comprehensive, quantitative, metrics for wireless network RF coverage. These metrics can be charted over time, compared with acceptable thresholds, and computed to yield uptime and connectivity statistics for the entire wireless LAN. These statistics are true, accurate, repeatable measurements of network RF connectivity. These metrics can serve as the basis for a service level agreement, since the network designer will design to the very same metrics that the network operator will monitor. DOT11 Monitor enables this by allowing the operator to plot the exact same metrics (RSS and SNR), to which the network was designed.

Conventional data throughput testing does not lend itself to enforcing an SLA in a wireless local network. Data throughput tests consist of running file transfers from a client device, through the wireless network, to a test station PC. However, such tests components are completely out of the hands of the wireless network designer, and do not provide clearly understood, repeatable results which can be used to enforce an SLA.

The problems with the conventional data throughput test are:

- Data throughput sensitivity to the test client device hardware, driver, and configuration
- Data throughput sensitivity to the test client O/S and processor
- Data throughput sensitivity to the host test station O/S and processor
- Data throughput sensitivity to the application running the test
- Misunderstanding about the difference between the wireless equipment vendors specified "signal rate" and actual data throughput.
- The need to perform data thoughput tests in a controlled environment. I.e. each time the test is performed, the same number of client devices are available, at the same distance, transmitting the same power, and interfering sources do not change.

Clearly, with the conventional data throughput test, many parameters are out of the hands of the network designer, and the designer cannot be held accountable for these variables.

DOT11 Monitor can measure Signal to Noise Ratio (SNR), which can be correlated to data throughput. On any wireless device, the transmission signaling rate is adjusted (usually automatically) depending on the SNR. A better SNR provides for a higher data rate, as shown in the chart below . This is true for 802.11a, b, g, and n devices. Regardless of the wireless technology used, SNR provides a verifiable metric to which the network owner and the designer can agree.

802.11g SNR (dB)	Wireless "Signaling" rate (Mb/s)	Actual data throughput (approx.) Mb/s	802.11a SNR (dB)	Wireless "Signaling" rate (Mb/s)	Actual data throughput (approx.) Mb/s
4	6	2-3	8	6	2-3
9	9	3-4	9	9	3-4
13	12	4-5	10	12	4-5
15	18	6-8	11	18	6-8
18	24	9-11	12	24	9-11
22	36	12-14	17	36	12-14
23	54	18-24	23	54	18-24

Chart is for example only. This example assumes –96 dBm interference level. Based on sensitivity specifications for Cisco 1242 access point. Actual data throughput is an estimate for each client device, assuming no simultaneous contention for the channel. Actual data throughput is dependent on hardware, drivers, application, and host O/S. Wireless data throughput is typically less than ½ the vendor specified signaling rate at any SNR

Figure 4 shows the DOT11 Monitor report for SNR over the last 4 hours. One of the client devices (shown by the blue cross-hair) is below the user-defined threshold when first turned on, shown as a red line (the 15 dB SNR threshold "red-line" is the original network design parameter, upon which the network designer and operator have agreed). When a client device is below the SNR threshold red-line, the data rate for that client device will be "non-compliant".

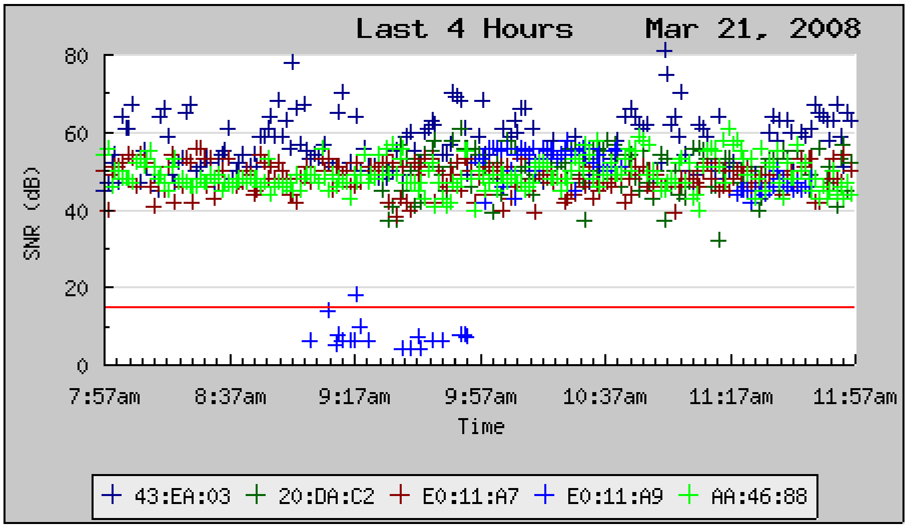

Figure 4 – Signal to Noise Ratio (SNR) compliance of 5 network connected client devices, the 5 device MAC addresses are in the legend. SNR can be correlated to data rate.

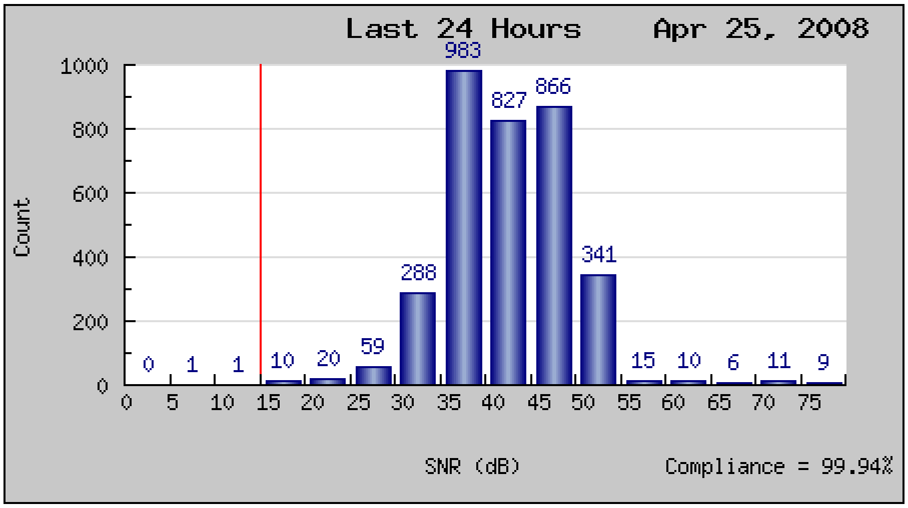

Figure 5 – Wireless network SNR compliance statistics

Since DOT11 Monitor has revealed that one client device appears to have poor RF SNR (over a short period of time), which will result in lower data throughput than desired, the network operator can have DOT11 Monitor compute the statistics of SNR over a longer period of time (up to 1 month). Figure 5 shows the RF SNR for the wireless network analyzed over a 24-hour period.

Counts above the red threshold line are “compliant”. Counts below the red threshold line are “non-compliant”, according to this design agreement. Over this 24 hour period, the SNR is compliant 3,445/ 3,447 = 99.9% of the time (shown in the lower right hand corner of the figure). This is above the SLA of 98%, and suggests that, although one client device has a low initial SNR when it is turned on (as shown in figure 4), over a 24 hour period the SNR is compliant, and no corrective action is required.

Managing Client Device Transmit Power for Design Compliance.

When the design criteria for the new wireless network are established, the network operator and network designer will agree upon the infrastructure access point transmit power setting to be used in the design. This is true for both the wireless site survey and the simulation approach to design. When the wireless LAN goes into service, the access points will be configured to the design criteria transmit power setting.

However, the wireless client devices nominally will not have the desired transmit power setting. Ideally, the best setting for client transmit power is identical to the access point transmit power setting. Since in a typical office environment the communication channel is reciprocal, the loss in the downstream path is the same as the upstream path. So if the client device transmit power setting is lower than the access point setting, the access point will receive a low signal level (as will be revealed by DOT11 Monitor), even though, by design, the client receives adequate signal from the access point. If the client device transmit power setting is higher than the access point transmit power setting, the excess transmit power is really nothing more than undesirable RF interference to other network connected devices.

DOT11 Monitor provides a means to set both access point AND all network connected wireless client device maximum transmit power settings. Figure 6 shows the RSS from 6 client devices. The client devices have initially been configured with a low transmit power, resulting in marginal or below “red-line” threshold performance. Through the DOT11 Monitor interface, all of the client devices have been commanded to a higher transmit power level to achieve higher availability.

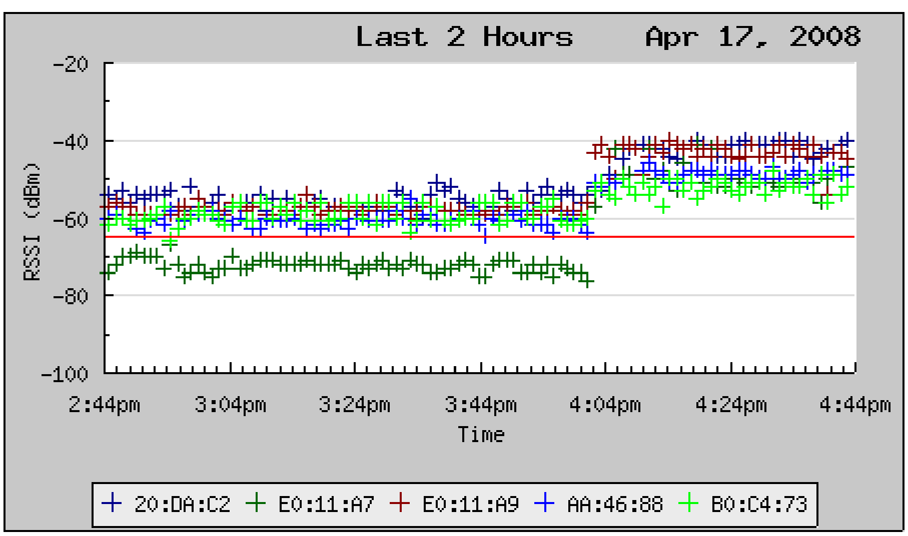

Figure 6 – DOT11 Monitor used to set client transmit power level