Intelligent Remote Power Amp Monitoring

Kentrox's Optima Site Manager & R&D Microwaves Intelligent Line Monitors

by R&D Microwaves

Until recently, network operators have addressed base station equipment failures at cell sites in one way – they dispatch a field technician to the site only after a problem has negatively impacted wireless subscribers. While service providers have deployed additional equipment to support traffic growth and reduce failures, fewer service personnel are available to repair and manage remote and geographically dispersed cell site assets. As a result, there is an increased need for more sophisticated, proactive monitoring methods that remotely measure and track degradations in wireless network performance. Driven by increased competitive pressures and consumer demand for improved wireless call quality, uptime and network performance, service providers need a more intelligent solution for cell site monitoring, control and management.

A newly released automated monitoring solution that proactively monitors and diagnoses base station equipment provides an alternative to the reactive methods currently used by service providers. Kentrox, a network infrastructure solutions provider, has incorporated R&D Microwave's Intelligent Line Monitors (ILMs) in its' Optima Site Manager solution to collect and report on raw data for an almost unlimited number of network and physical site elements across the network. In addition to threshold alarms, the ILMs collect, track, store and report on performance at Optima Site Manager equipped cell sites. This capability enables operators to rapidly diagnose problems and evaluate what preventative or corrective actions should be taken to avoid network performance degradation or service interruption. By preventing base station equipment failures altogether, wireless network quality, availability and performance improve. This has a positive impact on subscriber retention and lowers the service provider's maintenance and repair costs.

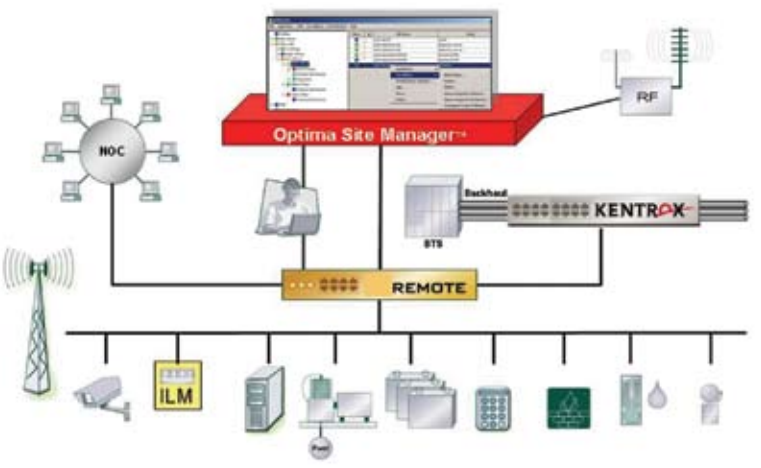

Figure 1: Optima Cell Site Solutions: 360º Management View

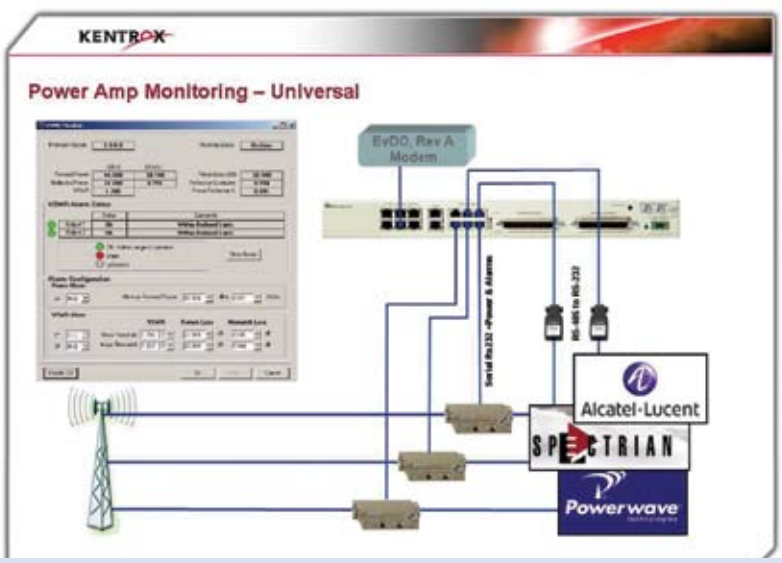

Figure 2: Universal Power Amp Monitoring

To optimize wireless network quality and performance, radio frequency (RF) site antenna monitoring with ILMs and applications such as Optima Site Manager, should be fully integrated with existing network management systems to assure compatibility with and interoperability between infrastructure elements ranging from RF to the final display. To have meaningful, actionable data, each site infrastructure element is precisely measured and tracked by R&D Microwave's ILMs over time. This includes monitoring the output and performance levels of the primary transmit power of the base station as well as the antenna voltage standing wave ratio (VSWR). In order to accurately report and depict the status of the RF transmitter and antenna performance, the RF data must be sampled at the location of the antenna then converted to a format that can be communicated and transferred to a remote location for further analysis. In addition to pro-active alarm information, performance of amplifiers, antennas and other components within the cell site can be collected and tracked for trend analysis and performance processing at remote locations and at network operations centers (NOCs).

Power levels and antenna integrity measurements are critical to knowing how each cell site performs during the course of its operational lifetime. As technology has evolved, some of the features inherently provided by base stations still lack desired functionality or have been phased out in favor of equipment with increased traffic bearing capacity. This means wireless carriers have limited or no RF or operational management visibility to the power amplifiers and antennas. Optima Site Manager solves this issue by supporting connections to the power amplifiers and antennas by use of "Intelligent Line Monitors"(ILMs). These monitors provide precise measurements of both RF forward/reverse power and VSWR. Optima Site Manager then uses the contact closures provided by the ILMs to interpret and report the status. Site Manager also uses its' serial interfaces to connect directly to the ILMs, providing real time links to the ILMs for remote site monitoring and management.

Equipped with R&D Microwave's ILMs, Optima Site Manager's monitoring capabilities consist of: a directional coupler; RF to digital data conversion capabilities; and a system-wide infrastructure and data reporting network.

Optima's use of the Remote module works in the following way:

1. The ILM is connected into the RF path at the remote site and locally provisioned with alarm and site information;
2. Optima Remote connects to both the alarm output points and to the serial port of the ILMs;
3. Optima Remote is then configured to report alarm outputs from each ILM via SNMP and to provide terminal server access to the ILM for in-depth access and visibility;
4. Optima Remote actively scans alarm inputs for any

change of state;

5. Once an alarm indication is received, Remote forwards an SNMP trap alerting the NOC, operations staff and RF performance that there is a VSWR or power alarm present; and
6. Staff then use Optima to organize, navigate and view the prioritized remote alarms and access the ILM's using its' virtual connection capabilities.

The ILM independently samples the forward RF transmit power and the reverse power that is reflected by the antenna. It must sample both forward and reverse powers with an absolute minimum amount of interaction between the forward and reverse powers in order to determine the exact ratio of the forward and reverse powers and resulting antenna VSWR. The specification that defines this performance is commonly referred to as the directivity of the directional coupler. The higher the directivity number, expressed in dB, the more accurate the results can expected to be, with generally greater than 30 dB for high very high performance directional couplers that are used in the ILM. To detect small changes in antenna VSWR performance, the directivity performance of the coupler must be much higher to obtain an accurate measurement. Large changes in VSWR can be detected and monitored with lower directivity couplers, but errors due to poor or low directivity of the coupler can be significant for small VSWR changes that are being monitored. This can result in false alarm conditions or it can make the difference in judging whether or not a system antenna is out of specification.

R&D Microwaves has introduced a new and unique [Patent pending] directional coupler that has been designed to achieve the highest directivity in combination with negligible PIM and insertion loss. As a result, it is virtually "transparent" when permanently inserted into a transmission line between the transmitter and the antenna and will not degrade system performance.

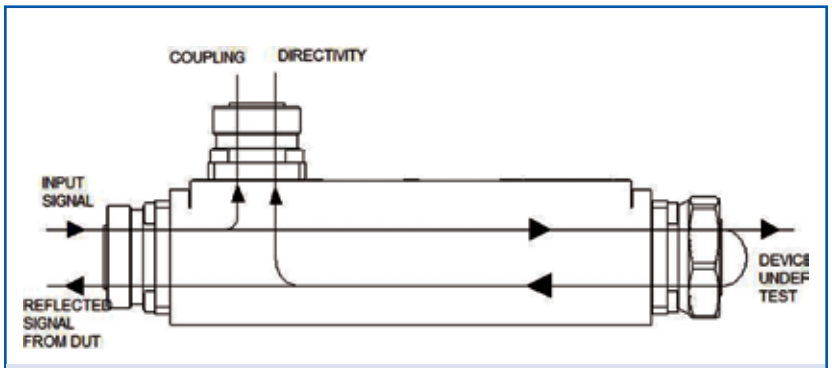

Figure 3

Generally good directional coupler performance can be defined as less that 0.1dB insertion loss, 25dB return loss, directivity greater than 25 dB, with PIM greater than 150dBc. The R&D design achieves better than 0.05dB insertion loss. As a result of special design considerations, coupling methods and materials used in this unique R&D product, directivity in individual operating bands within the multi-bandwidth 800-2170 MHz provided by the design, are actually greater than a remarkable 40 dB.

To achieve this combination of performance specifications, while operating at high transmitter power levels, a unique air dielectric coaxial directional coupler was developed. It is used as an ILM to monitor and retrofit an existing infrastructure application in the field that just introduced an MCPA to the base station architecture. The air dielectric and coaxial structure yields the lowest insertion loss with actual measured data of less than 0.05dB. The power handling capability of the directional coupler is 1000 Watts average at 1000 MHz.

One of the unique features of the directional couplers used in the ILM, is a symmetrical pair of two (2) separate couplers contained in a single housing, on opposing sides of the same section of the center conductor of the coupler. To achieve the highest possible directivity, it is important to have physically separate directional couplers, with one coupler in the forward coupling direction and the other in the reverse coupling direction. The symmetrical R&D design is implemented in half the length of separate couplers that would commonly be used in series rather than in parallel with the main line, thereby minimizing length and insertion loss. Each of the two couplers is terminated with a specially designed cylindrical resistor terminating load with better than 40dB return loss. A terminating load of this quality is needed to achieve the levels of directivity and resulting accuracy of the ILM that is desired.

In addition to the dual coupler arrangement, each of the couplers is a (2) section ¼ wave coupler for more than octave bandwidth operation. The units are uniquely designed for broadband performance over the full 800-2170 MHz band for multiple operating frequency band applications. The design emphasizes the need to achieve the highest directivity over the wide band width in combination with power handling of up to 1000 Watts. Directivity greater than a remarkable 40 dB is achieved in the R&D directional coupler.

Good PIM performance is critical to prevent system interference. It is determined by a combination of factors, including dissimilar metals and materials, plating, contamination, and joints between metals and oxidation effects. It is properly accounted for in the R&D product design and measured with two +43dBm tones on production products The ILM is used in the transmitter path and also commonly used in the receiver path where excessive PIM can effectively interfere with receiver performance. The R&D Microwaves ILM is measured for better than 150dBc

The core RF section of the Model CD-A11 monitor is the directional coupler that is described in some detail above. Two of the three RF outputs of the directional couplers are the inputs to detectors that convert the RF to a DC voltage with microprocessor based circuits with non-volatile memory. PC utility software is provided to interface with the unit for set up and continuous monitoring and reading of actual transmit forward and reverse power levels on a real time basis. In addition, dry relay contacts are provided for alarm indications and the microprocessor based circuit easily can be used to set alarm threshold limits for forward power levels and for load/antenna VSWR. With user friendly utility software provided in WINDOWs format, the alarm thresholds can set quickly over a wide range of forward power and Antenna VSWR levels. The ILM circuitry also provides serial data outputs (RS232) for alarm conditions, and for direct reading of power and VSWR levels in real time, expressed in multiple formats including Watts, dBm, % of reflected power, reflection co-efficient, etc. An additional RF output is provided for the forward power coupling, for local circuit analysis and troubleshooting purposes.

From Digital to the Web with Kentrox's Optima Site Manager Solution

Kentrox has designed the Site Manager module of its' Optima Cell Site Solutions with the following features:

- Simple installation – Optima Remote connects directly to the Intelligent Line Monitors (ILM's) contact and serial ports. This allows you to deploy Optima into your network quickly and easily.
- A cost effective alternative– no base station development or large third-party development needed.
- Faster, more reliable, RF

power visibility – receive sector Alarms on VSWR and power, then examine through the ILM's the what, when and where the issues are.

- Complete system scalability – Optima creates both scalable alarm capabilities and remote access to the ILM's so as your power and antenna systems grow so can your remote management capabilities.

Please note, Kentrox's Optima Cell Site Solutions have the capability to support multiple, diverse applications in addition to the application presented in this document.

For information on additional applications, please visit our web sites at www.Kentrox.com or call 800-247-9482. Contact for R&D Microwave is www.RDMicrowaves.com or call 908-212-1696

Table 1: Optima Site Manager Specifications

Kentrox Product Model Number	Description
Optima Director	Network Management System
Optima Remote	Economical Mediation/ Concentration Device

Table 2: ILM Components contained in Optima

Product Model Number	Description
R&D Microwave CD-A11	Antenna Line Monitor