Total Facility Monitoring for the Modern Radio Station

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Abstract – *Today, radio facilities are constructed with not only the ability to serve multiple radio stations, but also with the future in mind as well. Modern broadcast equipment today is almost universally designed with the ability to control, and monitor almost every feature included in the gear by remote control. Having all this control and telemetry available presents tremendous opportunities for engineers to be able to keep track of thousands of parameters, diagnose problems remotely, and quickly bring backup systems on the air if the need arises. However, the flip side to this is the need to organize and manage the plethora of data that is available, so that the station engineer can effectively work with all the information, and use it efficiently. This paper will describe concepts and real world examples of systems in use today, and that can be used to take advantage of today's modern equipment's capabilities.*

Basic Infrastructure

There are many ways that equipment can be monitored and controlled, but by far today the most common way is via TCP/IP Protocol over a standard business Ethernet Network. Tying all your sites together on a private computer network gives you the flexibility to not only control and monitor your equipment, but also add other services in the future to the broadcast signal and facility. This might include album art for HD Radio multichannel broadcasts, off premise telephones at the transmitters, HD-2 audio from an importer located at the studio, or traffic data for HD Radio broadcasts. Having a robust structure to act as the baseline for this communication is important for reliable site connectivity.

Spread Spectrum vs. Licensed Radios

If you have a less complex situation with one studio site, and one transmitter site, a simple microwave point to point system will suffice. There are two recommended types of microwave systems that can support a wide bandwidth for bidirectional data traffic. The first is the so called spread spectrum unlicensed radio system. This technology is cost effective, and is easily installed. These systems operate under the FCC's part 15 rules in the ISM (industrial, scientific, and medical) band usually at 2.4 GHz or 5.8 GHz. However, the lack of coordination among users can in some cases make it less reliable. Consequently, these systems offer no guarantee of interference free service over long periods of time. However, in less congested areas with relatively short RF Paths, and larger dish antennas, these systems can be quickly deployed at a very reasonable cost.

An alternate solution is to install a licensed microwave system under the FCC's part 101 rules. In August of 2012, the FCC adopted new rules to allow greater flexibility in licensing point to point microwave systems for broadcast STL links. The so called Part 101 radios commonly operate in the 11 GHz, 18 GHz, and 23 GHz bands. These more expensive and high capacity bidirectional links are coordinated and licensed facilities. This gives the operator some assurances that the path will be interference free. Additionally, a path study is required to insure the proposed equipment will work satisfactorily. While this is the better way to go, (especially in congested areas), it is also more expensive to install, and requires both an application to the FCC for the frequency, and prior frequency coordination studies.

Compliance Monitoring

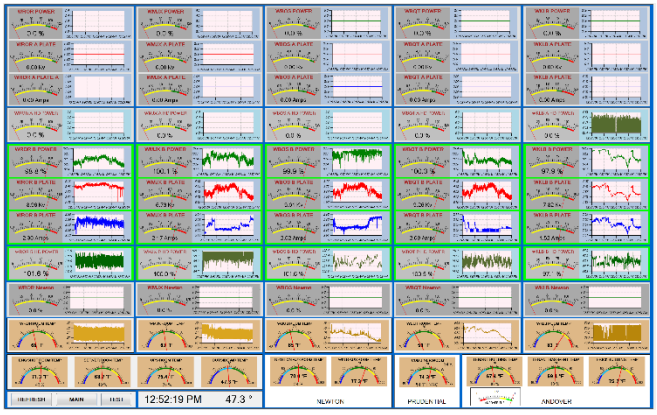

Fig 1 30 inch computer monitor shown displaying a history of transmitter parameters over the previous 24 hours

Once the basic infrastructure is in place, the next consideration is the method of monitoring all the parameters that are important. The FCC requires that stations monitor certain parameters related to their transmission to assure that they are in compliance with the rules. Some of the important items include forward power levels for transmitters, tower light operation, total modulation, and EAS records.

At a transmitter site, forward power level can be obtained from a reflectometer that is part of the transmitter, as well as an external power meter that derive a reading from an RF sample on a transmission line directional coupler. These readings are most widely regarded as the golden standard for power measurement, and a freshly calibrated external meter should be used to calibrate a transmitter reflectometer to

read actual power output, that will be used to determine compliance with the FCC licensed station parameters. Keep in mind that complex waveforms (like those found in combiners with multiple stations sharing an antenna array) and digital signals all require appropriate metering to insure that the readings obtained are accurate.

Fig 2 Array of modern FM modulation monitors that have remote control capabilities

Modulation is another important parameter to measure, as the FCC is concerned about making sure that every station stays within the occupied bandwidth that is on the station authorization. Operating a station at modulation levels that exceed the published guidelines would put a station in violation of FCC rules, and possibly cause harmful interference to adjacent channels. The best practice is to install a modulation monitor at the transmitter site, with a direct RF sample from a transmission line directional coupler. Doing this insures the cleanest signal possible for the monitor to analyze. Today, many modulation monitors offer remote control and monitoring capabilities, and some offer relay contacts that will close in case of a preset limit being exceeded. These types of remote indications on calibrated modulation monitors are beneficial for stations because it allows then to keep an eye on modulation parameters without having to travel to the transmitter site to verify compliance. Figure 2 shows an example of some modern modulation monitors with remote capabilities.

Data Acquisition Modules

Fig 3 In this case data acquisition modules are mounted to a rack panel and wired to status and analog inputs. These modules are addressable on an RS-485 data bus

Often times, it is desirable to display status, and analog values for multiple transmitter or tower sites in a central location where an operator, or staff engineer can see at a glance a summary of operational parameters for multiple locations. There are several options available to accomplish this. One option is to employ the use of data acquisition modules. Industrial style data acquisition modules are designed to be installed in close proximity to the parameter to be monitored. This facilitates short cabling, and reduces the possibility that radio frequency energy will interfere with the signal being measured. Typically, these autonomous modules are either given an address on a network, or are hooked up with a serial RS 485 connection to be strobed by a computer, that is usually remotely located at the site where the data will be displayed. These modules are addressable, so hundreds of the modules can be located wherever needed, and read in sequence by the computer. Figure 3 shows a single location where several modules are installed in an equipment rack. This type of installation is repeated throughout many different locations to provide real time data throughout many different buildings.

Displaying the data

Fig 4 This large computer screen is programmed to show bar graphs of plate voltage, plate current, forward power, HD Radio forward power, room temperature, and transmission line pressure as well as hundreds of status values all at a glance

The computer responsible for strobing the data acquisition modules, is also responsible for bringing the data together, and preforming displays of the parameters, creating enunciations, and dispatching email alerts. The logic here is that one computer running an appropriate program can pull all the data together from all the sites, and make intelligent decisions. This computer is also responsible for sending out emails and text alerts when certain conditions exist, as well as driving the light bright displays in the engineering area and studio locations. The result of the data screen for this computer is shown in figure 4.

Fig 5 One entire wall dedicated to displaying status and analog values

When displaying large amounts of information, a larger format screen is recommended. The use of a large format wall mounted screen is often helpful. The author designed a display using a 30" screen and a program that color coded the parameters to show all green during normal conditions, so that at a glance the engineers can see if there are any problems at multiple sites on just one screen. Figure 5 shows a wall at the entrance to the master control area showing all the critical parameters around the company, including four transmitter locations, and one studio location.

People Meter Confidence

Most large and medium sized markets now encode their on the air, and streaming audio with People Meter or "PPM" watermarks, these watermarks are detected acoustically by ratings panelists who wear a pager throughout the day, thereby keeping track and reporting listening habits for the ratings. However, the integrity of these watermarks is critical to the stations ratings. Therefore, it is crucial that these watermarks are broadcast and monitored to insure that they are being broadcast. The ratings service normally provides monitors that detect the watermark from off the air audio, and usually will close a relay showing good confidence. However, it can get complex, because with multiple stations, and multiple audio sources to monitor for each station, there is a lot of information to display. A screen to bring all this information together that can summarize all the data in an easy to interpret manor is another valuable tool.

Fig 6 30-inch computer screen showing the confidence of PPM watermarking for multiple audio sources over multiple stations. Green indicates high confidence

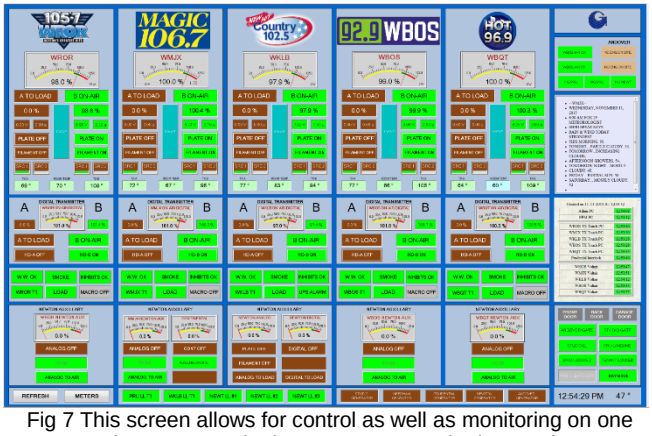

Fig 7 This screen allows for control as well as monitoring on one screen. Using a cursor, the buttons can control relays at the remote site.

Today there are some excellent, off the shelf commercially made remote control and monitoring systems that are built on a modular platform, that are expandable. These products can bring real time data together in customizable screens that can replicate much of what has been describe thus far. This can be a good option if time is tight and financial resources permit their purchase. An example of this is shown in figure 7.

Network Health and Real Time Performance Statistics

Dedicating a computer to run a "ping" program, can also be a great resource to see at a glance the network heath. In our case, we employed a 30" computer screen to display the ping times for many different data paths in one place. A simple glance at the screen reveals any bottlenecks or disconnection with regard to the network.

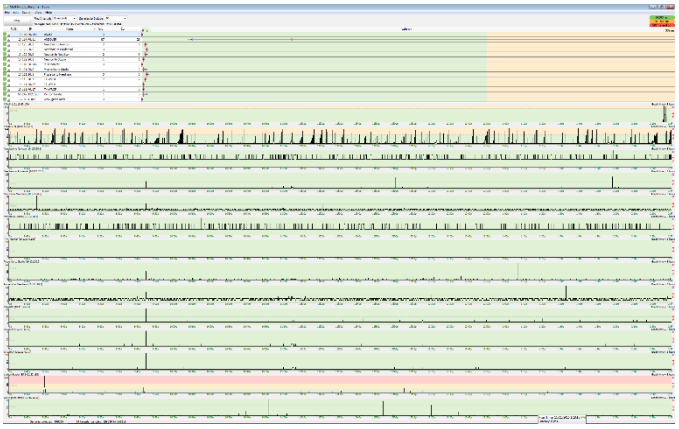

Fig 8 30-inch computer screen showing the ping time of different sites on the business network. Very useful to see if there are links that are down, or if there is unusually high latency experienced with data throughput.

UPS Monitoring Battery Health "Cellwatch"

Today's modern centralized UPS facilities require large banks of batteries to run their systems. These battery arrays are both large and expensive. Today, software along with hardware sensors can keep track of both the individual battery cell voltage and internal battery resistance, scanned every few minutes. This information can be displayed on a screen, showing a graphic depicting the health of each individual cell in the array. In addition, relay contacts from the cell watch hardware can trigger pager, or text message alters when the batteries need replacement. This is especially important since when a particular battery in a chain is showing its age, and drops out of tolerance, it can have a cascading effect on the other batteries in the chain bringing them down as well. Since the batteries are so expensive to replace, catching a bad cell before it has a chance to ruin adjacent cells in the chain can save thousands of dollars. "Cellwatch" software is one of the most important advances in UPS technology over the last decade.

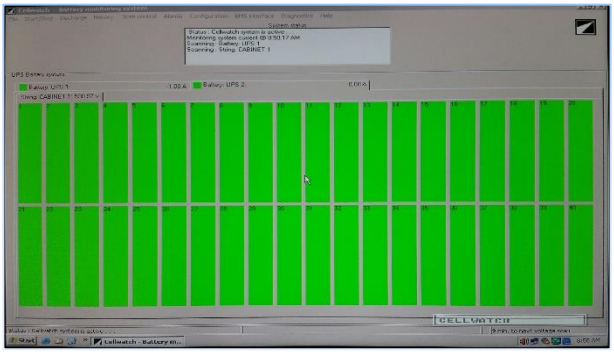

Fig 9 Computer screen showing the heath of a string of 40 batteries used to power a large centralized UPS System

Environmental Conditions "WEATHER"

Being able to monitor the weather conditions at a studio or transmitter site, can be valuable for several reasons. Microwave STL's are vulnerable to rain fade, wind, and icing. Having the ability to correlate STL changes in signal strength, and radio broadcast antenna VSWR with environmental conditions can help identify performance issues more quickly. Several commercial weather stations are available today that are accessible via either RS-232 or IP remote control. These instruments can be located at both ends of an STL link or in proximity to a broadcast antenna to record environmental conditions such as temperature, dew point, wind speed, and rainfall. Having a recent history of these parameters can be valuable when it comes to identifying causes of signal dropouts.

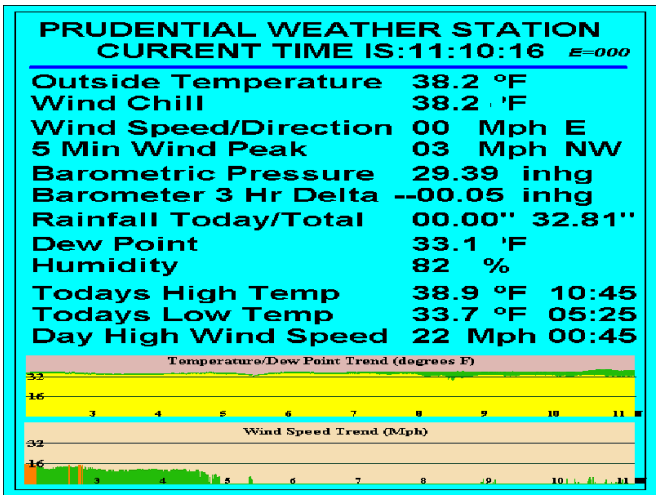

Fig 10 Real time web page showing the current environmental conditions at the transmitter site.

"Light Bright"

These types of scrolling LED displays are popular, and inexpensive to install. Being able to display plain English text to nontechnical operators allows them to understand and report any routine events (like tower light on/off cycles and EAS tests, or even off air conditions) to engineers in a plain and easy to understand message. Many of these light bright displays are addressable via RS-232 or RS 485, and that ends up making it easy to locate these displays remotely from the computer, and address them via RS-485 on a data bus.

Fig 11 Light Bright showing a scrolling LED Display

HVAC Monitoring

Modern HVAC Systems allow for computer based monitoring of the various fan boxes and thermostats located throughout a facility. Today's modern "SMART" systems can adjust and calibrate itself over time based on many parameters such as occupancy, time of day and other factors. The end result is to provide the most efficient and cost effective heating and cooling solutions.

Software today can allow monitoring and control of individual zones to make sure that energy usage throughout the studio facility is being consumed efficiently.

Streaming Audio

Internet streaming of the radio station's audio has become very popular over recent years. Some of the ratings are now derived from credited stream listening from listeners within the local market. Other listeners worldwide enjoy programming from local stations every day. Monitoring these audio streams to insure they are being properly broadcast on the internet has become another challenge for broadcasters today, several manufactures now have internet streaming radios available that will "tune into" a particular stream, and display data, and close a relay indicating that the stream exists. In many cases when PPM Watermarking is employed, the output of the streaming tuner can be fed to a PPM decoder monitor, and the status of the decoder monitor can be observed to indicate the status of the internet stream.

Fig 12 Array of PPM Monitors and internet streaming audio receivers

SNMP

SNMP (simple network managed protocol) is a protocol for collecting and organizing information about managed devices on IP networks. It is widely used in the broadcast industry to control and monitor broadcast equipment that is built to communicate using this language. Using SNMP extends into other industries as well, and it is commonly used to assess network security and performance. Typically, an SNMP Manager (typically a computer dedicated to communicating with SNMP agents) will query SNMP agents that collect data about their environment. These managed systems can simplify monitoring and control of a large number of devices on the network. SNMP is a very useful protocol, but requires all the devices that are to be monitored to be designed to communicate with an agent using this language. It is fast becoming the future of data acquisition.

Conclusions

Radio stations today can benefit greatly from systems that can bring the status and analog readings from hundreds of data points together to be observed on just one screen. These examples of bringing together many sites are applicable to many facilities today. Such hardware can help by keeping the stations within its licensed parameters, and with saving energy, as well as increasing ratings. Additionally, keeping track of subtle trends that can lead to trouble if appropriate action is not taken, tends to reduce downtime. While it can be time consuming to plan and implement these types of monitoring and control systems, the investment can be well worthwhile.