Getting the most out of your Modern Remote-Control System

Paul Shulins

Introduction

Today's modern broadcast remote-controls are microprocessor based and are capable of some useful functions that many broadcasters do not take full advantage of. There are many reasons why, but one of the most common is because most engineers are so busy, and they barely have time to install and maintain broadcast equipment like remote-controls, so we are forced to settle for the basic boilerplate functions like turning on and off transmitters, obtaining basic readings, and being able to switch audio sources when it comes to remote-control functions. However, many modern remote-controls that are being manufactured and sold today are capable of much more and can equip the busy engineer with extensive telemetry that can be useful in keeping the station operating in tip-top shape while also saving time and energy.

I have been working in radio for about 40 years and have had the opportunity see the industry go through many changes with both the way stations operate, and how the changing FCC rules and regulations affect broadcasters.

One of the largest factors driving the changes in broadcast remote-control technology has been the advent of IP communication and microprocessor-based hardware. Today, being able to address hardware from the next rack over, or from half way around the world in the exact same way has added power and flexibility to modern remote-control hardware.

Today, many major broadcast companies are responsible for hundreds of stations around the country and have found it is efficient to have a central monitoring location to be able to see all their facilities from one physical location. This facility, commonly known as a Network Operations Center (NOC) allows the broadcaster to monitor all their facilities from a single room with minimum staff. IP based communications today, makes this a reality. (Figure 1 Local Market NOC)

Broadcast-remote controls today can also dynamically calculate and monitor virtual channels. Virtual channels are channels on a remote-control system that are generated from two or more other channels and are updated continuously. These can be analog channels, or status channels.

Autonomous capabilities to react to status changes are also important features that can take actions to do many useful things quicker and more accurately than humans. Some examples include swapping transmitters if there is a fault, swapping audio sources, and managing power levels.

Finally, managing alarms efficiently is a big advantage of microprocessor based remote-controls today. With a high number of status and analog items that potentially cause an alarm condition, it is easy to get overwhelmed by dozens, if not hundreds of alarms that often can make the root problem difficult to diagnose. Remote controls today can intelligently prioritize alarms based on your programming to mask nuisance alarms that may be only be caused by the primary failure, making the root cause easier to detect.

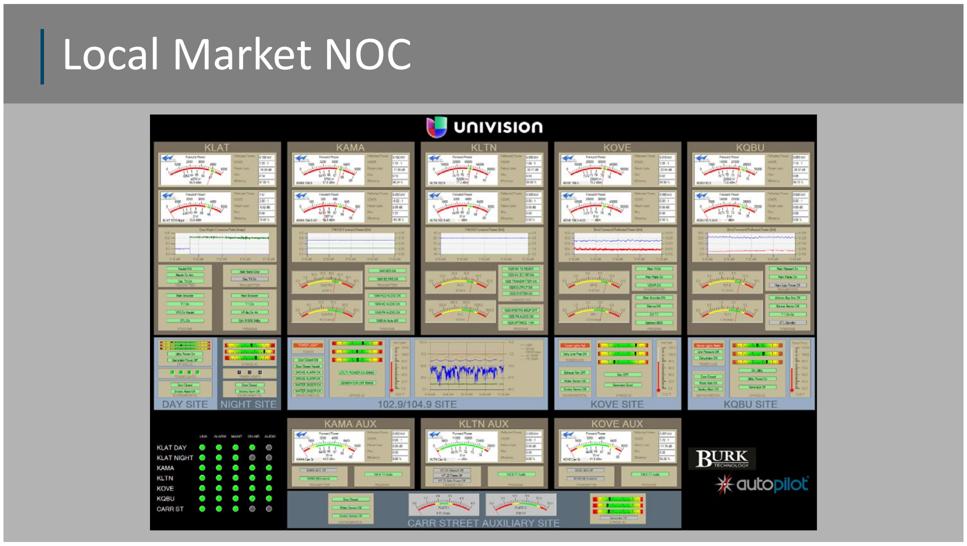

Figure 1: Typical NOC Screen showing multiple facilities on a single screen

The Power of Virtual Channels

A virtual channel is a remote-control channel whose value is determined by other channels using simple mathematical formulas and/or Boolean Logic. Commonly, there are two types of virtual channels: analog virtual channels and status virtual channels. One useful example of a virtual channel is the dynamic calculation and display of transmitter efficiency. Assuming you are already monitoring transmitter PA Volts, PA Amps, and power output, you can easily create a virtual channel to be defined by the formula to calculate transmitter efficiency. Using the formula: $Eff\ \% = 100 * (Pwr\ Watts\ /\ (PA\ Volts\ * PA\ Amps))$, we can make the following definitions:

- Let Analog Channel #1= Measured PA Volts
- Let Analog Channel #2= Measured PA Amps
- Let Analog Channel #3= Measured Power Watts
- Define Virtual Channel #4 to be calculated PA % Transmitter Efficiency

Channel #	Description	Scale	Decimal	Source
1	PA Volts	Linear	XXXX	Meter 11 on Plus-X IIU #2
2	PA Amps	Linear	XX.X	Meter 12 on Plus-X IIU #2
3	PA Watts	Linear	XXXX	Meter 13 on Plus-X IIU #2
4	PA Efficiency %	Linear	XX.X	100*M3/(M1*M2)

Figure 2: Defining a virtual channel to display calculated transmitter efficiency

Now we can display channel 4 dynamically as a meter, or historical graph that shows transmitter efficiency in real time or over a specific time. While all this is interesting, what real value does this bring to the average engineer? Well for starters, we can certainly alarm on efficiency changes that may indicate anything from a clogged air filter or air conditioner issues, to a tube going south. We can also recognize metering problems. For example, if the efficiency is constant, but the PA Voltage or PA Current look out of tolerance, we can assume that a metering problem exists, and can look at the transmitter samples to see if they are still proportional to the actual parameters. With older tube type transmitters, transmitter efficiency starts to change as the tube approaches the end of its life. Recognizing when this trend starts can help an engineer plan for tube replacements. Minimizing the amount of time having a tube on the shelf can help the station budget more accurately and can also minimize the chance of the tube becoming "gassy" from sitting around for a long time. It is easy to see that using the remote control to help give the engineer a heads up on potential issues, can help the engineer to manage his time more effectively be scheduling maintenance that will be needed soon, based on trends identified by the remote control.

Another parameter that can be dynamically calculated and displayed using a virtual channel is indirect power using the formula: $Pwr = PA\,Volts\ * PA\,Amps * Eff$.

Channel #	Description	Scale	Decimal	Source
1	PA Volts	Linear	XXXX	Meter 11 on Plus-X IIU #2
2	PA Amps	Linear	XX.X	Meter 12 on Plus-X IIU #2
3	PA Watts	Linear	XXXX	Meter 13 on Plus-X IIU #2
4	PA Efficiency %	Linear	XX.X	100*M3/(M1*M2)
5	Indirect Power (watts)	Linear	XXXX	M1*M2*0.71

Figure 3: Defining a virtual channel to display indirect power

In this example, we can define the 5th channel as the PA Volts multiplied by the PA Amps multiplied by the published PA efficiency factor (71%) for the transmitter (PAV*PAI*EFF). The advantages of doing this include allowing stations to confirm direct power readings, providing the ability to estimate power output without a direct power meter, and to confirm ongoing compliance with FCC Power limits.

Here is another great example of the power of virtual channels: We all know that VSWR (Voltage Standing Wave Ratio) is a very important parameter to keep track of. Sure, transmitters can display this on their front panel, but how can you see it at the studio? Well here again virtual channels can come to the rescue! Consider the formula to calculate VSWR:

- $VSWR = (1 + \boldsymbol{\rho})/(1 - \boldsymbol{\rho})$
- ***ρ****(Roh Reflection Coefficient) =SQRT(reflected power/forward power)*

So, in this example, we require 2 virtual channels. One is used to calculate Roh, the reflection coefficient, and the other to calculate VSWR.

Channel #	Description	Scale	Decimal	Source
1	PA Volts	Linear	XXXX	Meter 11 on Plus-X IIU #2
2	PA Amps	Linear	XX.X	Meter 12 on Plus-X IIU #2
3	PA Watts	Linear	XXXX	Meter 13 on Plus-X IIU #2
4	PA Efficiency %	Linear	XX.X	100*M3/(M1*M2)
5	Indirect Power (watts)	Linear	XXXX	M1*M2*0.71
129	Forward Power	Linear	XXXX	Meter 15 on Plus-X IIU #2
130	Reflected Power	Linear	XXXX	Meter 16 on Plus-X IIU #2
131	Roh	Linear	XXXX	SQRT (M130/M129)
132	VSWR	Linear	X.XX	(1+M131)/(1-M131)

Figure 4: Defining a virtual channel to display VSWR

By calculating and displaying VSWR, you can alarm on changes in VSWR before they affect operations, and by graphing these changes over time, you are able to spot trends before they become dangerous. Another use is to be able to automatically turn on and off de-icing equipment (such as antenna element heaters) based on the de-tuning of the antenna caused by icing. Having the remote control identify trends that could otherwise go un noticed until damage was done to the antenna or transmission line system will save time and potentially tens or even hundreds of thousands of dollars!

These are all great examples of virtual channels being defined by arithmetical calculations from other real channels. But what about combining analog channels with status channels to show a single meter that automatically changes to indicate the power level of only the transmitter that is currently feeding the antenna? Using Boolean logic can be useful for this purpose.

For this we need to consider the position of an RF switch, or RF patch panel. For this example, lets consider a 4 port RF switch. Typically, micro-switches contacts are available from the RF switch to indicate what position the switch is in. In most cases engineers will have already brought these status indications out to the remote control so they can determine what transmitter is feeding the antenna.

Figure #5 illustrates how we can create these channels. If we bind status channel #158 to be true (or 1) when the RF Switch is in position #1, and channel #159 to be true (or 1) when the RF Switch is in position #2 then we can use these values to create a virtual channel that displays the on-air power, lets define this as channel #160. This channel can be calculated by multiplying the transmitter power of transmitter “A” by the value of status channel #158 and summing with the transmitter power of transmitter “B” multiplied by the value of status channel #159. The transmitter that is not feeding the antenna will be multiplied by a zero value and will not be part of the value of channel #160. So, in this case we have built an analog virtual channel that is smart enough to display only the power value of the transmitter that is feeding the antenna. By doing so, you can make it easy for the operator to log readings and report power, since there is just one power meter to look at. Taking this a step further, you can do the same thing for PA Volts, PA Current, and VSWR. This can end up making a complex transmitter site much easier for operators to interpret and for engineers to troubleshoot. Again, the more we can do to simplify this telemetry for the operators and engineers, the more time we can save for other engineering duties.

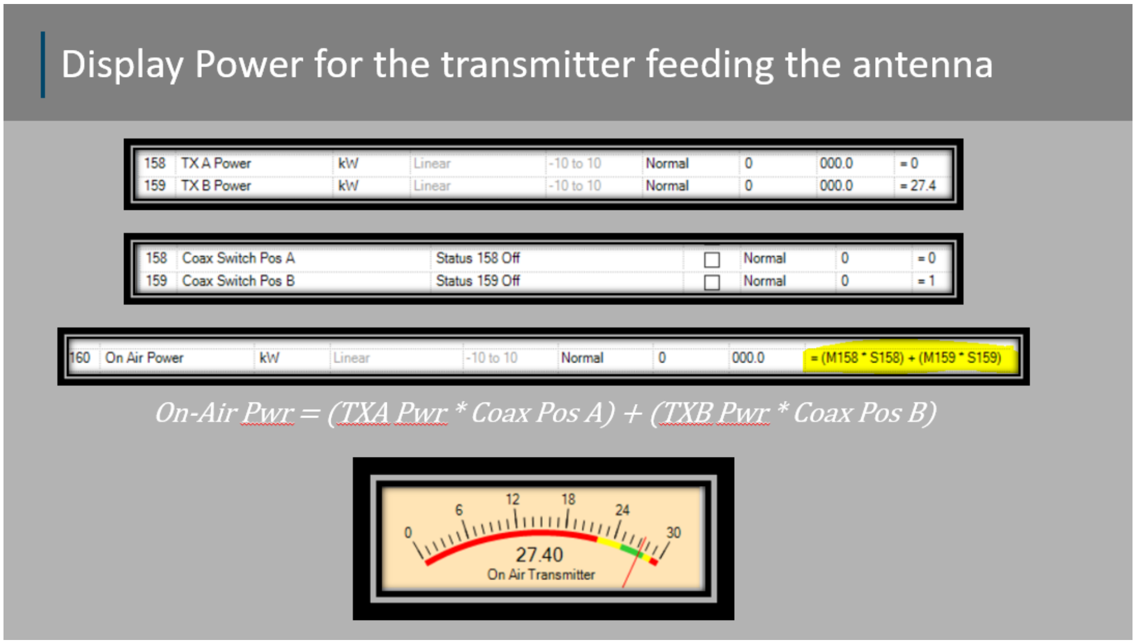

Figure 5: Creating a virtual channel to display the power output of the transmitter feeding the antenna based on the position of the RF Switch

Timed Functions

Many of today's modern broadcast-remote controls can track elapsed time. One useful example is looking at the cumulative run time of a nitrogen generator or de-hydrator. Binding a status channel on your remote control to a contact that closes when a device is running, can allow you to measure elapsed run time of the device. This can be a useful diagnostic tool in assessing the health of various systems. For example, recognizing that when the nitrogen generator is operating normally into a closed transmission line system with minimal leakage, (and under certain specific environmental conditions), the nitrogen generator would be expected to run for approximately "x" minutes over a specific period of time. Displaying this run time (or even alarming on excess run time), can give you a great diagnostic tool in detecting changes in your system before they become problems. When a weather station is associated with the system, air temperature and pressure can be automatically considered when making these observations. Some other ideas for using timed functions include tracking generator run times, looking at total run time for transmitters, and keeping track of tube hours. While it is true that many devices already have hour meters built in, most all of them do not have the ability to remotely display and alarm on run times that exceed certain values. This can save the engineer time by keeping track of run times automatically and allow the engineer to have the data at his/her fingertips.

Alarm Rollups and Repetitive Alarms

When a remote control grows to the point where is handling dozens or even hundreds of status inputs, there is a good chance that many of those status inputs can generate alarms. In many cases a failure of one piece of equipment can cause other equipment to send out alarms at the same time. Unfortunately, without proper management, this deluge of multiple alarms can be overwhelming, and make it difficult or even impossible to tell where the problem is. A good example of this is a utility power failure. Let's look at some of the types of alarms that might be generated if your site loses power, here are just seven I can think of to start with:

1. The Utility power status will alarm
2. The generator will start and alarm
3. The transfer switch will transfer the load and alarm
4. The transmitter will go off the air and alarm
5. There may be silence sense alarms
6. There may be STL alarms
7. There may be UPS alarms

Having all these alarms come in at once can be distracting and can mask the real problem that in this case is the very first alarm I listed indicating that the utility power went off, and all the subsequent alarms are normal effects of the root cause and should be expected and therefore should also be ignored. Most modern remote controls today offer the ability to prioritize alarms, and suppress alarms based on other alarms that have a higher priority. The result is a very clear picture of what the root cause is of the problem.

Repetitive alarms can be even more annoying. Consider the case where the weather is poor to the point where the signal for your STL keeps dropping below the threshold of usefulness and generates an alarm. Then a few seconds (or minutes) later the alarm clears when the fog lifts a bit. This cycle of alarming, and clearing can repeat for hours or even days, and can drive engineers to turn off the alarms because they occur so frequently, and the engineer is all too aware of the problem and doesn't need to be reminded every few minutes! Building in alarm dwell times, can be a solution for this. This functionality can prevent alarms for recurring for a certain amount of time. Also, the ability to disable individual alarms for a period can be useful for the same reason.

Automated Site Functions

Many transmitter sites today have become complex. There are multiple transmitters to manage, backup STL Systems, PPM Encoding monitors, and backup power systems. Remote controls today can manage transmitter swaps based on loss of RF, and audio swaps based on silence senses. Often these swaps can be made more quickly accurately, and efficiently than a human can. Generating carefully thought out flow charts and turning them into macros or can accomplish the goal of protecting your station from being off the air. Let's look at an example of a flow chart that considers what action is taken when a transmitter failure occurs. Consider a site with a main and auxiliary transmitter that has a motorized RF Switch installed. The flowchart below in figure 6 is a starting point to develop a set of commands or macros that a remote control can follow to monitor RF and swap transmitters upon loss of RF. Of course, this is just a starting point, but is meant to illustrate how you can easily take advantage of modern remote controls imbedded microprocessors to help keep your station on the air.

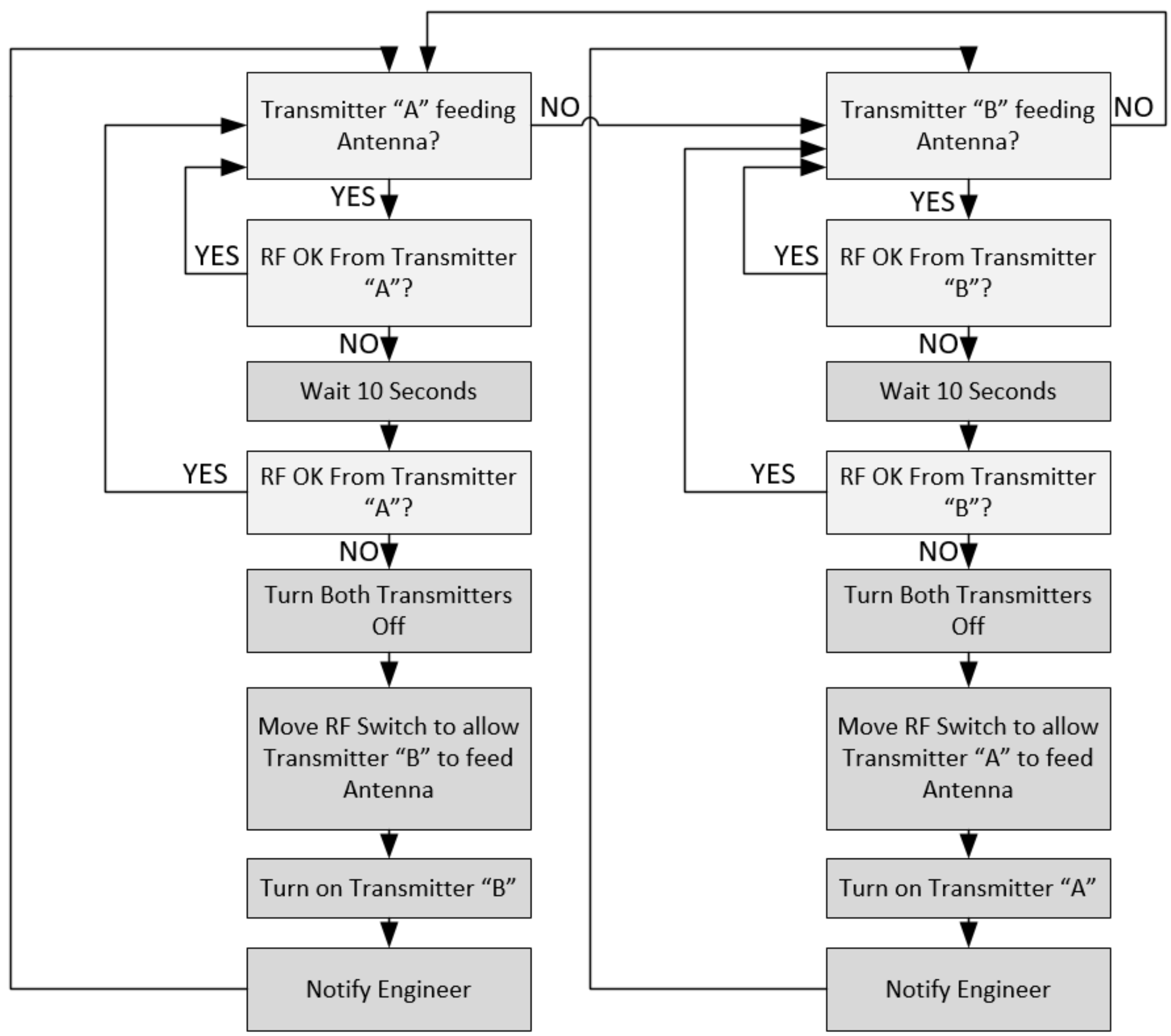

Figure 6: Flowchart to develop a macro for swapping transmitters when an RF failure is detected

Conclusions

As illustrated in this paper, there are many ways that modern remote-control technology can help to make your operation more efficient. Everything from predicting failures before they occur, to taking corrective actions in the event of a failure, the chances are very good that many of these capabilities are already built into the equipment you already own, and all it takes is a bit of time, imagination, and creativity to apply that horsepower to benefit your facility. The more you can take advantage of the technology you have already purchased, the more efficiently you can run your operation. This lets you target your valuable time in specifically the areas that need human attention and cannot be mechanized, something we never seem to have to look very hard for!

This paper has been adapted for publication with permission from the IEEE Broadcast Technology Society and is based on a presentation I made last fall at the annual BTS Symposium in Arlington, VA.