Network Control of Subscriber Broadcast Transmitters

This application note describes the system the Skylight Network uses to control the transmitters of several of its subscribers from the network control point. The system uses the network satellite distribution system and the dial up telephone network. These techniques can be used by other subscribers, other networks, or individual stations looking at the variety of control options available.

Unattended, almost

The FCC requires a broadcast transmitter to be operated by a licensed operator. A station cannot operate without an operator at a control point where the operator can observe various system parameters and meet certain control requirements. Typically, the transmitter operator has also been the board operator (disk jockey or the one who otherwise determines what goes on the air when). Satellite distributed program networks (such as Skylight) allow a station to operate without a board operator. This leaves the requirement for a transmitter operator, however. During the day and evening hours, a station generally has several people available that can do transmitter operation along with whatever their other jobs might be. The time period that is difficult to find a transmitter operator for is "after midnight". To fill the transmitter operator requirement, several stations have adopted some sort of "off premises control".

Off Premises Control

Off premises control is the control of a broadcast station from a non-traditional location. Traditionally, transmitter operation has been performed either from the transmitter or the studio (a traditional remote control point) while control of the programming has rested at the studio. Non-traditional control locations for broadcast stations include the manager's home, an answering service or alarm company, or a program network operations center. The Commission appears to have no objection to such systems as long as various requirements are met. These requirements are outlined below.

Continuous Carrier Control

The operator must at all times be able to immediately shut down the station. This is similar to the old remote control fail safe requirement. The requirement to immediately terminate operation is listed in 73.1410(e). FCC Public Notice 88-194 requires that remote control operation utilizing dial-up telephone circuits must ensure that the dial-up circuit is always available for the exclusive use of the duty operator, provide a means for the duty operator to preempt any other dial-up access to the system, or to provide an independent means of shutting down the transmitter. The Public Notice lists interruptions to the program audio, a second dial-up circuit, STL systems, or "continuous radio frequency cueing and control circuits" as possible methods of complying with this requirement. Most systems (including the DRC190 system utilized by Skylight) provide a method independent of the dial-up circuit to shut down the transmitter, providing "continuous carrier control." This contrasts with the first method listed in the Public Notice, allowing the duty operator to interrupt or preempt another operator using the dial-up circuit.

Continuous carrier control can be provided by an STL transmitter squelch relay or a program audio detect relay, if the transmitter operator does indeed have control over the STL carrier or the program audio. In cases where the STL squelch relay allows shutting down the transmitter on a continual basis from the studio, but this continuous control is not extended to an "off premises" control point (an answering service, etc.), it would appear that the station is not in compliance with these requirements. If a dedicated control circuit (radio, including through a satellite, or leased line) is provided to each control point such that the loss of that circuit (for more than a minute or so) would cause the shut down of the station, the dial up system could be used for additional control and telemetry.

Program networks that distribute their programming by dedicated circuits (typically satellites) are in an interesting position to provide off premises control to their subscribers. Since the networks generally provide a continuous control channel (for network cue signals), this cue channel could be considered a continuous circuit between the operator at network control and the studio. Passing the "presence of cue channel" through to the remote control, or perhaps just squelching the STL based on absence of network cue channel, provides continuous carrier control from the operator to the transmitter. The network uses the dial up network for routine control and telemetry. On failure of the dial up network, the network could use the network cue system to shut down individual stations. On failure of the network cue system, all stations would be shut down by the loss of the cue channel. Such systems are being used by at least two radio networks, including the Skylight Network (St. Paul, MN) and the Family Radio Network (Oakland, CA).

EBS System

The transmitter operator must monitor the assigned CPCS station and be able to respond to alerts. With transmitter control from a very distant point (such as a network control center several states away), it is difficult to meet the CPCS monitoring requirement.

Although this may be a bit complex, it would appear possible to have a dedicated dial up telephone line that auto-answers and runs the CPCS program audio down the dial up line. In addition, the EBS receiver tone detector could drive a status input to the remote control. A change in this status would cause a dial up of the network control point. On receiving this alarm, the network control point could call the CPCS monitor line at the station and

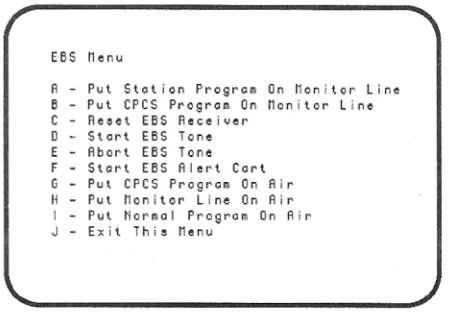

Figure 1: A possible EBS menu.

listen to determine whether this was a test or an alert. If the tone reception alarm was due to a test, the test can be logged and the tone detect relay reset over the modem line. If the tone reception alarm was due to an alert, the network control operator could (through the use of Raise/Lower commands over the dial up circuit), do appropriate audio switching to put the required alert announcement and the CPCS program on the air.

Through the use of appropriate menus on the program running on the studio unit of the remote control, a second dial up line could be put to several uses. A possible menu is shown in figure 1.

The use of such a menu would give the remote operator considerable control over the programming. It would even allow emergency programming for the individual station to be sent over the dial up "monitor line". Several safeguards should, of course, be built into the software.

It appears that the Commission is willing, under certain circumstances, to waive certain local EBS requirements, as long as the remote control system notifies the network operator and a local "on-call" person that an EBS tone has been received. The local on-call person would make a decision as to whether to participate in the local or state EBS. Since local and state EBS participation is voluntary, a station can stay on the air without participating. National level EBS, however, requires a station to participate in some form. A non-participating station must run the EBS tones, air an announcement, then get off the air. A participating station must run the EBS tones, air an announcement, then air the national EBS programming. Skylight is currently operating with the above mentioned waiver, authorizing the subscribers to handle local/state EBS by traveling to the station, if the station wishes to participate. National level emergencies are handled by the network, with it sending the required tones, announcements, and programming to the subscribers for rebroadcast.

Use of Notified Control Points

The FCC Public Notice 88-194, clarifying the remote control rules, allows authorized personnel to obtain data and adjust the transmitter from any location (not just notified control points). However, this does not negate the requirement that stations have a designated operator on duty at a fixed position.

To provide better system security, and to insure that station control is only from authorized control points, the Skylight control system utilizes "callback security". Should the network control operator wish to access a station's transmitter control system, the network calls the station and enters a password. Both ends then disconnect, and the transmitter control system calls the network operator back at the phone number corresponding to the password given.

The Skylight System

The transmitter control system used by the Skylight Network is based on the Hallikainen And Friends DRC190 remote control system. Each station has two "boxes", one at the transmitter, the other at the studio. It would be possible to have only one box at a station, providing that box has access to all required control signals (EBS, satellite carrier detect, etc.). Figure 2 is a block diagram of a typical station system.

The transmitter site box samples the various transmitter parameters and controls the transmitters with its control outputs. The transmitter site communicates with the studio over any of several communications media. These include: STL subcarrier up/Broadcast subcarrier down, bi-directional wireline, or bi-directional UHF radio.

The studio box is running a program written for the station. Similar stations may run the same program with different "data statements" to cover the variations between the stations. This program drives a CRT terminal and a printer.

A variety of "screens" are available on the CRT. The normal screen for an FM station is shown in figure 3.

```
                    KH&F
                 January 19, 1987
                   2:53:11 PM

Plate Voltage          7500.   Volts
Plate Current             3.00 Amps
Indirect Power          100.0  Percent
Reflected Power           0.4  Percent
Line Voltage            114.7  Volts

Press [ESC] for manual command menu
Main Transmitter Selected
Auto Power Controller On
Using Indirect Power Derivation

Now on site 1, channel 7
```

Figure 3: Typical main screen

Figure 4 shows the same screen, except that an over-power condition exists. The software used by Skylight includes an automatic power trim routine that tries to maintain the power output within authorized limits. It also backs down the transmitter power to limit the reflected power in the event of antenna icing. The program also brings up an auxiliary transmitter, if one is available. Figure 4 shows an over power condition with the automatic power adjustment turned off. This puts the alarm messages on the screen, beeps the terminal and advises the operator to hit any key to

```
                    KH&F
                 January 19, 1987
                   2:53:11 PM

Plate Voltage          7500.   Volts
Plate Current             3.25 Amps
Indirect Power          108.3  Percent
Reflected Power           0.5  Percent
Line Voltage            120.3  Volts

Press [ESC] for manual command menu
Press any key to acknowledge alarm
Main Transmitter Selected
Auto Power Controller Off
ALARM: Power Too High
ALARM: Reflected Power Too High
Using Indirect Power Derivation

Now on site 1, channel 7
```

Figure 4: Main screen with alarm condition

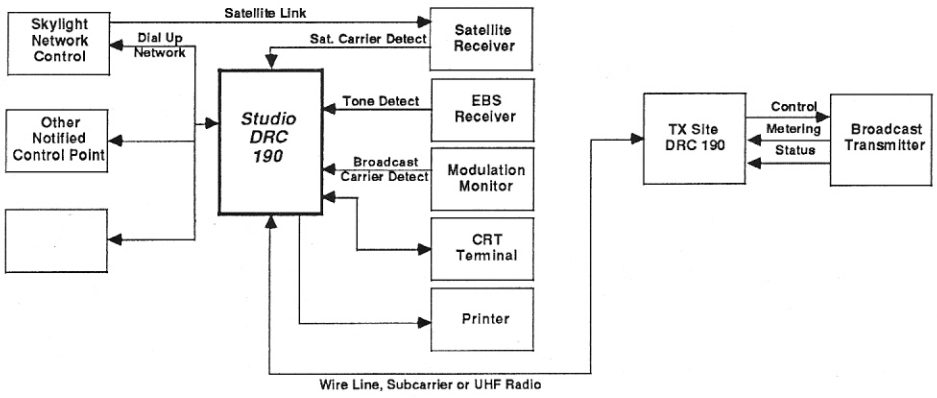

Figure 2: System Block Diagram

acknowledge the alarm. Once the operator acknowledges the alarm, the terminal stops beeping, but the alarm message stays visible. The operator must, at this time, decide what to do (such as shut the transmitter down due to an interference causing condition).

Should the operator not respond to the alarm within two minutes, the program starts calling the notified control points over the dial up network. This continues until the alarm is acknowledged by a local or distant operator. The distant operator (such as network control) has the same screens and control functions available as the local operator.

The Skylight program provides for two types of alarms. These are called "alert" and "priority" alarms. An alert alarm is handled by the procedure above. A priority alarm is used for interference causing conditions or loss of the satellite communications link (providing continuous carrier control). An unacknowledged priority alarm will shut down the transmitter after five minutes. Figure 7 shows the screen menu that displays the current alarm action and allows the action to be changed.

```
Status Change Action Menu

Flag  Flag True Description/Alarm Action

A   Main Transmitter Selected
        Action: Alert on going false
B   Aux Transmitter Selected
        Action: Alert on going false
C   Neither Transmitter Selected
        Action: Alert on going true
D   Auto Power Controller On
        Action: None
E   ALARM: Power Too High
        Action: Priority on going true
F   ALARM: Power Too Low
        Action: Alert on going true
G   ALARM: Ref Power Too High
        Action: Alert on going true
H   Afl Pwr Couldn't be lowered to 2.5%
        Action: Alert on going true
I   Power Couldn't Be Adjusted Up
        Action: Alert on going true

Choose flag to change (A-I) or space for more
```

Figure 7: Alarm Action Change Menu

For example, the power too high alarm causes a priority alarm. The main transmitter selected alarm (or flag) causes an alert alarm on going false. This alerts the operator should the program switch to the auxiliary transmitter or should the main transmitter fail.

The screen in figure 5 is brought up when the operator (local or distant) hits the escape key. This allows the operator to exert control over the system, selecting transmitters, enabling features, controlling the dial up modem or other actions.

The Skylight program includes a scheduler that can be utilized for a number of purposes. Figure 6 shows the display of the schedule. The times are in six digit HHMMSS format. Note that this figure

```
<A>  Bring Up Main Transmitter
<B>  Bring Up Aux Transmitter
<C>  Shut Down Current Transmitter
<D>  Turn Simulator On
<E>  Turn Simulator Off
<F>  Force a Log Printing
<G>  Set Date
<H>  Set Time
<I>  Turn Auto Power Controller On
<J>  Turn Auto Power Controller Off
<K>  Take Direct Power Readings
<L>  Take Indirect Power Readings
<M>  Manually Call a Number
<N>  Force Modem into Answer Mode
<O>  Disconnect Modem Contact
<P>  Change Alarm Action
<Q>  Raise/Lower Specific Channel
<R>  Display Schedule
<S>  Exit Manual Command Menu
```

Figure 5: Manual command menu

shows pattern change times. Although the existing Skylight program is designed for FM stations, provision was included to automatically change the pattern of an associated AM station. Of course, a program can be written to handle the complete control of an AM or an AM/FM. Note also that the schedule calls for the pattern change times to be loaded into the schedule at 3:00 a.m. The pattern change times are scheduled at this time so that the

```
Scheduled Events

 Time    Event
 80000.  Change To Day Pattern
171500.  Change To Night Pattern
 30000.  Load New Pattern Change Times
165322.  Do a Log Print

         Press any key to exit
```

Figure 6: The scheduled events menu

standard/daylight time decision has been made for the remainder of the day. The program knows when to advance and unadvance the clock for daylight savings time based on its calendar.

Figure 8 shows typical log entries. In the Skylight program, the status of all program flags is printed at the top of each page. Changes in the status of individual flags are printed in the remarks column of the log.

System Hardware

Figure 2 shows a typical DRC190 installation at a Skylight affiliate. The network control room and other notified control points (such as the chief engineer's home) are linked to the studio end of the system by dial up telephone link. The satellite link provides a continuous carrier control from a notified control point to the system. Although there is not continuous carrier control from the chief engineer's home, there is always an operator on duty at network control, where there is continuous carrier control.

The studio DRC190 is running the system control program (written in Basic). It is evaluating input from the satellite receiver (satellite still there?), the EBS receiver (alert tones received?) and the modulation monitor (are we still on the air?). The studio DRC190 also drives the local CRT terminal for operator interaction, the printer for log generation, the dial up line, and a communications link to the transmitter. This communications link can be a dedicated wire line, an STL or broadcast subcarrier, or a dedicated UHF radio channel.

Finally, the transmitter site DRC 190 gathers metering and status information, and generates control signals, as instructed by the studio DRC190. Many other hardware arrangements are possible, allowing for more or fewer sites in a system.

Why Skylight?

There are several advantages to use of the Skylight network for your transmitter control. Since there is a continuous control signal through the satellite, it is easy to meet the FCC's continuous carrier control requirement. The operators at Skylight are trained transmitter operators. They know how to properly operate your transmitter and respond to EBS. It is unlikely that the local answering service operator

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                                KH&F Transmitter Log
                                For Monday, January 19, 1986
                                All Times CST
                                Page 1

Main Transmitter Selected  Auto Power Controller On  Power not too high  Power not too low  Reflected
power ok  Reflected power adjusted below 2.5%  EBS OK  Remote Metering ok  FM carrier detected at
studio  TX site power ok  Studio power ok

 Time      |Plate |Plate ||Indir |% FWD |% REF |Line  |Line  |STL RX| Remarks
           |Volts |Amps  ||TPO % | PWR  | PWR  |Volts ||mbal |Level |

2:47:52 PM   7500.  3.00  103.1  102.5   0.4   114.7   2.0    5.0
2:50:13 PM   7500.  3.25  108.3  107.4   0.5   120.3   3.7    5.0    Alarm: Power Too High
                                                                     Priority Alarm TX shutdown
                                                                     scheduled for 145513
2:51:05 PM   7500.  3.00  103.1  102.5   0.4   115.0   1.9    5.0    Power not too high
```

Figure 8: Typical log entries

(an alternative off premises control point) knows much about broadcast transmitters, or how to respond to EBS.

More Information?

To discuss your transmitter control problems, please call us:

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