IP Microwave Connectivity – GTR8000

Presented by
Judy Hill and John Jenkins
ICOM 911 - ETSU Team
Oak Harbor, WA

Simulcast Solutions
Simulcast Forum XVII
IWCE March 14th, 2013
WASHINGTON’S COUNTIES AND COUNTY SEATS

British Columbia Canada

Seattle

Portland Oregon
**Island County**: 9 Islands, 517 square miles, Pop: 79,000 in 2011
**Skagit County**: 1,920 Square miles, POP: 118,000 in 2011
Island and Skagit County Network

• In 2009 the Island, Skagit, Whatcom, San Juan, and Snohomish Counties in NW Washington along with WSP-Washington State started the migration to IP Ethernet Connectivity as part of the Inter-Operability Project funded under PSIC Grants.
Why we needed Simulcast

• To overcome the need for the Island and Skagit 911 dispatchers to manually select a site based on the location of the field units along with filling in valleys and shorelines from the following Sites

• ICOM 911
• Windsun Way
• Race Road
• Cultus Bay Road
• Mt Erie
• Maynard Hill

• Skagit 911
• Lyman Hill
• Little Mt
• Burlington Hill
• Mt Erie
## Skagit IP Simulcast Channels Online

### Skagit County – 4 IP Simulcast Channels online

<table>
<thead>
<tr>
<th>Channel Type</th>
<th>Model</th>
<th>Site Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire-1 Simplex</td>
<td>Quantar</td>
<td>3 Sites</td>
</tr>
<tr>
<td>Fire TAC-2 Simplex</td>
<td>MTR2000</td>
<td>3 Sites</td>
</tr>
<tr>
<td>Fire TAC-9 P25 Repeater</td>
<td>Quantar</td>
<td>3 Sites</td>
</tr>
<tr>
<td>LE TAC-1 Repeater</td>
<td>Quantar</td>
<td>5 Sites</td>
</tr>
</tbody>
</table>

2 more Simulcast Channels in Planning
### Island County – 4 IP Simulcast Channels Online

<table>
<thead>
<tr>
<th>Channel Type</th>
<th>Model</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire-1 Simplex</td>
<td>MTR2000</td>
<td>4 Sites</td>
</tr>
<tr>
<td>Fire-3 Repeater</td>
<td>MTR2000</td>
<td>3 Sites</td>
</tr>
<tr>
<td><strong>Fire-4 Repeater</strong></td>
<td><strong>GTR8000</strong></td>
<td>3 Sites</td>
</tr>
<tr>
<td>LE TAC Repeater</td>
<td>MTR2000</td>
<td>4 sites</td>
</tr>
</tbody>
</table>

2 more IP Simulcast Channels in Planning
Equipment in the Simulcast IP System

- **GPS**
  - Spectracom SecureSync, Netclock 9383, GPS 8195B, and CTCSS 1118
- **Voters**
  - Raytheon JPS SVN-12 and AstroTAC 3000 Mixed Mode
- **Simul Amp**
  - Convex 2240A-2C (w/ CTCSS) and 2346 Delay Shelf
- **Ch Banks**
  - Harris NetXpress w/ SynchroCast3 Timing
- **Radios**
  - Motorola MTR2000, Quantar and GTR8000
- **Backhaul**
  - Alcatel MDR 8000E Microwave/Alcatel MPLS 7705
GTR8000 - IP Simulcast Audio Connectivity

Convex 2240A-2C AUDIO / PTT PANEL
Pre-emphasis, Limiting, and TX CTCSS

Raytheon JPS SNV-12
Receiver Voting

Spectracom GPS

Within the Cloud the IP Path is via the Alcatel Routers over Microwave or Fiber as determined by the Network Connectivity to each Site

Zetron Dispatch Console System

Harris NetXpress Prime Site
SynchroCast3 SNC-101S VF-40 w/ MA-311

Harris NetXpress Remote Site
SynchroCast3 SNC-101T VF-40 w/ MA-311
Motorola GTR8000
Digital & Analog - Rel 3.1

Harris NetXpress Remote Site
SynchroCast3 SNC-101T VF-40 w/ MA-311
Motorola GTR8000
Digital & Analog - Rel 3.1

Harris NetXpress Remote Site
SynchroCast3 SNC-101T VF-40 w/ MA-311
Motorola GTR8000
Digital & Analog - Rel 3.1
GTR8000 Conventional Options

- GTR8000 Base Radio
- VHF or UHF Band
- RX Preselector
- Conventional Mixed Mode (Analog and Digital)
- Wildcard /GPIO
- Conventional Simulcast
- Conventional Voting
- CPS Software
GTR8000 to the VF-40 Module

- **Motorola GTR8000** Model T7039A Release 3.1
- **Harris VF-40/MA-311 at TX Site**
- **GTR8000**
- **Wireline 8-Pin Jack** 66-Block (example for VF-40 “VF Channel 1”)
- **Pin-1** RX Audio +  VF-40 Card PB Pair-1 Pin-26 (Input Tip)
- **Pin-2** RX Audio –  VF-40 Card PB Pair-1 Pin-1 (Input Ring)
- **25-Pair “Champ ‘P’ Connector” connects with a 25ft Cable to the 50 pin SCSI Connector on the GTR8000**
- **Pin 5** TX PTT +  VF-40 Card PB Pair-4 Pin-4 (E-Lead A - Com)
- **Pin 34** TX PTT -  VF-40 Card PB Pair-5 Pin-5 (E-Lead A - N/O)
- **Pin 50** TX Audio +  VF-40 Card PB Pair-2 Pin 27 (Output Tip)
- **Pin 25** TX Audio -  VF-40 Card PB Pair-2 Pin-2 (Output Ring)

- **Note** – The GTR8000 is advertised as the “Quantar Replacement”, however, the Quantar P-17 Jack 25-Pr Pin Out is different and rewiring will be needed when replacing a Quantar with a GTR8000
GTR8000 Programming


• In addition to System Specific Programming -

• Hardware configuration:

  • Transceiver Option Card Enable
  • Frequency Reference External - 10MHz Back Panel

• Options:

  • Wildcard Expanded
  • Simulcast Option Enabled

• Wildcard TX Table:

  • External PTT Input 5
  • Action Key from Wideband
  • Inaction Dekey from Wideband
IP Connectivity Equipment – 10 Sites

Alcatel MDR8000E 150Mbps Microwave Radios  
Alcatel 7705 SAR MPLS Routers 150Mbps

Privately owned Dark Fiber 150Mbps

Comcast Fiber Network Routers 50Mbps

RadWin 4.9GHz 10Mbps Ethernet Radios

Last Mile Solution
Backhaul Site Locations

Legend
- MDR8000
- Comcast Fiber
- Private Fiber
- RADWin 4.9GHz

* = 7705 Router
Network Hardware Issue

In February 2010, the first attempts to get the NetXpress IP Streams to Sync up failed with a very high “Lost Packet” rate.

Spent a day with the Project Manager and Router Technician to confirm the source of the problem. It was looking like a Channel Bank issue...until the Router Tech asked for a roll of black Electrical Tape, taped a copper shield in the Router....the NetXpress started working immediately.

Problem was the Copper Shield on the Filler Plates would bend to where it was interfering with the Ethernet Ports that were directly above it. The shields have been redesigned using Stainless...
Two IT Network Connectivity Terms

• MTU – Maximum Transmission Unit, the largest number of bytes the Ethernet path will allow in one packet (Header Plus Data)

• STP - Spanning Tree Protocol is a network protocol that ensures a loop-free topology for any bridged Ethernet local area Network

• MTU & STP – Found these two items can create anywhere from an “Unexplained Intermittent Glitch” to being out right “NetXpress Killers”
MTU - Maximum Transmission Unit

- When adding the Comcast Fiber routes to the ALU Network Routers the NetXpress Streams would sync but Remote Access via the Web Browser would not display the NetXpress Home page after entering the user-password.

- The NetXpress MTU is 1500 and the Router MTU was set at 1514. Found the ALU Router Network MTU had to be a minimum of 1540 to “see” the Home Webpage.
STP - Spanning Tree Protocol

Cisco 2960 Switch
Had an Error but was not the problem

RADWin Winlink 1000
Had no Errors but was the problem

• Once again everything was sounding good then one Island County NetXpress Site “disappeared” and lost connection to the Prime Site. Only error code was from a Cisco Switch with a “Port STP Error”.

• The Cisco Switch code was “STP BPDU - Bridge Protocol Data Unit”

• Test results BPDU: sent 72, received 144 (should be “0” received) This would be like having a transmitter test showing 72 watts forward and 144 watts reflected power

• This turned out to be a problem in the RADWin 4.9GHz part of the WA State IP path which provided the “Last Mile” of the Ethernet path. The NetXpress Traffic LAN and the Maintenance LAN were “Talking to Each Other”. WA State reprogrammed their RADWin Radio and the NetXpress came back online and has been working great for 4 months.
Harris NetXpress Working Great then...

• ALU was upgrading the Island County, Skagit County, Whatcom County and Washington State MPLS Network which now has 99 routers.

• When a location ~ 200 miles away was updated first one site and then another site that has Island County Routers and NetXpress equipment crashed.

• Found the update enabled RFC 1588 Timing Clocks using 2 duplicate IP Network Addresses in the other router were already used in Island County.

• Washington State now has one person in charge of the all the Network level IP assignments for all Interconnected Routers.
Privately owned Dark Fiber Issue

• For one path on Dark Fiber we were given incorrect Fiber length (too short) from the IT Department who said “Clean the Fiber contacts” when we reported that our light levels were too low...had 10Km SFP Lasers and ended up getting 40km SFP Lasers and all is OK now.

• Another Dark Fiber path, light levels had degraded by 7dBm, Same Message “Clean...”. Ended up changing the Inter-Building Fiber. Kept the same SFP Lasers and Levels are 5dB higher than the original install...

• Router received “light” levels are now -10dBm +/- 2dB
Ping and Trace Route Tests

• Do “Ping” and “Trace Route” tests on all IP Paths for documenting your “Working System” in order to troubleshoot Network future problems

• PING 172.21.8.1

• Reply 64 bytes from 172.21.8.1: icmp_seq=5 ttl=55 time=39.7ms. If the “time” jumps more than about 15ms per reply then the network has too much Jitter and the Streams will have too many lost packets to run properly.

• If the Ping Test Reply time (latency) is greater than the Simulcast Delay then the NetXpress SNC-101T Delay will not lock to the SynchroCAST3 stream. In this case our delay is 180.0000ms and the reply is 39.7ms and the timing works great.
Trace Route on our longest Route

- traceroute to 172.21.8.1, (From 7705 SAR Router 192.168.10.8)
  - 1 10.0.0.41 (10.0.0.41) * 12.1 ms 33.3 ms 13.9 ms Comcast
  - 2 10.0.0.38 (10.0.0.38) 35.9 ms 12.6 ms 13.1 ms Comcast
  - 3 10.0.0.18 (10.0.0.18) * 13.8 ms 13.0 ms 13.4 ms MDR8000
  - 4 10.0.0.22 (10.0.0.22) 16.5 ms 16.3 ms 38.6 ms MDR8000
  - 5 10.0.0.1 (10.0.0.1) 11.1 ms 58.7 ms 11.9 ms MDR8000
  - 6 10.10.21.8 (10.10.21.8) 16.5 ms 14.6 ms 16.2 ms Fiber (Private)
  - 7 10.10.21.2 (10.10.21.2) 16.8 ms 16.7 ms 16.2 ms MDR8000
  - 8 10.10.21.0 (10.10.21.0) 10.9 ms 11.2 ms 11.5 ms MDR8000
  - 9 10.10.21.28 (10.10.21.28) 17.0 ms 11.6 ms 12.4 ms MDR8000
  - 10 172.21.8.1 (172.21.8.1) 11.6 ms 11.2 ms 12.9 ms RadWin 4.9GHz

- This tests the Network path through all of our major equipment types

- If the site “disappears” and now the Traceroute reply stops at “Site 6” then we know which router to check out first
**How do you know the IP Connectivity is Optimized??**

The NetXpress will have no Lost Packets in the Stream Statistics – (Recovered OK)

The NetXpress will have no Network or Stream Alarms in the Alarm History

<table>
<thead>
<tr>
<th>IP Stream Types</th>
<th>Multicast</th>
<th>Unicast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best to date &gt;155 days</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Timing Delay will be Locked

Normal Delay Error +/- 500 nanoseconds

Timing confirmed to the Microsecond with the Convex 806A TIMS

<table>
<thead>
<tr>
<th>Global Stream Settings:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoS Priority - High</td>
</tr>
<tr>
<td>Forward Error Correction - High</td>
</tr>
<tr>
<td>TDM Frames per Payload - 40</td>
</tr>
<tr>
<td>Jitter Buffer Size - 32</td>
</tr>
</tbody>
</table>

**We have 16 NetXpress IP Channel Banks in the System with 2 more planned**
- Field User Report –

“Sound like Simulcast Timing is off”

MTR2000 Simulcast RJ-45 and 10MHz Configuration

Remote Site 66-Block -NetXpress VF-40 (Reference is for 1st VF port)

<table>
<thead>
<tr>
<th>Field</th>
<th>User</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr-1 Tip</td>
<td>26</td>
<td>Receive Audio +</td>
</tr>
<tr>
<td>Pr-1 Ring</td>
<td>1</td>
<td>Receive Audio</td>
</tr>
<tr>
<td>Pr-2 Tip</td>
<td>27</td>
<td>Transmit Audio +</td>
</tr>
<tr>
<td>Pr-2 Ring</td>
<td>2</td>
<td>Transmit Audio</td>
</tr>
<tr>
<td>Pr-3 Tip</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Pr-3 Ring</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Pr-4 Tip</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Pr-4 Ring</td>
<td>4</td>
<td>E-lead “A” Normally Open</td>
</tr>
<tr>
<td>Pr-5 Tip</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Pr-5 Ring</td>
<td>5</td>
<td>E-lead “A” Common</td>
</tr>
<tr>
<td>Pr-6 Tip</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Pr-6 Ring</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

S6RR Plug

<table>
<thead>
<tr>
<th>Category</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White-Orange</td>
</tr>
<tr>
<td>2</td>
<td>Orange</td>
</tr>
<tr>
<td>3</td>
<td>White-Green</td>
</tr>
<tr>
<td>4</td>
<td>Blue</td>
</tr>
<tr>
<td>5</td>
<td>White-Blue</td>
</tr>
<tr>
<td>6</td>
<td>Green</td>
</tr>
<tr>
<td>7</td>
<td>White-Brown</td>
</tr>
<tr>
<td>8</td>
<td>Brown</td>
</tr>
</tbody>
</table>

CAT-5 Cabling

Remote Site RJ-45 “Biscuit” Jack

<table>
<thead>
<tr>
<th>Field</th>
<th>User</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line-2 +</td>
<td>Receive Audio +</td>
<td></td>
</tr>
<tr>
<td>Line 2 -</td>
<td>Receive Audio -</td>
<td></td>
</tr>
<tr>
<td>A19</td>
<td>Transmit Audio -</td>
<td></td>
</tr>
<tr>
<td>A17</td>
<td>Transmit Audio +</td>
<td></td>
</tr>
<tr>
<td>C10</td>
<td>E-lead “A” Normally Open</td>
<td></td>
</tr>
<tr>
<td>C19</td>
<td>E-lead “A” Common</td>
<td></td>
</tr>
</tbody>
</table>

10MHz Coax from GPS to MTR Ext Ref Port

MTR Programming - Ext Ref 10MHz, Ext PTT Aux Audio, Aux TX Input “230” Wireline 2175Hz RX tone on.
Questions???

• Contact Info

• Judy Hill  jhill@icom911.org

• John “JJ” Jenkins  jjenkins@icom911.org