

NXU Auxiliary I/O Control Signals over Ethernet

Purpose

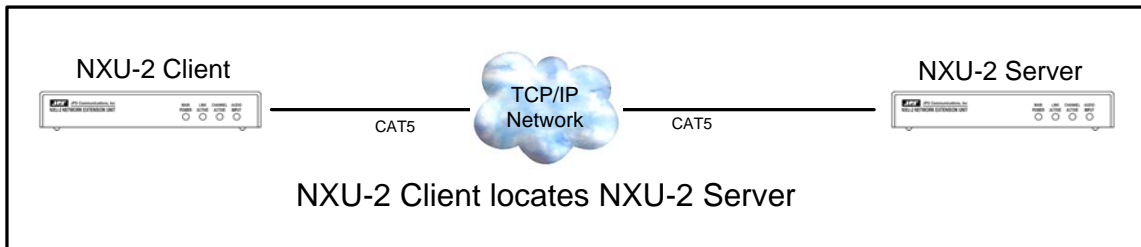
This application note will describe how the Auxiliary (AUX) I/O functions of Raytheon's Network eXtension Unit (NXU) can be used to provide basic remote control signaling of devices over an Ethernet link.

Introduction

The primary function of an NXU is to convert analog baseband audio into VoIP or RoIP data, and then transport this digitized audio over a TCP/IP network to another remote located NXU or DSP-2 module.

Two NXU units can be associated on a TCP/IP network by assigning one NXU as a CLIENT and the other NXU as a SERVER. This creates a dedicated point-to-point connection where VoIP/RoIP data or other data signals can flow between the (2) NXUs.

NXU Client / NXU Server Association

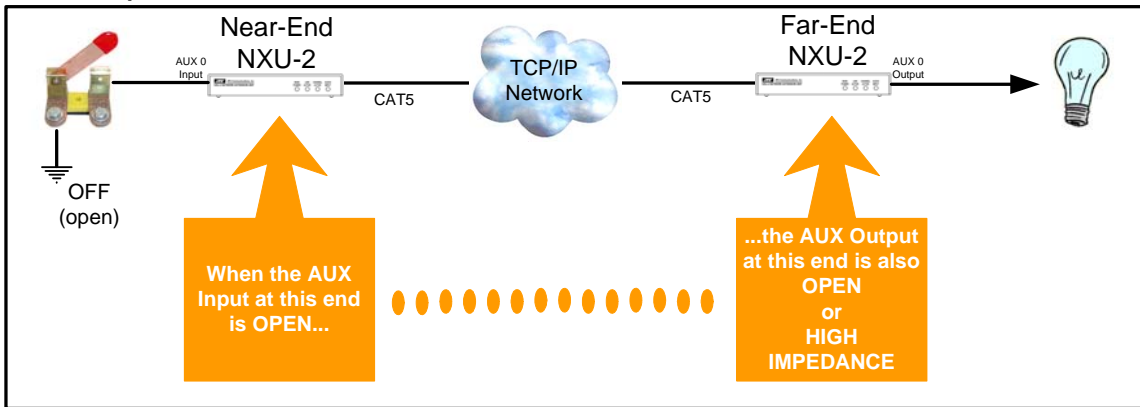


The NXU has other features and functions, which include multiplexing of RS-232 data, land mobile radio control signals, and Auxiliary I/O Signals onto the same Ethernet data stream as the VoIP data. In this application note we will discuss the Auxiliary I/O functions of the NXU.

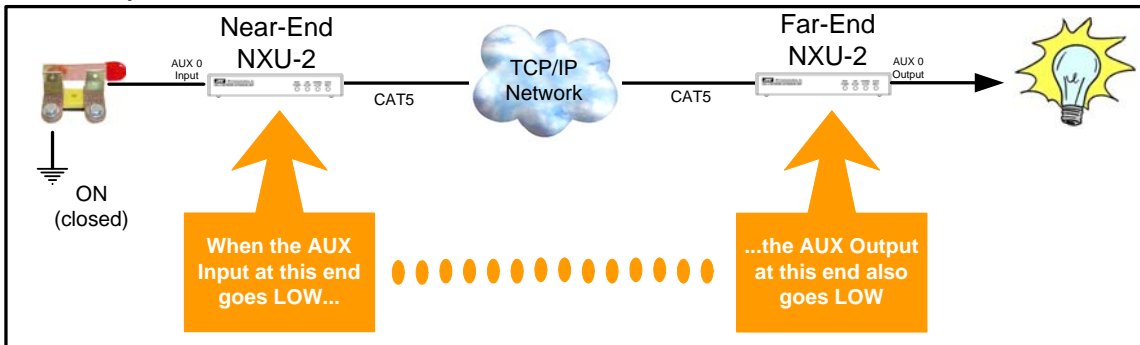
The NXU can support (2) auxiliary input and output signals, identified as AUX0 and AUX1. With (2) NXUs associated in a peer-to-peer connection over a network, a control signal can be introduced to one of the two AUX inputs at the originating NXU, and over the network, the AUX outputs at the far-end NXU will have an identical reaction that correlates to the control signal at the near-end NXU. Fundamentally, what happens at the near-end NXU AUX input will occur at the far-end NXU AUX output.

The following two diagrams illustrate, in simplified terms, what happens when the AUX input at the near-end is open, the far-end AUX output will be at a high-impedance. Conversely, when the AUX input at the near-end is closed or grounded, the far-end AUX output will also be grounded. The relay and light bulb are not true representations of a controllable output device, but it does help illustrate the relationship to the toggle switch at the near-end NXU. True logic outputs will be discussed later in this application note.

AUX Input: OPEN



AUX Input: Grounded or LOW



The NXU Auxiliary I/O feature can be used in a variety of ways to transfer a control signal from one location to a remote location, using an Ethernet network. The following are a few applications that can take advantage of this feature, and many of these applications are not necessarily related to land mobile radio communications:

- Alarm
- Sensor
- Reset Function
- Switch Function
- Radio
- Basestation
- Repeater
- Dispatch Console

Requirement

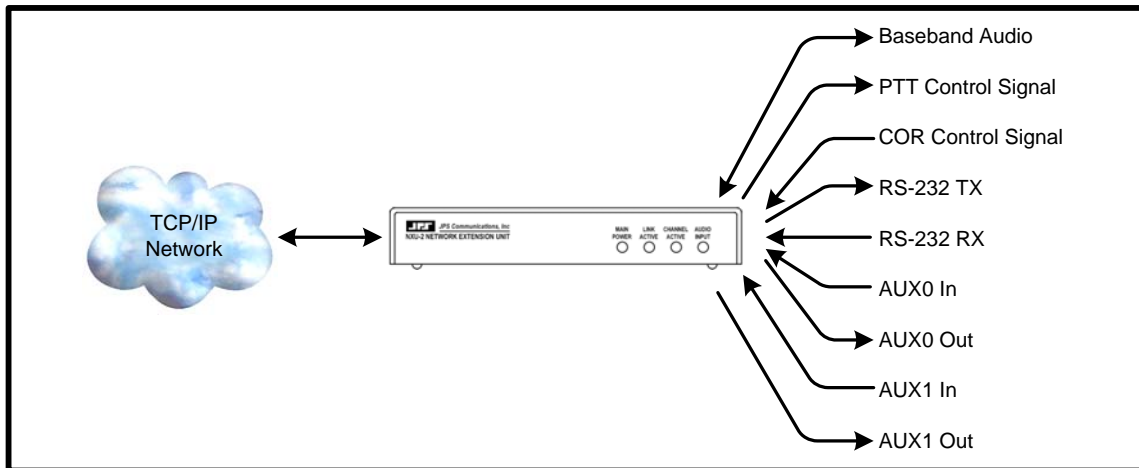
Provide simple remote control functionality of a device over an Ethernet network, while simultaneously transporting VoIP/RoIP data.

Solutions

Raytheon's NXU is a standalone device that interfaces full-duplex baseband audio, (1) RS-232 port, (2) Auxiliary I/O's, and (4) status bits onto a TCP/IP Ethernet network. The NXU uses RoIP (Radio Over Internet Protocol) to convert land mobile radio baseband audio to datagram, which can then be routed over an existing digital network. The NXU can also address the essential control signals used by land mobile radio systems. These control signals consist of the COR signal generated by a device when it is receiving a radio transmission, and the PTT signal which

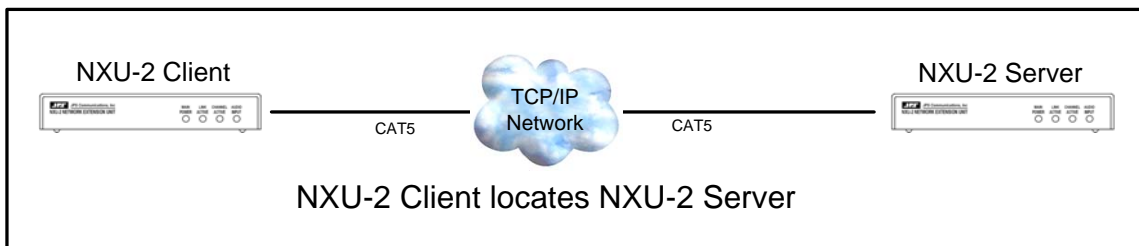
requests a device to begin a radio transmission. VoIP alone cannot handle these control signals, and that is why RoIP, used by Raytheon, is essential to providing compatibility to land mobile radio systems. The following diagram illustrates the signals that can be transported over a TCP/IP network.

NXU Functions



NXU units are network devices, meaning they can be identified over the network with unique IP addresses. Two NXUs can be associated across a TCP/IP network by assigning one NXU as a *Server*, and the other NXU as a *Client*. The purpose of the *Server NXU* is to wait on the network for a *Client NXU* to connect to it. The purpose of the *Client NXU* is to locate and connect to a specific *Server NXU* over the network. Since the *Server NXU* has a unique IP address, we can tell the *Client NXU* to associate or connect to the *Server NXU* using the server's IP address. Once the association is established (typically within 5 seconds) RoIP traffic can commence in full duplex fashion.

NXU Client / NXU Server Association

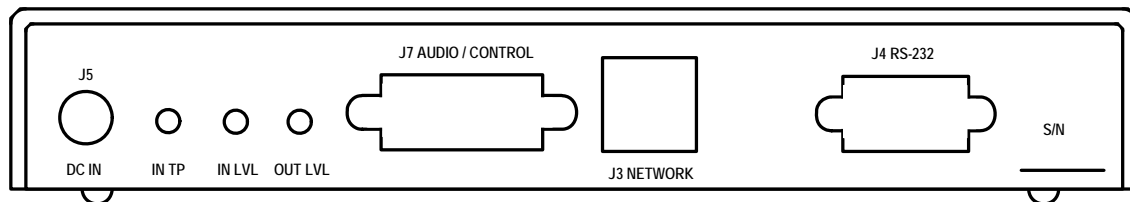


The NXU has (3) primary connections:

- J3 – RJ45 TCP/IP Network Connection, 10 mb/s Ethernet. Able to connect back-to-back NXUs using CAT5 Cross Over cable, or over a segmented network using CAT5 Straight-Thru cables.
- J4 – RS-232, Asynchronous, Full Duplex. DB-9 connection used for serial programming of the NXU, as well as means of transmitting RS-232 data from one NXU to another NXU at a maximum user selectable baud rate of 115200 bps. This auxiliary RS-232 link can be used to control serial equipment over the network

- J7 – Audio / Control. DB-15 connection that will accept any Raytheon supplied or end-user built radio interface cable. All baseband audio, COR and PTT control signals from the land mobile radio device will interface to this connection.

NXU Rear Panel Connectors



Any of the ACU Radio Interface Cables manufactured by Raytheon can be used to interface a radio to the NXU unit. However, the supplied crossover adapter must be inserted between the NXU J7 connector and the Built Radio Interface Cable to “Crossover” the proper control signals. Naturally, the end-user can fabricate similar cables and connect the leads to the associated pin on connector J7, thus eliminating the need to use the Crossover Adapter.

J7 Connector Description

PIN	Signal	Description
1	Ground	Ground connection.
2		Not used.
3	/AUX In 0	Auxiliary Input 0 - Active low.
4	/AUX Out 0	Auxiliary Output 0 - Active low.
5	Ground	Ground connection.
6	Audio Input	Balanced audio input.
7	Analog Ground	Analog ground.
8	Audio Output	Unbalanced Audio output.
9		Not used.
10	/AUX In 1	Auxiliary Input 1 - Active low; general purpose.
11	/AUX Out 1	Auxiliary Output 1 - Active low; general purpose.
12	/COR Input	Input from radio COR, programmable active high or low.
13	/PTT Out	Output to radio PTT, active low, open drain.
14	Audio Input	Balanced audio input.
15	Analog Ground	Analog ground.

Interface Cables:

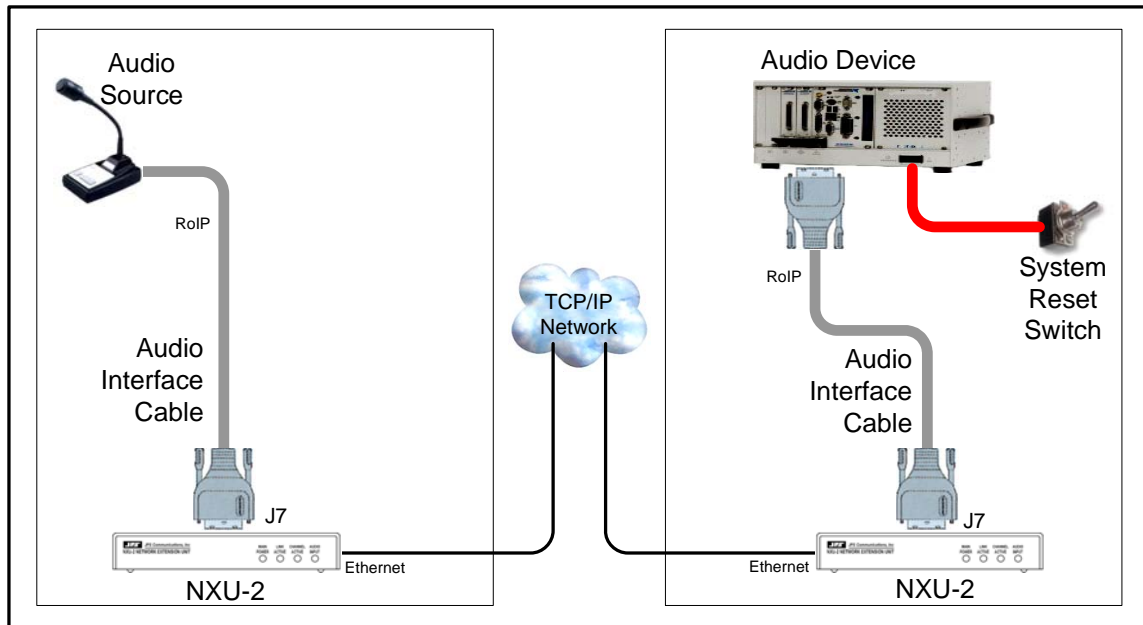
When connecting the NXU to an audio device, such as radio or land mobile radio equipment, basestation, dispatch console, ACU-1000, ACU-T or SNV-12, an interface cable will be connected to the J7, DB-15 connector at the rear of the NXU. The J7 connector will accept all ACU-1000 specific interface cables when connecting a radio, or straight-through cables when connecting to the ACU-1000 Intelligent Interconnect or SNV-12 Receiver Voter, for example.

If your NXUs use radio interface cables built by Raytheon you will need to make provisions or modifications to those cables, such that the AUX I/O signal lines are accessible. This will require a “Y” cable configuration.

“Y” Cable Example:

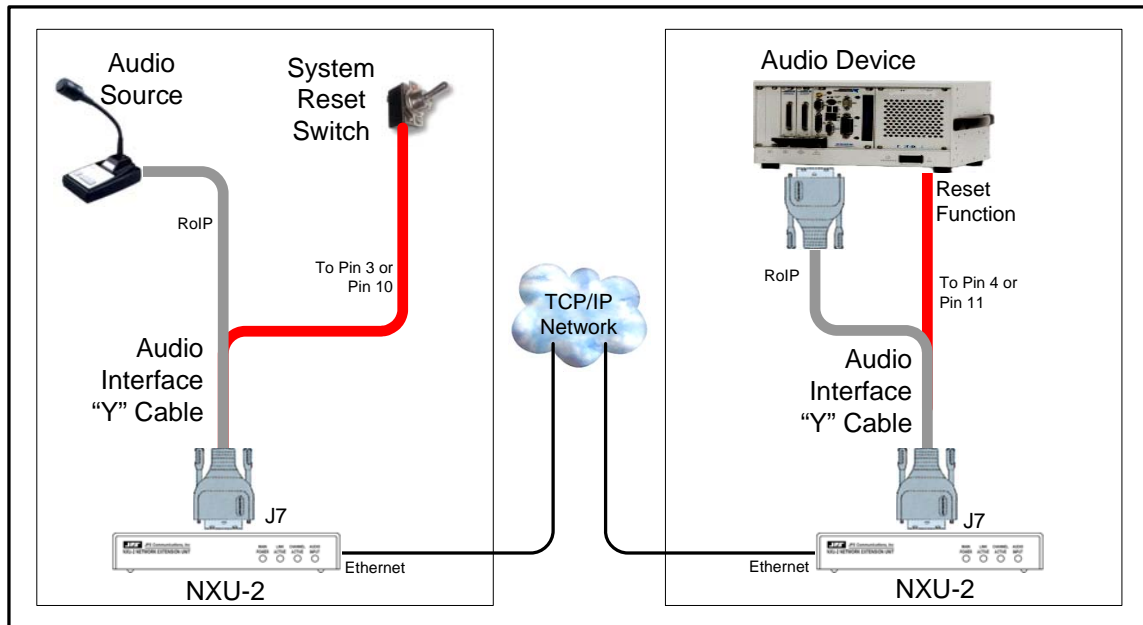
In the following diagram a “System Reset Switch” is located near the remote equipment. When the remote equipment requires a reset function, personnel will be required to travel to the remote location to reset the equipment.

Reset Switch at Remote Location



In this application, the AUX I/O functions of the NXU can be used to provide a remote “System Reset” function. A special cable or modified cable assemble must be used to “Breakout” the AUX I/O signals at both near-end and far-end NXUs. Resetting of the remote device can now take place at the local position.

Reset Switch Function over Ethernet AUX I/O



AUX Input and Output Connections:

The following table details the specifications and connection requirements of the Auxiliary Inputs and Outputs that are located on the J7 DB15 connector:

AUX Input Specifications	
Input impedance	47k ohm pull-up to +5V
Polarity	Active low
Threshold	+2.5V nominal
Protection	Up To + 100 VDC

AUX Output Specifications	
Output Type	Open drain, 47k ohm pull-up to +5V
Maximum Sink Current	100 mA
Max Open Circuit Voltage	+60 VDC

AUX Input Signal Considerations:

The active low input signal considerations of the AUX Input are very straightforward:

- AUX Input Open (high-impedance) = AUX Output is High Impedance
- AUX Input Grounded = AUX Output is Grounded

The AUX Input will also react to normal TTL or CMOS logic signals, as long as these input signals have a threshold of +2.5 VDC. A simple single-pole switch that has one pole grounded will act as an ideal stimulus at the AUX Input.

AUX Output Signal Considerations:

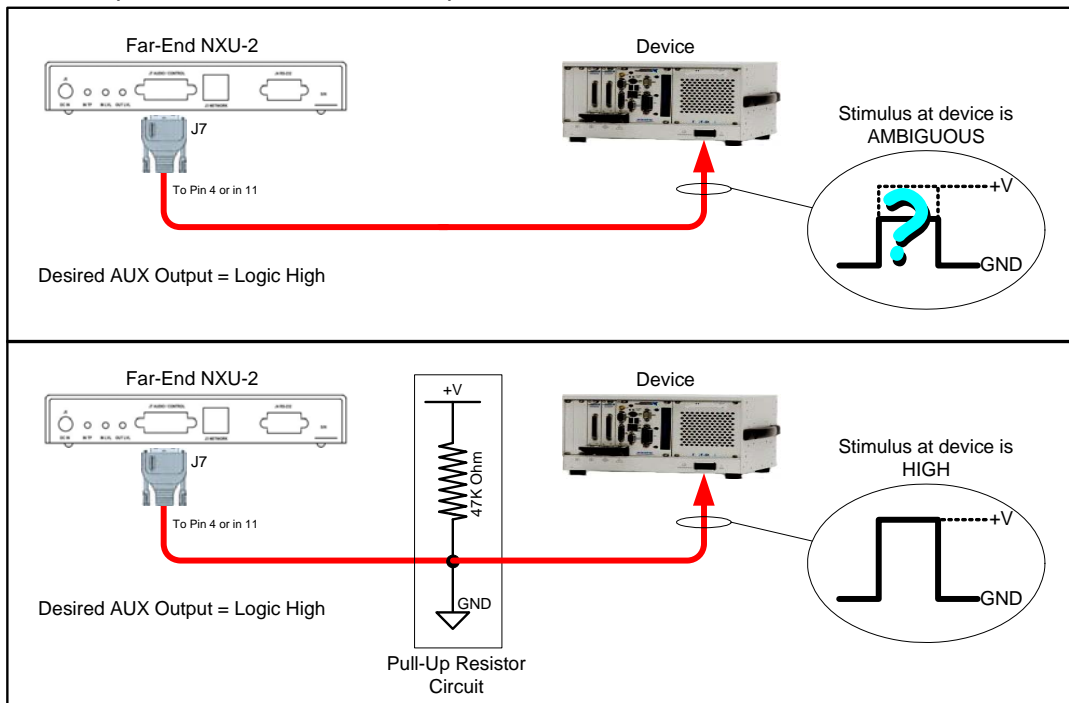
The active low output signal of the AUX Output of the NXU is derived from the drain of a FET. When the drain is open, it looks like a high impedance connection, or simply, an open circuit. When the drain is closed the output will appear to be grounded. Again, the AUX Output will follow the AUX Input of the near-end NXU.

Far-End NXU (AUX Input)	Near-End NXU (AUX Output)
Open	High Impedance
Grounded	Grounded (0 Volts)

The compatibility of the AUX Output depends upon the device that will be connected to the NXU. The device maybe able to react to HIGH / LOW or 1 / 0 logic levels, but in some cases these logic levels maybe ambiguous, particularly when the output is at a high-impedance level, or floating. To make this output logic level or voltage level more predictable or unambiguous the controlled device should incorporate a "Pull-Up" circuit.

This circuit will assure that the high logic level is truly high, and not floating. The pull-up resistor assures that the current is keep to a minimum, but still allows the control device to "see" the voltage that defines that logic. 10k Ω and 47k Ω are common values used as pull-up resistors. It is recommended that a 47k Ω resistor be used with the NXU to reduce current flow in the pull-up circuit.

AUX Output With and Without Pull-Up Resistor



Most equipment that will react to active low logic levels should function normally with the AUX Output levels of the NXU. If the device that is being controlled by the AUX Output is not reacting in a predictable fashion, it is possible that an external pull-up circuit maybe required. But in most cases, a direct connection to the AXU Output (Pin 4 or Pin 11) should be adequate.

Remember, what ever happens at the near-end NXU AUX Input, will happen at the far-end NXU AUX Output.

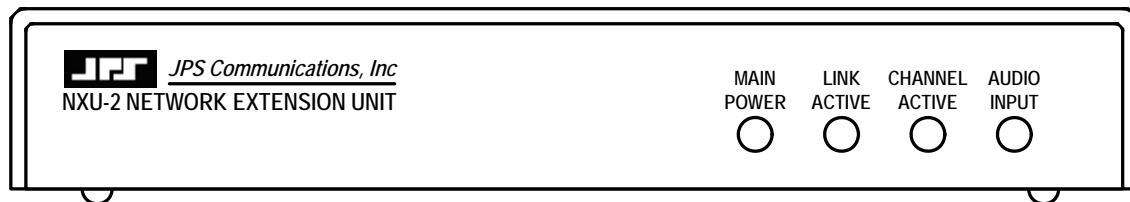
Network Configuration of NXU:

It is imperative that the network be configured such that the Server and Client NXUs have network visibility between themselves, otherwise the link will not be possible.

- Server NXU: This NXU must have a unique IP Address, and be configured as a SERVER.
- Client NXU: This NXU must also have a unique IP Address, and be configured as a CLIENT. Additionally, this client NXU must have the "Serve IP Address" field entered with the IP address of the Server NXU that it will be associating with.

If the devices are configured correctly the Link Active LED on each of the NXUs will be lit.

NXU Front Panel LED's



Once the network association of the peer-to-peer NXUs is established, VoIP data flow will be enabled and remote AUX signaling can occur between the (2) NXU units.

Conclusions

The Auxiliary I/O function of Raytheon's NXU Network Extension Unit is a feature that could provide simple low-level remote control signaling of device related or unrelated to land mobile radio communications. This signaling can take place over available Ethernet networks (intranet, LAN, Internet, etc) simultaneously with VoIP / RoIP and RS-232 data traffic. Once the NXUs are associated over the network the AUX0 and AUX1 Input and Output functions are always ready and available without further user management.

Acronyms

AUX: Auxiliary

COR: Carrier Operated Relay is a signal from a receiver that indicates when a carrier or signal is being received and that the receiver is unsequelched.

GND: Ground, is an electrical potential that is equivalent to zero volts.

GSM: Global System for Mobile Communications is a form of Voice Coding and Decoding algorithm used by the NXU.

NXU: Network Extension Unit, is a device used to connect a DSP-1 module or a land mobile radio device over an IP-based network. The unit creates a network link that passes both voice and control signals in the form of RoIP.

PTT: Push-to-Talk, A signal to a radio transmitter, which controls the actual transmission of radio frequency energy over the air.

RoIP: Radio over Internet Protocol, (compared to VoIP) not only converts voice to a digital format that can be sent over the Internet or other IP based network, but also convert PTT and COR control signals that are essential for seamless for radio interoperability. Also include are extra delay and jitter compensation.

RS232: Recommended Standard 232 is a specification for serial communications between a computer and modem, or computer to other device to be controlled.

TCP/IP: Transport Control Protocol / Internet Protocol, is an additional layer to the Internet Protocol, which ensures delivery of packets, sent across the network. It can handle situations such as lost packets or packets arriving out of order.

VOCODER: Voice Coder / Decoder, is an algorithm use by the NXU that reduces speech signals to slowly varying signals transmittable over TCP/IP networks to conserve network bandwidth.

VoIP: Voice over Internet Protocol, is a method of sending voice communications across a digital network.

References

NXU Installation and Operation Manual, P/N 5000-600200, Revision 3.1, Raytheon