

NXU to Help Migrate to New Radio System

Purpose

This Application Note will describe a method at which NXU Network eXtension Units can aid in the migration from a legacy radio system to a new, or different radio system.

Introduction

Migrating or “Cutting-Over” from an existing legacy radio system, to a new or different radio system can be accomplished using several methods. One method being, the wholesale swapping of all legacy portable and mobile radios, to the new portable and mobile radios after the new radio infrastructure is in place, tested and commissioned.

This is by far the most ideal method, but poses some logistical problems:

- Time – Depending upon the size of the enterprise or agency, physically replacing and testing of the new portable and mobile radios used in the field in such a short period of time may not be practical.
- Cost – Due to the size of the legacy radio system, and the costs related to the purchase of new radio equipment, the enterprise or agency may need to “Phase-In” the implementation or distribution of new portable and mobile radios to be used in the field.

Another common method at which an enterprise or agency can migrate from a legacy radio system is to have both old and new radio systems functioning in parallel for a period of time at which each radio in the field can be replace over that period of time.

If the legacy radio system and the new system can operate, side-by-side, for any number of months or years, this would allow the methodical installation and provisioning of the new portable and mobile radios into the field. This method requires the user to carry both, new and old radios.

Another method will *share* the baseband audio between the two disparate systems such that *temporary* interoperability can exist between the new and old radio users during this migration period. Legacy users can continue to user their existing radios while the newer users can take advantage of the new radio infrastructure, while still being able to communicate with the remaining legacy radio users.

Requirement

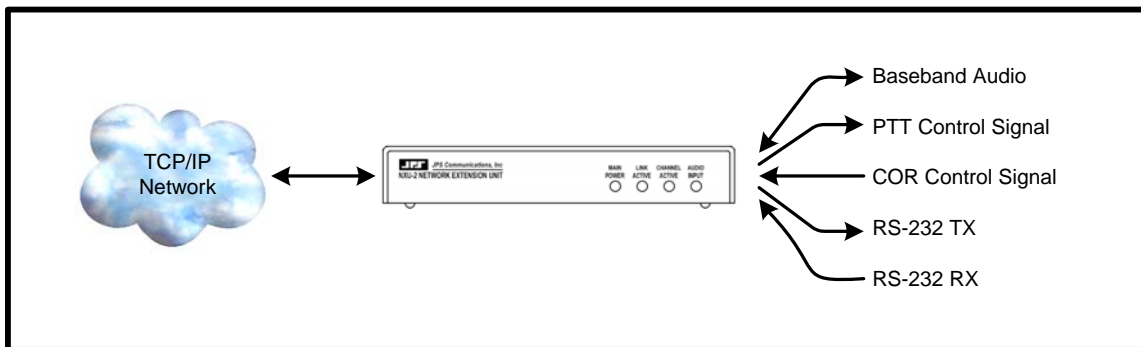
Allow a legacy radio system to function in parallel with the radio system for any period of time at which legacy users can slowly migrate to the new radio system as portable and mobile radios in the field are systematically replaced.

Solutions

During the migration, the disparate radio systems can coexist and function in parallel by sharing their baseband audio. This can be accomplished using JPS Communications NUX, Network eXtension Units.

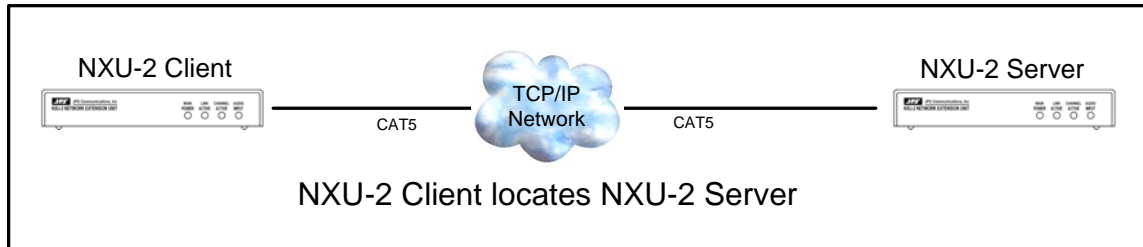
The JPS Communications NXU Network eXtension Unit is a standalone device that interfaces full-duplex baseband audio, (1) RS-232 port and (4) status bits onto a TCP/IP Ethernet network. The NXU-2 uses RoIP (Radio Over Internet Protocol) to convert land-mobile radio baseband audio to datagram, which can then be routed over an existing digital network. The NXU-2 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 JPS Communications, 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



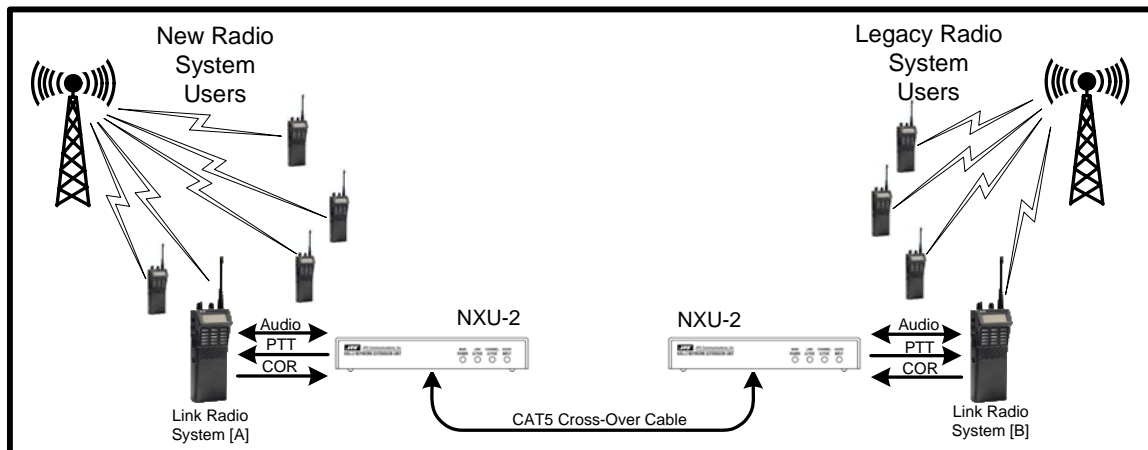
NXU units are network devices, meaning they can be identified over the network with unique IP addresses. Two NXU's can be associated across a TCP/IP network by assigning one NXU-2 as a *Server*, and the other NXU-2 as a *Client*. The purpose the *Server NXU* is to wait on the network for a *Client NXU* 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



Two back-to-back NXU units can be associated over an Ethernet network to facilitate the sharing of RoIP digitized baseband audio between disparate radios systems. The following diagram illustrates a method at which two NXU units, connected by a CAT5 Cross-Over Ethernet cable, utilize RoIP to route baseband audio between Radio System [A] and Radio System [B], in both directions.

Back-to-Back NXU's



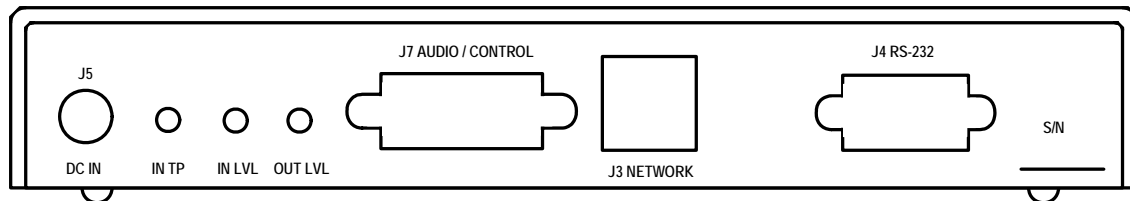
Since the NXU units deal with the baseband audio of the radio system, the protocol or frequency-band-of-operations of the radio systems is no concern, as long as there is a "Link Radio" available and connected to the NXU units using either JPS Supplied Radio-Interface cables, or user-built Radio-Interface cables. The "Link-Radio" is the interface to the radio infrastructure. Either portable or mobile radio units can be utilized as "Link-Radios", as long as the "Link-Radio" is able to *reach* the repeater.

When one user in the New Radio system keys his or her radio the Link-Radio at the NXU will transport the audio in the form of RoIP data over the CAT5 Cross-Over cable. The *far-end* NXU will receive the RoIP data and then convert it to baseband audio to be presented to the Old Radio system Link-Radio. Users in both systems will be able to communicate between the systems with a minimum amount of latency (~200 ms).

The NXU-2 has (3) primary connections:

- J3 – RJ45 TCP/IP Network Connection, 10 mb/s Ethernet. Able to connect back-to-back NXU-2's 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-2, as well as means of transmitting RS-232 data from one NXU-2 to another NXU-2 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 JPS Communications 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-2 Rear Panel Connectors



Any of the ACU® Radio Interface Cables manufactured by JPS Communications can be used to interface a radio to the NXU-2 unit. However, the supplied crossover adapter must be inserted between the NXU-2 J7 connector and the JPS 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.

Although it is recommended that the input and output of the NXU-2 be balanced, the unit can accommodate single-ended connections by grounding one of the balance lead of the NXU to the audio ground. The COR and PTT control signal connections to and from the radio device is also accommodated by the J7 connector.

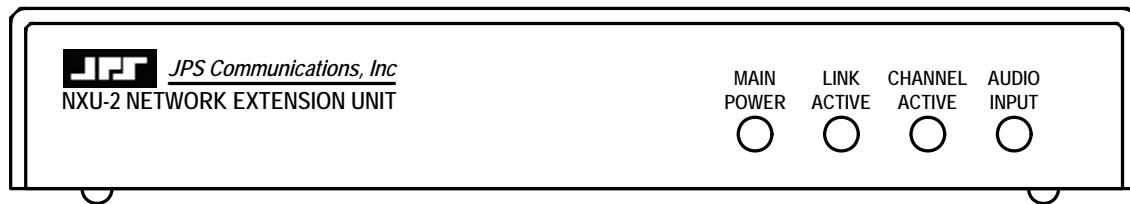
Network Configuration of NXU-2:

It is imperative that the network be configured such that the Server and Client NXU-2's have network visibility between themselves, otherwise the link will not be possible.

- Server NXU-2: This NXU must have a unique IP Address, and be configured as a SERVER.
- Client NXU-2: 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 NXU-2's will be lit.

NXU-2 Front Panel LED's



Adjusting the Input Audio:

The audio input will accept signal levels from -30 to $+11$ dBm from the connected radio. Internal circuitry is used to amplify or attenuate this input as necessary to optimize the level. The signal level is adjusted by the IN LVL potentiometer accessible from the rear panel. The input is set to 0 dBm when shipped. Test point, TP1, is provided at the rear panel so the actual audio signal voltage applied to the A/D converter can be measured with an AC voltmeter. The correct level for best operation as measured at TP1 is about 0.2V or -12 dBm (600 ohm reference).

If an AC voltmeter is not available, observe the AUDIO INPUT LED while programmed audio is present from the connected radio. The AUDIO INPUT LED should flash momentarily at each voice peak. Make appropriate adjustments using the IN LVL potentiometer.

Adjusting the Output Audio:

The audio output from the NXU-2 is a low impedance (10 ohm) unbalanced AC coupled output, which is to be routed to the radio through the interface cable. The output level is adjusted by the OUT LVL potentiometer accessible from the rear panel. This output provides a 0 dBm nominal

level; +15 dBm clipping into a 600 ohm load. The audio output will supply signal levels from –30 to +11 dBm. Make adjustments necessary to properly modulate the connected radio.

COR Input Control Signal:

The COR input on J7 controls the RoIP data across the network. If a unit has an active COR input, that unit's audio input will be transferred across the network and will appear at the audio output on J7 at the other NXU-2 unit at the remote end. As long as the COR input of this NXU-2 remains active, the PTT output will remain active on the unit it's connected to. The audio channels are independent, and full duplex operation is possible. If the radio or other audio equipment does not have a COR output, it's possible to tie the NXU-2 COR input line to the active state so that data will be transmitted continuously.

VOCODER Selection:

The NXU-2 uses VOCODER algorithms to compress the baseband audio when it is converted to RoIP data. This will conserve network bandwidth. For example, some compression methods work well with voice and provide a high amount of compression, but do not handle signaling tones very well. Other methods handle tones and voice, but use more network bandwidth because they offer less compression. You may select the method from the following voice compression schemes that optimizes the trade-offs for your particular application. Note both NXU's in the link must use the same VOCODER:

1. GSM 13Kbps - Suitable for voice communications only. Should not be used if any tone signaling is required. Offers the greatest compression with reasonable voice quality. This is the default setting.
2. ADPCM 16Kbps – Suitable for voice or tone signaling. Offers good voice compression, but the voice quality is lower than the other compression methods.
3. ADPCM 24Kbps – Suitable for voice or tone signaling. Offers less compression than ADPCM 16Kbps but the voice quality is higher.
4. ADPCM 32Kbps – Suitable for voice or tone signaling. Offers still less compression, but the voice quality is the best of the ADPCM compression types.
5. PCM 64Kbps – Suitable for voice or tone signaling. Offers the highest quality of all compression methods, but provides the least compression. *You should use this method only if your network offers low latency and good throughput.*

Refer to the NXU-2 Installation and Operations Manual for further installation and operations information.

Conclusions

When migrating from one land-mobile radio system to another land-mobile radio system, the transition may not be as straightforward as one would like. Because of physical, time and cost constraints, there maybe a period of time at which both, new and old radio systems must remain active during the transition period. This maybe accomplished over a period of weeks, months or years.

The NXU-2 can ease the transition period by allow both new and old radio systems to operate side-by-side, by simply using host link-radios to interface with both radio systems. The baseband audio from the link radios can be shared over a back-to-back NXU link utilizing RoIP and a simple CAT5 Ethernet Cross-Over cable. Simple adjustments to the input and output audio levels to, and from the NXU-2 will provide unity gain, thus providing transparency to the both radio system end-user.

Once the radio system migration is completed, the NXU units can then be utilized for other tasks, such as extended radio links, leased line elimination, or any other application that requires remote access to the audio of land mobile radio devices located over large distances.

Acronyms

ADPCM: Adaptive Differential Pulse Code Modulation, is a form of Voice Coding and Decoding algorithm used by the NXU-2

CAT5: An Ethernet cable standard that is the 5th generation of twisted pair Ethernet cabling and the most popular of all twisted pair cables used today.

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 unquelled.

GSM: Global System for Mobile Communications, is a form of Voice Coding and Decoding algorithm used by the NXU-2.

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.

PCM: Pulse Code Modulation, is a form of Voice Coding and Decoding algorithm used by the NXU-2

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: 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-2 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-2 Installation and Operation Manual, JPS P/N 5000-600200, Revision 3.1, JPS Communications.