Push-to-Talk Track – W33

NXDN Industry Update

NXDN™
Next Generation Digital LMR Technology.

Speaker Introductions

Mark Behrends

- Icom America, Inc.
- Vice Chair – NXDN Forum
- Senior Strategic Sales Manager

Mark Jordan

- JVCKenwood USA
- Regional Sales Mgr – Enterprise Systems

NXDN™
Next Generation Digital LMR Technology.

NXDN

- **Multivendor** low complexity digital two-way radio protocol
- **Standards-based**
- Originated with joint technical alliance between **JVCKENWOOD** and **ICOM**

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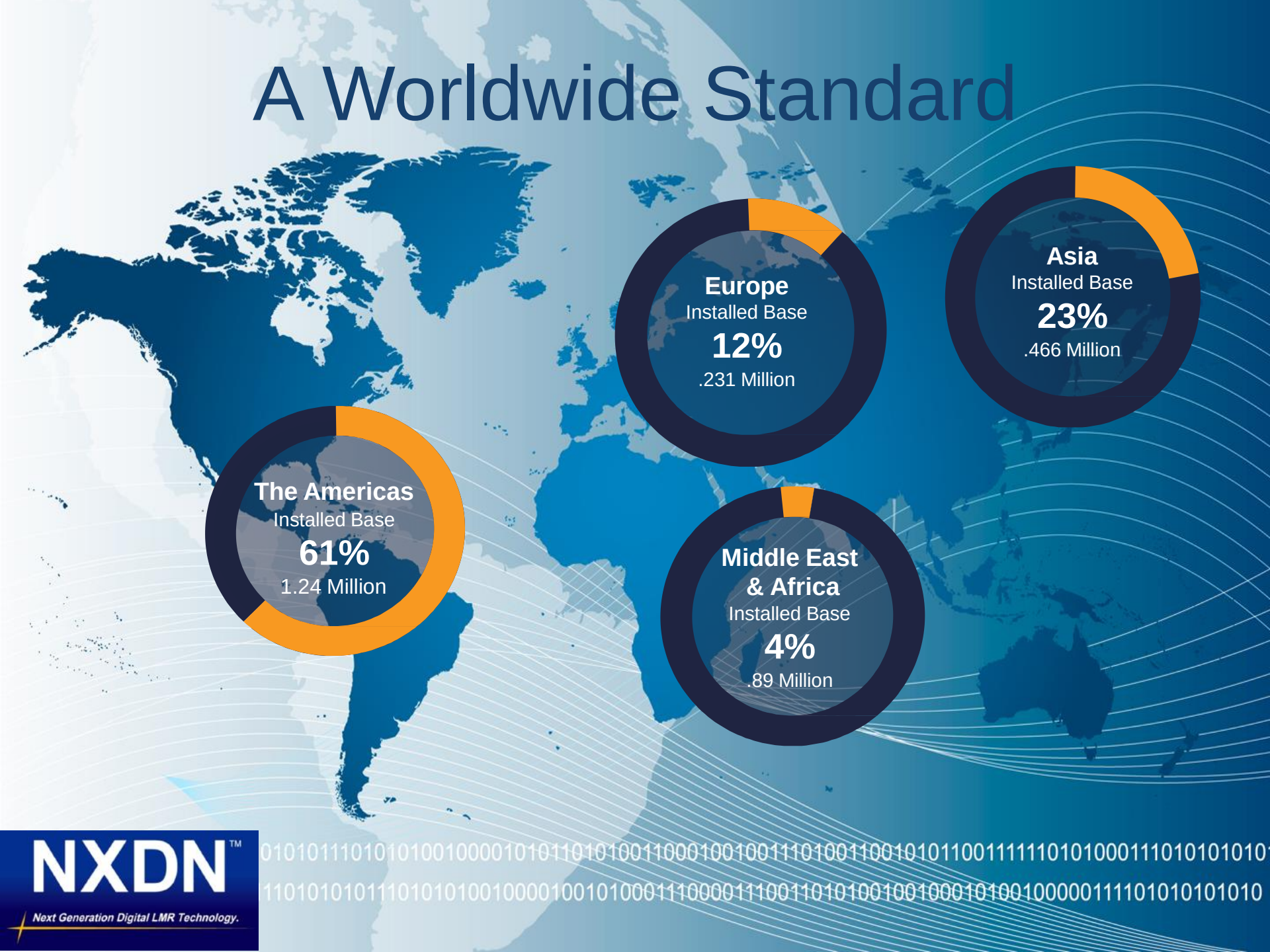
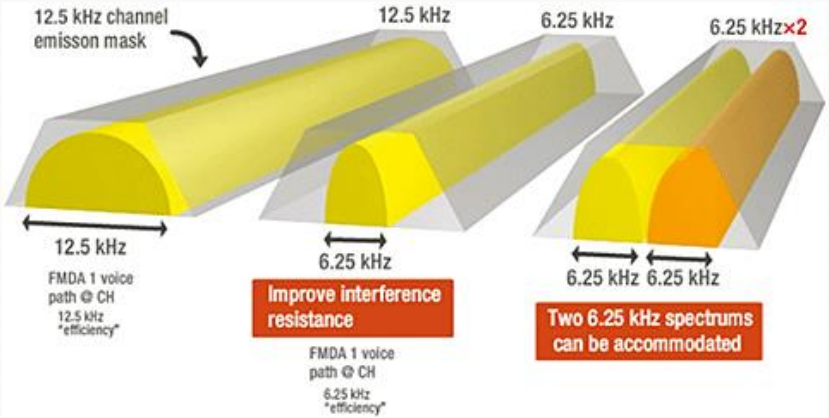
A Worldwide Standard

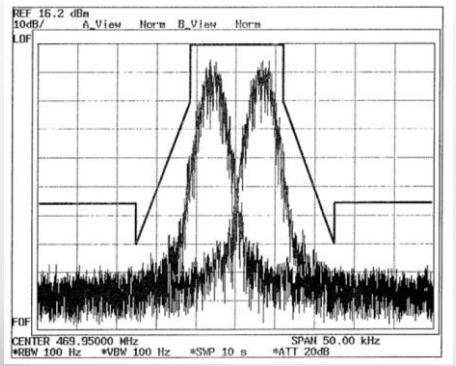


NXDN™
Next Generation Digital LMR Technology.

NXDN Technology



- FDMA achieving true 6.25kHz efficiency



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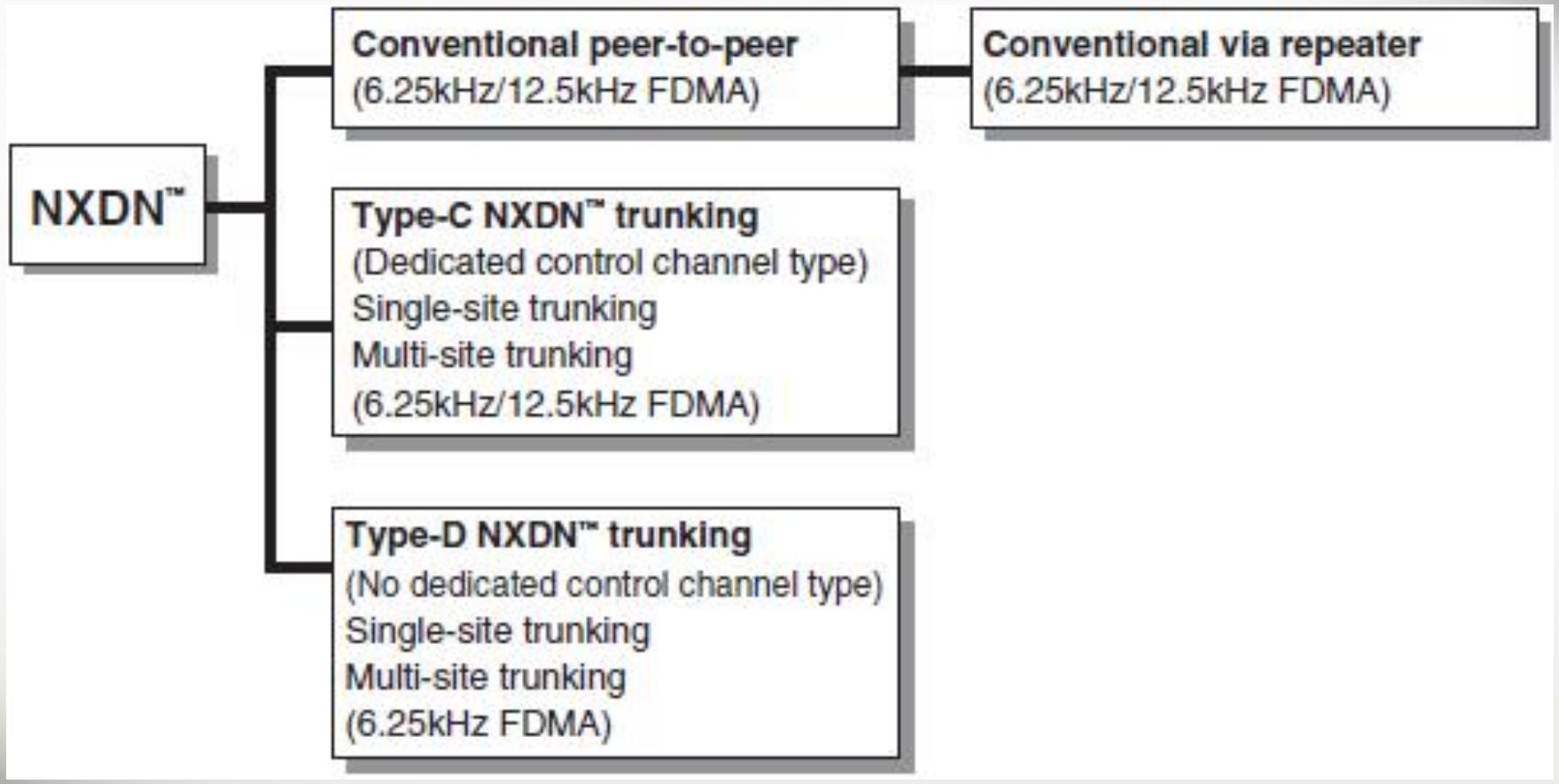
Operating Modes



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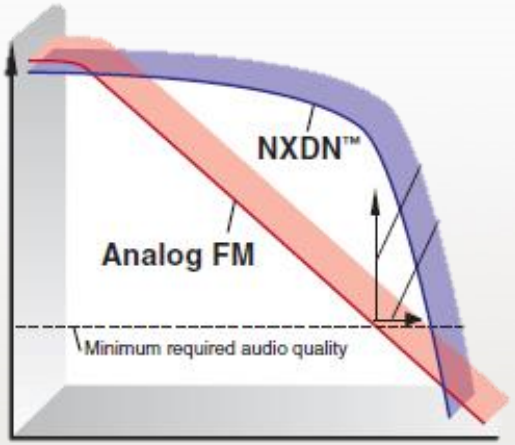
Digital Features

- Digital audio eliminates background noise
- Enables
  - ID, Alias and selective calling
  - Text messaging
  - GPS Location
  - Transparent data
  - Encryption
  - IP Connectivity



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Systems Simplified

- Single- & Multi- site operations
- Conventional and Trunking modes
- Simplified system integration
- Rich set of 3rd party application integration

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NXDN Forum

NXDN Forum membership from A to Z

- Alinco, Inc.
- Altonika Ltd.
- Anritsu Company
- Avtec Inc.
- Cimarron Technologies Corporation
- CML Microcircuits
- Cobham
- Compliance Testing LLC.
- Connect Systems Inc.
- CTI Products, Inc.
- CVDS Inc.
- Data Over Radio, Limited
- Etherstack
- Eventide Inc.
- EXACOM, Inc.
- Freedom Communications Technologies, Inc.
- GME/Standard Communications Pty, Ltd.
- HigherGround, Inc.
- Hoag Electronics, Inc.
- Hytera Communications Corp., Ltd.
- Icom Incorporated
- JVC KENWOOD Corporation
- Numonix
- Raven Electronics Corporation
- Ritron Inc.
- Rockwell Collins
- Telex Radio Dispatch Group
- Ultratech
- Zetron, Inc.

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The Evolution

NXDN™ History

2003: Icom and JVCKENWOOD form technology alliance to develop NXDN™

2005: NXDN™ protocol development was announced at IWCE 2005

2006: First NXDN™ products released to the market

2008: The NXDN™ Forum established

2010: An informal collaboration with the dPMR™ Association announced

2012: The NXDN™ Forum website was renewed

2017: Current membership includes 30 industry leading companies

NXDN™ Standards

2004: NXDN™ Common Air Interface developed

2009: “Type-C” NXDN™ trunking protocol added to standards suite

2011: “Type-D” NXDN™ trunking protocol added to standards suite

2011: AES and DES encryption standards added to standards suite

2012: The NXDN™ standards suite was opened to the public domain

2017: NXDN™ standard added to ITU-RM.2014 digital land mobile systems for dispatch traffic

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Public Standards

Standard	Sub-Part	Description	Version	Date of Issue
NXDN Technical Standard, Part 1 Air Interface	Sub-Part A	**Common Air Interface**	Ver. 2.0	Jul-16
	Sub-Part B	**Basic Operation**	Ver. 2.0	Jul-16
	Sub-Part C	**Trunking Procedures (Type-C)**	Ver. 2.0	Jul-16
	Sub-Part D	**Security**	Ver. 1.3	Nov-11
	Sub-Part E	**Common Air Inteface (Type-D)**	Ver. 1.3	May-15
	Sub-Part F	**Trunking Procedures (Type-D)**	Ver. 1.2	May-15
NXDN Technical Standard, Part 2 Conformance Test	Sub-Part A	**Transceiver Performance Test**	Ver. 2.0	Jul-16
	Sub-Part B	**Common Air Interface Test**	Ver. 2.0	Jul-16
	Sub-Part C	**Basic Operation Test**	Ver. 2.0	Jul-16
	Sub-Part D	**Trunking Operation Test (Type-C)**	Ver. 1.3	Nov-11
	Sub-Part E	**Trunking Operation Test (Type-D)**	Ver. 1.3	May-15

https://www.nxdn-forum.com/download_file/

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Forum Member Standards

Standard	Standard Number	Description	Version	Date of Issue
NXDN Forum Confromance Assessment	NFCA-01	**NXDN Conformance Assessment Process**	Ver. 1.1	Jul-16
	NFCA-02	**Conformance Test Procedures for Conventional Operation**	Ver. 1.1	Jul-16
	NFCA-04	**Conformance Certification Form Conventional Operation - SU**	Ver. 1.1	Jul-16
	NFCA-05	**Conformance Certification Form Conventional Operation - CR**	Ver. 1.1	Nov-11
NXDN Forum Miscellaneous Documents	NFMD-01	**Manufacturer's Number Assignment Guideline**	Ver. 1.0	Jul-16
	NFMD-02	**Manufacturer's Number Assignment Table**	Ver. --	Jul-16
	NFMD-03	**System Code Guideline**	Ver. 1.1	Jul-16

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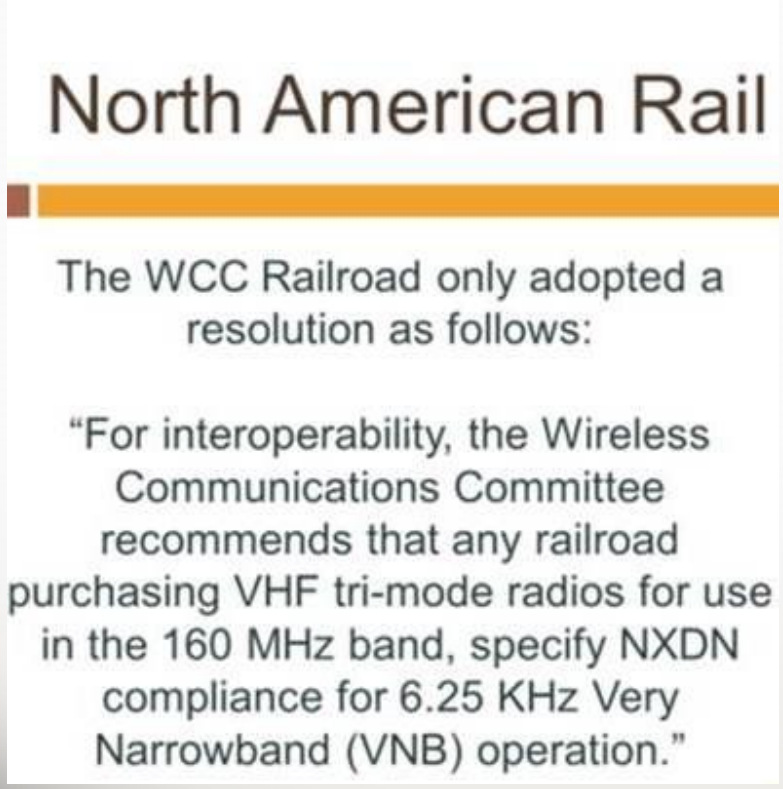
Railroad



- In 2007, the railroads began to prepare for narrow-banding
- Under the guidance of WCC, railroads evaluated all digital technologies
- They chose NXDN because:
  - Superior simplex (handset to handset) solution
  - Multi-vendor (Icom & Kenwood) offered NXDN
  - Long term solution can evolve with RR needs

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SMR Operators

- Combined total of active NXDN SMRs is over 150 carriers and 10's of thousands of subscribers
- Well over 3500 active channels on 1000 sites throughout the U.S. today

Signature Wireless Group

Diga-Talk®
THE WAY PUSH TO TALK SHOULD BE

Smith Radio
BE HEARD.

SILKE COMMUNICATIONS

COMMPATHS

NXDN™
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Public Safety/Service

- Public Safety
  - Police, Fire, EMS, SAR, etc.
    - Wide Area Coverage & In Building Penetration
    - Performance Value
- Municipal
  - Public Works, Services, etc.
    - Wide Area Coverage
    - Performance Value

City of Mesa

Cowlitz County

Henderson County

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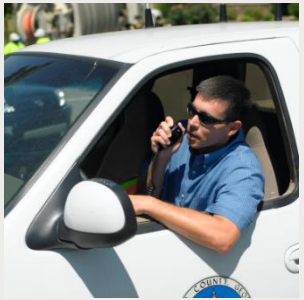
KENT WASHINGTON

Industries Choosing NXDN

- **Utilities** – Coverage and Multisite IP
- **Manufacturing** - Coverage
- **Warehousing & Logistics** - Coverage and Multisite IP
- **Hotels/resorts/casinos** - Migration from LTR/Passport
- **Hospitals** - Coverage and Multisite IP
- **K-12 schools** - Wide and Local Calling
- **Universitie**s - Coverage and Multisite IP



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NXDN Specs

Designed to be ‘future-proof’ in anticipation of 12.5kHz spectrum saturation

FDMA 12.5kHz and 6.25kHz channel spacing

Mixed mode analog and digital

Provides simultaneous voice and data

NXDN PARAMETER	NXDN SPECIFICATION DETAILS
Access technology	FDMA
Transmission rate	4.8 kbps
Modulation	4-level FSK
Vocoder	AMBE+2
Codec rate	3.6 kbps
Codec data partitioning	Voice - 2.45 kbps Error correction - 1.15 kbps

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4 level FSK

The NXDN radio system uses a four level frequency shift keying - 4FSK.

This is a two bit binary number is mapped to a single symbol which is modulated onto the carrier.

INFORMATION (BINARY DATA)	SYMBOL	DEVIATION
01	+3	+1050 Hz
00	+1	+350Hz
10	-1	-350Hz
11	-3	-1050Hz

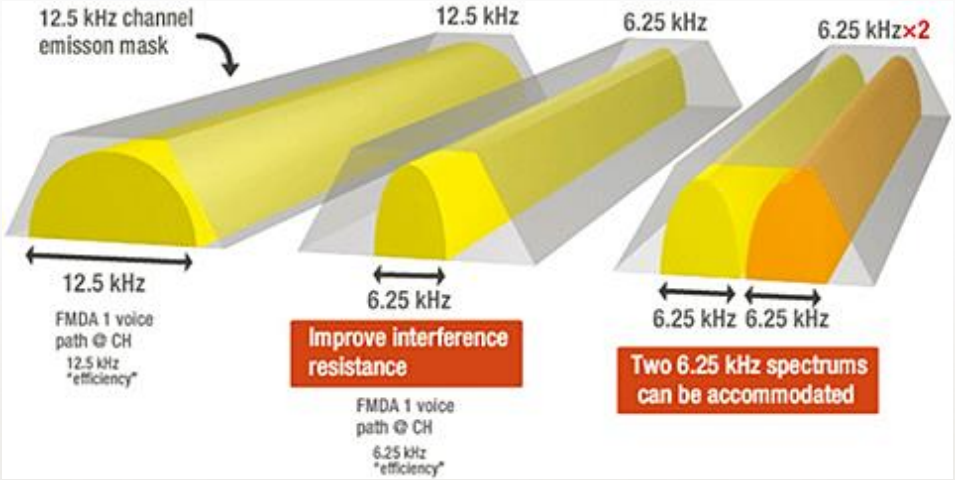
6.25 kHz Bandwidth

High spectrum efficiency (occupied bandwidth: 9600 bps @ 8.3 kHz and 4800 bps @ 4 kHz, respectively)

- This exceeds all regulatory and emissions mask requirements in all bands.

High receiver sensitivity compared with 12.5 kHz, both bandwidth and band-pass filters are narrower for 6.25 kHz mode, so noise is reduced.

- The carrier-to-noise ratio (CNR) is improved, as is the bit error rate (BER).



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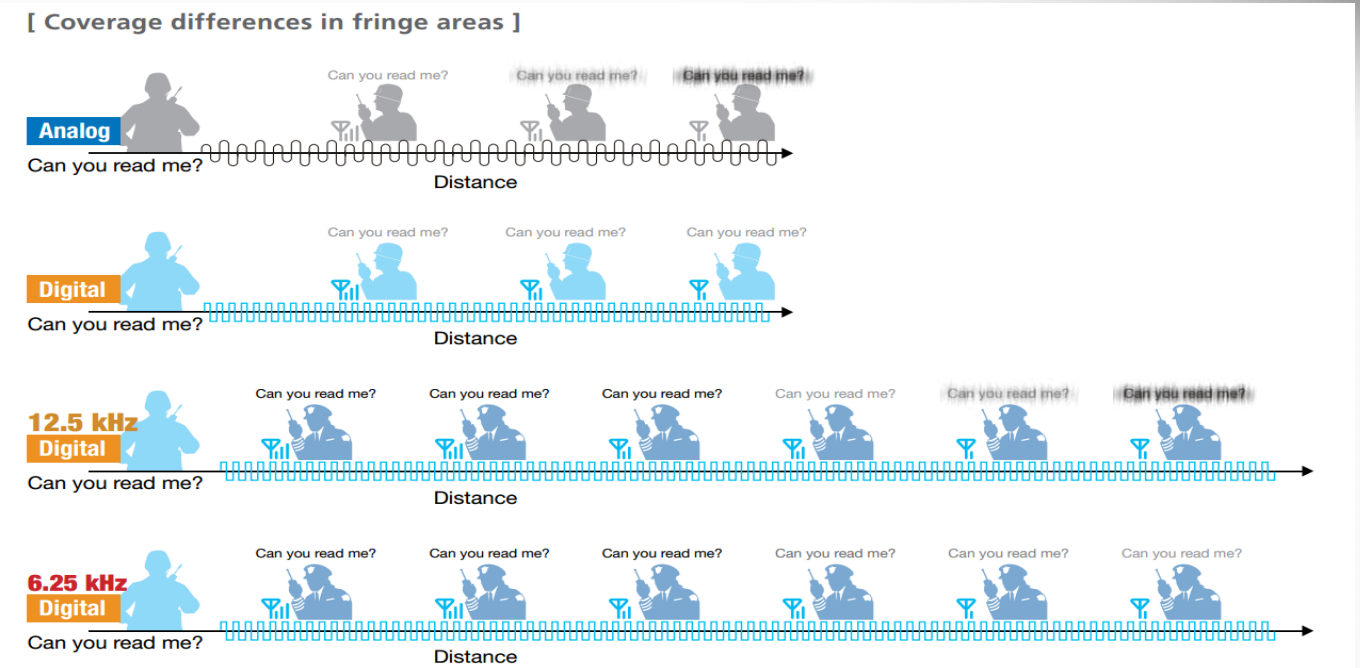
Superior Clarity in Extended Coverage



As RF signal strength weakens with distance, analog reception becomes increasingly noisy and intermittent. NXDN®'s low BER improves reception in fringe areas, thereby "effectively" increasing coverage as much as twenty percent over analog.

A key element of the NXDN® air interface is the AMBE+2™ vocoder which digitizes speech while retaining natural voice nuances, performs noise reduction, introduces FEC and compresses voice data to accommodate land mobile radio spectrum bandwidth and data rates.

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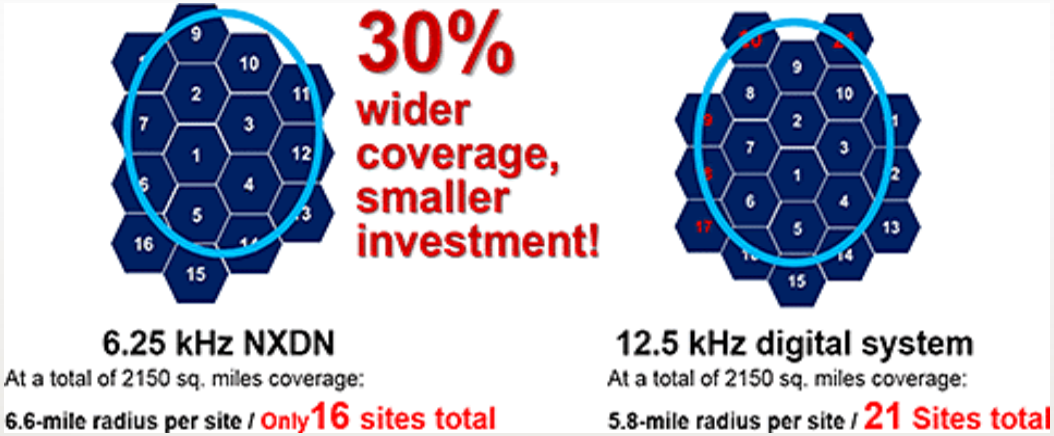
Extended Coverage

The low BER of NXDN™ improves reception in fringe areas, thereby effectively increasing range by as much as 20% over FM analog, resulting in a 50% increase in coverage area for digital 6.25 kHz.

- High receiver sensitivity compared with 12.5 kHz, both bandwidth and band-pass filters are narrower for 6.25 kHz mode, so noise is reduced.
- Receiver filters are narrower and can thus reduce noise. The net result is superior clarity over a 30% wider coverage area.



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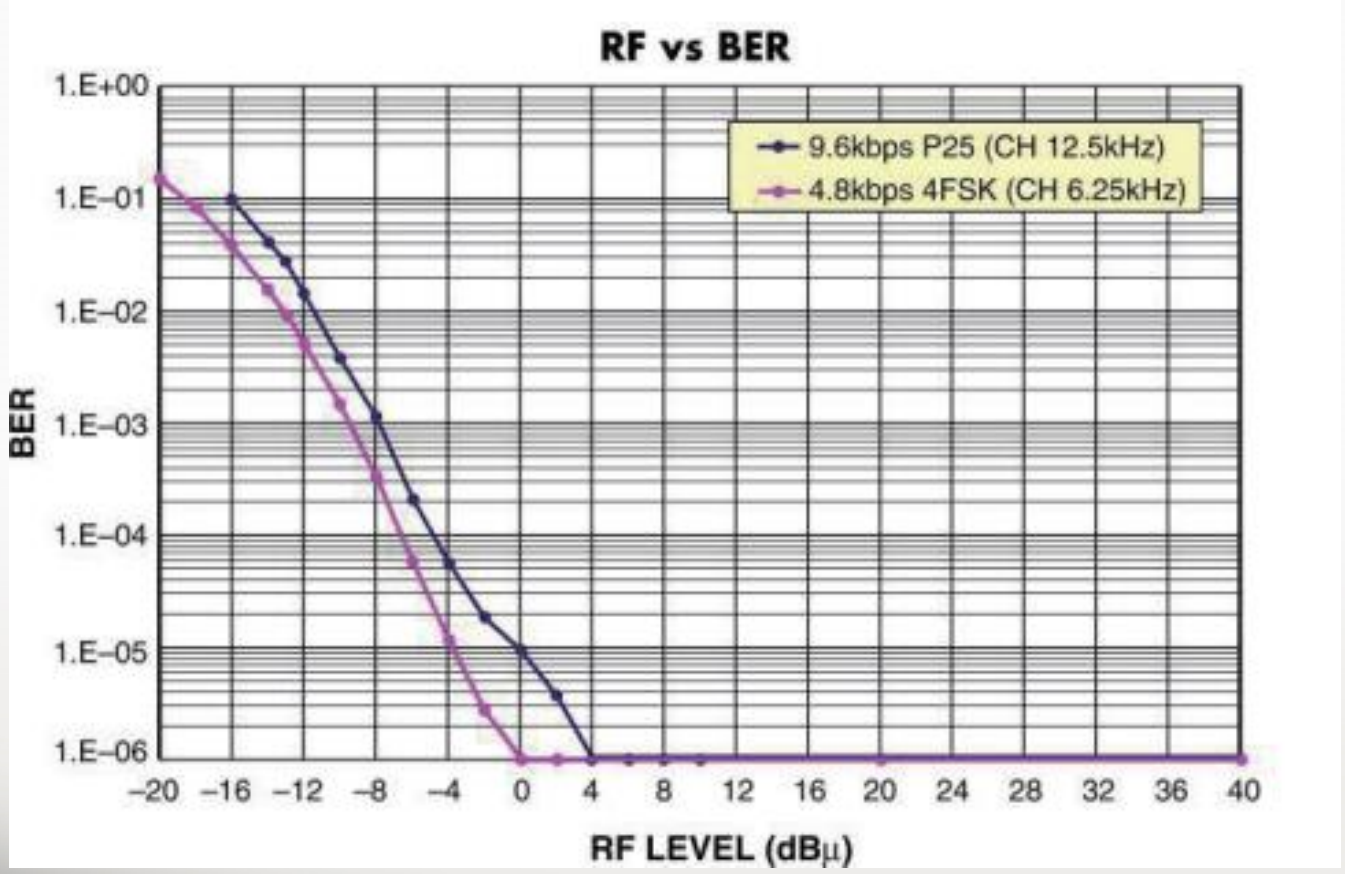
Extended Coverage

The FDMA signal BER performance exceeds that of APCO Project 25 Phase 1 radios, which have already been accepted by the market as quality digital radios.



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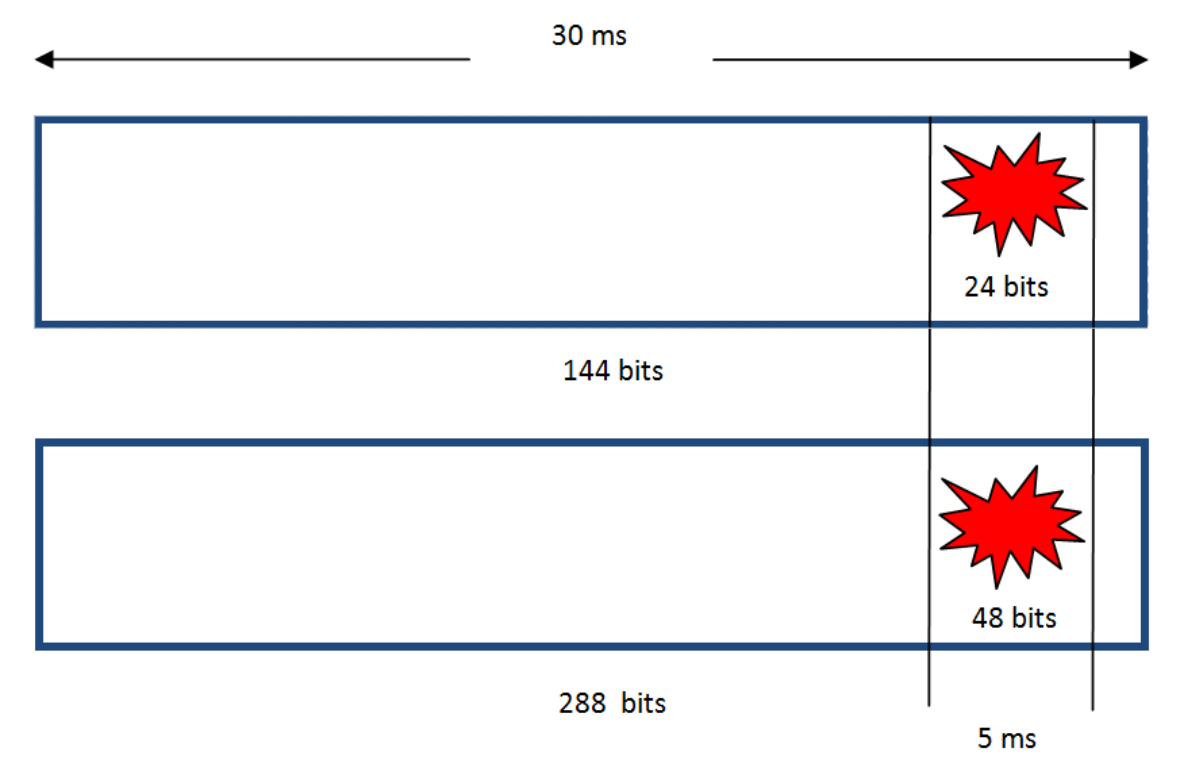
FSK Error Resilience

NXN VN modulates 4,800 symbols per second.

P25 and DMR modulate 9,600 symbols per second.



Fewer bits per ms = less damage per ms

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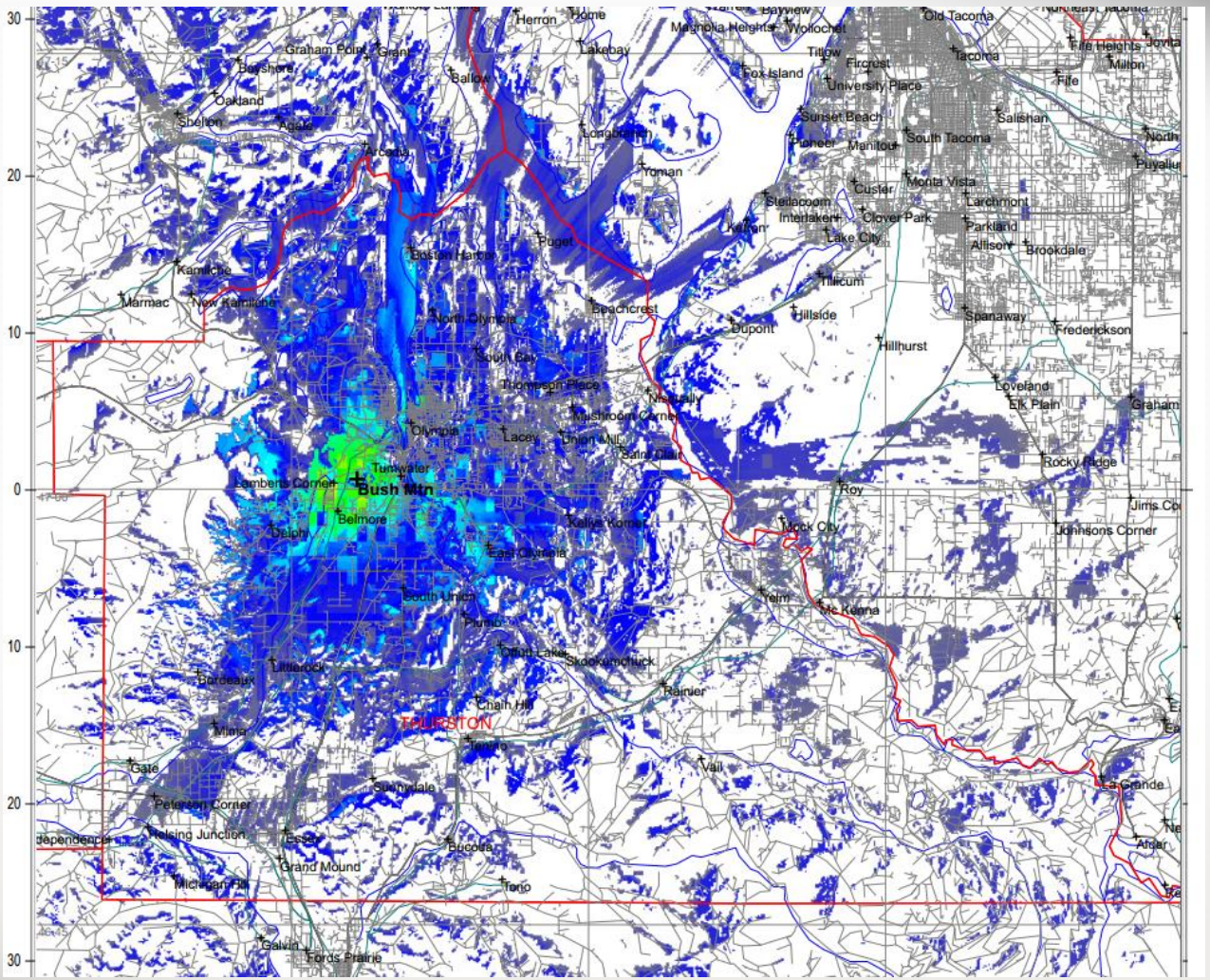
Analog 12.5Khz – Bush Mtn – Portable Talk Back



DB-264 at 43m AGL; Portable ERP = 1W; 155 MHz; Land Use Atten 95%
Longley-Rice sig str received from a helical ant 2m AGL

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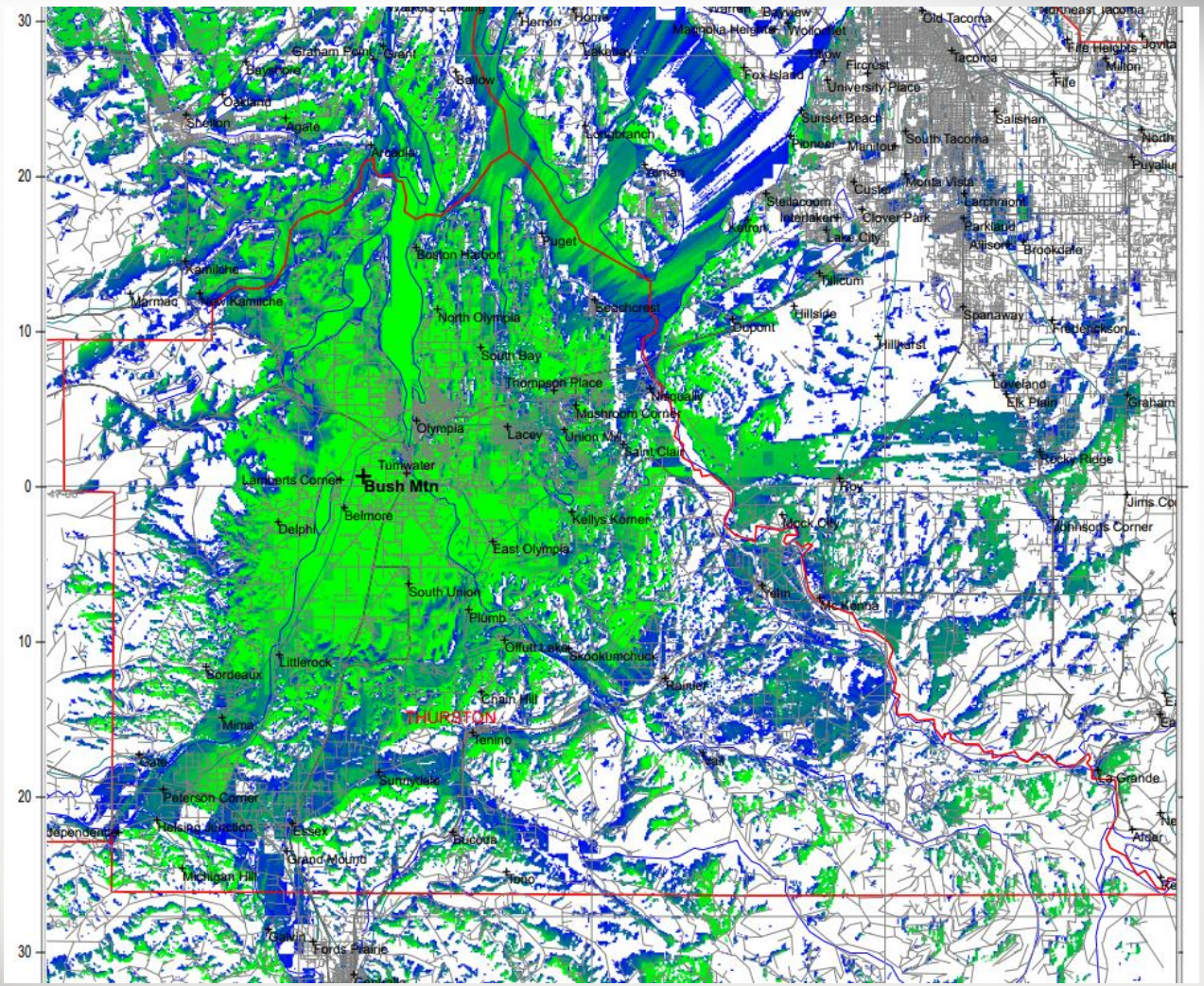
NEXEDGE 6.25Khz– Bush Mtn – Portable Talk Back



DB-264 at 43m AGL; Portable ERP = 1W; 155 MHz; Land Use Atten 95%
Longley-Rice sig str received from a helical ant 2m AGL

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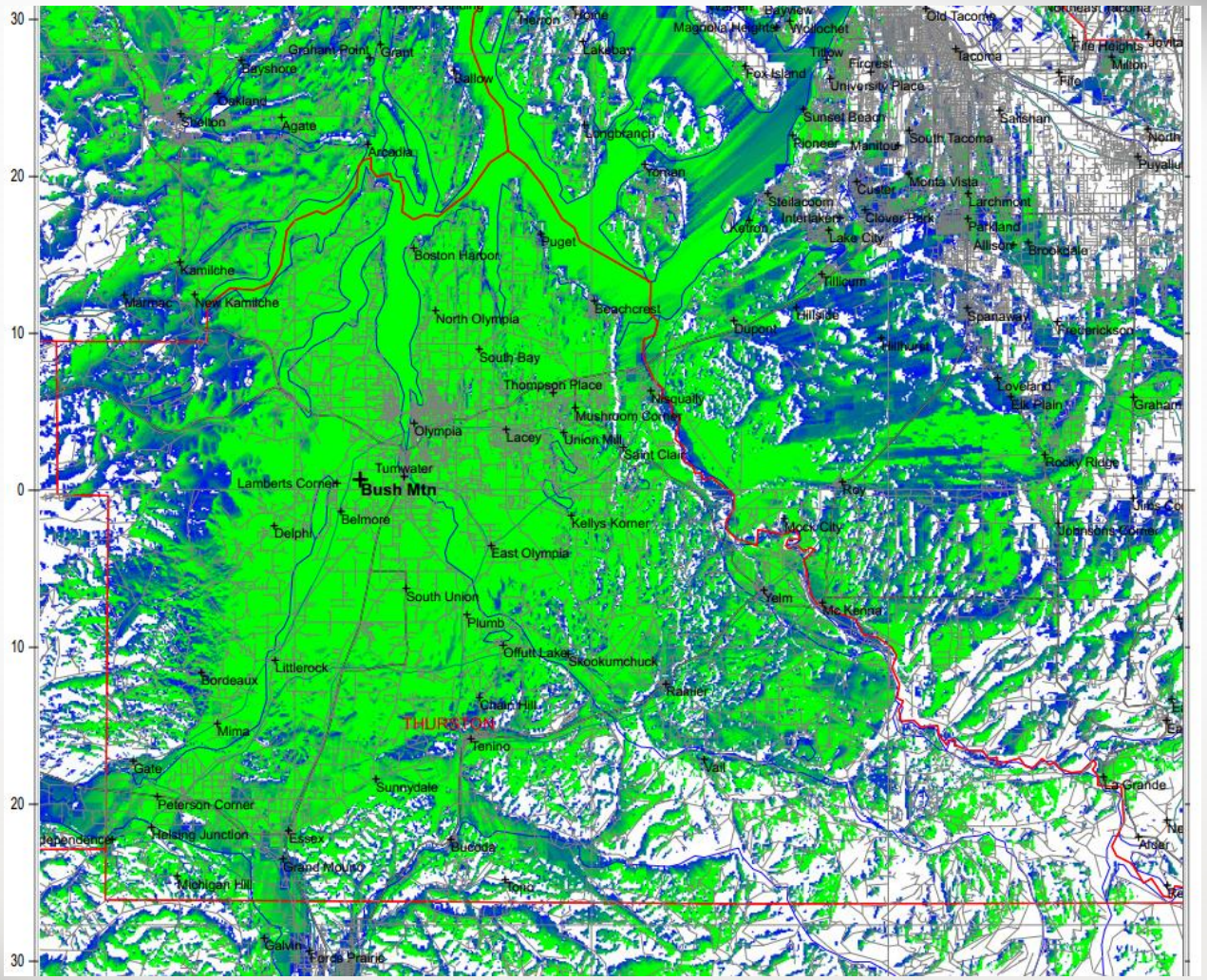
NEXEDGE 6.25Khz– Bush Mtn – Mobile Talk Back



DB-264 at 43m AGL; Mobile ERP = 30W; 155 MHz; Land Use Atten 95%
Longley-Rice sig str received from a 1/4 wave ant 2m AGL

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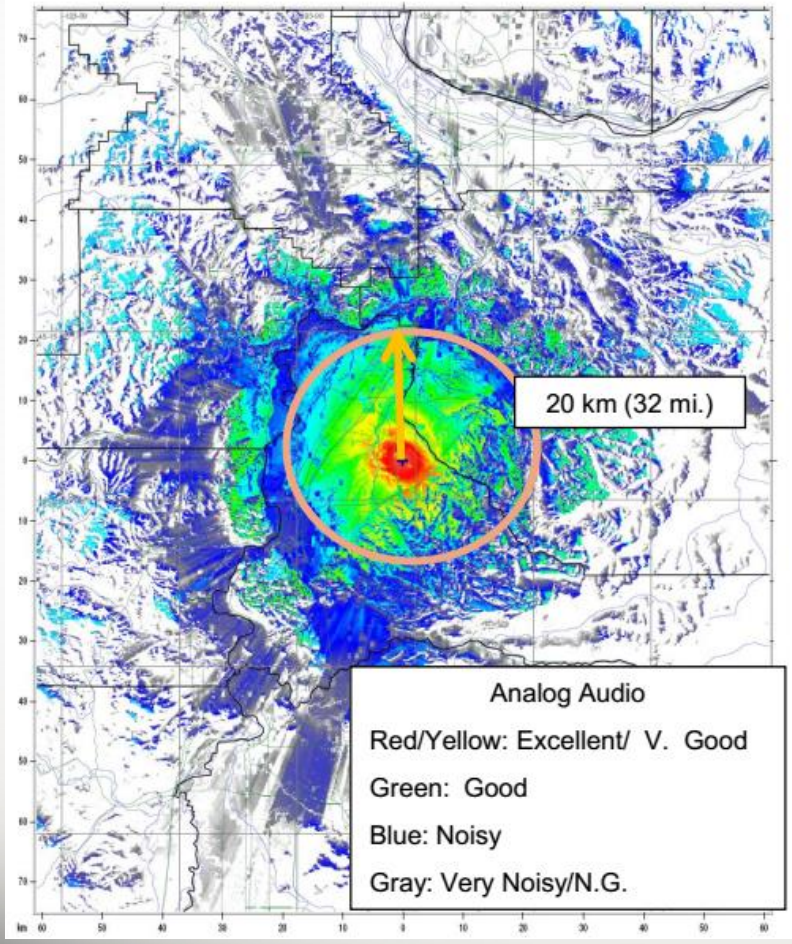
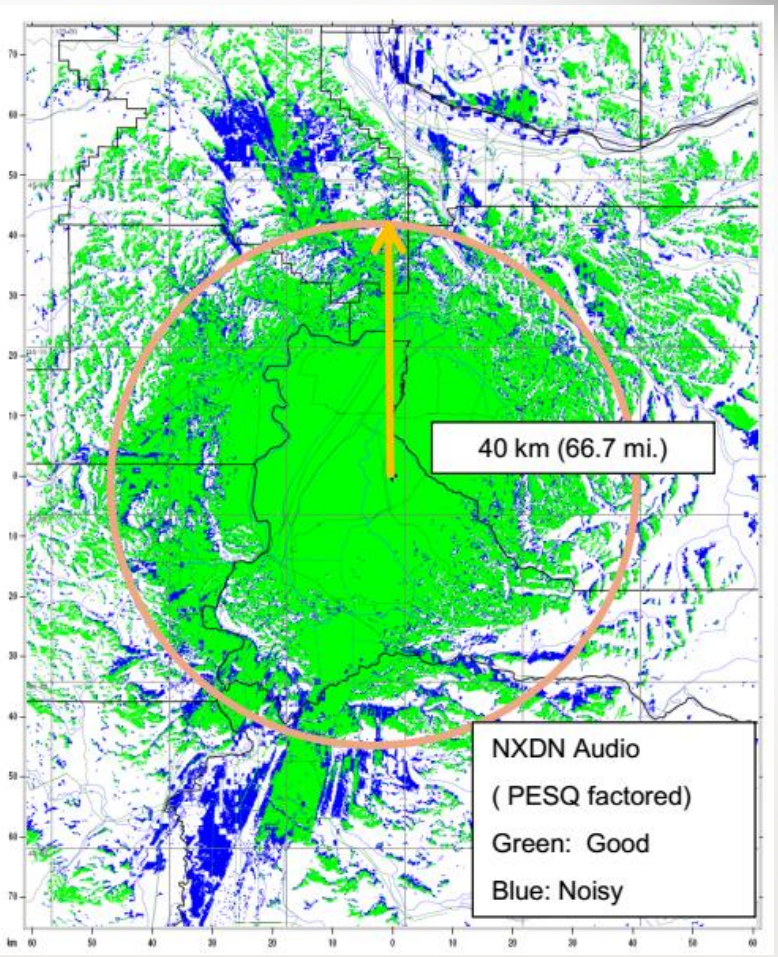
NXDN® Intelligible @ 2 x Distance of analog

Noise incursion starts @ -84 dBm (analog) @ -118 dBm (NXDN; BER increase)





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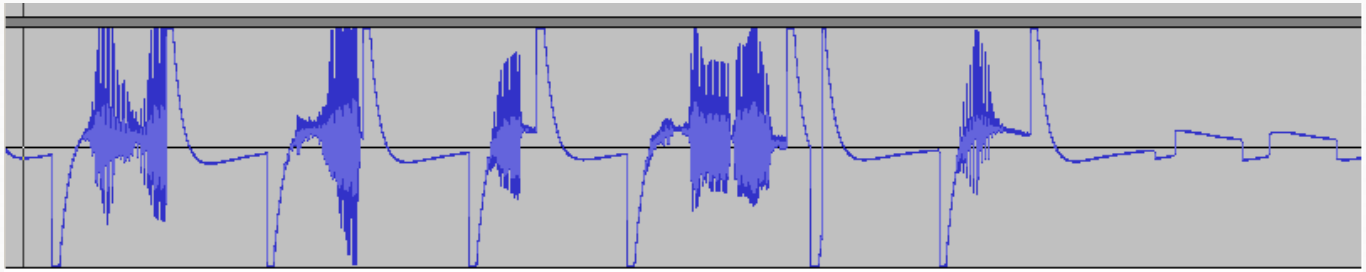
NXDN® 6.25 Talk-in, Worst Case Example

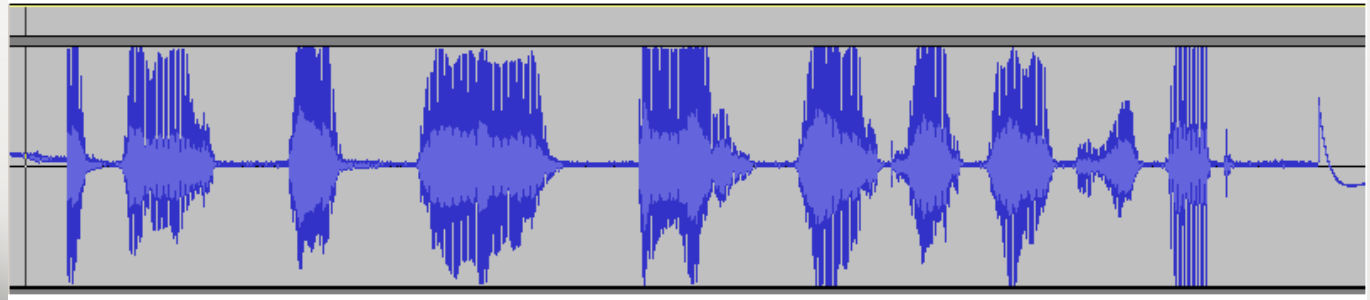
In a known fringe area with documented multipath and structural interference, NX-411 (900Mhz) low power, on the hip with a 10 dB attenuator, KMC-41 speaker mic, no audio adjustments, identical user, location and position for each call.

12.5 Narrow



FA10 Testing 12345 sample.wav

6.25 Very Narrow



FA10 Testing 12345 sample 6_25.wav

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Digital Conventional Systems

NEXEDGE conventional systems offer capabilities beyond analog conventional systems

- **RAN (Radio Access Number)** base units include a 16 RAN capacity conventional repeater controller for 16 user group site sharing.
- **1,000 GIDs** Large talk group ID capacity for group selective calling.
- **1,000 UIDs** Large unit ID capacity for individual selective calling.
- **Mixed Channel Type** FM & NXDN® conventional units can share the same RF channel.

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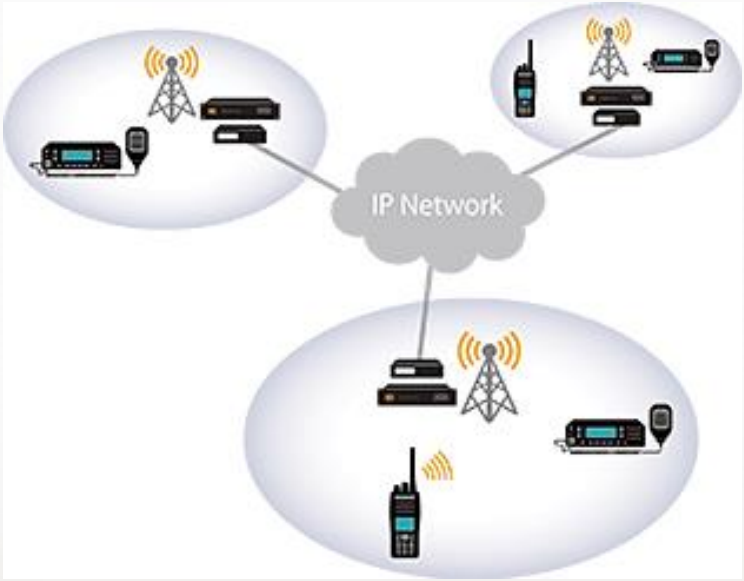
Digital Conventional IP Networks

NXDN Conventional IP Networks offer wide area coverage or coverage fill-in



- **16 or 48 Site Configurations** Conventional IP links up to 16 or 48 digital conventional repeaters into one system for wide area coverage.
- **Beacon Signals** As users roam throughout the network, the subscriber units use the beacon signals to choose the best repeater for communications.
- **Receiver Voting** Extends the portable talk-in range of a conventional repeater by utilizing satellite receivers linked to the repeater site. Portable signal strength is sent via IP link to the repeater site which compares and selects the receiver site with the best audio quality for re-transmission.

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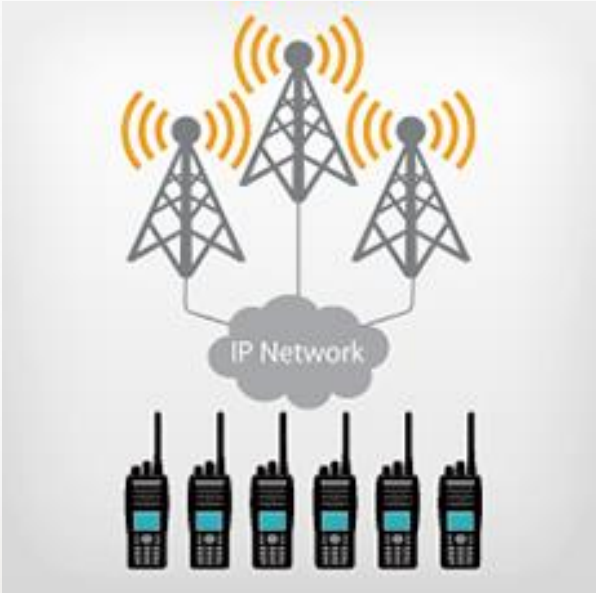
Digital Conventional Simucast - *Comming Soon

NXDN Conventional Simulcast will allow for efficient spectrum utilization



- **Channel Re-use** Conventional Simulcast allows the use of a single channel across the entire network.
- **Wide Area** expand inbound coverage area with RX sites allowing for a substantial footprint.
- **Server Based Design and built in security** All voting logic managed by centralized servers. Each repeater and voter will require authentications by key to use simulcast.

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NXDN Type-D Trunking

Efficient Single Site Trunking

- **No Exclusive Channel Requirement** This is the FB6*-based digital LTR protocol specified by the NXDN Forum.
- **No Control Channel** Unlike Type-C Trunking, there is no dedicated control channel. Trunking is under the control of the home repeater assigned to each radio. And like LTR, there is no registration.
- **Economical** Type-D uses the same platform as our conventional systems which reduces cost per channel significantly.

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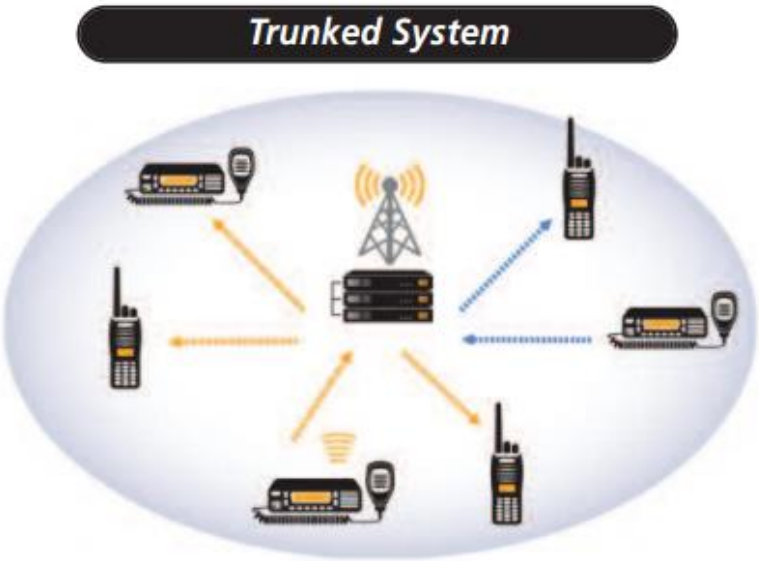
NXDN Type-C Trunking



- **Fast System Access** Channels selection is automatic so no user monitoring is required.
- **Enhanced Efficiency** Users share a pool of channels per site, enabling easier access during peak hours.
- **30 Channels** per Site, 3,000 Group IDs, 3,000 Unit IDs.
- **Late Entry** Permits subscriber units to join a group or individual call already in progress after powering on or upon entering the system coverage area.
- **Call Queuing** Automatically stacks call requests when the system is busy and processes calls when a channel becomes available.

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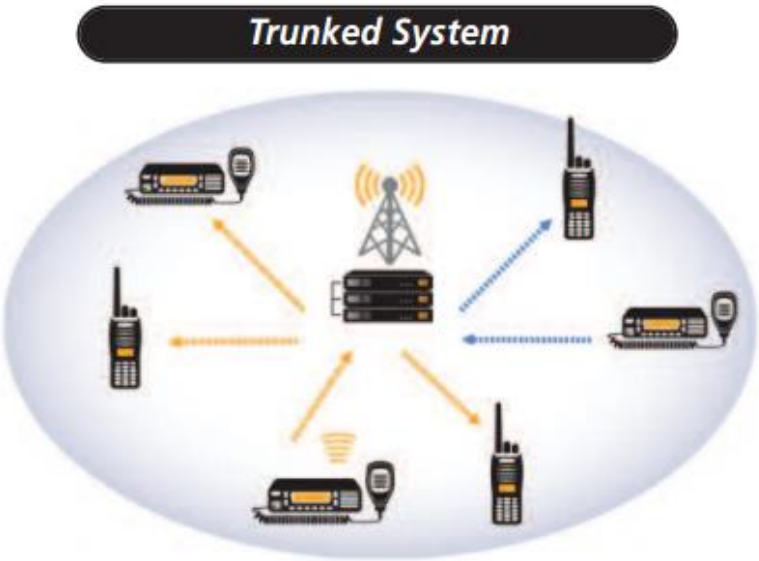
NXDN Type-C Trunking



- **Broadcast Call** Calls all fleets or all units in a fleet in emergencies and for critical incident response.
- **8 Priority Levels** with Preemption processes the call queue in order of priority. Preemption allocates a talk path for priority personnel, dispatch and emergency calls.
- **Failsoft Mode** When Trunking capability is disabled, the system reverts to conventional operation so basic communications can continue.
- **ESN Validation** Each subscriber unit has a unique factory embedded ESN validated by the system to protect against unauthorized access.

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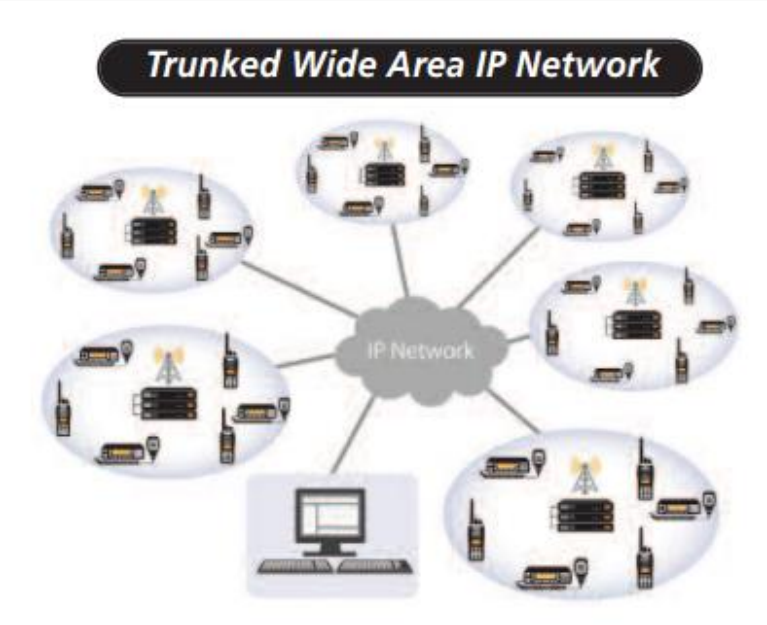
NXDN Type-C Trunking



- **16 to 48 Site** Network Multiple trunked sites can be linked together in one network across a campus, city, county, region or for interstate communications.
- **LAN/WAN Connectivity** Scalable networks can be created over existing IT assets.
- **IPSEC VPN** tunneling provides encryption and authentication.
- **60,000 GID's & 60,000 UID's**
- **Automatic Site Roaming** Subscriber units automatically search for the best accessible sites while moving throughout a network using RSSI.

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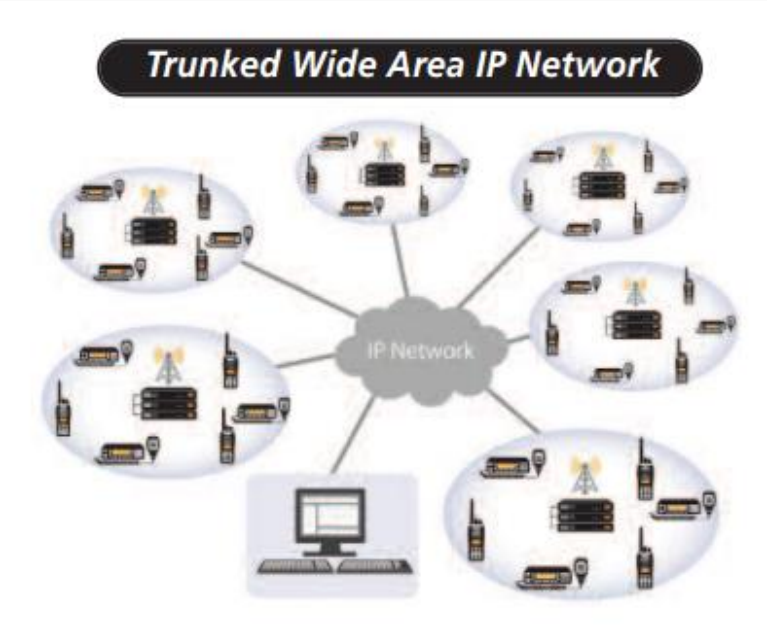
NXDN Type-C Trunking



- **All Call** Calls all fleets or all units in a fleet in emergencies and for critical incident response.
- **Remote Group Add** Adds a new GID to subscriber units remotely over-the-air to form a workgroup for emergencies, special events, special operations or critical incidents.
- **Control/Traffc Channel Switching** Designates a Traffc Channel as a new Control Channel should the original become disabled. Disabled Traffc Channels are automatically removed from service

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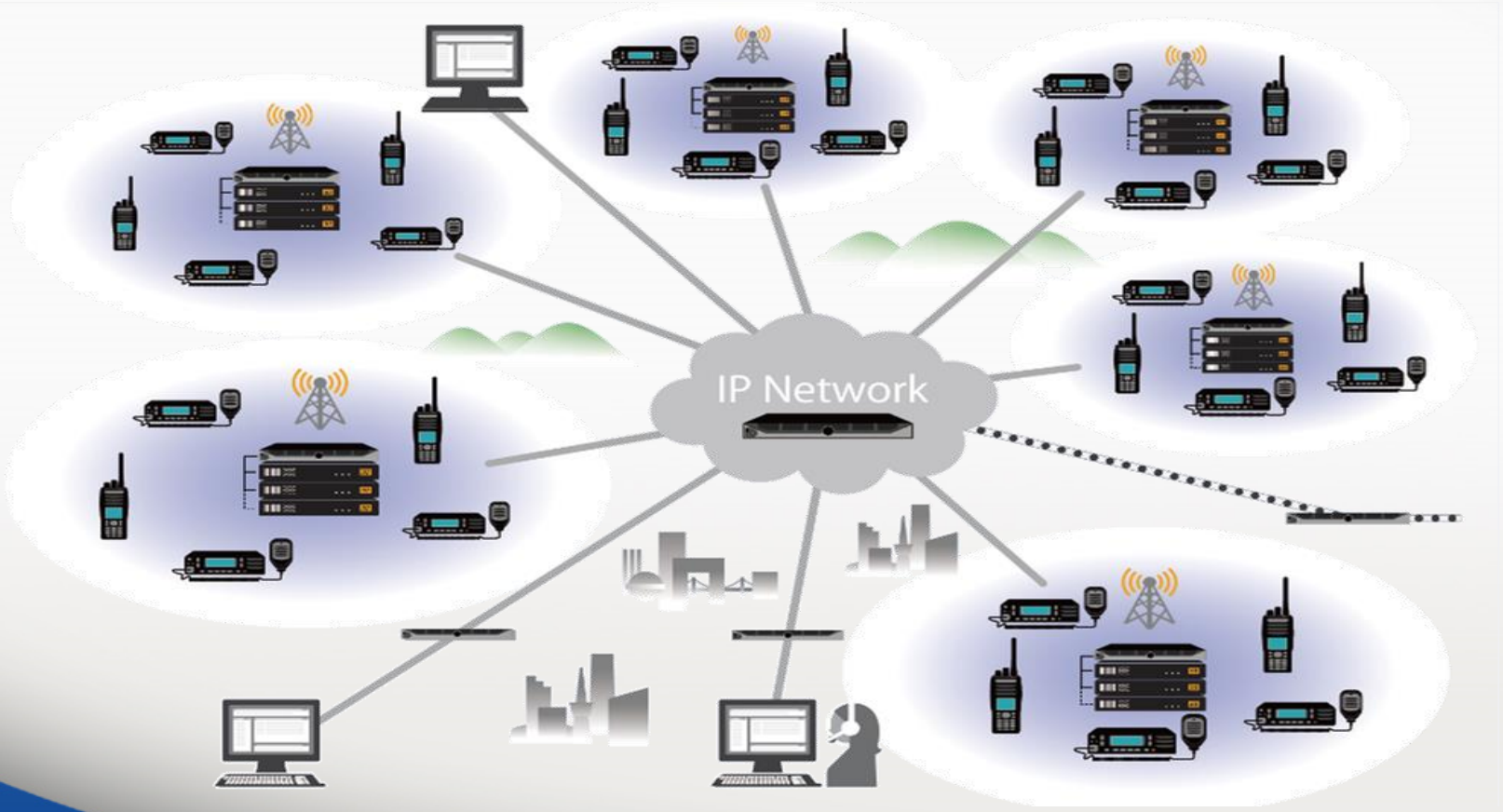
Gen2 - Beyond Cloud

Providing over 1,000 sites, enhanced capability, efficiency and functionality, the 2nd Generation System brings a cost effective solution specifically aimed at wide area and communication networks.



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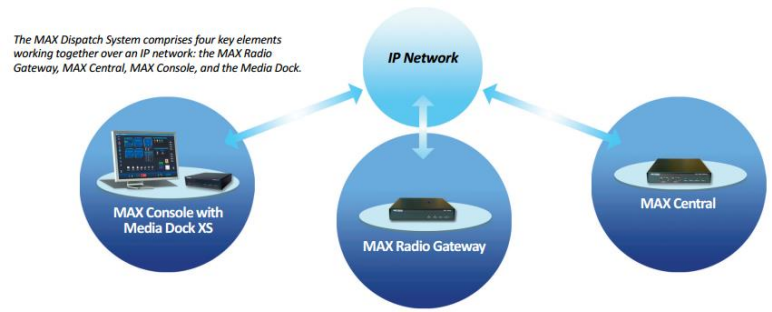
Enterprise Console Solutions

- **Simpler Operation, Lower Training Cost**: The user interface is designed to reduce screen clutter, response times, and user stress. Requires minimal training and fewer steps to perform tasks and access information.
- **Map-based dispatching**: Available for systems that support locations services.
- **High reliability**: End-to-end network redundancy keeps the system up and running even if the IP network goes down.
- **Minimize Maintenance Time and Cost**: Configure, troubleshoot and maintain the system from the convenience of the office.
- **Scalable Operations**: The architecture provides scalability for system designs ranging from dedicated LAN network to multi-node, geographically diverse WAN applications



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ZETRON

Thank you

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JVCKENWOOD USA Corporation