Push-to-Talk Track – W33

NXDN Industry Update
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

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

The Americas
Installed Base
61%
1.24 Million

Europe
Installed Base
12%
.231 Million

Middle East & Africa
Installed Base
4%
.89 Million

Asia
Installed Base
23%
.466 Million
NXDN Technology

- FDMA achieving true 6.25kHz efficiency
Operating Modes

- Conventional peer-to-peer
  6.25kHz/12.5kHz FDMA

- Conventional via repeater
  6.25kHz/12.5kHz FDMA

- **Type-C NXDN™ trunking**
  - Dedicated control channel type
  - Single-site trunking
  - Multi-site trunking
  6.25kHz/12.5kHz FDMA

- **Type-D NXDN™ trunking**
  - No dedicated control channel type
  - Single-site trunking
  - Multi-site trunking
  6.25kHz FDMA
Digital Features

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

- Single- & Multi-site operations
- Conventional and Trunking modes
- Simplified system integration
- Rich set of 3rd party application integration
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
- Ulratech
- Zetron, Inc.
# The Evolution

## NXDN™ History

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Icom and JVCKENWOOD form technology alliance to develop NXDN™</td>
</tr>
<tr>
<td>2005</td>
<td>NXDN™ protocol development was announced at IWCE 2005</td>
</tr>
<tr>
<td>2006</td>
<td>First NXDN™ products released to the market</td>
</tr>
<tr>
<td>2008</td>
<td>The NXDN™ Forum established</td>
</tr>
<tr>
<td>2010</td>
<td>An informal collaboration with the dPMR™ Association announced</td>
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<tr>
<td>2012</td>
<td>The NXDN™ Forum website was renewed</td>
</tr>
<tr>
<td>2017</td>
<td>Current membership includes 30 industry leading companies</td>
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</table>

## NXDN™ Standards

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>2004</td>
<td>NXDN™ Common Air Interface developed</td>
</tr>
<tr>
<td>2009</td>
<td>“Type-C” NXDN™ trunking protocol added to standards suite</td>
</tr>
<tr>
<td>2011</td>
<td>“Type-D” NXDN™ trunking protocol added to standards suite</td>
</tr>
<tr>
<td>2011</td>
<td>AES and DES encryption standards added to standards suite</td>
</tr>
<tr>
<td>2012</td>
<td>The NXDN™ standards suite was opened to the public domain</td>
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<tr>
<td>2017</td>
<td>NXDN™ standard added to ITU-RM.2014 digital land mobile systems for dispatch traffic</td>
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## NXDN Technical Standard, Part 1

<table>
<thead>
<tr>
<th>Sub-Part</th>
<th>Description</th>
<th>Version</th>
<th>Date of Issue</th>
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<tbody>
<tr>
<td>Sub-Part A</td>
<td>Common Air Interface</td>
<td>Ver. 2.0</td>
<td>Jul-16</td>
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<tr>
<td>Sub-Part B</td>
<td>Basic Operation</td>
<td>Ver. 2.0</td>
<td>Jul-16</td>
</tr>
<tr>
<td>Sub-Part C</td>
<td>Trunking Procedures (Type-C)</td>
<td>Ver. 2.0</td>
<td>Jul-16</td>
</tr>
<tr>
<td>Sub-Part D</td>
<td>Security</td>
<td>Ver. 1.3</td>
<td>Nov-11</td>
</tr>
<tr>
<td>Sub-Part E</td>
<td>Common Air Interface (Type-D)</td>
<td>Ver. 1.3</td>
<td>May-15</td>
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<td>Sub-Part F</td>
<td>Trunking Procedures (Type-D)</td>
<td>Ver. 1.2</td>
<td>May-15</td>
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## NXDN Technical Standard, Part 2

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<tr>
<th>Sub-Part</th>
<th>Description</th>
<th>Version</th>
<th>Date of Issue</th>
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<tbody>
<tr>
<td>Sub-Part A</td>
<td>Transceiver Performance Test</td>
<td>Ver. 2.0</td>
<td>Jul-16</td>
</tr>
<tr>
<td>Sub-Part B</td>
<td>Common Air Interface Test</td>
<td>Ver. 2.0</td>
<td>Jul-16</td>
</tr>
<tr>
<td>Sub-Part C</td>
<td>Basic Operation Test</td>
<td>Ver. 2.0</td>
<td>Jul-16</td>
</tr>
<tr>
<td>Sub-Part D</td>
<td>Trunking Operation Test (Type-C)</td>
<td>Ver. 1.3</td>
<td>Nov-11</td>
</tr>
<tr>
<td>Sub-Part E</td>
<td>Trunking Operation Test (Type-D)</td>
<td>Ver. 1.3</td>
<td>May-15</td>
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</tbody>
</table>

[https://www.nxdn-forum.com/download_file/](https://www.nxdn-forum.com/download_file/)
## Forum Member Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Standard Number</th>
<th>Description</th>
<th>Version</th>
<th>Date of Issue</th>
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<tbody>
<tr>
<td>NXDN Forum Conformance Assessment</td>
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<td><strong>NXDN Conformance Assessment Process</strong></td>
<td>Ver. 1.1</td>
<td>Jul-16</td>
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<tr>
<td></td>
<td>NFCA-01</td>
<td>Conformance Test Procedures for Conventional Operation</td>
<td>Ver. 1.1</td>
<td>Jul-16</td>
</tr>
<tr>
<td></td>
<td>NFCA-02</td>
<td>Conformance Certification Form Conventional Operation - SU</td>
<td>Ver. 1.1</td>
<td>Jul-16</td>
</tr>
<tr>
<td></td>
<td>NFCA-04</td>
<td>Conformance Certification Form Conventional Operation - CR</td>
<td>Ver. 1.1</td>
<td>Nov-11</td>
</tr>
<tr>
<td>NXDN Forum Miscellaneous Documents</td>
<td></td>
<td><strong>Manufacturer's Number Assignment Guideline</strong></td>
<td>Ver. 1.0</td>
<td>Jul-16</td>
</tr>
<tr>
<td></td>
<td>NFMD-01</td>
<td><strong>Manufacturer's Number Assignment Table</strong></td>
<td>Ver. --</td>
<td>Jul-16</td>
</tr>
<tr>
<td></td>
<td>NFMD-02</td>
<td>System Code Guideline</td>
<td>Ver. 1.1</td>
<td>Jul-16</td>
</tr>
</tbody>
</table>
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
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
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
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
- **Universities** - Coverage and Multisite IP
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

<table>
<thead>
<tr>
<th>NXDN PARAMETER</th>
<th>NXDN SPECIFICATION DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access technology</td>
<td>FDMA</td>
</tr>
<tr>
<td>Transmission rate</td>
<td>4.8 kbps</td>
</tr>
<tr>
<td>Modulation</td>
<td>4-level FSK</td>
</tr>
<tr>
<td>Vocoder</td>
<td>AMBE+2</td>
</tr>
<tr>
<td>Codec rate</td>
<td>3.6 kbps</td>
</tr>
<tr>
<td>Codec data partitioning</td>
<td>Voice - 2.45 kbps</td>
</tr>
<tr>
<td></td>
<td>Error correction - 1.15 kbps</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>INFORMATION (BINARY DATA)</th>
<th>SYMBOL</th>
<th>DEVIATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>+3</td>
<td>+1050 Hz</td>
</tr>
<tr>
<td>00</td>
<td>+1</td>
<td>+350 Hz</td>
</tr>
<tr>
<td>10</td>
<td>-1</td>
<td>-350 Hz</td>
</tr>
<tr>
<td>11</td>
<td>-3</td>
<td>-1050 Hz</td>
</tr>
</tbody>
</table>
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).
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.
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.
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.
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
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
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
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
NXDN® Intelligible @ 2 x Distance of analog
Noise incursion starts @ -84 dBm (analog) @ -118 dBm (NXDN; BER increase)
**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

6.25 Very Narrow
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.
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.
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.
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.
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.
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.
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.
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/Traffic Channel Switching** Designates a Traffic Channel as a new Control Channel should the original become disabled. Disabled Traffic Channels are automatically removed from service.
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.
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.
Thank you