NXDN™ Introduction

Next Generation Digital LMR Technology.

NXDN™ Introduction
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Icom Incorporated and JVCKENWOOD Corporation made a 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 was established with an initial eight members</td>
</tr>
<tr>
<td>2009</td>
<td>The NXDN™ website was opened (<a href="http://www.nxdn-forum.com/">http://www.nxdn-forum.com/</a>)</td>
</tr>
<tr>
<td>2010</td>
<td>An informal collaboration with the dPMR™ Association announced</td>
</tr>
<tr>
<td>2011</td>
<td>“Type-D” NXDN™ trunking protocol added to the standards suite</td>
</tr>
<tr>
<td>2011</td>
<td>Five new members join the Forum and membership increases to 21</td>
</tr>
<tr>
<td>2011</td>
<td>AES and DES encryption standards added to the standards suite</td>
</tr>
<tr>
<td>2012</td>
<td>Nine new member companies join the Forum</td>
</tr>
<tr>
<td>2012</td>
<td>The NXDN™ Forum website was renewed</td>
</tr>
<tr>
<td>2012</td>
<td>The NXDN™ standards suite was opened to the public domain</td>
</tr>
<tr>
<td>2016</td>
<td>7 additional new members join</td>
</tr>
<tr>
<td>2017</td>
<td>NXDN™ standard added to ITU-M2014 Mobile Radio report</td>
</tr>
<tr>
<td>2018</td>
<td>NXDN™ celebrates 10 year milestone since introduction</td>
</tr>
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</table>

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What is NXDN™?

An Introduction

- An open technical standard consisting of 6.25 kHz/12.5 kHz narrowband CAI protocols “Type-C” and “Type-D” trunking protocols Encryption (DES/AES) standards Interoperability and Conformance test procedures

- Narrowband digital protocol/6.25kHz FDMA technology
  Low complexity, low cost and spectrum efficient
  A digital alternative for analog FDMA systems

- Encourages a Multi-vendor environment
  Radio products from multiple manufacturers
  Test equipment, silicon chips, applications, protocol stacks
What is NXDN™?

Conventional Peer to Peer
(12.5kHz/6.25kHz FDMA)

Conventional via Repeater
(12.5kHz/6.25kHz FDMA)

Type-C NXDN™ Trunking
(Control Channel type trunking)
Single site trunking
Multi-site trunking
(12.5kHz/6.25kHz FDMA)

Type-D NXDN™ Trunking
(No Control Channel type trunking)
Single site trunking
Multi-site trunking
(6.25kHz FDMA)

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What is NXDN™?

Conventional peer to peer operation

Conventional via Repeater operation

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What is NXDN™?

IP Connectivity
Conventional IP linked wide area communications

Note: IP network specification is manufacturer specific.

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What is NXDN™?

Type-C/Type-D Trunking
Full single and/or multi-site wide area trunking networks
Type-C: Control channel based trunking
Type-D: Distributed logic based trunking

Note: IP network specification is manufacturer specific.

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The Basic Technology

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access Method</td>
<td>FDMA</td>
</tr>
<tr>
<td>Modulation</td>
<td>4-level FSK</td>
</tr>
<tr>
<td>Vocoder</td>
<td>AMBE+2™</td>
</tr>
<tr>
<td>Channel Spacing</td>
<td>6.25kHz / 12.5kHz</td>
</tr>
<tr>
<td>Transmission Rate</td>
<td>4800 bps / 9600 bps</td>
</tr>
<tr>
<td>Codec Rate</td>
<td>3600 bps / 7200 bps</td>
</tr>
<tr>
<td>Conventional</td>
<td>Yes</td>
</tr>
<tr>
<td>Trunking</td>
<td>Yes Type-C and Type-D</td>
</tr>
<tr>
<td>Digital Scrambling</td>
<td>Yes (15-bit, 32,000 keys)</td>
</tr>
<tr>
<td>Encryption</td>
<td>Yes (AES, DES)</td>
</tr>
</tbody>
</table>

![Modulator Diagram](image)

![Demodulator Diagram](image)

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**Advantages**

- The use of FDMA technology provides a “low complex, low cost” development platform
  - Basic design technology maintained from analog FM
  - Low complexity does *not* mean simple capability. NXDN™ can be scalable from 1 repeater to a multi-site system

- Two-way radio fundamentals “built-in”
  - Peer to peer standard (No “reinvention of the wheel”)
  - No reduction in coverage vs analog FM
  - Technical advantages in analog apply equally to digital

- A like for like natural transition from analog to digital
  - System design fundamentals do not change
What is good about NXDN™?

Advantages

- Leading vocoder utilized
  AMBE+2™ is the standard vocoder for NXDN™
  Excellent noise suppression for clearer communications

- NXDN™ is spectrum efficient
  True 6.25kHz channels, no “equivalent” caveats needed
  Will be a viable technology when 12.5kHz spectrum is full
  Future proofed investment for the near and mid-term

- IPR Licenses and Royalties not required
  No added costs resulting from IPR licenses or royalties

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NXDN™ and other technologies

**dPMR digital**

- **Tier 1** (TS 102 490)
  - dPMR446 License-free
- **Tier 2** (TS 102 658)
  - Mode 1: Peer to Peer
  - Mode 2: Repeater Mode
  - Mode 3: Single site trunking Multisite trunking

**Conventional Peer to Peer**
(12.5kHz/6.25kHz FDMA)

**Conventional via Repeater**
(12.5kHz/6.25kHz FDMA)

**Type-C NXDN™ Trunking**
(Control Channel type trunking)
- Single site trunking
- Multi-site trunking
(12.5kHz/6.25kHz FDMA)

**Type-D NXDN™ Trunking**
(No Control Channel type trunking)
- Single site trunking
- Multi-site trunking
(6.25kHz FDMA)

**Tier 1** (TS 102 361)
License-free digital PMR446 (12.5kHz FDMA)

**Tier 2** (TS 102 361)
- Peer to peer Repeater Mode
(12.5kHz/2 slot TDMA)

**Tier 3** (TS 102 361)
- Single site trunking
- Multi-site trunking
(12.5kHz/2 slot TDMA)

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The NXDN™ Forum

- Founded in 2008
  Started with eight members

- Currently 28 member companies (As of March 2019)
  Support a broad range of core competences in the industry

- Established to follow up NXDN™ standards work
  Maintenance and addition of the standards suite

- Mandated the standard vocoder (AMBE+2™)

- Promote NXDN™ and a Multi-vendor environment

- Create and support interoperability testing regime

- Obtain/register trademarks for NXDN™
# Current Members

<table>
<thead>
<tr>
<th>ALINCO</th>
<th>AVTEC</th>
<th>CVDS</th>
<th>etherstack</th>
</tr>
</thead>
<tbody>
<tr>
<td>mindshare</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eventide</td>
<td>EXACOM</td>
<td></td>
<td></td>
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<tr>
<td>FREEDOM</td>
<td>Hytera</td>
<td></td>
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<tr>
<td>INTERTALK</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ICOM</td>
<td>JVCKENWOOD</td>
<td>NUMONIX</td>
<td></td>
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<tr>
<td>RITRON</td>
<td>Rockwell Collins</td>
<td></td>
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<td>REMOTA</td>
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<tr>
<td>TELEX</td>
<td>UltraTech</td>
<td>VIANI</td>
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NXDN™ in the Market

<table>
<thead>
<tr>
<th>Market Segment/Tier</th>
<th>Vertical Markets</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-tier Public Safety/</td>
<td>Emergency Services/Police/Military, Professional Utilities (Airports etc.)/</td>
<td></td>
</tr>
<tr>
<td>Professional</td>
<td>Government/Private Systems</td>
<td></td>
</tr>
<tr>
<td>Mid-high tier B&amp;I/Light</td>
<td>Transportation/Local Govt./Utilities/Large Industry (Manufacturing etc.)/</td>
<td>NXDN™ main</td>
</tr>
<tr>
<td>Commercial</td>
<td>Small-mid sized Systems/Security</td>
<td>target markets</td>
</tr>
<tr>
<td>Low-tier B&amp;I/License-free</td>
<td>Construction/Security/Retail/Hotels/Restaurants/Warehouses/Theme Parks/</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private Security/Rental</td>
<td></td>
</tr>
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Examples of Actual NXDN™ Users

- Police and Public Safety entities
- Amusement parks and Casinos
- United States Class-1 railways
- Humanitarian agencies
- University and Industrial campuses
- Medical Centers and Rescue services
- Security entities and Sports facilities
- Transport entities and Airports
- City Councils and Local Government agencies
- Road maintenance and Highway Administrations
- Private System Operators and Utilities

Over **3.7 MILLION** NXDN™ Units in the field!

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# The Basic Migration Alternatives:

- **“Big Bang” Migration**
  Throw away the existing system and completely start anew
  Obvious cost and system down time risk considerations need to be analyzed

- **Infrastructure migration**
  Initially replace older infrastructure with digital infrastructure
  Allows an orderly switchover of the system with no down time
  Can set up and monitor IP links and RF coverage for maximum smoothness of the eventual transition to digital mode

- **Infrastructure/Terminals mixed migration**
  Replace sites and radios as required
  Mixed analogue/digital mode terminals allow continuous communications with existing radios
  Advantages in cost outlays and system planning requirements
The NXDN™ Advantage:

– FDMA offers a like for like migration
  Use of existing site equipment possible
  RF propagation and coverage characteristics would be similar to analog FM

– Cross protocol communications
  Some NXDN™ solutions offer the ability to have NXDN™ and MPT radios operate in the same system for example
  Radio users can continue to use analog radios for a smoother gradual migration as needed

– Natural system integrity
  Failsafe peer to peer if system fails
  Only one channel lost if repeater fails
**In Summary**

**NXDN™ is:**
- An open standard
- A continuously evolving standard
- Supported by multiple leading industry players
- Supported via a dedicated industry group
- A multi-vendor selection of products/services
- Has a legitimate interoperability qualification system
- Spectrum efficient and viable solution beyond 12.5kHz channel spacing
- Used in the field with proven success

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