NXDN™

Next Generation Digital LMR Technology.

NXDN™ Introduction

NXDN™ History

2003: Icom Incorporated and JVCKENWOOD Corporation made a 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 was established with an initial eight members

2009: The NXDN™ website was opened (http://www.nxdn-forum.com/)

2010: An informal collaboration with the dPMR™ Association announced

2011: "Type-D" NXDN™ trunking protocol added to the standards suite

2011: Five new members join the Forum and membership increases to 21

2011: AES and DES encryption standards added to the standards suite

2012: Nine new member companies join the Forum

2012: The NXDN™ Forum website was renewed

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

2016: 7 additional new members join

2017: NXDN™ standard added to ITU-M2014 Mobile Radio report

2018: NXDN™ celebrates 10 year milestone since introduction

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™?

NXDN™

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

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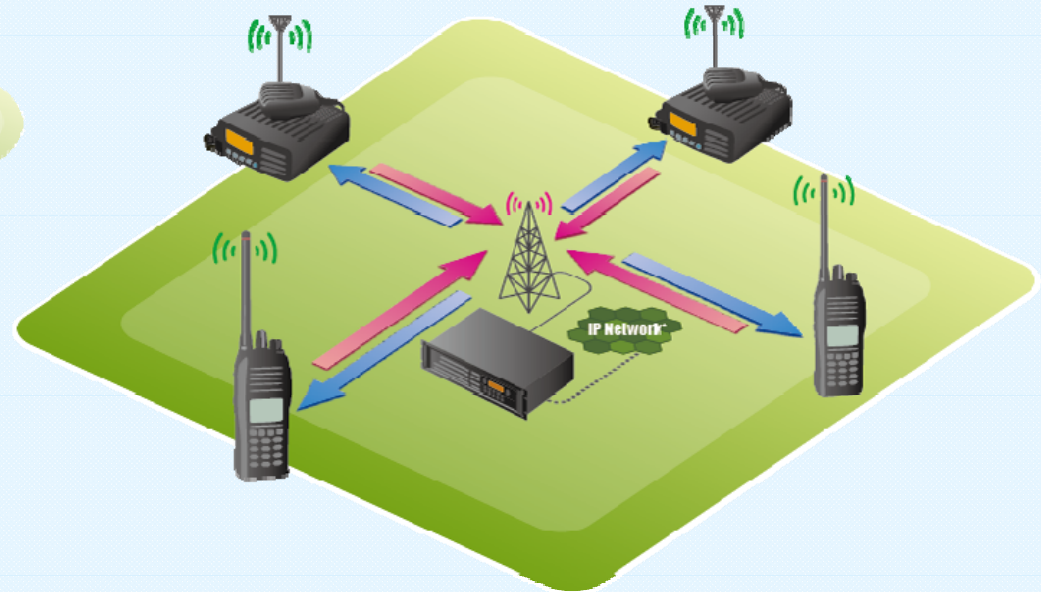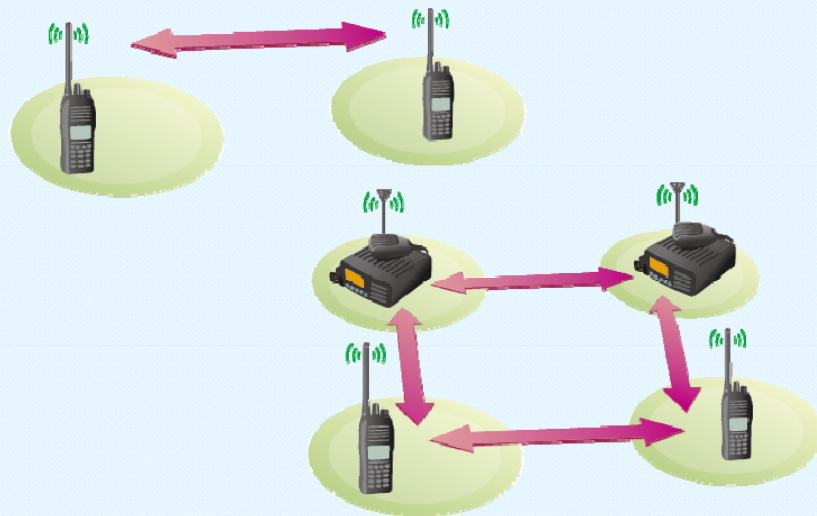**(12.5kHz/6.25kHz FDMA)**

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
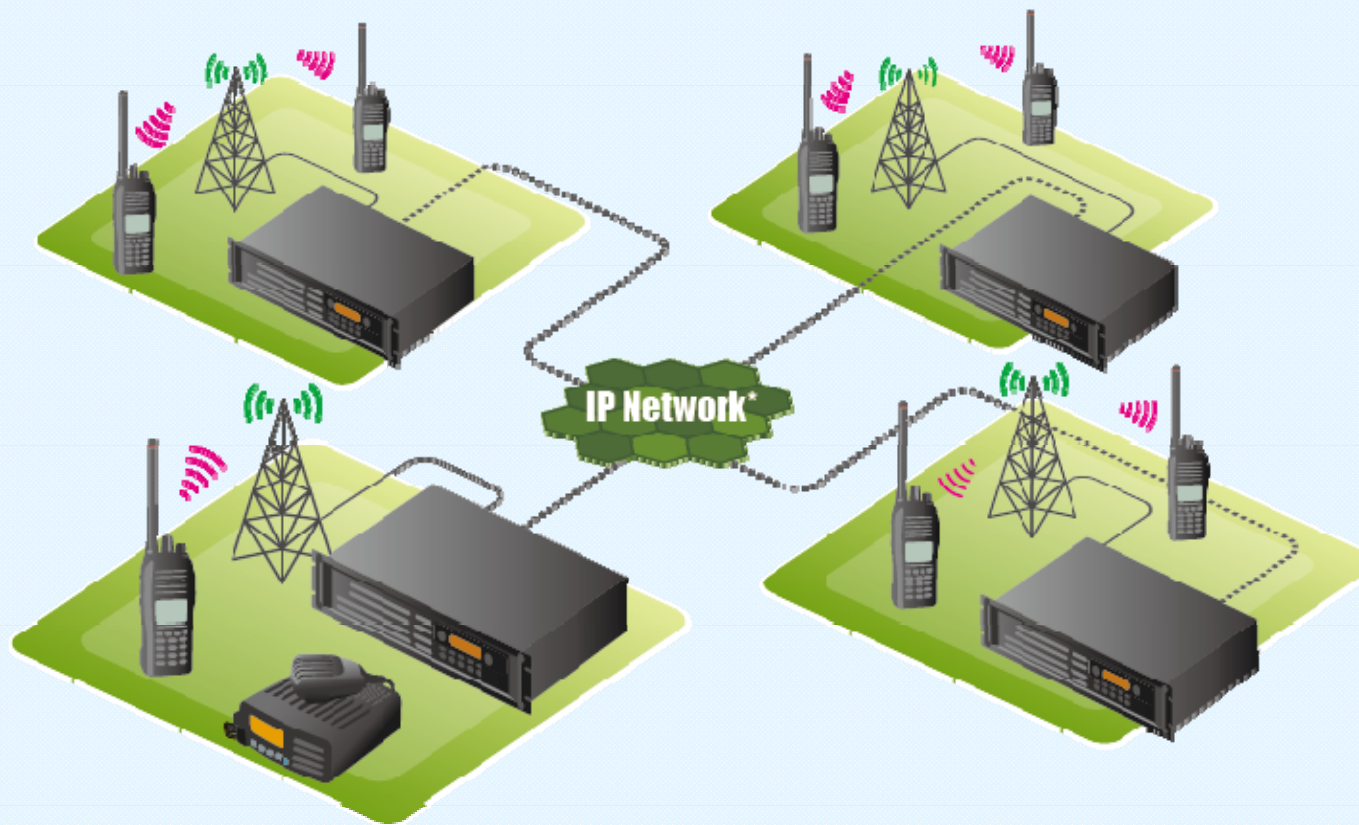**Multi-site trunking**
(6.25kHz FDMA)

Conventional peer to peer operation

Conventional via Repeater operation

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IP Connectivity
### Conventional IP linked wide area communications

Note: IP network specification is manufacturer specific.

NXDN™

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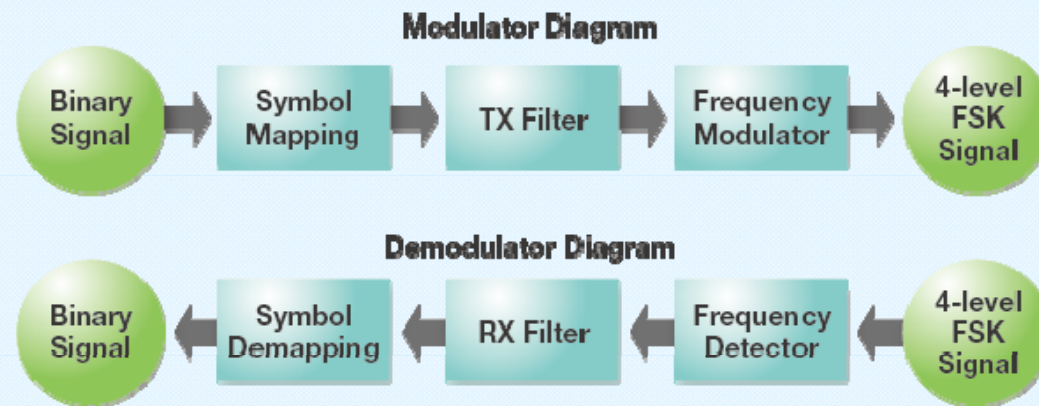Type-C: Control channel based trunking
Type-D: Distributed logic based trunking

IP Network*

Note: IP network specification is manufacturer specific.

The Basic Technology
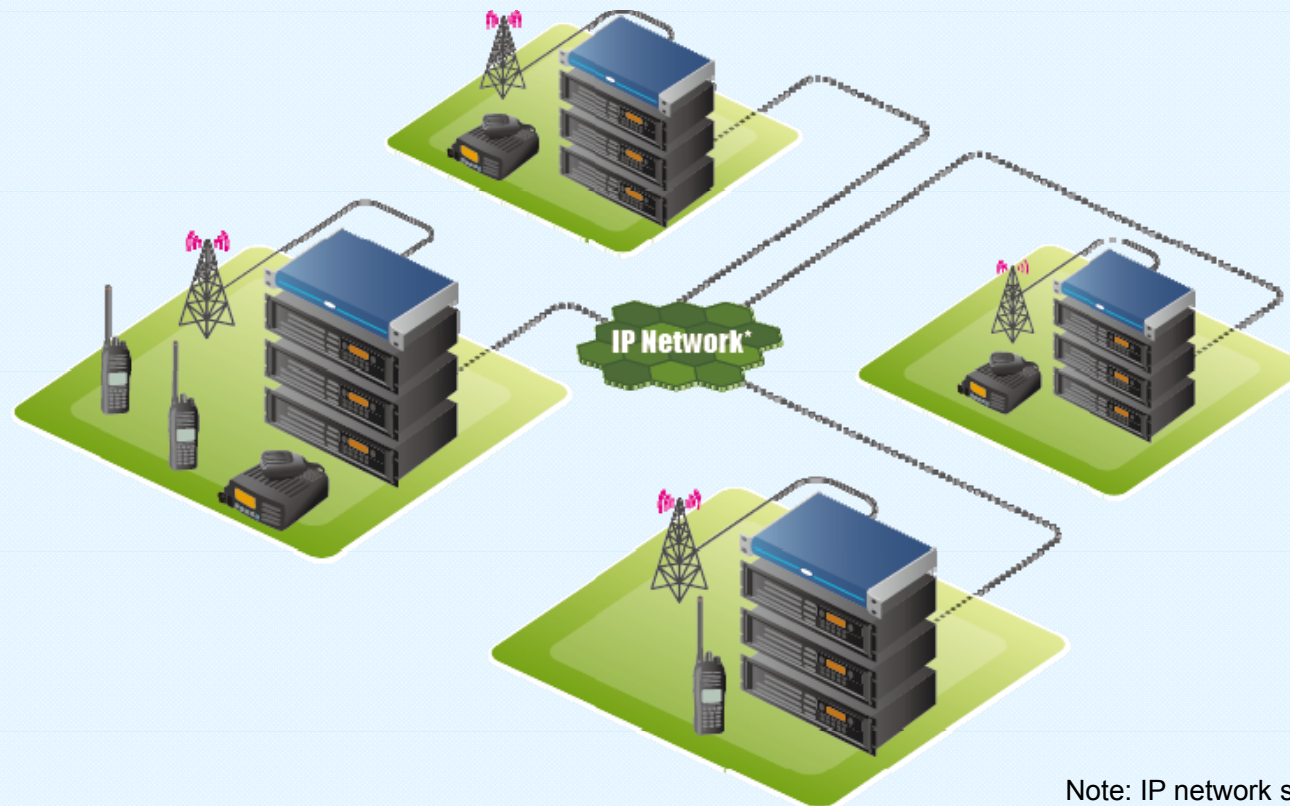
−**General specifications:**

Access Method	:	**FDMA**
Modulation	:	**4-level FSK**
Vocoder	:	**AMBE+2™**
Channel Spacing	:	**6.25kHz / 12.5kHz**
Transmission Rate	:	**4800 bps / 9600 bps**
Codec Rate	:	**3600 bps / 7200 bps**
Conventional	:	**Yes**
Trunking	:	**Yes Type-C and Type-D**
Digital Scrambling	:	**Yes (15-bit, 32,000 keys)**
Encryption	:	**Yes (AES, DES)**

Modulator Diagram

Binary Signal → Symbol Mapping → TX Filter → Frequency Modulator → 4-level FSK Signal

Demodulator Diagram

Binary Signal ← Symbol Demapping ← RX Filter ← Frequency Detector ← 4-level FSK Signal
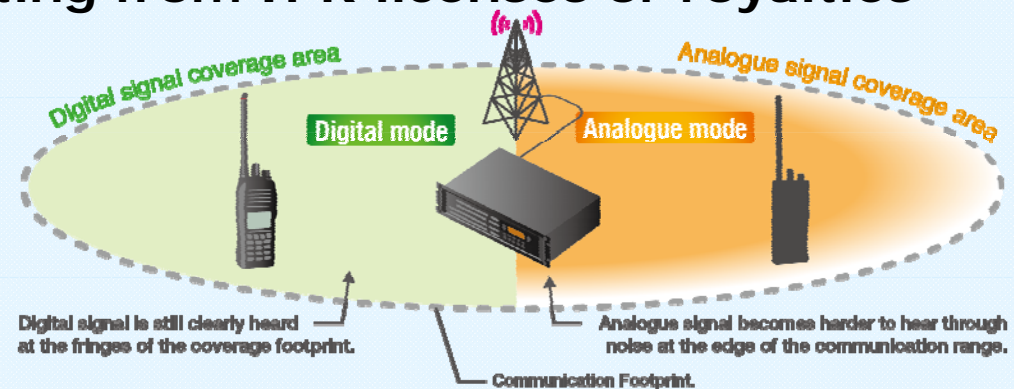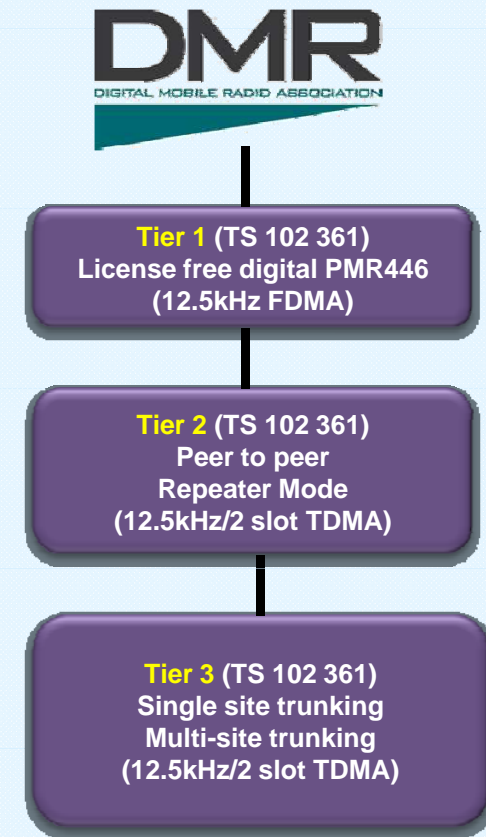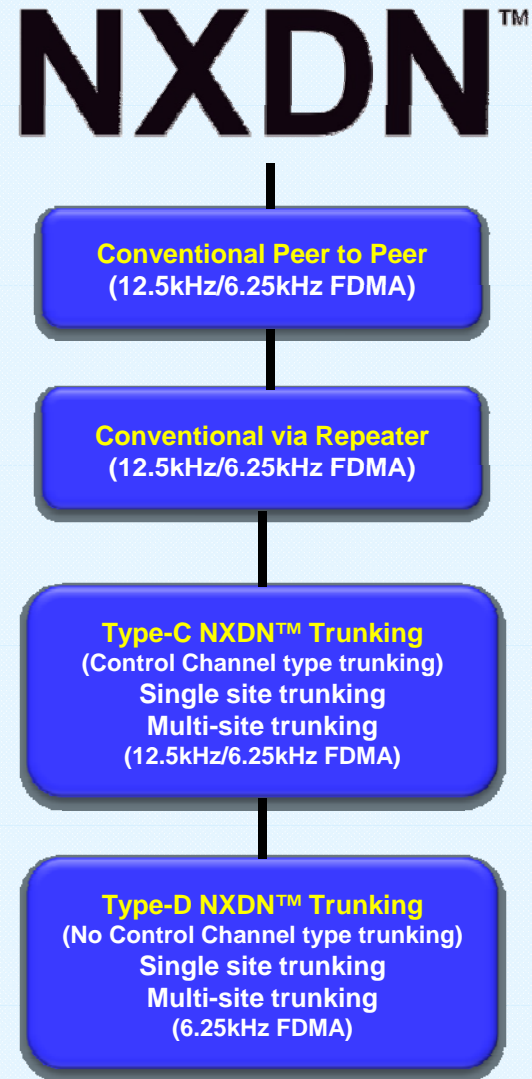
Advantages

– 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

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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

Digital signal coverage area — Digital mode — Analogue mode — Analogue signal coverage area

Digital signal is still clearly heard at the fringes of the coverage footprint.

Analogue signal becomes harder to hear through noise at the edge of the communication range.

Communication Footprint.

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NXDN™ and other technologies

NXDN™

dPMR™ digital

NXDN™

DMR DIGITAL MOBILE RADIO ASSOCIATION

Tier 1
(TS 102 490)

Tier 2
(TS 102 658)

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

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

dPMR446
License-free

Mode 1
Peer to Peer

Conventional via Repeater
(12.5kHz/6.25kHz FDMA)

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

Mode 2
Repeater Mode

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

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

Mode 3
Single site trunking
Multis-ite trunking

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

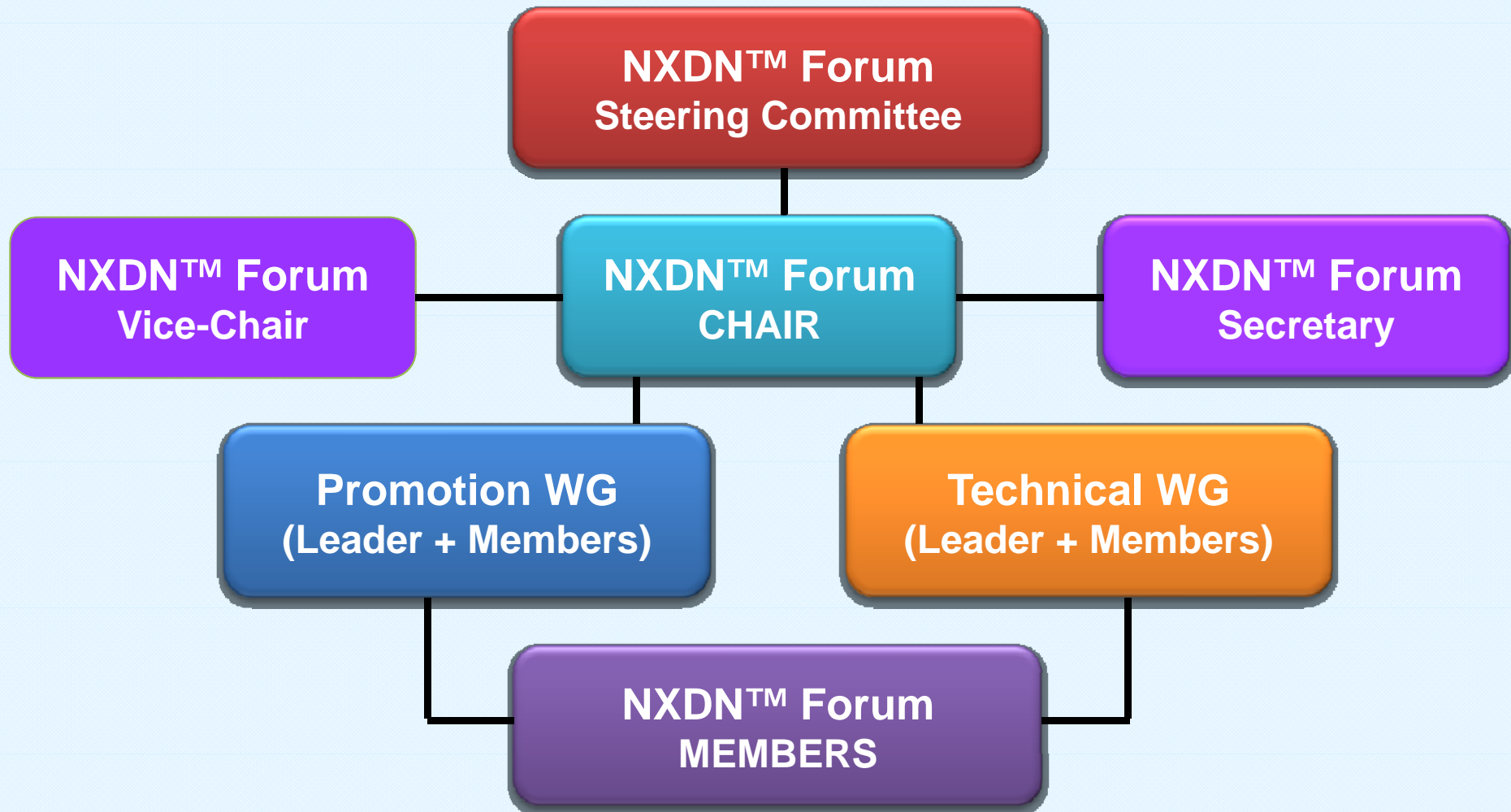Copyright 2019 NXDN™ Forum.

The NXDN™ Forum

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™

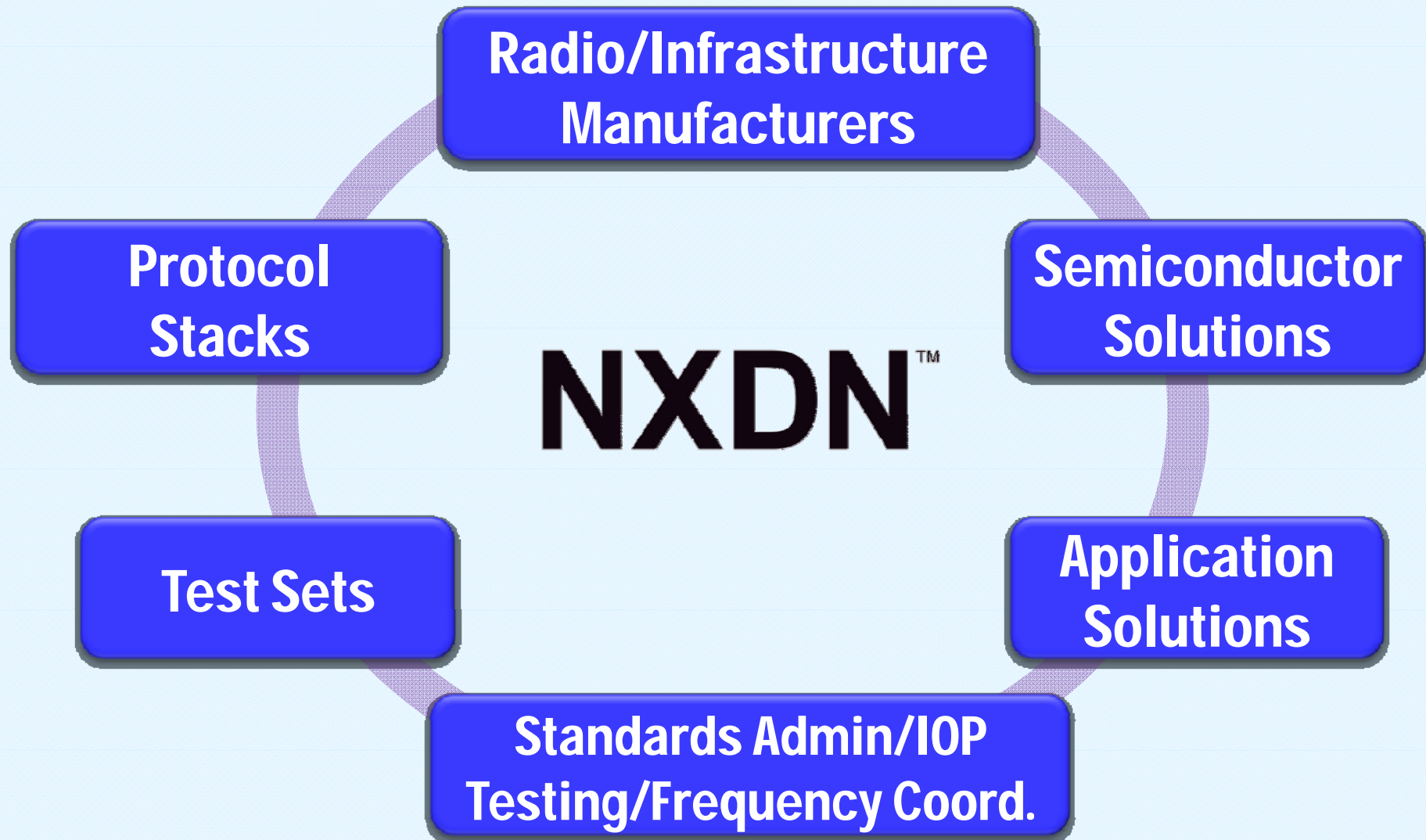**NXDN™**

Structure of the Forum

NXDN™ Forum
Steering Committee

NXDN™ Forum
Vice-Chair

NXDN™ Forum
CHAIR

NXDN™ Forum
Secretary

Promotion WG
(Leader + Members)

Technical WG
(Leader + Members)

NXDN™ Forum
MEMBERS

Current Members

More details at:

http://www.nxdn-forum.com/our-members/who-are-members/

Member's Core Competences

NXDN™

- Radio/Infrastructure Manufacturers
- Semiconductor Solutions
- Application Solutions
- Standards Admin/IOP Testing/Frequency Coord.
- Test Sets
- Protocol Stacks

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NXDN™ in the Market

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Market Segment/Tier	Vertical Markets	Technology
High-tier Public Safety/ Professional	Emergency Services/Police/Military Professional Utilities (Airports etc.)/Government/Private Systems	
Mid-high tier B&I/Light Commercial	Transportation/Local Govt./Utilities/Large Industry (Manufacturing etc.)/ Small-mid sized Systems/Security	**NXDN™ main target markets**
Low-tier B&I/ License-free	Construction/Security/Retail/ Hotels/Restaurants/Warehouses/ Theme Parks/Private Security/ Rental	

NXDN™

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!

Migration

NXDN™

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

Migration

NXDN™

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
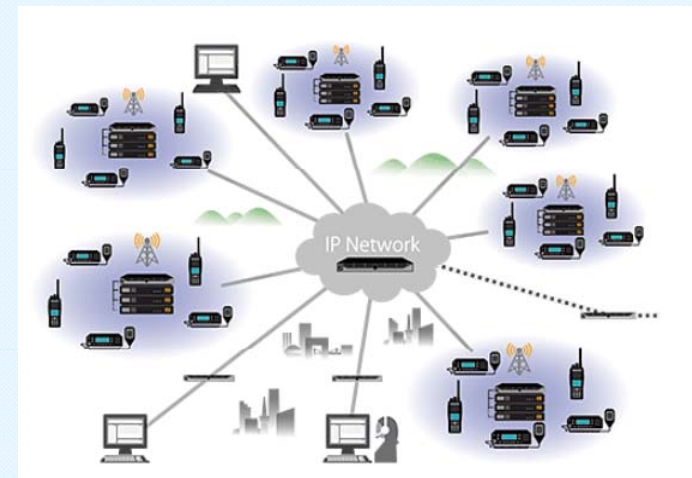
NXDN™ is:

–**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** ☑
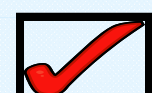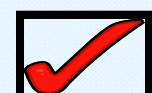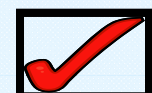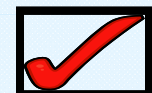
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