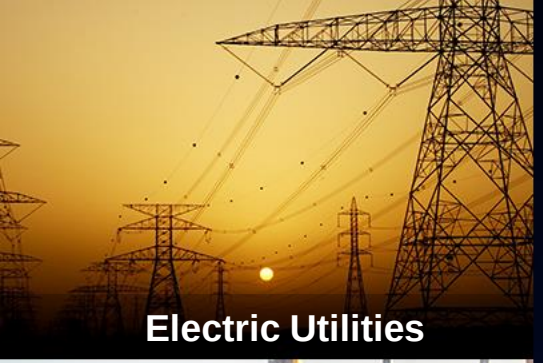

ONDAS
NETWORKS
Connectivity Solutions for
Mission Critical IoT

Who is Ondas?

- **Company founded in 2006 (formerly Full Spectrum, Inc) by Senior Wireless Communications Executives**
  - Delaware Corporation headquartered in Sunnyvale
  - Former AT&T, Nokia, Bell Labs – extensive wireless R&D and operator experience
- **Formed specifically to develop private, licensed, wireless field area networks (mobile and fixed) for electric utilities**
- **Multiple patents based on our Software Defined Radio (SDR) and Cognitive Radio technology**
- **End-to-end SDR platform supports frequencies from 70 MHz to 6 GHz, channel sizes 12.5 kHz to 10 MHz with configurable TDD ratios (90/10, 10/90)**

Many Industries, *All* Critical Applications



Electric Utilities

- Field Area Networks
- Grid Automation

Water / Wastewater Utilities

- Pump / Valve monitoring and control

Oil & Gas Fields & Pipelines

- Intelligent monitoring and control of fields and pipes
- Rig-to-Shore, Rig-to-Rig monitoring and control

Defense Markets

- Air Drones / Sea Drones
- Ship to Shore

Transportation (Highway / Rail)

- Autonomous Vehicles
- Train Monitoring & Control

Security

- Border Security
- Intelligent Fences / Walls

Commercial / Industrial Drones

- Secure reliable control channel and video

Mobile Airport Communication

- Terminal / field automation

Requirements


Public
Private

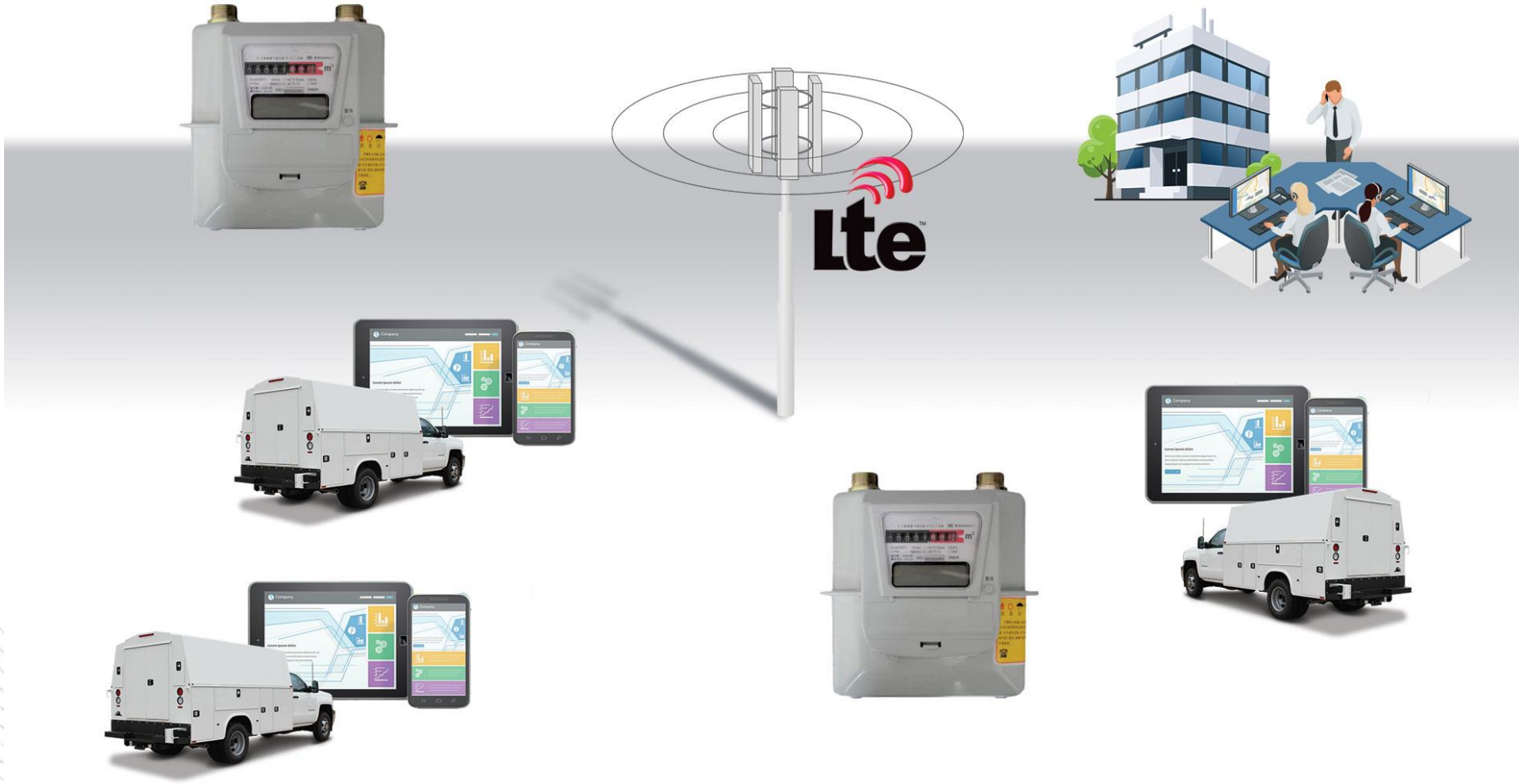
Public Networks

- **Benefits**
  - Already built in many places
  - Low capital expenditure
- **Challenges**
  - Lack of coverage in rural areas
  - Availability & Reliability are less than needed for mission cr communications such as SCADA
  - No commercial network has stayed up during a disaster (natural or manmade)
  - Lack of generator back up at most sites for extended power outages.

Public Networks - Applications

- **Non-Critical Communications**
  - Work force management
  - Automated Vehicle Locating (AVL)
  - Email
  - Meter reading

Public Networks



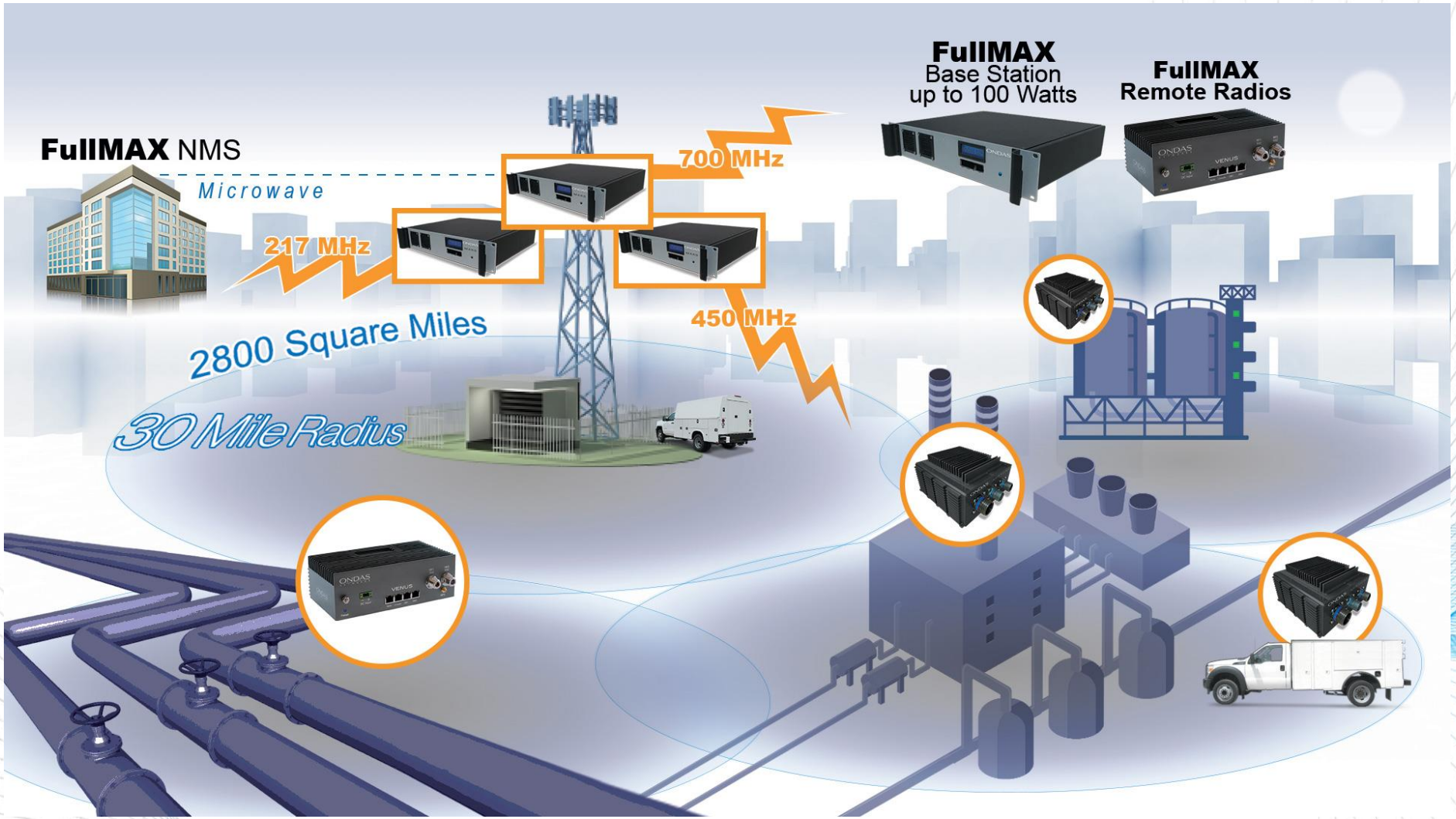
Private Networks

- **Benefits**
  - Utility owned and controlled
  - High availability, reliability, security & low latency
  - Lower O&M
  - Can share network with electric business if desired
- **Challenges**
  - Spectrum
  - High capital expenditure
  - Need telecommunications expertise & staff
    - Engineers & Technicians

Critical Communications

- SCADA
- Compressor/pumping stations
- Flow meters
- Meter collectors
- Can share with electric business

Private Networks



Public Networks

- **Hurricane Harvey – August 2017**
  - 64 counties affected, 0% - 94.7% Cell sites per county down 1st day; Total 4% of all cell sites down
  - 64 counties affected, 0% - 30.6% Cell sites per county down 7th day; Total 2.4% of all cell sites down
- **Hurricane Michael – October 2018**
  - 101 counties affected, 0% - 78.3% Cell sites per county down 1st day; Total 18.8% of all cell sites down
  - 64 counties affected, 0% - 46.2% Cell sites per county down 7th day; Total 3.2% of all cell sites down

Standards

ONDAS

NETWORKS

Connectivity Solutions for

Mission Critical IoT

- Grass roots effort – started by utilities
- All existing solutions were proprietary, needed a narrower channel standard

Standardization for Narrowband WiMAX –IEEE Steps Up

- Demand for Standard Solution to Leverage Available Spectrum
- Project Initiated by Coalition of Interested Parties…

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Utilities Technology Council™

WiMAX FORUM®

- Project adopted by IEEE 802.16 Working Group

IEEE 802.16s Project Authorization

"Standard for Air Interface for Broadband Wireless Access Systems Amendment: Fixed and Mobile Wireless Access in Channel Bandwidth up to 1.25 MHz"

IEEE 802.16s Project Timetable

- EPRI / UTC Kickoff Meeting - May 2015
- IEEE 802.16 Working Group Meeting - January 2016
- IEEE 802.16s PAR - CSD Approved - March 2016
- IEEE 802.16s First Task Group Meeting - May 2016
- IEEE 802.16s Task Group Activity Complete - June 2017
- IEEE 802.16s New Standard Published - October 2017

TDD vs. FDD

FDD

IEEE 802.16s - Highlights

IEEE 802.16s

- The only standard developed SPECIFICALLY to serve mission critical industries and NOT the consumer market
- Minimizes overhead to maximize data throughput to make it extremely efficient for mission critical applications
- Designed so it can be reverse asymmetrical (more throughput for upstream than downstream) which is how most mission critical systems function
- Designed for channel sizes mission critical industries have access to (100 kHz up to 1.25 MHz)

IEEE 802.16s

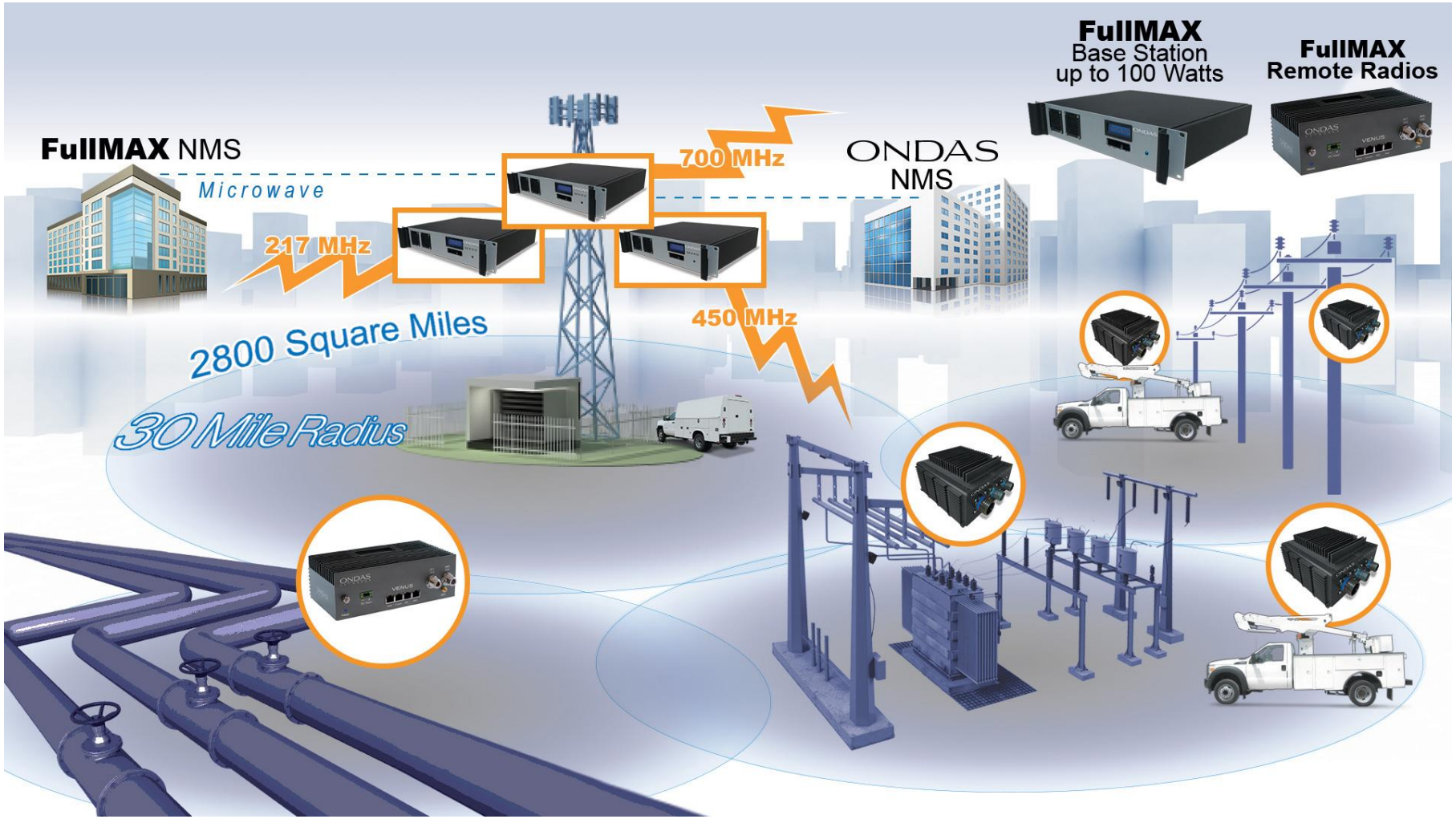
- **IEEE 802.16 Working Group-New Revision**

Starting work in 2020.

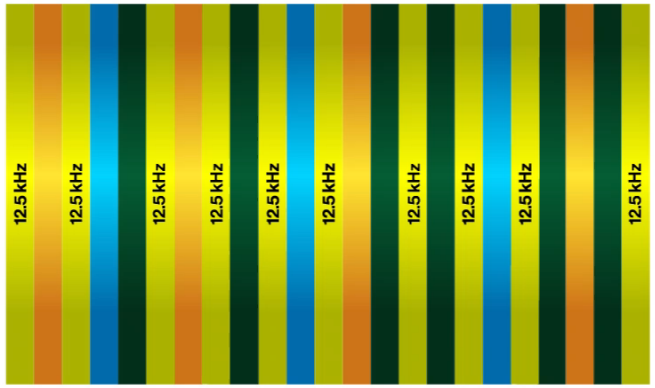
- Reducing channel sizes to 12.5 kHz or lower
- Ability to aggregate non-adjacent spectrum
- More manufacturers
- Other changes as dictated by users
- Get involved in the standard. This is our industry's standard – more input=better standard

IEEE 802.16s – Mulitple Frequency Bands – One Network

IEEE 802.16s



Spectrum Harvesting



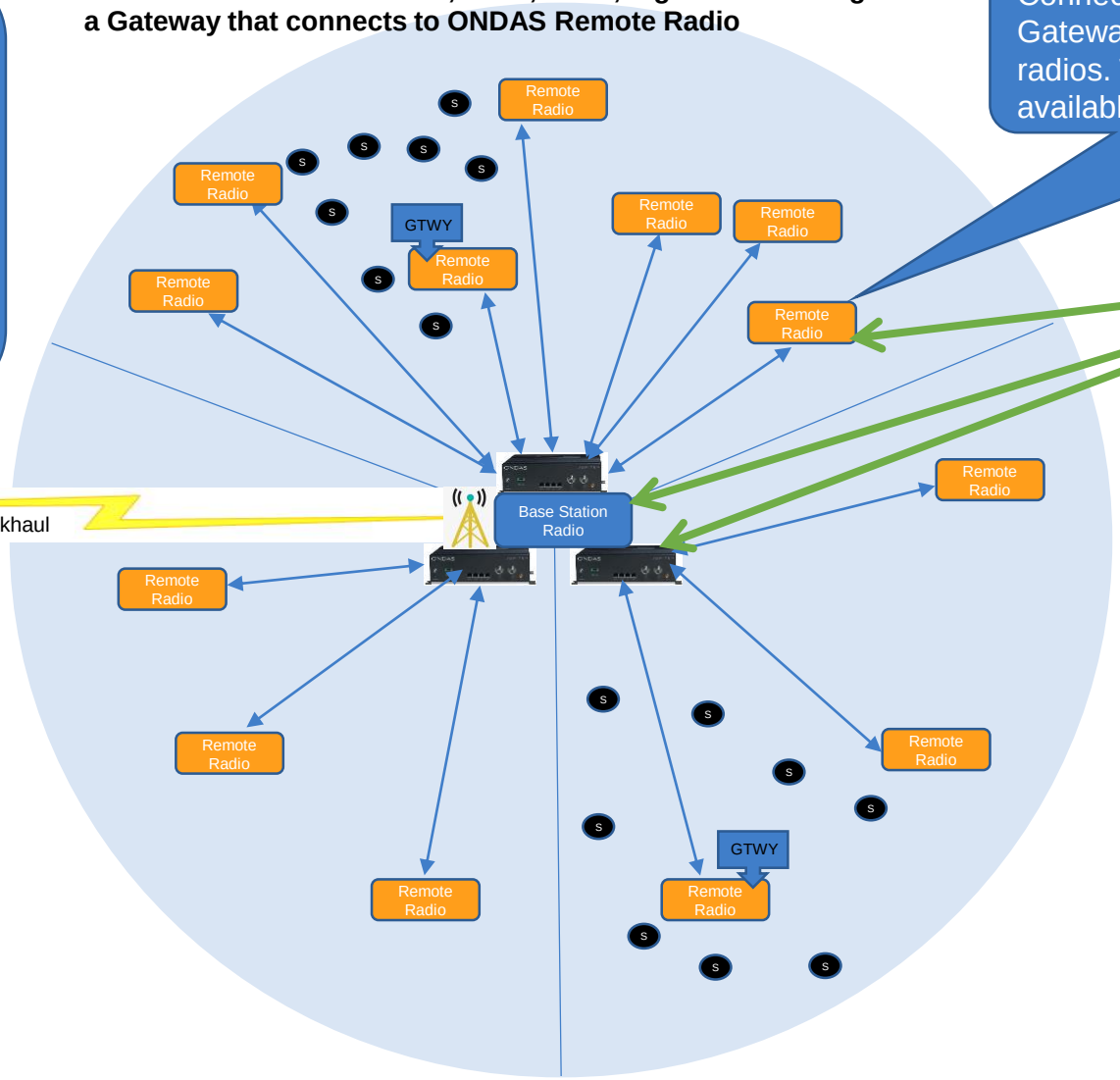
RADIO FREQUENCY SPECTRUM

Non-adjacent channels can be bound together to form one larger channel

FullMAX™ Point to Multipoint Network Architecture

- High Power Base Station
- High and Low power remote radios with **narrower channels** connected to any type of sensor network
- Up to 30 mile radius, 2800 Square Miles coverage with **ONE** Base Station

Sensor network can be BLE, Wi-Fi, LoRa, Sigfox connecting to a Gateway that connects to ONDAS Remote Radio



Connect SCADA, Teleprotection, Sensor Gateways or any other data input to the remote radios. Two ethernet ports and an RS232 port are available on the Venus HW Platform

Remote Radio and Base Station for FAN (Field Area Network) and microwave link for backhaul are all ONDAS Radios

FullMAX NMS

Microwave Backhaul

Conclusion

- Public networks have their place and can provide good value for utility communications
- For mission critical communications such as SCADA and teleprotection, transfer trip, etc., private networks are still needed
- Licensed, private networks are still needed for mission critical applications
- Standards are needed for stability & risk mitigation for utility mission critical applications