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
- Defense Markets
- Security
- Water / Wastewater Utilities
- Transportation (Highway / Rail)
- Oil & Gas Fields & Pipelines
- Commercial / Industrial Drones
- Mobile Airport Communication

- Field Area Networks
- Grid Automation
- Pump / Valve monitoring and control
- Intelligent monitoring and control of fields and pipes
- Rig-to-Shore, Rig-to-Rig monitoring and control
- Air Drones / Sea Drones
- Ship to Shore
- Autonomous Vehicles
- Train Monitoring & Control
- Border Security
- Intelligent Fences / Walls
- Secure reliable control channel and video
- Terminal / field automation
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 critical 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
Public Networks

Hurricane Harvey – August 2017
- 64 counties affected, 0% - 94.7% Cell sites per county down 1\textsuperscript{st} day;
  Total 4% of all cell sites down
- 64 counties affected, 0% - 30.6% Cell sites per county down 7\textsuperscript{th} day;
  Total 2.4% of all cell sites down

Hurricane Michael – October 2018
- 101 counties affected, 0% - 78.3% Cell sites per county down 1\textsuperscript{st} day;
  Total 18.8% of all cell sites down
- 64 counties affected, 0% - 46.2% Cell sites per county down 7\textsuperscript{th} day;
  Total 3.2% of all cell sites down
Standards

Connectivity Solutions for Mission Critical IoT
Grass roots effort – started by utilities

All existing solutions were proprietary, needed a narrower channel standard
Demand for Standard Solution to Leverage Available Spectrum

Project Initiated by Coalition of Interested Parties…

Project adopted by IEEE 802.16 Working Group
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
Connectivity solutions for MISION CRITICAL IoT

TDD vs. FDD

FDD
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 802.16 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 – Multiple Frequency Bands – One Network
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

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

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.
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.