Larson Data Communications, Inc.

Presenting today:
Mike Larson

EVOLVE
CONSOLIDATE
ACCELERATE
“Total solutions provider of GE MDS industrial wireless data communications systems & services.”

* Established in 2002
* Specializing in all things relating to Wireless Data Communications

MDS “Triple Certified” Full Service Partner for:
Iowa, Minnesota, Montana, Nebraska, North Dakota, South Dakota, & Wyoming
A well designed, well installed, well maintained wireless system is a beautiful thing…
Antenna Systems

The Weak Link In High Data Throughput Wireless Communications Systems
A Brief History…

150 Years Of Advancements & Trends In Wireless Systems Technology
Or...

Where is wireless data coming from...

...and where is it going?
Well, in the beginning...

James C. Maxwell predicts the existence of electromagnetic waves: “A Dynamical Theory of The Electromagnetic Field”

(1864)

Spark Gap Transmitters (1900s – 1910s)

Electron Tubes (1910s – 1950s)

Transistors (1950s - 1980s)
But, this was the age of Analog Data. And, analog waveforms are highly susceptible to noise & distortion. So, what starts out at the transmitter looking like this:

\[ x(t) \]

...ends up at the receiver looking like this:
Then came digital...
Which allowed radios to perform multiple tasks simultaneously:

- Noise Filtering
- Forward Error Correction
- Over-the-air Diagnostics

Digital Communications

...and the Digital Signal Processor!
Legacy Point-To-Multipoint RS-232 Serial Radio System

Point-To-Multipoint RS-232 Serial Radio System

- ELECTRIC UTILITY
- WATER UTILITY
- PIPELINE
- LOTTERY / FINANCIAL
- MDS MASTER STATION
- GAS/OIL WELL
- MDS REMOTE
- DIAGNOSTICS COMPUTER
- HOST COMPUTER

(1980s-2000s)
...and then came Ethernet – and what started out in the office...

...was quickly adapted to industrial communications systems.
and the ability to send any packet, to any port, on any device, anywhere - on a given network.
Other Advancements In Wireless Technology

Additional technologies/manufacturing techniques have been perfected:

- Digital Signal Processing Gain has become a reality - increasing Rcvr sensitivity.
- Remote/Over-the-Air firmware upgrades and wireless network management.
- New modulation techniques have developed allowing for faster data speeds.
  - BPSK, QPSK, QAM-64QAM, CPFSK, OFDM…
- “Media Access Control” techniques have been developed which allow for:
  - Elimination of over-the-air packet collisions (still common in some manufacturer’s systems).
  - Guaranteed packet integrity and delivery, even from weaker stations. (GE MDS only)
  - Multiple Polling SCADA Masters/Devices on a single radio network. (GE MDS only)
  - Push/Report-by-Exception communications from remote sites. (GE MDS only)
  - Store-&-Forward transport of true Ethernet Bridge communications. (GE MDS only)
- Reverse compatibility was maintained & “Transparent” mode perfected.
- Embedded/On-board Serial Device Servers, Ethernet Routing, Firewall, etc.
- Higher system operating frequencies & the antenna systems to support them.
A typical aging SCADA system today...

- Legacy systems still in service
- Newer generation/Ethernet systems being installed:
  - “Transparent Mode”
  - “Hybrid” networks
    # Spectrum sharing
    # Non-spectrum sharing
More smart machines producing more data, passing over more connections.

Growing Demand for Additional Network Connectivity

The Evolving Wireless Landscape

- More automated processes
  - Advanced Metering Infrastructure (AMI)
  - Early Flood Warning Systems
  - Treatment Plant PLC
  - Cathodic Protection (CP)

- More devices

- More intelligent systems
  - Hosted Network Operations Centers (NOCs)
  - Real-Time Diagnostics

- More data
  - Field Area Networks (FAN)
  - Video Surveillance
Growing Demand for Additional Network Connectivity

The Evolving Wireless Landscape

Increased wireless network demands require optimal wireless links, sound network plans, & network equipment configurations that minimize OTA traffic.
Convergence of IT and OT:

**Information Technology:** Servers, PCs, Printers, Switches, & Routers…
all configured to support routine business & administrative network requirements
usually consisting of non-time-sensitive communications.

Typically:
* over only short distances within or between office/plant buildings.
* connected via copper or fiber (near unlimited network capacity).

**Operation Technology:** Servers, PCs, Printers, Switches, & Routers…
AND PLCs, RTUs, Sensing/Controlling/Metering/Pumping/(ad infinitum) devices…
all configured to support critical industrial automation & control network requirements
usually consisting of time-sensitive (real/near real time) communications.

Typically:
* over long distances between system sites and/or control points.
* connected via wireless circuits (limited network capacity).
Multiple network segments on a single, integrated, manageable, secure network.
“What could go wrong…?”
The rapid adoption of highly sophisticated wireless systems & complex industrial control Ethernet networks has resulted in expertise gaps between what is required and what is available.
Knowledge of, and experience working with, legacy RS-232 serial connectivity radios and field devices is of little use when dealing with state-of-the-art Ethernet based wireless networks.
Some advanced Ethernet networking knowledge is a must.

Other requirements:

* Realistic expectations.

* A sound network IP address scheme employing network segmentation where appropriate.

* Network equipment (managed switches and/or routers) configured to shield low bandwidth wireless networks from unnecessary Ethernet traffic.
Knowledge of, and experience working with, legacy low frequency radio antenna systems is of little use when dealing with higher throughput, higher frequency wireless networks.
Antenna Selection & Installation...

...can make, or break, your system!!
### Common SCADA System Frequency Bands

- **130-174 MHz** Licensed
- **220-240 MHz** Licensed
- **330-512 MHz** Licensed
- **746-794 MHz** Licensed
- **800-960 MHz** Licensed
- **902-928 MHz** Unlicensed
- **2.40-2.50 GHz** Unlicensed
- **3.65-3.67 GHz** Registered
- **4.94-4.99 GHz** Registered
- **5.20-5.30 GHz** Unlicensed
- **5.70-5.80 GHz** Unlicensed
- **6.00-39.0 GHz** Licensed
**Common Issues With Higher Operating Frequencies**

- **Failure to Optimize Antenna Selection For Maximize Performance**
- **Failure To Optimally Place Obstructed Radio Link Antenna Systems**
- **Inadequate Transmission Line Selection - Excessive Line Losses**
- **Inadequate Grounding System – Storm Related Equipment Losses**

*Use of higher frequency, higher data throughput radio systems requires more than just a casual knowledge of electromagnetic, antenna, & transmission line theory and system grounding.*
Antenna Fields – Remember this…?

Magnetic Field

Electromagnetic Field
Antenna Options – Differences?

- Omni Antennas
- Directional Antennas
All Antennas Are Not Created Equal...
Here in the upper plains states, we almost never have bad weather...
...or have to deal with antenna icing - like this...
...or perhaps like - this...
The design was right.

The specifications were right.

The installation - not so much…
Self Interference (1)…
Self Interference (2) [GS-16]...
Self Interference (3)
Self Interference (4)
Self Interference (5)…
Self Interference (6)
Self Interference (8)…
Side Mounted Omni-directional Antenna Position (1)
Side Mounted Omni-directional Antenna Position (2)
Side Mounted Omni-directional Antenna Position (3)
Side Mounted Omni-directional Antenna Position (4)
Side Mounted Omni-directional Antenna Position (5)
Antenna System Components – Not the place to skimp...

* Transmission Lines
* Grounding
* Lightning Protection
Transmission Lines, Grounding, & Lightning Protection
Grounding, & Lightning Protection - 2

[Images of damaged areas and equipment showing the consequences of improper grounding and lightning protection.]
“To Do” List:

- Do commit to planning for (and “riding”) waves of change.
- Do take advantage of highly beneficial new technology.
- Understand the limits of limited wireless system expertise.
- Ensure that both the design & installation of sensitive systems are performed by those with proven expertise.
- Do plan for funding & facilitating additional staff training.
- Do seek out and work only with support & product vendors known to have invested in advanced wireless systems and network training for their staffs.
The path to an optimally designed, optimally functioning, optimally maintained wireless system can be difficult...

But with the right technology partners...

...the ride can be a smooth one!
Thoughts?

Questions?
Larson Data Communications, Inc.
**GE MDS Full Service Partner for:**
IA, MN, MT, NE, ND, SD, & WY

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