Wireless Technology & Application

RAD–line wireless

Paul Mercier – Project Engineer

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Wireless Technology

RAD–line wireless

Our Company

HQ – Blomberg, DE

USA – Harrisburg, PA

Regional Tech Centers

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It All Starts Here with Phoenix Contact

Leading Developer of Industrial and Electronic Technology

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Phoenix Contact - USA

US-based Logistics and Manufacturing

U.S. Headquarters

PHOENIX CONTACT USA Inc.
Harrisburg, Pennsylvania

Founded:	1981
Employees:	700

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Wireless Made Easy

RAD–line wireless

AGENDA:

- Background Basics
- Signal Basics
- Technology
- Security Issues
- Applications

Wireless Technology enabled by IEEE

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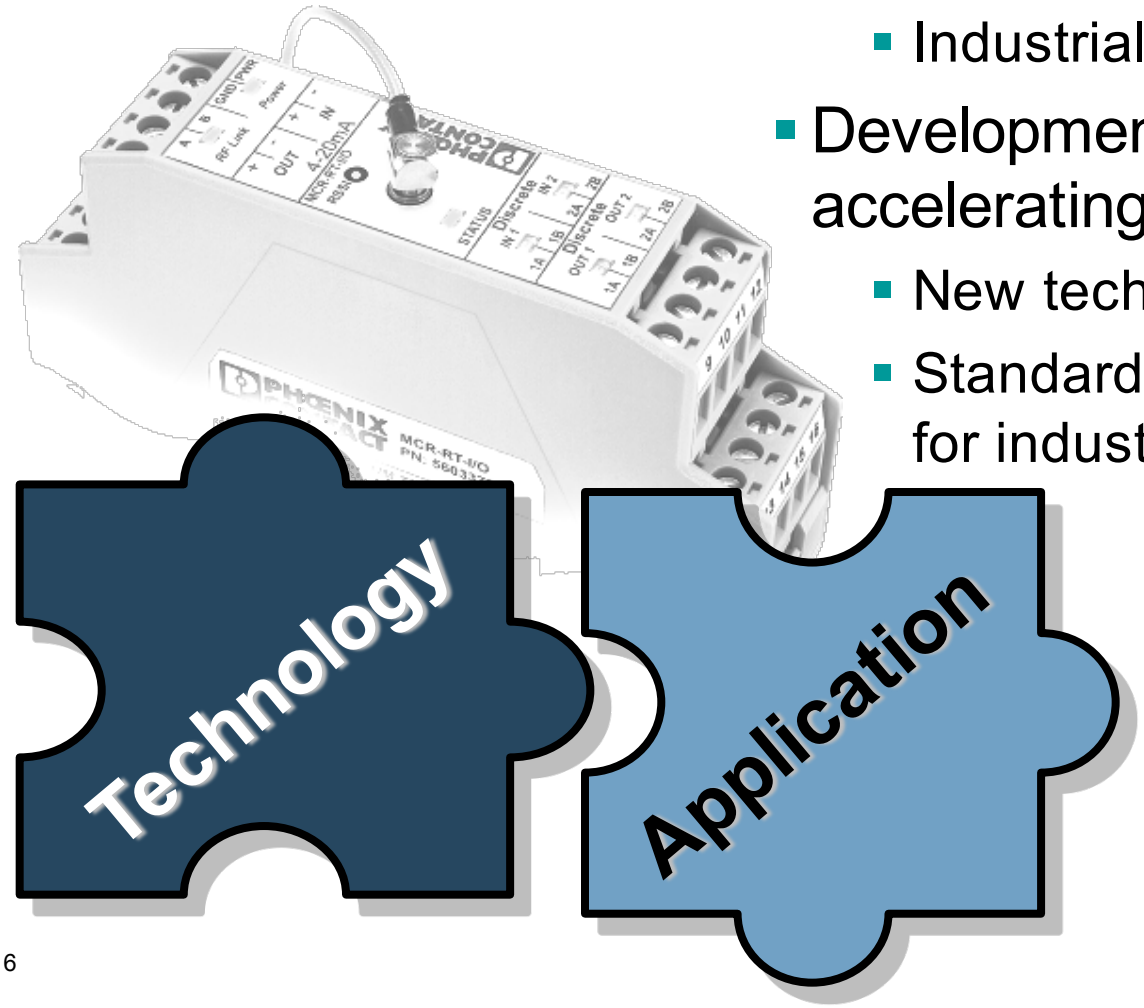
- Wireless has become a standard in everyday life, thanks to IEEE
  - Commercially, for convenience
  - Industrially, to solve problems
- Developments in industrial wireless are accelerating very rapidly
  - New technologies are in development
  - Standards are being created specifically for industry



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Benefits of Wireless

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- Lower installation costs (than wired solutions)
  - Labor savings
  - Permits and delays
  - Material cost
- Faster installation vs. traditional cabling
- More application flexibility
- Enable mobile computing
- Extend Ethernet beyond the reach of cables

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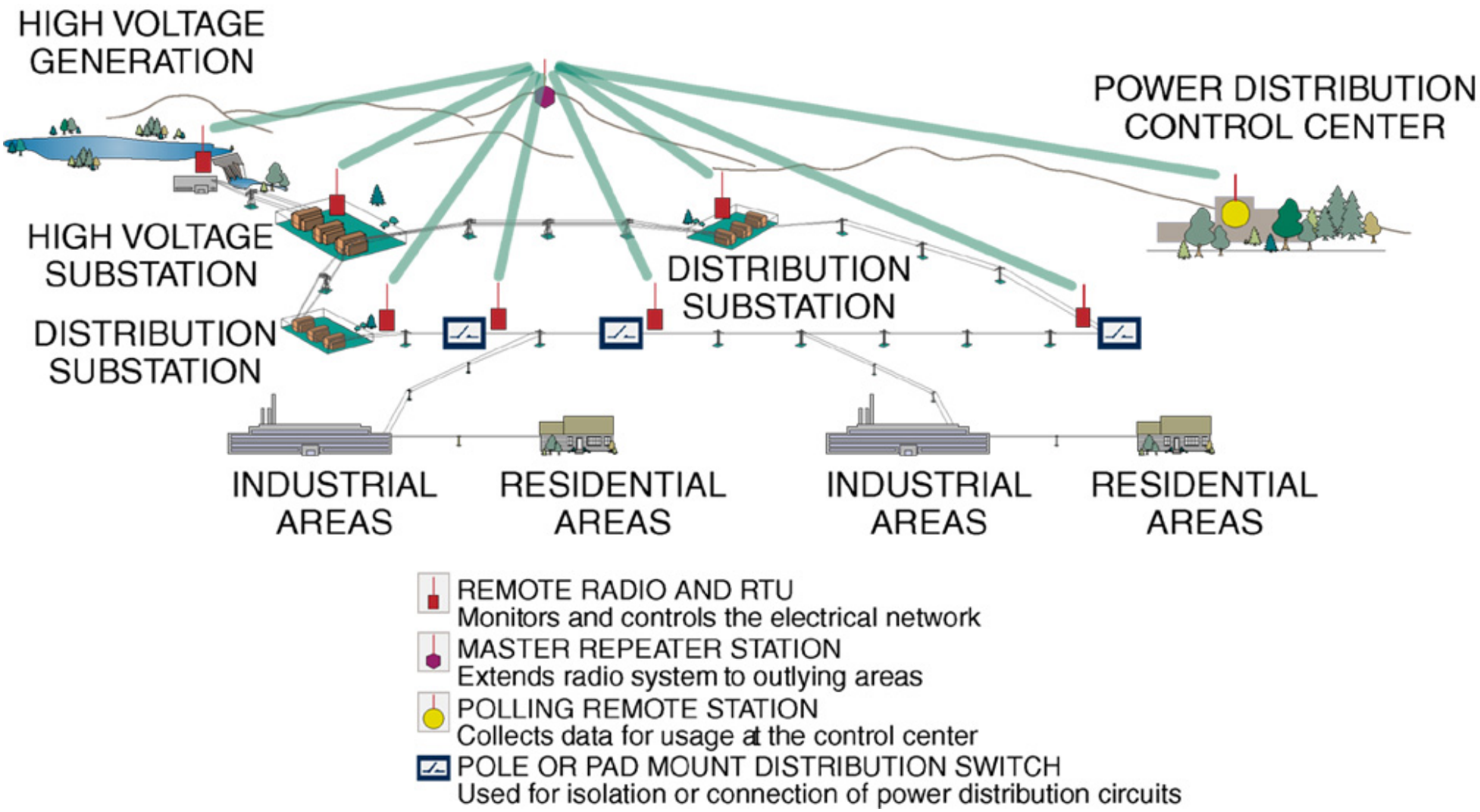
Wireless IP Solutions: *Utilities*

Energy Management Systems, Advanced Metering and more

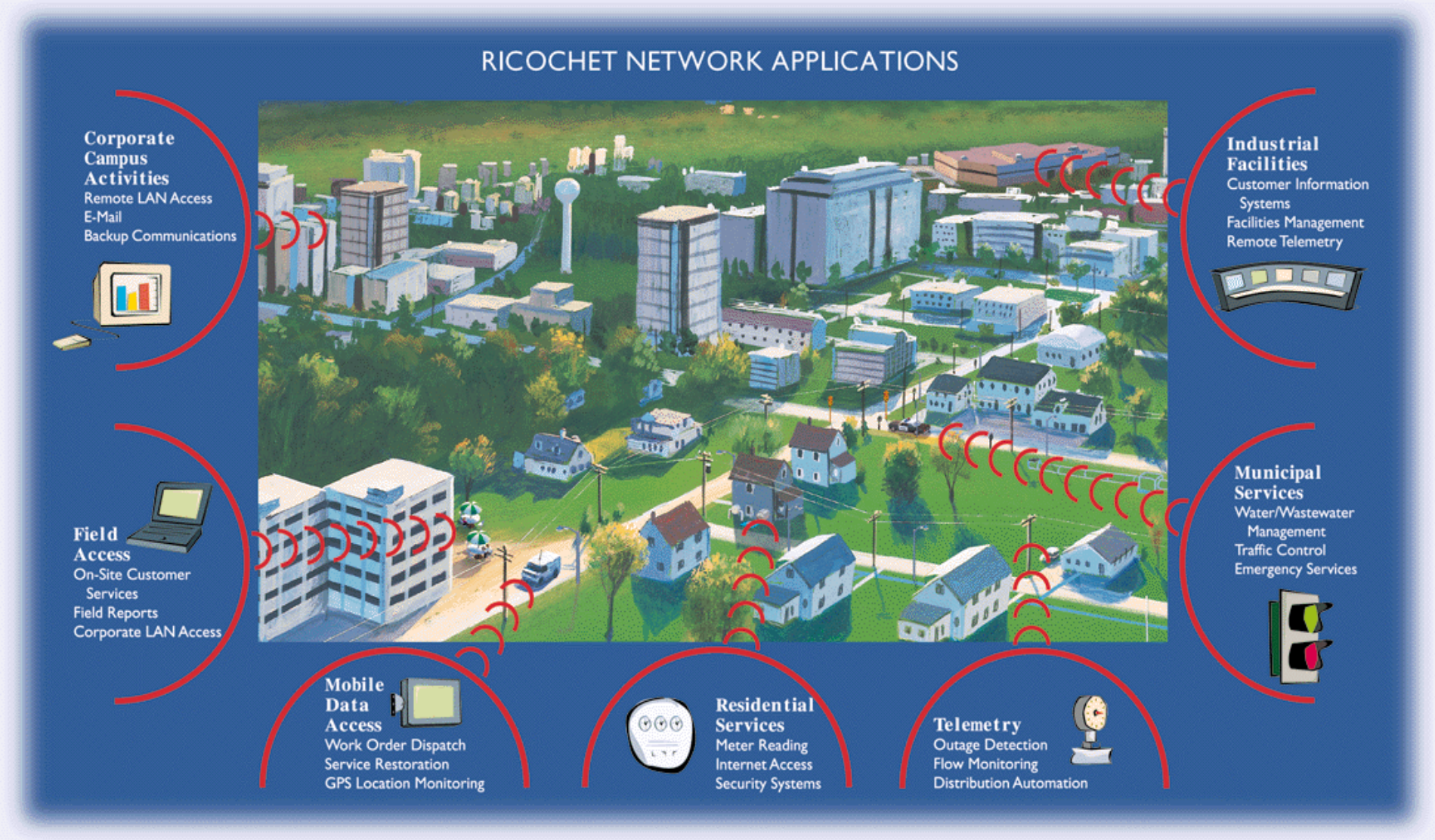
- Metering and Monitoring (commercial & industrial customers)
- SCADA for Transmission and Distribution Applications

- **End Users**
  - Electric, gas, water, sewage, rail
- **Benefits Realized**
  - Reduced outages
  - Improved asset management and predictive maintenance
  - Improved customer service
  - Increased employee safety
  - Increased profit margins

Utility T&D Wireless Radio SCADA



Solving Utility Needs with Wireless Technologies



Technology By Application

RAD-line wireless

Wi Fi™

Enterprise

SCADA

Plant

Remote Sensor

Instrumentation

Programming

Proprietary

ZigBee™

ISA

LTE Advanced

Bluetooth®

Wi SUN Alliance

WirelessHART

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Choosing Wireless Technology

RAD–line wireless

- The decision is made much easier by outlining the requirements for a product and technology

  - RF Requirements
  - Network Topology
  - Device Connectivity
  - Network Size

There is no one-size-fits-all for wireless!!

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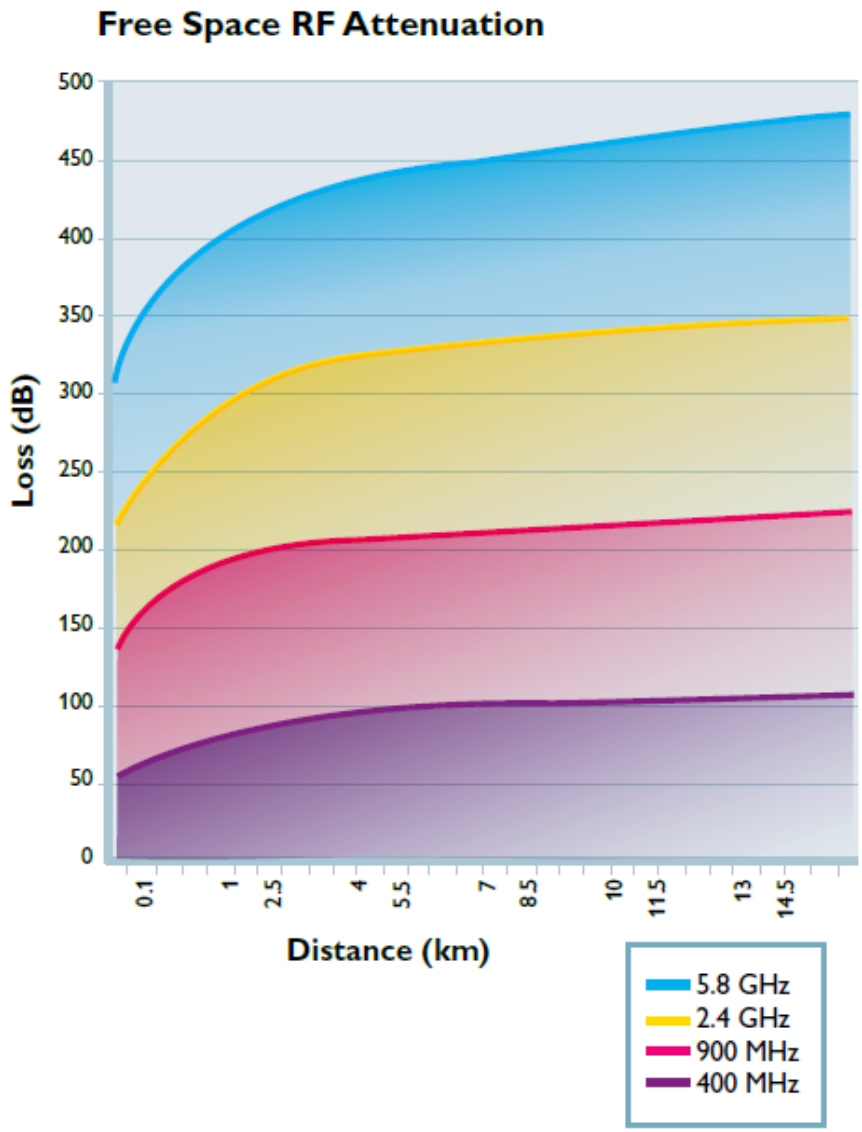
Wireless Performance

- There are several key factors in determining a technology's performance
  - Distance
  - Data rate/volume
  - Interference
- All 3 are interdependent
- Users must find the correct balance

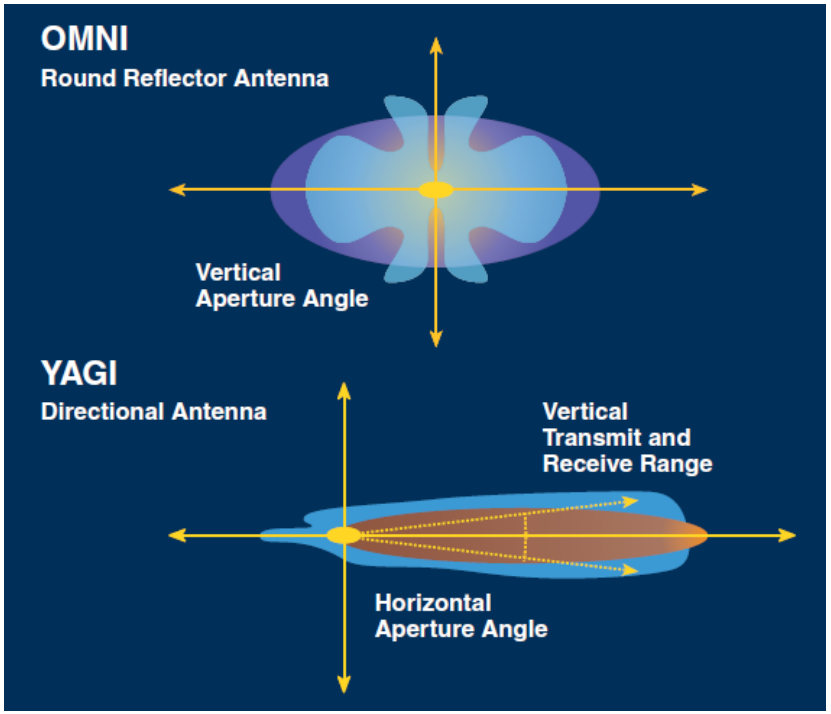
Range



- Transmission range is affected by:
  - Operating frequency: as frequency increases, range decreases
  - Over-the-air speed: as speed increases, range decreases
  - Interference: as interference increases, range decreases
  - RF Power: Higher power goes farther, may be limited by technology or government

Site Planning

- Software path study will model paths and identify obstructions
- Field test will validate software data
- Antenna Selection
  - Omni:
    - Use when multiple sites have to connect
    - Typically used on master location
    - As gain increases, “donut” flattens
  - Directional/Yagi:
    - Use when sending/receiving to a specific location
    - Typically used on remote site
    - As gain increases, “beam” becomes narrower
    - Can be used to reduce effects of interference



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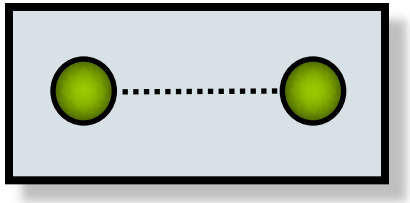
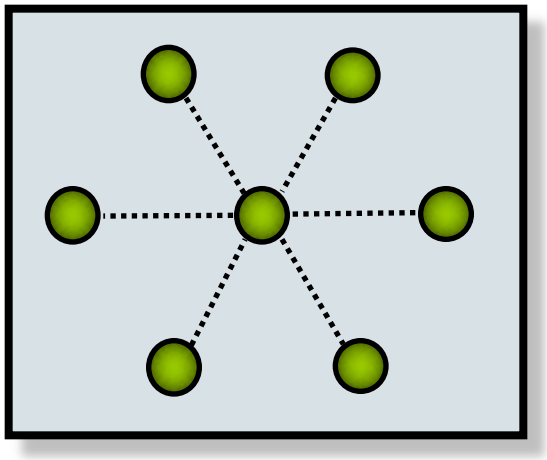
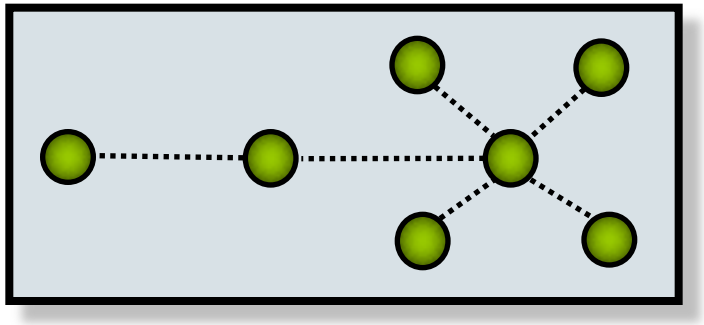
Network Topologies

- **Point-to-Point**
  - Information is exchanged between 2 points
- **Star / Point-to-Multipoint**
  - A central station communicates with multiple remote devices
- **Repeaters**
  - Repeaters receive a weak or low-level signal, then retransmit the weak or low-level signal at a higher level so that the signal can cover longer distances or avoid obstacles

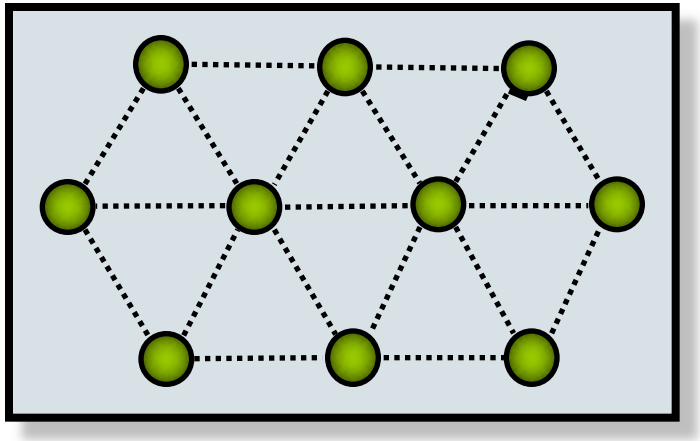


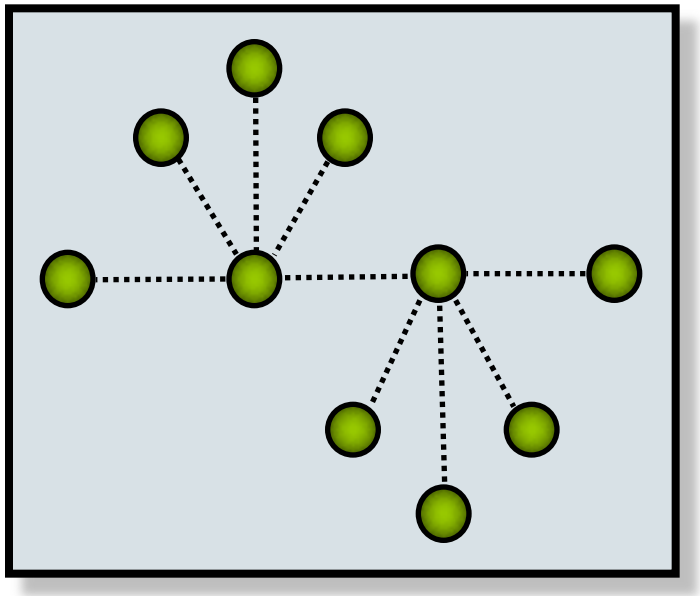




Network Topologies

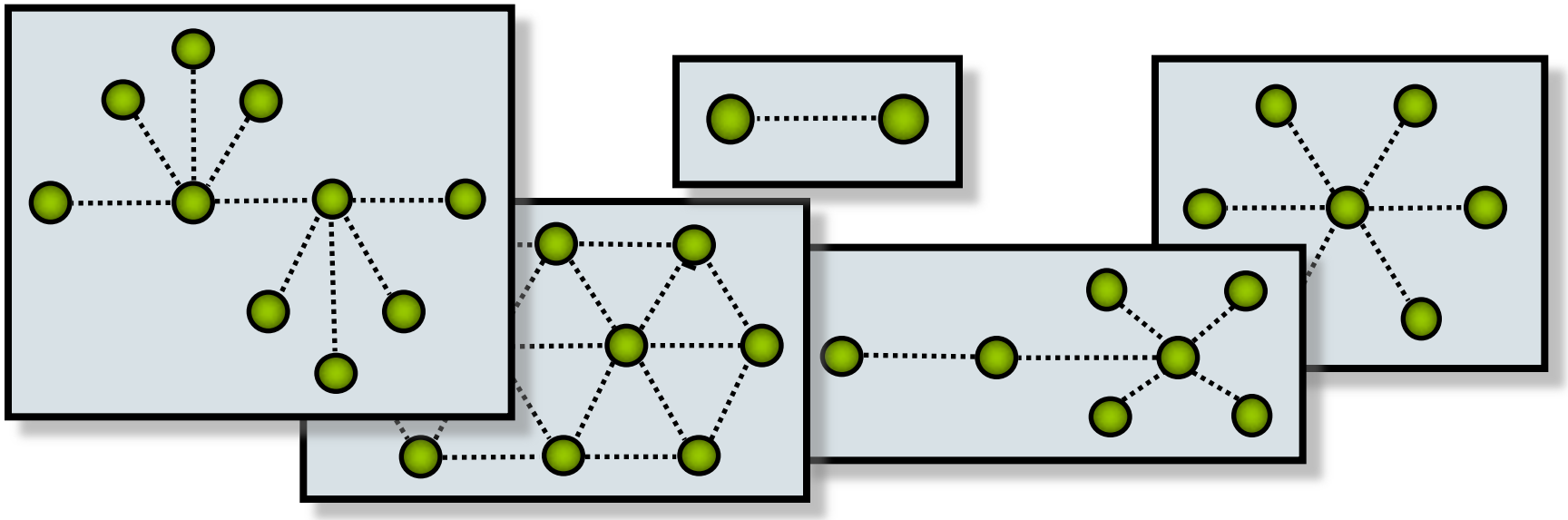
- **Mesh networking**
  - Data is routed between multiple nodes. Allows self-healing reconfiguration around broken or blocked paths by "hopping" from node to node
- **Trunk Networking**
  - Use break-off connection points to leverage existing infrastructures, and add bandwidth capabilities





Network Topologies

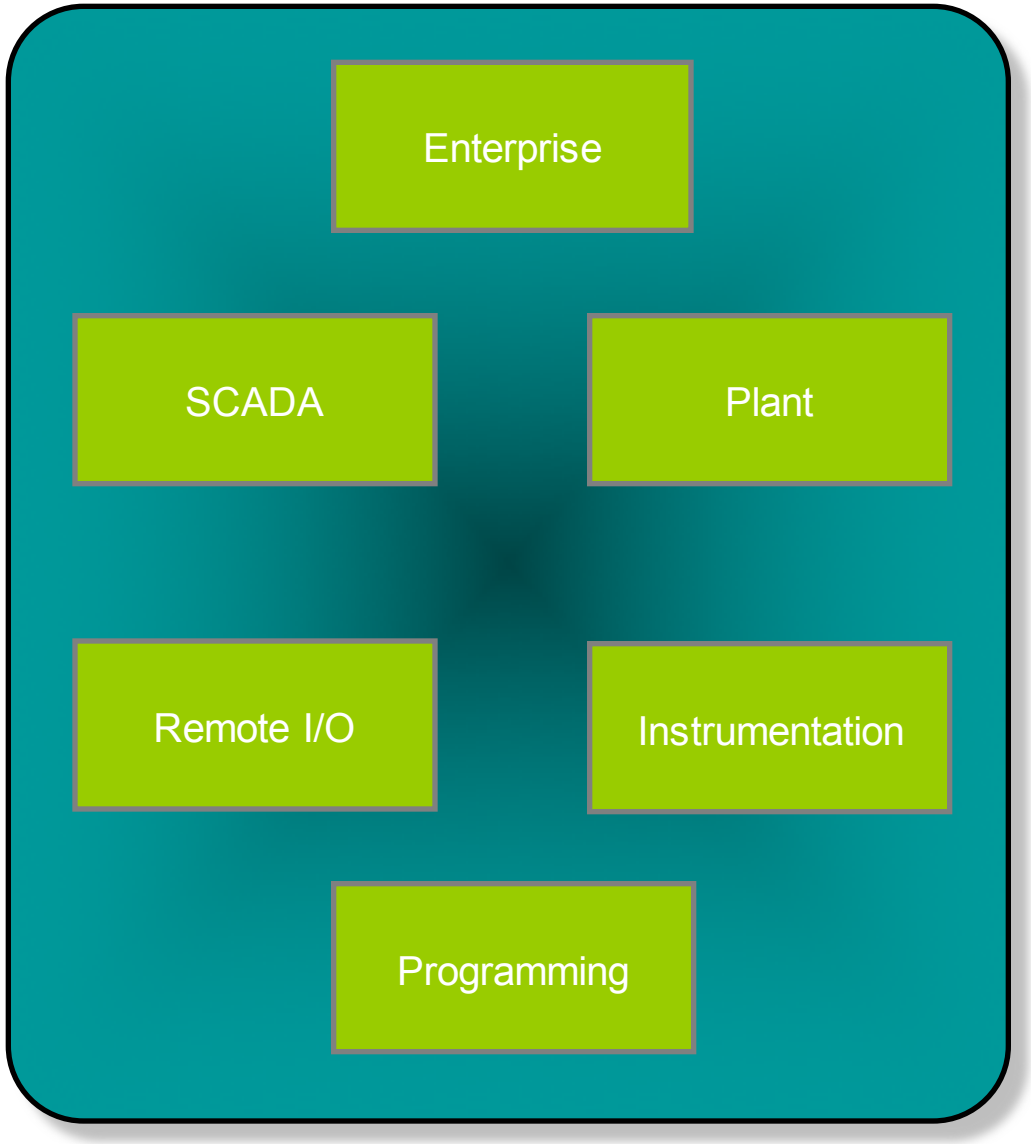
- It may not be initially possible to determine a specific architecture is needed—it may be defined by the chosen technology
  - Should consider things that can't be implemented, i.e. no repeater location sites are available



Choosing Wireless Technology

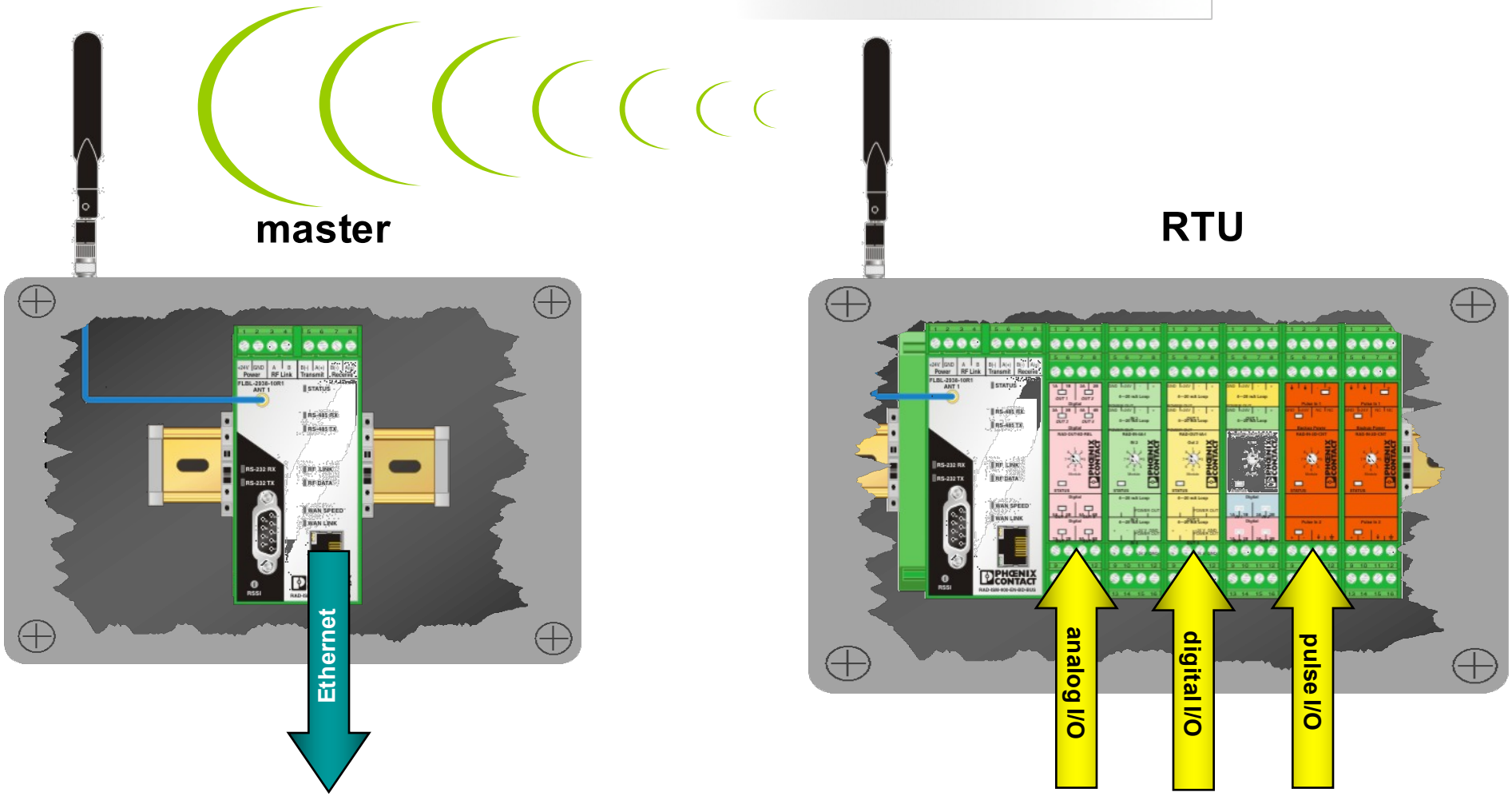
- The decision is made much easier by outlining the requirements for a product and technology
  - RF Requirements
  - Network Topology
  - Device Connectivity
  - Network Size

Device Connectivity



- What type of data?
  - Ethernet
  - Serial
  - I/O
- How much data?
  - Megabytes or kilobytes
  - Bytes or bits
- Use case
  - Convenience
  - Monitoring
  - Control

wireless remote I/O



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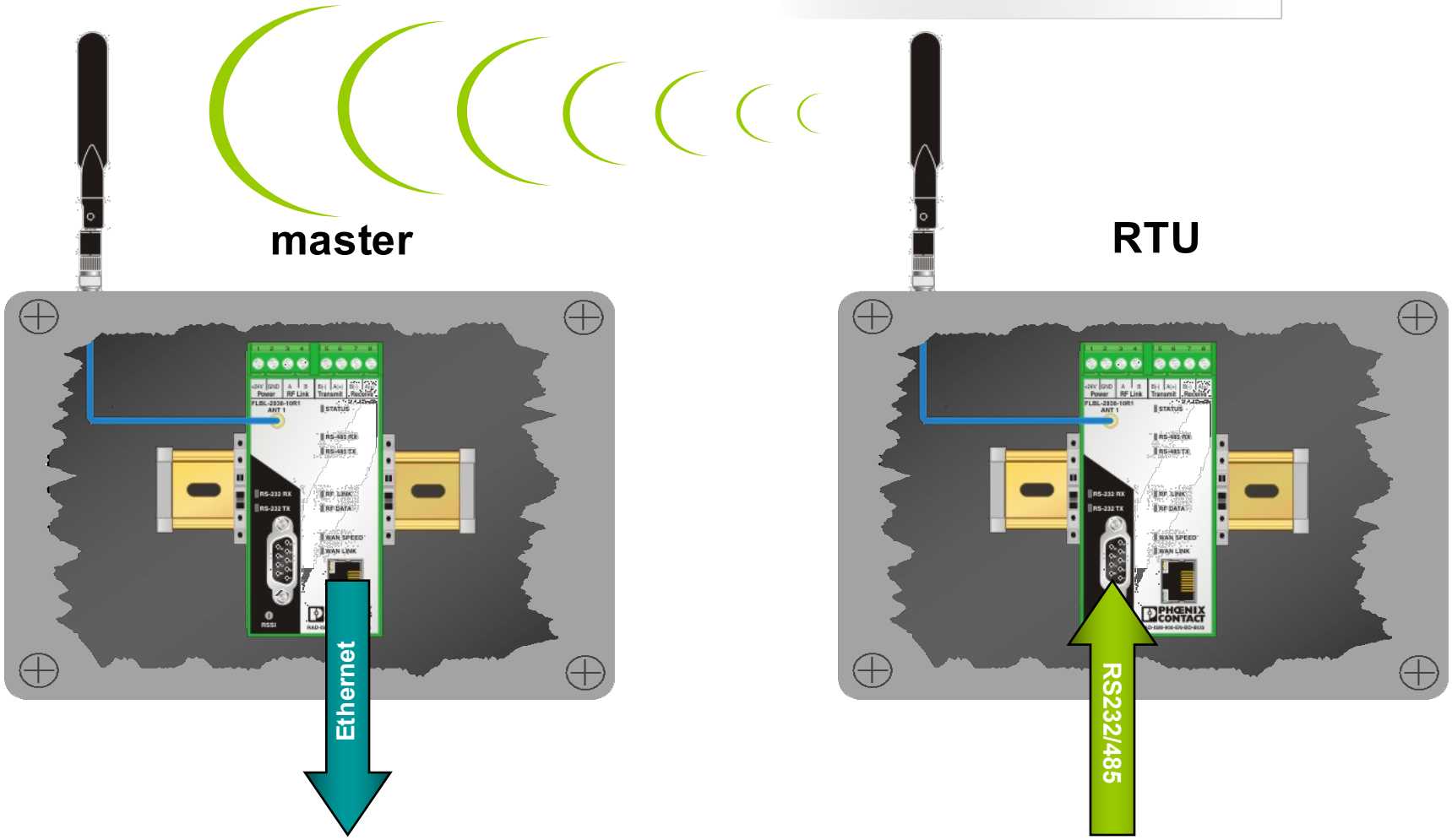
wireless device server



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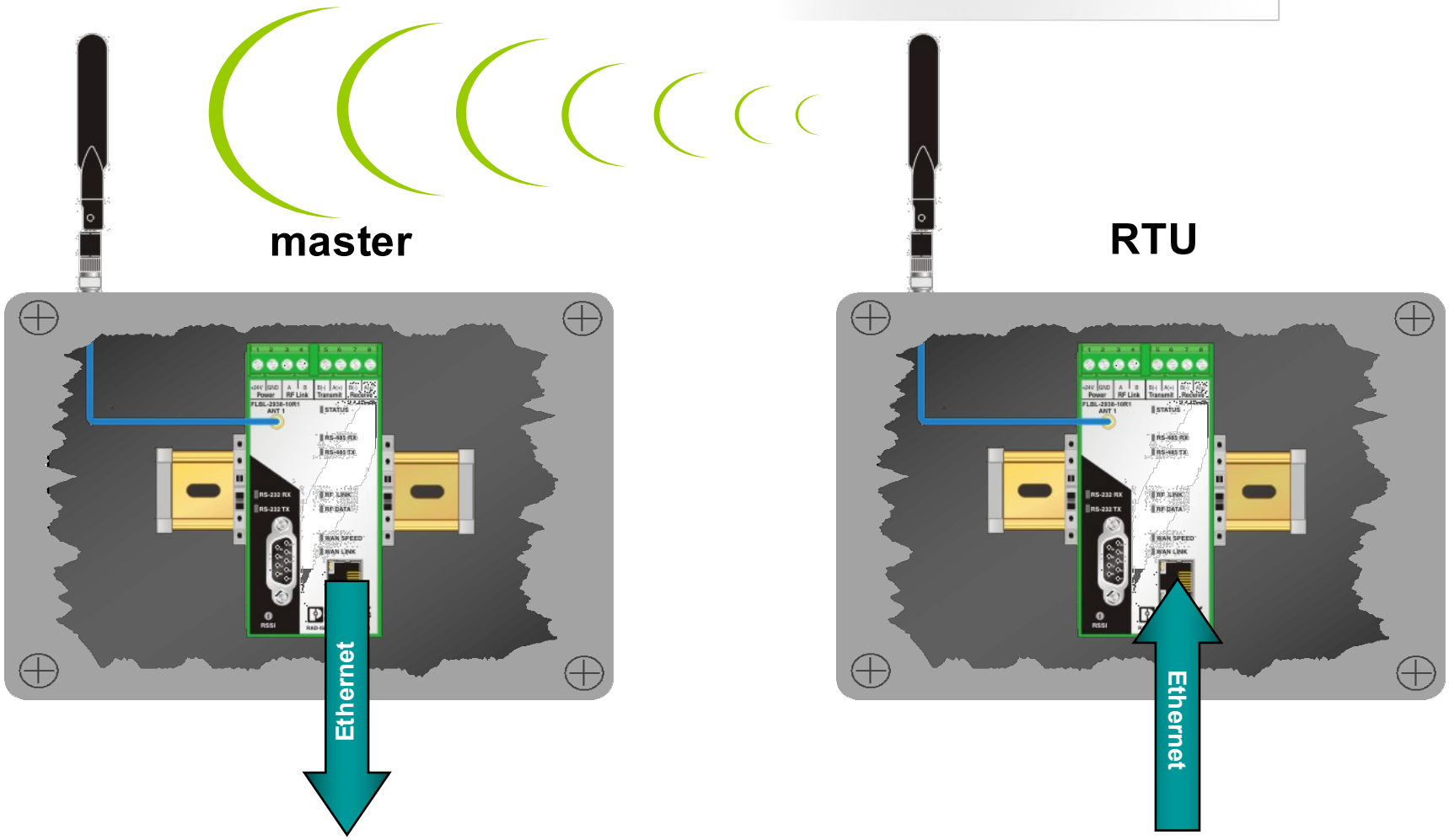
wireless Ethernet



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Device Connectivity

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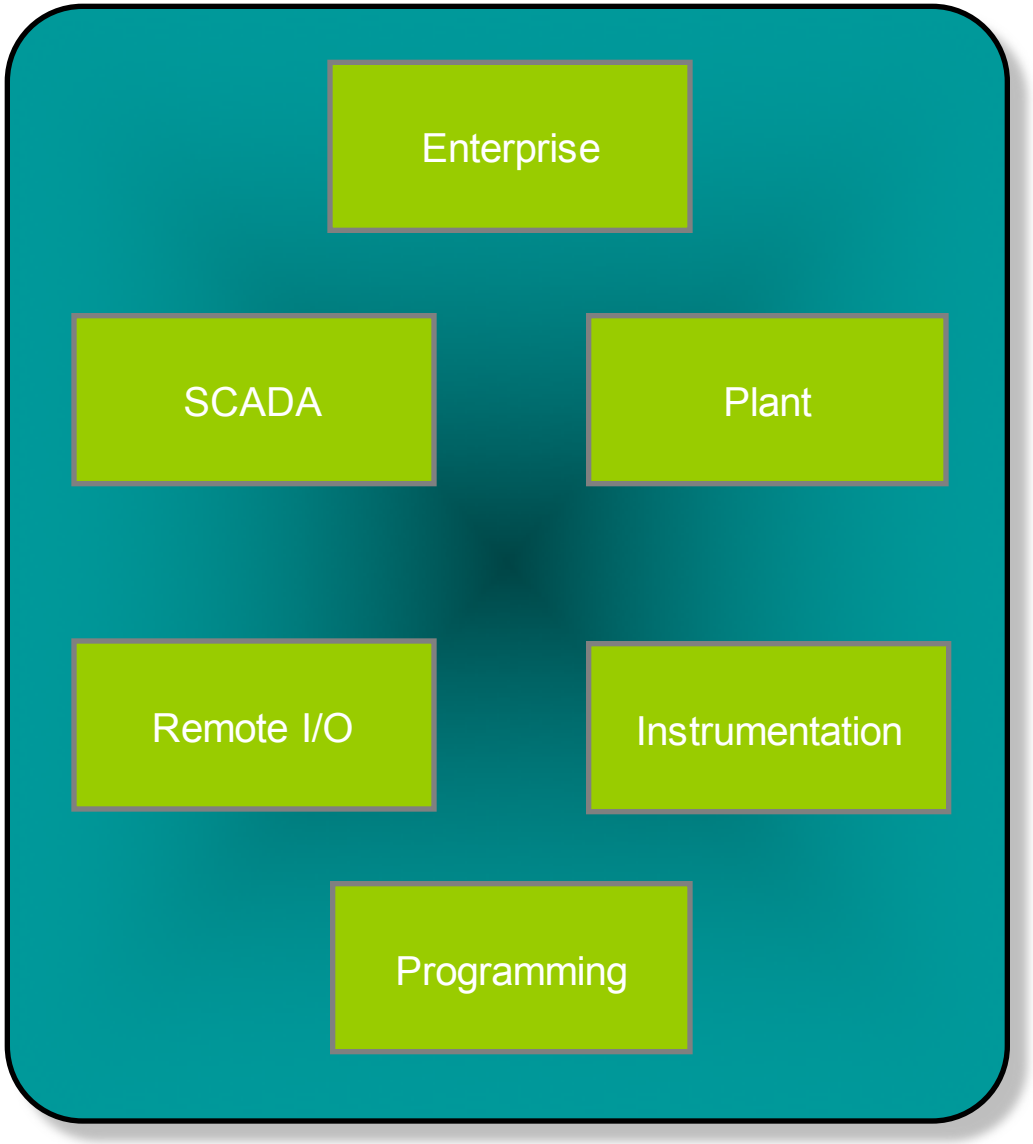
Proprietary

ISA

ZigBee™

GSM®
GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS



Wi Fi™

Bluetooth®

WirelessHART

Wi SUN Alliance

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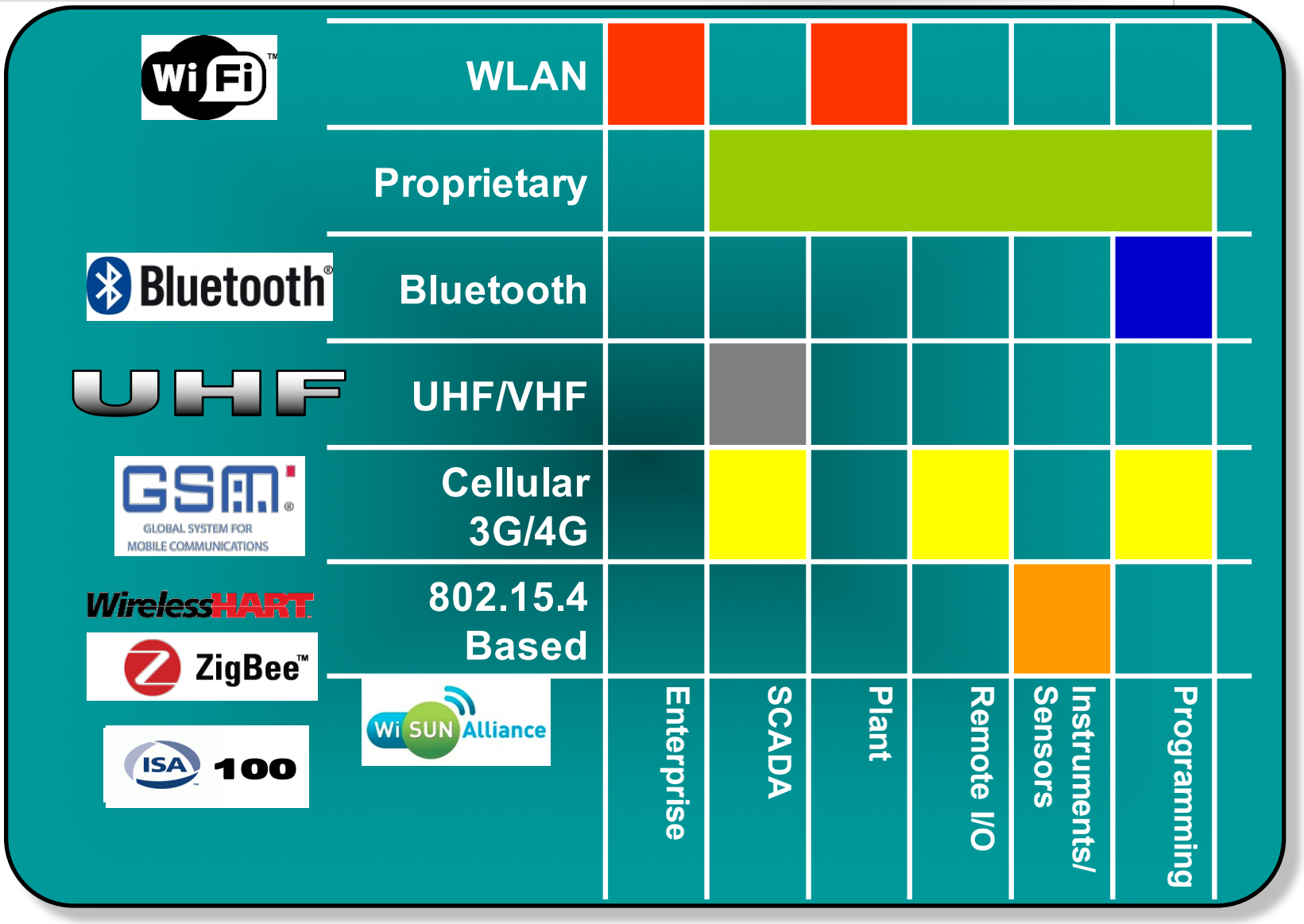
Industrial Wireless Usage



Security Issues

Reducing Accessibility

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Security Issues

Transmit Technologies

Encrypt/Authenticate

Installation Practices

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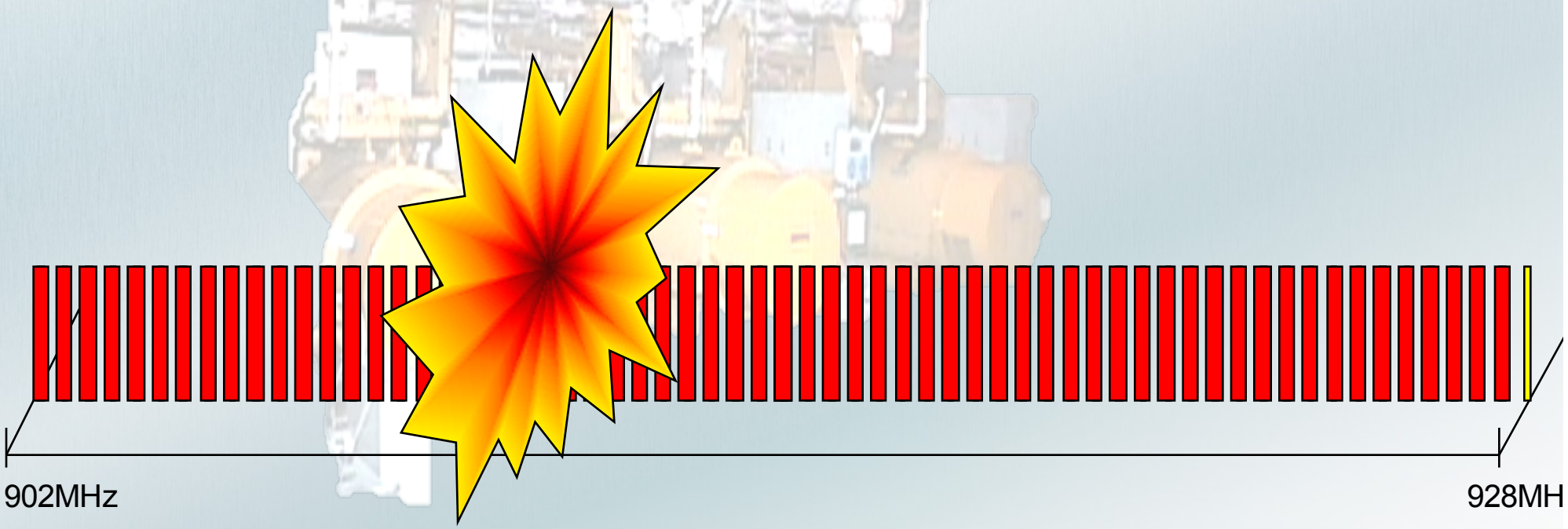
Transmission Technologies

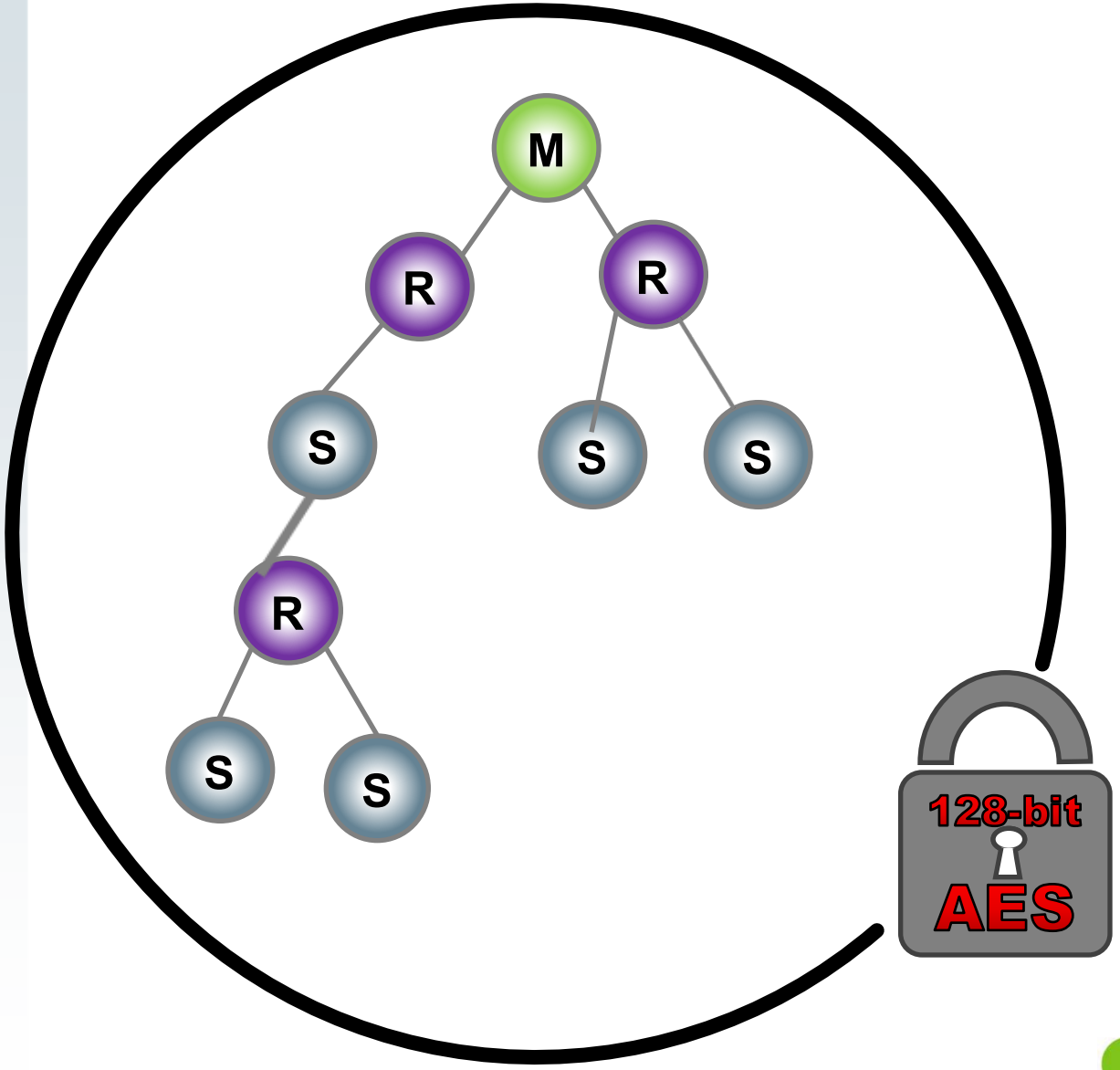
Frequency Hopping Spread Spectrum

- **Military Technology Declassified in 1980's**
  - **Low probability of intercept**
  - **Anti-jamming techniques with frequency agility**



Encrypt and authenticate

Encryption puts a ‘secret code’ around messages and network



authentication

1. listen
2. synchronize
3. follow hop sequence
4. send join request
5. receive join acknowledge

PASSWORD ESSENTIAL

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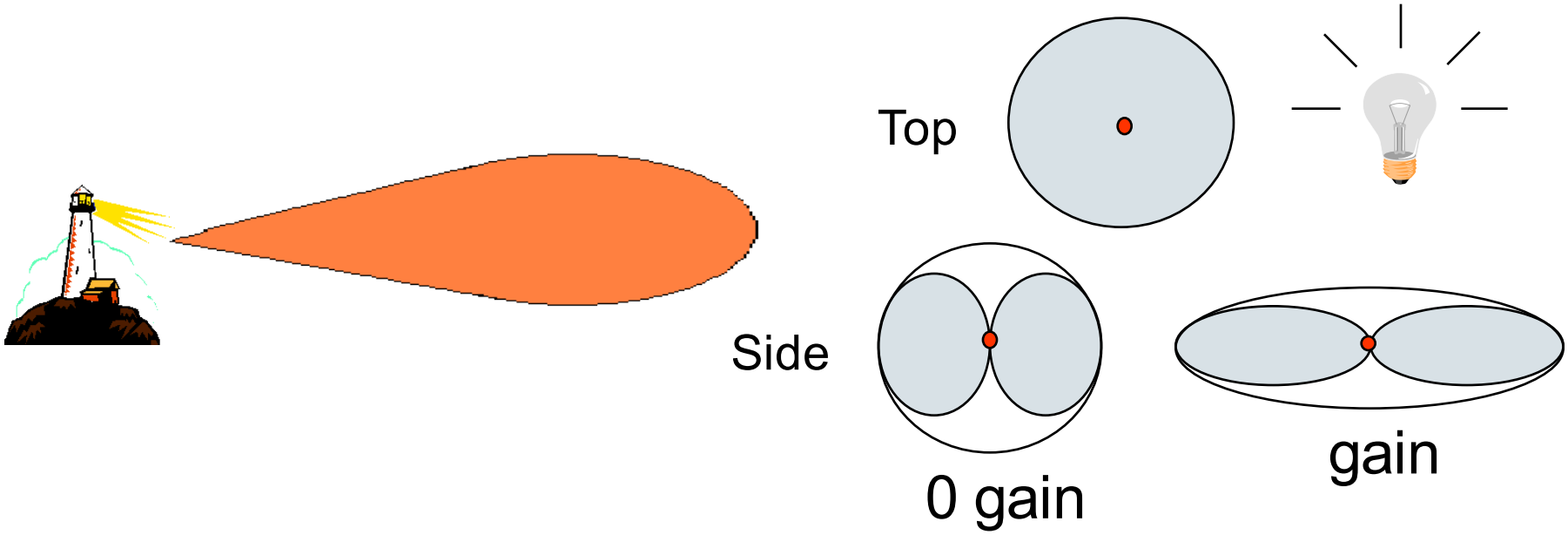
Installation Practices Secure Network

- Use best antenna – get coverage, but not too much
  - Keep radio signal narrow with directional antennas
  - Use minimal gain on omni antennas
  - Turn down transmit power to minimum acceptable level



Ethernet infrastructure – optimizing performance with the right fit

Ethernet over wireless - WLAN

- Open wireless Ethernet standard WiFi (802.11)
- Interoperable, multi-vendor support
- Distance limited to hundreds or thousands of feet
- High bandwidth, high speed applications

Examples:

- *Video suveillance*
- *Mobile worker (using iPads, etc on site)*
- *General extension of wired Ethernet networks*
- *Extension of DNP3.0 and Ethernet/IP networks*

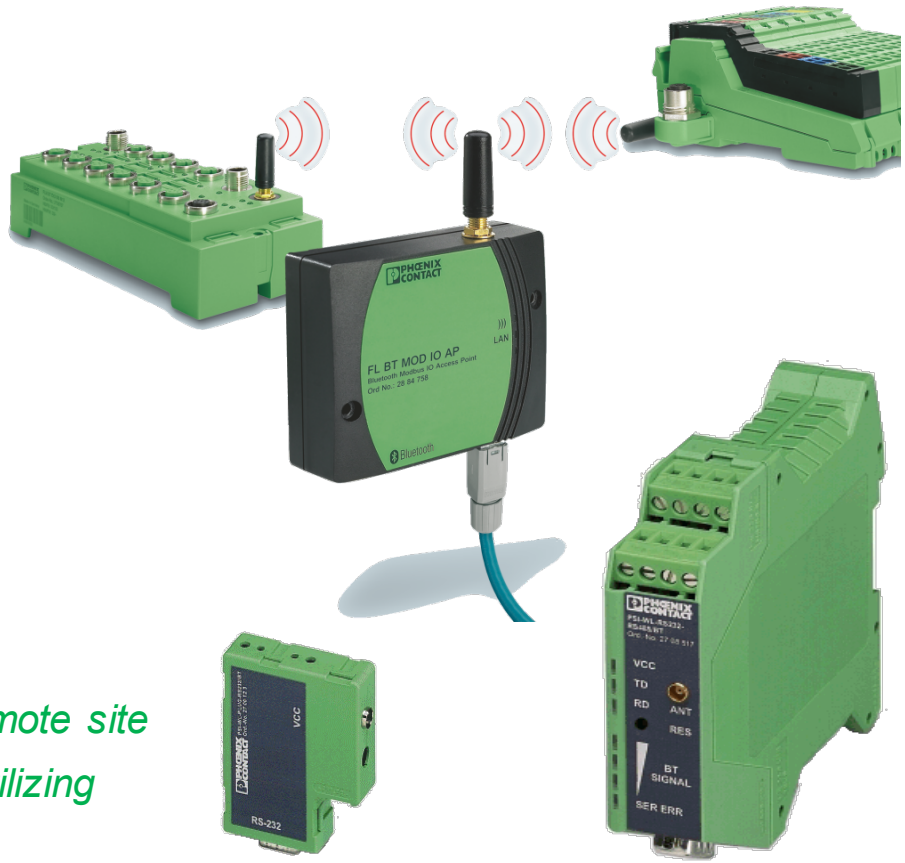
Industrially rated WLAN radios and accessories

Ethernet infrastructure – optimizing performance with the right fit

Ethernet over wireless - Bluetooth

- Ethernet over open Bluetooth 2.1 (802.15)
- Interoperable, multi-vendor support
- 32mW (15dBm) transmit power
  - Several hundred feet maximum
  - DNP3.0 and Modbus compatible
  - Reliably replace wired applications for local programming and diagnostics
  - Eliminate slip-ring connections
- Coexistance with WLANs, blacklisting, etc.

Example: mobile worker needs to be able to perform remote site Diagnostics at substation without entering property or utilizing Ethernet cable. Results in reduced risk and safer work environment.



Ethernet over Bluetooth Wireless

Ethernet infrastructure – optimizing performance with the right fit

Ethernet over wireless – 900MHz Trusted Wireless

- Proprietary Manufacturer Specific Product
- 30dBm (1 Watt) of transmission power
- Optimized for SCADA
  - Several miles transmission distance
  - Modbus/TCP (polling)
  - Ethernet/IP (Explicit messaging only)
  - DNP3.0
- Slower than WiFi, but perfect for SCADA (<500kbps)

Example: SCADA networking (Utility Recloser Monitor)

Ethernet infrastructure – optimizing performance with the right fit

Ethernet over cellular wireless – GSM, CDMA

- World-wide range...just need a cellular signal
- GSM (AT&T), CDMA (Verizon) capable
- Security with VPN, Firewall functionality
- Lower capital cost than traditional radio systems
- Enables traditional, as well as cloud-based architectures
- Incurs monthly data plan charge from cellular provider

Example: Connecting remote assets to SCADA, where the high capital costs associated with traditional radios sytems (building tower, etc) is not desirable.

Worldwide access using Ethernet Router

Ethernet infrastructure – Appropriate technologies for unique application needs

Monitoring a distant substation or RTU – 5 miles away

Challenges:

- Distance is too far for copper (Cat 5/6 cable)
- Currently no fiber run to this site (in this example)
- Currently no wired internet access (in this example)
- Mature 30‘ pine trees block line-of-sight to a municipality-owned water tower which is 3 miles away, and can be seen from the Control Center.

Additional information:

- RTU with Ethernet interface is at substation
- The utility has an existing SCADA that they would like to tie this site into.
- The utility doesn‘t own any FCC licenses, none are available per search

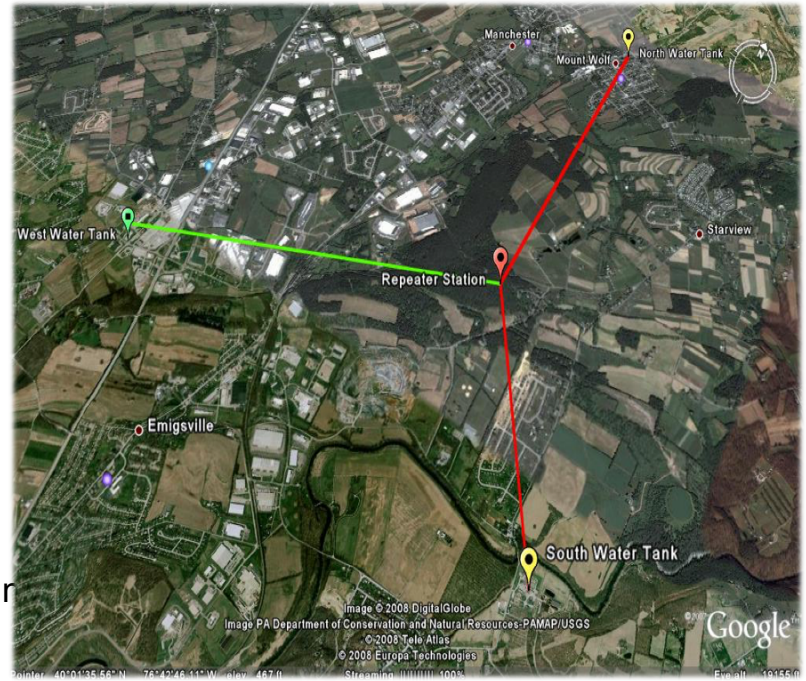
Remote monitoring of a distant RTU station

Ethernet infrastructure – Appropriate technologies for unique application needs

Monitoring a distant substation – 5 miles away

Option 1 – Proprietary 900MHz Wireless Ethernet Radios

- Qty 3 needed
  - One in the substation panel, with RTU plugged into it
    - Directional antenna
  - One at the water tower, acting as a repeater
    - Omnidirectional antenna
  - One at the Operations Center, plugged into the SCADA's Ethernet network
    - Directional antenna
- Tower to be built at substation to get antenna above treeline, enabling lin of-sight from this antenna to the water tower's omni antenna.
- Ethernet/IP (Explicit messaging), Profinet, Modbus/TCP (polling) all possible.



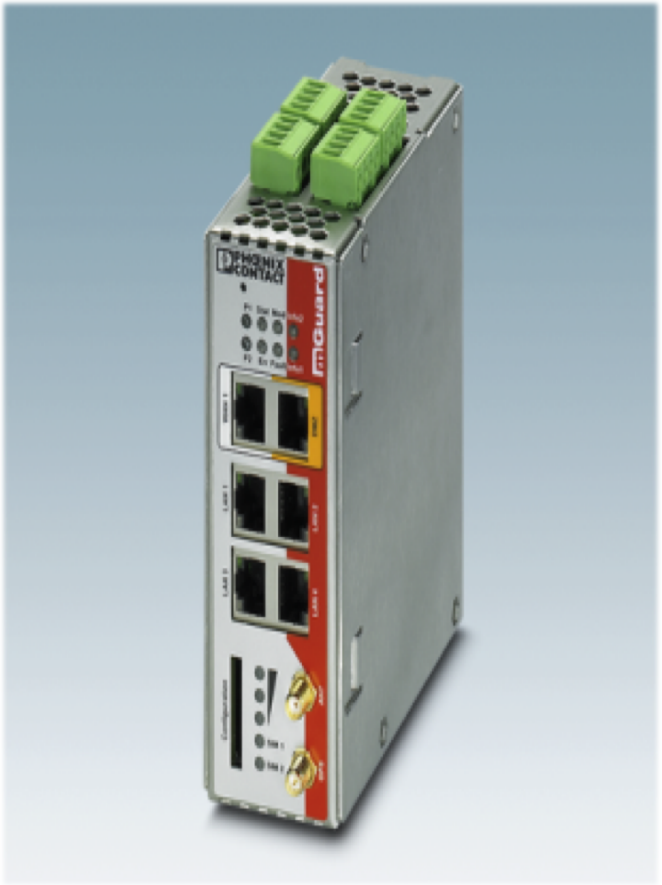
TWE radio connection through repeater

Ethernet infrastructure – Appropriate technologies for unique application needs

Monitoring a distant sub-station RTU – 5 miles away

Option 2 – Cellular Router / VPN

- Qty 1 needed
  - One in the RTU Rack/Cabinet panel, with RTU or IED plugged into it
    - Cellular antenna
- VPN tunnel formed with existing networking gear or hardwired version of mGuard in WWTP
- No tower necessary as long as there is a cellular signal at the lift station (AT&T, Verizon, Sprint, T-Mobile).
- Monthly charge incurred for cellular data plan.
- Ethernet/IP (Explicit messaging), DNP3.0, Modbus/TCP (polling) all possible.

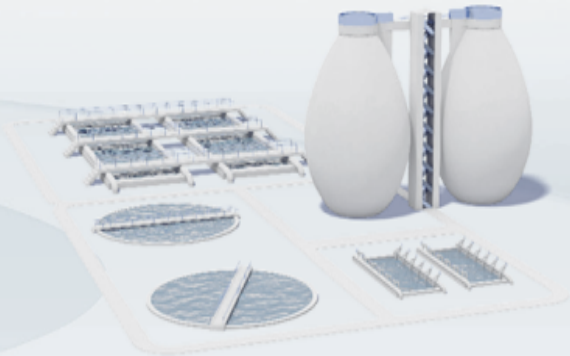


Cellular Router /VPN/Switch

Solving Utility Automation applications with quality components, systems and solutions

Excellent products

Innovative systems

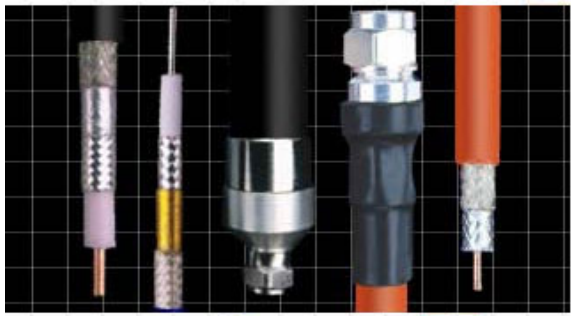


Inspiring industry solutions

Wireless Accessories

- RTU Cabinet
  - NEMA 4X Enclosure
  - Power supply and UPS
  - Surge protection
  - Empty DIN rail for any radio

- Antennas, Cables, and Adapters
  - Use the
    - Antenna Selector Guide Web
    - Wireless Selector Guide brochure



- Remember: A system is only as strong as its weakest link.

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Wireless Selection Guide

- There are several key factors in determining a technology's performance
  - Distance/Obstructions
  - Data rate/volume
  - Interference/RF noise
- All 3 are interdependent
- **Users must find the correct balance**

Choosing/Using Wireless Technology

- The decision is made much easier by outlining the requirements for a product and technology

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Any Questions?

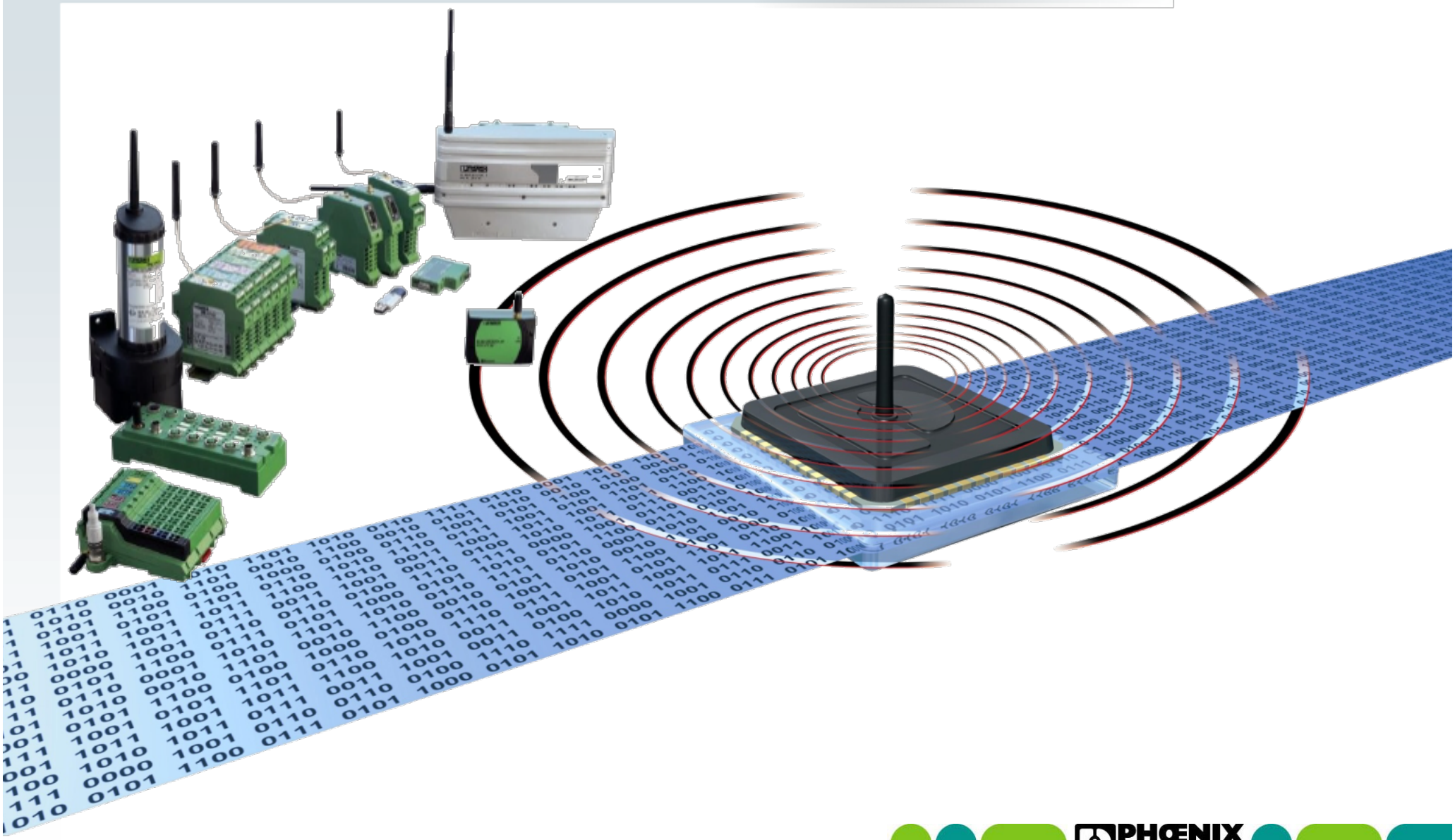
www.phoenixcontact.com/wireless

Thank you!

Paul Mercier - pmercier@phoenixcon.com

Phoenix Contact Wireless

RAD–line
wireless



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