Security of Wireless Sensors & Networks at PERA Level 0 to 1

MLM-079-A

Industry – All
Principal Role – All
Professional Role – Control Engineers
Enterprise Phase – Design &Operation

Turn on your audio and click start to begin video

START

This MLM examines the reliability and cybersecurity of commonly used wireless industrial networks.

Click the NEXT button when you are ready to advance to the next slide.

Wireless Protocols for Plant Instrumentation

The following are two of the most common wireless networks for industrial applications (e.g., a continuous chemical process or a batch pharmaceuticals facility).

- Wireless Hart
- ISA 100.11a

Other common wireless sensor networks include Zigbee, Thread, and Z-wave. These are also low power, multi-path radio networks that share many characteristics of Wireless Hart and ISA 100 so we will not specifically address them in this module.

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Commercial Offerings

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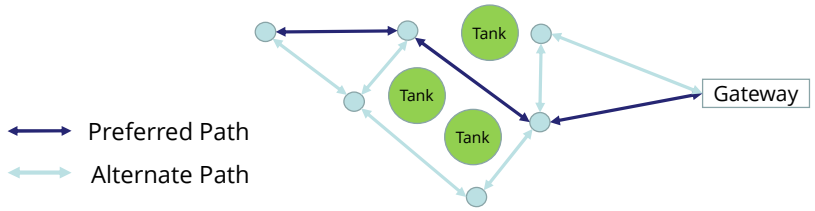
Comparison of Wireless Hart and ISA 100.11a

Similarities

- Both use the same low power IEEE 802.15.4 radio (same range, beam propagation patterns). Both are often battery powered.
- Both are mature technology that has been in use for over 10 years.
- "Mesh networking" overcome range and obstruction problems.
- Dynamic "Self-healing" bypasses device failures or wave-path obstructions.



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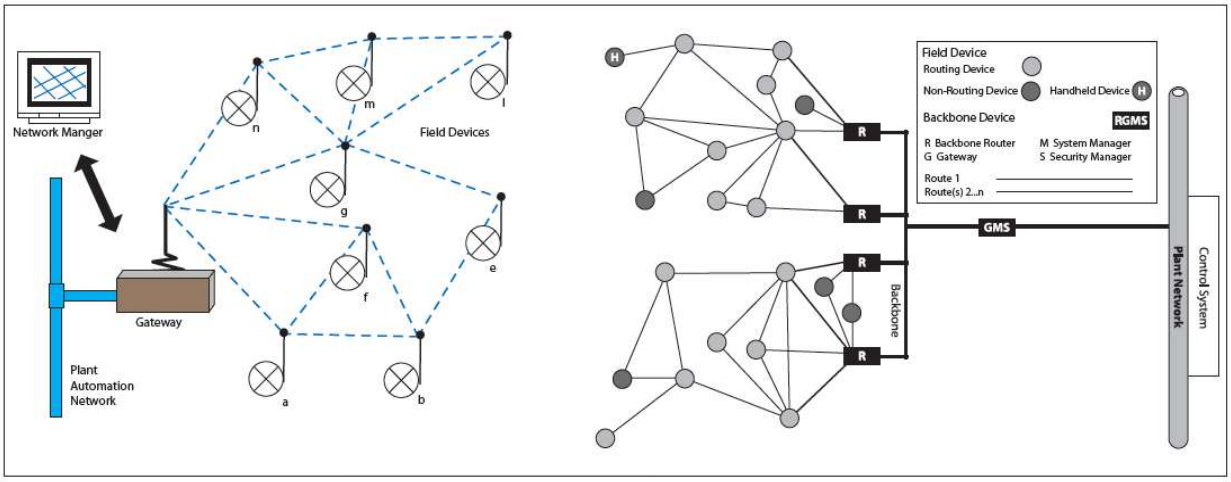

Wireless HART has no backbone

ISA100.11a defines a high speed backbone

Comparison of Wireless Hart and ISA 100.11a (cont'd)

Wireless Hart

- "Self-organizing" is much easier to configure and deploy.
- However, inability to over-ride automatic configuration may result in:
  - bandwidth bottlenecks,
  - common points of failure may shut down large areas
- Dynamic re-configuration results in "attack surfaces" for cyber intruders (eg., "worm-hole exploit").
- Lack of monitoring tools makes optimization, network performance and security monitoring difficult or impossible.
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ISA 100.11a

- **"User configured," so the design requires more expertise and time.**
- **Configuration tools allow:**
  - Optimization of Network Paths and backup configuration (e.g., pinch-points)
  - Monitoring of Network bandwidth and reconfiguration as needed
  - Configuration of "mesh" where needed, but can also define primary and backup paths.
  - Larger networks with multiple gateways and routers.
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Battery Life is a Reliability Consideration

Eliminating signal & power wiring is a key Wireless benefit, however:

- If a network includes Analyzers (like Gas Chromatographs) or slow measurements like tank levels, radio transmitters need only "awaken" every couple of minutes, and battery life may be a couple of years.
- but, if a network includes safety gas sensors or high-speed sensors or analyzers used for control, it may be necessary to poll these devices every second. In this case, that same battery could be exhausted in a week. (365x2/60x2 = ~7 days)
- Even worse, in a self-configuring network, adding a device that is polled every few seconds, could suddenly exhaust the batteries of devices that only "pass on" the data in a mesh network.

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Management of Change

- Connecting a device to an industrial network (wired or wireless) requires special equipment, procedures & training.
- Adding new network types or replacing old ones requires a large investment of manpower and equipment.
- If existing networks are to be changed, it must therefore be for well-considered reasons and be carefully planned and funded.

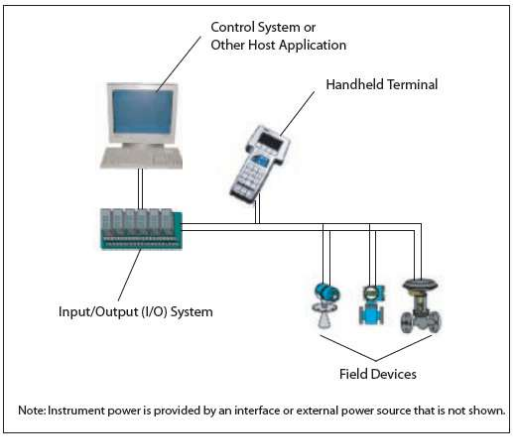

Figure 2. Typical HART system (courtesy of HCF)

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- Ensure approval and documentation of network changes
- Protect updates and "patches" (Solar Wind Hack)
- Test network configurations (using simulation tools)
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New Wireless Alternatives

- **LoRaWAN** – Low Power High Bandwidth Wide Area Network.
- **WiFi** – Industrial "hardened" versions of popular commercial LAN.
- **5G** – 5th Generation "microwave broadband"

Some key features of these are discussed below.

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Low power Radio Wide Area Network (LoRaWAN)

- Low power, high bandwidth based on "chirp" spread-spectrum tech.
- Range of several miles (depending on terrain and obstacles)
- Easy attachment of IoT and IIoT devices (local, regional and global).
- Provides end-to-end security (frequency agile spread-spectrum was invented for torpedoes).
- Scalable to very Large Networks
- Supports "cloud" connections
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Industrial version of commercial Wi-Fi Network

- Many suppliers of low-cost, reliable chips and components
- Supports mesh networking, self-healing, and multi-layer IP routing
- Sophisticated Network configuration and Monitoring Tools
- Most Technicians already know how to configure and troubleshoot
- Well integrated in all common operating systems
- Easily integrated with other networks, including Ethernet, 5G, etc.
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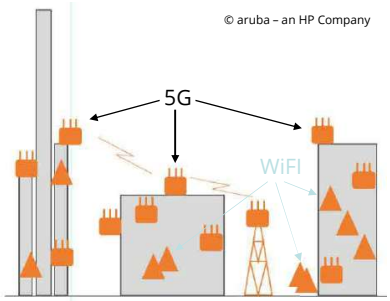
5th Generation Private and Public Networks

- Special frequencies are reserved for private "campus networks"
- Time Critical Network standards are in testing.
- Easily integrated with other networks, including Ethernet, Wi-Fi, etc.
- Highly scalable (to city or even nation-wide networks).

- Configure Wi-Fi inside structures
- Use 5G for "outside" networks
- Consistent "top to bottom"
  - Authentication and encryption
  - Configuration
  - Monitoring and optimization
  - Cyber defense and response



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Cybersecurity and Reliability of Wireless Networks

- **<u>Legacy radio networks</u> are less cybersecure and reliable than wired networks because of:**
  - Inherent "attack surfaces" (e.g. worm-hole)
  - Small user base
  - Battery failures
  - Weaker configuration and monitoring tools

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Cybersecurity and Reliability of Wireless Networks (cont'd)

- **New Radio networks like LoRaWAN, WiFi and 5G can be more cybersecure than traditional wireless and wired networks because:**
  - Better monitoring tools detect bandwidth problems and misconfiguration
  - Wider user base detects vulnerabilities and eliminates bugs.
  - Better configuration management detects unauthorized changes (whether poor practices or cyber attacks).
  - Artificial intelligence monitoring can detect anomalous traffic (more sophisticated protocols - Blackberry example)

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Author

Gary has more than 40 years of experience with enterprise integration and optimization projects, including PERA master planning and project management.

As one of the initial authors of the PERA Handbook of Master Planning, he has used PERA Enterprise Architecture and Master Planning methodologies throughout his career including control and information systems for oil production, pipelines, refining and marine loading, petrochemicals, coal, gas, and oil-fired power plants, polyethylene, ammonia, explosives, paint, pulp and paper, food and beverage, and pharmaceuticals. LNG facilities included world-scale Arctic, European, and US Gulf Coast complexes.

infrastructure facilities included Fire, Police, and Emergency Response systems for major US cities, as well as emissions reporting and trading systems for more than 100 US Power Plants.

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