Practical Considerations for Selecting an Industrial Wireless Sensor Network

By Kevin Zamzow

Wireless trends

Choosing a wireless network requires evaluation of communication protocols, device availability, and present and future user needs.

Wireless sensor solutions are now being used in countless situations where it is necessary to monitor remote, difficult, and costly to reach locations, or moving applications. When choosing the best wireless approach, there are many technology tradeoffs and vendors to consider. See Tables 1 and 2 below, which offer means to compare network selection criteria according to application needs.

A search of technical publications and websites will turn up a variety of technical comparisons of industrial wireless sensor networks (IWSNs), which provide detailed analysis valuable to large end users or engineering firms with dedicated resources to evaluate technical nuances. But many potential end users lack such resources, have a less formal selection process, and are perhaps not sure of the key differentiators when evaluating various options.

Criteria	Weight	IWSN A	IWSN B	IWSN C
Battery Life	25%	3	7	5
Security	35%	3	9	9
Network Design Flexibility	13%	1	9	5
Scalability	2%	3	9	7
Support for Future Application	10%	1	9	3
Stranded Investment Risk	7%	1	7	5
Ease of Use	7%	9	5	5
Total	100%	2.8	8.1	6.3

Engineers making a selection typically use mixes of similar factors. They assign weights based on the use case, but the factors typically include:

- Availability of the communication link
- Security
- Scalability
- Connectivity to desired devices
- Hazardous location rating
- Power options to meet desired publication period
- Ease of use
- Integration with control systems
- Stranded investment risk
- Other practical factors specific to a given site.

	Battery Life	Security	Network Design Flexibility	Scalability	Support for Future Application	Stranded Investment Risk	Ease of Use	Total	Normalized
Battery Life	x	1/7	3	5	7	5	3	23.1	24.8%
Security	7	x	5	5	7	7	9	33.0	35.4%
Network Design Flexibility	1/3	1/5	x	3	5	3	1	12.2	13.1%
Scalability	1/5	1/5	1/3	x	1/3	1	1/5	2.1	2.2%
Support for Future Application	1/7	1/7	1/5	3	x	3	3	9.3	10.0%
Stranded Investment Risk	1/5	1/7	1/5	1	1/3	x	5	6.8	7.3%
Ease of Use	1/3	1/9	1	5	1/3	1/5	x	6.6	7.1%

Two-step Wireless Selection

The IWSN selection process involves two steps: selection of a networking protocol, followed by selection of vendors and individual devices. The protocol determines how the network will operate, and device selection will be driven by the specific applications. Both must work together. A protocol meeting all desired networking requirements is great, but if the devices needed to solve the individual applications are not available, it can't be used.

Some selection criteria may be absolute and therefore disqualify some possible sources. For example, if Class I Division 1 hazardous location approvals and ingress protection rating of IP67 are required, solutions lacking those approvals would either be eliminated or require the additional cost and space of a properly rated enclosure.

Some users may insist an IWSN worthy of consideration builds on an international standard rather than a proprietary, single-sourced solution. The risk of stranded investment, limited scalability, less vetted security, and limited product offerings from one vendor may rule out a proprietary solution.

ISA100 and WirelessHART are both IEC standards. They have been heavily scrutinized for security and are supported by multiple global process automation vendors, so vendor viability does not increase risk of stranding an investment. As a practical matter, ISA100 and WirelessHART will pass most, if not all, common selection criteria, but key differences remain, which the following factors highlight.

IWSN Design Flexibility

Mesh networks offer many benefits including the ability to self-form, self-heal, and manage routing of communication packets. They also offer multiple takeout points (gateways) for redundancy and scalability. Their self-administering capabilities depend on complex algorithms used to determine the network design or topology.

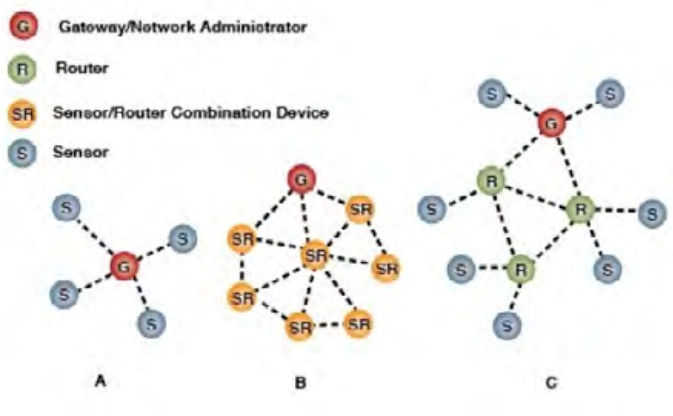
For example, they must constantly evaluate communication paths assigned to each hop between wireless sensors, along with the signal quality of each hop, avoiding hops resulting in more retries due to higher packet-error rates. For IWSNs with adequate mesh density (meaning enough nodes to provide multiple communication paths), the topology of a given network is typically stable.

On the other hand, a mesh network relying solely on its ability to self-organize may not meet determinism requirements for monitoring or control applications unable to tolerate longer latencies or deviations in latency (jitter). Some wireless mesh networks allow users to set the maximum allowable number of hops from a sensor to a takeout point (mesh depth), but flexibility in designing a specific network following a desired structure is often beneficial (See diagram).

WirelessHART only supports a mesh topology, which requires all wireless devices to operate as sensors with routers. ISA100 supports three possible configurations:

- Wireless routers
- Sensors with routers
- Sensors only with no routing capability, but with the ability to select multiple routers or gateways for self-healing in the event of a network disruption.

ISA100 thus supports the ability to create a fixed point-to-multipoint network (star or extended-star with repeaters), mesh, or combination of star and mesh.



Wireless Network Performance

The flexibility of ISA100 allows designers to improve availability of an IWSN by designing it to provide optimum signal quality and meet latency requirements in more dense networks, without requiring the use of more takeout points (ISA100 backbone routers or WirelessHART gateways).

Another consideration for IWSN design flexibility is support of different device communication rates or publication periods. Some sensors may require monitoring every one to five seconds, for example a pressure or temperature transmitter, while other sensors can be monitored much less frequently or their data can be transmitted over longer, continuous timeslots such as waveforms from vibration sensors. ISA100's flexible timeslots allow wireless devices with different publication rates to co-exist in one network, extending battery life for slower publication rate devices and reducing bandwidth use across the overall network.

The flexibility of a star or combination network provides tools to manage power consumption and battery life. A device configured with a slow reporting rate can have a very long battery life since it sleeps for extended periods. With mesh networks, every device has to be available to function as a router to support the network when called upon, so all devices consume power to serve that function regardless of reporting rate.

Future-proofing Networks, IIoT

Minimizing stranded investment risk is very important for any major investment, including IWSNs. While few process automation investments are truly future-proof, the odds of some wireless technologies being available in the future and adaptable for new applications arising from trends, such as the Industrial Internet of Things (IIoT), are greater for some than for other IWSN technologies. Open, standards-based solutions are much more likely to evolve and be supported by IIoT applications, such as asset management systems than proprietary, single-sourced solutions. Even the standards-based IWSN protocols offer varying degrees of future-proofing.

WirelessHART, for example, is exactly what its name implies: HART master/slave command communication over a wireless network. ISA100, on the other hand, is designed to support many protocols as its communications are object-oriented and as various protocols can tunnel, or be passed through, the ISA100 network-including HART and other common process industry protocols like Modbus.

In addition to being object-oriented, ISA100 differs from WirelessHART in supporting Internet Protocol version 6 (IPv6), addressing to each device in the ISA100 network. An IWSN using the HART protocol to communicate with HART devices will clearly not support future applications such as the IIoT, which is inherently IP-based. IIoT applications will evolve over time, so deploying IWSN infrastructure capable of supporting new sensors and additional application connectivity from existing transmitters, such as condition-based monitoring, will avoid stranding an IWSN investment.

Multiple Vendor Support

Proprietary, single-source IWSN solutions unsupported by multiple vendors carry a much higher risk. If the company fails or is acquired, it may lose key people and cease supporting the platform. WirelessHART and ISA100 have large ecosystems of multiple infrastructure and adapter/integrated transmitter vendors. Websites for the FieldComm Group (WirelessHART) and the ISA100 Wireless Compliance Institute provide listings of devices using the protocols.

Some devices support infrastructure (gateways, routers, etc.), others serve as wireless adapters for conventional field devices, and both groups have instruments designed to be wireless from initial concept. Device certification ensures interoperability within their respective environments.

When considering which wireless solution will best meet requirements for those applications too difficult or expensive to monitor with conventional wired instruments, develop a short list of key selection criteria reflecting application needs today and looking ahead. Evaluate each IWSN solution against those points, assigning weights based on criticality. This process can be informal, or it can be used to generate a request for quote (RFQ) as the process advances. This kind of systematic evaluation will help ensure the best selection for a specific application.

YOKOGAWA

Yokogawa Corporation of America
12530 W. Airport Blvd.,
Sugar Land, TX 77478
yokogawa.com/us

Yokogawa Canada, Inc.
Bay 4, 11133 40th Street SE,
Calgary, AB T2C 2Z4
yokogawa.com/ca

Yokogawa de Mexico, SA de CV
Urbina No. 18
Parque Industrial Naucalpan
Naucalpan de Juarez, Estado de México
C.P. 53370
yokogawa.com/mx