ISA**100** Wireless®

Architecture for Industrial Internet of Things

IEC 62734

IPv6 Industrial Wireless Network
Universal, Reliable, Scalable

ETSI EN 300 328 V1.8.1 Compliant

What is ISA100 Wireless?

An international standard (IEC 62734), ISA100 Wireless is an open, universal IPv6 wireless network protocol that

Extends existing applications

scalability and flexibility unattainable with traditional wired installations.

Enables new applications

process visibility and control in locations where wiring would be infeasible and/or prohibitively expensive.

Eliminates protocol barriers

universal object-oriented application model and tunneling technology supports any protocol, protecting legacy investments

Establishes the Industrial Internet of Things

IPv6 addressibility makes ISA100 Wireless the only industrial Network Protocol compatible with the Internet of Things

WITH ISA100 WIRELESS:

Many applications…

Many protocols…

BUT ONLY

ONE technology to learn

ONE technology to operate

ONE technology to maintain

ONE security system to manage

ONE plant-wide, integrated wireless infrastructure

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Built by the Industry, for the Industry

The ISA100 Committee's standards development processes are open; meaning professionals from across the industry—suppliers, end users, and other stakeholders—collaborated to craft a standard that meets and exceeds user requirements. Subject matter experts from over 250 companies participated in defining ISA100 Wireless.

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3e Technologies
3M Company
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Adelsa Group LLC
Advanced Industrial Networks
Aerocomm
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Aerospace-Wireless Inc
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ELPRO Technologies
ELTAV Ltd
Emcom Instruments Pvt Ltd (India)
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Ember
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Endress + Hauser
EPCO Inc
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ESA
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Exxon Chemical Engineering
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E-Senza
FDT Group North America
Festo AG& Co
Fieldbus Foundation
Fisher Rosemount Inc
FlexWorks Solutions Int'l
Flow Products LLC
FluidIQs
Flywheel Ventures
Ford Motor Company
Franklin Engineering Group
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Freescale Semiconductor Inc
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Frontline Test Equipment, Inc.
Fuji
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G2 Microsystems
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GE Fanuc Intelligent Platforms
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ioSelect Incorporated
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Jamar Int'l Inc
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Johnson County, (KS) ITS
KAPM Strategic Management
KB Intelligence
KCF Technologies
Kinney Consulting LLC
Krohne Inc
KTH (Sweden)
Kuwait National Petroleum Co
Lampe Consulting (Germany)
Landis+Gyr Inc
Langdon Coffman Services
Lasman Instrument Co
Lawrence Livermore National Lab
LS Industrial Systems
The Lubrizol Corp
Luminant
Lyondell Equistar Chemicals LP
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Meriam Process Technologies
Michigan Technological University
Microchip
Microdul AG

Micropelt GMBH
Millennial Net
MIT Forum for Supply Chain Innovation
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Molex
Moteiv Corporation
Motorola
MTL Instrumens Group (Great Britain)
MTS Allstream Inc
Myotis Wireless
Nanotron Technologies
NASA JSC Engineering
National Instruments
Navigant Consultants
Nebula Networks
NERC
Nestle Purina PetCare Co
New Jersey Microsystems
NewTrax Technology
NIST
NIVIS LLC
Nova Chemicals
NuFlo Measurement Systems
Oak Ridge National Labs
Oceana Sensor
Occidental Mukhizna
Omnex Control Systems
ON World Inc
Oneida (Canada)
OnRamp Wireless
OnSet Corporation
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RASGAS
Raven Group
RealNet Solutions Inc
Red Wing Technologies Inc
Relcom Inc
RF Monolithics Inc
Rice Lake Weighing Systems
RLW, Inc.
Rockwell Automation
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S3C Inc.
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SAIC
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Sara Lee Food and Beverage
Saudi Aramco Oil Company
Schneider Automation
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Segment Marketing ARM Inc.
The Semaphore Group
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Sensors Magazine
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Shenyang Institute of Automation - China
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Ship Star Associates Inc
Siemens AG
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Smar Equipamentos Ind
Smart Material Corp
Smart Sensor Systems
SmithKline Beecham (Ireland)
Software Technologies Group
SolarPrint Ltd
Southern Co
Southern Nuclear Operating Co
Southwest China University
Spartan Controls Ltd
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Texas Instruments
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Universitat Politecnica De Catalunya (Spain)
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Water Resources - Calgary, AB - Canada
Westinghouse Electric
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White Rodgers
WIB
WIKA Instrument Corporation
Wunderlich-Malec Engineering
Xanadu-Wireless
Xanthus Consulting Int'l
XSilogy
Yamatake Sensing Control
Yokogawa Electric Corporation
Zhejiang University (China)
Zormco Associates
Zurich University of Applied Sciences (Switzerland)

ISA100 Wireless Benefits

OSI Layer	Function	Technology	
Application (7 – AL)	Interface with software applications that implement a communicating component	• ISA100 Wireless native protocol, similar to FOUNDATION Fieldbus • Object mapping, tunneling protocol	
Presentation (6 – PL)	Establishes a context between Application Layer entities, in which the higher-layer entities may use different syntax and semantics	• Extensible to support FOUNDATION Fieldbus, Profibus, HART, and legacy protocols • Contract-based reservation of resources	
Session (5 – SL)	Controls the dialogues (connections) between computers. It establishes, manages and terminates the connections between the local application and the remote application.	• State-of-the-art AES128 bit encryption security • Join key, network ID, end-to-end security • Over-the-air provisioning with PKI (asymmetric key) • Hop-by-hop security and end-to-end security • Time as security material to guard against replay attacks	
Transport (4 – TL)	Provides transparent transfer of data between end user applications	• UDP: Internet standard service • IPv6 addressing: Globally addressable Internet of Things	
Network (3 – NL)	Provides the means of transferring variable length data sequences from a source to a destination via one or more networks; performs network routing functions	• Backbone routing, IPv6 access points • Compatible with 6LoWPAN	
Data Link (2 – DLL)	Provides the means to transfer data between network entities and to detect and possibly correct any errors that may occur in the Physical Layer	• Mesh network modeled at Layer 2 • Second layer of AES128 security • Mesh/Star/Hybrid network configurations • Redundant communication links to backbone; duocast • Channel hopping: Multiple hopping patterns • Multiple media access methods: TDMA, CSMA, and Hybrid • Extensive wireless diagnostics • Channel blacklisting for coexistence • Routing / Non-routing (I/O) devices	
Physical (1 – PHY)	Defines the electrical and physical specifications for devices, particularly the relationship between a device and a transmission medium	• IEEE 802.15.4, 2.4GHz ISM band	

Benefits

- Easy integration with existing wired host systems

- Extensible to cover specialty application protocols

- Covers a wide range of applications

- Open to a rapidly growing variety of device types from diverse ecosystem.

- Assured QoS from AL.

- Strong security in every message for data protection and confidentiality

- Message integrity and authenticity

- Replay attack protection

- Future-proof and scalable

- Integration with IP technology

- Scale network through IP backbone

- Simple integration with IPv6

- High integrity due to AES128

- Self-configuring

- Reliable and fast update

- Flexible and better performance for different types of applications with efficient data transmission

- Deterministic and large data transfer

- Robust to EM interference

- Lick & stick sensors, low-cost sensors

- Global use without license

- Transceivers available from many sources

- Designed to coexist with other IEEE radios, especially WiFi

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Proven-in-use

Over 1 billion operating hours across the globe

Map legend: Chemicals | Life Science | Mining | Oil & Gas | Refining | Pulp & Paper

Countries shown: Alaska, Canada, USA, Venezuela, Brazil, Chile, Argentina, Norway, Sweden, Ireland, The Netherlands, Belgium, Czech Republic, UK, France, Germany, Spain, Italy, Hungary, Romania, Russia, China, Korea, Japan, Taiwan, Philippine, Kuwait, Qatar, India, Saudi Arabia, Thailand, Malaysia, Singapore, Indonesia, South Africa, Australia, New Zealand

Used in a variety applications:

- Machine health monitoring
- Basic process control
- Monitoring of well heads
- Remote process monitoring
- Leak detection monitoring
- Diagnosis of field devices
- Condition monitoring of equipment

- Environmental monitoring
- Tank level monitoring
- Gas detection
- Fuel tank gauging
- Steam trap monitoring
- Open loop control
- Stranded data capture

Universal Industrial Wireless Network

ISA100 Wireless is an open, flexible framework that accommodates legacy applications regardless of protocol, thus protecting end user's existing application investments.

ISA100 Wireless Objects

ISA100 Wireless can simultaneously accommodate multiple protocols all within a single, interoperable network via the ISA100 Wireless object-oriented application model. Examples available today include:

- GasSecure gas sensor (ProfiSafe for enhanced security)
- 3eTi network nodes (FIPS 140-2 for military grade security)
- GE Bently Nevada Vibration sensors (proprietary protocol)
- Honeywell Enraf radar level gauge (proprietary protocol)

Tunneling

Another way to transmit non-native protocols through ISA100 Wireless networks, tunneling gives device manufacturers multiple options when building ISA100 Wireless product.

ISA100 Wireless Adapter

The ISA100 Wireless object-oriented application model enables the ISA100 Wireless HART Adapter to seamlessly integrate HART devices into the network while maintaining interoperability.
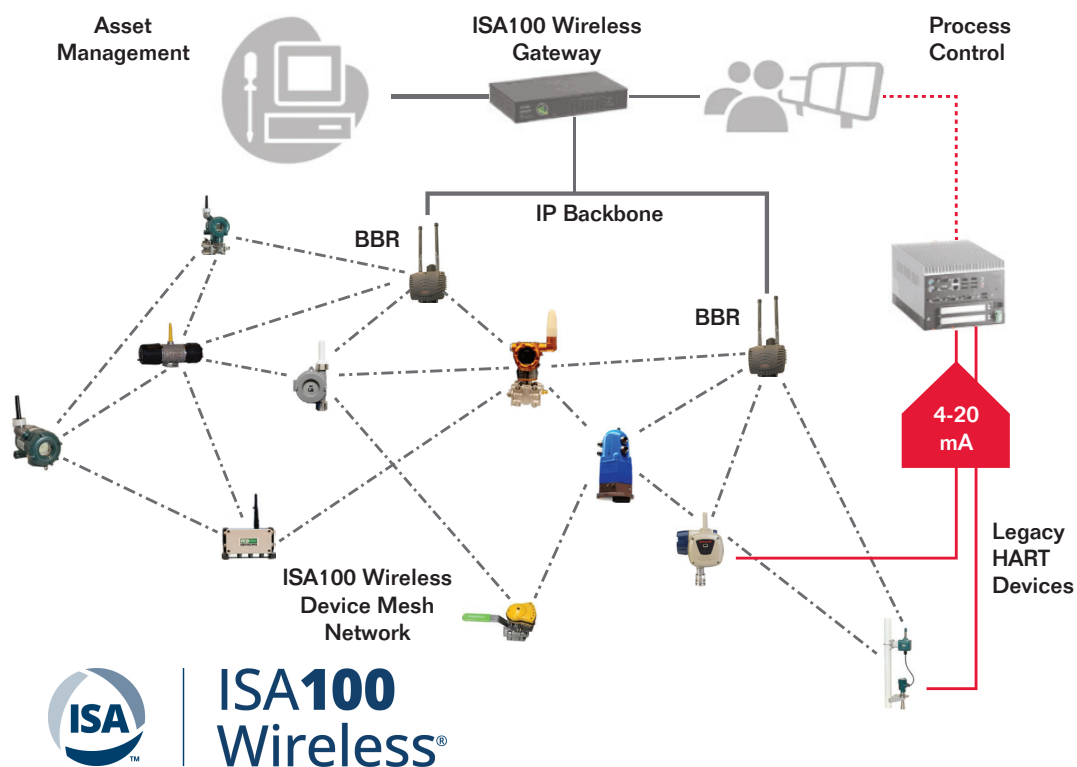
The figure above shows the flexibility of the ISA100 Wireless universal network. The ISA100 Wireless mesh network is comprised of devices from multiple manufacturers, some are using the native ISA100 Wireless protocol, and others are using ISA100 objects with different protocols. The two legacy HART devices, wired to a controller, are reporting HART digital data to the ISA100 Wireless network via ISA100 Wireless HART adapters.

Why Does IPv6 in ISA100 Wireless™ Matter?

Internet of Things (IOT), Internet of Everything (IOE), Industrial Internet of Things (I2OT)

Whatever your name for it, IPv6 and ISA100 Wireless make the Industrial Internet of Things (I2OT) a reality TODAY.

ISA100 Wireless is the only industrial wireless protocol standard to incorporate IPv6 directly as part of its network layer and transport layer. This gives ISA100 Wireless the advantage of seamless end-to-end routing with "anything anywhere" effectively in a single environment.

IPv6 in ISA100 Wireless supports multiple subnets which enables sensors to be grouped together much like a VLAN for traffic and network management, while also breaking the network into zones for security reasons. Support for subnet-level mesh, as well as backbone-level routing, is also supported in ISA100 Wireless.

IPv6 networks use familiar standards-based addressing and can be managed using tools derived from traditional IT network management tools and systems. Today's generation of network managers and automation engineers understand IPv6 and so will future generations.

Many think IPv6 only increases IP addresses, but there are a number of other advantages:

- **Security Boost** – Internet Protocol Security (IPsec), a major design improvement of IPv6, authenticates and encrypts each IP packet of a communication session. IPsec operates in the Internet Layer, thus it protects any and all application traffic across an IP network.

- **Support For New Services** - By eliminating Network Address Translation (NAT), true end-to-end connectivity at the IP layer is restored, enabling new and valuable services. Peer-to-peer networks are easier to create and maintain, more robust Quality of Service (QoS).

- **More Efficient Routing** - reduced routing table sizes, more hierarchical routing.

- **More Efficient Packet Processing** - simplified packet headers; eliminated IP-level checksum that exists in IPv4

- **Directed Data Flows** - IPv6 supports a superior multicast method saving network bandwidth

- **Simplified Network Configuration** - address auto-configure is built into IPv6 (address assignment)

With the IOT, everyone wins and ISA100 Wireless with IPv6 is already helping companies today.

User Benefits:

- Improve Performance and Reduce Downtime
- Lower Asset Lifecycle Costs
- Platform for Innovation and Continuous Improvement

Suppliers Benefits:

- Improve Service Performance
- Improve Service Business Profitability
- Platform for Innovation
- Sell Products-as-Service

Control-Ready

ISA100 Wireless is ready for use in wireless control applications:

- Fully wireless control loop
- Wireless actuator, wired sensor in control loop
- Wireless sensor, wired actuator in control loop
- Wireless sensor providing supplemental information to control loop

The benefits

1. Improved reliability	• Troublesome wired sensors replaced by wireless counterparts. • Wireless may serve as a backup for wired technology.
2. Improved control	• Add wireless devices to existing processes for more optimal control.
3. Cost savings	• Up to 90% of installed cost of conventional measurement technology can be for cable conduit and related construction. • New and existing applications are now economically feasible.

ISA100 Wireless Features for Control

1. Rate and Latency	• Publication rates 1-2 seconds • Capable of 100 ms latency • Controlled latency, ~50% publication rate • 4 Hz publication in constrained configurations
2. Flexible System Architecture	• Engineered and scalable IP backbone • High redundancy: duocast communication and redundant hardware • Network layout flexibility: multiple access points, field routers, and meshing/non-meshing devices
3. Mesh Networking	• Mesh and non-mesh network topography • Interoperable peer-to-peer connections • Function blocks at the device level • Battery life is deterministic. • Meshing access points and field devices
4. Reliability	• Wireless transmission is deterministic. • Wireless transmission is received. • Wireless transmission is accurate. • Dual communication paths up to process control network
5. Security	• Wireless transmission has not been hacked.

Secure

ISA100 Wireless provides robust, multi-tiered, policy-based security to ensure the safety of system operations. Communications are protected using a time-enhanced application of the NIST standard 128-bit Advanced Encryption Standard (AES) block cipher. Only devices that have legitimate and unique secret join keys are admitted to the network. Multiple-tiered AES-128 keys are derived from join keys and updated periodically. This secure key derivation method is the basis for a trusted relationship that makes the ISA100 Wireless network secure throughout the entire system life cycle.

Completely Wireless

ISA100 Wireless delivers the first completely wireless security solution on the market. When building, installing, or maintaining a wireless device, a wired provisioning interface adds time, cost, and risk. ISA100 Wireless uses infrared ports or over-the-air communications to make provisioning convenient and safe.
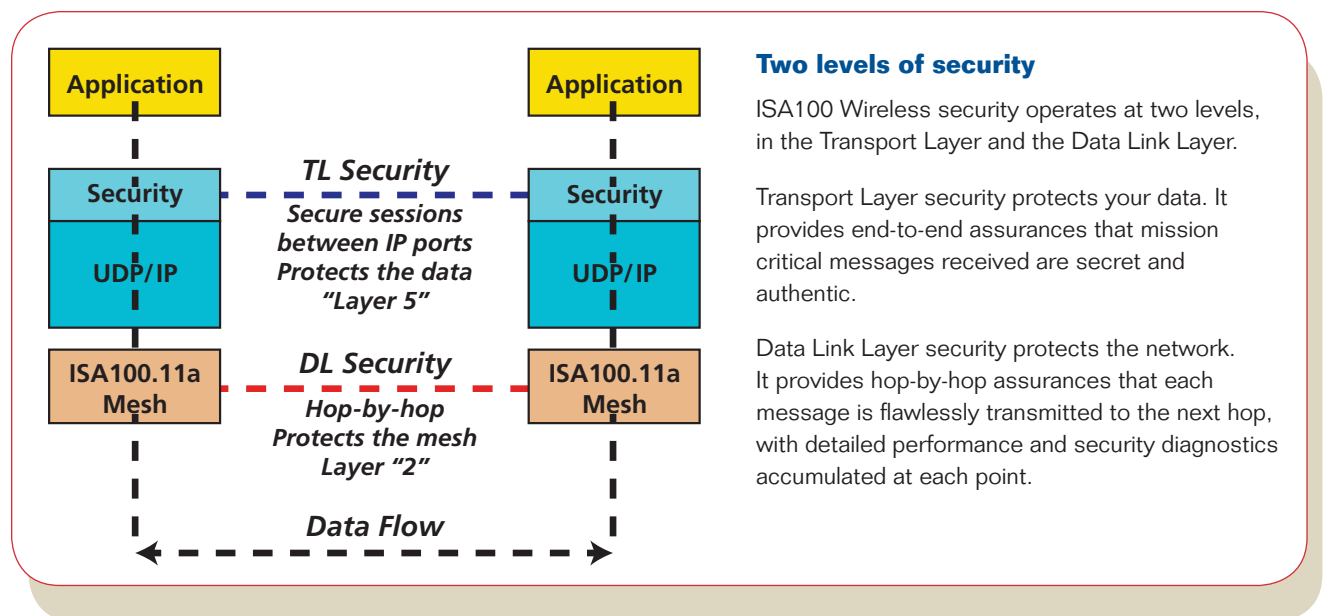
Scalable

The security industry is evolving rapidly, and ISA100 Wireless' security features are designed with change in mind. Scalable encryption in two security layers ensures that ISA100 Wireless products and systems will continue to meet users' and regulatory agencies' future security needs.

Time-Enhanced

AES-128 security is the industry standard. We've made it better. By adding an additional layer of security based on time signature, ISA100 Wireless systems are protected against replay attacks.

Proven

Anyone can claim their system is secure, but the open, consensus-based design and review process ensures ISA100 Wireless delivers confidence. Its security is based on the well-established NIST standard 128-bit AES block cipher and has been validated by a broad range of security experts from industry, government, and academia.

Application

Security

TL Security
Secure sessions between IP ports Protects the data "Layer 5"

UDP/IP

ISA100.11a Mesh

DL Security
Hop-by-hop Protects the mesh Layer "2"

Data Flow

Application

Security

UDP/IP

ISA100.11a Mesh

Two levels of security

ISA100 Wireless security operates at two levels, in the Transport Layer and the Data Link Layer.

Transport Layer security protects your data. It provides end-to-end assurances that mission critical messages received are secret and authentic.

Data Link Layer security protects the network. It provides hop-by-hop assurances that each message is flawlessly transmitted to the next hop, with detailed performance and security diagnostics accumulated at each point.

Robust

Users should have an interoperable network that doesn't sacrifice performance even if other wireless solutions are already installed.

That's why ISA100 Wireless is designed with coexistence in mind, delivering optimal performance in the presence of other wireless networks.

Ensuring performance and scalability with spectrum monitoring and device management

The Problem:
Sharing The Spectrum
Radios operating in the 2.4GHz ISM band must share frequency in the presence of other RF systems.

ISA100 Wireless' Solution:

Channel Blacklist
Automatically avoid congested channels

Frequency/Channel Hopping
Minimizes error by spreading signal over entire available band

Direct Sequence Spread Spectrum
Energy spreads so it looks like noise to other systems

Dynamic Power Control
Limits interference

Low Duty Cycle Operation
Short time-synchronized communication reduces congestion

Clear Channel Assessment
Avoids collisions with other radio systems

Frequency Selection
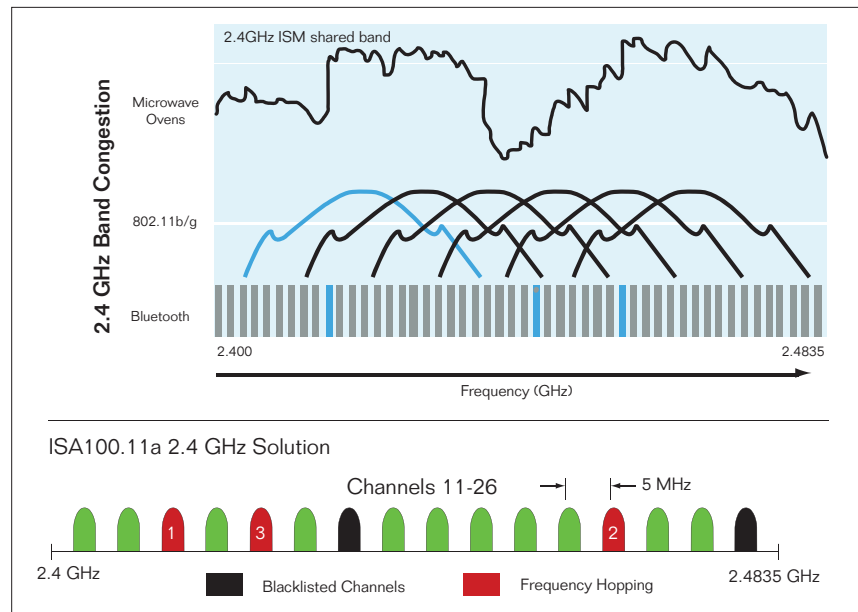Force operation on specific channels to optimize performance

Measuring to Manage

Spectrum Analysis	System Management	Policy Enforcement
Identifying Interferers Monitoring Saturation	Device Configuration Element Provisioning Performance Monitoring	Channel Allocation Rules Creation Blacklisting

ISA100 – Ensured Coexistence with Many Wireless Networks

Certified Interoperable

The ISA100 Wireless Compliance Institute provides assurances of interoperability via our device testing and interoperability testing programs. This ensures that any supplier's products can work securely and reliably "out of the box" in any other supplier's network.

What does certification accomplish and what are the benefits?

- Assures interoperability based on a test specification derived from ISA100 wireless communication standards
- Provides instant recognition of wireless communication characteristics
- Promotes a key differentiator for product or system
- Allows equal and fair testing for all products to gain compliance
- Enables registration for an easy-access listing of conforming products on the web
- Use of an independent ISO/IEC 17025 test lab ensures objective, rigorous certification results.

- Parity and fair access for all suppliers
- Reduced costs, time, and risk in integration and deployment for end users
- Faster time to market for suppliers
- More flexible system configurations
- Consistent and predictable performance
- Single forum for voicing product needs for end users

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EP06-3405-0314