



Industrial

Eliminate Infrastructure. Connect Everything.

Fault Tolerance

Industrial plants, which run 24/7 with scheduled down time only every couple of years, present some of the most challenging environmental conditions for deploying wireless equipment—from the 3,000°F+ temperatures of an industrial kiln to the dust that encrusts Wave Relay® devices at cement plants. The Wave Relay® router and all of its connectors, cables, and antennas are designed specifically for these extreme conditions. But Wave Relay®'s fault tolerance extends well beyond its physical construction, industrial temperature rating, and IP67 industrial rated connectors and enclosure. Wave Relay® also possesses a number of specific technological capabilities that allow it to deliver fault tolerance limited only by your deployment budget.

these systems are extremely fragile and will suffer a total failure if a single device fails.

The Wave Relay® System is a true peer-to-peer mesh networking solution in which no device has any special capabilities. If any device in a Wave Relay® system fails, the rest of the devices will continue to communicate using any remaining connectivity. By eliminating master nodes, gateways, access points, and central coordinators from our system design, we can deliver extremely high levels of fault tolerance regardless of which nodes fails—a most valuable feature, especially for industrial deployments.

No Single Point of Failure

Most existing wireless systems are susceptible to a single point of failure. Consider a cell phone system: if the cell phone tower fails, none of the cell phones are able to communicate with each other. In an 802.11 system, if the access point fails, all of the client devices become disconnected. In a WiMAX system, a central GPS-equipped base station device is used to synchronize and connect subscriber devices. If a WiMAX base station fails, all of the subscribers are disconnected. In commonly used Point-to-Multi-Point wireless systems, all of the subscriber devices can only communicate with the central access point device. Even a number of competing "mesh" solutions rely on connecting all of the mesh devices to a specialized central gateway/controller node. All of

Hot Fail-over / Redundant Bridging / Device Diversity

Wave Relay® is commonly used to bridge remotely located industrial devices or networks and to connect them with the rest of the plant network. If a device fails, all of the devices that it was bridging will immediately become disconnected from the network—an unacceptable situation for industrial facilities. With Wave Relay® any number of routers can be connected to the same Ethernet device or segment in order to bridge it with the rest of the network. If two Wave Relay® routers are used to bridge each device or segment, then a failed device can be replaced without causing any network down time. This combination of hot fail-over, redundant bridging, and device diversity allows Wave Relay® to deliver extremely high levels of fault tolerance and reliability.

Frequency Diversity

One major concern when deploying wireless equipment in any industrial facility is in-band interference from preexisting wireless devices. While the general practice of performing a site survey to select the "cleanest" channel is beneficial, it fails to consider the fact that environments can change. The cleanest channel today may in fact be the most congested channel tomorrow. Wave Relay® devices are able to utilize up to four radios in each router, each of which can be configured to operate on a different channel in one of three bands-900 MHz, 2.4 GHz, or 5 GHz. (The probability that all of the channels in all of these different bands are all jammed or experiencing interference at the same time is extremely low.) The Wave Relay® system then selects routing paths based on a performance-driven metric. If particular links become jammed from external interference, Wave Relay® will immediately bypass them in order to maintain the best possible connectivity, a feature not possible in single-radio systems. This multi-radio frequency diversity, when combined with Wave Relay®'s routing agility, enables continuous high-level service even in the presence of jamming and interference.

Routing Agility

The Wave Relay® system is designed to maintain connectivity while under vehicular levels of mobility. While most industrial deployments involve stationary routers deployed at fixed locations, the routing agility of the Wave Relay® system is still extremely beneficial, because even in a static topology the RF conditions of a wireless network change continuously. Fading channels and fluctuations in the levels of interference greatly affect the system performance, throughput, and capacity. Since Wave Relay® is designed to operate in a rapidly changing mobile environment, it can easily adapt to changing RF conditions and maintain the best possible connectivity.

Security

Security is-or should be-the single most important factor for any industrial facility that is considering the deployment of a wireless network. Industrial facilities are responsible for the world's

electricity, gas, and water and in the current age of information warfare are therefore primary targets of attacks. Perhaps most vulnerable is the wireless medium, which cannot be protected by physical security mechanisms such as fences and alarm systems. The only means of defense is the correct application of authentication and cryptographic mechanisms.

The Wave Relay® System not only provides these security mechanisms, but provides them without compromising system performance. In order to ensure that computationally demanding cryptographic operations do not add latency to real-time process control, each Wave Relay® router includes an integrated high-speed cryptographic accelerator chip. The accelerator can provide up to 150 Mbps of 256-bit AES (government recommended) encryption. By utilizing an accelerator that is faster than our radios, no delay is added to the data flow. Every packet transmitted by a Wave Relay® router is encrypted and then authenticated at every wireless hop. Even Wave Relay® routing control packets are encrypted and authenticated to prevent disruptions.

In addition to just protecting data, Wave Relay® employs a sophisticated key management scheme. In the event that a Wave Relay® device is stolen, it can be immediately revoked from the system to prevent an adversary from gaining access. These revocation mechanisms are also scalable, so they won't interrupt ongoing communication.

Wave Relay® also allows you to connect securely from a standard laptop device using built-in 802.11a/b/g access equipped with WPA2 security, the most secure standard client access commercially available. WPA2 allows client laptops to securely connect to the system and encrypt all data using 128-bit AES encryption. Wave Relay®'s accelerated encryption and authentication mechanisms, scalable key management solution, and secure client access ensure the highest level of security for your industrial network.

Scalability

Industrial plants often span large geographical areas, contain large obstructions such as silos and towers, and require connectivity to thousands of industrial devices and controllers. The demanding requirements of industrial facilities require a wireless

solution with both massive scalability to connect all of the devices and an extremely flexible design in order to operate over long distances and route around obstructions. Wave Relay®'s unique set of capabilities allows it to meet these industrial needs.

Thousands of Devices

Wave Relay®'s proprietary routing protocol allows it to route between thousands of destinations without collapsing from routing overhead. This unique capability ensures that your Wave Relay® deployment will be able to scale to meet the increasing need for connectivity at your industrial facility. In addition to scaling to a large number of Wave Relay® routers, each individual router can bridge a whole Ethernet network of devices with your system. There is no need to maintain a 1:1 ratio of industrial devices to Wave Relay® routers. Each router can be connected to an Ethernet switch, allowing a single Wave Relay® router to wirelessly bridge hundreds of remote industrial devices into your larger plant network. The end result is almost unlimited system scalability.

Delivering Connectivity

The Wave Relay® system not only scales to a large number of devices, but it delivers sufficient bandwidth to all of those devices as well. By utilizing multiple radios, Wave Relay® transmits high bandwidth across multiple non-interfering channels. On a single 40 MHz channel, Wave Relay® is able to deliver a maximum of 63 Mbps of real application-level throughput. (Most competing industrial radios measure their capacity in Kbps.) By utilizing multiple non-overlapping channels, numerous high-capacity links can be used to distribute massive amounts of bandwidth over large geographical areas. The multi-radio design allows the bandwidth to move through multiple hops without losing any performance along the way. Wave Relay® can therefore be used to run video surveillance applications, deploy VoIP phone systems, back up a fiber optic cable, interconnect multiple buildings in a single network, and connect thousands of industrial devices and controllers. Wave Relay® provides the added value of using a single high-speed network infrastructure for multiple applications.

Process Control

In order to provide real-time process control over a wireless network, Wave Relay® is designed to curtail latency in every aspect of the system. The latency or delay of each wireless hop is extremely low. Queuing delays are precisely controlled. Process control packets are prioritized to preempt non-critical data flows. Data not only "cuts in line" but is given additional preferential treatment when accessing the shared wireless medium. Route setup delays are minimized, and data reliability is maximized. The system immediately adapts to faults and disruptions so all data reaches its destinations. The Wave Relay® system provides the performance, reliability, and security needed for wireless industrial process control.

Remote Maintenance

Each Wave Relay® radio is capable of providing both standard 802.11a/b/g access and meshed connectivity, simultaneously reducing costs and increasing system capability. Utilizing 802.11 equipped laptops, personnel can securely connect back to the plant network from the field, so they can access online documentation, view SCADA information, and even control the plant remotely if necessary. With Wave Relay® you can use a single system to connect all of your wireless devices AND provide remote access to your users.

Seamless Connectivity

The Wave Relay® system is designed to operate at layer 2 of the ISO/OSI network stack. Any industrial protocol that is able to operate over Ethernet will also operate over Wave Relay®. Most existing industrial devices can run directly over Ethernet or be connected using off-the-shelf serial to Ethernet adapters or remote IO servers. Other competing solutions operate at layer 3 and therefore rely on IP routing, rendering them useless for many industrial applications. Wave Relay®'s seamless plug and play connectivity makes it an ideal solution for the industrial sector.