Technology Intro

Wave Relay® is a Mobile Ad Hoc Networking System (MANET) designed to maintain connectivity on the move. It is a scalable, peer-to-peer network which provides data, video, and voice even in the most challenging applications. With user throughput of 37Mbps UDP and 27 Mbps TCP, Wave Relay® provides a dynamic, reliable, and secure wireless networking solution beyond mesh.

The Gen4 (MPU4) is a compact radio designed for installation or user-worn applications. Seamless Layer-2 Ethernet connectivity facilitates plug-and-play operation of cameras, video encoders, IP sensors, and other devices. The device is easily integrated into avionics bays, vehicles, machinery, and other third party systems.

Mobile Ad Hoc Networking

A Mobile Ad hoc Network is a collection of mobile devices (often referred to as "nodes") that form a self-configuring network. The devices communicate wirelessly by relaying data across the network through a sequence of transmissions. In a true MANET such as Wave Relay® every node can communicate with every other node enabling true peer-to-peer connectivity. This is in marked contrast to the far more common mesh network design, in which a series of stationary access points connect end users only to the Internet. The Wave Relay® MANET is designed to maintain both peer-to-peer routes and connectivity to an Internet gateway while under mobility. The system detects changes in connectivity and, using a revolutionary routing protocol, elegantly adjusts the pathways in order to maintain the most efficient route between them.

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>MOBILE AD HOC NETWORK</th>
<th>MESH NETWORK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any-to-Any Routing</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Routing to Gateway/Internet</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Mobile Routers</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Users Included in Routing</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Fault Tolerant Architecture</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Military Capable</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Public Safety Capable</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Designed for Industrial Apps</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>
Mobile Ad Hoc Networking vs. Mesh Networking

In response to the challenge of developing a scalable MANET solution, a number of companies in the commercial sector have recently introduced products for building mesh networks. Though a mesh network and a MANET appear similar at first, a closer look reveals significant differences in their capabilities.

### Many-to-One vs. Any-to-Any

A mesh network generally consists of a number of static access points around which end users connect in order to send data back and forth to an Internet gateway. This many-to-one architecture, while easier to scale, is far less powerful than the any-to-any connectivity provided by a MANET such as Wave Relay®. Wave Relay®’s any-to-any connectivity allows users to communicate directly and efficiently, giving it a clear advantage over more basic mesh networking solutions. This efficient any-to-any communication capability is particularly useful for tactical, public safety, and industrial networks, where participants need to be able to communicate directly, even when all of the fixed infrastructure has failed. A typical mesh network simply cannot provide this. In such systems, without a connection to a gateway you don’t have a network.

### Wave Relay® vs. Mesh for Internet Deployments

Wave Relay®’s ability to deliver the mesh to the end user results in multiple advantages ideal for municipal and ISP deployments.

<table>
<thead>
<tr>
<th>PROBLEMS WITH TRADITIONAL MESH</th>
<th>WAVE RELAY® SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client computers use consumer-grade 802.11 radios that do not operate dependably over long distances or through obstructions.</td>
<td>Meshed radios bring the AP straight to your computer. Data is routed efficiently through other meshed CPEs in the area.</td>
</tr>
<tr>
<td>Weak signals between end users and APs located outside homes and offices result in lower bandwidth. (Usually 1Mbps shared among all area users.)</td>
<td>Meshed end users share a huge 54 Mbps of bandwidth.</td>
</tr>
<tr>
<td>Single-radio mesh networks must forward data through the mesh on the same radio they use for client connectivity.</td>
<td>Data is forwarded through the mesh by peer-to-peer routing. Quad Radio Architecture incorporates four meshed radios operating on different channels.</td>
</tr>
</tbody>
</table>

### Scalable Routing

Wave Relay® was designed to maintain connectivity among a large number of highly mobile nodes. Wave Relay® proprietary algorithms deliver scalability that is orders of magnitude greater than that offered by competing products. Wave Relay® is the only technology able to scale to a network that incorporates large numbers of continuously moving nodes in an any-to-any topology. This capability allows Wave Relay® to be used in large deployments without the need to divide the mesh artificially into independent “sub-networks”. The result is a networking tool that provides optimal performance in even the most demanding environments.

**Key Advantages:**

- Increases routing options, leading to better connectivity and higher network capacity
- Provides nearly unlimited node mobility
- Makes efficient use of network resources
**High Throughput Routing**

Wave Relay® keeps information flowing. As the distance between two wireless devices in a mobile network increases, the signal strength between them decreases. Thus, the capacity and reliability of different pathways through a network fluctuate continuously as the devices themselves move. Wave Relay® quickly detects these movements and routes traffic onto the highest-capacity path, delivering the best possible bandwidth for each particular moment. This high-throughput route selection guarantees peak network performance at all times.

**Peer to Peer Routing**

Wave Relay®'s peer-to-peer routing means that any node in the network may communicate directly with any other node without inefficient data relays through an Internet gateway. This capability significantly increases the performance and efficiency of user-to-user traffic. This Wave Relay® feature is particularly useful in Public Safety networks, wherein users communicate primarily amongst themselves as opposed to with the Internet.

**Quad Radio Architecture**

Wave Relay® dramatically increases throughput by operating each of its four radios on multiple channels and by routing data across non-interfering channels. Superior scalability allows each radio to function as a part of the mesh.

The Quad Radio Architecture enables a single router to serve multiple purposes simultaneously and thus provides end-users with deployment flexibility. For example, one radio may be connected to an antenna designed to communicate with high altitude aircraft while a second radio is connected to a standard omni directional antenna to communicate with dismount group users. Utilizing the optimal antenna for each application ensures that overall performance is optimized.

**Seamless Layer 2**

Wave Relay® runs on OSI Layer 2 (the Ethernet link layer) and is designed to be hassle-free. Joining users and devices to the network is as simple as plugging them into an Ethernet switch. Any device that runs over Ethernet may thus be connected to the network instantly. Additionally, Wave Relay® may be connected directly to an existing Ethernet switch, bridging entire wired networks into the system. Whether a cluster of video surveillance cameras, a group of industrial controllers, or a squadron of first responder communications vehicles, Wave Relay® keeps all of your devices connected.

**Security**

**Key Advantages:**
- FIPS 140-2 Level Validated
- Utilizes All Suite B Algorithms
- Hardware Cryptographic Accelerator

Wave Relay® Routers are validated by the governments of the United States and Canada to meet the requirements of FIPS 140-2 Level 2. The Routers utilize cryptographic algorithms that are part of the Suite B list of algorithms recommended for use by NSA. The correct implementation of each algorithm has been certified by NIST.

The standard encryption approach utilized by Wave Relay® is CTR-AES-256+HMAC-SHA-512 (Counter Mode AES encryption with a SHA-2 HMAC which is 512 bits). Additionally, all of our cryptographic operations are performed on a hardware cryptographic accelerator that enables extremely high levels of performance while utilizing low power embedded processors. The existing Wave Relay® Product Family (MPU Gen2/3 and Quad Gen 2) are all FIPS 140-2 Level 2 validated by NIST (Certificate #1418). The system operates via a shared network key, and individual radios must utilize the same encryption key to communicate.
Fault Tolerant System

Wave Relay® is a network with advanced self-healing properties. There is no single node within the network upon which the network depends. No matter which node fails, the network will continue to function. This makes Wave Relay® particularly well-suited to public safety and industrial networks and to any other situation wherein network dependability is critical. Together with its frequency diversity, device diversity, rapid re-routing, hot failover, and freedom from any centralized coordinator device or gateway, Wave Relay®’s advanced ability to self-heal makes it the most robust wireless communication system available commercially.

Key Advantages:
- Multi-channel devices provide fault tolerance against interference by routing through alternate channels
- For added reliability use multiple Wave Relay® routers to bridge the same Ethernet segment
- Wire and connect the system with multiple redundant paths without creating loops in the network

2 W Radio Capability

Wave Relay® Gen3 and Gen4 Man Portable Units (MPUs) are now available with an optional 2 W S-Band Radio Module that greatly extends range and provides industry-leading performance. In dismount applications where small antennas must be employed and body masking degrades performance, the increased transmission power fundamentally increases system performance. Real-world testing has demonstrated that our 2 W module delivers up to twice the range of standard 600 mW radios.

The 2 W S-Band Radio Module is also an excellent solution on unmanned platforms where small antennas are the norm and long communication ranges are standard system requirements. The 2 W radio is fully integrated and eliminates the need for large/heavy external power amplifiers.

Note: 2 W radios are available for military customers only.

Push to Talk Voice

Key Advantages:
- Integrated Push-to-Talk Voice Capability over MANET
- Compatible with Standard Headsets
- Up to 16 Simultaneous Voice Channels
- RoIP Integration with Cisco IPICS and Twisted Pair WAVE

Wave Relay® radios offer a fully integrated Push-to-Talk (PTT) Voice capability. Unlike traditional voice radios, the Wave Relay® system enables voice communication to traverse the entire Mobile Ad hoc Network (MANET), greatly extending range and improving robustness.

The PTT Voice capability enables the user to monitor up to 16 talk groups (channels). A priority scheme ensures that critical information is easy to monitor. Optional audible channel announcements enable users to track the talk group to which they listen. PTT audible feedback tones emulate the MBITR radio (channel busy/available) for easy and intuitive use. End users may also elect to receive audible notifications of particular network events. For example, a user may choose to be notified each time an airplane is overhead and its video feed is available.

The 16 talk groups are easily mapped into channels in commonly utilized Radio-over-IP (RoIP) systems such as Cisco IPICS and Twisted Pair WAVE. This enables seamless radio interoperability with traditional land mobile radios for military, public safety, and commercial applications.

The Wave Relay® radio is fully compatible with the Silynx Communications C4OPS headset (www.silynxcom.com). The 20m immersible, software defined C4OPS features channel selection, volume control, last-message replay, and a remote PTT button. An ICD specification exists to enable other headset manufacturers to support the complete array of Wave Relay® PTT features.