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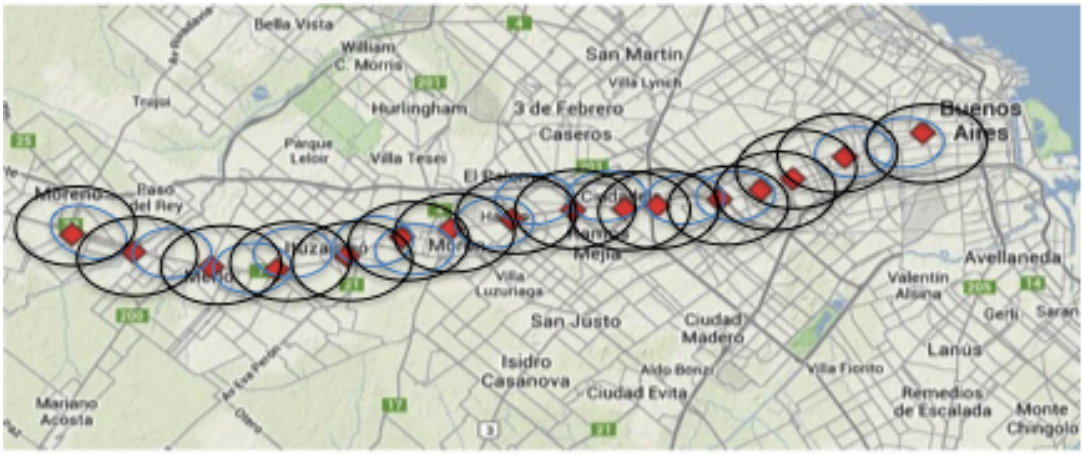
A Private Meshed IP Network (over RF) for Rail Systems

May 15, 2015



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THE NEED

Tragic incidents including the recent collisions of trains and automobiles and transfer trucks in the United States and the Lac-Mégantic rail disaster in Canada have underscored the need for faster, more efficient, more certain communication between trains and rail infrastructure in order to prevent disasters and for effective collaboration when handling emergencies. Access to command and control centers, the need for streaming of live video, the demand for interoperable multimedia communication involving a wide range of agencies and resources when and as needed, and the increasing demand for IP connections for effective communication demands that high speed IP based communcation be available to trains at all times.

TRAINS IN ARGENTINA

[The 2012 Buenos Aires rail disaster, also known as the Once Tragedy, occurred on 22 February 2012, when a train crashed at Once Station. The train crashed into the station at a speed of 26 kilometres per hour (16 mph). Fifty-one people were killed and more than 700 were injured.]

Global InterLink's recent work in Argentina is an example of the firm's lifesaving technology. After a tragic incident in 2012, train officials embarked on an aggressive program to assure that such an accident would not recur. After adding onboard video and other safety measures, the agency turned to the issue of live streaming of video from trains to central observation points. In the case of the Sarmiento Line, this meant up to 26 trains, each with two video sources, with one being active at any given point in time during operating hours. Thus the system had to be sized to handle simultaneously up to 26 realtime high def video streams.

Consider a fleet of trains in constant motion. Most modern communciation is based on high-speed Internet connections regardless of location. Trains and train crews are no exception. Safety requires constant communication as well as high speed streaming video from the trains to their control stations. All that is most effectively accomplished over Internet connections. But how do you provide a high speed Internet connection on a train that is moving along a track at 50 or 60 mph?

Even in countries where cell coverage is good, 4G cellular systems are not reliable enough or fast enough for a lot of critical uses. In countries where cell coverage is weak and slow along large stretches of track, LTE is not a workable solution at all. The Trains administration turned to Global InterLink's solution, a military/industrial class of IP radio that supplies high speed wireless Internet connections at great distances, delivering reliable, very high speed Internet connections 20 or 30 miles away--wirelessly.

An added advantage is that InterLink Mesh IP Radios can link (mesh) together wirelessly to create chains of relay connections that deliver Internet connections up to several hundreds of miles from the nearest wired Internet. InterLink Latinoamerica, Global InterLink's partner in Argentina, has now installed radios on all the trains on the commuter line, as well as in all the stations along the track, as well as on towers in the area near the trains and stations. This created a wireless network that blankets the entire area where the trains run. Now all the trains, stations, and control centers are connected at high speeds, and they can collaborate with each other routinely, or instantaneously in the event of an emergency.

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Operadora Ferroviaria Sociedad del Estado (abbreviated SOFSE) (http://en.wikipedia.org/wiki/Operadora_Ferroviaria_Sociedad_del_Estado), the semi-governmental agency that manages the Sarmiento Line turned to Global InterLink Corporation and our partner company in Latin America, InterLink Latinoamerica, S.R.L., for a solution to allow real time streaming of live video feeds from the cockpits of trains on the Sarmiento Line. Each of the 26 Sarmiento trains was equipped with an InterLink Meshed IP radio in the locomotive cars leading and trailing each train, as well as the 16 stations along the primary urbanized portion of the Line. Supplemental relay points were established to resolve two problematic NLOS situations found to exist along curved and/or trenched sections of the line. The InterLink Meshed IP radios created a blanket of secure, high speed, long range IP coverage that encompased the entire lenght of the urban Sarmiento Line. The network mesh therefore consists of over 70 individual nodes, any number of which may be active at any given point in time. In order to reduce the number of hops from node to node to node, a backhaul line was established from end to end, situated on high (up to 90 meters) towers at each end and at two intermediate points. The backhaul network is cross connected with the operational network, using wired lines from stations to towers, thus providing a high degree of redundancy for the networks.

Multiple Trains at Multiple Stations or between stops, each train constantly streaming mulitple HiDef Video Streams. A private end to end network providing instance IP access to all stations and all trains, as well as to the Command and Control Center.

Small white omnidirectional puck attennas atop each cab connect with the primary mesh network located at stations along the track. These in turn connect to a backhaul network on high towers. The backhaul increases network efficiency and provides end to end redundancy.

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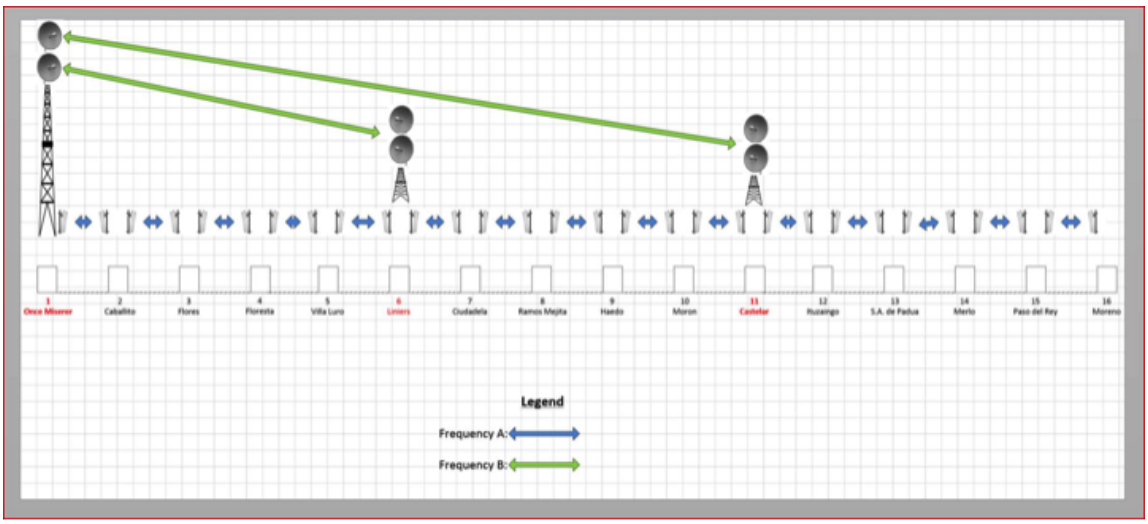
NETWORK ARCHITECTURE

The overall system design consists of one InterLink IP Mesh Radio at each railway station and one InterLink IP Mesh Radio in each of two engine cabins on each train. The combination of all radios creates a continuous end to end private IP network. Each train is within the coverage area of at least one station at all times. The Network is self healing. Hence any node may relay any other node at any time to create an uninterupted mobile network at all times. There is no need for wired infrasture at any place within a given Network. However, if wired infrastructure is available for any segment of the Network such as from one station to another, wired lines can be used to supplement the Network as primary or secondary links.

In order to further reduce the likelihood of Network congestion, a backhaul Network at a different frequency can be deployed as well. A four node backhaul network was deployed. It is based on slighty higher towers than the station based nodes.



CUSTOMIZABLE NETWORK CONFIGURATIONS

Mesh networks allow unlimited flexibility in network configuration. Our specialists analyzed the Buenos Aires rail network and presented an optimal configuration that maximizes reliable throughput and minimizes overall network costs. The resulting configuration features the following:

- Ability to create LANs and WANs wirelessly over RF
- Connectivity under highly mobile conditions from trains to trackside infrastruture
- Extremely fast networks, capable of handling many simultaneous video streams
- Near-Zero latency for streaming video
- Highly secure
- High bandwidth (40 Mbs or greater)
- Highly configurable (WAN/LAN/VPN over wired and wireless links)
- Ranges longer, Signals stronger without degradation compared to non-MIMO
- Capable of relay over many nodes

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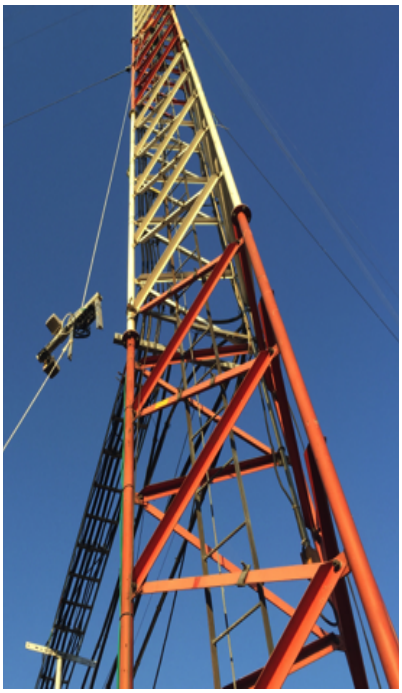
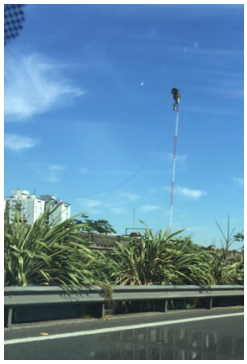
Now, InterLink's antennas (in the case of trains, the small white pucks atop the cabs) can be seen atop every front-facing and every rear-facing locomotive car on the Sarmiento line; on top of the railway stations and atop some supplemental structures located between stations; as well as on some of the highest towers in the city.





RELATED NETWORK ARCHITECTURE

InterLink has delivered a number of InterLink Model 500 MN-MIMO radios to SOFSE and these have been deployed on the Sarmiento line. Other Lines are currently being bid. The number proposed will be determined by an RF survey considering all layouts, obstacles, and connectivity requirements. Each radio will serve as a node in the mesh as well as a point of entry for user systems and devices including:

- wi-fi hubs,
- routers,
- switches,
- PCs,
- handheld devices, and
- other IP connected devices and services.

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InterLink's IP MESH RADIO SOLUTION

The commuter rail system of Buenos Aires, Argentina has deployed the InterLink Meshed (IP over RF) Radio Network. The initial installation involves a single line with 16 station and 26 trains. Each station has one node installed on a mast and each train contains two nodes with puck antennas mounted on the top of the engine cabin. Each train will stream two simultaneous High Definition videos. InterLink's IP Meshed radios have the ability to:

- Create LANs and WANs wirelessly over RF
- Provide connectivity under highly mobile conditions on the ground, water, and in the air
- Provide highly secure (AES256), high data throughput rates (up to 80 Mbs), at long range
- Allow wide selection of Licensed and Unlicensed frequencies (from 400 MHz to 6 GHz including VHF, UHF, 800 MHz, etc.)
- Create mesh networks (self-forming, or managed)
- Support multiple antenna configurations as required; omnidirectional, high-gain directional/hybrid
- Support of GPS positioning

The InterLink Model 500 Radio is the world's first MN-MIMO radio ruggedized for military and public safety applications. MN-MIMO is the breakthrough technology that is ushering in the next generation revolution in commercial wireless data communications and enabling WLANs to support high definition video. The Model 500 uses the best of these commercial technologies while extending and improving the capacity, range and reliability of wireless communications for mission-critical needs in the military, first responder, and industrial markets.

Ease of Use

Each transceiver enables bidirectional networking to simplify logistics. As an IP-Router, the Model 500 can be interfaced with countless third party applications, and a multitude of configurations are accessed via web pages within the radio.

The Model 500 allows for real-time management of all the radios in the network for TX power, frequency, channel bandwidth, link adaptation and other parameters.

Automatic link adaptation changes the radio operating parameters in real-time to provide performance as close to capacity as possible while not losing the link when abrupt changes in channel conditions occur such as moving around a corner or entering a building.

Missions Benefitting from the Model 500

The Model 500 is ideal for missions that require superior communications of voice/video/data in NLOS multipath rich environments. Examples of such missions include:

- Trains to trackside infrasture, stations, and central command and control
- Below deck wireless networking / ship-boarding
- Air-to-air & air-to-ground (manned, or unmanned)
- Urban ops, requiring video links within a building and with units outside the building
- Autonomous convoy
- Aircraft to ground high data rate transfer / comms
- First Responder urban network / relay