PTP 400 and PTP 600 Series

Technology Overview

The Motorola wi4 Fixed Point-to-Point Solutions employ a unique combination of technologies that offers up to 99.999% availability in high-interference, non-line-of-sight and long-distance line-of-sight environments. Such performance is unique in the point-to-point broadband wireless world where 95% availability or less is often the norm.

Solutions Portfolio

Motorola's wi4 Fixed Point-to-Point (PTP) 400 and 600 Series Wireless Ethernet Bridges operate in the 5.4 and 5.8 GHz unlicensed radio frequencies. In addition, the PTP 400 bridges operate in the 4.9 GHz (public safety) licensed frequency while PTP 600 bridges operate in the 2.5 GHz Educational Broadband Service (EBS) licensed frequency. PTP 400 and PTP 600 radios are cost-effective, quick to deploy and easy to manage. Operating at Ethernet data rates up to 300 Mbps, the systems support a wide variety of demanding applications, including:

- Backhaul for point-to-multipoint, WiMAX and mesh networks
- T1/E1 replacement
- Last-mile access and backbone operations
- Migration from an analog to a digital network
- Building-to-building and campus connectivity
- Internet access and distance learning
- Voice-over-IP and video surveillance
- Temporary fixed point-to-point links for emergencies and special events

Award-Winning Technology

Because of their unique technology combination, Motorola's PTP 400 and PTP 600 bridges work where other systems often do not, delivering high-bandwidth and carrier-class reliability in non-line-of-sight (NLoS) environments, across long-distance line-of-sight paths, over water and open terrain, even in extreme weather conditions.

This performance is a result of the powerful combination of award-winning technologies which enable the bridges to overcome the key factors that degrade all radio signals – signal attenuation, fading, dispersion and polarization. First, Motorola adds intelligence to proven technologies like Orthogonal Frequency Division Multiplexing (OFDM), Adaptive Modulation and Dynamic Frequency Selection. Then Motorola combines these technologies with its own breakthrough hardware and software innovations to deliver a high level of capacity, signal quality, spectral efficiency and performance.

MOTOwi4™

Multiple-Input Multiple-Output (MIMO)

Non-line-of-sight (NLoS) environments create all kinds of signal issues. Connections are subject to massive periodic fading, often dropping to 1/10,000th of the already highly attenuated level. Signals are prone to be out-of-phase, because there is no main path, just many indirect paths of similar energy, dramatically raising the risk that signals will cancel each other.

With Motorola's MIMO technology, numerous data streams are transmitted between multiple transmitters and receivers. At the receiving end, all the data streams are compared and evaluated until the data image is accurately restored and sequenced. The result is significantly reduced NLoS fading, providing consistently reliable, high-quality communications in even the toughest environments.

MIMO minimizes signal fading due to path obstructions or atmospheric disturbances.

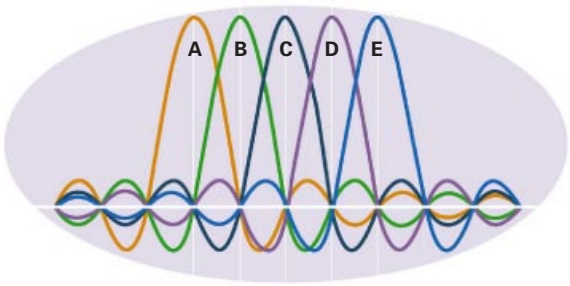
Intelligent Orthogonal Frequency Division Multiplexing (*i*-OFDM)

In NLoS environments, signals arrive by many different (dispersed) paths. The path lengths vary, so the signals also arrive at different times. In addition, the paths have different delay characteristics, causing previously transmitted data bits to interfere with current data bits. This interference is known as multipath inter-symbol-interference or ISI.

Conventional radios resolve the problem using an ISI equalizer. Many NLoS vendors employ some form of OFDM (Orthogonal Frequency Division Multiplexing) to overcome this problem, but none of them add the intelligence that is embedded in Motorola's *intelligent* OFDM.

Motorola's *i*-OFDM separates data into channels which overlap in frequency. Orthogonal to each other, the channels do not interfere with each other, resulting in better spectrum efficiency and higher data throughput. In addition, *i*-OFDM allows the radios to compensate for environmental conditions by applying a uniform phase correction to all channels simultaneously – a correction value that can be modified on the fly in response to external events. Thus, Motorola's *i*-OFDM not only resolves channel dispersion, achieves high spectral efficiency and offers high resistance to frequency-selective fading, but it also offers the following enhancements not available in other products:

- Significantly more pilot tones and sub-carriers
- Instant fade recovery



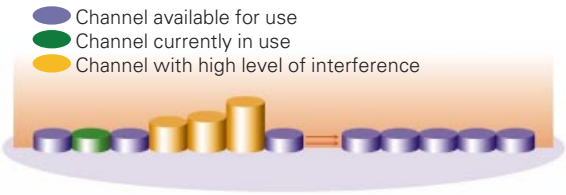
i-OFDM transmits data on multiple frequencies, resulting in higher channel bandwidth and greater resistance to interference and signal fading.

Advanced Spectrum Management with *i*-DFS (*Intelligent* Dynamic Frequency Selection)

Channel frequencies can be set either manually or dynamically. The Motorola PTP 400 and 600 families of wireless bridges monitor all available radio channels – 500 times a second – and dynamically select the frequency over which they can sustain the highest data rate at the best quality. This means that the bridges are very likely to find a clear channel (without operator intervention) even in a crowded space. Our 30-day, time-stamped database alerts the operator to any interference that does exist and provides statistics that help pinpoint the channels that provide the clearest data paths. From the user's point of view, this experience is equivalent to having exclusive rights to use a licensed channel.

In addition to *i*-DFS, Motorola's unique spectrum management capabilities include two other techniques:

- Fixed frequency – the operator presets (locks in) link frequency so that it stays within the best channel known to be available
- Channel tuning – the operator can adjust the center of the channel up or down to optimally fit it into the available spectrum



i-DFS self-selects the frequency over which it can sustain the highest data rate at the highest availability.

Adaptive Modulation

Adaptive Modulation continually optimizes signals according to the conditions of the radio frequency (RF) path, allowing transmissions to travel from one receiver to the next without signal loss. The radio power output is dynamically modified according to the received signal level, upshifting or downshifting to overcome fading. Since the channel may vary in intensity on a sub-second basis, adapting the modulation dynamically allows the maximum amount of data possible to be sent across the path while keeping the link quality at the highest level.

Available modulation modes include 256 QAM, 64 QAM, 16 QAM, QPSK, BPSK, multiple FEC rates, single and dual payload.

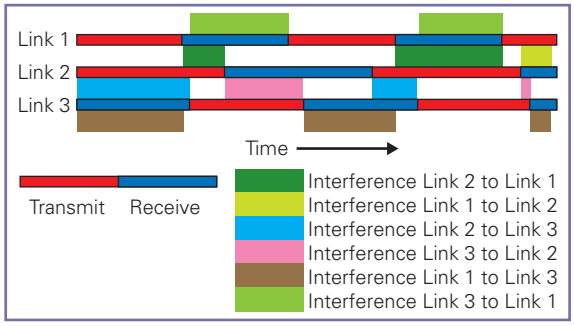
Modulation Scheme	Data Rate (Mbps)	System Gain (dBm)
64 QAM 7/8	42.51	138.1
64 QAM 3/4	36.44	142.3
64 QAM 2/3	32.99	144.4
16 QAM 3/4	24.29	150.4
16 QAM 1/2	16.20	156.2
QPSK 2/3	10.80	160.7
QPSK 1/2	8.10	163.0
BPSK	3.60	168.5

Sample Modulation and Data Rates for Motorola PTP 58400 and PTP 54400 Bridges

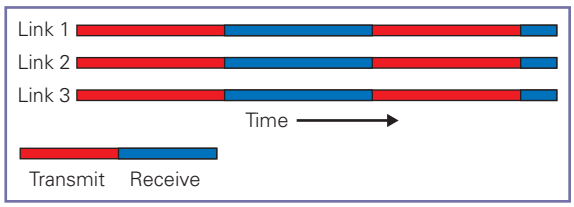
Time Division Duplexing (TDD) Synchronization

Multiple radios that are located in close proximity to each other – typically on the same tower or rooftop – can generate significant amounts of interference as the radios send and receive data. As an example, if radio-1 is transmitting when radio-2 is receiving, radio-2's incoming transmission can be interfered with even if the transmissions are on different frequency channels. Because radio-1's signal is so close, it is strong enough to "flood" or interfere with the communications flowing to radio-2.

To eliminate such interference, it is important that all the radios on the tower or rooftop transmit at the same time and receive at the same time. On PTP 600 Series bridges, Motorola's TDD Synchronization capability times and synchronizes transmit and receive signals, enabling efficient frequency reuse. This allows network operators to co-locate multiple radios on a rooftop or tower without the radios interfering with each other. The TDD Synchronization is accomplished using an external GPS Synchronization Unit that ties all radios in the designated network to the same "clock."



Before TDD Synchronization



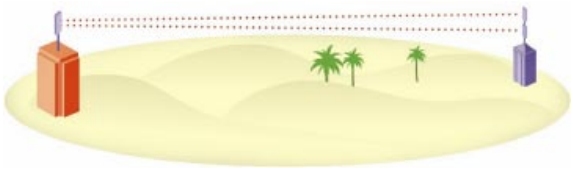
After TDD Synchronization

Spatial Diversity

The PTP 400 and PTP 600 families of point-to-point radios have inherent spatial diversity capability to combat ducting and multipath fading, allowing communications to travel over water, across vast expanses of open terrain and in deep non-line-of-sight environments without signal loss.

As radio waves travel across distances, especially over water and flat terrain, they run an increased risk of multipath interference caused by signals reflecting off the water, desert or flat plain. This interference can cause the signals to cancel each other as they travel to the receiver from various directions over multiple paths. In addition, signals can experience ducting as they move through air masses of different densities, which deflect the signals away from the receiving antenna, often cutting communication between radios.

In these situations, vertically separated antennas can be deployed at one or both ends of the link, sending two radio paths to the receiver that don't experience reflection and ducting at the same time. By optimally combining the separate transmissions, Motorola eliminates signal cancellation and maximizes the signal received in each direction.

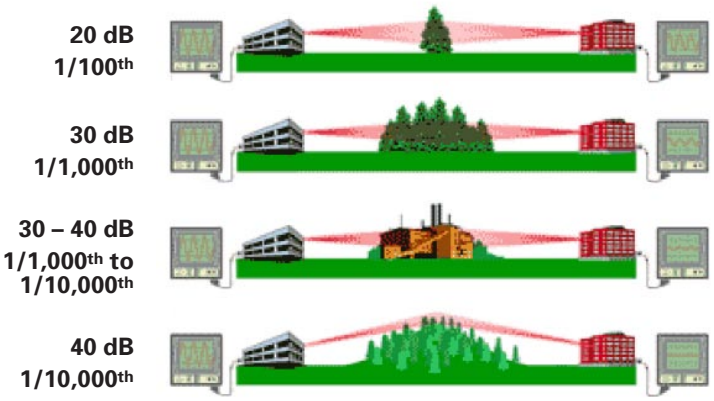


Spatial diversity combats ducting and multipath fading via vertically-separated antennas at one or both ends of a link.

Best-in-Class Radios*

Signal attenuation occurs when natural or man-made obstacles in the path reduce the signal. Typical NLoS environments can reduce a signal to 1/10,000th of a normal LoS signal, because the signals are forced to arrive by diffraction around an object or reflection off objects that surround the obstruction, or by penetrating the obstruction – all of which substantially weaken the signal.

Motorola's best-in-class radios maximize the system gain to effectively overcome attenuation. By pairing a high-output transmitter with an ultra-sensitive receiver, the radios can achieve a system gain of up to 167 dB using 23 dBi integrated antennas.



Radios maximize system gain

* The Motorola PTP 58600 (formerly Orthogon Systems OS-Spectra) is the winner of the Network Computing 2006 "Well-Connected" Award and the Network Computing 2005 Editor's Choice Award.

Applications

The Motorola PTP 400 and PTP 600 families of point-to-point wireless bridges are enabling wireless service providers to extend broadband to remote areas and backhaul traffic efficiently and are connecting disparate networks in a wide variety of markets including corporate enterprises, government, education, healthcare, utilities and transportation. Enterprises and service providers alike find that Motorola's point-to-point wireless systems handle a wide variety of communication challenges when they need to:

- Deliver fast, reliable and highly-available data streams for networked applications
- Transmit data reliably over obstructed paths, across expanses of open terrain or water, or in areas with significant interference
- Backhaul more local loops using a single link
- Backhaul traffic from Motorola Point-to-Multipoint and Mesh networks
- Support bandwidth-intensive IP voice, video and data applications
- Combine T1/E1 and Ethernet ports in a single radio
- Implement a WiMAX-compatible backhaul solution
- Add capacity and redundancy to 6 GHz networks

Wherever point-to-point wireless is a candidate for Ethernet connectivity, the PTP 400 and PTP 600 Series solutions are a good fit, delivering faster data streams, more reliable connections and higher availability than comparable systems.

MOTOwi4™

The PTP 400 and PTP 600 bridges are included in Motorola's MOTOwi4 portfolio of innovative wireless broadband solutions that create, complement and complete IP networks. Delivering IP coverage to virtually all spaces, the MOTOwi4 portfolio includes Fixed Broadband, WiMAX, Mesh, and Broadband-over-Powerline solutions for private and public networks.

Additional Information

For more information on Motorola's point-to-point bridges, refer to the PTP 400 and PTP 600 Series Brochures and Technical Specifications.

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