BridgeWave

BridgeWave AdaptRate™ Solutions

White Paper

WHY ADAPTRATE?

It is a law of physics that rain downpours attenuate RF signals by scattering energy off of the desired path. This is especially true for radios with operating frequencies of over 10GHz, where most high-capacity point-to-point links operate. To deploy reliable high-frequency radio links, it is necessary to provision the links with enough RF link margin to prevent outages during periods of severe rainfall. Traditionally, for a given path distance and a required level of link availability, the only tools available were antenna size and link data capacity. Larger antennas increase link budget by better focusing energy between the two link end points, but increase link installation cost and time, as well as providing poorer link esthetics. Reducing data capacity improves link budget by using narrower frequency channels and/or allowing for the use of lower-order modulation, but typically results in reduced application performance. For longer required link distances, there are sometimes no acceptable choices for antenna size and data capacity, without accepting frequent cloudburst outages.

Some lower-frequency link products offer adaptive modulation solutions that allow the links to dynamically switch from high-order modulation (e.g. 64-1024QAM) to lower-order modulation (e.g. QPSK, BPSK, or BFSK), to improve the link budget at the expense of data rate. These approaches are suitable for lower-frequency products where the use of higher-order modulation is an effective means to utilize the limited available spectrum allocations.

In the 50-100GHz frequency range, the permanent use of lower-order modulation is ideal – the large spectrum allocations and “pencil beam” antenna beamwidths make the use of narrow RF channels unnecessary. By utilizing lower-order modulation, transmit amplifiers can be run near their maximum power ratings and radios are able to accept much weaker RF receive signal levels. These factors keep link costs down without sacrificing link performance. Since these links normally use low-order modulation, this limits the use of adaptive modulation as a tool to significantly improve link budgets.

BridgeWave's AdaptRate technology overcomes this limitation, providing temporary increases in link budget (when needed) by reducing over-the-air signal bandwidth, rather than by changing modulation order. Reducing the air signal bandwidth by a factor of ten (e.g. from 1.4GHz to 140MHz) reduces the amount of background noise that the received RF signal must exceed by a factor of ten (or 10dB). This 10dB noise reduction provides 10dB of additional rain fade link budget, an amount sufficient to materially improve link availability in the presence of strong rain fades.

ADAPTRATE AND THE RADIO AIR INTERFACE

BridgeWave AdaptRate links normally run at full-rate, full-duplex GigE speeds. However, when heavy rainfall hits, they shift on the fly to an over-the-air 100 Mbps data rate, providing 10dB more rain fade budget. This happens automatically, with less than a 50-millisecond interruption of service. When the rain fade subsides, the links automatically shift back to full GigE speed. The result is that AdaptRate links remains connected at the maximum error-free data rate. The switch from GigE to 100 Mbps occurs when the radio's RF Receive Signal Level (RSL) drops to approach the minimum needed for the link to operate error-free at full GigE data rates. As the rain-fade subsides and the RSL increases well beyond the minimum needed for error-free GigE operation, the link switches back to full GigE operation.

AdaptRate technology makes it possible to install full-rate GigE links over distances that traditionally would only reliably support 100 Mbps data rates. For example, suppose you need to provision a one-kilometer 60GHz link in Miami (the heaviest rain region in the U.S.) that requires a tough 99.99% link availability – less than one hour/year of rain outage. Before BridgeWave's AdaptRate capability, you could have only achieved this level of availability using a 100 Mbps link. Using an AdaptRate link, you can achieve the required 99.99% total link availability, running 99.9% of the time at a full GigE rate and 0.09% of the time at 100 Mbps.

For another example, consider an 80GHz GigE link with a one-foot antenna in Los Angeles, which normally provides 99.99% availability at distances of up to 2.4 miles. A comparable 99.99% available AdaptRate link can operate at 3.6 miles – a 50% increase in link distance without requiring the use of larger antennas.

ADAPTRATE AND THE APPLICATION INTERFACES

In the presence of a strong rain fade, AdaptRate links reduce their RF air interface bandwidth and data rate, but do not make any corresponding changes to their fiber or copper (wired) interfaces – the fiber interface always operates at full GigE data rates and the copper interface always operates at 10/100 Mbps data rates, regardless of the air interface speed. There is no immediate impact on wired interface traffic, since the radio's internal Ethernet switch buffers inbound and outbound traffic between the wired and air interfaces. TCP/IP traffic entering the radio through the wired interfaces will naturally slow (if needed) in response to delays in peer acknowledgements and/or momentary packet losses due to short-term traffic congestion. If the radio's fiber port is configured for auto-negotiation (the default – with flow control enabled) and the fiber traffic inbound to the radio exceeds 100Mbps, then the radio will send the user's network equipment an Ethernet pause request to prevent data overflow within the radio unit. This allows the user's network equipment to provide backpressure through the network and to prioritize the flow of traffic to the radio.

When the traffic sent through the link contains both high-priority (e.g. VoIP) and lower-priority (e.g. web browsing) packets, and the user's network equipment is configured to prioritize the high-priority packets, then the net result is that the high-priority packets will continue to flow without impact (assuming that this traffic is less than 100 Mbps), while the lower-priority traffic will throttle back to accommodate the reduced air bandwidth. This makes AdaptRate suitable even for demanding application environments such as mobile backhaul, where high-value voice traffic typically consumes much less total bandwidth than general user data traffic.

ADAPTRATE PRODUCTS

BridgeWave's AdaptRate GigE wireless links offer a cost-effective means to finesse the traditional laws of millimeter-wave link deployment, providing highly available links at extended distances without sacrificing link data capacity. BridgeWave is the only manufacturer of GigE links offering the AdaptRate capability, available as an option for all products operating either in the license-free 60GHz band or in the "lightly licensed" 80GHz band. Contact BridgeWave or an authorized BridgeWave reseller for more information.

BridgeWave

BridgeWave Communications, Inc.
3350 Thomas Road, Santa Clara, CA 95054
Ph: 866-577-6908 | Fax: 408 567-0775

www.bridgewave.com

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