

# Microwave Adaptive Bandwidth Feature: Make Better Use of Available Bandwidth



## What You Will Learn

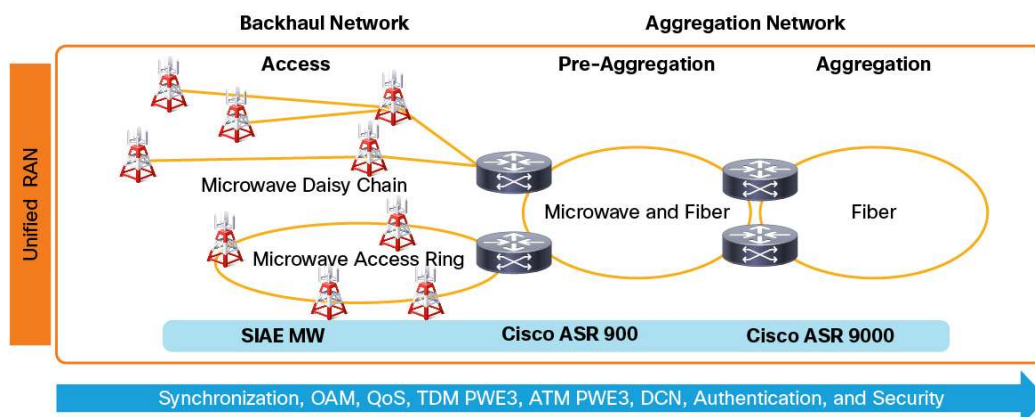
With the advent of small cells and increasing use of data devices in mobile networks, many operators now seek to optimize their microwave infrastructure to address these new challenges in the radio access network (RAN).

Cisco and SIAE MICROELETTRONICA developed the Microwave Adaptive Bandwidth (MAB) feature to provide reliable quality of service (QoS) management and optimized performance for both ring-based and non-ring-based topologies, even under worst-case radio propagation conditions. Although the MAB feature is generic, this document describes it with specific application to mobile backhaul network architectures.

## Introduction

Traditional time-division multiplexing (TDM) allowed mobile operators to deploy stable networks with well-defined deterministic traffic flows and fixed bandwidth circuits. Although ideal for voice traffic, this model cannot support the recent rapid growth in data traffic. Packet networks, the only solution to this problem, are characterized by QoS-based traffic flows and variable bandwidth circuits. This shift requires a unified RAN environment and new features to integrate different network elements (Figure 1).

**Figure 1.** Unified RAN



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With the advent of small cells and cloud RAN (CRAN) models in mobile networks, many operators want to reuse their installed microwave infrastructure to address new challenges and opportunities. In many mobile networks, microwave equipment is a very significant portion of the backhaul network, at times representing a large majority of base station interconnections. Operators are looking for high-capacity solutions to address the increased capacity requirements of data traffic from small cell long term evolution (LTE) deployments and fiber extension connectivity.

The migration of data networks, coupled with data growth caused by densely deployed base stations with small cell deployments, promotes the use of ring architectures to provide better network protection. Until now, microwave ring architectures were implemented with fixed microwave modulation schemes, because ring protocols are not designed to react to dynamic bandwidth changes. In traditional fixed modulation schemes, any degradation in wave propagation (for example, due to adverse weather conditions such as heavy fog or rain) led to a complete loss of signal and a disruption of traffic. Using fixed modulation, the microwave radio link was either “available” (on) or “unavailable” (off).

More advanced microwave radios can use adaptive modulation schemes. The radio changes its modulation to a more robust scheme when the microwave link degrades due to adverse weather conditions (in this case, bandwidth is also reduced). The radio continues to transmit, maintaining connectivity, and forwards traffic in proportion to the adopted modulation scheme. As a result, the radio link can be in several capacity or bandwidth states, not just on or off.

In an Ethernet ring, capacity degradation can affect one part of the ring, while the rest remains unaffected. If congestion occurs, the microwave radio frequently uses QoS to prioritize the Ethernet traffic with higher importance, helping ensure that those packets get a fixed amount of the available bandwidth.

Traffic shaping is required in the packet transport network to optimize bandwidth and avoid traffic overflow resulting from bursty LTE traffic. Unlike ring topologies, other topologies (chain, star, tree, and so on) do not have alternate paths for forwarding traffic when adverse conditions occur in one part of the network. Traffic shaping and QoS are widely used to manage traffic flows. In these cases, changes in microwave modulation must be reported to upstream Ethernet switches or routers, which in turn must adapt traffic shaping and forwarding rules to the new network conditions.

Cisco and SIAE MICROELETTRONICA have developed a generalized MAB feature to provide reliable QoS management and optimized performance, even under worst-case radio propagation conditions, for both ring-based and non-ring-based topologies. This solution is generic, although the following description highlights its applicability to mobile backhaul networks.

### Cisco and SIAE MICROELETTRONICA Solution

The joint solution addresses the consequences of microwave variable bandwidth techniques, in relation to traffic shaping and QoS configuration in networking equipment and dynamic ring topology reconfiguration. The solution allows operators to take advantage of the maximum available air bandwidth under any atmospheric conditions, because they can deploy ring topology or non-ring topology backhaul networks in the RAN, while cooperating with adaptive modulation radios.

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The MAB feature is based on IEEE 802.1ag Connectivity Fault Management (CFM) and ITU-T Y.1731 protocols, and it uses Cisco IOS® Embedded Event Manager (EEM), a powerful and flexible subsystem that provides real-time network event detection to trigger traffic changes. A CFM vendor-specific message (VSM) has been defined to communicate between SIAE MICROELETTRONICA microwave radios and Cisco® switches and routers.

When the microwave radio detects signal degradation, the radio triggers a modulation change, notifies the adjacent Cisco equipment using specially designed VSMS, and periodically sends updates until the standard maximum bandwidth is restored. The switch receives these VSMS from the microwave radio port and notifies the Cisco IOS EEM subsystem of a signal degradation event.

The subsystem checks new available bandwidth values from the signal degradation event information against configured thresholds. If the new value crosses a defined threshold, traffic forwarding is managed according to the topology (ring) or hierarchical QoS (HQoS) shaping application. If a complete link failure causes a loss of microwave signal, a signal failure event is signaled. Signal failure events take priority over signal degradation events.

### Ring Topology Application

The MAB feature developed by Cisco and SIAE MICROELETTRONICA allows operators to benefit from adaptive modulation, even in a ring topology (Figure 2). The feature extends the capabilities of the G.8032 Ethernet Ring Protection Switching (ERPS) mechanism and Ethernet CFM to achieve this benefit.

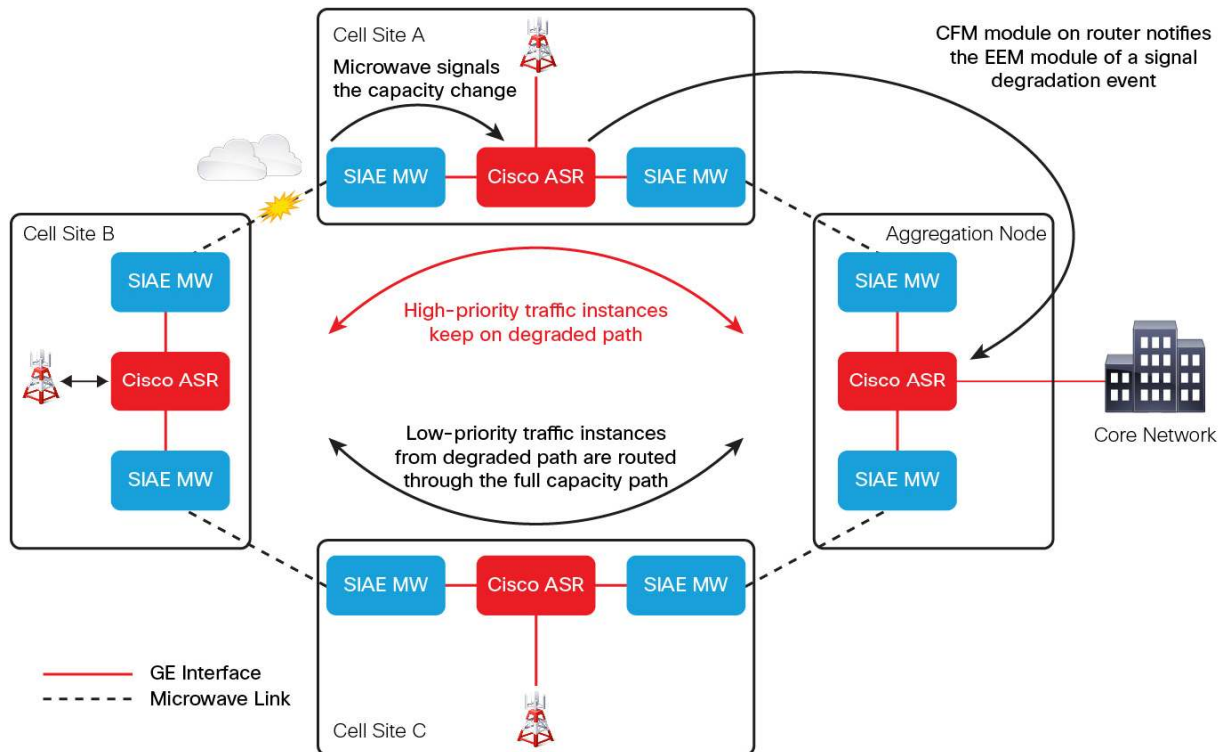
Microwave links are often deployed in redundant ring topologies that use ERPS techniques based on ITU-T G.8032. Typically, adaptive modulation is not activated in these deployments, because capacity variation within a ring was not foreseen by protocols such as ERPS. Nevertheless, using adaptive modulation can bring tremendous advantages, by allowing operators to couple protection with full use of the available bandwidth.

For microwave links with adaptive modulation, the normal operation, administration, and maintenance (OAM) protocols used by ring protection protocols cannot make the best use of the available bandwidth for the following reasons:

- If the OAM protocol used for failure detection is tagged as high-priority traffic, frames bypass degraded (congested) microwave links, and no protection switching is triggered.
- If the OAM protocol used for failure detection is tagged as low-priority traffic, then momentary congestion over the native Ethernet links could lead to loss of continuity and spurious protection switching.

In general, the network topology must be provisioned with enough redundant bandwidth to handle a complete failure. In certain situations, however, when the service committed information rate (CIR) is very low, forwarding as much traffic above the CIR as possible still represents an important value. Treating bandwidth degradation as a complete failure is not desirable.

**Figure 2.** Ring Topology



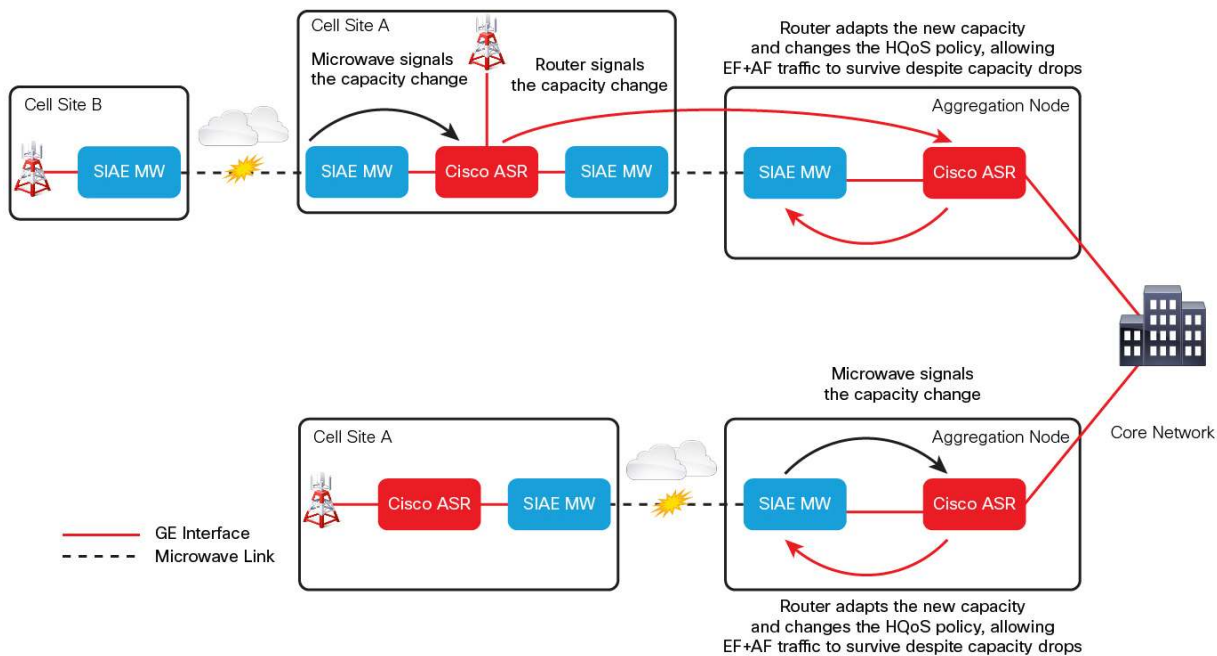
As bandwidth capacity changes because of switching to a different modulation scheme, the MAB feature triggers a CFM notification to the Cisco Ethernet switches within the ring. This allows the switches to optimize the traffic-forwarding rules of the affected traffic. Instead of reconfiguring the ring to switch all traffic to an alternate path, the MAB feature selects a more efficient ring configuration that increases traffic throughput. A complete rerouting of traffic occurs only if the switches detect a complete loss of continuity, for example, through the complete absence of connectivity connection messages (CCMs) from CFM.

With the MAB feature, G.8032 ERPS mechanisms can be used as a control mechanism in response to bandwidth degradation (such as an SD indicator) on microwave links. Ethernet CFM interacts with the microwave system to continuously monitor the quality and bandwidth of the microwave link. When microwave link degradation is detected, CFM notifies the Cisco IOS EEM facility on the Cisco switch to invoke G.8032 ERPS mechanisms. Based on service-level agreement (SLA) information and configured thresholds, some ERPS instances can be switched to an alternate path (for example, when the instances are based on VLAN), while other ring instances carrying high-priority traffic may still be switched through the degraded microwave link.

### HQoS Traffic Shaping Application

The adaptive modulation of SIAE MICROELETTRONICA microwave radios can be used to help ensure that high-priority Ethernet traffic continues to pass through a degraded link, even under the worst weather conditions. When SIAE MICROELETTRONICA microwave links and Cisco switches are in daisy-chain or star topologies, the MAB feature dynamically controls HQoS class-based traffic shaping (Figure 3).

**Figure 3. HQoS Traffic Shaping**



As in the ring topology, Ethernet CFM continuously monitors the quality and bandwidth of the microwave link. When bandwidth capacity changes due to changes in the modulation scheme, Ethernet OAM triggers a CFM notification to the Cisco switches, so they can optimize traffic-forwarding rules for the affected traffic flow. However, in this case, instead of changing the ERPS ring configuration, Ethernet CFM modifies HQoS traffic-shaping rules to dynamically increase high-value traffic throughput across the degraded link.

This mechanism is achieved with the following steps:

- The operator specifies a rate for traffic shaping, on the Cisco router, that avoids bottlenecks and packet loss on the SIAE MICROELETTRONICA microwave links during normal operation.
- Traffic shaping is configured in a hierarchical policy map structure to help ensure that a packet acts according to a stipulated contract, based on available bandwidth. The structure includes primary (parent) and secondary (child) policy maps.
- The Cisco switch or router is also configured with alternative traffic-shaping rules that are appropriately tuned for circumstances in which microwave links run in a degraded or constrained state.
- The alternative traffic-shaping rules are defined to improve the value and use of newly determined available resources. This means that microwave equipment will be presented only with high-value traffic and with only the amount of traffic that can be handled without dropping.
- As bandwidth changes on microwave links, the SIAE MICROELETTRONICA radio will use a CFM message to initiate a signal degradation event in the Cisco IOS EEM facility on the Cisco switch, which then reconfigures HQoS to switch to alternate traffic-shaping rules.

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## Conclusion

Operators have invested substantial resources in building robust and highly capable RAN backhaul networks based on microwave radio. Additionally, SIAE MICROELETTRONICA has substantial experience in designing and delivering sophisticated adaptive modulation techniques that significantly improve use of available bandwidth and capabilities under adverse conditions. What has been missing, until now, is the ability to apply new intelligence in backhaul applications.

With the MAB feature developed by Cisco and SIAE MICROELETTRONICA, operators can use adaptive modulation to optimize the use of available resources, so that subscribers experience improved service under challenging conditions. The MAB feature allows high-priority, high-value traffic to be forwarded under conditions that would normally lead to service outages and promotes much more intelligent use of available resources.

## For More Information

<https://www.siaemic.com/index.php/applications/mobile-backhaul/28-applications/238-ip-multi-vendor-environment>




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