Smarten Your Backhaul Network with Automatic Adaptive Modulation

DragonWave

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How to Increase Network Capacity While Reducing CAPEX & OPEX

Wireless operators are faced with the ongoing challenge of reducing their operating costs while scaling to meet the rapidly growing bandwidth demands of their customers. As a result, it has often become necessary to make tradeoffs between network availability and CAPEX/OPEX.

Fortunately, a technique called Automatic Adaptive Modulation (AAM) provides service providers with a solution that enables higher capacity microwave backhaul links, and an overall improvement in network economics.

This white paper will present an overview of AAM followed by an examination of the drivers of AAM adoption, principal benefits to the wireless operator, and factors affecting adoption.

What is Automatic Adaptive Modulation?

Automatic Adaptive Modulation is a key technology for both existing and emerging 4G operators.

AAM is essentially a software enabled feature which allows the modulation scheme to fluctuate from its defined operating mode, shifting to a lower modulation when weather conditions cause signal levels to deteriorate below acceptable levels. This allows the radio link to remain functionally active, albeit at a lower modulation rate and lower throughput level. The modulation scheme is then returned to the original scheme, and the throughput returned to normal, once the link operates above an acceptable level (i.e. 2dB above RSL threshold of the higher modulation). On average, fade events requiring a modulation shift only take place a couple times per month, lasting around 15 minutes per occurrence.

For example, 256 QAM modulation and cross-polarization provide for high capacity, but they do so at a reduced link budget. Mobile networks generally have strict service level agreements (SLAs), requiring link availability of 99.995% - 99.999%, so there is no room for compromises. During rain fade, the link will therefore switch to an intermediate modulation, providing additional system gain at a reduced throughput. If there is a heavier rain fade, the system will shift to the lowest modulation, providing even more system gain improvement.

AAM can provide up to 30 dB system gain improvement when switching from the highest modulation to the lowest modulation. A link that is engineered for 400 Mbps at 99.99% availability can deliver greater than 99.999% at 110 Mbps with AAM. When the link shifts to the lower modulation, the highest priority traffic is expedited by priority queuing, allowing the operator to guarantee high value services such as voice, while still providing 400 Mbps for 99.99% of the time. A figure illustrating AAM is shown in figure 1 below.

A network with AAM will typically only shift down from its highest link capacity or modulation scheme for a few hours per year.

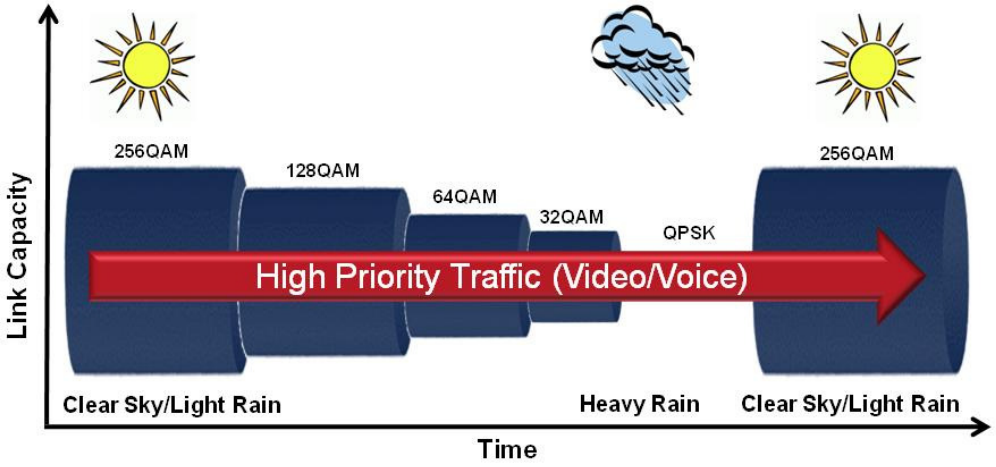


Figure 1: Automatic Adaptive Modulation (AAM) Operations

Operator Benefits

Whether boosting the performance of an existing deployment or rolling out a greenfield network, AAM is a valuable tool for wireless operators. The unique advantages of AAM include the following:

- ***Scaling existing networks:*** Established operators, with existing network and frequency licenses can use AAM to get much more throughput from their current channels without compromising their high SLA traffic. A 28 MHz channel may have only been engineered to 16 QAM with about 80 mbps throughput. With AAM, this same link could now run at 256 QAM during regular operation, resulting in speeds closer to 200 mbps.

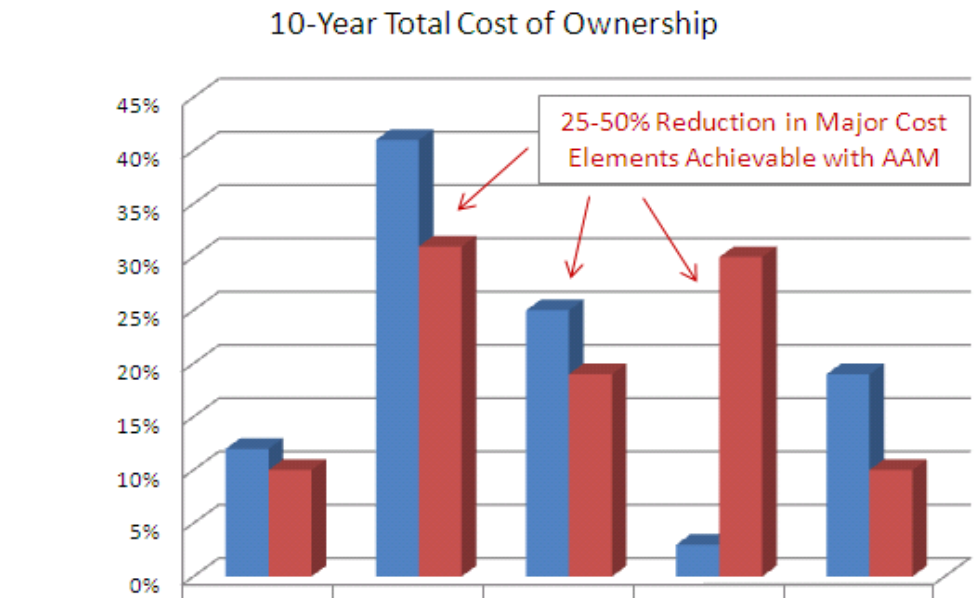
- ***Efficient spectrum utilization:*** The greater spectral efficiency of the higher modulation schemes employed with AAM mean that spectrum usage is optimized, resulting in a reduction in annual frequency costs. This is particularly attractive outside the US, where spectrum costs represent a large portion of operator expenses.

- ***Lower antenna and tower leasing costs:*** The flexibility of AAM allows operators to minimize antenna sizes while maintaining high transport capacities. Other than the obvious savings on the reduced antenna cost, the considerable ongoing tower leasing and installation costs are also greatly reduced.

- ***Increased link spans:*** The added throughput resulting from the implementation of AAM also means that operators have the ability to increase link spans thereby reducing the number of hops in their network. This has the potential to greatly decrease both the operating and capital costs of their microwave backhaul network.

The dramatic capacity increases made possible by AAM are often viewed as a primary driver for adoption. Equally significant are the cost reductions achieved in virtually all of the major cost of ownership components of the operator's backhaul network (as shown in figure 2 below).

AAM can reduce spectrum, leasing, equipment, and installation costs, which all account for a significant portion of service provider expenditures.



	Capital Cost	Antenna Lease	Site Lease	Backhaul Spectrum	Installation & Maintenance
North America	12%	41%	25%	3%	19%
Western Europe	10%	31%	19%	30%	10%

Figure 2: 10 Year Cost of Ownership Components in North America and Western Europe

Factors Impacting Adoption

There are clearly considerable benefits to AAM. However, there are a few hurdles and deployment challenges operators must consider prior to adopting this technology.

Firstly, AAM requires an Ethernet core, since any partial loss of a TDM circuit would result in a loss of the entire circuit, meaning that the complete capacity is required at all times.

The second important issue is around regulatory constraints. While many regulators, such as the FCC in the United States, allow adaptive modulation today, several European regulators are still evaluating the technology and the rules under which they will permit deployment. In addition, European regulators generally have restrictions on modulation states and the ability to increase transmit power during modulation. These operating modes are however permitted in the United States.

"As converged networks are deployed, operators will be incented to adopt adaptive modulation in order to reuse existing investments, such as antennas and licensed spectrum."

- *Greg Friesen Director of Product Management at DragonWave*

Another consideration is the operator and network type. An operator building a new Ethernet-only network optimized for next generation services such as LTE or WiMAX will see significant and immediate advantages to AAM. Maximized network capacity with reduced antenna size, spectrum requirements, installation and tower leasing costs would all be achievable from day one. Existing operators with TDM networks are more likely to delay until they have deployed a converged Ethernet/TDM network.

The Horizon Advantage

In addition to offering market leading throughput, DragonWave's Horizon solutions offer significant AAM advantages:

- ***Automatic adaptive coding:*** Horizon systems automatically adjust the coding rate depending on operating conditions in order to ensure an optimal ratio of error correction payload bits.

- ***Adaptive transmit power:*** By varying the amount of transmit power at different modulation schemes, DragonWave's solutions can generate up to an 8 dB link improvement, reducing the number of modulation shifts required to maintain higher throughput levels. Transmit power can also be locked for those regions where regulatory bodies do not permit its use.

- ***Intermediate modulation shifts:*** As operating conditions fluctuate, so do Horizon's modulation schemes, taking intermediate steps between 256 QAM, 128 QAM, 64 QAM, 32 QAM and QPSK as required.

- ***Service transparency:*** Horizon solutions have sub 20 ms switch times, resulting in modulation that is completely transparent to voice and TCP/IP connections. In addition, the system hardware supports hitless capability via software upgrade.

- ***Full traffic prioritization:*** Priority queuing ensures that high priority traffic is always treated as such, regardless of modulation shifts or system operating mode.

DragonWave's unique advantages put it at the forefront of AAM technology.

Summary

Rapid increases in packet based traffic are driving the need for higher capacity mobile backhaul networks. Rather than taking a brute force approach to meeting this demand, operators are making their networks smarter by deploying techniques such as AAM. While there remain some regulatory and deployment hurdles, the many cost and performance benefits make AAM a very attractive option for both existing and greenfield operators.

By deploying microwave backhaul networks with AAM, such as DragonWave's Horizon solution, wireless operators will greatly benefit from a spectrally efficient, scalable and cost reduced solution to meet the needs of tomorrow's mobile networks.