With the advent of newer data services and increase in usage of smart phones, there is an increased demand for data traffic. This puts wireless backhaul operators in catch up mode. To service this increased demand, it becomes critical for operators to maximize spectrum usage and increase capacity for wireless backhaul networks.

This paper explains how Shyam’s RM Series radio solutions can help you maximize operational efficiency of your wireless backhaul network through Adaptive Coding and Modulation (ACM).
INTRODUCTION

Traditionally, licensed and unlicensed radios supported only Fixed Modulation Mode, where the modulation mode was decided at link planning and installation phase (assuming maximum fading). In case more fading took place, the link would go down, thus impacting overall link efficiency.

Adaptive Coding & Modulation (ACM) improves operational efficiency and reduces impacts due to changes in environmental conditions. Operational efficiency of wireless links is improved by increasing network capacity over the existing infrastructure. Impact of changes in environmental conditions are mitigated by monitoring the link conditions and changing coding and modulation scheme as soon as link conditions change. ACM refers to the automatic adjustment that a wireless system can make in order to optimize over-the-air transmission and prevent weather-related fading from causing communication on the link to be disrupted. This capability can provide significant savings in both CAPEX and OPEX.

For illustration, let's take the case of a 10 km link operating at 5.8 GHz with 20 dBm txpower and 24 dBm antenna gain. According to link budget calculations, expected received signal level for the link is -61 dB. With fading margin of 12 dbm, link in Fixed Modulation mode will be configured to operate at 16QAM. In good link conditions and with ACM algorithm, the system automatically moves to higher modulation (i.e 64QAM) and will give higher throughput. This higher throughput can be used to carry additional low priority data traffic.

HIGHLIGHTS

- In 2011, Shyam introduced its MIMO based wireless backhaul solution which features advanced ACM technique to enable operators to simplify network planning and help operators to achieve better operational efficiency.
- Enables planning for higher capacity along with availability.
- Improved spectrum efficiency: In good conditions, due to lower fading and lower loss, link operates at higher modulations, thereby providing higher spectrum efficiency.
- Improved Link Efficiency: By shifting link to lower modulation and coding, resulting improvement in RSL and extra fade margin helps in higher link availability.

SHYAM’S APPROACH TO ACM

- Hitless and errorless: No bit errors or suspension of traffic during change of modulation.
- Support for 16 different modulation & coding schemes.
- Fast shifting: Quick shifts to cope with up to 10 dB/sec fading.
- Flexible control: user defines minimum MCS and guaranteed bandwidth requirements. Alarm is raised if guaranteed bandwidth requirements are not met.
- Different modulation rates for uplink and downlink.
HIGHER REVENUE - ENABLE NEW SERVICES IN EXISTING LINKS

ACM enables introduction of new services in existing backhaul links by taking advantage of extra margin built into link design to ensure higher availability. In today’s networks, data generates significantly more traffic than voice and unlike real-time services, such as voice or video, most data applications do not require stringent high availability.

In voice only networks, operators have generally had to do a tradeoff between availability and capacity. If availability was important, low capacity was used. If high capacity was used, it impacted availability. With the advent of ACM, networks planners can plan for higher capacity along with availability.

MULTIPLEXING DATA WITH VOICE

In wireless backhaul links deployed only for voice/E1 services - the use of ACM is less relevant. However, additional capacity requirement is mainly for data and hence there is a need to optimize cost-per-bit. Assigning different availability classes to different types of service over a single radio link allows more efficient planning of link capacity for best case scenario rather than for the worst case as it is done today.

Voice and real-time video applications will continue to be assigned higher availability, while non-real-time data packets can be reduced to lower availability with little or no sacrifice to user experience. By using ACM to drop some of the data under fading conditions and allow the constant flow of high priority bits at all times, the overall radio capacity can be maximized at no extra cost.

A quality of service awareness mechanism ensures that high priority voice and data packets are never “dropped”, thus maintaining even the most stringent service level agreements (SLAs).

SHYAM’S ADAPTIVE CODING AND MODULATION

User bit rate in the link is dependent on two main factors i.e. modulation rate and forward error correction. Modulation scheme dictates the number of bits that are carried by each transmitted symbol e.g. QPSK carries 2 bits/symbol, 16QAM carries 4 bits/symbol and so on. FEC is a technique used for controlling errors in transmission, wherein the sender encodes the messages in a redundant way by using error correcting code. The redundancy enables the receiver to correct a limited number of errors without re-transmission.

The ACM algorithm adjusts both these factors on the basis of current ongoing link conditions. The solution uses lower forward error correction code and higher modulation rate under good link conditions, thus giving more throughput. As soon as the system detects errors over the link, it automatically moves to stronger FEC and lower modulation rate. Change in FEC and Modulation happens dynamically thus making it possible to design MW radio link with satisfactory capacity and practically makes it “Hitless”.
Shyam’s wireless radios are built around the “Hitless” concept i.e. E1 traffic is considered as highest priority traffic and is given a preferential treatment in the wireless link. Dynamic change of coding and modulation is “Hitless” – this means that the change in modulation occurs with no errors and no loss of Synchronization (in case of E1 traffic) and ensures that TCP/IP sessions do not time-out.

The ACM algorithm maintains a hysteresis of information and keeps on collecting Error Rate at different modulation and coding rate. This is done to prevent too many dynamic changes of coding and modulation.

The system is capable of operating at different coding and modulation rates in uplink and downlink. Any shift in modulation and coding rate is unidirectional i.e. if conditions change in one direction—say uplink—then only uplink modulation and coding rate will be changed.

The adaptation algorithms react to channel conditions by adapting the operating point of the link with the goal of achieving the maximum possible rate for the conditions. The degree of freedom such algorithms exercise is the choice of the modulation and coding (MCS) scheme to be used for a given transmission. The highest order modulation that can satisfy a desired signal to interference and noise ratio (SINR) is chosen given the channel conditions.

In ACM the algorithm also implements adaptive multi-rate retry mechanism. The system sends multiple RF packets to the remote end in one transmission. Experiments have shown that in case of bad link conditions, some RF packets don’t reach the remote end. The system keeps track of the dropped RF packets and only retransmits the ones that have not been transmitted successfully. This ensures that there will be less amount of data to be retransmitted, so retransmission is done at lowest possible modulation scheme to enhance the chances of delivery.

The hitless ACM, working in tandem with QoS packet prioritization, provides significant link reliability improvements for critical services over traditional fixed modulation products.
ABOUT SHYAM NETWORKS
(A DIVISION OF VNL)

Shyam Networks provides state-of-the-art networking and security solutions for diverse corporate enterprises, governments, educational institutions, offices and residences. From high end enterprise network solutions and wireless broadband connectivity to simple broadband access for homes, we ensure speed, capacity and range for both outdoor and indoor applications. We understand your networking needs as they evolve in a dynamic environment and manage them with cost effective, innovative answers.

Shyam Networks offers end-to-end solutions for homeland security, industrial security, and mission critical, sensitive sectors. We also offer a range of products that bring you an enhanced internet experience, in dense urban locations or remote rural areas where power and infrastructure are unreliable. Shyam Networks has networking solutions to connect subscribers in even the most challenging environments.

CONTACT US
21-22, Phase IV, Udyog Vihar,
Gurgaon 122015
Haryana, India
Phone: +91 124 395 9200-04
Fax: +91 124 395 9205
Email: sales@shyamnetworks.com

http://www.shyamnetworks.com

Shyam Networks assumes no responsibility for any inaccuracies in this document. Shyam Networks reserves the right to revise this document without notice.