Briefing on Adaptive Coding and Modulation (ACM)

September 2010

ACM, Adaptive Coding and Modulation, has the potential to improve the availability of your satellite links and also deliver significant bandwidth savings.

What is 'ACM'?

Adaptive Coding and Modulation is a technology which can automatically change the modulation and forward error correction or FEC of a link (referred to as MODCOD) to compensate for changes in link conditions – commonly weather induced (e.g. rain fade) but also due to changes in the RF environment (e.g. level changes, interference).

The use of ACM makes it unnecessary for service operators and system designers to trade off desired link availability and throughput. When compared with links designed using fixed coding, ACM can increase the throughput of a robust link by allowing it to dynamically adjust to a less robust modulation/coding (MODCOD) resulting in higher throughput under clear sky conditions. Conversely, when compared to a modestly robust fixed rate coded link, ACM can provide increased link availability by dynamically adjusting to lower order MODCOD under rain fade conditions.

Telesat has extensive experience designing, and operating ACM systems at both Ku-band and Ka-band and can assist customers with ACM link design by providing analysis and in-orbit testing.

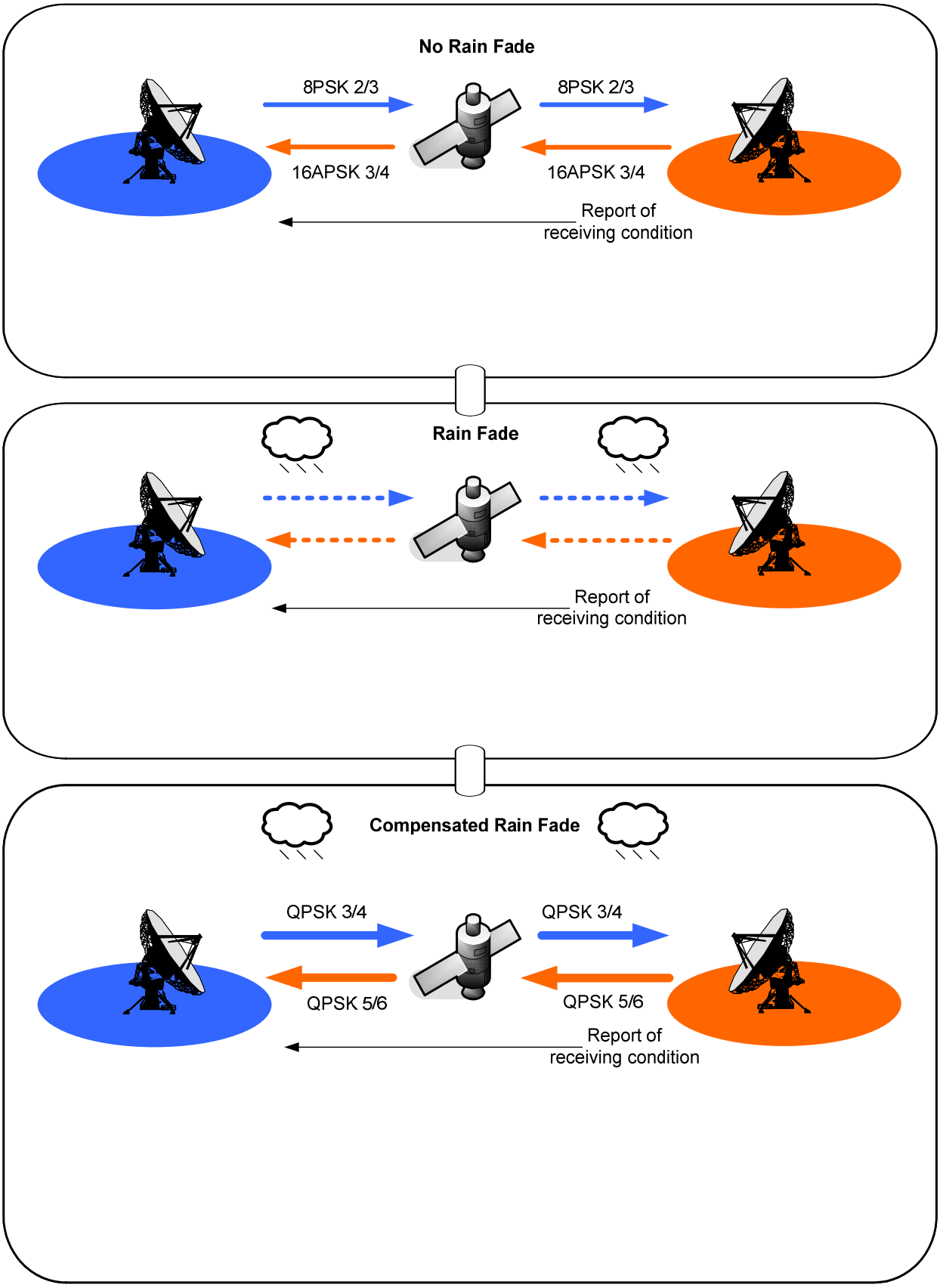
To sum up, using ACM can significantly increase link throughput and/or link availability when compared to a fixed MODCOD service.

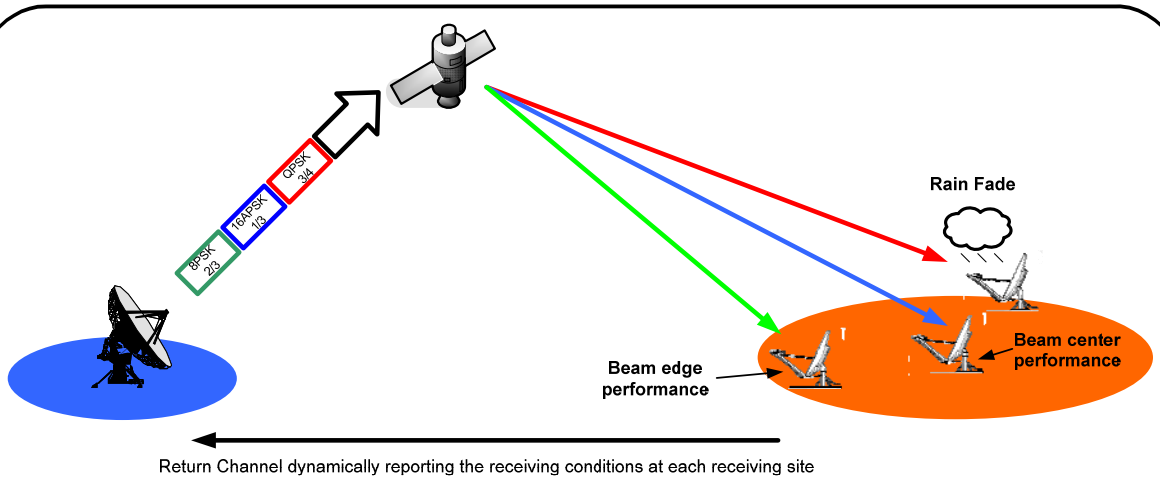
How does ACM work?

Standard duplex services assign fixed modulation and FEC for each leg of the link. ACM technology is able to alter the modulation and FEC by implementing a 'feed-back' circuit containing link performance information. This circuit can be combined with the service or provided on a separate link (e.g. PSTN).

Normally the symbol rate of the link must be constant to ensure the allocated bandwidth remains the same on the satellite. Accordingly the data rate is altered to compensate for any ACM changes in modulation and FEC.

The following diagrams show the effects of ACM technology under different atmospheric conditions.


No Rain Fade
8PSK 2/3
8PSK 2/3
16APSK 3/4
16APSK 3/4
Report of
receiving condition
Rain Fade
Report of
receiving condition
Compensated Rain Fade
QPSK 3/4
QPSK 3/4
QPSK 5/6
QPSK 5/6
Report of
receiving condition



For a shared platform with widely distributed remotes, the benefits of ACM can be very significant. Shared platforms with ACM have the ability to alter the MODCOD for traffic assigned to a specific remote on a frame-by-frame basis. The ACM capable system is not restricted to use of the MODCOD appropriate for the worst case site under fade conditions. As a result, higher throughputs relative to fixed code point systems can be achieved under both clear sky and rain fade conditions. Additionally, ACM systems allow sites that are not affected by fade conditions to run at the highest MODCOD possible whilst fade affected sites have a reduced MODCOD configured to maintain link connectivity.

ACM Link Design

When designing an ACM link, the following must be taken into consideration:

- The rate of change in fade conditions versus the latency and processing time of the chosen ACM system's 'feed back' mechanism for MODCOD adjustments.
- Careful design and allocation of minimum MODCOD, maximum MODCOD and MODCOD switching margins is required to insure the service is operated within the required service availability.
- The use of DVB-S2 'long block' versus 'short block' mode can affect system performance. This is especially true if the link is a low data rate service.
- All ACM systems are proprietary – one manufacturer's system will not work with another's. One reason for this is that they have different methods of transmitting the return channel required for ACM operation.

- ACM is usually an additional cost option from manufacturer's standard CCM products

- Link budget analysis can be calculated for the best and worst case MODCODs to compare throughput and availability which results in at least a doubling of the number of link budgets required.

Commissioning ACM services

Telesat recommends testing of the service in non-ACM mode (i.e. CCM) before enabling ACM to confirm correct operation. This can be achieved by utilizing additional test capacity within the satellite.

Changing the MODCOD too quickly can cause ACM 'flapping' of the terminals and may unnecessarily lower the network throughput performance. Changing the MODCOD too slowly may cause packet loss during rapid changes in link conditions.

ACM link performance at each planned MODCOD should be tested by simulating fade conditions. This can be done with coordinated carrier power level modifications during system commissioning.

Only after correct operation and performance of the service is confirmed should ACM be enabled. Telesat will assist customers during the test process, including providing satellite test capacity as necessary.

Conclusion

ACM is one of various techniques that the satellite industry is utilizing to help reduce bandwidth costs for customers and improve network performance. It may be a solution that can provide advantages for your network implementation, or it may have limitations given hardware costs at each site and other factors.

Telesat has experience supporting many customers who run ACM services.

Please contact your Telesat sales representative if you would like to learn more about the suitability of ACM for your operations, or to discuss other ways Telesat can improve the efficiency and performance of your satellite network.