



Adaptive Coding and Modulation

Advantech Wireless has pioneered integrated Ethernet data connections with licensed microwave radio solutions. Focus on high performance, high quality and high functionality has positioned the company firmly as the native Ethernet supplier since early 2000's. Now this position is moved forward with the launch of the new product, Transcend™ 800.

With the innovations implemented in Transcend™ 800, inherent performance limitations of high capacity systems are tackled. In line with the company history, this again allows for longest possible hops, smaller antenna sizes and best possible throughput and availability in the market. This is offering customers lowest cost of ownership at best possible performance.

Background - Adaptive Coding & Modulation

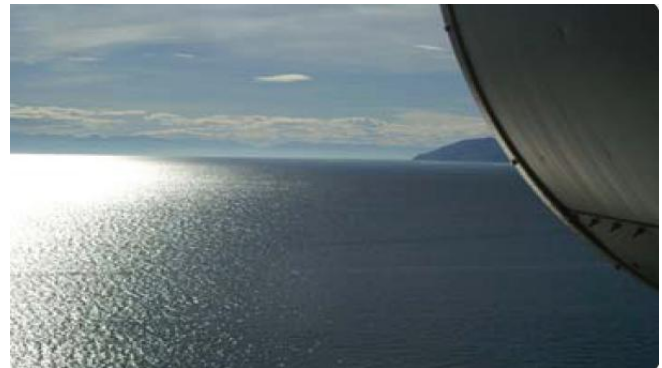
As the name shows, the coding and modulation of the microwave system will adaptively and errorless adjust to changing environmental conditions. This means that instead of losing the connection due to heavy fading, ACM will adjust the radio performance to maintain the connection and increase the total up-time and availability.

The system monitors in real time the performance and upon reaching the performance threshold, the system automatically adjusts the coding and modulation in order to maximize the capacity-availability ratio at any given time. The adjustment is typically made in 16 steps and improves the system fade margin with up to 21 dB. This is unique for licensed microwave radio.

The New Planning for High Capacity Ethernet Availability

Transcend™ 800 with the available ACM functionality radically changes the way that network planners can look upon System Gain and availability. ACM allows for planning microwave availability even at high capacities with small antenna sizes and/or long hop lengths; the same sizes and hop lengths that are standard for lower capacity systems. The normally unavoidable negative trade-off between high capacity and system gain can be overcome. Fading does not lead to loss of connection anymore.

On top of the Transcend™ 800's unique end-to-end flow control over the hop and priority functionality, the



ACM allows for completely new thinking in microwave planning of Ethernet data connections; enabling substantial cost savings to the users

Maximizing Throughput

Unlike Adaptive Modulation (AM) mechanism, which only allows one code-rate per modulation, Adaptive Coding and Modulation (ACM) allows multiple customizable code-rates per modulation. With higher granularity, Transcend™ 800 automatically adjusts to the highest possible code-rate/modulation to maximize the throughput. Multiple ACM level is illustrated below.

AM levels (7)		ACM levels (16)	
Mod-CR	Mbps	Mod-CR	Mbps
QPSK-3/4	73	QPSK-3/4	73
8PSK-3/4	110	QPSK-10/11	89
16QAM-3/4	147	8PSK-5/6	122
32QAM-3/4	184	16QAM-3/4	147
64QAM-10/11	269	16QAM-5/6	163
128QAM-10/11	314	16QAM-10/11	178
256QAM-10/11	359	32QAM-3/4	184
		32QAM-5/6	204
		32QAM-7/8	214
		64QAM-5/6	247
		64QAM-7/8	259
		64QAM-10/11	269
		128QAM-6/7	296
		128QAM-10/11	314
		256QAM-7/8	346
		256QAM-10/11	359

Technologies Used

The delivery of this innovative system has been made possible by the implementation and innovative use of a number of new technologies, such as:

ACM with Transcend™ 800

- Low Density Parity Check (LD PC)**
 An enhancement of the more standard Reed-Salomon based Forward Error Correction (FEC). LDPC offers highest possible correction degree for systems with very low latency requirements.
- Pilot Assisted Carrier Recovery**
 Enables the use of standard oscillators for higher order modulation systems with maintained performance.
- Adaptive Time Domain Equalization**
 To achieve maximum robustness against multi-path fading.

Case Study

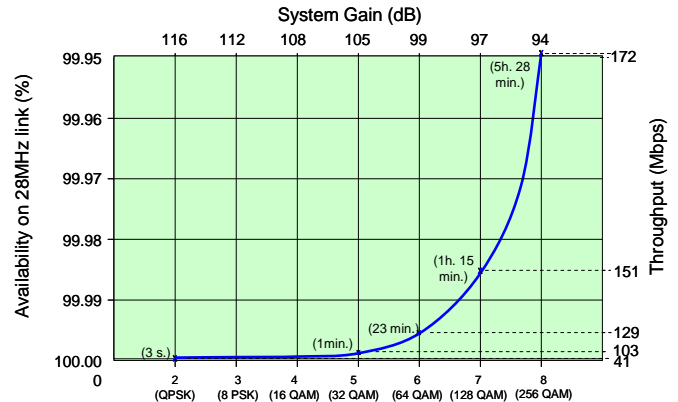
ACM will help the radio and data connection planners to increase availability and greatly reduce cost by using the Ethernet and TCP/IP inherent functionality to adapt to lower capacities during shorter periods.

The true end-to-end flow control is needed to assist these inherent data functions to improve the total end user quality experience.

Let's examine an All-IP radio link in South America, operating in 28MHz at 7GHz frequency band. A total throughput of 170 Mbps is required, of which, 40 Mbps is dedicated to priority 1 data (highest), 60 Mbps to priority 2 (medium) and 70 Mbps to priority 3 (lowest).

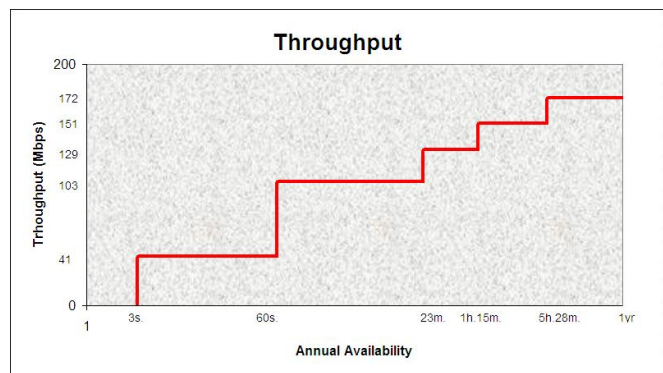
Without ACM, this Transcend™ 800 link would require a 1.8m antenna to reach a 99.999% availability (5 minutes outage per year).

With ACM, the same link could use a 0.6m antenna to reach a 99.99999% availability (only 3 seconds outage per year). During momentary deterioration, the capacity will be lowered but capacity would never fall below 40Mbps, hence guarantee an almost always-on transport link for priority 1 data.



From the user's point of view,

- Priority 1 data (all 40Mbps) is guaranteed on during 365 days minus 3 seconds.
- Priority 2 data (all 60Mbps) is guaranteed on during 365 days minus 60 seconds.
- Priority 3 data (all 70Mbps) is guaranteed on during 365 days minus 5h26m. Between the 60s and the 5h26m marks, priority 3 data will be on a best-effort basis.



Aside from All-IP, other PDH data can be prioritized in a similar fashion.

Conclusion

This paper illustrates that by using the unique Advantech Wireless' functionalities, a data connection over microwave can reach a higher availability and still save a substantial amount of money on antenna sizes, as well as mast rental and installation cost.

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