EDGEQAM MODULATORS:

What, How, Why?

Seldom is there a discussion around video, switched digital video (SDV), video-on-demand (VOD) or DOCSIS 3.0 that does not mention the edgeQAM (eQAM) modulator. In the past couple of years, eQAM has rapidly become part of our vocabulary.

Yet I frequently hear people ask, “What is an eQAM?” and “How does it work?” Let’s clear up some of these questions.

INPUTS

Unlike conventional QAM modulators that have a DVB ASI input, eQAM modulators have multiple Gigabit Ethernet (GigE) data inputs. At a minimum, they should have four GigE inputs. (Carrier-class systems may have multiple 10 GigE inputs).

Why four minimum? Typically eQAM modulators will be able to generate a minimum of 48 QAM channels. We know that at 256 QAM, video channels can transport about 37 Mbps of video data. So 48 * 37 Mbps = 1.776 Gbps, which is more data than one GigE port can handle. So right away, we need two ports to support all of the data we may be feeding the device.

Now we must take into account the requirement for redundancy, which will add one port each to the two we already require, bringing the total to four.

In addition to GigE ports, eQAM modulators will have provisions for DOCSIS Timing Interface (DTI) clock inputs, with redundancy. A DTI server is an extremely precise reference clock defined in the DOCSIS 3.0 DTI specification, which aims to ensure that the eQAM modulator and the DOCSIS 3.0 CMTS are concisely synchronized.

In DOCSIS 3.0 modular configurations, the CMTS core and the eQAM modulator are physically located in two separate chassis. The DTI server clock is connected to each chassis in order to maintain accurate timing, synchronization and jitter between the CMTS and eQAM downstreams. This is a necessity in order to provide high quality of experience (QoE) for voice over IP (VoIP) and IPTV applications in a DOCSIS 3.0 bonded channel environment to our subscribers.

DTI servers enable the ability to be remotely synchronized via GPS satellites, so an eQAM modulator in a hub site can be time-aligned with the CMTS in a headend. In the unlikely event of DTI server failure, the backup DTI server should be online and connected to the modulator's secondary port. Never forgo your backup regimen!

The actual content that you would send to an eQAM over the GigE interface would generally be framed in an MPEG-2 transport stream (TS). A function of the eQAM is to support both Single Program Transport Stream (SPTS) and Multiple Program Transport Streams (MPTS). Additionally, the eQAM can support unicast video (VoD), multicast video (Switched Digital Video), and Modular CMTS (DOCSIS framing in the MPEG-2 TS). The eQAM can also re-stamp PCR timestamps for de-jitter processing, which helps reduce network impairments. It can also support various levels of video compression, such as MPEG-4 and new standards that are emerging. From an IT infrastructure perspective, it can very quickly be seen the power an eQAM can have on network efficiencies.

MAPPING

Let's say you have an MPEG-TS stream (aka video) or a DOCSIS channel that you want to associate with a physical QAM modulator port. How does it occur in the eQAM device? Through simple IP address and UDP (User Datagram Protocol) mapping to each QAM channel. Here's how.

The GigE port of the eQAM modulator is manually assigned an IP address, the same way that you assign your PC an IP address if you took it out of DHCP mode and filled in the information manually. Most eQAM modulators have an internal Web page that let you do this for each GigE port.

Next, the device gives you a list of all of the QAM channels that it has available and lets you set the RF frequency and RF power based on standard HRC/IRC channels for Annex B. (You can also configure non-standard channels). If you use an international channel plan such as Annex A or C, then you would select the appropriate channel plan accordingly.

Finally, there is a UDP port setting for each channel. For example, I might set 501 MHz to port 49120, 507 MHz to port 49140, 513 MHz to port 49160, and so on. You get the picture. I am basically incrementing my frequency in 6 MHz steps and incrementing my UDP ports in integers of 20.

Now, when you want to send a video stream to a particular QAM frequency, you must only enter the IP address of the GigE port and UDP port of the QAM frequency that the video needs to be sent out on. You will also need the appropriate backend video content delivery system—a separate topic for my blog. (See bradyvolpe.com.)

Further, each QAM channel will support more than one video stream. In my example above, mapping is usually done on a more granular level.

Let's suppose we want to send two high definition (HD) and one standard definition (SD) video channels on 501 MHz. We would then map 501 MHz with three UDP ports as follows: 501.1 = 49120; 501.2 = 49122; 501.3 = 49124. The first HD would be streamed to UDP port 49120, the second to UDP port 49122 and the SD to UDP port 49124.

OUTPUTS

The outputs of the eQAM modulator are standard F connectors. (MCX RF connectors are available in high-density platforms.) Most manufacturers will bond four ITU Annex B QAM channels to one (1) physical RF connector. So a 48 QAM channel eQAM modulator will typically have 12 RF connectors.

From here conventional RF combining schemes apply, though one exception must be taken into consideration.

A typical QAM modulator/RF upconverter has a maximum RF output of 60-61 dBmV. An eQAM modulator with all four outputs enabled on an RF connector has a typical maximum output of 54 dBmV. This means you may have to make adjustments to your current combining schemas in your headend when migrating from legacy QAM to eQAM equipment.

EQAM BENEFITS

Why has the industry migrated to the eQAM moduators? Let's name a few reasons:

1. They offer a lot of QAM channels in a small form factor.
2. They enable new services such as SDV and VOD by seamlessly enabling an operator to change video content from one QAM channel to another just by changing a UDP port number.
3. They help make complex cabling a thing of the past.
4. They enable diverse video inputs with variable video compression levels.
5. They enable DOCSIS 3.0 downstream channel bonding.
6. Finally, they enable convergence. The same eQAM modulator used for video distribution can be used simultaneously for DOCSIS 3.0 data transport. As data demands grow, video channels can be re-purposed for more DOCSIS channels.
7. Much discussion in the industry currently surrounds the feasibility of one day migrating all video to IPTV – which can be supported by eQAM modulators, truly a universal device.

Further reading on this and other related topics can be found on his blog at www.bradyvolpe.com