Society of Cable Telecommunications Engineers

Rocky Mountain Chapter

TheSpectrum

Newsletter of the Rocky Mountain Chapter
http://www.scte-rockymountain.org/
November 2012

This Issue's featured articles:

Ron Hranac: Spectral Efficiency
Jorge Salinger: Evolution in the Access Networks

SCTE Rocky Mountain Chapter

Election Nominations

Please send in your nominations!!!

It is that time of year again. It is time to make your voice heard. So we can do that we are looking for individuals desiring to support the continued growth of our chapter.

When? **Immediately – Nominations are open now, and close on November 27, 2012**

What? **Send your Nominations to the Chapter**

Any member is eligible

You may nominate yourself or a colleague

How? This email address is being protected from spambots. You need JavaScript enabled to view it.">**nominations@scte-rockymountain.org**

New Members On The Board

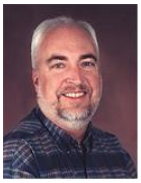
It is the belief of our SCTE society that all members should have an opportunity to serve. Having new members and fresh ideas is what makes our chapter one of the best in the country.

If you are interested and would like to participate:

The prerequisite for RMC Board of Directors is that they be outstanding individuals dedicated to their own careers and the careers of others they work with daily. An incoming board member will help drive the direction of the chapter and initially will be teamed with another more seasoned board member to help arrange seminars in the Colorado area.

To become a nominee send us a Bio to be placed on the Ballot:

Biography Sample of one of our past board members:

 Alan Babcock, National SCTE Member #81456

I have spent 25 years in the cable industry and have held a number of positions from installer to chief technician to system manager. Most of my time has been spent associated with training in one way or another. I have held training positions with Time Warner, TCI, SCTE and now Jones/NCTI. I strongly believe in sharing what I know with others in the industry and recognize that it is getting more and more difficult for all of us to keep up with the rapid technological change that is all around us. For this reason, I would be happy to serve another term on the board for the Rocky Mountain Chapter of SCTE.

I want to work with your board to provide training opportunities that will help all of you keep pace with the new technologies, products and services that are being introduced. I also currently sit on the SCTE Professional Development committee at the national level where we are wrestling with how to provide learning opportunities and make certification programs more relevant and accessible.

I have served with your board of directors for the past 2 years and would be honored to be able to continue to serve another term.

For questions please contact:

Election committee chair:

This email address is being protected from spambots. You need JavaScript enabled to view it.">Lane Johnson

Additional committee members:

This email address is being protected from spambots. You need JavaScript enabled to view it.">**Stephanie Trotter**

This email address is being protected from spambots. You need JavaScript enabled to view it.">**Idilio Moncivais**

This email address is being protected from spambots. You need JavaScript enabled to view it.">**Rex Kohart**

Upcoming Seminars

Also, visit our SCTE Rocky Mountain chapter website at:

http://www.scte-rockymountain.org

Date	Location	Subject	Speaker
January 2013 17th	Comcast on Iliff	Working in an All-Digital World	Ron Hranac

Event Summary - November 8th 2012

Metro Ethernet Services and Technology

1. John Quesenberry, Principle Network Architect – Sumitomo
2. Curtis Knittle, PhD, Director, Digital Video Services – CableLabs

Review:

Metro Ethernet Services, Implementation with EPON, and Provisioning with DPoE

On November 8th, 2012 The Rocky Mountain Chapter held a wonderfully insightful event at the Comcast Theater. The event provided an overview of Metro Ethernet Services, outlined its implementation using EPON, and the provisioning process of EPON with DPoE.

We were extremely lucky to have 3 experts and leaders in our industry as speakers at this event: Dr. Mehmet Toy, Distinguished Engineer from Comcast, John Quesenbury, Principal Network Architect from Sumitomo, and Dr. Curtis Knittle, Director of Digital Video Services with CableLabs. The three speakers together brought over 70 plus years of industry experience to the event. Unfortunately weather in the East coast prevented Dr. Toy from coming to Denver for the seminar, but Dr. Knittle was ready and able to "pick-up the slack" as he quickly took over the presentation of the materials that Mehmet had prepared. The information conveyed was very extensive, and seminar attendees were left with a lot of additional material to review at the leisure.

The seminar covered the following topics:

- Metro Ethernet Services
  - Benefits and drivers, including capex and opex cost benefits, applications, etc.
  - The protocol stack as seen for MetroE services and by the IEEE and MEF
  - Key Metro Ethernet services, especially focusing on private line and LAN, and virtual private line and LAN services
  - And service parameters, such as committed information rate, QoS, etc

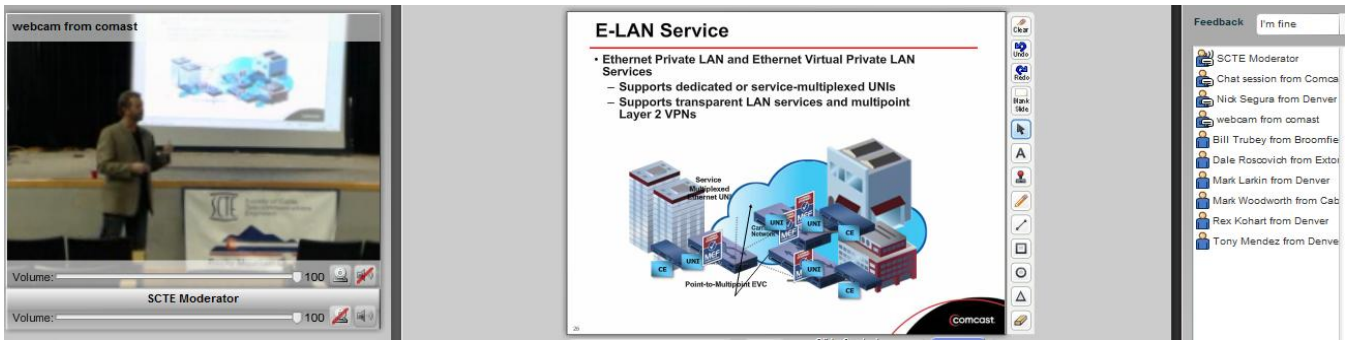
- MetroE Services with PON
  - Compare and contrast point-to-point versus point-to-multipoint
  - Focus on PON, and especially EPON architectures and implementations
  - Details of the EPON architecture, including optical budget and its components
  - The MAC-layer of EPON, including how the downstream and upstream work, the EPON Multipoint Control Protocol (MPCP), and discovery and signaling
- DOCSIS Provisioning of EPON (DPoE)
  - Introduction and motivation
  - The DPoE Architecture and its components
  - How DPoE works, including a description of the specs
  - DPoE's status and its current vendor supporters

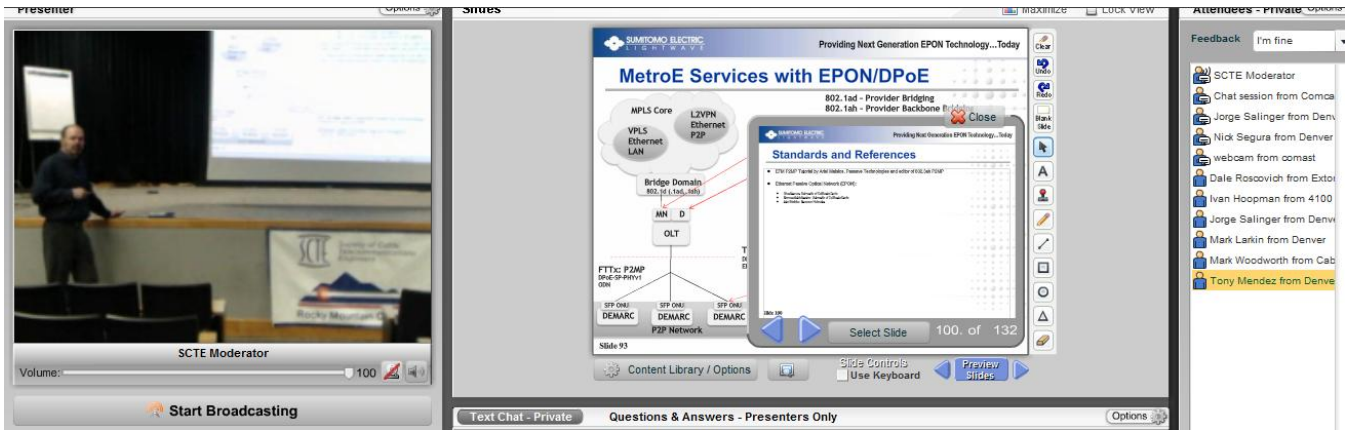
If you were unable to attend be sure to visit our Rocky Mountain Chapter website (http://www.scte-rmc.org) and or link tohttp://www.MyEventPartner.com/SCTE/EA51DB86864D and or link to and watch the recording of the seminar or just download the slides. Either way, we hope this seminar is useful to you.

Please send us any comments or suggestions. We are always eager to hear from our members. We do this for your benefit, so please let us know what would work better for you. Photos from Seminar are below.

Thanks!

Jorge Salinger (This email address is being protected from spambots. You need JavaScript enabled to view it.">jorge_salinger@cable.comcast.com)





Technical Forum
Spectral Efficiency

By Ron Hranac, Senior Technical Editor, Communications Technology

Ron Hranac is technical leader, broadband network engineering at Cisco Systems and senior technology editor for Communications Technology magazine. Contact him at This email address is being protected from spambots. You need JavaScript enabled to view it.">rhranac@aol.com. The following article originally appeared in the 4Q12 issue of *Communications Technology*. Reprinted with permission of the author.

What do you think of when you hear or see the phrase “spectral efficiency?” The answer, at least from a cable-network perspective, has to do with the amount of information that fits in a given RF channel bandwidth. In other words, just how efficiently can that piece of spectrum be used to transmit information from one point to another?

Before digging into the nuts and bolts of spectral efficiency, it’s important to realize there is a hard limit to how much data can be transmitted in a given bandwidth. The well-known Shannon-Hartley Theorem, a topic for another day, establishes what is commonly referred to as the Shannon limit.

Spectral efficiency usually is expressed in the format “bits per second per hertz,” abbreviated as bits/s/Hz. A common definition is the net data rate in bits per second (bps) divided by the bandwidth in hertz.

The aforementioned definition contains some terminology that deserves a closer look. One is net data rate – also called net bit rate – that is the usable data payload in bits per second, after subtracting the non-payload parts of the data stream used for Reed Solomon forward error correction (FEC), Trellis coding, Moving Picture Experts Group (MPEG) overhead, and DOCSIS and Internet protocol (IP) overhead. Symbol rate is the number of symbols transmitted per unit of time, typically seconds, and it’s the same as modulation rate or baud. My copy of the *McGraw-Hill Dictionary of Scientific and Technical Terms, 4th Ed.,* defines baud as “a unit of telegraph signaling speed equal to the number of code elements (pulses and spaces) per second …” An important point to remember is that symbol rate, or baud, may or may not equal the bit rate. Indeed, in the world of high-speed data communications, a single symbol generally represents multiple bits, so the symbol rate is less than the bit rate. More on this in a moment.

Net data rate and symbol rate are related to the raw data rate – also called raw bit rate – that includes the usable payload and all overhead.
Consider a quadrature amplitude modulation (QAM) signal carrying high-speed data. QAM is a form of modulation in which the phase and amplitude of the signal vary to represent the data being transmitted. In the case of, say, a DOCSIS upstream 16-QAM signal, each of 16 states, or combinations of amplitude and phase, represents a symbol. Each symbol represents a combination of four bits. For example, if the instantaneous phase of the RF signal is 45 degrees and its instantaneous amplitude is 1, that particular state of the signal represents a symbol comprising the bits 1111. If the instantaneous phase is 18.43 degrees and instantaneous amplitude is 0.75, the state of the signal represents a symbol comprising the bits 1110. *(Quick side note: “Amplitude” as used here refers to the normalized magnitude in a square data constellation. Magnitude is equivalent to the length of a vector from the center, or origin of the constellation, to the symbol point in question. The constellation’s four outer-corner symbol points are assigned a normalized magnitude of 1. All other symbol points have a normalized magnitude less than 1.)*
All versions of DOCSIS use some variation of QAM as the modulation type for transmission of the data payload, ranging from quadrature phase shift keying (QPSK, also called 4-QAM) to 256-QAM. The number of bits per symbol varies with order of modulation. The following is a summary of the number of bits per symbol for common DOCSIS orders of modulation:
Assuming the channel characteristics are suitable to support the desired modulation, then a higher-order modulation generally will support a higher raw data rate than a lower-order modulation, given the same channel bandwidth.

Let’s look at an example, using downstream 256-QAM: The symbol rate of a DOCSIS downstream 256-QAM signal is 5,360,537 symbols per second (sym/s), or about 5.361 megasymbols per second (Msym/s). The channel bandwidth is 6 megahertz, and the QAM signal’s -3 dB bandwidth is equal to the symbol rate *(for more on this, see “Digital Transmission: Carrier-to-Noise, Signal-to-Noise, and Modulation Error Ratio,” by Broadcom’s Bruce Currivan and yours truly, available here)*.

Because there are eight bits per symbol with 256-QAM, the raw data rate is 5,360,537 sym/s * 8 bits/sym = 42,884,296 bps, or about 42.88 Mbps. Squeezing 42.88 Mbps into a 6 megahertz-wide channel seems to be a pretty efficient use of the spectrum. But some percentage of the total data being transmitted is used for overhead, leaving a smaller net data rate for the actual usable payload. The net data rate in a downstream DOCSIS 256-QAM signal is about 38 Mbps, give or take.

The approximate spectral efficiency of the example downstream 256-QAM signal is 38,000,000 bps ÷ 6,000,000 Hz = 6.33 bits/s/Hz.
How can one achieve higher spectral efficiency? If overhead could be reduced, the efficiency would go up somewhat. But an important part of overhead is the previously mentioned FEC, which provides data transmission robustness. The other pieces and parts of transmitted overhead are important, too. For the sake of this discussion, let’s assume that reducing overhead is off limits. Another way to improve spectral efficiency is to use a higher order modulation. If the channel characteristics can support, say, 1024-QAM (10 bits per symbol), and assuming the same symbol rate as before, the raw data rate is 5,360,537 sym/s * 10 bits/symbol = 53,605,370 bps, or about 53.61 Mbps. Subtracting overhead yields a net data rate of somewhere around 47.5 Mbps. In this example the approximate spectral efficiency is 47,500,000 bps ÷ 6,000,000 Hz = 7.92 bits/s/Hz.

Determining DOCSIS upstream spectral efficiency can be a little tricky, largely because of the wide range of configurations possible with FEC and other overhead. Once overhead is known, the spectral efficiency in bits/s/Hz is calculated the same way as in the downstream: channel bandwidth in hertz divided by the net data rate in bps.
One cannot simply switch to a higher order modulation in an attempt to improve spectral efficiency. As mentioned before, the channel characteristics must be able to support the desired modulation. An example: Assume the only channel impairment is additive white Gaussian noise (AWGN, or thermal noise), the starting modulation is 64-QAM at a certain carrier-to-noise ratio (CNR) and bit error ratio (BER), and there is no FEC. In order to maintain the same BER with 256-QAM, the CNR must be 6 dB better than it was for 64-QAM.
Jumping to 1024-QAM requires another 6 dB CNR improvement if the same BER that existed with 64-QAM is desired. In the real world, there are channel impairments in addition to AWGN: ingress; impulse noise; such nonlinear distortions as composite triple beat and composite second order; such linear distortions as micro-

reflections, amplitude ripple and group delay; and so forth. FEC can buy some wiggle room, as can such tools as adaptive equalization. Even so, a clean plant is required to support higher orders of modulation and the accompanying improvement in spectral efficiency.

Spectral efficiency provides a useful tool with which to sort out the amount of data that can be carried in our networks, and it puts the comparison on a level playing field. For instance, whether the pipe is a single 6-megahertz-wide channel carrying 256-QAM or four bonded 256-QAM channels occupying 24 megahertz of bandwidth, the spectral efficiency is the same: approximately 6.33 bits/s/Hz.

Should the cable industry someday adopt new physical layer data transmission technology, the spectral efficiency of that technology can be easily compared to today's single-carrier QAM (SC-QAM) using the methods just described.

Evolution in the Access Networks

By Jorge Salinger

Jorge Salinger is the Vice President of Access Architecture at Comcast and frequent contributor to Broadband Library (www.broadbandlibrary.com).

Is more evolution in the access network possible? You bet !!

If anyone had the impression that HFC is reaching its limits, here come CCAPs, DOCSIS® 3.1 and EPoC. Not only is HFC alive and well, there is more evolution moving forward than ever before. Here is a summary of the 3 key developments in progress.

Those of you involved in access networks that were fortunate to attend SCTE Expo this year, the extent to which CCAPs have evolved already was probably marveling. Literally all CMTS and Edge QAM vendors showed their equipment under development, several of them even in operation, with half announcing their equipment to the press and demonstrating it publicly in their booths.

Given that the spec effort started just 2 years ago, what a remarkably fast evolution!

How and why did this happen so quickly? I think it is due to 3 key drivers:

a. MSOs got together and developed a common set of specifications making it very clear what was needed;

b. the technology was ripe for the implementation of CCAPs; and,

c. most importantly, quite literally all MSOs are experiencing significant growth in the use of spectrum for narrowcast QAMs, which demands the need for CCAP equipment.

CCAP trials have already started, and MSOs and vendors are ramping up testing activities fast. It seems that, as an industry, we are marching towards lots of deployment activities starting in 2013.

On a separate but related vein, the DOCSIS specification, which has served our industry extremely well, is now undergoing yet a new phase of evolution. Publicly announced during a specially designated SCTE Expo panel session, DOCSIS 3.1 will be the latest incarnation of this incredibly successful platform for cable.

The 3 key goals for DOCSIS 3.1 are:

1. Much more efficient use of spectrum, with a 50% improvement in capacity for any given amount of spectrum, mostly resulting from the use of more efficient forward error correction (called LDPC) and higher order modulations (1024 and 4096 QAM downstream and 256 and 1024 QAM upstream). Who would have thought 15 years ago when we started using DOCSIS, which at the time was targeting 256 QAM downstream and 16 QAM upstream as lofty goals, that we could achieve these target levels of efficiency!
2. Cost reduction, mainly by leveraging technologies commonly used in other transmission media. Technologies such as OFDM will allow us to "pack" many more bits in the HFC network at much lower cost per Hz, and likely resulting in a larger supplier ecosystem, increasing innovation and fueling competition.
3. Enable a simple transition, as DOCSIS 3.1 cable modems will operate with DOCSIS 2.0 and 3.0 CMTS/CCAP enabling deployment of DOCSIS 3.1 CPE as soon as available to seed the market, while DOCSIS 3.1 CCAPs will support DOCSIS 2.0 and 3.0 CPE allowing MSOs to upgrade headend equipment without having to change any of the existing CPE.

When will DOCSIS 3.1 become available? Pretty quickly! In fact, DOCSIS 3.1 will become the fastest spec-to-product evolution of DOCSIS ever, with cable modems likely becoming available in 2014 and CCAP equipment as early as 2015.

And, as if this were not enough evolution, the cable industry is working with the Institute of Electrical and Electronic Engineers to develop a version of EPON for cable. Called EPON Protocol over Coax (EPoC), this new access technology will enable the use of the HFC network to deliver EPON services. Mainly targeting business service applications, in one of its possible implementations EPoC would unleash currently unused spectrum in the HFC network, which coupled with the advent of DOCSIS 3.1 would more than double the capacity that can be delivered with HFC.

As these technologies make their way from the drawing board to products I will explore them in greater detail in this column. In the meantime, feel free to reach out to me with any questions or comments at

Scholarship Opportunity

In these hard times job loss is collateral damage to the effects of the credit, housing, and energy issues affecting our country. The Rocky Mountain Chapter is proud to be in the position to offer its members a way of providing some security or opportunity in these times. We believe that through a scholarship program we can assist members wanting to differentiate themselves from their peers through education and certification.

Why does the RMC support a Scholarship Program for its Members?

We make it easy on our members to enroll, test, and certify for SCTE certifications covering a wide range of job classifications and skills. Certificates range from residential installation practices to digital video engineering and all points in-between. Visit our web site at http://scte-rockymountain.org/education-opportunities/chapter-scholarship to get more details. Our scholarship application should take you less than 15 minutes to complete and you'll just need to add two letters of recommendation before sending to us.

Why should I certify with the SCTE?

The SCTE is the leading source of certification specific to our industry. There are over 15,000 worldwide members and more than 3,000 members enrolled in SCTE certification programs. It is the most comprehensive and widely recognized program in the industry.

In this competitive job market any edge you can give yourself will help you rise above the masses when being considered for a promotion or a new job. Believe me when I say, that experience and "time in the trenches" is invaluable to our employers and it has let many of us earn a great living in a great industry.

However, there are large numbers of people out there looking for job that have time and work experience on their side. Unemployment is regular and competition more fierce. How will you secure your current position or prepare yourself for the next promotion opportunity? Today you need something else to demonstrate your commitment to expanding your work knowledge and skills. Otherwise your resume looks just like the two dozen other ones sitting on a hiring manager's desk.

College classes are another avenue for motivated individuals. A college degree is a fantastic goal and the SCTE Foundation has funds available for grant to help you here as well. Consult the www.scte.org web site for more details. But College is not for everyone and the time, family responsibilities, and other constraints are endless. SCTE certification allows you to simply test at a local seminar after home studying for as long as you wish. There is no set class schedule or deadlines. The RMC offers testing at about every seminar. Certification is a viable route for many whom have full time jobs but yet want to advance and demonstrate their knowledge. The Rocky Mountain Scholarship program covers membership cost, testing fees, and peer recognition.

2012 Elected Board of Directors				
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Jorge Salinger	Jorge_Salinger@cable.comcast.com	Comcast	Board	215 439-1721
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Tom Gorman	tom@opxl.net	opXL	Board	303 502-4982

Supporting Associate Board Members 2012 Definition: Somebody who supports the functions of the local chapter by participating in meetings provides input that helps drive board decisions, volunteers, speaks supportive, and generally those who make an impact through their involvement. *Associate Board Members do not have the ability to vote.*				
Name	email	Company	Position	Phone Number
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