OARtech
December 10, 2003

Al Stutz

Currently have 60 applicants for the OARnet Director's search, and will have a conference call Friday to verify that all the committee are on the same page for reviewing the applications. The committee is made up of representatives from a mix of schools. They will bring candidates in after the holidays. The committee and management will meet with candidates. Candidates will be doing presentations, possibly via video conferencing. Feel free to send comments on the process.

Last week the Presidents signed an energy bill. This will affect the OARnet and TFN because of a site in Springfield. The advance computational group is looking at nuclear lifeline of our stockpiles. Part of the money is to bring up a satellite in Springfield for DOE to work with OARnet on this project.

Children's Hospital and other groups will do research on childhood cancer causes. They will be using the computers at OSC to help with this research and make it available for further research by other organizations.

They would like to accelerate connecting teaching hospitals to TFN. Thus accelerate sharing of research structures throughout the state and into undergraduate instruction. This is likely to be funded at the $5M level and is part of the activity that is looking for applications to use the new network and as well as funding to help with these applications.

None of the funding for the network was to have come from the Governor's TFN bond. It was included in the project to help provide funding for application projects. TFN would have accelerated the funding of the applications to use the networks. We have not been damaged by the failure of the bond issue. The fiber network had no direct funding from that bond issue.

They are still trying to contact the PUCO to work through some funding using SBC money. PUCO is working slowly because of the power outage. So they will continue pursuing that funding possibility.

OARnet, SBC, HPC has been nominated for the "TopCat award".

Ben Flowers, Cisco
DWDM Networking Primer

Slides are available off the OARtech web site.

Terminology
Decibels (dB) = unit of level - loss over a medium
Decibels-milliwatt (dBm) = decibels referenced to a milliwatt
Wavelength = length of a wave in a particular medium
Frequency = the number of times that a wave is produced in a time period
Attenuation = loss of power in db/km

Chromatic Dispersion = spread of light pulse in medium
ITU Grid = standard set of wavelengths to have interoperability between equipment and the assignment of the wavelengths to be assigned to vendor and use.
Optical Signal to Noise Ration (OSNR) = ratio of optical signal power to noise power for the receiver
Lambda= greek letter used for Wavelength
Optical Supervisory Channel (OSC) = management channel

Note that db is different than dbm. Normally your losses are given in dbm.

Optical budget = output power - input sensitivity.

Fiber options require very high purity glass. Fiber optics glass will travel 9 miles before it gets 50% reduction in signal loss.

Fundamental characteristics: Attenuation, Dispersion, Nonlinearity, Distortion. Attenuation reduces power level with distance. Dispersion and Nonlinearity erodes clarity with distance and speed.

Optical fiber is made of three sections: core, cladding, and coating. Light going through the core is bounced off the cladding to be conducted to the far end. Each light ray is a mode. The modes that bounce off the cladding take longer to reach the end. Multimode fiber uses a 50 micron or 62.5 micron core diameter and lets too much light in to the core and so loses some light out of the cladding. Single mode has a smaller core and allows better sending of the light.

For wavelength division DWDM uses the 1550 nm window, where the 1310 is used for the lower needs of multimode fiber. How does the LX and SX fit into this? SX is a short haul and is tuned for 850 nm area. LX is tuned for the 1310 nm area and is longer range.

For every 3 dBm the power level is cut in half.

Chromatic Dispersion is different wavelengths traveling at different speeds. It causes spreading of the light pulse. Polarization mode dispersion (PMD) in single mode fiber supports 2 polarization states. Fast and slow axes have different group velocities and causes spreading of the light pulse. The biggest dispersion that you have to deal with is the chromatic dispersion. The effect as the signal widens is they start to overlap and can cause some crosstalk. Higher bit-rates are affected more by chromatic Dispersion. To combat chromatic dispersion use negative dispersion fiber types.

Negative dispersion fiber cuts the spread off the shape of the wave. As dispersion is applied to the fiber the dispersion increases, they apply negative dispersion to bring the signal back repeating to generate a saw tooth pattern in the dispersion as it moves through the path. These compensators are put in to return the dispersion back to 0. It is not an electronic; but is just a coil of fiber that is not managed or powered. It is plugged in line with the trunk fiber and it compensates for the dispersion. The loss with these is typically 1-2 db per km. That loss has to be figured into the loss budget or compensated by electronics.

Polarization mode dispersion (PMD) is caused by how fast the vertical or horizontal moves through the fiber. Factors contributing to PMD are bit rate, core symmetry, environmental factors, bends/stress and imperfections. Solutions are improved fiber, regeneration of signal and better installation practices.

Single mode fiber in the 1310nm is the mode most widely deployed so far (SMF-28e). DSF (Dispersion sifted fiber) is intended for single channel operation at 1550 nm. NZDSF (non-zero dispersion shifted fiber) is especially good for DWDM.

3 types of degradations - loss of energy, shape distortion, loss of timing (jitter) to resolve the attenuation apply an amplifier, re-shape the pulse and for timing they regenerate the signal. Regenerating the signal is the most expensive. These are the 3 Rs of optical networking: reamplify, reshape, and regenerate.

Increasing network capacity options: use more fibers, use Time division multiplexing (faster electronics), or use wave division multiplexing (splitting the wavelengths). Wave division multiplexing splits the wavelength to the channels. A new technology that is coming into play uses tunable lasers. You have to have 32 lasers for 32 lambdas.

TDM takes sync and async signals with the electronics to mux them onto the fiber. DWDM takes multiple optical signals and multiplexes on to a single fiber. No signal format conversions are required. The industry has been doing WDM since the late 80s. 2nd generation came in the early 90s going from 2 channels to 8 channels in the 1550 nm window with 400+ GHz spacing. Currently equipment uses 16-40 channels in 1550nm window with 100 to 200 Ghz spacing. Next generation DWDM will go 64-160 channels in 1550nm window with 50 and 25 GHz spacing. WDM allows you to add more channels by just changing the equipment at the ends. With TDM you have to add repeaters all along the way.

What about trans-oceanic fibers? Used optical powered optical signals to get the necessary distances.

WDM Characteristics that are important: transparency, wavelength spacing (compressing the wavelengths more densely), and wavelength capacity (the larger the wavelength the larger the spacing has to be)

Optical Transmission Bands - C-Band is in 1530-1565 nm wavelength is the flattest area of the wave. If you use multiple bands, you have to amplify for each band used. An L band amplifier can cause noise in the C band. The actual limit is probably 240 wavelengths within the C band.

The next generation multiplexing uses sub-wavelength multiplexing or MuxPonding. It takes multiple services into a single wavelength. They put a mux in front of the WDM system to mux the multiple services in the wavelength. In some cases this is TDM sometimes it's packetized.

DWDM provides enormous amounts of capacity. It is unconstrained by the speed of the electronics and is capable of graceful growth.

Components are layer one devices. Transponders are the client interface - a single card with the client and trunk interface. It phase shifts from the 850/1310 to ITU 15xx . Optical multiplexers take lambdas to one fiber, optical de-multiplexer takes the wavelengths out of one fiber to the lambdas. Other components include optical amplifiers (EDFA - Erbium Doped Fiber Amplifier), optical attenuators (VOA), and dispersion compensation modules (DCM/DCU).

Must have a transponder at each end operating in parallel:
DWDM - VOA - EDFA - DCM - DWDM
(Transponder, amplifier, attenuator, dispersion compensation, transponder) The multiplexers are just refractive devices. The service mux (muxponder) acts as the management wavelength and controls the VOA and EDFA.

Transponders convert the broadband optical to ITU optics and perform 2R or 3R regeneration functions depending on the payload. They are regeneration devices. Performance monitoring is done on a per wavelength basis through the transponder with no modification of the overhead and preserves the data transparency. This would apply only on the 3R system. The client laser pumps as much light as possible to the fiber. A DWDM laser has a much tighter single line and tighter wavelength control. Receivers are common to all transponders and not specific to wavelengths.

Optical amplifiers are used to boost the signals and must be used for each band window and they cause noise in the other bands. There are 2 typical types of amplifiers to effect signal (pre and post amplifiers) and not all amplifiers work in all cases. Every amplifier will add more noise - it's cumulative. This limits the number of amplifiers you can have on the system.

You have all wavelengths going into the fiber and hit a dialectic filter which is tuned to drop specific lambdas. All other wavelengths pass through. Multiplexer/de-multiplexer takes the lambdas in and uses a dialectic filter that determines how the wavelengths are multiplexed. These do introduce db loss but no noise.

Forward Error Correction (FEC) detects and corrects errors and adds a little bit to the payload. It allows the signal to go further and is applied by the transponder.

DWDM Design
Uni-directional uses 2 fibers for a full duplex system.
Bi-directional uses 2 wavelengths on one fiber to do a duplex signal.
Uni- is 32 channels full duplex , bi- 16 channels full duplex. Cisco does not manufacture uni-directional systems.

Protection review - been talking about unprotected wavelengths. Client protected is a protection mechanism owned by the client. It uses 2 optically unprotected geographically diverse paths and all protection is done via higher layer protocols. Splitter protection is the protection done by the transponder and used to reduce the cost of the client protection and protects against fiber breaks. It still has geographically diverse paths. Y-cable protection protects the fiber

and the transponders and splits the client interfaces with a y cable. It increases cost and availability.

To determine to if a DWDM system is the one to deploy ask if you need Gigabits per kilometer. On extremely long haul systems both optical attenuation noise and fiber dispersion limit the total distance before regeneration. But can be accomplished by having back to back transponders. You want to avoid this as much as possible.

DWDM provides hundreds of Gbps of scaleable transmission capacity today. Metro DWDM is an emerging market for most vendors, but DWDM is growing more quickly in the long haul space.

What platforms are the DWDM interfaces available for? It can be used in any device that has a GBIC ports. But this only applies to the Cisco GBICS. Cisco SFPs will be supported.

What reference level the DWDM will run at? 2 types - transmit level and receive sensitivity. When they design a system they use the worse case.

If just building a metro deployment would you have to worry about dispersion limits? No. Not until your span reaches past 500 km.

Lunch

We did introductions of attendees at this time.

Brian Moller, OSU
OSU has been approached to do a password study. They will be looking at policy versus the hardware based passwords. What might be available from OARtech sites that they could use in the study? They would like to see some encrypted passwords that they can work at cracking. Don't want to know any info about the password like username, system, etc.... Does anyone have suggestions to do this research safely? Looking at the password quality and how policy affects the quality of the passwords being used. Study has been requested by an insurance company.

TFN Questions from Otterbein
Would it be helpful to begin looking at local architectures for connecting to the fiber network as a group? There is a committee that is looking at the recommended equipment. They are looking at GigE for handing off the lines. The demark will be a router, what type will be depend on the site. There will be some regional ring issues that will determine how big a demark is needed. As small sites have to replace equipment, what do they need to look at to be compatible to the new fiber? The GigE will be rate limited to your subscribed rate. Sites need to know what the limitations are, what equipment is needed, etc....

You may have to look at what you think you will need for bandwidth. Each campus will be different. If multiple entities are involved, the best thing would be for the several entities would come together in at least a policy-making body. OARnet will have to manage the egress equipment in order to have the equipment play well with the rest of

the network. You will have to consider the robustness of the common site.

OARnet updates
Chris Cook
OARnet has moved from this building to OSC. They are moving their web site away from cold fusion. As they do this they have to rebuild the various sites. One of these is the OARtech site. If there are any files you wish to see on the site let Chris Cook know. ccook@oar.net

Paul Schopis
OARnet Services Update
Fully redundant commodity gateways: Currently have 3 that are geographically diverse. They provide full statistic disclosure and troubleshooting tools: Statscout, Looking glass Router Proxy, and full netflow reporting for TFN. They provide I2 and similar venues advanced services including multicast and IPv6. IPv6 is currently a tunnel environment. But with TFN IPv6 will be a full environment. NLR OSU is a class A member and CWRU is also a member and OARnet will be looking at supporting it. They will provide direct support for campus research and demonstrations.

Fiber Status
WillTel is moving the POP (regeneration sites) which will slow down the final construction. Columbus core site surveys to begin on 12/16/03. Equipment installation will be completed 1/17/03 for the Columbus ring. Integration/conversion engineering is being done in many areas. Fiber characterization and site surveys will be completed by beginning of February 2004. Optical equipment has been received and will start burning in routing equipment in January. The gigE equipment (3750) that will be the uplinks between the old network and the new network are being shipped from staging directly to OARnet. Installation and testing should be completed by OARnet staff by 3/24/04. The Last Mile Committee contract should be in place by mid February. Implementation committee has the key milestones for installation. Fiber integration/conversion should be done by 1/28/04. Staging is on going from 1/7 to 3/15 and should have completed rings by 3/23/04. Disconnect of the current leased backbone and convert service to TFN backbone by 3/29/04. They are having weekly project and engineering team meetings. Collocation contracts should all be done by this Friday. The funding from PUCO is still on hold.

Will there be any more discussion with AEP to connect Athens through Portsmouth? This line would run down through WV and KY and they may be look at other schools in those states to see about bringing up this line as a ring.

Funding model - The fiber pricing committee put their funding model in front of the Osteer pricing committee. Since then the pricing committee has a sub-committee to bring up numbers based on the model. They hope to have real numbers by the next Osteer.

On the coming holidays, OARnet will have the support organization page on-call or leave a message. They will not have staff in the support center on the Christmas and New Years Day.

Minutes from the last meeting were approved.

Meeting was adjourned.