NEW GENERATION NON-COMPRESSED DIGITAL TRANSPORT TECHNOLOGIES ARE CHANGING THE SCOPE OF TODAY'S BROADBAND NETWORKS

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Abstract

This paper discusses the following trends in Non-Compressed Digital Video Transport:

- *Comparison of current technologies*
- *Interconnects driven by new revenue sources*
- *Economical digital interconnect improves business case*
- *Feature list of new digital technology*
- *Description of new revenue services*
- *Business case structure for interconnects*

DIGITAL TRANSPORT TECHNOLOGY

Modern non-compressed digital transport technology performs the most efficient long-range video transport of any methodology today. For a number of years, non-compressed digital transport has been used to interconnect major markets with many channels of video. The traditional benefits of interconnection include fewer, smaller, simpler headend facilities: fewer costly and unsightly outdoor dish farms; and better use of skilled technical people.

New Revenue Sources for MSOs

With the surging demand for additional revenue-generating services, these inter-connect systems are becoming increasingly significant. Operators who rapidly and efficiently introduce these revenue-generating services are able to fend off competition, and command early high rates of return. The consolidation of services in a master headend significantly reduces the amount of equipment and support overhead in each of the original remote headends, as summarized in Table 1.

Thus headend consolidation eliminates all or most of the support overhead expenses associated with each remote headend, savings that fall directly to the bottom line.

MSO Consolidation

The continued trend toward MSO consolidation has enabled the aggregation of adjacent properties that will be most efficiently run through a single master headend.

When the application demands long distance carriage and transparent signal quality, only non-compressed digital tech-nology can deliver the necessary performance.

But this level of quality and performance always carried a price tag, which limited its use to interconnecting major markets, where the cost could be spread over a large subscriber population. Now a new class of non-compressed digital interconnect technology is becoming available which, due to its lower cost, accommodates new applications in an affordable manner. These new systems will provide basic transportation of high quality video by taking full advantage of the newest multiplexing techniques, simplifying the packaging mechanics, and limiting bells and whistles to those features needed to assure reliability, such as status monitoring and path redundancy.

Service	Support Overhead
• Video-on-demand, NVOD	• Servers and support center
• Digital distribution (e.g. HITS)	• Satellite antennae, receivers, headend equipment
• High Speed Data	• Servers, support personnel, user help bank
• Telephony	• Equipment and local support infrastructure
• Commercial insertion	• Equipment and staff
• Video studio services	• Staff, equipment, floor space
• Local venue contribution networks	• Staff, equipment

Table 1.Master Headend Service Consolidation Reduces Equipment and Support Overhead Needed in Original Remote Headends

Trend toward Optical Multiplexing

The new breed of specialized video transport technology can be integrated in a compact package, which occupies limited rack space in already crowded headend facilities. It combines passive multiplexing using Dense Wavelength Division Multiplexing (DWDM) with the traditional Time Domain Multiplexing to carry up to 128 channels on a single fiber.

IF and Baseband

The new breed of digital transport technology carries both baseband video and IF, allowing long distance transport of IF carriers modulated with scrambled video, QAM, or QPSK information.

Channel-by-channel switchable IF or baseband transport provides flexibility to accommodate changing needs of the operator.

Optical Bit Rate and Range Implications

Since most of the multiplexing function can now be accomplished passively in the optical domain, relatively low bit rates can be used while still providing the necessary capacity on a single fiber. All DWDM transmitters operate in the 1550 nm optical window, where fiber dispersion limits distance between active repeaters. Higher bit rates yield shorter range. The effects of chromatic dispersion diminish the effective range of digital systems inversely proportional to the optical bit rate. As a result of this effect, SONET systems operating at 2.4 GB/s for the transportation of video typically have a range under 90km. With the lower modulation rates (typically 1.5 Gbps), range can be extended to hundreds of km with optical amplifiers before a repeater is needed.

Less Repeaters - Longer Distances

Long distance transport, and the expansion of distances between repeaters mean there will be less time and expense in establishing sites for repeaters.
This becomes especially critical when long distances are needed to close the return loop for the path redundant, self-healing ring.

Unlimited Expansion

Since traditional clock jitter problems have been overcome, it is possible to repeat and regenerate the digital signal for thousands of kilometers. This provides an open architecture for the future that would support transmitting some or all of the channels in an interstate network.

Data Transport

The advent of economical optical multiplexing allows integration of dissimilar technologies and data formats to coexist on the same fiber. Data transport technologies and formats are evolving rapidly, fueled by the tremendous decentralized demand created by the Internet. Demand for cable modem data, telephony, and other forms of digitized information are growing exponentially. Few people predicted the pace of Internet demand, as content providers rapidly emanated from decentralized sources.

As a result, data transport formats and equipment will continue to ride the crest of a well-funded development wave for several more years to come. Optical integration of the data carriage assures that the CATV operator will be able to avail himself of the most advanced and cost-effective data transport technologies, using Dense Wave Division Multiplexing, rather than Time Division multiplexing. Data services from various third party sources are integrated via selecting a compatible ITU wavelength laser. A multi-data format product is under development using the same modular optical and element management components as the digital video transport products.

APPLICATIONS FOR NON-COMPRESSED DIGITAL

It is easy to identify many otherwise difficult problems that non-compressed digital technology can solve. Here are some examples of applications for which this transparent transport technology can be useful.

Wide Area Interconnect

Headend facilities can be consolidated in regions that span hundreds of kilometers. As new revenue services appear, the economic critical mass is often inadequate to sustain the necessary equipment, facility, and support staff investment. An economical interconnect system can aggregate a sufficient number of subscribers to make the venture profitable. As a result, only fiber availability, not the cost of electronics, will drive the economics. Operators of classic systems can now consider the benefits of interconnection and headend consolidation.

Supertrunk or Interconnect over Telecommunications Fiber

It is generally not advisable to carry analog (CATV) and binary telecommunications (e.g., SONET) signals on different DWDM wavelengths on a single fiber. Yet there may be opportunities which are best served by transporting video on wavelengths leased from a telecommunications provider. Since non-compressed digital video is fully compatible with existing DWDM telecommunications networks, the technology can be used directly to transport video on unused wavelengths in these networks. In contrast, analog transmission over a leased wavelength is not at all straightforward, and will in many cases be impossible for reasons such as intolerably large (nonlinear) crosstalk effects. Apart from its ease of integration, non-compressed digital video is also the most cost-effective solution for such applications.

Lease Wavelengths to Others for Video Transport

Perhaps your company or an affiliate has telecommunications fiber serving business parks and large enterprises. Consider selling high quality, dedicated video circuits using DWDM wavelengths on the same fiber that carries telecom services. Simply use non-compressed digital equipment to encode and decode the video signals. This approach can generate revenue from service to sport venues, university and medical campuses, and entertainment and advertising video production centers. It allows telecommunications services and many channels of high quality video to be carried over the same fiber strand.

Localized Analog Programming to Complement Analog Program Spectrum

Operators strive to provide a programming lineup tailored to each community. This is difficult to do with conventional supertrunking techniques, which carry the same bulk analog spectrum to each hub. While it is feasible to transport targeted analog services in separate fibers and inject them into the channel lineup at appropriate frequencies in each hub, this is not a flexible approach. Non-compressed digital equipment delivers neighborhood-targeted programming to hubs in baseband or IF form, where a conventional modulator creates a clean RF channel at the proper frequency. Consider this as a method for "supertrunk bypass" to customize the channel lineup for neighborhoods.

Zoned Local Advertising

Local ad insertion is an important revenue stream. In major markets, this revenue can be enhanced by selling available advertising timeslots on a zoned basis -- a special case of the targeted programming application. The top-20 ad revenue channels will be in the analog domain for many years, of course, since advertisers buy into the most widely viewed programming. What is the best way to deliver customized versions of popular programming like ESPN to each neighborhood?

One way is to locate the ad insertion equipment in each hub, but this requires space in the hub for the insertion equipment and a baseband signal which supertrunk transport techniques do not normally provide. A better alternative is to perform the ad insertion at the headend or primary hub to create multiple versions of the top local ad channels and deliver these to hubs using the non-compressed digital supertrunk bypass system described above.

Or, if you prefer to keep the insertion equipment in each hub, use the non-compressed digital feed to provide the network signal. This way it arrives in baseband form as required by the insertion equipment.

PEG and Broadcaster Program Backhaul

Any interconnected region by definition serves a number of communities. The Public/Education/Government (PEG) programming is different for each community, and often originates at locations that are distant from a cable headend or hub (e.g., city hall). This content is created in baseband video form, so non-compressed digital transmission technology is the natural choice to carry PEG programming to cable facilities. Similarly, local over-the-air broadcasters use this technology to supply a pristine version of their broadcast signal for cable distribution.

This is just a sampling of applications for non-compressed video transport systems. As new models come to market, there are many choices which complement traditional video transport techniques and enhance the economic opportunities for cable operators.

ECONOMIC ANALYSIS

The business case for headend interconnects is critical to the decisions of how soon and how widely to establish interconnect systems. Recent advances in digital and DWDM technologies make a compelling case toward establishing super-headends with economical distribution of a full set of revenue services in a primarily optical domain all the way from the super-headend to the node.

Speed-to-Market for New Revenue Services

Time-to-market studies show that more rapid deployment of such revenue services provides the largest market capture rate and the earliest return on investment. Time-to-market is facilitated by rapid scaleable use of existing facilities, and avoidance of new brick and mortar.

Coupled with a DWDM hub distribution architecture, a high bandwidth forward and return system for each of these new services could rapidly be deployed using only existing space and facilities.

Some markets, typically outside of dense metropolitan areas, are candidates for interconnects to add additional services. Areas of lower population density, with smaller headends often do not have enough subscribers to support the business cast for the investment in additional services. Rural cable system owners are anxious to enter into the market for added revenue services such as high speed data, VOD, and cable telephony. Until recently the cost barriers to provide the interconnect were prohibitive. The introduction of more cost effective interconnects, has lowered the barrier to entry. A phased deployment of a multiple headend interconnect might proceed as shown in Table 2. Services following this could be telephony and true video on demand.

A profit-loss analysis (P&L) will demonstrate the economic viability of an interconnect. The P&L should be estimated over periods of one, two, and three years for each of these new service offerings:

- Internet Services
- NVOD
- VOD
- Telephony
- Commercial Insertion
- Venue contribution
- Studio Services
- Leased Transport

The below profit and loss analysis should be conducted for each of the service offerings.

- Added Revenue
- Cost Savings Interconnect
  *Reduced Staff
  *Reduced Buildings
  *Reduced Taxes
  *Reduced utilities
  *Reduced Operating Expenses
  *Elimination of remote headend equipment such as satellite dishes and receivers
- Cost Avoidance Interconnect
  *Obsolete Equipment Replacement
  *Duplication of Equipment in Remove Headends
- Total Revenue and Cost Savings
- Cost of Interconnect Equip & Installation
- Net Gain (Loss)

Phase 1	Installation of interconnect equipment at headends, (fiber in place).
Phase 2	Installation of NVOD servers
Phase 3	Installation of Cable Modem server
Phase 4	Initial NVOD revenue
Phase 5	Initial high speed data revenue

Table 2. Example of a Multiple Headend Interconnect Phased Deployment