# A Cost and Performance Comparison Between Uncompressed Digital Video and Lightly Loaded AM Supertrunking Methods within CATV Network Upgrades and Rebuilds

Robert W. Harris
C-COR Electronics, Inc.
State College, PA

*Abstract*

***This paper compares two types of fiber optic supertrunking methods - Lightly Loaded AM (LLAM) and uncompressed digital video - to determine the "overall" cost and performance impact on 750 MHz CATV upgrades and rebuilds employing a supertrunk. The analysis outlines channel loading, performance, fiber requirements, cost, and system compatibility issues for both AM and Digital supertrunking technologies. Included is a discussion of the advantages and disadvantages of each method as well as the associated cost and performance tradeoffs. It is found that the choice of supertrunking technology has a notable impact on the end-of-line system performance and, hence, the total cost of the CATV network upgrade or rebuild.***

## INTRODUCTION

The advances in AM and digital video fiber optic technology have led to dramatic improvements in CATV network designs that enhance system performance and reliability. One application for both AM and Digital fiber optic technologies has been their use in CATV supertrunking to deliver high quality signals deeper into the network.

Supertrunking is not a new concept in CATV. In the past, supertrunking was done to avoid the relatively higher costs of adding additional headends with their associated earth stations, large buildings, satellite receivers, modulators, and maintenance. Franchise extensions were accomplished through feedforward amplifiers, FM over coax, FM over fiber, and AML microwave. While signal quality at the end-of-line (EOL) improved, these technologies had their limitations with respect to transmission distance, performance, reliability, maintenance and cost.

The objective of today's CATV fiber optic supertrunks is to deliver a headend or near-headend quality signal at the receive site(s) or hub(s) relatively deep in the CATV network. The supertrunk receive site location also serves as a launch point for secondary AM fiber links which distribute services to the subscriber serving area. Future CATV supertrunk hubs may be a point of presence for telephone service transmission similar to the current telephony CO (Central Office). As such, the supertrunk receive site equipment is typically located in an environmentally controlled building with plenty of available equipment rack space.

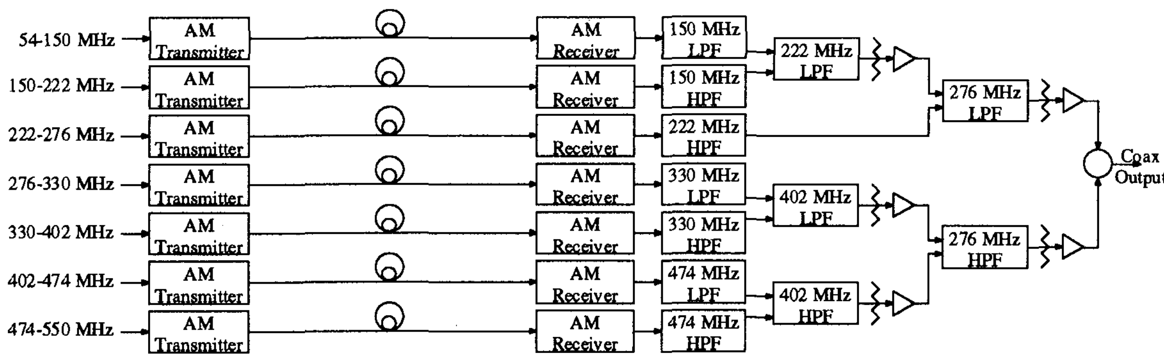
The supertrunk must also support a variety of signal formats such as VSB-AM, baseband and RF scrambled video, digital data, future digitally compressed video, and provide an output that is easily interfaced to the CATV RF distribution. It should have the capability for upgrade and expansion for redundancy and have minimal maintenance requirements.

This paper builds upon the information presented earlier in [1]. In the following pages, two types of CATV supertrunking methods are compared. The first is Lightly Loaded AM (LLAM) which transports about 10 channels per transmitter. The second is uncompressed 8-bit digital video transporting 16 channels per transmitter at 1.6 Gb/s. This analysis describes the channel loading, fiber requirements, performance, configuration, cost and compatibility issues of each supertrunk technology. This paper will also demonstrate the cost and performance impact on the secondary AM fiber link distance and RF distribution operating levels served from the supertrunk hubsite.

## LIGHTLY LOADED AM SUPERTRUNK DESCRIPTION

AM supertrunking is described in [1] and [2] as a method for eliminating and/or consolidating headends. This approach utilizes a tiering method whereby groups of 9 to 13 VSB-AM signals are directly modulated onto seven DFB lasers and transported over seven fibers (four fibers using wave-division-multiplexing). A block diagram of an AM

**Typical Lightly Loaded AM (LLAM) Supertrunk Configuration**
**Figure 1.**




supertrunk is shown in figure 1. The main advantage to this approach is the frequency arrangement of each tier. Except for the first transmitter, each subsequent transmitter is channel loaded at less than one octave. By loading to octave or less, the composite second order (CSO) distortion products fall out of the band being transmitted by the respective laser.

However, the CSO products which fall out of one RF band will appear in another RF band. To reduce the effect of this problem, each frequency band is filtered such that the distortion products are attenuated before recombining the various RF bands. Pads and post-amplifiers are used to obtain proper isolation and RF output levels. Through a 26 km path, the performance of the LLAM system is approximately 57 dB CNR, -70 dBc CSO, and -70 dBc CTB.

LLAM supertrunks are usually considered when the distance to the hubsite and/or secondary headend is 15 to 35 km away from the primary headend. This means that the LLAM supertrunk will operate through about 8 to 14 dB of fiber loss, assuming 0.4 dB/km at 1310 nm. The loss budget should typically not exceed 14 dB in order to maintain an adequate CNR performance (>55 dB).

After adding in connector, splice and WDM losses, little, if any, additional budget is available for splitting the optical output power from each transmitter in order to share a bank of transmitters with two or more hubsites. Therefore, when multiple hubs are served, the AM supertrunk requires a separate and *dedicated* LLAM link (bank of transmitters and bank of receivers, filters and combinors) from the headend to each hub site.

A complete 80 channel LLAM system with RF outputs typically occupies no more than one half of a six-foot rack at the headend and about the same at the hub site. The receive equipment is usually housed in an environmentally controlled building.

## DIGITAL VIDEO SUPERTRUNK DESCRIPTION

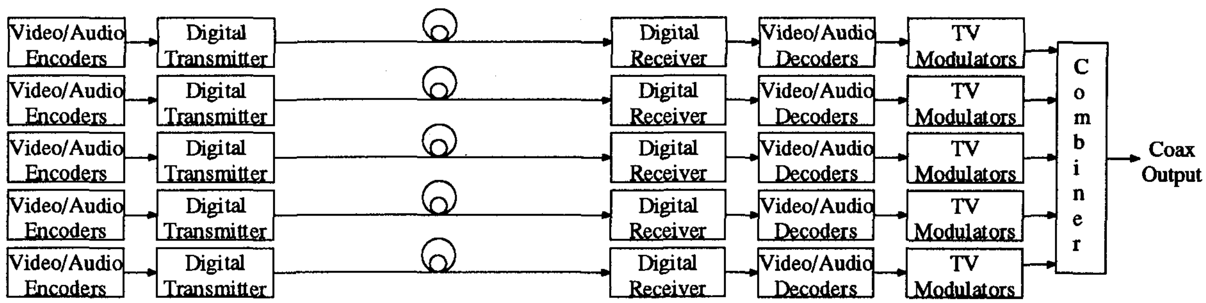
Uncompressed digital video transmission is described in [3] as another method for transporting headend quality video/audio signals to hubsites. One type of system is based on 8-bit video resolution codecs that provide RS250C medium haul performance at each hub site. A typical high speed digital transmission system has a data line rate between 1.6 and 2.4 Gb/s operating at either 1310 or 1550 nm and transports up to 16 uncompressed channels on a single wavelength through an optical loss budget of 30 dB. A block diagram of an 80 channel digital supertrunk is shown in figure 2.

In an uncompressed digital video system, each of the 16 channels are digitally encoded separate from one another then time-division-multiplexed (TDM) to create a high speed serial data stream operating at say, 1.6 Gb/s. The high speed data is then directed to the laser transmitter where it intensity modulates a Fabry-Perot or DFB laser diode.

The digital transmission system provides RS250C medium haul performance which is considered headend quality in that it delivers a 60 dB video SNR. Also, because of the use of synchronous time division multiplexing within the digital network, each channel is completely independent of one another and, therefore, *no* composite distortions are generated.

Digital transmission technology provides consistent signal performance at each hub and is not affected by channel loading, path loss variations or fiber chromatic dispersion as in AM fiber optic technology. Digital signals can be transparently

**Typical Digital Fiber Optic Supertrunk**
**Figure 2.**




dropped and repeated and new signals inserted (Add/Drop Multiplexing) at each hub. The digital network can be expanded to offer full optical component and path redundancy. Further, digital systems require very little maintenance and no operational adjustments or optimization.

An 80 channel digital system with RF outputs typically requires no more than one six-foot rack at the headend and about two six-foot racks at the hub site. The digital transmit and receive equipment requires an environmentally controlled building.

## COST COMPARISON BETWEEN LLAM AND DIGITAL SUPERTRUNKING

Given below in Table 1 is a direct cost comparison between supertrunking technologies for an 80 channel system with multiple receive sites. The LLAM system cost includes all optical modules, RF filtering and post-amplification. It is assumed that each of the hub sites are fed with a dedicated LLAM system, i.e., no optical splitting of the transmitters.

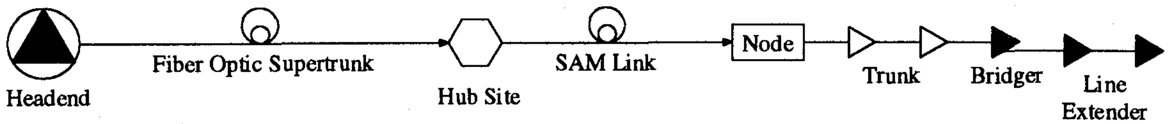
The uncompressed digital fiber network, with a 30 dB loss budget, can make use of optical splitting at the transmitter output to increase the number of receive sites served from a transmit site. Sharing the transmitters with multiple receive sites lowers the total cost of the digital network. The cost provided for the digital network includes all modulators and/or IF to RF output converters for delivering RF outputs.

Table 1 indicates that the LLAM system equipment cost is less than the digital video system equipment cost regardless of the number of receive sites. However, one must look beyond the direct cost differences and consider the *overall* impact from the supertrunk with respect to cost and performance on the entire CATV system. In other words, what effect, if any, does the slightly lower performing (near-headend quality) LLAM supertrunk have on the secondary AM fiber and RF cascade performance? And specifically, what impact do changes in that portion of the system have on the overall system cost due to the finite composite distortions (CSO and CTB) incurred through the LLAM system?

**Cost Comparison Between LLAM and Digital Supertrunk**
**Table 1.**

| Number of Receive Sites | Equipment Cost for LLAM System ($) | Equipment Cost for Digital Network ($) | Cost Premium for Digital ($) |
|---|---|---|---|
| 1 | 110,000 | 345,000 | 235,000 |
| 2 | 220,000 | 580,000 | 360,000 |
| 3 | 330,000 | 815,000 | 485,000 |
| 4 | 440,000 | 1,050,000 | 610,000 |
| 5 | 550,000 | 1,250,000 | 700,000 |
| 6 | 660,000 | 1,480,000 | 820,000 |
| 7 | 770,000 | 1,710,000 | 940,000 |
| 8 | 880,000 | 1,940,000 | 1,060,000 |

**Fiber Rich Architecture Employing Fiber Optic Supertrunk, Secondary AM and RF Distribution**
**Figure 3.**




## EOL PERFORMANCE AND COST PER MILE IMPACT RESULTING FROM EACH SUPERTRUNK APPROACH IN A FIBER RICH ARCHITECTURE

Figure 3 shows the CATV network diagram that uses headend to hub supertrunking within a 750 MHz fiber rich system loaded with 80 analog carriers. The output of the hub site is a secondary AM link defined in this paper as the SAM link. The SAM link carriers the full 50 to 550 MHz AM-VSB signal format on a single fiber. Following the SAM link are two power doubling trunk amplifiers, a power doubling bridger and two power doubling line extenders. On average, the serving area covered by each secondary AM node is 10 miles of RF distribution. The EOL performance objective is 48 dB CNR, -53 dBc CTB and -58 dBc CSO.

### EOL Performance from a Digital Hub

The output of a digital video fiber optic supertrunk yields a performance identical to that of a standard CATV headend. This is a best case initial starting point and allows the maximum optical path losses on the SAM link and the highest operating output levels on the RF amplifiers. The SAM link distance and the RF amplifier operating levels are determined to meet the EOL performance of the system. Table 2 shows the secondary AM path distance, RF operating levels and EOL performance.

### EOL Performance from a LLAM Hub

With the hub site fed from a LLAM supertrunk, the system again meets the EOL performance by determining the secondary AM link distance and RF amplifier operating levels. The secondary AM path distance, RF operating levels and EOL performance are given in Table 3.

The LLAM supertrunk provides near-headend quality performance with a CNR of 57 dB. However, even though lightly loading the transmitters with 9 to 13 channels, a finite and measurable level of composite distortions still exist.

Table 3 shows that the LLAM performance does affect the secondary AM node optical path distance as well as the operating levels in the RF distribution. To meet the same EOL performance as achieved with a digital supertrunk, the secondary AM link distance was ***decreased by 1 dB*** and the RF operating levels of the line extenders was ***lowered by 2 dB***. Next, the total system cost impact from the SAM fiber link loss and RF level changes will be discussed.

### Secondary AM Electronics Cost per Mile Using Digital Supertrunking

From Table 2, we see that the SAM link is designed for an 11 dB link loss. Typically, the SAM link uses optical splitting in order to serve two or more nodes from a single transmitter. A common transmitter-to-receiver usage ratio ($\rho$) is 1:2.5 or one transmitter for every 2.5 nodes. In other words, each AM link shares 40% of the cost of an AM transmitter. From this, we can determine the secondary AM cost per system mile from an ideal starting point (a headend or digital hub) using the equation,

$$SAM_{DS} = [(C_T * \rho_1) + C_N] / N_m \qquad \text{eq. 1}$$

where,

$SAM_{DS}$ = secondary AM cost per system mile using Digital supertrunk
$C_T$ = cost of AM transmitter
$C_N$ = cost of AM Node
$\rho_1$ = AM transmitter usage ratio with Digital
$N_m$ = number of miles of RF distribution served per node.

With $C_T$ = \$13,000, $C_N$ = \$2,000, $\rho_1$ = 0.4 and $N_m$= 10 miles, we find the secondary AM fiber electronic cost to be about \$720 per mile. Again, this cost is assuming that the Hub is providing headend quality signals at the input to the SAM transmitters.

### Secondary AM Electronics Cost per Mile Using LLAM Supertrunking

With a LLAM fed hubsite, the secondary AM link can still use optical splitting in order to serve two or more nodes from a single transmitter. And each node still serves 10 miles of distribution. However, there is now only 10 dB of fiber link loss to work with instead of 11 dB, a 20% reduction. As

**End-of-Line Performance with Digital Supertrunk (Analog carriers to 550 MHz)**
**Table 2.**

| Cascade Length | Equipment Description | Output Level 750/54 MHz | CNR (dB) | CTB (dBc) | CSO (dBc) |
|---|---|---|---|---|---|
| 1 | Digital Supertrunk to hub site(s) | N/A | 60.0 | -120 | -120 |
| 1 | Secondary AM fiber to Nodes, 80 channel loading, 11 dB optical link loss | 37/32 | 51.0 | -65.0 | -63.0 |
| 2 | 29.5 dB spaced, 750 MHz Power Doubling Trunk, 80 analog channels | 38.5/27.5 | 55.5 | -72.5 | -67.0 |
| 1 | 37 dB gain power doubling Bridger | 46/35 | 58.5 | -69.0 | -70.5 |
| 2 | 33 dB gain power doubling Line Extender | 47/36 | 57.5 | -59.5 | -62.0 |
| | | **EOL Performance** | **48.2** | **-53.1** | **-58.5** |

**End-of-Line Performance with LLAM Supertrunk (Analog carriers to 550 MHz)**
**Table 3.**

| Cascade Length | Equipment Description | Output Level 750/54 MHz | CNR (dB) | CTB (dBc) | CSO (dBc) |
|---|---|---|---|---|---|
| 1 | LLAM Supertrunk to hub site(s) | N/A | 57.0 | -70.0 | -70.0 |
| 1 | Secondary AM fiber to Nodes, 80 channel loading, **10 dB optical link loss** | 37/32 | **52.0** | -65.0 | -63.0 |
| 2 | 29.5 dB spaced, 750 MHz Power Doubling Trunk, 80 analog channels | 38.5/27.5 | 55.5 | -72.5 | -67.0 |
| 1 | 37 dB gain power doubling Bridger | 46/35 | 58.5 | -69.0 | -70.5 |
| 2 | 33 dB gain power doubling Line Extender | **45/34** | 55.5 | -63.5 | -64.0 |
| | | **EOL Performance** | **48.1** | **-53.3** | **-58.8** |

a result, this reduces our transmitter-to-receiver usage ratio ($\rho$) by 20% to 1:2.0 or one transmitter per 2 nodes. In other words, each AM link now supports 50% of the cost of an AM transmitter. From this, we can determine the LLAM fed secondary AM cost per mile. Using equation 1a we find,

$$SAM_{AS} = [(C_T * \rho_2) + C_N] / N_m \qquad \text{eq. 1a}$$

where,

$SAM_{AS}$ = secondary AM cost per system mile using LLAM supertrunk
$C_T$ = cost of AM transmitter
$C_N$ = cost of AM Node
$\rho_2$ = transmitter usage ratio with LLAM
$N_m$ = miles of RF plant served per node.

With $C_T$ = \$13,000, $C_N$ = \$2,000, $\rho_2$ = 0.5 and $N_m$= 10 miles, we find the secondary AM fiber electronic cost to be about \$850 per mile. This cost is assuming that the Hub is providing a near-headend quality signal at the input to the SAM transmitters. Relative to the headend quality digitally fed hub site, this represents an additional \$130 per system mile in secondary AM fiber electronic costs.

**RF Electronics Cost Impact due to LLAM Supertrunking**

There is also a cost penalty for operating line extender RF amplifiers at lower levels relative to the levels when served from a headend quality hub site. Lower operating levels in the RF distribution results in an increase in the number of active and passive RF components used. Design models [4] have shown that the associated cost penalty ranges from \$175 to \$225 per 1 dB lower operating levels per one mile of CATV system with active return. An equation is given to calculate the additional cost of operating RF amplifiers at lower levels.

$$CP_{RF} = RF_{C/M} * n \qquad \text{eq. 2}$$

where,

$CP_{RF}$ = cost penalty per n dB of RF level change in one mile of active plant
$RF_{C/M}$ = additional RF electronics cost per mile per 1 dB of level change
n = number of dB level change from an optimum headend output

Using the average additional cost of \$200 per 1 dB level change per system mile, we find that 2 dB lower RF operating levels results in an additional cost of \$400 per mile in the RF distribution.

**Overall CATV Cost Impact Associated with Each Supertrunking Method**

This section investigates the total system cost impact on the secondary AM and RF electronic components as a result of employing a supertrunk. We look at various system sizes and determine the cutoff point where any cost savings from the LLAM supertrunk are offset by additional expenses in the secondary AM and RF portion of the plant.

From the above discussions, we can formulate an equation (equation 3) which characterizes the total system cost penalty from using a LLAM supertrunk system. This model considers system size in miles and assumes that a certain number of hubs are required for a given system size. In this example, it is assumed that a Hub is required for every 500 miles of CATV distribution. The cost premium of the digital supertrunk is then subtracted from the cost penalty associated with the LLAM supertrunk.

$$CP_{AS} = S_m[CP_{RF} + (SAM_{AS} - SAM_{DS})] - CP_{DS} \quad \text{eq.3}$$

where,

$CP_{AS}$ = total system cost penalty from using LLAM supertrunk
$C_{RF}$ = RF electronics cost per mile associated with change in RF operating levels
$SAM_{AS}$ = secondary AM cost/mile when using a LLAM supertrunk
$SAM_{DS}$ = secondary AM cost/mile when using a digital supertrunk
$S_m$ = total number of system miles
$CP_{DS}$ = cost premium of digital supertrunk

The following example illustrates the point. Assume a 2,000 mile plant with four hub sites. From Table 1, the cost premium for a digital supertrunk ($CP_{DS}$) with four hub sites is \$610,000. From equation 3 we get,

$$CP_{AS} = 2000 * [\$400 + (\$850 - \$720] - \$610,000$$

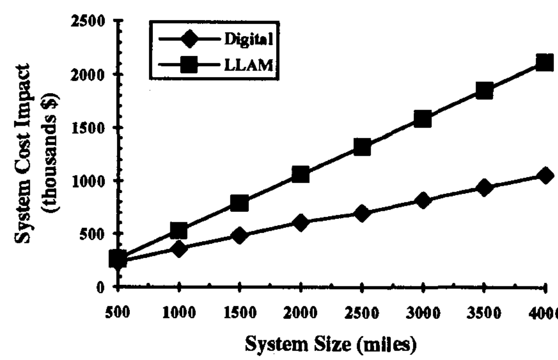
$$= 2000*(\$530) - \$610,000$$

$$= \$1,060,000 - \$610,000$$

$$= \$450,000$$

In other words, the original cost savings of \$610,000 (\$1,050,000 cost for digital minus \$440,000 cost for LLAM) from using a Lightly Loaded AM supertrunk is offset by \$1,060,000 from additional costs in the secondary AM and RF distribution portions of the network. This results in an additional \$450,000 overall system cost from using the LLAM supertrunk. Table 4 and figure 4 shows the total system cost impact from implementing either LLAM or digital supertrunk over a variety of system miles.

**Cost Impact of Each Fiber Optic Supertrunk on the CATV Network**
**Figure 4.**




Note that the digital network used in the example is a simple point-to-multipoint star configuration and it is assumed that a single bank of optical transmitters can be split to feed all the receive sites. More sophisticated digital networks with "self healing" and redundancy options and/or longer path losses requiring additional transmitter and/or repeaters will increase the cost of the digital network.

## ADVANTAGES AND DISADVANTAGES OF EACH SUPERTRUNKING TECHNOLOGY

**LLAM Supertrunk Advantages**

There are a number of advantages when using the LLAM supertrunking approach as outlined above. Using wave-division-multiplexing (WDM) only four fibers are required to transport 80 channels. There are no signal format changes that

**Total CATV System Cost Penalty When Using AM Supertrunk**
**Table 4.**

| System Size (miles) | # of Hubs (est.) | Cost Premium for using Digital ($) From Table 1 | AM and RF Cost Penalty from using LLAM ($) | Total System Cost Penalty from using LLAM ($) |
|---|---|---|---|---|
| 500 | 1 | 235,000 | 265,000 | 30,000 |
| 1,000 | 2 | 360,000 | 530,000 | 170,000 |
| 1,500 | 3 | 485,000 | 795,000 | 310,000 |
| 2,000 | 4 | 610,000 | 1,060,000 | 450,000 |
| 2,500 | 5 | 700,000 | 1,325,000 | 625,000 |
| 3,000 | 6 | 820,000 | 1,590,000 | 770,000 |
| 3,500 | 7 | 940,000 | 1,855,000 | 915,000 |
| 4,000 | 8 | 1,060,000 | 2,120,000 | 1,060,000 |

need to take place (AM-VSB in, AM-VSB out). Scrambled signals are transported in the same manner as non-scrambled signals. Spare equipment requirements are relatively modest and inexpensive.

For the system architecture shown here, the overall system cost is not significantly impacted when the Hub site is fed from a Lightly Loaded AM supertrunk and the RF distribution served from that Hub is less than 500 miles.

The rack space requirements are modest - about one half of a six foot rack in the headend and the same in the receive site. The receive site equipment can even be located within an outdoor pedestal that is environmentally controlled with a relatively small (< 2,000 BTU's) air conditioning unit.

**LLAM Supertrunk Disadvantages**

The main disadvantage of LLAM supertrunk is its cost impact on the secondary AM and RF distribution electronics in the network. This is the result of its slightly lower performance (near-headend quality) relative to uncompressed digital. For the given model above, this occurs in supertrunk Hub distribution areas larger than 500 miles.

Also, for an 80 channel LLAM supertrunk, there can be as many as twelve RF bandpass filters. The use of these filters yields seven cross-over channels. Each cross-over channel will suffer a slight degradation relative to the non-crossover channels in carrier level and CNR performance.

Additionally, each AM link will require optimization for obtaining the proper RF output and signal performance from each frequency band. If optical automatic level control (ALC) is not employed within each transmitter and receiver, path loss and transmitter output power variations over time may cause one or more of the RF frequency bands to vary in level relative to one another causing each group of frequency bands being "off" in level.

**Digital Advantages**

Uncompressed digital video networks provide an identical and consistent headend quality signal performance at each and every hub site regardless of path loss. Digital systems do not require optimization of each link or path. Optical loss budgets of 30 dB allows multiple splitting of the transmitter output so as to share the cost of the transmit equipment with multiple receive sites. WDM can be used to transport 80 uncompressed digital channels over three active fibers with a spare window available for future use.

Neither diplex filtering nor post-amplification is required and there are no cross-over channels in a digital system. The RF output levels and performance at each digital receive site does not vary with changes in the optical path or additional channels added to the network. At least one digital video equipment supplier can now transport all forms of IF scrambling. The technique used to accomplish IF scrambling allows transportation of digitally compressed video using 64 QAM and/or 16-level VSB carriers.

A relatively simple and inexpensive digital network (point-to-multipoint) can be installed and later upgraded to a redundant and automatic "self-healing" ring network that provides the maximum level of protection from fiber path or component failures. With an installed digital network, a platform is in place for future growth into regional networking.

**Supertrunking Comparison**
**Table 5.**

| 80 Channel Supertrunk Features | Digital | LLAM |
|---|---|---|
| Consistent Signal Performance at each Hub Site | Yes | No |
| Variation in performance due to different path losses or channel loading | No | Yes |
| RF Diplex Filters required | No | up to 12 |
| Number of Cross-over Channels | None | 7 |
| Potential for variation in RF output level due to fiber electronics | No | Yes |
| Requires RF Scramblers at receive site(s) | No | No |
| Transports *all* forms of scrambling (Baseband and IF) | Yes | Yes |
| RF Scrambled channels transmitted per wavelength | 16 | Variable |
| Requires Modulators or IF/RF converters at receive Site(s) | Yes | No |
| Post-amplifiers required at receive rite(s) | No | Yes |
| CNR | 60 dB | 57 dB |
| CSO (worst case) | None | -70 dBc |
| CTB (worst case) | None | -70 dBc |
| Number of fibers required without WDM | 5 | 8 |
| 1550 nm optical terminals available | Yes | Yes |
| Number of fibers required with WDM | 3 | 4 |
| Platform in place for interconnected hub sites and regional networking | Yes | No |
| Transports digitally compressed video carriers | Yes | Yes |
| Transparent optical repeating | Yes | No |
| Optical loss budget available | 30 dB | < 14 dB |
| Maximum point-to-point distance | 100 km | <35 km |

**Digital Disadvantages**

Digital video networks do, however, require considerably more rack space and power consumption than an AM supertrunk approach. This is primarily because each channel is processed separately. Unlike the VSB-AM in/out from AM fiber systems, digital system inputs typically require baseband video and either baseband audio or 4.5 MHz audio subcarrier. Modulators or IF/RF upconverters are required at each hub site. Each digital receive site requires as many as 2 seven-foot racks and air conditioning of about 7,000 BTU's. Table 5 shows a comparison between LLAM and digital supertrunking.

## CONCLUSION

Two methods of fiber optic supertrunking for CATV applications, Lightly Loaded AM and uncompressed 8-bit digital video, have been examined to determine the impact each technology has on the overall cost and performance. LLAM supertrunking provides near-headend quality performance through less than 12 dB of optical loss while digital video transmission provides headend quality through 30 dB path losses. Both technologies can employ WDM to reduce active fiber count requirements.

The slightly lower performance of the AM supertrunk relative to digital supertrunking has been shown to directly add expense in the RF distribution and secondary AM portions of the CATV system. This leads to the requirement of, 1) operate the RF distribution at lower operating levels and, 2) design lower path losses for the secondary AM links that serve the nodes.

As a result, the total system cost can actually be *less* when using a digital as opposed to a LLAM supertrunk. This is due primarily to the performance difference of the LLAM relative to the digital supertrunk which results in shorter allowable secondary AM path links and lower RF distribution levels which translate into additional AM transmitter and RF electronics costs, respectively.

This analysis has shown that there are more factors associated with the selection of a supertrunk than simply the head to head cost comparison. The CATV network design engineer must carefully consider the overall system cost impact from each method of supertrunking. Factors include transmit/receive site building size, power consumption and cooling requirements, as well as any additional RF distribution and secondary AM costs.

## ACKNOWLEDGMENT

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