Media Centers: A Means of Adding Flexibility and Management Capability to the Physical Layer of Computer Networks

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Abstract

Over the past decade the size of computer networks has steadily grown. Most network support staffs have struggled to keep pace with this growth because many companies have been hesitant to add staff at the same rate the number of network nodes have increased. Therefore, the importance of SNMP-based management tools such as OpenView and SNMPc in meeting this growth cannot be overstated. These products provide a GUI interface to network resources that allows the network administrator to manage many critical network functions from his/her workstation resulting in a substantial increase in the number nodes a given administrator can manage.

SNMP technology has been around for a number of years, and the success of its usage in devices that function on data link, network or higher OSI layers such as bridges, routers and servers/hosts is well documented. Until recently this technology had seen limited application on the physical layer. Over the past year a number of companies have introduced the concept of a media center which provides a central manageable connecting point for all copper or fiber links coming into an equipment room. These media centers are SNMP configurable to take advantage of the power of SNMP management capabilities. Furthermore, these rack-mounted, open architecture devices typically feature redundant power supplies, SNMP modules and 16 slots to support a wide variety of media conversion cards such as 100baseFX to 100baseTX, 10baseF to 10baseT and ATM:OC3F to ATM:OC3T. This concept adds flexibility in linking the existing media to the array of hubs, switches, bridges and routers required to provide network connectivity. For example, two switches with a 100baseTX ports could easily be connected together with fiber by simply plugging the fiber into 100baseFX to 100baseTX conversion cards. Besides providing flexibility in connectivity, the media center concept

is also cost effective. In fact, the money saved from rewiring and adding expensive fiber ports to nodes is many times greater than the cost of the center itself.

To illustrate how a media center could be integrated into the network fabric a case study approach will be employed. In this case study the use of a media center to facilitate the relocation of the main network equipment room to another building will be examined. The benefits of employing the media center approach will be analyzed from a flexibility, reliability, management, transparency and cost effectiveness perspective.

The flexibility of the media center will be described by citing examples from the case study in which existing components were linked to different flavors of existing media via the media center. The examples cited will also be analyzed in regard to saving realized as a result of not having to rewire. Reliability will be examined by an analysis of the center's fault tolerance and hot swap capabilities. Furthermore, the configuration process and use of the SNMP capabilities will be described. Specifically management of power supplies, link states and connection statuses through SNMPc will be illustrated through examples from the case study. Last, the media center will be examined in regard to manufacturer's promises of transparency. To accomplish this a workload generator will be used to transmit a replicable data stream to a data sniffer. This data flow will be transmitted twice – once with the media center cards between the devices and once without. The manufacturer published delays will be compared to the results of the experiment to ascertain if the minimal delays advertised can be realized.

Need/Rationale

Computer networking in any environment is a challenging endeavor, but in the educational environment that challenge is heightened by the effects of rapidly changing technology and limited funding. Therefore, any networking devices that allow the network administrator to do more with the existing infrastructure are welcomed additions.

Increased workload which translates to new and/or higher speed protocols on the physical layer has necessitated changes within the physical media of most networks. In some cases the solution has been to almost completely recable between the nodes. This may provide the optimal design solution, but it is very expensive. Paying for the wire, labor and termination devices can rapidly run into the tens of thousands of dollars – a sum that can often eclipse the entire equipment budget of an academic department.

A more cost effective solution would be to use the existing wiring structure as much as possible and convert it to the new technology through the media center technology.

The Media Center

The media center is billed by one manufacturer as a high density multi-protocol, multi-media conversion center incorporating hot swap ability and SNMP management. [1]. It is designed to provide a central physical connectivity point for large LANs which would make it attractive for university applications which involve substantial numbers of nodes and expect additional growth.

The basic rack mount chassis can be populated with a wide variety of modules representing numerous network types. In fact, one company markets twenty four different modules which represent most of the common network types, such as ethernet, fast ethernet, ATM, token ring, FDDI, gigabit ethernet and 5250. [2]. Because the chassis has 16 available slots it is possible to analyze the current need then configure the chassis and populate other slots as the need arises. For mission critical applications, redundant power supplies are available and SNMP modules can be added to support remode diagnostics/management through a software product such as Castlerock's SNMPc.

Case Study

The case study herein illustrated is based upon the reconfiguration of a wiring plant used by an educational network domain. The network in question consists of approximately 250 nodes and supports labs, servers, and workstations for an academic department. The reconfiguration was necessitated because due to expansion the main communications equipment room was moved to another building approximately 1000 feet away. Figures 1 and 2 depict the network design prior and after the move. Prior to the move the equipment room was adjacent to the main lab which allowed convenient access between the two rooms. Adequate performance could easily be insured by breaking the lab into virtual networks and bringing the required number of physical feeds. The added distance made this strategy no longer feasible. An analysis of the peak traffic between the lab and the servers revealed that a fast ethernet feed (100 Mbs) would be inadequate. A gigabit ethernet solution was studied but was found to greatly exceed the available funding. The solution enacted was double piping fast ethernet. This solution was cost effective but required the use of two pairs of fiber to carry the traffic. Prior to the implementation of the proposed solution, only one pair was in place. That pair supported a fast ethernet connection to the research and development lab from the original equipment room.

Figure 1

Old MCS Network

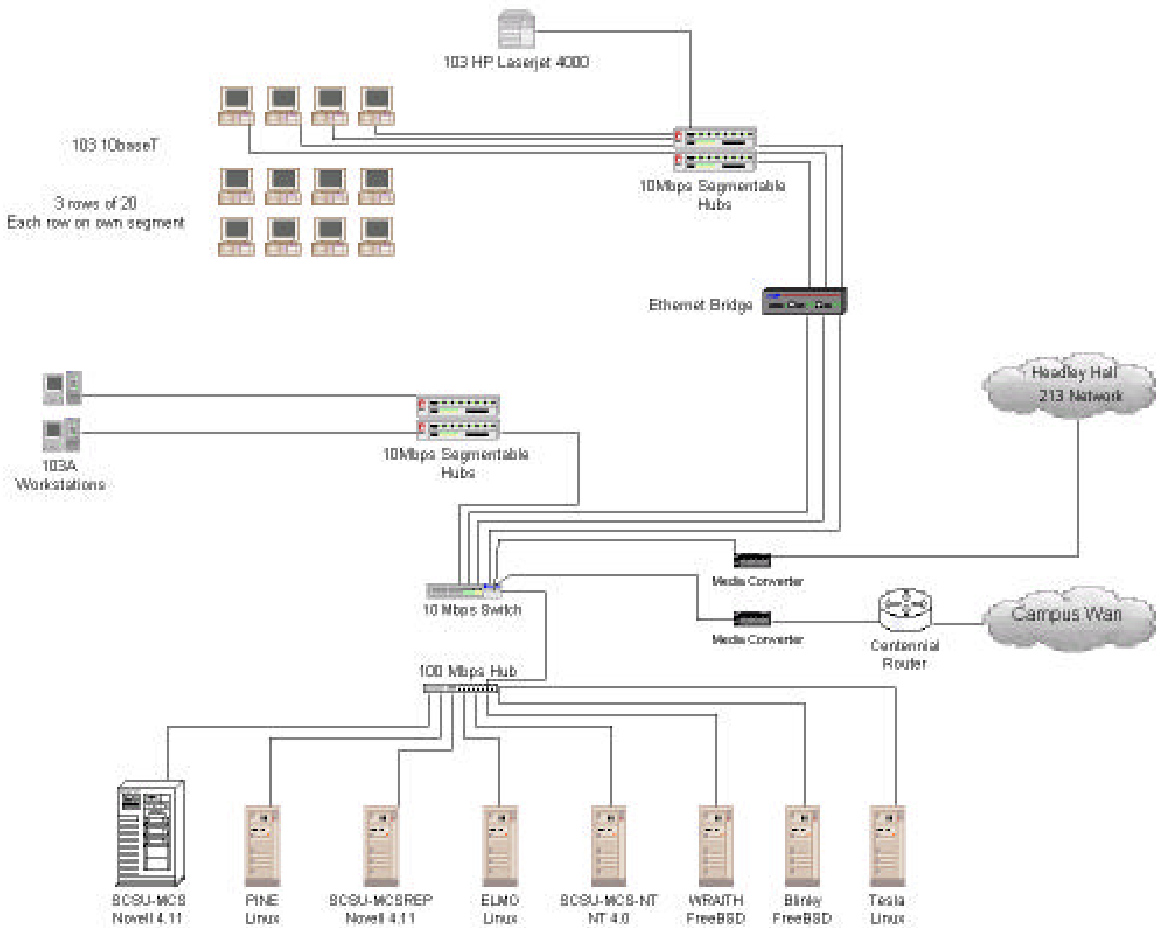
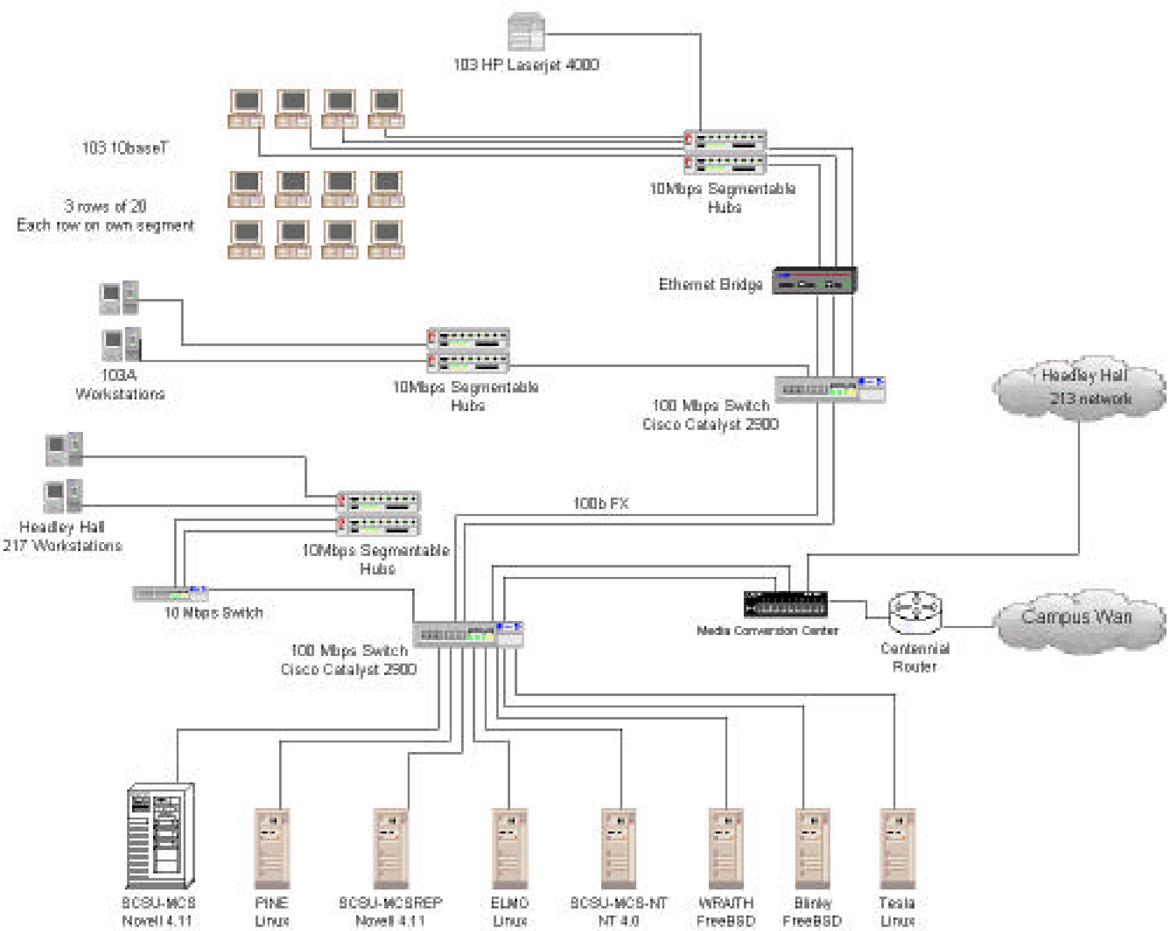


Figure 2

New MCS Network



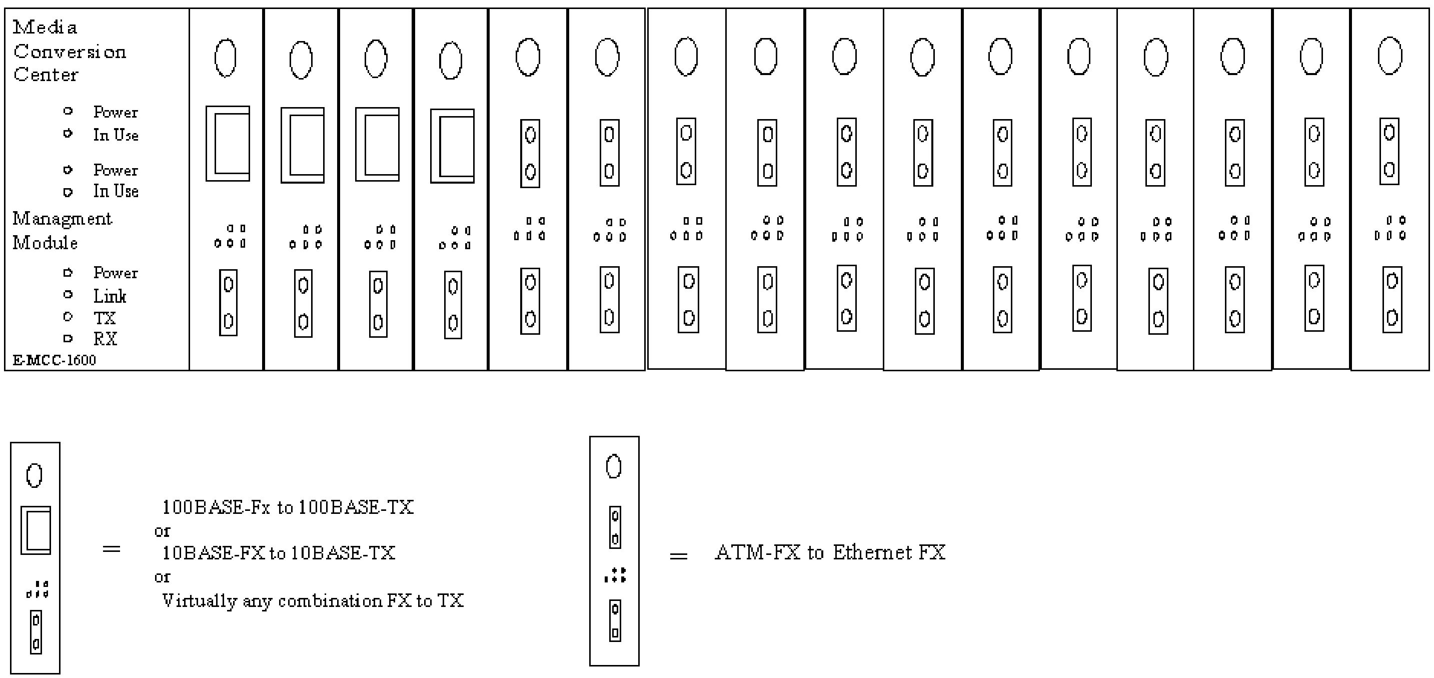
The devices selected to support a dual fast ethernet connection were Cisco 2900 series switches. Because it was known that the double pipe would run on fiber, the switches were purchased with two fiber ports and sixteen twisted pair auto detecting ports. It was suspected that during the process of moving the equipment room additional fiber connections would need to be made to the switches, but it wasn't clear where. So rather than pay for additional fiber ports in switches that may or may not be used, it was decided to use the media center concept to handle conversion. Two mission critical applications appeared immediately. First, a fast ethernet connection to the research and development lab was needed because the prior connection had become one of the two physical link of the dual fast ethernet connection. The R and D lab was now in the same building as the equipment room which lessened the distance the physical media would need to be run. Second, the network domain's campus and ultimately internet feed had to be rerouted through the new building. In both cases access would be provided via the new building's central communications closet. Because twelve pair fiber had already been run between that closet and the new equipment room to support the dual fast ethernet connection, no additional wiring would be needed if the fiber could be converted to twisted pair to match the available open ports in the switch.

This was easily accomplished in the media center by configuring one 100BaseFX to 100BaseTX converter for R and D lab connection, and one 10BaseF to 10BaseT converter for the campus connection. Furthermore, the rerouting of the campus connection frees up a fiber port on a workgroup switch (3 com Linkswitch 1000) which now can be allocated to provide workstation connectivity to an upper level networking lab. To accomplish this, the workgroup switch will be connected to the catalyst switch by fiber which will need to be converted to twisted pair to match the available ports on the catalyst switch.

In order to enhance instructional capabilities in WANs and new cell transfer technologies an asynchronous transfer mode (ATM) network is planned to be added to the upper level network lab. To be cost effective, the fiber based network will require media conversion on each end of the planned 12 fiber links. By purchasing twisted pair technology on the ATM switch and NIC level savings were realized and the flexibility was available through the media center if fiber connectivity was required. Figures 3 and 4 show the configuration of the front and back of the media center used in the case study.

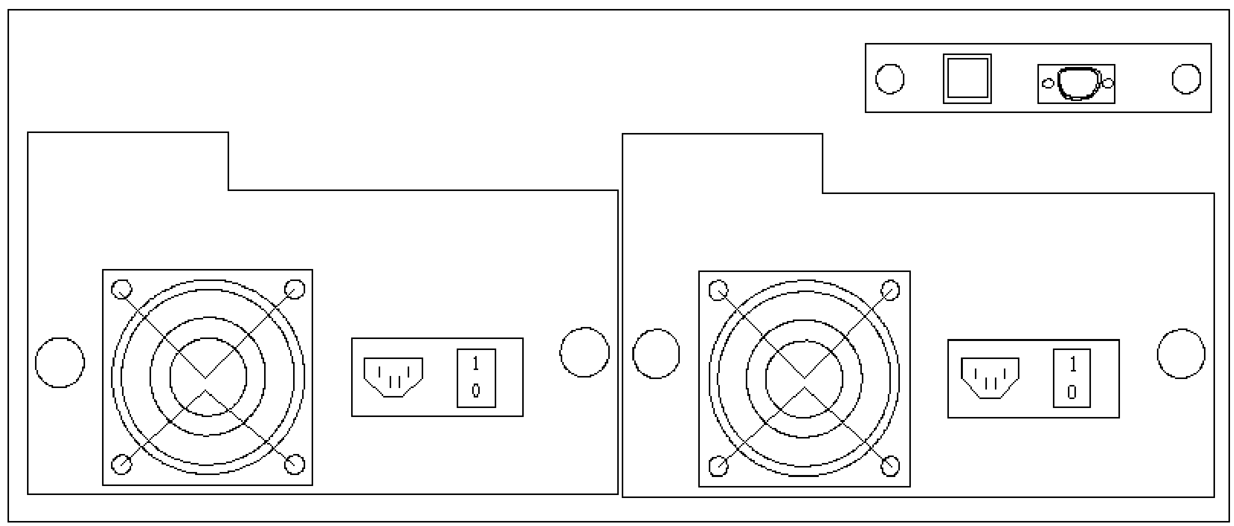
Figure 3

Media Conversion Center Front



Media Conversion Center Rear

Figure 4



Approximately six months after moving the computer room the campus engineer decided to upgrade the campus feed for the domain from 10 Mbs ethernet to fast ethernet. Once again the media center proved its value because all that needed to happen was changing the media converter in question from a 10BaseF/10BaseT to a 100BaseFX/100Base TX. Because the center supports hot swap capability the conversion can easily be accomplished in five to ten minutes.

SNMP Capabilities

An optional SNMP module is available on some of the centers. Because SNMP is widely used with other network components, this seems a logical way to provide remote management. SNMP or simple network management protocol derives its name from the fact that it uses a simple method, polling, to collect data. This simplicity, however, is a disadvantage from a performance perspective because of the numerous poll (UDP) packets it generates. [3] SNMP has been joined in TCP/IP protocol suite by new protocols such as CMOT which is event driven rather than poll based. [4]

Most major network components have these SNMP capability. Either the logic is included on the hardware level through firmware (such as in hubs, media centers and switches) or it is a loadable process (used for servers and workstations). Once configured these “SNMP agents” are able to provide diagnostic, management and statistical information through monitoring interfaces such as Castlerock SNMPc, HP-Openview and Novell’s TCPcon. The first two would run on windows-based workstations, whereas TCPcon runs on a Netware fileserver.

The process for integrating the media center into the management strategy of a network is relatively simple. First, via a standard RS-232 port the media center receives initial start-up instruction including the assignment of an IP address. Second, the network monitoring software being used needs to be upgraded to include the management information based on the type of media center being installed. After that management can take place remotely via an ethernet connection using the monitoring software as the interface.

The monitoring software allows the network administrator to remotely view what type of card is in each slot of the chassis, and the status of both the primary and secondary (if so configured) chassis power sources. It is also possible to control each individual module and view its power status, link state and transmit/receive status.

Media Transparency

Media converters are electronic devices and, therefore, generate additional delay on a network link. If that delay is minimal, the added flexibility gained in converting that media is well worth that delay. To determine if that delay was indeed minimal a test bed was devised using two PC’s. One PC ran a workload simulator that could be programmed to generate the same workload stream multiple times. The second PC served as the data monitor and was used to collect the time stamps of each individual packet as it arrived. The same data stream was sent twice. First the machines were simply connected by a crossover cable. In the second trial they were connected by patch cables to 10BaseT to 10BaseF media converts which were in turn connected by a fiber patch cable. The crossover was accomplished with the fiber patch cable.

According to one manufacturer there is a four-nanosecond delay in crossing the 10Base media converter [5]. This value is certainly well within the acceptable levels of cost effectiveness from a delay to flexibility gained perspective. In the example above, that value would need to be doubled because there were two media converters in the link. Also, there was an additional copper patch cable and a fiber patch cable that would further but minimally add to the propagational delay on the link configured with media converters.

Table 1 provides descriptive statistics obtained from the two trials. The mean interarrival rates are similar in fact adding the media converters to the link only increased the mean about .0042 seconds. Furthermore, the variance within each trail is similar based on the standard deviation observed. The data from each trail was fitted to a number of known distributions, and they both fit a weibul distribution and exhibited similar parameters. However, for that relationship to take place, the alpha had to be set at .01 indicating only a marginal fit. For the no media converter trial the values were theta = 0, slope = .24, and scale = 0. When the media converters were inserted the values observed were theta = 0, shape = .23, and the scale = 0. This consistency in distribution would indicate that the delay is not compounding over time based on the sample utilized. Although it is worth noting that larger samples beyond the approximately 7500 packets studied herein might provide different results.

Table 1
Media vs. no Media
Interarrival Times
With ARP Packets Removed

Variable: IA

MEDIA	N	Mean	Std Dev	Std Error
N	7476	0.01862850	0.40406253	0.00467320
Y	7480	0.022811105	0.45581334	0.00527031

It would, therefore, appear from the analysis conducted herein that transparency has been achieved. The data sniffer was only capable of recording to 100th of a second which certainly affected the accuracy of the analysis. So, therefore, it is not possible to precisely verify the four-nanosecond parameter but it is safe to conclude that the delay is quite minimal.

Summary/Conclusion

The case study that depicted the relocation of an equipment room illustrated several advantages of the concept of a media center. First, ports on the main backbone switch could be matched to the available wiring without having to shut down, modify or reconfigure that switch. Second, changes in the network dictated by outside sources can often be easily reconciled by inserting the appropriate media converter into the media center. Lastly, integration of new technologies such as ATM can be often supported by the existing wire scheme via the appropriate media converters.

Providing SNMP support on the physical level gives network administrators one more useful tool in the diagnostics and correction of network problems. Furthermore, the minimal packet delay observed indicates that the ideal of transparency is realized at least on a practical level.

References

[1] Transition Networks (1998) Media Conversion Center Product Description. Minneapolis, MN: Transition Networks.

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[3] Comer, Douglas E., Internetworking with TCP/IP. Prentice Hall, Upper Saddle River, NJ, 1995.

[4] Halsall, Fred. Data Communications, Computer Networks and Open Systems. Addison-Wesley, Reading, MA, 1996.

[5] Schrupp, Gary. Email response to the author concerning media converter delay from a technical support specialist at Transition Networks, Inc., 1998.

Acknowledgements

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