行政院及所屬各機關出國報告
（出國類別：考察）

考察國外有線電視與電信整合發展
出國報告

出國人員：

服務機關	職稱	姓　名
交通部	視察	楊魯齊

出國地區：美國
出國期間：89 年 11 月 24 日至 89 年 12 月 2 日
報告日期：90 年 02 月 20 日

摘　　要

「The Western Show-Broadbandwagon」係由美國加州有線電視協會(The California Cable Television Association , CCTA）主辦，該協會每年均於美國加州舉行年會，會中除了舉辦各項有關有線電視發展及未來趨勢之議題研討會外，去年並有有線電視、電信及多媒體方面的相關廠商八百餘家之參與展示，參訪人數超過三萬人次，為美國有線電視及電信工業最大規模之展示會之一；今年國內有線電視系統等相關業者，亦組成三十餘人參訪團與會。

美國舊金山地區之CISCO公司為全球DOCSIS系統開發之領導廠商，其系統配置遍佈美國、歐洲、亞洲等地區，產品包括寬頻交換機（ATM/Frame-Relay）、超高速交換路由器（Giga Switched Router）、數位用戶迴路（DSL）相關產品、有線電視網路相關產品、區域網路交換機及Internet撥接存取與網路管理軟體等;CARLENT公司係生產VoIP設備;GEMSTAR公司則是以生產電子節目表（EPG）為主要產品。

目　　　　錄

壹、行程

「The Western Show-Broadbandwagon」於洛杉磯時間八十九年十一月二十八日至十二月二日舉行，本次行程並配合本國中華衛星與有線電訊工程學會事先安排至其他相關產業公司之活動，自十一月二十四日起程，共計九日，略述如下：

十一月二十四日	於桃園中正機場搭乘中華航空，同日飛底美國洛杉磯。
十一月二十五日	駕車至舊金山參訪 CISCO 公司。
十一月二十六日	星期假日
十一月二十七日	參訪 CARLENT 及 GEMSTAR 公司，駕車回洛杉磯。
十一月二十八日至三十日	觀訪 The Western Show
十二月一日至二日	於洛杉磯搭乘中華航空飛抵桃園中正機場。

貳、目的

在邁入二十一世紀的時刻，將是有線電視企業經營的一個嶄新轉捩點，世界各國均致力推行有線廣播電視數位化，以期提昇有線電視網路光纖化及交換寬頻化，國內業者除了經營有線電視外，還可以經營電路出租，邁向有線電視電信、網路 3C 整合之新領域，提供安全、可靠、高品質、高速率、大容量之傳輸電路，多元化先進之通信服務。

本次奉派出國主要目的是因國內有線電視事業蓬勃發展所建立之有線電視傳播網路，代表著網路傳播通訊勢力之興起，交通部並於八十八年六月開放「固網電路出租業務」之申請，使有線電視業者依法得提供電信服務，其為達到通信業務開放之目標，減少有線網路重複投資與建設，以期提供消費者價廉且便利之電信服務，落實電信自由化及促進國家整體經濟之發展，故需要瞭解國外有線電視與電信整合發展的情形，尤其是美國的發展情形。

「The Western Show-Broadbandwagon」舉辦有關有線電視、多媒體及其他相關議題多場之研討會，並有三百多家廠展示有線電視與電信整合方面之最新設計，是全球最大的有線電視年會之一，以本次參展產品之現象，很明顯看出是以數位化整合為未來趨勢，本出國考察計畫即欲藉由參加該年會瞭解其對全球有線電視與電信系統的影響，並蒐集相關資料俾供本部制定政策之參考。

參、國內有線電視與電信整合之發展過程

台灣有線廣播電視以其特殊環境及發展風格，自八十二年八月行政院新聞局公布「有線電視法」後，用戶普及率高達近乎八成，用戶數之成長亦趨近飽和，單純有線電視服務業務之發展與利潤已達瓶頸階段。

八十八年二月行政院新聞局公布之「有線廣播電視法」，修訂有線電視事業與電信事業業者需利用有線電視寬頻之特性，創造新的加值服務與商機，有線電視與電信之整合，不僅提升社會大眾之生活品質，也加速資訊交流，促進經濟、文化、學術、政治及宗教等各方面的發展。

本報告就國內有線電視過去發展過程、數位化的發展趨勢及於電信領域之應用，略述於後：

一、有線廣播電視系統之發展

初期階段

- 取得籌設許可證。
- 成立公司。
- 規畫、設計及建設光纖同軸混合網路。
- 建設頭端機房。
- 申請並通過施工與訊號查驗。
- 取得營運許可證。

中期階段

- 開播營運。
- 申請第一類及第二類電信籌設執照。
- 規畫、設計及建設雙向光纖同軸混合寬頻網路。
- 取得第一類及第二類電信籌設執照。
- 申請查驗取得第一類及第二類電信執照。

終期階段

- 經營第一類及第二類電信業務服務。
- 推展電路出租及線纜數據機上網業務。
- 推展 PTV、PPV 及 VOD 業務服務。
- 推展 Cable Phone 及 VoIP 業務服務。
- 推展電視(子)商務服務。
- 推展數位電視服務。
- 推展其他雙向互動之業務服務。
- 環狀備援網路之建置。

二、寬頻網路之發展趨勢

- 國際性：海纜(頭城)及衛星(C、Ku、 Ka 及 V 頻段)。
- 區域性：光纖 。
- Last Miles ：FTTH、FTTC、CATV 、 xDSL & LMDS。
- 用戶終端 :Cable Modem、xDSL 及數位選台器 D-STB.
- Cable Modem (MCNS/DOSIS): 上網及網路電話(VoIP).
- xDSL : 上網際網路及 VOD。
- LMDS : 適用都市區。
- 數位選台器(D-STB) : 親子鍵、鎖碼(IC-Card)、T1 上網、VoIP、硬碟、DVD(選用)、信用卡(選用)及電子商務。
- Open Cable Standard、POD & Middle-Ware 標準。

三、寬頻多媒體網路發展方向

- 有線(光纖)無線(LMDS、3G)整合。
- 雙向互動(Interactive)及 FTTC(WDM & DWDM)。
- 數位化(Digitalize)(頭端、網路及用戶終端)。
- 標準之纜線數據機(DOSIS 1.1)。
- 數據、語音及影像之整合。
- 隨選視訊及數位電視(DTV)。
- 標準數位送收器(Digital STB)系統。

- 電子商務及計費系統。
- 多媒體(MPEG-II/MPEG-4/MPEG-7)。
- 安全機制。

四、全方位有線電視系統建設

初期目標:

- 建設標準 550MHz 之類比頭端系統。
- 建設大區域之 750MHz 雙向光纖同軸混合(HFC)網路。
- 通過新聞局施工及電信總局訊號查驗。
- 取得開播營運執照。
- 申請及取得第一及第二類電信經營執照。
- 提供單向或雙向網際網路及其相關附加服務,增加系統獲利率。

中期目標:

- 頭端增加數位(550-750MHz)系統。
- 每一光節點為 600 戶之雙向光纖同軸混合寬頻網路，提昇系統可靠度。
- 提供互動式電子節目表。
- 電路出租業務服務(3G、低功率、ISP、ICP、ASP)。
- 配合固網經營市話服務、網路電話及 VPN 服務。
- 利用衛星與環島光纖執行 51 個經營區之聯網服務。
- 提供 PTV、PPV 及 VOD 節目。
- 提供 CABLE-MODEM 之數據語音服務。

長期目標:

- 頭端系統數位化。
- 光纖網路系統全面數位化。
- 提供數位電視節目服務。
- 提供數位化視訊、數據及語音之多媒體服務。
- 提供雙向互動之家庭間電動遊戲。

- 提供數位音樂服務。
- 建設環狀保護環路。
- 全面化推展資信與通信整合服務。

五、頭端機房之發展趨勢

- 三機房一體及媒體電腦及通信之整合。
- 軟硬體及人力資源共享。
- 電腦自動控制及緊急人工控制之網管系統。
- 從類比頭端至類比數位混合再至全數位化頭端。
- 影像訊號全面採用 SDI 或 IEEE 1394 介面標準。
- 低速率訊號全面採用 RS-422 或 USB 標準介面。
- 各自獨立之備援系統、電源系統及不斷電系統。
- 各自獨立之接地系統。
- 智慧型頭端及網路監控及調校系統。
- 數位式鎖碼系統。
- 自動障礙通報系統(呼叫器及大哥大)顯示告警。
- 最佳之避雷系統。 、
- 完善及安全之電腦網路系統(10/100 或 Gbps)。
- 充足之硬碟櫃系統(DISK ARRAY)。
- 充足之 DVD 儲存系統。
- 完善之頭端管理系統。
- 完善之客務服務系統(客服系統與維運系統結合)。
- 完善之附加服務計費系統。
- Cable Modem、VOD、Real Video Audio 、DTV 、電表讀取及各種應用服務之軟硬體設施建置.
- 電子節目表(Electronic Program Guide)使用戶非常方便瀏覽、查詢、收看及選購節目)。
- 提供分級付費之節目(BTV、PTV、PPV 及 VOD)。
- 提供精緻及小眾化之節目。
- 最佳之防拷備系統。
- 有線電視與網際網路相結合。
- 有線電視與電信之結合.數位交換機、ATM-SW、防火

牆等建置。

- 電子商務(E-Commerce)與家庭購物相結合。
- 制度化之節目與廣告之製作、修改、潤飾、儲存及播送之權責。

六、有線電視網路品質之提昇

- 網路品質是有線電視提供電信服務能否被市場接受的關鍵因素。
- 有線電視網路品質提昇之因素：
  - 慎選網路器材並妥善規劃網路架構。
  - 正確的網路位準設計。
  - 健全的網路管理系統（NMS)。
  - 網路主動維護哲學。
  - 施工品質確保。

七、標準數位式（Digital）機上盒

- 200MHz CPU & System OS
- Pjava & HTML
- 16MB Applications Memory
- 4MB(16MB for DTV)Video Memory
- 16-bit color(24-bit color for DTV)
- 640 * 480
- 3 Tuners
- DOSIS or DAVIC Cable Modem
- Smart Card reader
- Front Panel USB
- S-Video & AC-3
- Integrated CA
- Digital STB
- Optional Items :

- Internal Drive
- 3-D Graphics
- IEEE-1394
- POD (for FCC)
- BTSC Encoder
- DTV Decoder
- DVD
- VISA Card Reader

八、有線電視與電信整合技術

- 頭端之控制設備。
- 終端設備(Cable Modem)。
- 彈性之速度調整。
- 系統之架構(雙向 HFC)。
- 支援多通信協定。
- MCNS/DOCSIS 之標準。
- 流量控制。
- 服務功能: Video/Data/Voice。
- 頻寬效率(64K-38Mbps)。
- 系統安全與管理:設定與障礙處理。
- 可與 ATM 系統聯接。
- 依訂戶需求提供不同之速率(受益者付費之原則)。
- 視訊,音訊,數據及多媒體應用(PLUG & PLAY)。
- 與 Tanet,Seednet,Hinet 及 ISP 連線。

九、資訊管理系統(MIS)

- 請假差勤系統。
- 事務用品申購系統。
- 文件管理系統。
- 合約資料管理系統。
- 員工人事資料庫。
- 會議追蹤系統。

- 財務現金申請系統。
- 費用報表資料庫。
- 業務支援系統。
- 客戶資訊管理系統。
- 進料與出料管理。
- 專案管理。
- 電子地圖管理。
- 檔案管理系統。
- 電子佈告欄。
- 討論園地。
- 設備、財產管理。
- 稽核系統。
- 備份系統。

十、未來服務之趨勢

- 網路數位化將使第一類電信事業與第二類電信事業界線更加模糊。
- 未來網路服務並非在傳統之語音傳輸，主要是在於整合公眾電話／數據、影像等之多元化服務【即以8C(Consumer、Contents、Communications、Cable、Computer 、Control、Components、及 Cost)來服務客戶】。
- 個人通信網路（PCN）使電信服務達到個別化及個人化，克服無線或行動電話的限制。
- Cable Modem 與 STB 之整合是藉由有線電視網路為資訊來源，可提供網路遊戲、遠距教學、網路消費等新的網路多媒體應用服務。
- 提供互動有線電視娛樂節目(BTV、PTV、PPV 及 VOD)。

十一、有線電視與電信整合成功之重要因素

- 申請第一類出租網路電信執照(經營 Cable Modem 業務)及第二類 ISP 電信執照(取得 IP)。

- 建立三系統一體之機房(有線電視、通信及 ISP)。
- 應用密集分波多工（DWDM）及 SDH 傳輸系統，加速網路升級建設並向「光纖到家」方向發展，以提升頻寬及傳輸速率，進而系統網路全面數位化(4Mbps/頻道及 2500CHs/4Gbps)；更新單向寬頻網路成為雙向不斷電系統寬頻網路。
- 建置 ISP 及 ICP(本地節目資料庫)系統。
- 建置具新服務計費及客服特性之 MIS.
- 建置 MCNS/DOCSIS1.1 標準之 Cable Modem System.
- 以網際網路之 IP 交換及 ATM 技術，連接 Hinet、Seednet、Tanet、各 ISP 及各 ICP，爭取長途電話及國際電話市場。
- Cable Modem 產品的整合功能、低廉價格及推展時程及便利的安裝。
- 建立完整之電子地圖資料庫系統(可配合客服系統，建置完善之管理,業務,行銷,廣告,工程,客服,財會之整體制度）、
- 建立安裝維護迅速制度及監控維運調度系統使可靠率達到 99.7%以上。
- 建置無線電之障礙主管通報系統。
- 建置工程車之 GPS 系統。
- 建立電腦及通信人才之培育制度。
- 提供地方政府單位、學校、社區及 SOHO 等雙向數位之視訊會議、IP-VPN、保全、讀表、電視商務、遠距交學等附加價值 24 小時客戶服務。
- 引進新技術開發附加價值。

肆、心得

電信、資訊與傳播在過去是三個涇渭分明的不同領域，但因數位科技之快速發展，導致此三個領域日漸匯流，在本世紀初勢必整合成無法分割的單一產業，一般稱為「通訊（infocommunications）產業」，成為未來資訊社會中的

主流產業。

從此次參展之狀況已很清楚的顯示，有線電視與電信之數位化設備，隨著規格標準化及商業化量產，使得近期未來需求將會快速成長，傳輸速率的提升及功能多樣化亦是未來服務的趨勢，國內的改革環境若不加快腳步迎頭趕上，將遠遠落後於國際進步的步伐，對台灣想成為亞太營運中心的理想，亦變成遙不可及的夢想。

伍、建議

一、隨著科技的快速發展，有線電視與電信整合之技術領域，可以「日新月異」來形容，使得相關產業間的分野變得更為模糊，所以個人建議應以全球化的角度，「立法從寬，執法從嚴」的心態，力求制定具有發展彈性空間的法律、規章。

二、目前國內有線廣播電視系統之主管機關為行政院新聞局，電信之主管機關為交通部，在產業整合愈來愈緊密結合之情況下，不僅彼此間權責不易劃清，相互間溝通協調亦不易達成。

三、在科技快速發展及推動資訊化社會之同時，網路線上交易及個人資料傳送所引發安全等各種問題，仍為相關應用服務發展的瓶頸，因此亟需儘速建立網路安全及管理機制，有效帶動網路應用服務之蓬勃發展。

四、本次參展幾近於全為數位傳輸之產品，此時，行政院新聞局正於國內積極推動之定址鎖碼設備，有線電視業者因目前數位之產品雖尚未全面推出，但以是指日可待，為免造成雙重投資浪費，業者希望能暫緩執行。

伍、附件（參展廠商研討資料摘要）

DWDM Digital Technology in the Return Path

The cable plant is fast changing into a two-way network. The cable plant has always had a forward band and a return band, but up until recently, the return path bandwidth was not utilized completely. The return band was used for monitoring the network and providing minimal services to the end user. Now, with the cable plant transforming itself into a truly bidirectional network carrying information and content in both directions to and from the end user, the demands on the return path are increasing. Applications requiring more bandwidth and better performance in the return path are on the rise. IP telephony, cable modems, high-speed Internet access, and VOD services are some of the applications requiring a larger, more flexible return path. Without effective means, fiber count in the return path bandwidth becomes a major issue, and a scalable fiber aggregation solution is desired. At the same time, with all applications not having matured completely, and due to large costs associated with upgrading plant, network operators want solutions that will incrementally allow them to upgrade the existing plant with minimal swap out of legacy equipment.

This article discusses the incorporation of DWDM digital technology in the return plant as the optimal solution for service providers. Using digital optical transmitters and receivers in the return path, it will be shown how return path bandwidth can be doubled or quadrupled in a single point-to-point optical link. Further applying DWDM technology, multiple reverse path links can be combined over a single fiber, and deeper penetration of fiber into the plant can be achieved.

Digital Return

A digital return optical link, as described in this article, is shown in Figure 1. A 5-42 MHz return path RF band is sampled and digitized into a bit stream. A laser transports this digitized bit stream over an optical fiber link to a receiver. The receiver recovers the bit stream and extracts the 5-42 MHz band.

Using current technology and electronics, a 1.25 Gbps optical link is capable of transmitting a single 5-42 MHz band over a single fiber. It is possible to design a 1.25 Gbps optical transmitter to replace an existing analog return transmitter in a node and a digital receiver to replace an analog return path receiver at a hub or headend. The advantage this digital link gives over an analog link is that the digital link can operate over long distances without degrading link performance. An analog link's CNR will degrade with increasing optical distance. A

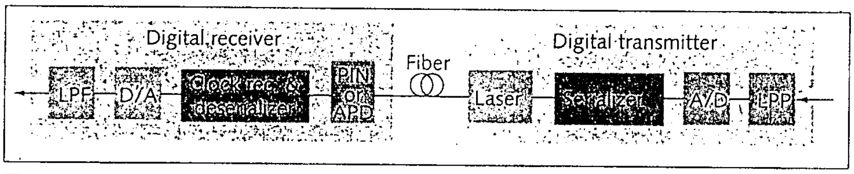


Figure 1: Reverse path digital optical link block diagram.

digital link's CNR will remain constant over the complete optical link budget and will yield a larger link budget in comparison to analog.

With the digital and optical technology available today, a 2.5 Gbps optical link is capable of transmitting two 5-42 MHz bands over a single fiber yielding twice the return bandwidth, but without degradation of link performance, in comparison to a 1.25 Gbps digital link. One such transmitter can be designed in the same package as an existing analog transmitter.

In a node that can accept two reverse path transmitters, it is possible to replace the analog transmitters with two 2.5 Gbps transmitters: one transmitter operating at 1310 nm, and the other transmitter operating at 1550 nm. The outputs of the two transmitters can be combined and transported over a single fiber. At the receiving end, WDM filters can separate the two wavelengths and route them to two separate 2.5 Gbps optical receivers. The result is four times the analog return bandwidth over a single fiber.

This demonstrates how, by using digital technology in existing plant, service providers can incrementally increase return path bandwidth fourfold without having to lay more fiber. Digital technology also allows service providers to drive fiber deeper and deeper into the network. The digital technology used in these transmitters and receivers is also widely used in other telecommunications networks that are experiencing exponential growth. This demand is leading to a constant improvement in the technology and reduction in cost of existing technologies.

DWDM Digital Return

This section will discuss how digital return technology, combined with DWDM optics, will provide greater incremental growth and penetration of the return path plant. Digital return transmitters can be designed to operate on different ITU channels of the 100 GHz or 200 GHz grid. An optical multiplexer (mux) can combine groups of 2, 4, 8, 12, 16, 24, or 32 channels on to a single fiber for transmission to hubs or headends where a demultiplexer (demux) can separate each of the channels and route them to receivers. This can allow network operators to transport up to 32, 5-42 MHz return bands using 1.25 Gbps DWDM transmitters and receivers over a single optical link. Using 2.5 Gbps DWDM transmitters and receivers, up to 64, 5-42 MHz return bands can be transported simultaneously over a single fiber.

Figures 2 and 3 show two basic network architectures deploying N-channel DWDM digital technology in the return path. Both figures describe return links from optical node to a hub, and then on to the headend. In Figure 2, the optical node to hub optical link may be analog or digital. The transmitter in each node carries the return path signal to a receiver in the hub. At the hub, the received optical signal

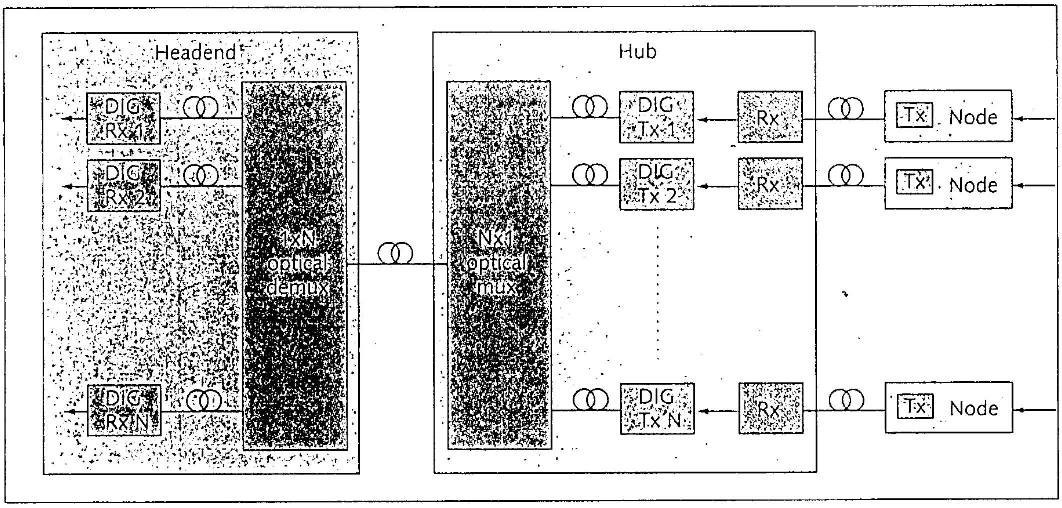


Figure 2: Optical node to headend reverse path link with N-channel DWDM digital transmitters at the hub.

Configuring to Compete

Operators building tomorrow's multimedi transport systems are being squeezed betw marketplace demand the limitations of their network. Rapid chan demand, rapid respon and the interaction of services—video, data, telephony and more make that response m complex. Operators w have to segment their networks to accommo date subscriber demai preferably without dis rupting service. Testin and troubleshooting v be more critical than ever. And to further complicate matters, w organizations go thro the necessary change communication may temporarily suffer, me ing even less planning time than in the past. The only viable soluti is a nimble, robust ne work that is easy to expand and reconfigu

Design for Flexibility

Consider the elegai engineered flexibility kids' building sets. Gi enough parts, you ca build anything. The secret is the connec- tions—putting togethe the pieces in a flexible changeable manner. ADC's fiber distributio frame products and R Worx™ platform pro hybrid fiber/coax net- works that same sim flexibility.

The RF Worx soluti organizes critical sign management functio into a single system. integrates forward an return path amplifiers splitters/combiners, d is converted back to RF and fed back into a DWDM digital transmitter. Signals from multiple DWDM digital transmitters are multiplexed together and transported to a headend, where a demux separates individual wavelengths and sends them to digital receivers. This architecture requires a well equipped, and monitored hub housing a lot of opto-electronics. It allows for incremental reverse plant expansion at the node and the hub. In a network where the node to hub link is digital, it may make sense to not go back to RF at the hub with expensive opto-electronics. The DWDM digital networks shown here are only two basic functional networks, which show tremendous potential for reverse path expansion without having to obsolete existing equipment and lay new fiber. Other star and ring topologies can be constructed to enable optimal network design, keeping future expansion, cost, redundancy, and link protection in mind. Extremely long link capabilities are possible with the use of APD receivers, 1550 nm source lasers, and EDFAs.

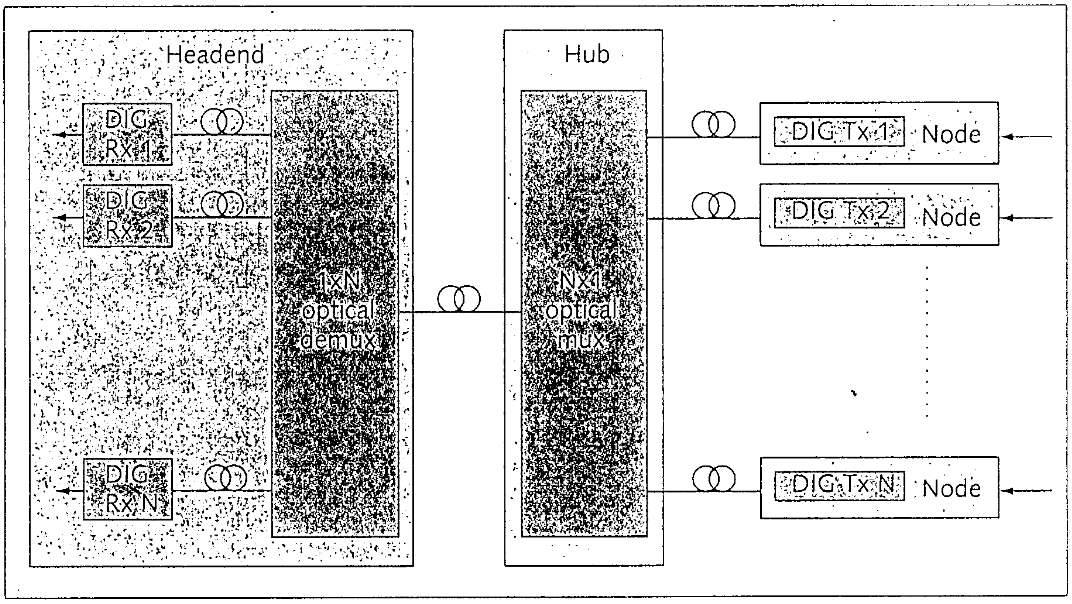


Figure 3: N-channel DWDM digital reverse transmitters in optical node to headend with optical multiplexing at hub.

hub receiver. The receiver at the hub will recover the digitized bit stream from the received signal and send it on ahead to the DWDM digital transmitter without converting back to RF. This will result in improved link performance from end to end and reduce cost of the receiver and transmitter at the hub.

The network shown in Figure 3 incorporates digital DWDM technology at the node. The transmitter in the node is a DWDM digital transmitter operating at a specific wavelength in the 1520 to 1565 nm optical band. The hub location contains only a passive optical Mux, which aggregates the different DWDM channels coming in from remote node locations on to a single fiber for delivery to the headend. This solution is more cost-effective than that of Figure 2, because it eliminates the need for a

Conclusion

Existing network service providers with legacy reverse path plant and alternate service providers building new plants have an optimal solution in DWDM digital technology for reverse plant installation and expansion. The flexibility of this technology will allow for incremental expansion of the reverse path without costly upgrades requiring swap out of equipment. The same technology can be applied to 5-65 MHz return plants, too. Most of the digital hardware and optical passive components are widely used in many other communication systems. This is resulting in reduced costs and constant improvements in technology. In addition, as the forward path HFC plant migrates to digital, the reverse path will already be state of the art.

Niranjan Samant, Senior Engineer

A Technici Guide to Networks

Help Ease Customer Frustrations

By Tony Ghaffari

If you're not teaching your broadband installers and technicians about home networking, you're already behind in today's competitive market.

an's Home

Cable customers are much more data savvy than they were 10 years ago. It's not uncommon for a broadband technician to arrive at a customer's home to install a cable modem and discover a network with a hub, a router or even a server already installed.

Of course, most cable operators don't support such home networks. They require that the technician simply tell the customers that they have to make the connection between the cable modem and the network themselves. In fact, in my own recent experience, the technician handed me the modem, the cable, the network interface card (NIC) and the work order, and said I had to do the install myself. This took me the better part of a day, because I was missing some essential network parameters.

But, wouldn't it be nice if your technicians knew how the cable modem should be connected within a home network, and what role the different network components play? As the technicians are your directors of first impressions, it's essential that they have a basic understanding of home networks so that they don't appear completely intimidated. Plus, there is critical information they'll need to provide so that the customer may complete the installation successfully. Let's look at some common home network configurations.

What is a home network?

Internet and data are the fastest growing of all broadband services. More people are working from home, and more students are using computers for homework and research, not to mention online games. Not so long ago, a computer in the home was a luxury. We are now finding multiple computers in the home. But, customers still are reluctant to spend money unnecessarily. Instead of spending hundreds of dollars on separate peripherals at each computer (like printers, scanners, CD-ROMs and even modems), they are finding that a low-cost alternative is a high-speed home network. The home network allows each user to share all the resources on the network.

The most basic home network requires two computers, each with a NIC, and a crossover network cable to connect them together.

In a simple home network, each computer and its devices will be connected to the network through the hub (see Figure 1, page 124). The hub simply passes all the network information to all of the computers. It is the job of the NIC to capture only the data designated for that particular computer. The computers on the network are all assigned a unique Internet protocol (IP) address. This address is used by the NIC at each computer to identify what data to capture and what data to ignore.

Every computer on the Internet, just like the home network, has a unique IP address which is used for routing. No two computers on a network or the Internet can have the same IP address because conflicts would occur. Certain blocks of IP addresses have been reserved for private networking and do not exist on the Internet. The most common for home use are 192.168.0.0 through 192.168.255.254.

With the home network, each computer still needs a telephone modem to access the Internet. Theoretically, all computers could share one 56K modem. In reality, the limited speed of the typical dial-up modem would be too slow to allow sharing.

The cable modem's role

A cable modem provides a connection to the Internet through the local cable company. Most cable operators supply and support everything needed for one properly operating computer to access the Internet through the cable modem. Assuming all of the cable (RF) connections are made from the tap to the ground block, an additional coaxial line is installed to

LINE

> ### How Do You Support Home Networks?

With the proliferation of personal computers, home networks are becoming more common. When your technicians arrive at a customer's home to install a cable modem, they may discover a network with a hub, router or even a server already in place.

There are three basic types of home networks that technicians may encounter: those with a hub, those with a router and those with a server.

Unfortunately for the customer, most cable operators don't support such networks. While they allow customers with networks to access the Internet through their modems, technicians aren't allowed to install those modems in home networks, nor do customer service representatives support them.

Because many technicians are not trained to understand the basic components of home networks, they may appear intimidated to customers, and may fail to give customers the network parameters they must have to complete the install. Customers need information concerning computer name, domain name, proxy server, mail server, news server and gateway in order to get their modem up and running. All of this information is the same as it would be for a single computer install and is available to the technician.

e computer. The cable modem is connected to the coax-l cable. A NIC is installed in the computer and connect-l to the cable modem by a twisted-pair cable with RJ-45 onnectors on both ends. Installing the software com-etes the process. The software configures the computer r networking with a cable modem.

During this configuration process, the computer's dy-amic host configuration protocol (DHCP) functions are nabled. With DHCP turned on, the only information that

Vouldn't it be nice if our technicians knew ow the cable modem ould be connected ithin a home network?"

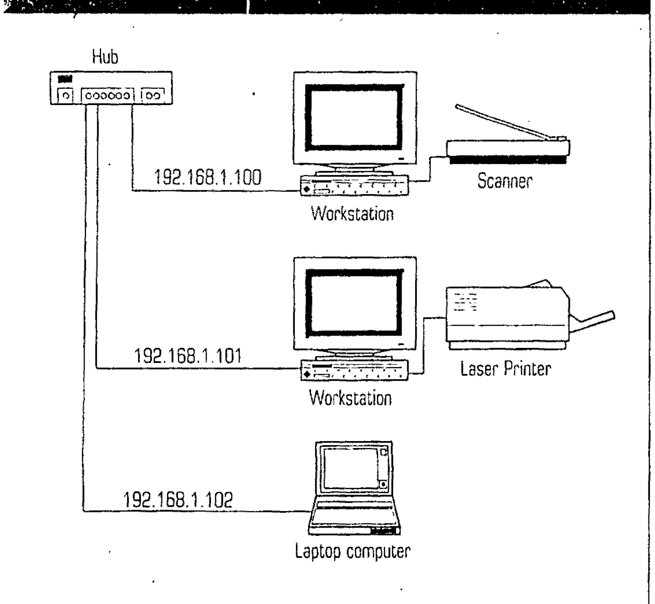
eeds to be entered is a host name (and in some cases, a omain name). The computer will then acquire all of the equired parameters from the cable operator or Internet ervice provider (ISP) and configure itself. The software lso includes a Web browser and associated Internet ap-plications, plus help files.

Iome networks meet able modems

Most cable operators give their subscribers an option to onnect additional computers to the cable modem for about 5.00 each per month. This option requires a home net-vork (see Figure 2, page 126). The hub is connected direct-y to the cable modem and each additional computer is ssigned an IP address by the cable company. Customers are llowed to connect up to three computers in this manner.

Some subscribers prefer not to pay the additional $5 a nonth, or they may need to connect more than three com-outers to the cable modem. Two options are available to

FIGURE 1 HOME NETWORK



them: dedicate one computer (a server) to act as a router (see Figure 3, page 126), or install a dedicated router (see Figure 4, page 126).

The server configuration requires the computer to be on all the time the home network is active because it serves as the interface or bridge between the home network and the wide area network (WAN) or Internet. Additionally, this computer needs two NICs, one to connect to the cable modem and the other to connect to the hub (home network). The hub then sends all data to all computers. Some may see this as a reduction in the overall speed of the network because all network traffic is sent to every point in the network, thus sharing the network capacity among all computers.

The router configuration is probably the better of the two options. A four-port router costs about $200, and does not need a hub because four computers may be

> **Common Home Networking Terms**

Cable modem: An enhanced network interface card (NIC). It has an address and captures and rejects information just like an NIC. Unlike the NIC, its input is in the form of RF through a coaxial connection, and its output is data through an RJ-45 connection. It also may be controlled from the headend (turned on and off).

DHCP: The acronym for dynamic host configuration protocol. DHCP allows the headend server to dynamically assign IP addresses to users. DHCP also assigns the IP subnet mask, gateway address and domain name server (DNS) addresses to the users. This is advantageous because any changes made to the network automatically are updated to the users.

Hub: Similar to a splitter/combiner. It is the network computer where many circuits are brought together and either sent back to other computers on the network or multiplexed into a single connection to be connected to the wide area network (WAN), hybrid fiber/coax (HFC) network or Internet.

LAN: The acronym for local area network, which in this case is the home network.

Network interface card: Provides the physical connection between the network cables and the computer. NICs are now available in an external universal serial bus (USB) version.

Router: An interface, or bridge, between two networks. Routers are available in single-port and multiple-port configurations. Routers optionally can act as a firewall: a computer through which all incoming and outgoing packets must pass and only authorized packets are allowed. The router does not have the capacity to store any data except for its own configuration.

Server: A computer used as a repository and distributor of data. The server also may serve as the interface, or bridge, between two networks.

WAN: The acronym for wide area network, which in this case is the HFC network or Internet.

FIGURE 2 Two Computers with Two IP Addresses

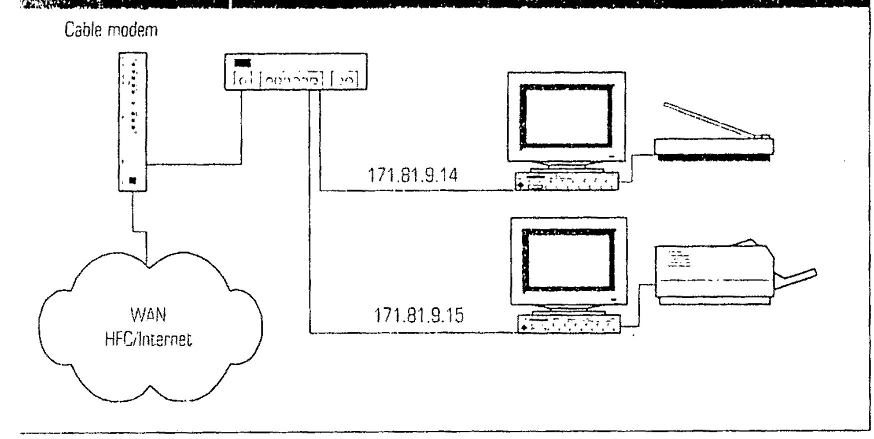


FIGURE 3 Cable Modem with Router

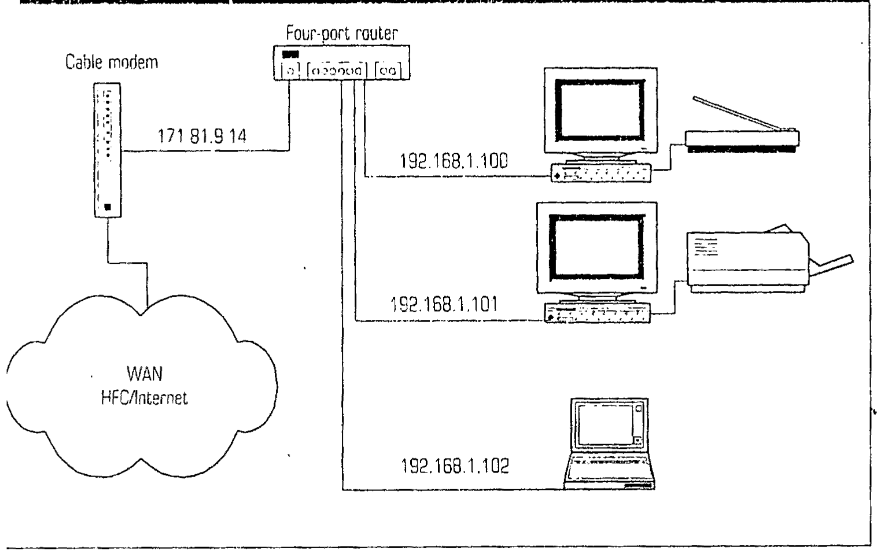
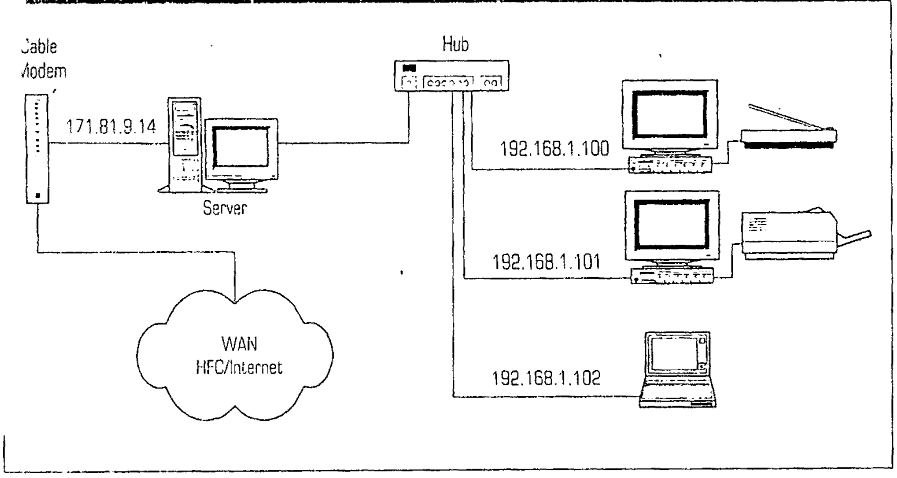


FIGURE 4 Cable Modem with Server



connected directly to it. The router also is intelligent and "routes" data only to the destination computer. If a one-port router were installed, it would need to be connected to the home network through a hub. The router also may integrate firewall capabilities, which are an additional software cost with the server configuration.

On the Internet or wide area network (WAN) connection, the router takes on the identity of a computer, which the cable company has authorized for use with the cable modem. On the port connections (home network side), the router acts as a DHCP server and assigns IP addresses to the network computers connected to it.

Information requests from the user's computer are routed through the server or router to the cable modem. The responses from the Internet are routed back from the cable modem through the server or router to the requesting computer.

After contacting several cable operators, it seems that all of the configurations discussed are allowed, but generally are not supported by technicians or customer service reps That's not surprising really, as a novice could go to Best Buy to purchase the equipment needed for a home network, not know how to install it, and spend hours on the phone with your call center trying to figure it out.

But, those customers will need information that the technician has in order to complete a cable modem install. Rather than implementing a totally hands-off policy regarding home networks, it would be beneficial to familiarize your technicians with the information they'll need to give the customer. All of the information is the same as for a single computer install and includes: computer name, domain name, proxy server, mail server, news server and gateway.

While you may not yet be ready to support home networks, the growing proliferation of such networks makes it essential that broadband technicians can intelligently provide users with the network information they need to complete the modem install. And, it will enhance your customer service. CT

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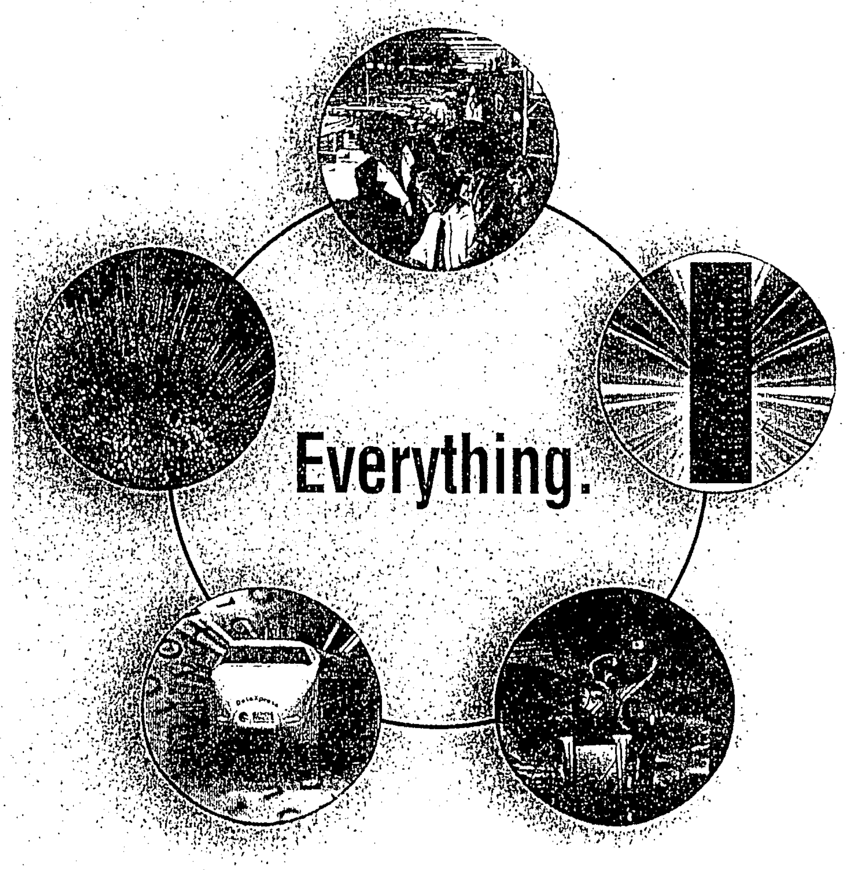

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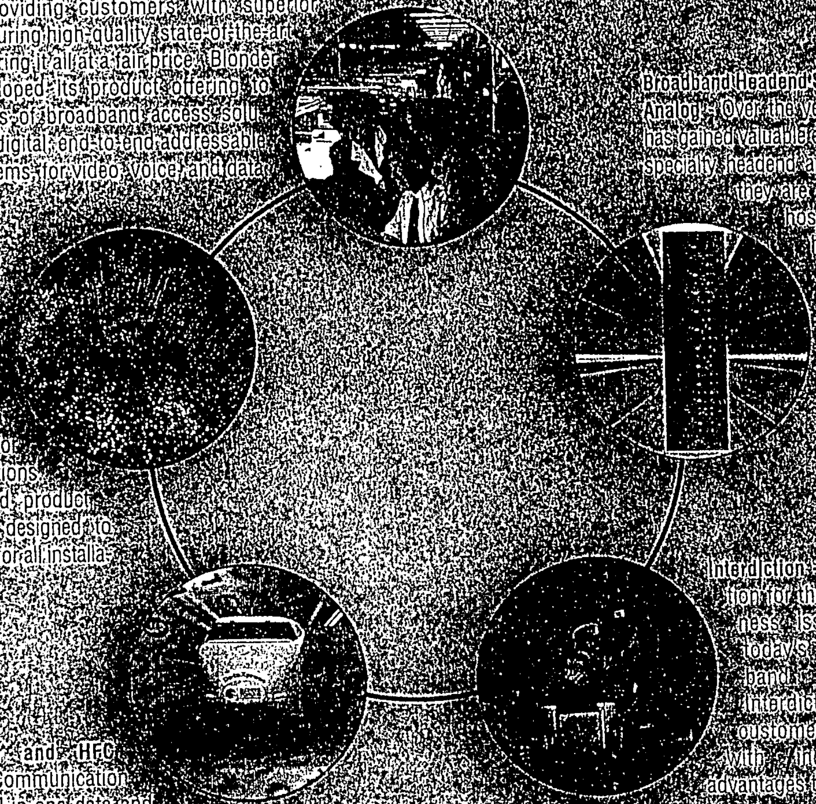

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December 1995, the Company successfully completed an initial public offering of its common stock, which is traded on the American
ock Exchange under the symbol "BDR". For more detailed information, refer to the Company's web site: www.blondertongue.com

OPPORTUNITIES FOR APPLICATION SERVICE PROVIDERS IN CABLE NETWORKS

Part One

Pablo L. Martinez

ASP service model

The ASP service model is "one-to-many." Applications run in a network-hosted environment, serving a dispersed customer base. Initially, the ASP service model targets the small- and mid-market business customer segments. However, the large business segment also is showing interest, and in the lower part of the spectrum, home-based businesses may quickly become one of the key segments benefiting from this model.

There are many reasons why the ASP service model is quite compelling. A partial list of these benefits include:

- Access to enterprise-grade applications and information technology (IT) resources at a lower price;
- The shifting of large, unpredictable, up-front capital costs to smaller, predictable, recurring monthly expenses;
- Lower operational costs because of smaller IT staff focused on business core competencies, longer equipment life [eight years for thin clients vs. three years for personal computers (PCs)], reduced system downtime costs and better overall utilisation of specialised applications;
- Software rental for short-term projects;
- Access to the latest application versions;
- Global access from anywhere, anytime, on any device;
- Multiple "desktops" for both personal and business purposes;
- Reduced risk of virus propagation and other security threats; and
- Ability to quickly add new end-users.

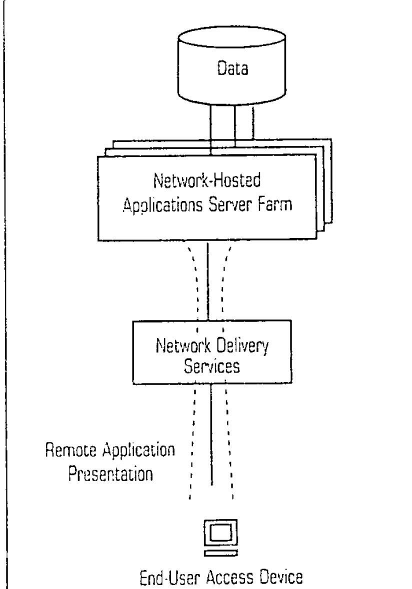
Partnering to add value

Given the nature of the ASP concept, the service model is structured into the "layered" framework where applications become services delivered over networks (shown in Figure 2). The lowest layer provides infrastructure such as data center facilities, physical connectivity and data networking equipment, including routers and firewalls. This layer is responsible for maintaining expected levels of network performance, reliability and security. The next layer provides the ASP platform and includes application-specific infrastructure, computing resources such as servers and operating systems, data storage resources and application management. Next is the applications layer where application services reside. A professional services layer provides application planning, consulting and integration services.

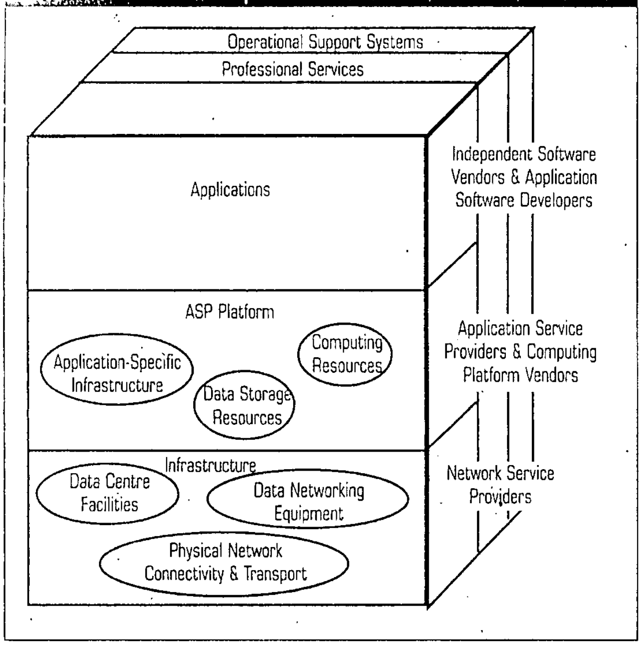
The operations support system (OSS) layer provides fault and configuration management, accounting, application and network performance monitoring and security functions. It also supports subscriber management and customer care functions.

Service providers may partner with others to support all these layers. For instance, a network service provider (NSP) partner provides the networking infrastructure. An independent software vendor (ISV) partner provides applications and tier-two/tier-three application-related customer care. An ASP partner provides tier-1 customer care and overall service management. A professional services partner provides consulting, planning and integration services. In some cases, an ASP may be cross-selling services from other ASP partners. In other cases, an ASP may have a presence in an Internet service provider (ISP) portal, allowing the ISP to offer ASP services.

FIGURE 1
DELIVERING APPLICATIONS AS A SERVICE



ASP COMPONENTS



LINE

> **Benefits of Network-Hosted Service Models and Architectures**

- Shifts large, unpredictable, up-front capital costs to smaller, predictable, recurring monthly expenses.
- Includes voice-enabled data applications that take advantage of new programmable communications platforms.
- Emphasises application service availability via redundancy and business continuity plans.
- Improves end-to-end security in cable networks.
- Enables more controlled application offerings for better quality of service (QoS) support.
- Provides security and QoS in a coordinated way.
- Simplifies end-user equipment to "multimedia" user interface devices.

Target applications

The ASP service model initially targets business segments. In particular, this model is attractive to small- and mid-tier business customers because it provides access to enterprise-class applications at a lower price.

Right now, business applications not requiring extensive integration or software-code customization are the most suitable to offer with the one-to-many ASP service model. Good examples are desktop productivity suites, e-mail hosting, Web hosting, calendaring, data warehousing, storage, virus control and unified messaging. However, applications requiring a higher level of customisation, such as e-commerce hosting, electronic customer care (including customer relationship management), sales force automation and back-office applications (for example, human resources, payroll, supply chain management and electronic payment) are what end-users are demanding the most from ASPs.

Initial service offerings are targeting traditional, data-centric enterprise applications. A next step is offering voice-enabled data applications that take advantage of the convergence capabilities of new programmable communications platforms. There also are opportunities in offering application services to residential end-users. Some example applications include managed home-networking services, media streaming and network-hosted games.

The ASP service model bundles network access, managed network services and network-hosted applications as one service. That gets complemented with ancillary services, such as end-user authentication, application-usage reporting and application monitoring. The advantage of providing these value-added service bundles is a reduction in end-user churn. This model takes service bundles to the next step in the value chain.

Service delivery architecture

The ASP service model dictates a service delivery architecture. This architecture is client-server in nature, although the functionality is distributed differently when compared to traditional "fat client" architectures. In a "fat client" architecture, the client performs some processing and relies on remote servers, if needed, to provide additional data or processing functions. In the ASP service delivery architecture, clients do not perform any processing functions other than presentation to locally display or "publish" remotely executed applications. Clients only perform functions to display the user interface of invoked applications. A specific protocol is used between the client and server to carry keystrokes, mouse clicks, and screen updates across the network.

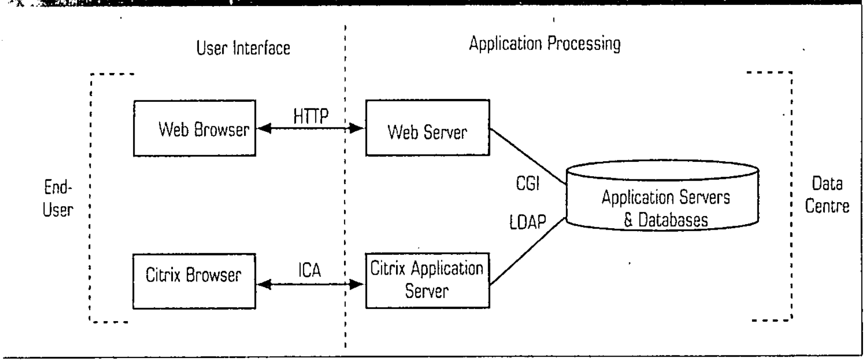
As seen in Figure 3 (page 52), there are two variants of the ASP service delivery architecture. One is Web-based, where end-users remotely run applications on a Web server and associated backend servers. In this case, the hypertext transport protocol (HTTP) is used between the browser client and the Web server. The other architecture is thin client-based. In this case, the end-user relies on a Citrix client to access network-hosted applications running on Citrix-enabled application servers. The server runs a multi-user operating system. The remote presentation-services protocol used between the Citrix-based client (browser) and the application server is the Citrix Independent Computing Architecture (ICA).

Network functional architecture

Applications are hosted in server farms running in data centres. Multiple instances of these centres are dispersed over a geographic area to increase service availability and improve application response times via load balancing. Backbone network interconnectivity may be leased from a network service provider. For improved performance, multiple private peering connections from data centres to major Internet backbone network providers may be coordinated to bypass congested Internet network access points (NAPs).

Given that the ASP service model initially offers business applications, security is an important consideration. A lay-

FIGURE 2 | ASP SERVICE DELIVERY ARCHITECTURE



:red security scheme covering host, network, application and end-user (authentication) security should be adopted. Another important consideration is application performance, in particular response times and packet loss. Resource management, including traffic management to evenly distribute the traffic load over the network and traffic shaping to enforce SLAs, plays a key role in supporting this. QoS treatments are another part of application performance and are based on application-specific or end-user-specific policies.

Virtual private networks (VPNs), providing end-user access to network-hosted applications, may offer the necessary security, resource management and QoS treatments in a coordinated way. These are "ASP value-added VPNs" where VPNs complement ASP service delivery offerings. A special case of this is the offering of managed extranet services.

Data centres

The key goal of data centre facility design is the optimisation of application service availability. Meaning data centre facilities need to be highly secure and disaster-resistant. Data centres consist of four basic elements: application processing, data networking, transport and operations.

Application and Web-server farms run on shared or dedicated servers. Redundant servers may be located at separate data centres and accessed via multiple network connections. This may be coupled with Layers 4 through 7 (Web) switches to provide local and distributed load balancing among servers. These Web switches monitor server and application response times, and network utilisation. Web-caching servers complement load-balancing functions to offer Web access acceleration services. Highly redundant database clustering or storage area networks (SANs) provide data storage management services with fail-over capabilities. Firewalls, VPN gateways and intrusion detection systems provide secure access to applications. This may include secure ID token-based end-user authentication, host-based security and router access control lists.

A core switch/router interconnects components in data centres, providing connectivity to the backbone network. Multiservice access concentrators may support dial-up and dedicated access.

OSS performs application monitoring, management and billing. A customer care gateway, or customer network management (CNM) system, allows end-users to manage their services online. With CNM, an end-user may monitor network and server availability/performance and enter and monitor the status of trouble tickets.

Application architecture

The ASP service model is multi-user and subscription-based, having an impact on application design, as network-hosted applications need to be scalable and customisable while keeping operational costs down. End-users demand customised applications at a lower cost than owning a fat PC-client. This becomes more critical when ASPs target business customers with premium applications while adopting a commodity service delivery model. One way of dealing with this is to design applications end-users may configure via templates or wizards.

Alternatively, ASPs could build libraries of frequent customised application versions, although that requires keeping larger inventories.

The ASP service model and architecture move application processing, security and QoS to the network and relays presentation functions to end-user terminals. Security and QoS treatments are needed to guarantee proper delivery and application response times, but these may be provided in a more efficient and simpler way over the cable access network. End-user equipment gets simplified, meaning a reduction in truck rolls and overall maintenance support.

There are challenges, however, needing to be addressed. Depending on the situation, the ASP service model may require partnering with other service providers to provide certain components. Meaning proper measures need to be in place to guarantee the combined security and QoS that satisfy end-to-end SLAs. Another challenge is the definition of best practices. Critical areas include: data centre operations, network operations, client-server operations, application management and monitoring, and CPE management.

Other challenges include: designing applications that run on distributed network computing environments under a service subscription model, evolving data centre computing platforms to support converged voice/video/data applications and developing schemes allowing cable operators to guarantee the required application and network performance levels as dictated by SLAs. CTI

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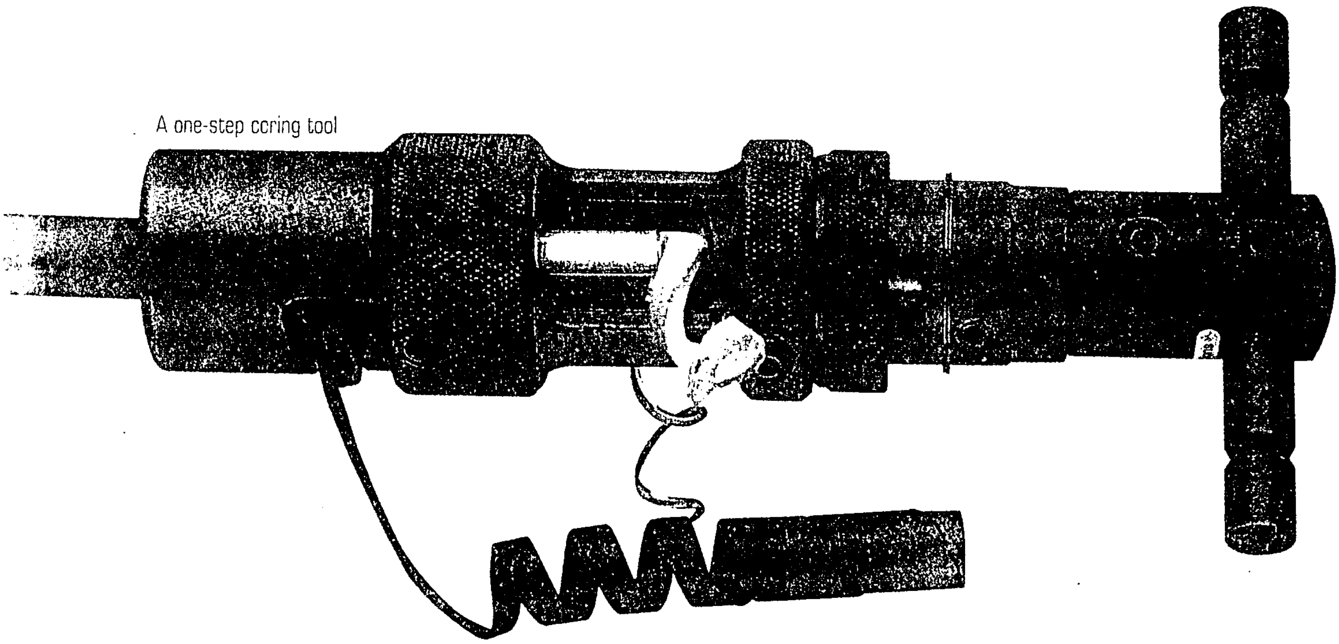
Connectorising Your Coax



A one-step coring tool

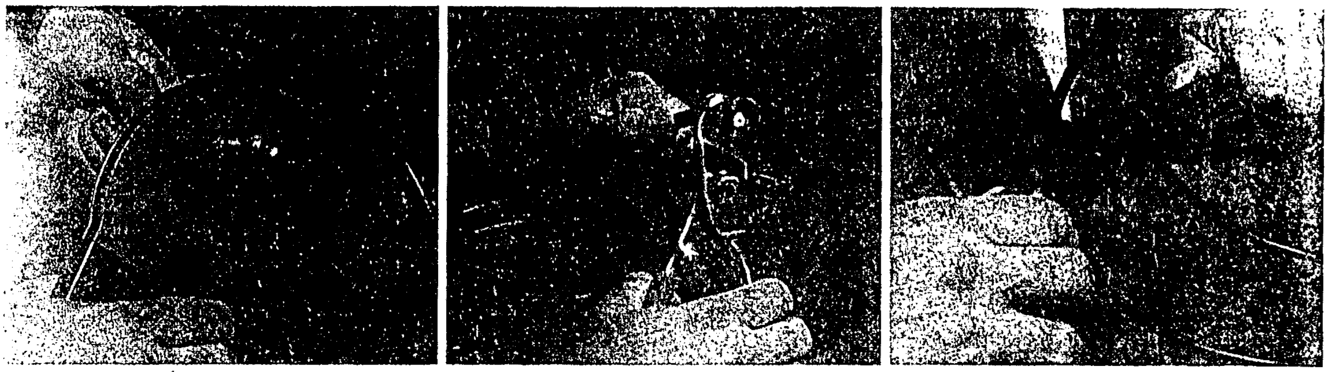
Techniques and Troubleshooting Strategies

By Mark Alrutz and Jim Crunk

As the race to upgrade steps up, attention to craftsmanship is imperative. We explain the best way to prepare and connectorise coax, and how you can head off potential problems down the road.

Upgrade. This one simple word has completely transformed our industry in the last few years. Networks are being redrawn, redesigned and rebuilt at an unprecedented pace to facilitate the many new revenue streams available, from digital video to high-speed data to telephony. In order to make this happen, new testing techniques and technologies have to be learned, all with fewer staff and less time than ever before. This article addresses a foundational issue—coaxial connectorisation, or splicing—that is more critical in today's broadband systems than ever before.

Craftsmanship in coaxial construction has always been an area of concern, but one easily overlooked in the rush of progress. We haven't heard of a system yet that feels it has received enough training. Fortunately, coax has proven to be a somewhat forgiving product, at least at lower fre-



Left: An installer uses an F-connector crimping tool to fasten an F-style connector securely.
Centre: Coaxial cable-cutters are used to cut the cable to length.
Right: A coring tool removes dielectric material, shielding and the jacket, enabling preparation of the centre conductor.

quencies. A loose fitting here or there is a minor offence, and doesn't matter much at 450 MHz. In the US, the advent of stricter signal leakage requirements in 1990 brought a lot of issues to the forefront, but not all.

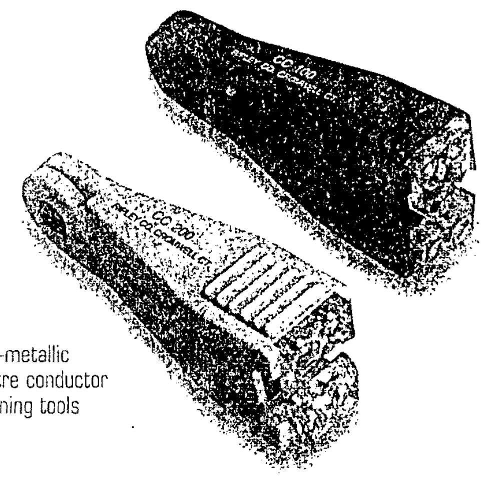
Today, with systems upgrading to 750 MHz and beyond, craft issues that were once hidden, specifically splicing, require particular care and attention. A loose fitting or improperly prepared centre conductor may induce frequency-dependent loss into your system, and be difficult to isolate and repair. We address this issue with a discussion of how to properly prepare and connectorise coax, then how to troubleshoot a frequency-response issue. Finally, we describe some new advances that should help lessen craft-sensitivity.

Preparation and splicing

Proper splicing begins with proper preparation and a simple review of critical elements. Before splicing, make sure you have the correct tools. This includes a review of tool sizes used, which may seem obvious, but could easily be overlooked with many different cable types and sizes in each upgrade. Make sure the tools are clean enough, and check that they aren't damaged or misaligned. These tools include a coring tool, a file, a centre-conductor cleaning tool, and wrenches sized for the connectors and cable cutters. A high-torque, low-speed drill or a ratchet are optional, but will speed up the process. Wearing safety glasses and gloves is recommended.

You will notice knives and slip-lock pliers are not mentioned, simply because they should not be used. Knives may damage cable components, leading to premature mechanical failure and high-frequency suckouts. Slip-lock pliers may damage the connector and slip, which may lead to damaged shrink boot or other problems.

Once the correct tools are ready, prepare the cable by trimming it with the cable-cutters to a smooth, round end. Straighten the cable slightly to ensure a better core. For traditional cables, use a jacket-removal tool or one-step tool to remove the jacket, and remove the flooding compound as necessary. Low-loss cables often utilise one-step tools that do not require jacket removal first.



Non-metallic centre conductor cleaning tools

FIGURE 1 | TWO-PIECE INSTALL

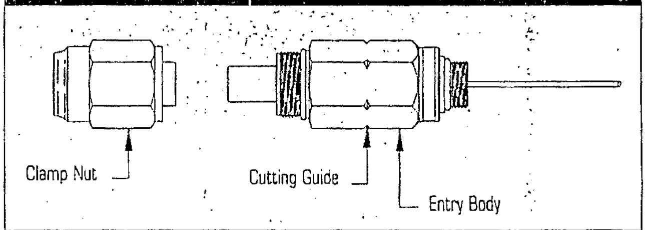
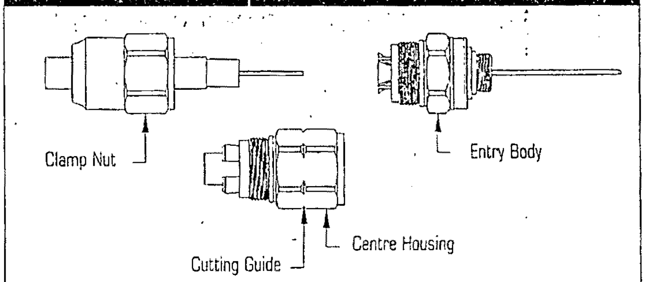
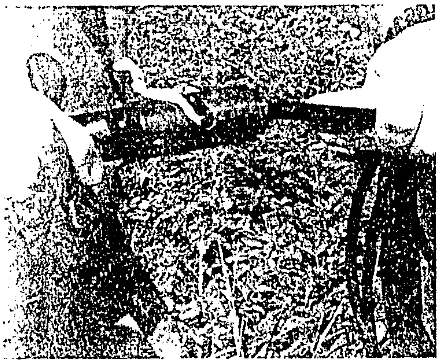
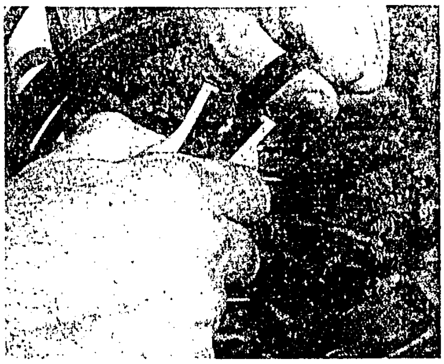


FIGURE 2 | THREE-PIECE INSTALL

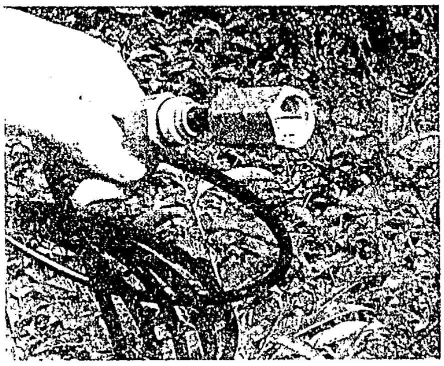


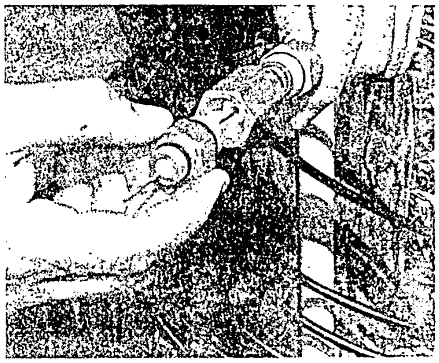
Remove the proper amount of shield and dielectric with the coring tool. Slide the cable into the tool until it stops. With slight forward pressure, twist the coring tool—either by hand or mechanically with the ratchet or drill—so that the blade begins to strip and core the cable. Continue to turn the coring tool until it spins freely—many tools have a preset stop that requires no adjustment.





Top Left: A coring tool as it is used. Note the excess material being removed.
Top Centre: A prep tool removes bonded dielectric material from the centre conductor.
Top Right: Rotating the jacket prep tool until it spins freely ensures a good connection between connector and shield.
Near Right: A pin-type connector is installed in three parts.
Far Right: The third part of the connector (the pin section) will connect the cable to a distribution node.





Clean the dielectric and shield residue from the tool to help ensure the next cable you prepare will be correctly cored as well. The key to proper coring is to let the tool do the work, and do not perform secondary operations unnecessarily. This may be particularly tempting with bonded cables, which may leave a residue on the inside of the shield. If the tool leaves a residue, it is by design, and should not be manually removed.

BOTTOMLINE

> **Getting Connected**

Systems operating at higher frequencies are more sensitive than ever to craft issues, splicing in particular. A loose or improperly prepared connector interface, which was unnoticeable at 450 MHz, can cause a terrible response problem at 860 MHz. The foundational steps that can be taken to prevent these problems in your plant include:

- Using proper tools and procedures. This requires time and attention to detail.
- Following proper connector installation procedures.
- Utilising new available cable technologies, tools and connectors.

Troubleshooting and repairing frequency response problems require systematic searching for the root cause, followed by simple application of standard craft procedures. While frequency-sensitive issues may be difficult to trace, they aren't ghosts and don't require any new "techniques" to address. Proper craftsmanship, consistently applied, will eliminate frequency response issues well into the future.

Clean the centre conductor by using a non-metallic cleaning tool. Score the coating on the centre conductor at the shield and scrape it toward the end of the conductor. The conductor is clean if the copper is bright and shiny. Do not use a knife or other metal tool because it may damage the copper cladding. Any residue left on the cable may cause frequency response issues.

Generally, entry connectors come in a two-piece or three-piece design. It comes down to personal preference as to which one you use. First, slide the shrink tubing over the cable end. With two-piece entry connectors, install the entry connector into the housing using 15 foot-pounds of torque.

Remove the clamp nut from the connector and slide it over the cable until it bottoms inside the ferrule. Insert the cable over the mandrel until it bottoms. Using a back-up wrench, tighten nut firmly to the positive stop or what ever foot-pounds of torque the manufacturer recommends.

Tighten the seizing device inside the housing for the entry connector terminal and install heat shrink if applicable.

Note: if you are using a heat-shrink boot, apply the flame carefully. Overuse of the torch may melt the cable's jacket and dielectric.

For three-piece connectors, start by installing the entry connector into the housing using 15 foot-pounds of torque. Remove the clamp nut from the centre housing and slide it over the prepared cable end. Install the heat shrink if applicable.

Remove the centre housing and insert it into the prepared cable end until bottomed. Insert the cable centre conductor into the entry body until it bottoms while tightening the centre housing firmly against the positive stop on the entry body or use the proper foot-pounds of torque the manufacturer recommends. Use a back-up wrench on the entry body.

Slide the clamp nut up to the centre housing and tighten firmly against the positive stop. Use a back-up wrench on the centre housing. Tighten the seizing device inside the housing for the entry connector terminal. Now it's time to install the heat shrink if applicable. And again, be careful with the flame around the cable.

Troubleshooting frequency-response issues

Proper craftsmanship will eliminate frequency response concerns. Unfortunately, older plant, particularly those built by a variety of contractors, may hold some hidden surprises. We have found that trouble spots may be isolated by careful sweep techniques. Often a frequency suckout, or "notch," can be traced to a single connector or splice location by systematically moving from the end of the line to the amplifier, one tap at a time. This procedure is required because a troublesome splice may project its frequency response problem all the way through a tap run.

"The key to proper coring is to let the tool do the work, and do not perform secondary operations unnecessarily."

In the majority of systems with response issues, loose connectors somewhere in the system most often were found to be the cause of a frequency "notch." In other cases, improperly cleaned centre conductors or connectors assembled from mismatched components were to blame. In all cases, a properly prepared splice, using recommended procedures, corrected the issue.

Splicing advancements

Splicing tools have improved as system demands have increased. New tools often perform coring and jacket-removal in one step. New connector designs for premium cables, which reduce craft sensitivity in the critical higher-frequency bands, also are available. Careful cleaning and tool maintenance are still required for proper tool use. Proper care and craftsmanship, combined with these new products, will ensure solid high-frequency performance for the future. CT

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CTI welcomes your questions and comments. Please send an email to kmcdonald@phillips.com.

By Jim Farmer

This month, we offer part two of our series on return loss, an often misunderstood parameter. In this installment, Jim Farmer looks at the effect of reflections on digital and optical signals.

In the digital world, it is convenient to look at the time domain effects of the reflections. Assume the same conditions as in Figure 2 of last month's installment. Figure 1 shows a constellation diagram for a quadrature phase shift keying (QPSK, also known as a 4 quadrature amplitude modulation signal with a reflection[1]). The constellation diagram is developed by plotting the location of many data bits on a diagram in which the radius from the centre is proportional to the amplitude of the signal during that bit. The angle from the X–axis represents the phase of the signal during that bit.

If a bit appears in the correct quadrant, it will be interpreted correctly regardless of where it appears in the quadrant. If a bit crosses either the X– or Y–axis, it will be interpreted incorrectly. In QPSK, the decision threshold is at the quadrant boundary. In Figure 1, the reflection is about –12.3 dB. With QPSK, there would be no problem with this amount of reflection.

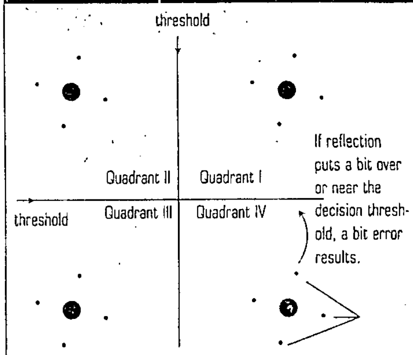
Figure 2 shows the same amount of reflection for a 16 quadrature amplitude modulation (QAM) signal. With 16 QAM, we have twice as many states on each axis. With more states, the decision thresholds are closer together. They are seen in the figure as a series of horizontal and vertical lines. Note: A complete second constellation exists around each point, which is caused by the reflection. Some of the reflected bits cross a decision threshold, so there will be bit errors as a result of the reflections.

If we were transmitting higher orders of modulation, such as 64 QAM and 256 QAM, the problem would be more severe. In order to allow these higher orders of modulation to be successfully transmitted, the receivers use adaptive equalisation. Adaptive equalisers delay the signal by the amount of the reflection, then subtract that delayed signal from the non-delayed signal to cancel the reflection.

Optical return loss

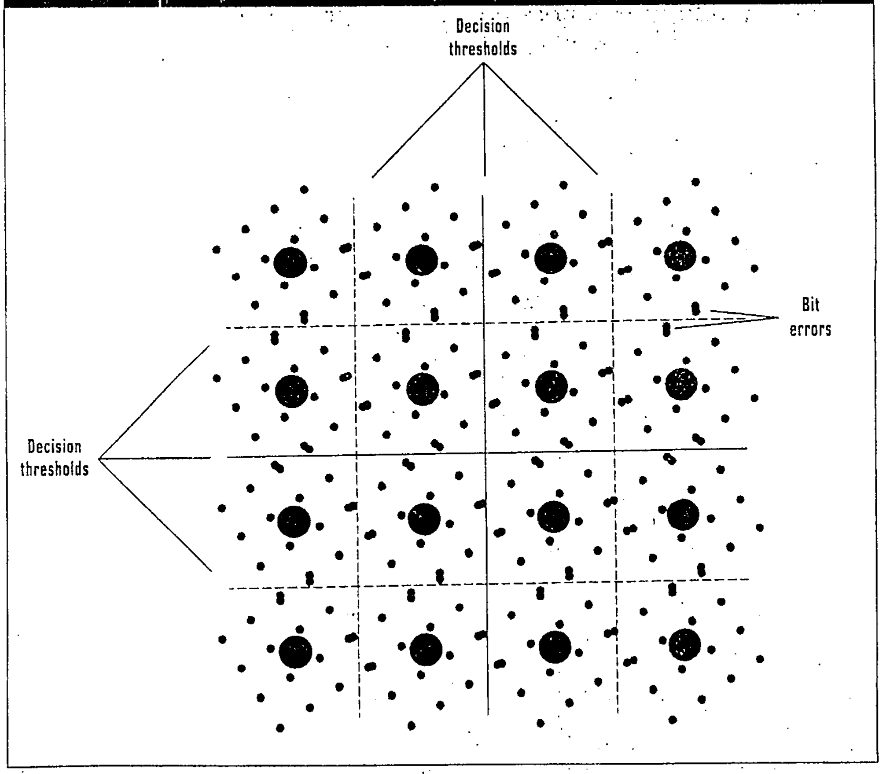
Optical systems have other requirements for return loss. Consider the operation of a laser transmitter. The transmitter works by varying the light power out of the laser according to the input signal. Most of the transmitters used in cable television are of the directly modulated type in

Figure 1: A Reflection on a QPSK Signal

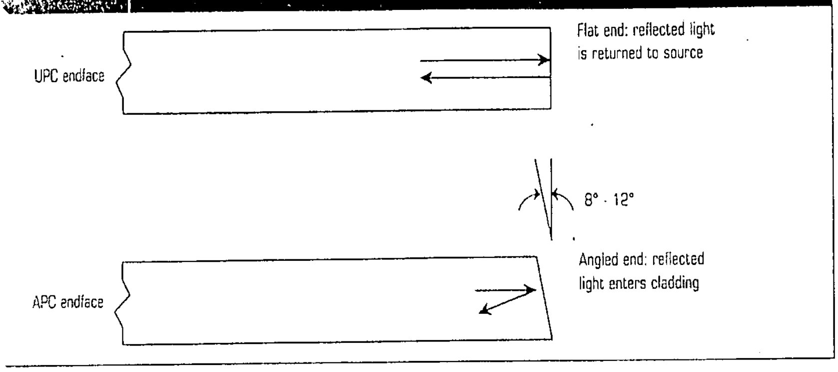


Reflections cause a replication of the constellation about each data point, rotated by an angle related to the RF phase of the reflection.

Figure 2: A Reflection on a 16 QAM Signal



REFLECTION FROM UPC AND APC OPTICAL CONNECTORS



which the diode current is modulated with the input signals.

If you have a situation in which energy is reflected back to a laser diode, it may cause the laser wavelength to "pull." This phenomenon is like an injection-locking of a radio frequency (RF) oscillator. If you have ever tried to operate two RF oscillators that have nearly the same frequency of oscillation, you know that if power from one gets to the other, the second will try to oscillate on the frequency of the first—but its own frequency-determining network is trying to make it oscillate on a slightly different frequency. The result is a lot of noise in the output.

The same thing occurs with the laser diode. The wavelength (reciprocal of frequency) changes slightly with modulation. Normally, this doesn't cause problems. However, if you have a reflection from the cable back to the diode, the reflected signal will be of slightly different wavelength than the emitted wavelength because of oscillator-pulling and the return delay of the reflected signal. This may cause the laser to "pull" or "chirp," resulting in considerable excess noise.

Another effect of reflection may occur at the receiver. Receiver diodes don't have particularly good return loss so they will reflect some signal back towards the source. If that signal is reflected again, such as by poor return loss at a connector, it will arrive back at the receiver delayed by the round-trip time. Not only will the delay cause a reflection with the frequency response and echo errors shown earlier in Figure 2, but also the difference in frequency (because of laser chirp) will cause a beat between the direct and reflected signals, again causing more noise in the received signal.

From experience, we like to maintain the return loss of an optical path handling frequency multiplexed analogue signals above about 45 dB. This will prevent reflections from causing problems. Because practical optical links have several connectors, the primary source of reflections, we like to maintain the return loss of any one connector pair in the mid 50-dBs. This return loss is possible with good connectors and proper cleaning.

The selection of a connector type is important. A few years ago, ultra-polished connectors (UPC) were popular, and looked good when perfectly cleaned and mated. However, when connections are not properly cleaned, return loss degrades significantly. For this reason, angled polished connectors (APC) have become more popular. The angle causes reflected light to enter the fibre-cladding where it is absorbed. A perfectly cleaned APC connector has more attenuation. When cleaning is less than perfect, however, they degrade in return loss more slowly than UPC connectors. The return loss degradation of a UPC connector often outweighs the slight improvement in transmission loss.

Figure 3 (page 40) illustrates the end faces of the two types of connectors with the angle on the APC endface[2]. The reflection into the cladding makes the APC connector more immune to problems with cleaning errors, making the connector less of a problem if it is unterminated. In talking to colleagues who do field service repairs, I found that at least half the field problems are a result of poorly cleaned optical connectors. You can save yourself a lot of grief by cleaning optical connectors correctly. CT

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> **Return Loss**
> Return loss limitations on both ends of a path effect a digital signal by creating a reflection of that signal, resulting in potential bit errors. Higher order modulation techniques, such as 64 quadrature amplitude modulation (QAM) and 256 QAM are much more susceptible than are lower order techniques, such as quadrature phase shift keying (QPSK). Return loss problems in optical paths often causes additional noise in the received signal. The effect may be minimised with proper connector cleaning.

[1] For more information on interpreting the constellation diagram, see this author's digital modulation series that appeared in *International Cable* magazine April-December, 1998. Also, see Chapter 4 of Ciciora et. al., Modern Cable Television Technology: Video, Voice and Data Communications, ISBN 98-35328. This book is available at www.mkp.com; www.amazon.com; www.barnesandnoble.com; and other outlets.

[2] From Chapter 11 of the Ciciora et. al. book referenced above.

Next month: How splitters and directional couplers work.

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Did this article help you? Are there other topics you'd like to see covered in this column? Please send an email to kmcdonald@phillips.com.

Opportunities for Application Service Providers in Cable Networks

Capture New Revenue Streams

By Pablo L. Martinez

The always on broadband access provided by cable networks offers operators the opportunity to be application service providers (ASPs). In part two of our series on the relevance of the ASP model to cable networks, we develop a business case built upon the service models and architectures introduced in part one.

Internet access for e-mail and Web browsing is currently driving initiatives to upgrade cable plants to IP-centric platforms. However, the flexibility and ubiquity of IP technologies give cable operators the opportunity to offer new innovative services not only to residential customers but also to telecommuters, small office, home office (SOHO), and medium business customers. One example is application rental services, where end-users remotely invoke features from applications running on network-centric server clusters (see Figure 1 on page 134).

This network-centric service model simplifies end-user system requirements and maintenance. It provides cable operators the opportunity to offer application services that take advantage of the always on broadband access that cable networks offer. In this role, cable operators become ASPs.

Market trends

According to the **Yankee Group**, the ASP market will grow from $3.1 billion in 1999 to $14.2 billion in 2003, (see Figure 2 on page 134). According to this forecast, Web hosting and e-commerce are the key revenue generators.

A market segment of interest is income-generating home offices. By the end of 2002, **IDC** expects over 30 million U.S. home-office households with someone running a business. About 8.2 million U.S. households will be equipped with cable modems, out of which 6.2 million are expected to be home offices. This represents more than 75 percen of the cable modem customer base.

One of the elements driving home-based businesses to access and have a presence on the Internet is that it serves as a low-cost conduit for revenue-generating opportunities such a e-commerce. Also, the Internet is quickly becoming a strategic portal for business information and research, especially for small businesses, which tend to have a higher percentage of knowledge workers. This type of customer is cost sensitive, prefers to deal with local service providers and expects high-quality customer service. The ASP service model may help cable operators satisfy those needs.

Business case assumptions

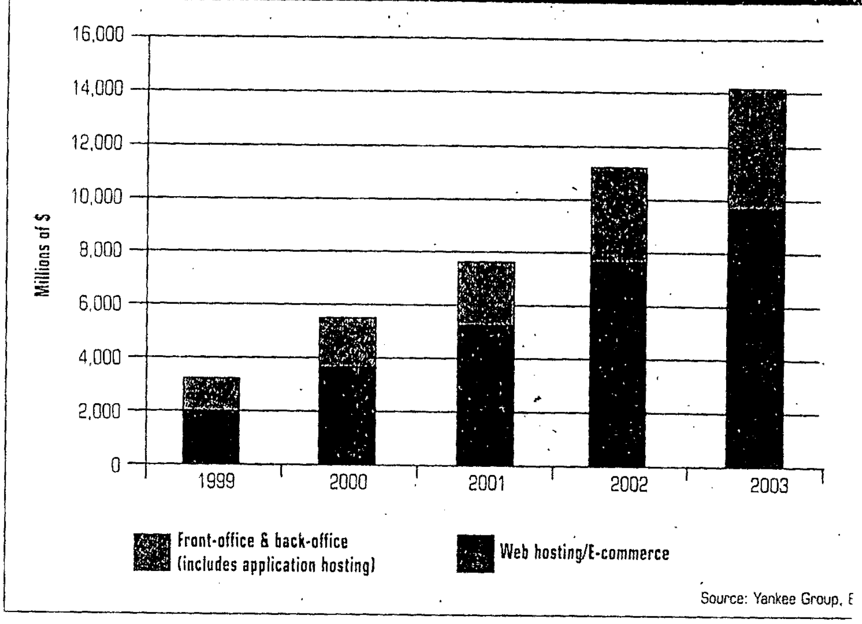
A business case built around a simple scenario is presented in Table 1 on page 138. A cable operator providing traditional Internet access services to residential end-users via cable modem wants to become an ASP. In this scenario, the cable operator built a data center capable of supporting a total of 50,000 end-users (20,000 end-users subscribed to ASP services and the remaining 30,000 end-users subscribed to regular Internet access services).

Another option would be for the cable operator to have a third-party service provider host the data center. This option reduces up-front capital outlays and allows faster entry into the market. But, for the purposes of the business case presented here, it is assumed the cable operator builds its own data center. The rest of the assumptions used to build the business case are presented in Table 1.

The business case assumes that the cable operator offers a simple set of ASP applications. Basic human resource applications, financial management, collaborative computing, sales automation, groupware and e-mail all are offered as a service bundle.

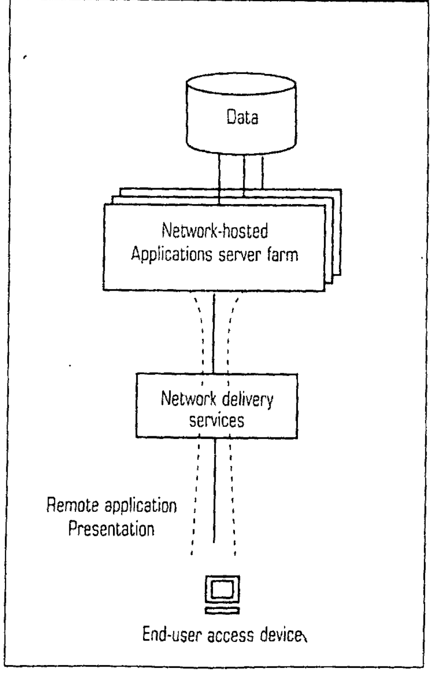
In addition, a simple pricing plan is assumed based on flat user per seat, per month fees. More sophis cated billing schemes are needed support usage-based pricing eithe the application level or at the trai action level. Determining the cor level of billing granularity depen not only on current technologica capabilities, but also on ASP busi ness and service arrangements fo the application frameworks. >

FIGURE 3 ASP MARKET FORECAST



Source: Yankee Group, E

FIGURE 4
DELIVERING APPLICATIONS AS A SERVICE



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> **Revenue Opportunities in a Network-Hosted World**

Cable operators may increase their revenue streams and attract new customers by pursuing the application service provider (ASP) model. The ASP model also:

- Targets the growing home-based business market segment without the need to expand current cable plant footprint
- Helps overcome some of the upstream bandwidth limitations of the hybrid fiber/coax (HFC) plant
- Enables the offering of higher margin, converged voice/video/data applications and value-added service bundles
- Shifts pricing models toward subscription-based and transaction-based schemes, thus generating recurring revenues from end-users
- Promotes cable operators in th value-added chain to differenti ate from traditional Internet se vice providers (ISPs)
- Creates opportunities to expar and complement service portf lios with professional services
- Allows cable operators to partn with other service providers an add value to their service offeri
- Increases end-user satisfaction and retention via a growing se lection of hosted applications
- Adapts to end-user's need to switch services while still red ing end-user churn
- Simplifies the process of addi new end-users
- Improves end-to-end security cable networks

ASP pricing models

Figure 3 (at right) shows how ASP pricing models may evolve over time. The diagram shows a shift towards subscription-based and transaction models and implies that pricing models eventually may rely less on traditional software licensing.

The ASP service model offers applications to thousands of users on a monthly subscription basis. This requires adapting application-licensing schemes to fit a dynamic recurring monthly fee model. One example is software licensing utilities enabling ASPs to provision applications for rental without incurring up-front license fees. The software licensing utility measures concurrent usage of application software, and the ASP makes monthly payments to application software vendors accordingly. This utility may also apply tiered discounts as the ASP's customer base grows.

The flat-rate pricing plan used in this analysis is based upon application types. The pricing criteria takes into consideration application value and application configuration time. Other pricing plans are in use today, such as charging according to server type and configuration (shared vs. dedicated servers). This type of pricing plan may be broken down further into hardware and maintenance fees. Another example is charging according to end-user access rights to application data (read-only versus editing privileges).

FIGURE 3 | EVOLUTION OF ASP PRICING MODELS

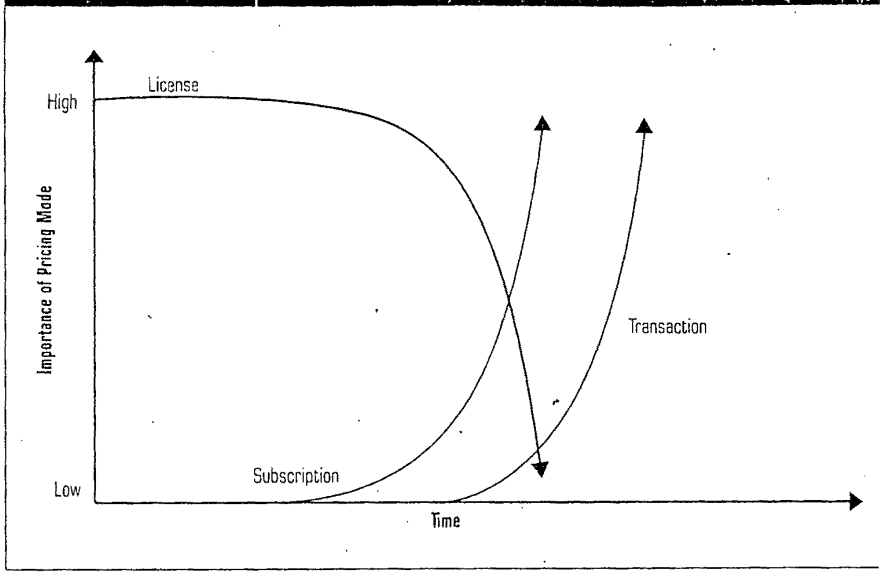
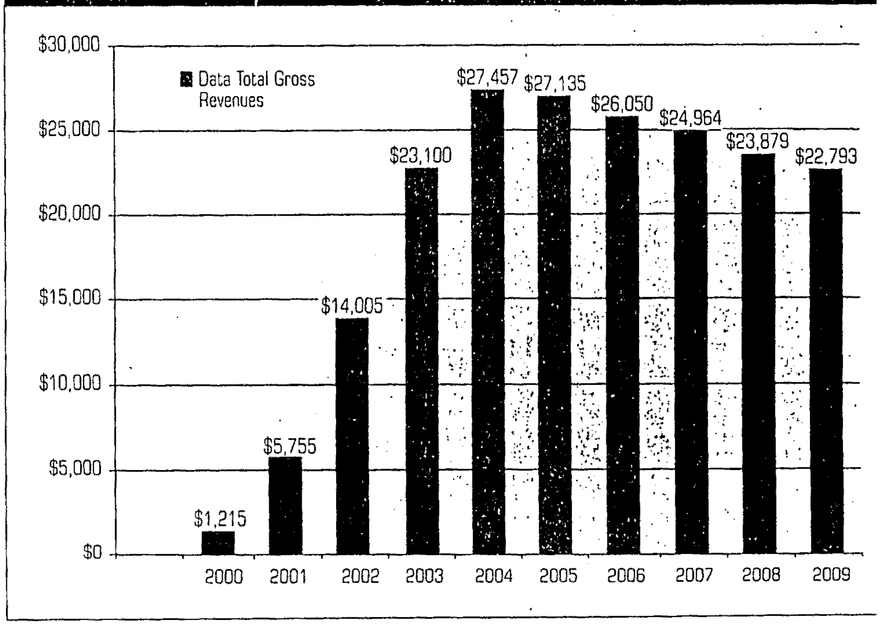


FIGURE 4 | ASP BUSINESS CASE—GROSS REVENUES



Projected revenues

The ASP service model rests on a pricing structure that generates monthly recurring revenues independent of the pricing plan used. ASPs have opportunities to increase these

> **"More sophisticated billing schemes are needed to support usage-based pricing."**

revenues. For instance, many existing applications are being "ported" to network-hosted environments. In addition, new network-hosted applications are emerging, creating opportunities to expand service portfolios and offer professional services. In fact, the ASP service model allows ASPs to cross-sell solutions from other ASPs. The service model simplifies adding new end-users as well.

In this business case example, gross revenues will grow from $1.215 million in 2000 to $27.457 million in 2004 (see Figure 4, above). After the fifth year, gross revenue begins to decrease. This is because of the assumption that there were no plans to expan beyond the capacity of the single data center deployed initially, and that service pricing decreases as technology matures. This means that after five years of steady customer base growth, either new data center facilities need t be deployed or the capacity of the exis ing center must be expanded. This, of course, depends on the growth-rate profile assumed in the analysis.

Anticipated expenses

In terms of expenses, there are sev eral elements that must be considere One element is the cost of implemer ing data center facilities and an improved Internet protocol (IP) infrastructure. Storage costs are particularly important.

Another element is the cost of customizing application software. As mentioned before, customized software does not fit well with the one-to-many ASP service model. The time an ASP spends customizing an application for a customer is time that cannot be applied to serving the needs of other customers. Also, application customization may increase the time it takes to complete application software upgrades. Applications must be designed in ways that optimize their customization capabilities or at least expedite the creation of libraries of pre-customized application templates.

Other expenses include application delivery costs, application service trial costs, best practice implementation costs, the cost of integrating new applications into existing service bundles and information technology (IT) staff costs, such as hiring and training. In terms of IT staff costs, the expense is spread over a growing customer base, thus providing economies-of-scale benefits. IT utilization is "bursty" in nature when dedicated to one company. Once IT resources are shared among multiple customers, their utilization increases and maintains a more stable rate.

The total expense results for the business case are shown in Figure 5 (above). Expenses reach $2.011 million and climb to $6.859 million in 2004. Again, after the fifth year, the expense growth rate slows down considerably, corresponding to the data center reaching its maximum capacity at that time.

Cash flow analysis

Figure 6 on page 140 shows the results of the free cash-flow analysis of the business case. Again, after the fifth year, cash flow decreases, given the assumption that maximum capacity is reached at that point in the data center and there are no plans for additional growth. At the same time, annual service revenues keep decreasing while no additional investments are made. In

FIGURE 5 ASP BUSINESS CASE—TOTAL EXPENSES

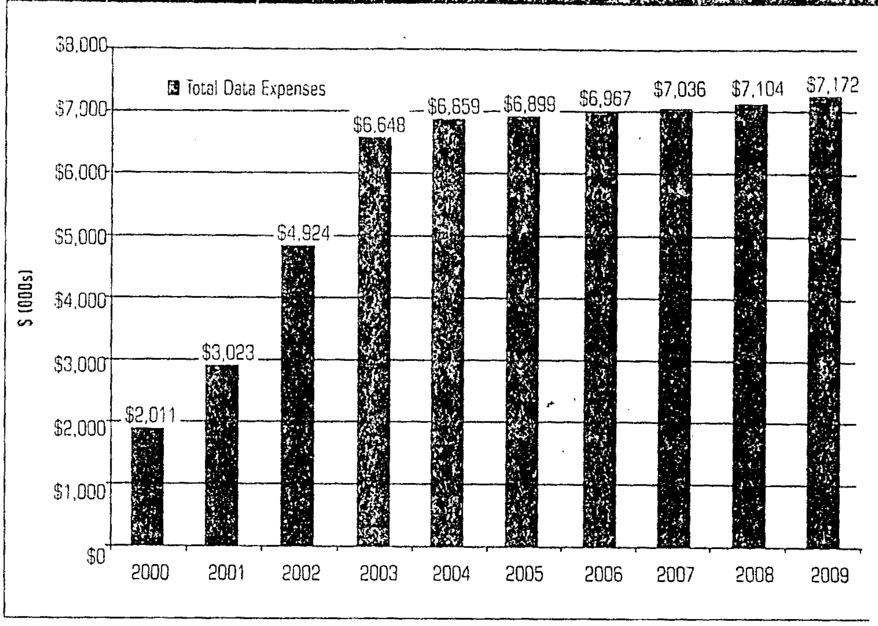


TABLE 1 CABLE-ASP BUSINESS CASE ASSUMPTIONS

Item	Assumption
Market Size Assumptions	
Initial footprint (i.e., first year)	150,000 end-users
Growth rates	30 percent (years 1-3)
	25 percent (years 4-6)
	20 percent (years 7-9)
General Assumptions	
Weighted Average Cost of Capital (WACC)	12 percent
Terminal rate	4 percent
Tax rate	36 percent
ASP Service Penetration	
Initial penetration	1 percent
Annual increase	2 percent
Maximum	6 percent
Churn Rates	
Initial churn	12 percent
Incremental churn	0 percent (economically stable service area)
ASP Service Pricing	
Service revenue	$150/month/subs
Annual increase	-$5
Partner share	10 percent
Equipment Expense	
CMTS (incremental to support ASP subs)	$150/sub
ASP equipment (1 data center)	$1.7 million ($700K for software, $300K for servers, $400K for data networking, $300K for data storage)
Data Center Expenses	
Recurring expenses per year	$500,000 + 5 percent of gross revenue
Engineering & design	$200,000 (first year only)
Billing and OSS Expenses	
Recurring expenses per year	$250,000 + 3 percent of gross revenue
Customer Service & Support	
Recurring expenses per year	$30 x average number of subscribers
Sales and Marketing Costs	
Recurring expenses per year	$100K + ($150 x number of new subscribers)
General & Administrative	
Recurring expenses per year	$500,000 + 3 percent of gross revenue
Installation Costs	
Installer salary & benefits per year	$100K
Number of installations per technician per year	7,500

a more realistic scenario, the cable operator may plan for growth of both the customer base and the service portfolio. Also, technological advances that will increase infrastructure capacity and enable more profitable emerging applications will occur.

Figure 7 on page 142 shows cumulative discounted cash flow results of the business case. With an initial investment of $2 million, a relatively simple portfolio of application offerings and limited growth planned, the business case predicts more than $41 million in 10 years with the break-even point reached in less than three years.

The ASP service model and architecture provide cable operators the opportunity to differentiate from traditional Internet service providers (ISPs) and exploit their strengths in offering converged service bundles. This model moves application processing, security and quality of service (QoS) to the network and relays presentation functions to end-user terminals. Security and QoS treatments still are needed to guarantee proper delivery and application response times, but these may be provided in a more efficient and simpler way over the cable access network. End-user equipment gets simplified, which results in a reduction of truck rolls and overal maintenance support.

The ASP service model rests on pricing structure that generates monthly recurring revenues. It cre ates opportunities to expand servi

FIGURE 6 ASP BUSINESS CASE—FREE CASH FLO

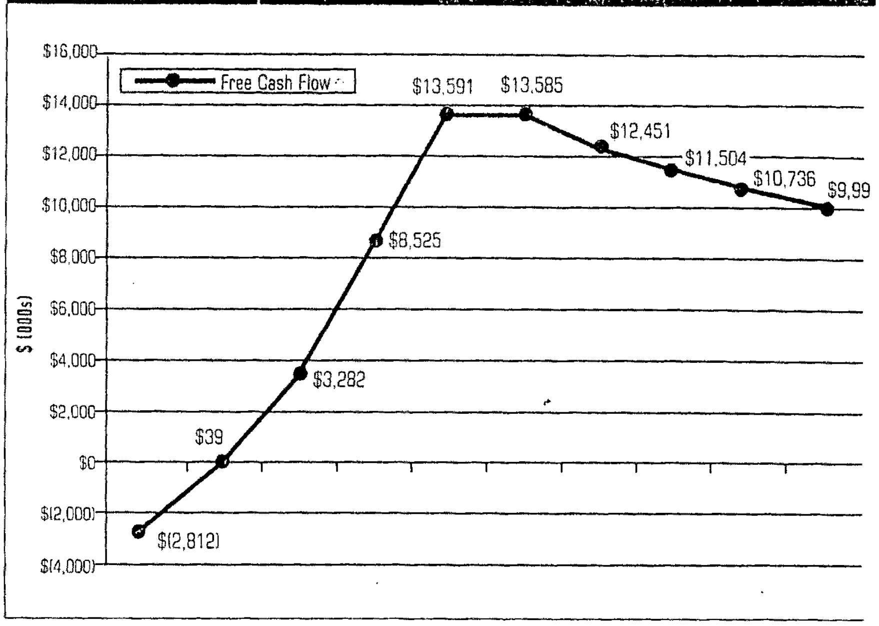
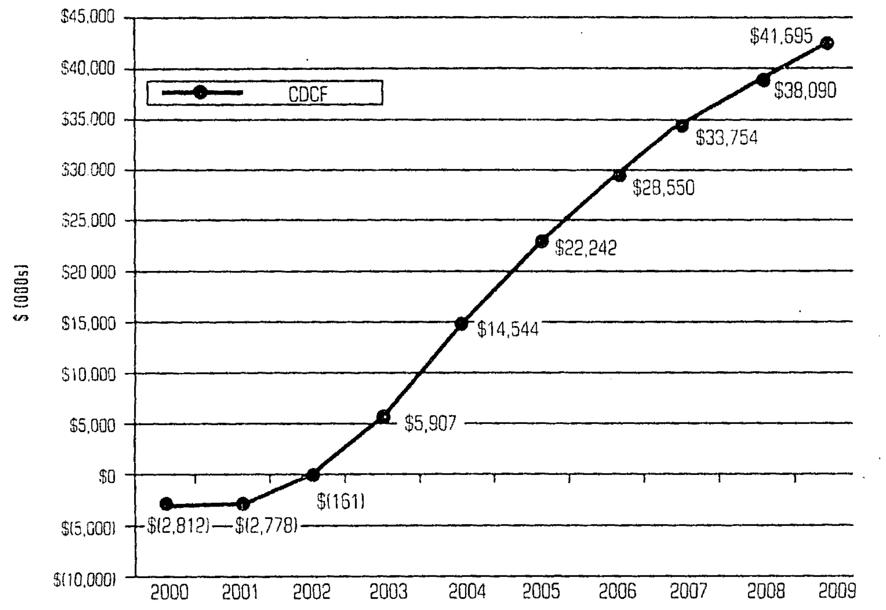


FIGURE 7 ASP BUSINESS CASE—CUMULATIVE DISCOUNTED CASH FLOW (CDCF)



portfolios, offer professional services and to cross-sell solutions from other ASPs.

There are some challenges, however, that need to be addressed. For instance, more sophisticated billing schemes are needed to support usage-based pricing. The level of billing granularity depends on technological capabilities, and the ASP business and service arrangements upon which application frameworks are implemented. Adapting application-licensing schemes to fit a dynamic recurring monthly fee model is another challenge. A third challenge is designing applications in ways that optimize their customization capabilities at reasonable costs.

Once these challenges are addresse the ASP model will provide cable ope ators with additional revenue stream and the ability to attract a new segment of SOHO customers. CT

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Has Open Access Got You Lost?

A Roadmap for Providing Choice—Part 1

By Bruce Bahlmann

)pen access weighs heavily on the minds of ;oday's cable engineers. You know it's com- ng, but what exactly does open access nean? Does it only pertain to high-speed lata (HSD) services? How will you implement t, and what are the challenges?

Vhile the advent of open access romises to bring nothing but good hings to customers, the challenges aced by vendors and broadband oper- itors are extremely steep. In fact, nany of the components required to :ompletely implement an open broad- and system do not exist yet. We'll pend the next three issues dissecting his thorny problem.

Vhat is open access?

The basic concept of open access is o provide individual broadband cus- omers with a choice of service oroviders. The term "service provider" epresents a supplier of content like nformation and entertainment or :onnectivity service. From here on out ι service provider represents any com- oany that can utilize the broadband nedia to deliver some service directly o customers. The breadth and scope of content and connectivity services ιvailable are limited only by the imag- nation. This is especially true as the ımount of bandwidth available be- tween the service provider and the customer increases.

The basic components

Open access will afford each broad- band customer the opportunity to choose those service providers that best meet their needs. Figure 1 (see page 98) represents the major areas of challenge with regard to open access. They are basic hybrid fiber/coax (HFC) connectivity, connectivity man- agement and service management.

Basic HFC connectivity in a com- pletely open access environment goes beyond today's single frequency pair. Basic HFC connectivity in this case represents a spectrum of bandwidth dedicated to open access and managed by the broadband operator. This band- width permits the guaranteed delivery of one or more subscribed services to every broadband customer. Connectiv- ity management represents the low- level switching and routing necessary to permit various service providers to deliver diverse connectivity options that do not interfere with one another. Lastly, service management adminis- ters the resulting array of service op- tions that will be available, the presentation of these options to broad- band customers, and the subscription changes to their respective service provider. Of the three components, service management represents a green field business area with few (if any) shipping products.

It's more than data

Remember that open access means more than simply allowing customers to access the Internet as today's high- speed data (HSD) over cable service provides. Open access means freedom of choice for all types of information and entertainment services via the broadband media (see Figure 2, page 98). Choice implies competition, and it's competition that drives innova- tion, diversity, and value—all good things for broadband customers. Management components are essen- tial to provide customers with an oranized and fair selection of service nd connectivity options.

While choice is to be commended, obstacles loom large for cable operators. Many of the components needed or an open broadband system aren't available. Some of these challenges are described in this article.

Bandwidth is scarce

As the model of open access gains more popularity, traditional broadband operators will grow ever more limited as they continue supporting analog video along side new digital services. This is because it is too expensive for them to reclaim the bandwidth used by these analog systems because it would require their analog customers to return their set-top boxes in favor of a digital set-top (or equivalent).

In the meantime, new broadband operators (perhaps those who have overbuilt HFC to compete with traditional broadband operators) can maximize their use of the available bandwidth without giving up some of their best frequency spectrum to analog services. Until traditional cable operators can rid themselves of analog video, new broadband operators will enjoy a significant advantage. They will have more than twice the available bandwidth (of traditional cable providers) to deploy new services.

In contrast, traditional broadband operators must squeeze out everything they can from the new bandwidth made available as a result of upgrades. Those that have not yet upgraded cannot offer any new services without taking something away from their existing analog customers. Thus the problem of getting rid of analog video may slow or reduce the number of services that can be offered in an open access market.

FIGURE 1 MAJOR COMPONENTS OF OPEN ACCESS

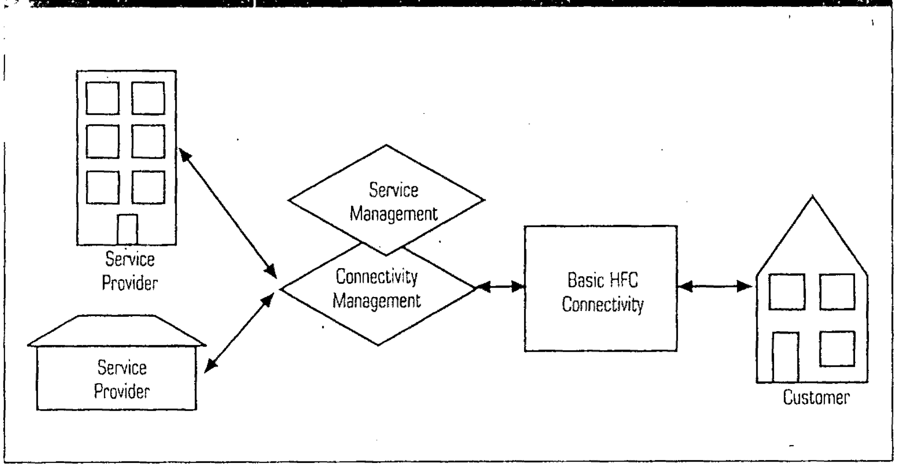
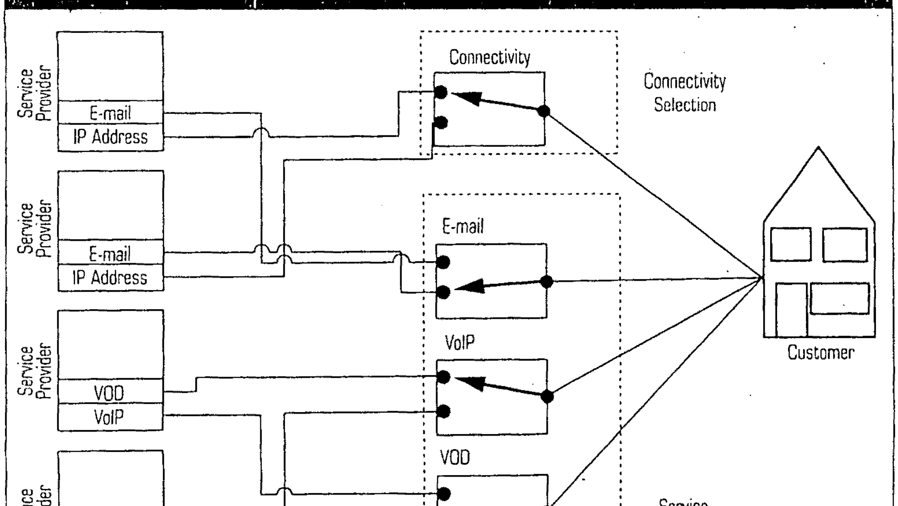


FIGURE 2 MANAGEMENT COMPONENTS OF OPEN ACCESS



Analog is inefficient

A customer watching a video program on a 6 MHz analog channel throws away the rest of the available spectrum on a 870 MHz system. Meaning, on an analog system if you are watching a program on one channel all the other programs running on other channels are still being received—they are just not being watched (tuned). This does not take into account the inefficiency inherent in using a full 6 MHz for viewing a single video program. Bandwidth needlessly is wasted in analog systems, and this wasted spectrum often is some of the best quality bandwidth that broadband operators have because it is usually the least prone to interference.

In contrast, a higher quality digital video channel requires only a fraction of this bandwidth—as many as 16 digital channels could occupy the same bandwidth as a single analog video channel. Additionally, broadband operators also broadcast channels that are rarely watched. In fact, a high percentage (as much as 30 percent to 40 percent) of a broadband operator's content is viewed by less than 1 percent of its customers. This is the result of concessions made to obtain various franchise agreements as well as how certain video channels are packaged.

If progress is to be made in making broadband more bandwidth efficient, some mechanism is needed to distribute content only where it is subscribed. Video-on-demand (VOD) is the ultimate application of this, but it is only designed for single, well defined programs and not continually running events (for example, a 24-hour news channel). Products are needed to allow broadband operators

to route more content to each customer or distribution hub rather than broadcast everything to everyone.

Fresh content, Revolutionized distribution

Much of today's broadband content is replicated. Essentially, it's the same movies playing over and over again. Very few cable channels actually maintain "fresh" (continually changing) content—some examples of these include 24 hour news channels, sports channels, etc. Oddly enough, most all public broadcasting stations maintain "relatively fresh" content—as one is unlikely to see the same program twice in one day or during the same week.

Service providers that just repeat the same content over and over will face stiff challenges from more diverse service providers that offer fresh or personalized content on demand. The advent and perfection of VOD along with assembling extensive libraries of popular movies will decrease demand for long-standing movie channel providers.

> "Until traditional operators can rid themselves of analog video, new broadband operators will enjoy a significant advantage."

Customers want to watch what they want when they want rather than what is playing at specific times that may or may not be convenient—that is the beauty of VOD. Although some movie channel providers produce some original content, it will be difficult for them to spin off as a separate service provider organization or sell their services directly to broadband customers, because they do not officially own a majority of their content.

It is the movie-making companies who are in the driver's seat to make their extensive archive of movies available for VOD viewing. Such a service provider would be attractive to broadband operators and would permit movie-making companies to directly sell their movies to broadband customers. In the end, the number of service providers that offers movies would decrease or perhaps specialize into genre specific focuses (sci-fi, action/adventure, humor and so on). Regardless, the content distribution mechanism must be revolutionized.

Maximizing return on Capital investments

Open access will challenge traditional broadband operators' ability to compete with businesses that specialize in providing information and entertainment. Some new broadband operators have already taken a more toll-road type of common carrier approach as the time required to turn profit on capital investments to launch new content services is growing out of control.

To address this, broadband operators may need to create a separate operating group that could sell its information and entertainment services to several broadband operators. These new service providers would compete with other service providers to ensure that broadband customers receive increasingly better services and quality content. By doing this, smaller broadband operators could offer nearly the same content as larger operators (depending on their available bandwidth) without investing in costly capital equipment.

In this case, becoming a service provider also is more attractive because a single capital investment can claim several income streams. However, traditional broadband operators only have considered providing open access to the Internet. In the grand scheme of things, open access is not simply Internet access. Rather, open access means freedom for broadband customers to choose from a much broader array of information and entertainment services provided by a multitude of different entities. Open access for Internet service is but a small step in this direction, and more steps are needed to realize its full potential.

Rock-solid reliability

Before service providers can be successful using broadband, the HFC network must be tight and ultra reliable. By not having to seek new content services, broadband operators could invest more energy in scrutinizing minute changes in the HFC network in an effort to make broadband a very reliable transmission media. However, today's operators are spread thin attempting to move new services onto broadband, while building up completely new HFC maintenance and network operations organizations. As

LINE

> The Freedom of Choice

Although most of the attention on open access has focused on high-speed data services, we ought not to limit our thinking to data. Open access means freedom of choice for all types of information and entertainment services.

While open access promises to bring nothing but good things to customers, the challenges faced by vendors and broadband operators to implement it are steep. Many of the components required to completely implement an open broadband system do not yet exist. In part one of this three-part series, we explore at some of the issues to be tackled before open access is a success. They include:

- Scarcity of bandwidth
- Inefficiency of analog video
- Freshness of content
- Distribution mechanisms
- Reliability of the hybrid fiber/coax network

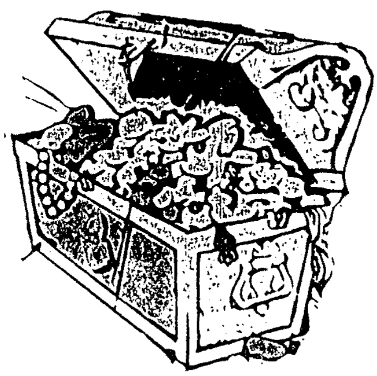
a result, HFC maintenance, automation, and staffing takes a back seat to launching new services which are increasingly dependent on a rock-solid broadband transmission media.

While the broadband industry claims good network availability numbers, they are not "five nines" or 99.999 percent, let alone the old Bellcore spec of 99.99 percent. There also is some doubt about the accuracy of these numbers as explained in last month's article about customer premise versus end of line monitoring (see *Communications Technology*, November 2000, page 92). Essentially, a large portion of the HFC network is invisible to broadband operators. If it is invisible, the availability numbers do not reflect the health of the whole broadband network but only a portion of it. Products are needed that permit operators to delve further into the inner workings of their HFC networks and help them detect, diagnose, troubleshoot, and correct problems before they become service impacting.

Pushing content to the edge

Another challenge with moving to open access is the problem of providing readily available content. As the network pipe that connects individual users to broadband increases, the availability of content at the networks' edge becomes paramount. This problem has plagued many popular Internet sites as they quickly discovered that providing a single web site for the world to access is unachievable. Instead, the best method of providing content is to push it down to the far reaches (or edges) of the network so it can be cached as close the customer as possible.

For broadband providers, this means placing content in the headends and distribution hubs. Traditional broadband HSD actually was designed with this in mind, placing numerous Internet services extremely close to customers. However, open access may pull this content back away from customers and place it at more distant service provider facilities.



For example, in order for multipl service providers to offer e-mail to customers, each would need to place a e-mail server in every broadband opera tors' headend—an unlikely solution be cause broadband providers would no be willing to give up the floor or rack space to facilitate this (some don't ev have the available space).

Pushing content further up from the networks' edge forces the rest o the network to handle more capacit while juggling critical service quali scalability, and redundancy issues. a result, solutions are needed to en able completely open access to different service providers without extending the content beyond its o timal reach.

All broadband providers can benef from open access because it allows them to specialize in taking care of their customers while managing thei service providers, bandwidth, and ne work reliability. Best of all, open acce completes the vision of broadband b placing new service activation on the open market and making bandwidth available for any new startup that wants to become part of broadband.

Stay tuned...

Next month, we'll be back to address the problem of managing the connectivity associated with open ac cess. We'll introduce some of the hu dles that you'll need to negotiate an how you can begin preparing for a more complex infrastructure. CT

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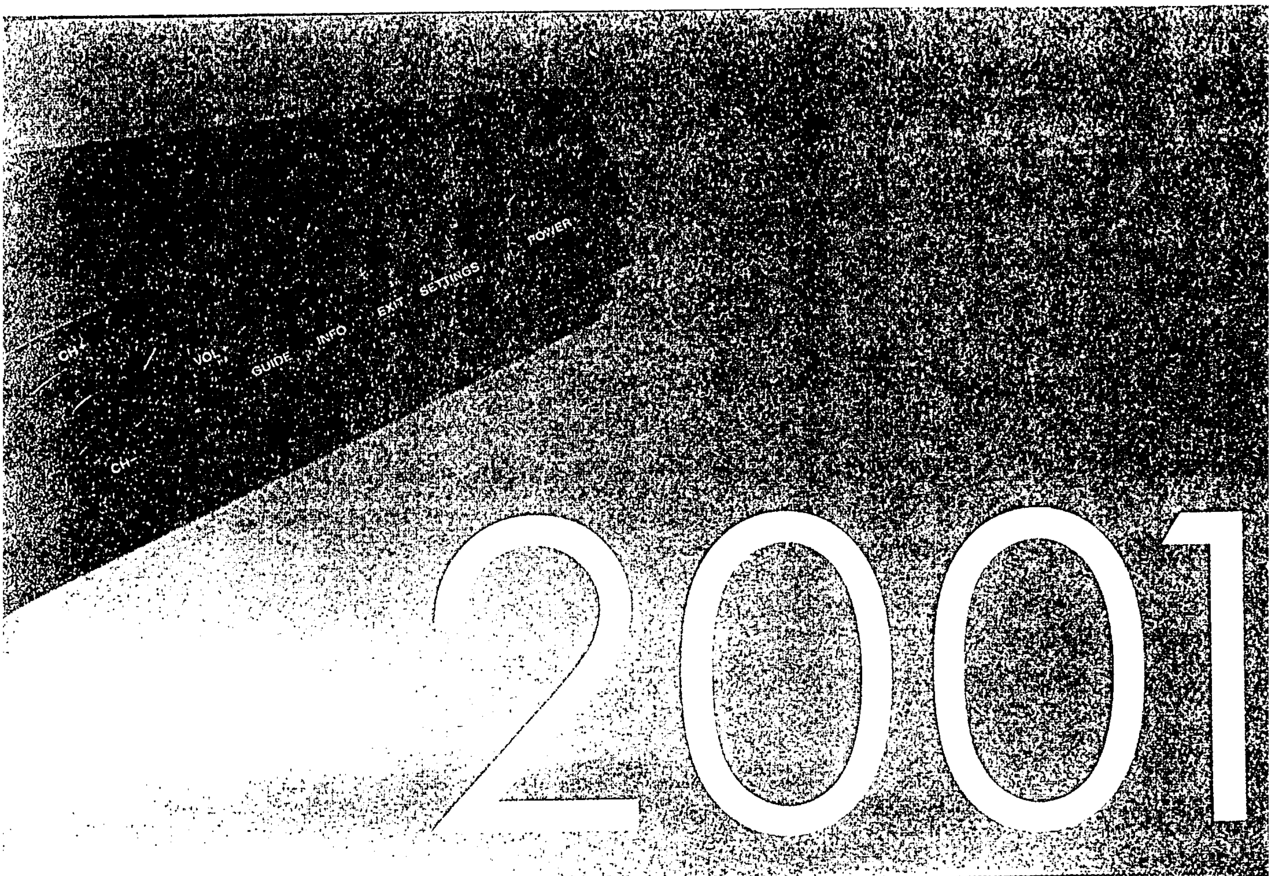
Did this article help you? Let us know your thoughts. Send an e-mail to jwhalen@phillips.com.



2001

The dawning of the DOCSIS delivery platform?

BY DOUG JONES, CHIEF ARCHITECT, YAS CORP.

There are compelling reasons to converge set-top box control over DOCSIS

Photo illustration by Ron Brown

Mankind has been in the world for 30,000 years. During the first 29,500 years, the agricultural age, we worked together and created a world of towns and cities of up to 100,000 people. During the last 500 years, we created the industrial age and developed cities of up to 15 million people and the workplace of the past century. In the last 15 years, we have started to build the information age. We have created a global economy where more than 1 billion people communicate together over the Internet.

Our vision and work over the next 10 years will continue to build on the Internet and create a broadband world. Experts predict that all people will be connected to vast amounts of content and media. This is a world in which video, data and voice will not only be truly integrated, but also a profitable business.

Cable, DSL, wireless, satellite and power line will all be competing to provide the best "first mile" connection from consumers to this broadband network.

Cable's access network offers the most aggregate "first mile" bandwidth into a subscriber's home. The cable access network is "channelized" into 6-MHz chunks of bandwidth as defined by the ITU J.83 standard. This channelization of the cable path allows flexible bandwidth allocation. It also allows different services to be placed on different channels. This is a unique property of cable networks, and can be referred to as frequency division multiplexing (FDM). That is, individual channels are at specific frequencies (e.g., the EIA channel plans).

Visit a large cable system headend and chances are video, data and voice services will be offered. But a closer look reveals that these services are offered as "parallel networks" that take advantage of the channelization of the cable access network. Not only do these services use separate channels on the cable plant, they also require separate sets of headend equipment. Cable operators have to procure separate systems, implement separate training programs, and run separate operations to offer these services. So, while cable operators offer voice, data, and video, they do so using three separate "silos" (see Figure 1). Although the huge bandwidth available on cable networks has allowed this strategy to work, the resulting amount of equipment and proliferation of complex technologies in the headend is growing to an unwieldy size.

The rapid increase in the amount of equipment needed to offer these services is a result of how the services evolved and what the suppliers offered as solutions. Voice and data have their own networks—the public switched telephone network (PSTN) and the Internet, respectively. Suppliers created proprietary product offerings to gain access to these existing networks over the cable access network. Back then, there was no universally accepted standard for two-way communication over the cable plant.

As a result, cable operators had to continually add more equipment to offer these services. All of this new equipment, each with its own complex technology, requires more capital expense, more operations expense, more training, more space, more air conditioning, etc. As will be introduced now, for competitive reasons, operators should consider a strategy to reduce the amount of equipment needed to offer voice, data and video services.

Consumers are fickle. They want new services, and they care neither who provides them nor what access technology is used. In light of current and future competition, cable operators need to offer the most compelling services while maintaining a competitive cost structure. Cable cannot continue to deploy parallel networks and proprietary products for each new service. Parallel networks increase both capital and operations costs.

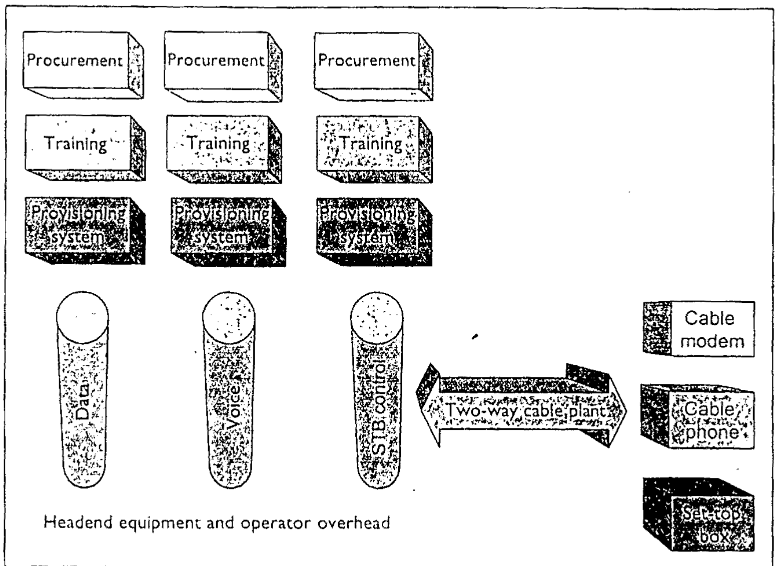


Figure 1: Offering data, voice and video services through three separate "silos."

Proprietary products limit both operators' flexibility and the control they maintain over their networks and services.

This article proposes the further convergence of DOCSIS- and MPEG-based services. DOCSIS and MPEG have shown that open standards facilitate both interoperable product development and competitive cost structures from multiple suppliers. Open standards also benefit suppliers by creating larger markets for their products. Cable operators should consider taking both the MPEG and DOCSIS efforts to the next level by specifying a new standards-based delivery platform that includes open interfaces to both the access cable network and subscriber equipment. This platform will facilitate both rapid application and service development and will lead to the first true generation of broadband services. To be complete, the proposal will also account for deployed legacy platforms and strategies to transition to the new platform.

This new platform is developing now, and uses DOCSIS as a transport mechanism. Note: the author does not advocate offering video services over DOCSIS. MPEG-2 transport is the most efficient method for delivering MPEG encoded digital video on a cable plant (see sidebar below.) Rather, this article advocates migrating set-top box (STB) control to DOCSIS.

The DOCSIS data transport standard is widely deployed in North America and the world. PacketCable, another effort underway at CableLabs, is reaching fruition in its goal of offering voice service over DOCSIS. The fact that data and voice services will share a common transport means they can use the same equipment in the headend. This saves on procurement, training and operations; hence, the attraction of convergence. The industry should not pursue convergence just for the sake of technology, but to position itself more competitively by lowering capital and operations expenses.

With voice and data services converging over DOCSIS, the next area for study is STB control. Here, STB control information is considered to be anything other than analog or digital video. This includes conditional access (CA) information, management and control messaging, application data, etc. In most North American deployments, STB control messages are carried on an out-of-band (OOB) channel. While these STBs all decode the same standard MPEG programming, the OOB transport channels from the two largest STB suppliers do not interoperate. The end result is that operators are locked into specific suppliers, which limits their flexibility and control over their own networks.

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Cable has faced, and solved, similar situations with both data and voice products. Initially, there were proprietary offerings from suppliers. These are now converging over DOCSIS transport. Operators are gaining more experience with DOCSIS equipment and services every day. Technically, there is no reason why STB control messages can't also be carried using DOCSIS transport.

Another note about the competition. While DOCSIS has benefited the cable industry, it has also benefited its competitors. Modified DOCSIS technology is in development by both satellite and wireless providers for two-way access into subscriber homes. DSL suppliers are adopting DOCSIS-like processes to help them finally converge on an interoperable standard (see Figure 3).

Unlike voice and video, the challenge of migrating STB control will be the large embedded base of STBs. By the end of 2001, there will be an estimated 10 million deployed digital STBs using the legacy OOB channels. Any proposal to converge STB control over DOCSIS must address this legacy issue. In fact, there is such a solution. The legacy OOB channel will have to remain on the cable plant, but it is narrow and already accommodated in the spectrum allocation plan. The issue is with the legacy headend equipment that will need new interfaces to allow the control information to be dual-carried on a DOCSIS STB control channel. Because the legacy forward path QPSK channel is low bit rate, it can easily be dual-carried on a 6-MHz, 64-QAM forward path DOCSIS channel, with many megabits of additional capacity available to carry other interactive application data. The legacy set-top provisioning and conditional access systems (and hence the legacy STBs) can be used with both populations of STBs as long as the proper headend interfaces are made available. These legacy systems currently perform both device and service provisioning. The device provisioning will migrate to the already existing DOCSIS systems and the service provisioning systems will need to grow anyway to support the next generation of interactive services.

Another question is how to get DOCSIS into new STBs. This issue will solve itself. Most suppliers of advanced digital STBs have announced plans to include DOCSIS modems in their products to support interactive applications. Hence, these STBs will easily connect to the same headend equipment as the data and voice equipment. But even with a DOCSIS modem in the STB, the legacy STB suppliers continue to embed their OOB control mechanisms. Most advanced digital STBs that also include a DOCSIS modem will in fact contain two cable modems. One modem, generally either DAVIC (e.g., the Explorer 2000) or based on the ALOHA protocol (e.g., the DCT-2000), is used for STB control. The second modem, DOCSIS, is intended for interactive applications.

This business plan benefits the legacy STB suppliers by continuing to embed their OOB transport equipment. Additionally, the cost of "two modem" next-generation STBs are burdened with the additional modem. Going forward into a competitive en-

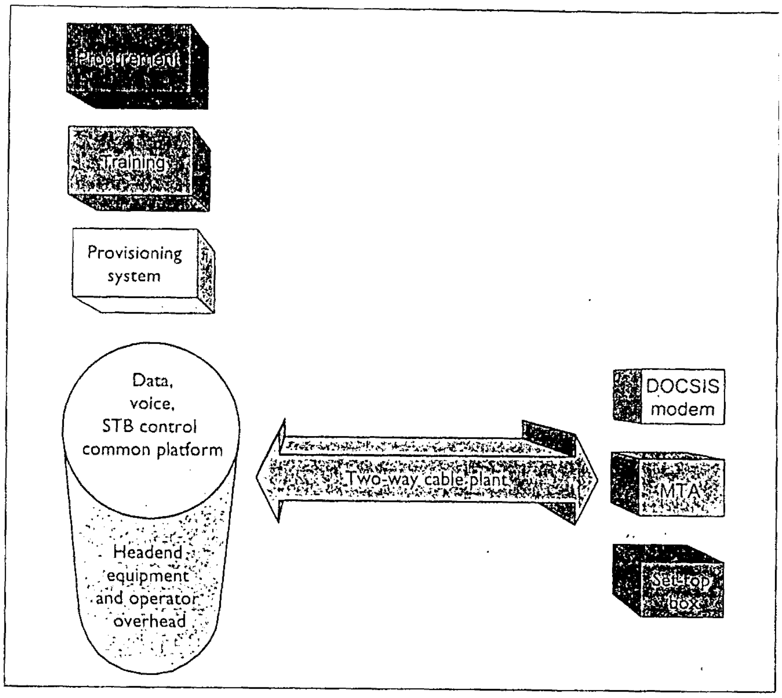

Figure 2: Converged DOCSIS delivery platform.

MPEG or IP?

Should digital video be delivered over MPEG or over IP? This is a technology choice. Broadly, MPEG-2 defines two technologies: First, a digital video encoding/compression technique; and second, a method for data transport over cable plant. MPEG-2 encoded digital video (ostensibly a form of data) can be delivered over either MPEG-2 transport or by encapsulating that digital video in IP and delivering it over DOCSIS transport. Both work. That said, MPEG-2 transport is the most efficient method for delivery of MPEG-2 encoded video on a cable network. With MPEG-2 transport, there is less overhead–which translates to more "bits" being available for content delivery. Encapsulating digital video in IP is a reasonable way to deliver digital video if that content is sourced on the Internet (e.g., Real or QuickTime) or from a centralized data center that is connected to headends via a private intranet. Conversely, MPEG-2 transport is most easily used for content delivered off satellite or from a local server. Both technologies work for delivering digital content and the proper choice depends on the context.

–DJ

vironment, operators may lack both the flexibility and cost structure they might desire. Suppliers will argue that their legacy technologies work and are scalable. But a single-supplier solution lacks both the innovation and cost structure needed when facing competition for subscribers.

Using DOCSIS for STB control, with no legacy OOB channel, is in fact a reality. Pace Microelectronics has shipped more than 600,000 such devices and is continuing to advance the product line. Philips is rumored to be developing an "all DOCSIS" STB for another major European operator. The STB services an operator would expect, including conditional access and "carousel-type" services, are included. These STBs exist now and they do not use the legacy out-of-band QPSK carrier for STB control. Instead, these STBs use the same headend equipment, including the provisioning system, as both DOCSIS cable modems and PacketCable Media Terminal Adapters (MTAs).

The move toward retail also makes a strong case for migrating STB control to DOCSIS transport, with respect to both portability and cost. Most every North American headend will deploy DOCSIS transport for either data or PacketCable service, or both. In contrast, the Scientific-Atlanta and Motorola legacy STB transport protocols are each available in about half the headends, and they are generally mutually exclusive. Hence, a STB that communicates over DOCSIS will be inherently more portable. The Point of Deployment (POD) module, as currently defined, was necessary to provide portability because generally only one of the two non-interoperable STB transport protocols is implemented in a headend. By migrating to a common DOCSIS transport, which has no licensing fee, the cost of renewable security could be reduced.

The proposal is not all motherhood and apple pie, however. If DOCSIS is to be considered for STB control, the protocol needs to be reviewed for operation in one-way plant. Again, this is not as difficult as it sounds. For example, DAVIC is also designed for two-way communications, but DAVIC-based STBs continue to operate during a return path outage, albeit in a limited fashion. It's a similar engineering exercise to modify DOCSIS-based STBs to work in a one-way environment.

Also, there is a potential business issue with migrating STB control to DOCSIS transport. Operators are confronted with allowing customers to choose from a variety of Internet service providers (ISPs) for data service. What are the implications of including STB control over DOCSIS? Will operators be confronted with allowing subscribers to choose a provider for interactive applications? By including DOCSIS modems in set-tops, even if for just interactive applications and not STB control, the issue has been broached and will need to be addressed.

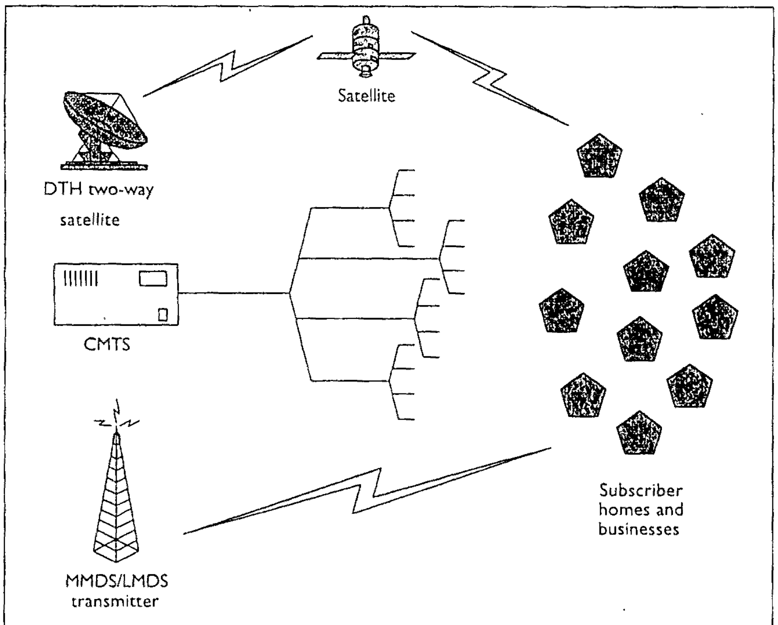

Figure 3: Point-to-multipoint access architectures that can use DOCSIS technology.

The move toward retail also makes a strong case for migrating STB control to DOCSIS transport...

In summary, there are compelling reasons to converge STB control over DOCSIS. Data and voice are already there, and for competitive reasons, cable operators need to both remain efficient and regain control over their network and services. The biggest issues are the large deployments of set-tops using legacy OOB channels for STB control and the business issue of providing access to other service providers. The industry should research solutions to these issues.

The intent is to reduce the number of complex technologies in the headend. Each technology is burdened with capital cost (separate equipment) and operations cost (separate training, provisioning, etc.). Proprietary technologies are burdened with poor economics, low rates of innovation and less control for the operator. While cable has plenty of bandwidth to carry voice, data and video services, there are penalties in doing so with separate technologies. Moving forward into a competitive environment where other access providers will be offering voice, data and video services, cable should consider its competitive position. Cable has settled on DOCSIS as the method of choice for data and voice transport, and suppliers are including DOCSIS modems in set-tops. DOCSIS for STB control is the next step.