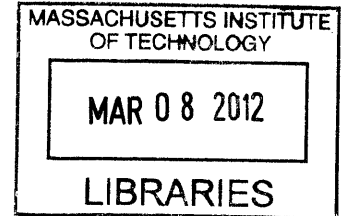


Business Development Trends and Analysis for the Data Networking Market

By

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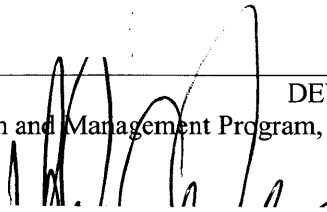
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By

Devadas V. Patil

Submitted to the System Design and Management Program on December 15, 2010 in Partial Fulfillment of the Requirements for the Degree of Master of Science in Engineering and Management

ABSTRACT

The Internet has come a long way after the widely reported invention by Sandra Lerner and Leonard Bosack of the router, a device that can transmit data from one network to another based on certain protocols and principles. Despite a slow start in the mid 1980s, the Internet has emerged as one of the primary means of communication for people of all walks of life. Sophisticated, network-aware applications that integrate data, voice and video have helped fuel this growth.

This thesis examines the latest technology trends and historical developments in various market segments of the Internet. Using technology trends as a backdrop, it analyzes business development at Cisco Systems, Inc., a major player in all Internet market segments. Well-known tools and concepts such as the Familiarity Matrix and Technology S-curve are used for case studies of business development at Cisco.

Business Development is almost always a high-stakes endeavor requiring keen insight on both financial and strategy fronts. What are good strategies for corporate entrepreneurship? What are the challenges in business development by way of acquisitions? Will cyber anonymity continue to make us lonely and distanced, or will there be a new breed of Internet applications that will genuinely bring people closer?

These are some of the questions this thesis explores, drawing on the wisdom and experience of industry experts.

Thesis Supervisor: Howard Anderson

Title: Bill Porter (1967) Distinguished Senior Lecturer of Entrepreneurship

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Acknowledgements

As I walked the hallowed hallways of MIT's infinite corridor one chilly morning in Fall 08, I mulled over the prospect of writing a thesis on the Internet "revolution." I decided to discuss the idea with Professor Howard Anderson, whose articles appeared frequently in Network World magazine. In retrospect, I feel that this thesis would not have been possible without the strong sense of motivation and enthusiasm I felt after my first meeting with him. His knowledge of networking technology, vast experience in the fast-paced world of technology business development, and down-to-earth objectivity inspired me. I consider myself fortunate to have had the opportunity to work with someone of his status, and thank him for his guidance and encouragement during the course of this thesis.

Professor Val Livada's course on Corporate Entrepreneurship was an eye-opener and equipped me with tools and concepts I needed for this thesis. My initial discussions with Professor Henry Weil and Professor James Utterback were vital for scoping and structuring the work. Pat Hale and Jan Klein were immensely helpful in answering questions about thesis requirements and interviewing guidelines. I wish to thank these faculty members and many others at Sloan and ESD who have helped me all along. The staff at SDM/LGO is wonderful. Chris Bates, Bill Foley, Lisa Hill, and many others were always prompt and courteous.

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1 The Ubiquitous Internet - A Snapshot

The Internet is a great equalizer. Over the past two decades, it has fundamentally changed our outlook on business and communication. This change was largely brought about by two primal forces: (a) the widespread deployment of sophisticated applications that empower users without requiring them to be technically proficient; (b) the development of highly available and scalable network infrastructure devices.

The network infrastructure that forms the basis of the Internet can be considered under the following four sections, as shown in Figure 1 below.

- a) Advanced Technologies that enhance the experience of the Internet
- b) The Local Area Network (LAN) that provides connectivity in close physical proximity
- c) The Wide Areas Network (WAN) that provides connectivity over long distances
- d) The Access Network that provides connectivity to end users and businesses with the rest of the Internet

Network infrastructure technology has seen disruptions in all its market segments such as LAN, WAN, Access, and Advanced Technologies. In Clay Christensen's words ¹, "Disruptive businesses either create new markets or take the low end of an established market." A large majority of disruptions in networking infrastructure technologies have created new markets. The disruptive forces have challenged network infrastructure vendors, often requiring them to react quickly. Below, significant technology disruptions and trends that affected network infrastructure businesses have been discussed.

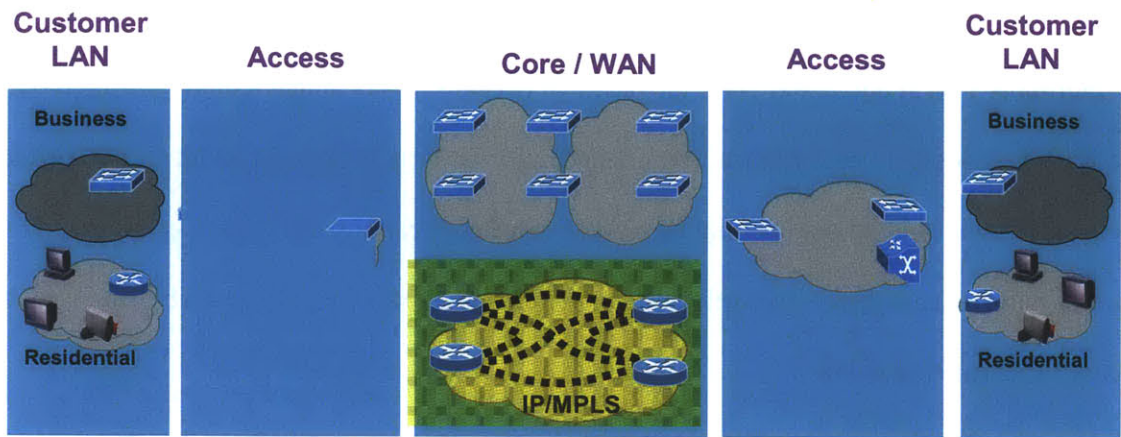


Figure 1. The LAN, WAN, and Access clouds of modern networks comprise of various devices including routers, switches, and access aggregators.

2 Advanced Technologies

Several technologies enhance the performance and the overall experience of the network. In the recent years, the Internet has been recognized as a democratic media, where information and ideas are freely shared by an increasingly connected user population, using sophisticated web applications. Technological innovation continues to happen in several areas, including WAN, Security, Storage, and Convergence among other areas. A few of these advancements are discussed below.

2.1 Web as a platform

The rising popularity of the Internet as a user-driven platform has resulted in the development of several technologies that are collectively termed as Web 2.0. With the Internet as the platform, users control their own data. This democratization of the Web benefits from the following core competencies²:

- Web services, as opposed to packaged software
- Architecture of Participation
- Cost-effective scalability
- Remixable Data source and transformations
- Software above the level of single device
- Harnessing collective intelligence

Examples of Web 2.0 applications are Wikipedia, Flickr, Napster, Blogging, and Youtube. Some internet experts believe that the next generation of the Web (Web 3.0) will be able to handle complex searches and requests from users. Web 3.0 will also act as a personal digital assistant to the user, by attempting to understand user profiles and patterns, and tailoring web content and responses accordingly³.

A fundamental building block of Web 3.0 applications is the Web Application Programming Interface (API). These APIs will allow developers take advantage of unique capabilities that a particular website or a hosted service can offer. Developers can also combine input from several different sources in the Web to offer powerful web applications. These are commonly called *mashups*. An example of a mashup is google maps, which allows users to not only map a community, but also locate businesses such as restaurants, shopping malls etc.

2.2 Cloud Computing

Cloud computing is becoming popular as corporate Information Technology departments look to cut costs by being able to add capabilities or capacity without investing in new hardware, software, or personnel. This is made possible, as the Internet or the “cloud” is used as the means to provide computing resources on the fly. Some technologies that enable cloud computing are discussed below⁴.

- 1) **SaaS** (Software As a Service): Using SaaS, providers can host software services on the web and make it available to thousands of end-users using a multi-tenant architecture. Salesforce.com and Google Apps are examples of SaaS. With the licensing of software for use on demand, the demand for server hardware among end-users will decrease. As

the concept becomes more popular, we could also see an increase in demand for server hardware among the providers of service. With network based access to software, centralized management, software upgrades, and support for integrated delivery of custom features, SaaS is bound to demand superior performance from the underlying network. This includes robustness, speed, and scalability, both in the host enterprise networks and end-user access networks.

- 2) **PaaS (Platform As a Service):** PaaS provides the entire computing platform, including hardware and software, as a service. The primary benefit is the simplicity of management where the whole IT arm of organizations appears as an out-sourced service. PaaS offers the whole gamut of typical software activity including software development, testing, database management, storage etc. PaaS is complementary to SaaS. Often PaaS users will subscribe to SaaS based services. Once again, the possibility of many concurrent users imposes demands similar to those of SaaS on the underlying network.
- 3) **Cloud Networking:** To meet the networking demands of cloud computing, including features such as SaaS and PaaS, the network needs to be scalable and should provide low latency and high resiliency. The creation of such a high performance underlying network constitutes cloud networking. In addition to the general network attributes mentioned above, the network needs to also provide predictable performance and extensible management⁵. In order to deliver such performance, some companies are looking at new approaches in design and architecture. Arista Networks' Extensible Operation System (EOS) is an example of innovation in this area. Arista EOS architecture is based on a new paradigm where the state and the process are maintained separately. The global state is maintained in a centralized component (System Database or sysdb), and various

components access it. For example, if there is a state change on a specific network port, sysdb is the central repository that has the latest state information. All management and protocol processes rely on sysdb, as shown in Figure 2. EOS also lets applications have their own private address space. This enhances performance by allowing applications to be restartable and upgradable without interrupting packet flow.

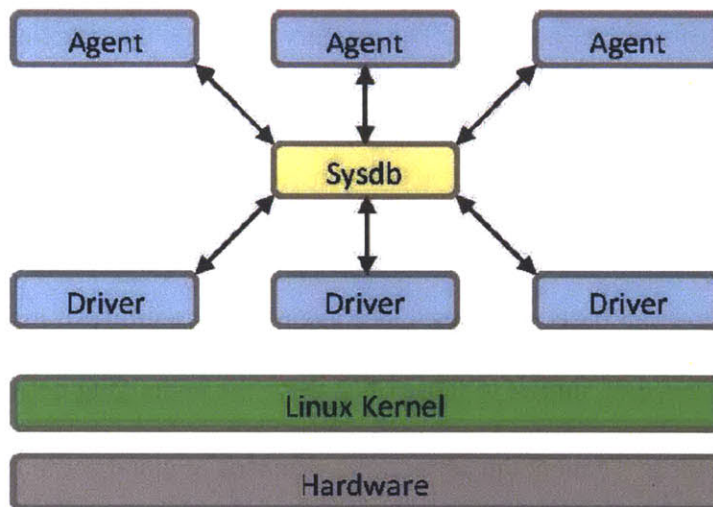


Figure 2. Arista Networks' EOS Architecture with restartable processes

2.3 WAN Optimization

WAN optimization is done by dedicated devices at either ends of a WAN link to improve network performance. These devices, called WAN Optimization Controllers (WOCs) help avoid network latency using protocol optimization, reduce data transit using compression and caching, and prioritize traffic streams according to business needs⁶. These controllers can allow security features such as SSL and encrypted tunnels. Routing functionality such as policy based route

selection can be enabled within the WOC. According to Gartner Inc., Blue Coat Systems has the highest market share in WAN Optimization⁷.

2.4 Medianet

A Medianet is a network that is optimized to cater to rich media applications over the network⁸. Examples of rich media applications are IPTV, online video driven collaboration, media streaming etc. Many multinational companies are increasingly demanding video applications to run over their enterprise networks. At the same time there is an increasing variety of devices that are connected to the network. For example, video surveillance cameras and digital signs connected to an IP Network. A Medianet is aware of its end-points, media, and the underlying network. It optimizes the transmission of content to best suit the end-points it caters to. For example, Medianet can effectively handle the transmission and adaptation of video from a surveillance camera to a handheld wireless device. It does it by applying the necessary media transformations (transcoding) and making the necessary signal encoding based on changing network conditions. This results in an enhanced quality of experience while ensuring manageability and security.

From a service provider perspective, it is estimated that 90% of all the IP traffic on the internet will be video by 2012⁹. Service Providers are finding themselves in a new role as “Experience Providers.” They are increasingly turning to intelligent IP based infrastructures that can be optimized for video delivery. Preliminary tests have proven that two million video subscribers can be serviced with Quality of Service and a variety of video applications over IP Next

Generation Network (IP NGN). Several Cisco products such as the Carrier Routing System (CRS-1), Nexus 7000, Cisco ASR 9000 series, and Cisco 7600 series enable service providers to offer rich media applications. The ability to configure and serve thousands of multicast groups is critical for service providers that hope to monetize video channels and other rich service offerings over an IP Network.

2.5 Collaboration

In the past decade, globalization trends have necessitated a new breed of applications for collaborative development. Today's workforce demands the ability to work together at a short notice, around the clock. Companies increasingly want to tap local talent to take advantage of off-shore development opportunities. Employees are often willing and able to make adjustments to their traditional work day routines in order to accommodate the needs of a global economy. For example, Software Architects in United States may conduct design review meetings at midnight with their counterparts and allied development teams in India.

To enable a high degree of collaborative work flow, today's enterprises are equipped with voice and video conferencing solutions that can be classified as follows¹⁰.

IP Communications: A full suite of end points that enable employees in the main and branch offices make voice calls over an IP Network. Examples of such devices are IP phones

Messaging: The ability to access and deliver voice messages via any medium, thereby improving business processes. For example, Unity Voice Messaging system that lets employees manage calls and voice messages.

Presence and Clients: The ability to connect with other employees directly from a desktop, without the overhead of using a full-scale email program. For example, IBM Lotus Sametime lets employees maintain lists of other colleagues that they actively work with. It indicates their availability and offers a chat console to exchange information quickly and securely.

Conferencing: The ability to talk and concurrently share desktops is demanded by geographically dispersed teams in any of today's multinational companies. Several applications like Webex make this possible. Users could make themselves seen using a web camera. More recent applications like Cisco Telepresence take the collaboration experience to a whole new level using conferencing "suites" that will make distant participants feel that they are all sitting in the same room.



Figure 3. A collaborative meeting being held on Cisco Telepresence

2.6 Data Center Trends

Network Virtualization is emerging as a major trend in the Data Center, as it helps customers in two major ways: (a) reduces overall costs and supports green initiatives (b) provides a pool of resources that businesses can use to develop different business models¹¹. By making network, computing, and storage resources virtual in a unified platform, today's data centers attempt to offer customers with unprecedented flexibility and manageability. An example of such an integrated platform is the Cisco Unified Computing System. By using service profiles it can provide the flexibility to deploy network, storage and virtualization resources via server blades. The management of virtualization is simplified and it can even be automated. Server migration can be done seamlessly, where resources can be reconfigured without disruption of service.

The underlying technologies that enables data center virtualization is I/O consolidation over 10 GB Ethernet and Virtual Machine Awareness. Traffic of different types such as LAN, SAN and clustered applications can be handled over a single link, using what are called sub-links. Typically a link is divided into 8 sub-links and these are then dedicated to different traffic types. This is called Priority Flow Control¹². Virtual Machine (VM) Awareness helps bridge the server, network and management domains to make sure changes in one domain are communicated consistently to others. For example, a VM move from one physical server to another triggers corresponding SAN moves, along with changes to network profiles. An example of VM aware networking platform is the Cisco Nexus 1000V, which uses a Distributed Switching Architecture.

2.7 Consumer Solution Trends

The consumer networking solutions are increasingly becoming more aware of the need to integrate computing and entertainment needs of the modern, connected home. Homeowners and SOHO customers are seeking solutions that provide (a) simplicity of management (b) integration of functionality (c) cost effectiveness by reuse of existing home infrastructure.

Consumer entertainment delivery platforms such as set top boxes are now IP Aware. Apart from providing live programming and the ability to record many hours of programming, these devices offer ports for IP based LAN connectivity within the home, along with USB ports. The Cisco Explorer 8550HDC HD DVR, shown in Figure 4, is an example of the trend to integrate IP based networking into entertainment platforms.



Figure 4. A home entertainment platform with IP networking capabilities

Vendors like Linksys have expanded their product portfolios to include storage, video, print servers, range expansion, and powerline equipment for the end user. Such products were not common at the consumer level even a few years ago. The powerline equipment is particularly

interesting. It helps convert existing power wiring inside homes into a high speed network, without the need for additional cabling. With speeds of up to 85 Mbps, these can be used for video and VOIP¹³

2.8 Security

As internet access became more affordable and access speeds increased, a new breed of applications have enabled connectivity from virtually anywhere. People are increasingly using a variety of hardware and software applications, and there is an increasing tendency to collaborate over the Internet. However, these trends have also made the end-user more prone to security attacks. Also, the variety of Internet access modes makes the network perimeter increasingly vague and difficult to safeguard¹⁴.

The current trends in network security follow a systems approach to security whereby security is considered in four major domains: (a) Network and Endpoint Security (b) Content Security (c) Application Security (d) System and Identity Management. For example, the Cisco ACE Web Application Firewall provides comprehensive XML and HTML traffic inspection. Network and content security is brought about by a wide variety of hardware and software solutions like Firewalls, VPN systems, Intrusion detection and prevention systems. Identity management via sophisticated authentication schemes are integrated in all security solutions.

Network security solutions form a classic example of Systems Architecture, with a solution neutral statement, *“To store, access, and transmit user data securely.”* We have numerous

stakeholders, including end users, enterprises, governmental organizations, financial institutions etc. A complete dissection of the Systems Architecture of Network security merits a thesis in itself, but it is sufficient to conclude that considerations of form, function, cost etc results in numerous solutions at the 2nd and 3rd level of architectural decomposition. For example, VPN is implemented in both hardware and software; it is the user who chooses based on the need. Typically end users opt for software VPN, while small and medium businesses might be able to afford hardware VPN solutions.

2.9 Network Convergence

There are architectural changes happening to the network infrastructure to enable the migration of data, voice, and video on a single packet-switched network. This is a major change from the earlier architecture where voice and data existed mainly as circuit-switched and packet-switched networks respectively. The advantage of having a converged network is primarily in the lower capital expenditures for users, and ease of maintenance for service providers.

In the core network, this implies a migration from PSTN to VOIP. Underlying legacy Layer 2 technologies will migrate to using Layer 2 and Layer 3 VPNs, which are protocol independent, and ride on MPLS, a highly efficient switching mechanism. In the access networks, DSL and Cable providers will be accommodating voice ports. At the application layer, Session Initiation Protocol(SIP) and H.323 will be used in the local loop and long haul backbones respectively¹⁵.

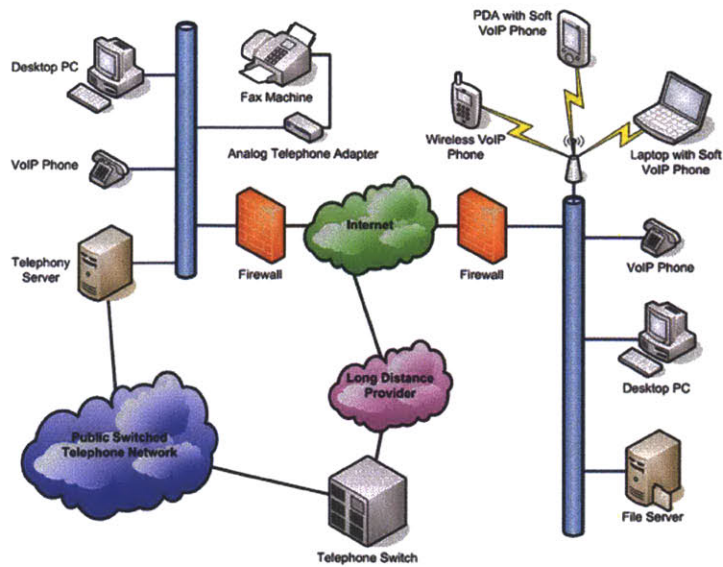


Figure 5. VOIP is a form of converged network¹⁶

Video over IP is made possible by first converting the video content into MPEG-2 using a video codec. It uses lossy video compression and audio data compression to allow transmission over existing Internet bandwidths. It is then transmitted using IP Multicast by encapsulating MPEG-2 over IP. IP Multicast allows the efficient transmission of content to multiple destinations, without the overhead of replication incurred in unicast transmission¹⁷.

2.10 Metro Ethernet

Based on the Ethernet standard, Metro Ethernet technology provides Internet access to end users and branch offices. Ethernet may be used in its pure form, based on SONET/SDH, or with

MPLS. Pure Ethernet deployments are less expensive, where as SONET/SDH deployments provide investment protection for underlying SONET infrastructure. MPLS based Metro Ethernet provides reliability and scalability¹⁸.

A basic infrastructural element of a Metro Ethernet Network is the Ethernet Virtual Connection or the EVC. An EVC connects two subscriber sites (UNIs). It provides data protection by carrying only the frames that belong to the connection. Metro Ethernet offers E-LINE service via point-to-point connections, and E-LAN services via multipoint-to-multipoint connections¹⁹.

These are shown in Figure 6.

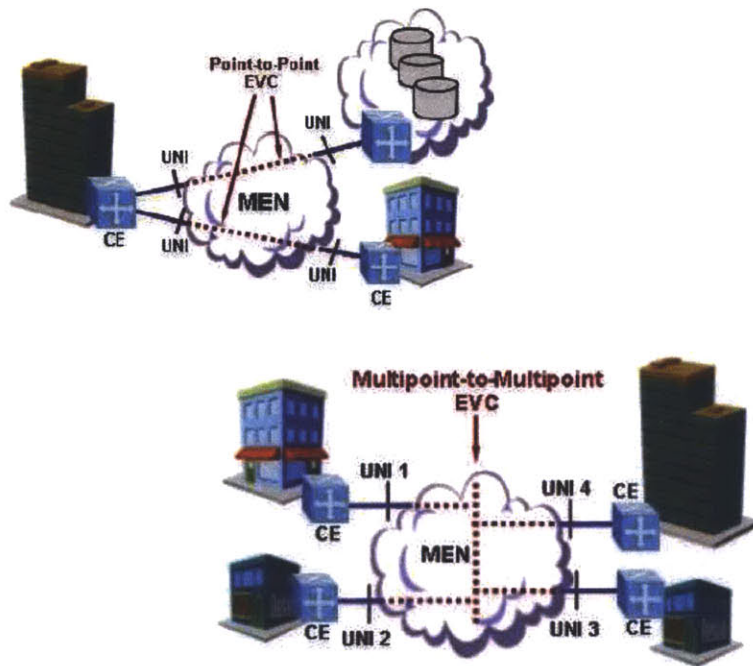


Figure 6. E-LINE (left) and E-LAN services in a Metro Ethernet Network

3 LAN Technology Trends

In the early to mid 80s, LANs (Local Area Networks) were dominated by technologies such as ARCNET and Token Ring²⁰. The ARCNET used a star-wired bus topology, whereas Token Ring used a ring topology. These technologies and the high-capacity variant of Token Ring, known as FDDI, all use tokens to access the physical media. Token Ring networks could provide throughputs of 16 Mbits/sec, while FDDI throughputs could reach as high as 100Mbits/sec.

3.1 Ethernet

Although Ethernet was patented in the mid-seventies, it did not emerge as a disruptive technology until the development of its variants: (a) switched Ethernet and (b) high speed Ethernet. This disruption caused the original token based LAN technologies to become obsolete. Although Ethernet started at throughput rates of 10 Mbits/sec (a tenth of what FDDI offered), its later versions far exceeded FDDI. Today's high capacity variants of Ethernet, for example, can operate at 10 Gigabits/sec. Figure 7 captures historical trends for the Ethernet technology²¹.

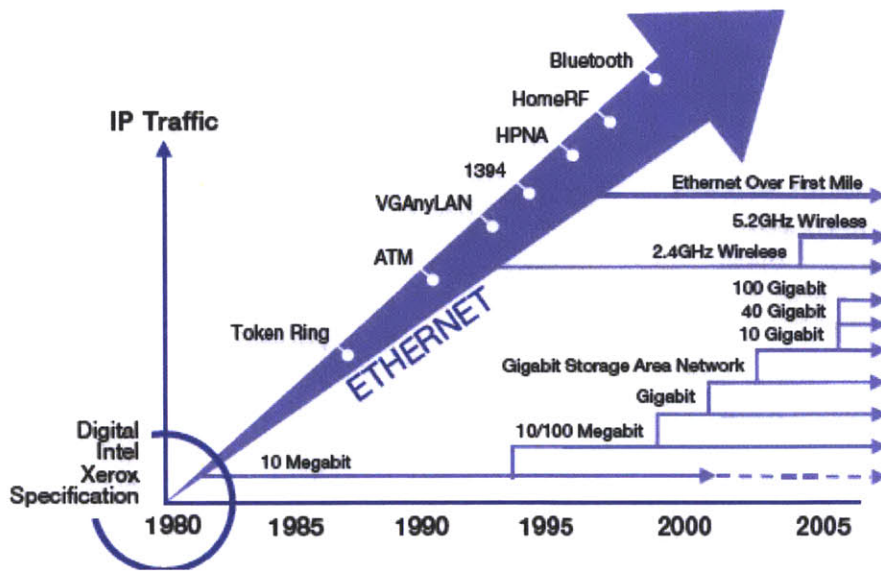


Figure 7. Evolution of the Ethernet Technology

As of 2006, revenues from Ethernet Network Interface Cards at Gigabit speeds totaled about 1.6 billion worldwide.

3.2 Switched Ethernet

In its most basic form of Ethernet, end nodes are connected to an Ethernet hub in a star topology. However, Ethernet hubs have some shortcomings. First, the available bandwidth has to be shared by all the nodes attached to the hub. Secondly, each end node has to wait for the common bus to become available before it can transmit its data. Finally, data can be transmitted in one direction only, making it a half-duplex connection.

Switches overcome these shortcomings by establishing a temporary, dedicated connection between two nodes. They eliminate the need to wait for transmission, since there is no possibility

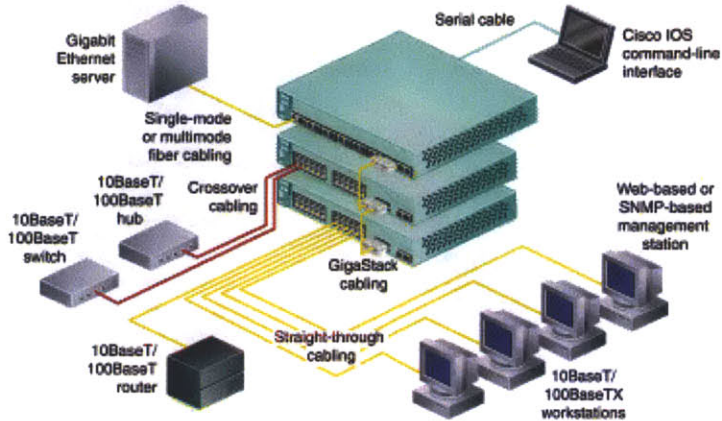


Figure 8. A switched Network

of collision on a dedicated connection. They also enable multiple traffic streams to flow simultaneously in both directions. In summary, they allow highly scalable, full duplex connections between network nodes. The first Ethernet switch was introduced by Kalpana in 1990. By 1995 LAN switching was in high demand. Figure 3 shows the major players in this market in 1995, and their market share²²

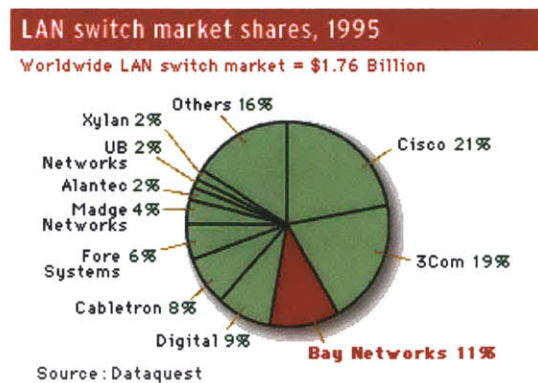


Figure 9. Major players in the 1.76 billion LAN switching market in 1995

This market has grown significantly. In Q4 2006 alone, the LAN switching market had increased to 4.7 billion. According to the Dell'Oro group, Cisco dominates this market²³, as shown in

Figure 10.

Vendor	Market Share %
Cisco	73.00
HP Procurve	3.60
Nortel	3.50
Foundry	2.20
3Com	1.90
Others	15.60

Figure 10. LAN switching market share as of Q4 2006

3.3 Wireless LAN

The possibility of linking computers by wireless connections was originally demonstrated in Hawaii as part of the Aloha Network. IEEE standardized the technology via 802.11 and its variants. It gained popularity in the mid to late nineties, as laptops became more affordable and users increasingly wanted to stay connected. The primary benefits of the Wireless LAN are its convenience, ease of deployment, and mobility. However, even high speed wireless LANs operating at 100Mbps/s are comparatively slower than their Ethernet counterparts²⁴.

The wireless LAN market surpassed 3.6 billion in 2006.²⁵ Figure 11 shows the market share of major players in this segment in 2007.

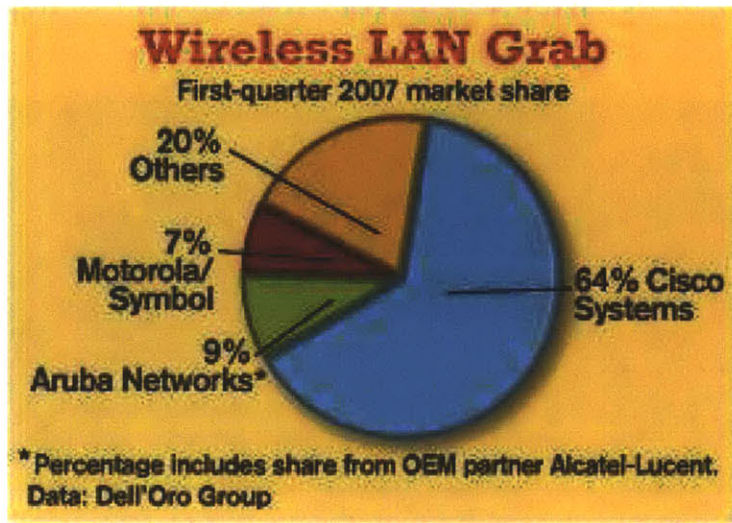


Figure 11. Wireless LAN market share in Q1 2007

4 WAN Technology Trends

A Wide Area Network (WAN) is one that spans a wider geographic area, sometimes across different continents. It connects different LANs together. Organizations can own their private WAN or subscribe to one provided by an Internet Service Provider. A WAN can operate in one of the following modes: Leased Lines, Circuit Switched, Packet Switched, and Cell Relay²⁶

Leased lines are dedicated point-to-point connections between two networks. They use protocols such as PPP, HDLC and SDLC. Switched WANs are less expensive, and can offer speeds of up to 156 Mbits/sec. Circuit switched WANs use protocols such as PPP and ISDN, while packet switched WANs use X.25 and Frame Relay. Cell Relay, considered a variation of packet switching, uses ATM. Historically, the use of Leased lines has dominated the WAN market segment, as shown in Figure 12. Overall, WAN has seen the following trends: (a) obsolescence of X.25; (b) emergence of MPLS; (c) adoption of PPP over SONET

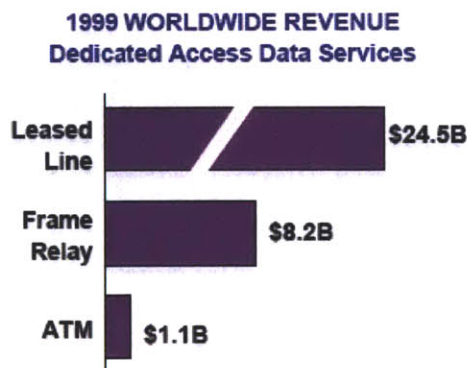


Figure 12. WAN provider revenue makeup

4.1 Obsolescence of X.25

X.25 was widely used in the 1980s to operate the financial Automated Teller Machine Network. However, the protocol came with significant overhead in its error correction mechanism. As the underlying WAN hardware became more robust, the protocol was replaced by Frame Relay, which did not have the error correction overhead. Frame Relay uses the concept of virtual circuits (VCs) to establish connections between two end-points. ATM, too, operates using the concept of VCs; however, it uses cell relay to divide the network payload into 52 byte cells. The cells are segmented and reassembled, usually in hardware.

As shown in Figure 13²⁷, ATM and Frame Relay registered significant growth rates in the US in the late nineties, when the Internet became hugely popular. The use of leased lines was still widespread, although it showed a slight downward trend.

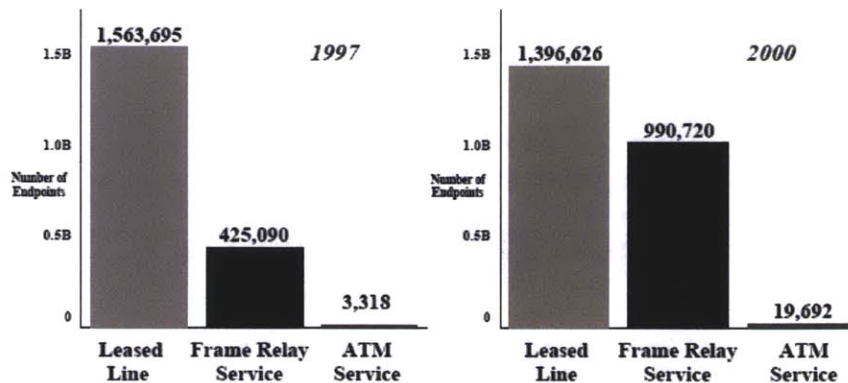


Figure 13. US Leased lines, ATM, and Frame Relay market trends in the late nineties

4.2 Emergence of MPLS

MPLS (Multi Protocol Label Switching) is a packet switching technology. Network packets are assigned labels, and MPLS capable switches switch packets based on the labels. When packets enter the MPLS cloud, the edge router (Label Edge Router or LER) pushes a label onto to the protocol stack. This label is popped when the packet leaves the cloud. Intermediate switches switch packets based on the label stack, and exchange labels using a protocol called Label Distribution Protocol (LDP). Figure 14 shows a conceptual MPLS cloud²⁸.

The primary advantage of label-based packet switching is that it carries less overhead than cell relay. Secondly label based switching is protocol agnostic. It could operate on any Layer 2 protocol such as Frame Relay, Ethernet or ATM. Accordingly, MPLS is considered to be at Layer 2.5 in the OSI model. Also, MPLS enables class of service (CoS) tagging and prioritization of network traffic, so administrators may specify which applications should move ahead of others²⁹.

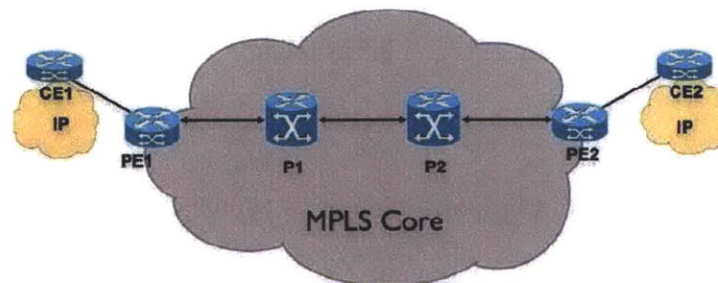


Figure 14. A conceptual MPLS cloud with edge and intermediate routers

Cisco has dominated the market in MPLS edge routers³⁰, as shown in Figure 15.

	2001	2002	2003
Cisco	49.6%	64.0%	62.0%
Juniper	15.3%	13.8%	21.3%
Lucent	1.8%	0.7%	0.1%
Nortel	11.4%	5.5%	6.5%
Redback	10.1%	9.1%	6.0%
Riverstone	2.2%	1.3%	3.3%
Unisphere	7.3%	4.0%	0.0%

Source: Synergy Research Group Inc.

Figure 15. MPLS edge router market share

4.3 Adoption of PPP over SONET

Cisco has been actively involved in the creation of a protocol to provide high point-to-point line rates in the WAN. The resulting Packet over SONET (POS) technology uses PPP (point-to-point protocol) over optical fibers that transmit data using lasers. This technology enjoys major advantages such as low overhead, rapid point to point transmission, self-healing ring structure to reroute traffic, and widely deployed transmission infrastructure³¹.

POS served as a viable technology to transport Ethernet LAN traffic over the WAN. However, it did need a router to convert Ethernet frames to POS. Later, other standards have made the transportation of Ethernet frames directly over SONET more efficient. They are Virtual Concatenation (ITU-T G.707 2000) and Generic Framing Procedure (GFP, ITU-T G.7041)³²

5 Access Technology Trends

As the Internet became available to general consumers in the mid 80s, the first technology to be used by residential customers was dialup. However, the original dial up access used dedicated telephone lines and was generally slow³³. Top speeds with typical dial-up were 56kbit/sec.

5.1 Beginnings of Broadband: ISDN

Integrated Services Digital Network (ISDN) uses telephone lines to provide broadband access to residential customers. The technology can be used to transmit both voice and data. It was highly popular in the mid 90s. It used two types of channels, namely B and D channels. The B channel operates at 64 kbps and carries data, voice and video. The D channel operates at 16 kbps and provides signaling support.

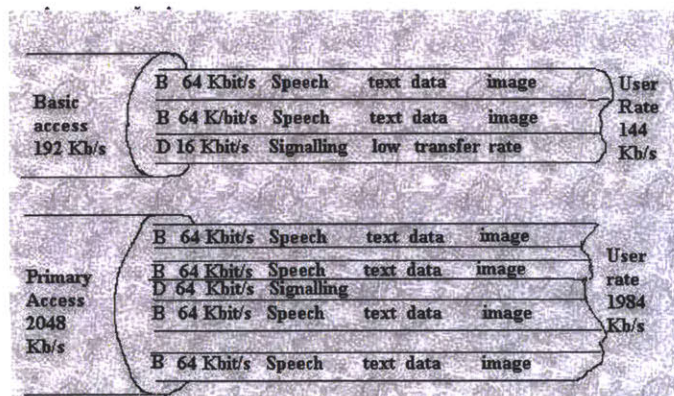


Figure 16. ISDN service types

As shown in Figure 16³⁴, ISDN service can be offered using a combination of B and D channels. There are generally two levels of service: Basic Rate Access (BRA) and Primary Rate Access (PRA).

5.2 Mainstream Broadband: DSL and Cable

Digital Subscriber Line (DSL) is a technology that uses higher frequencies on telephone lines to transmit data. The frequency band is 25 kHz and above.. The bandwidth of DSL ranges from 256 kbits/sec to 24000 kbits/sec. Typically, upload speed is lower than download speed for Asymmetric DSL; they are equal for Symmetric DSL³⁵.

Cable broadband works on cable television networks, based on a standard known as DOCSIS (Data Over Cable Service Interface Specification)³⁶. Customers would typically use a cable modem that bridges the home Ethernet LAN and the Cable network. DOCSIS 1.0 and 1.1 uses channel widths between 200kHz and 3.2MHz. Additionally, cable is a shared media in the sense that all users share the available bandwidth. This is done by using Time Division Multiple Access (TDMA), whereby the cable frame is divided into multiple slots and each user is allotted a time slot. Cable offers upstream bandwidth of 30.72 Mbits/sec and a downstream bandwidth of 55.62 Mbits/sec. Compared to DSL, cable is less secure, because of its shared bandwidth. DSL experiences signal degradation with distance; however, this is not an issue for cable broadband³⁷.

Figure 17 shows the market share of different broadband service providers in the US³⁸.

Figure 18 shows the trends in market penetration of various broadband technologies³⁹.

Market Share of Leading Broadband Service Providers

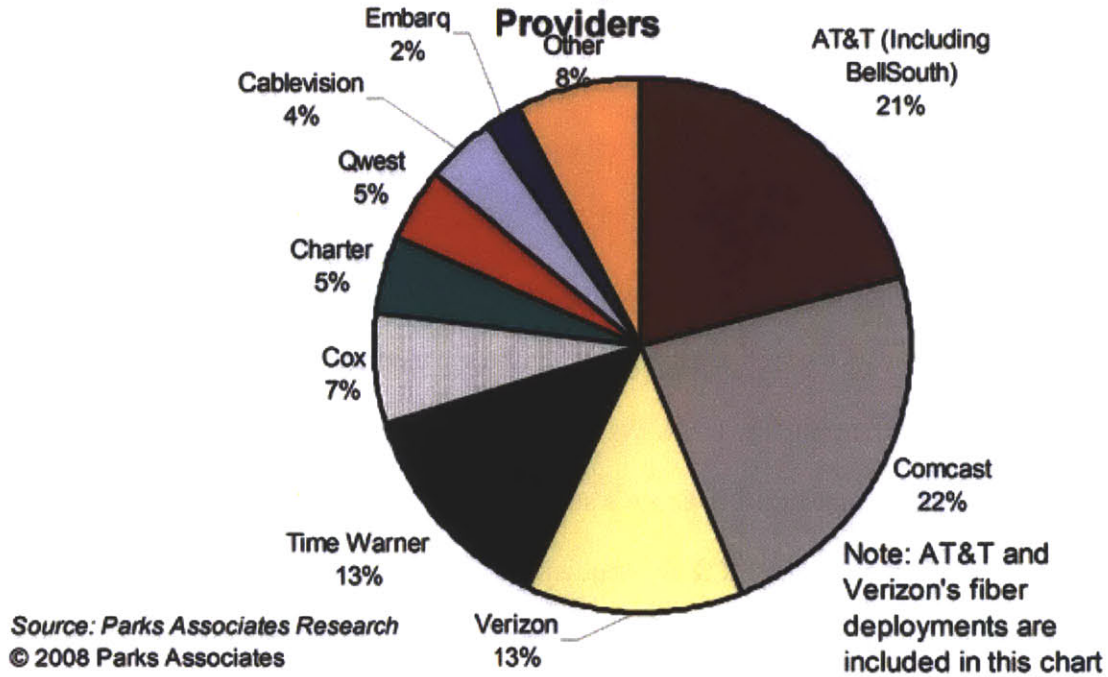
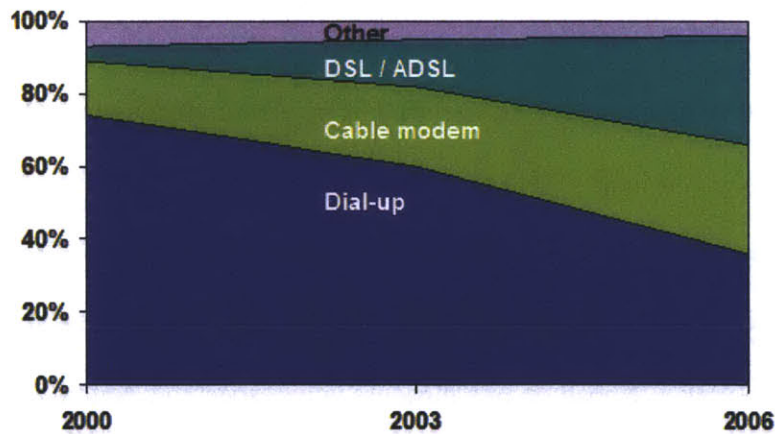


Figure 17. Broadband Service Provider Market share

Internet Connection Type



Source: Consumer Electronics Association

Figure 18. Broadband access market penetration

6 Business Development Trends at Cisco Systems

“Certain things have happened that have been very lucky for Cisco along the way, but I think that in a lot of ways you create your own good luck,” said Barry Eggers, a Silicon Valley venture capitalist⁴⁰. Cisco, starting out with a basic routing solution in the mid 80s, has grown to be a leader in end-to-end networking technology with an impressive portfolio of products in all the major areas discussed earlier, namely LAN, WAN, Access, and Advanced Technologies. Two factors have significantly contributed to Cisco’s success: (a) a balanced outlook to business development that comprises internal R & D, Acquisitions, and Alliances (b) mistakes made by key competitors.

In this section, we analyze the business development at Cisco in response to the rapid growth in demand for network infrastructure devices. It is fair to say that the company could not have grown at the rate it has by internal R & D alone. Since 1993, a steady stream of acquisitions of relatively small companies has helped Cisco position itself competitively in the market. The data from more than a 100 acquisitions can be analyzed using well-known tools such as the Familiarity Matrix. The Familiarity Matrix essentially provides optimum entry strategies for business development, using two types of factors that determine the success of for any technology enterprise: (a) Technology (b) Market⁴¹. The terms ‘Newness’ and ‘Familiarity’ are used to understand the relative position of a business with respect to a certain technology or market. Familiarity refers to the degree to which a factor -- technology or market – is known to the business but may not yet be implemented. Newness takes the opposing viewpoint in that it is the degree to which the factor is not implemented within the business.

With 3 levels of familiarity for both Technology and Market factors, we have a 3 X 3 Familiarity Matrix as shown in Figure 19 below. The optimum entry strategies for each cell of the Matrix have been indicated.

New Unfamiliar	Joint Ventures	VC or VN Or Educ. Acquisition	VC or VN Or Educ. Acquisition
New Familiar	Internal Mkt. Dev. or Acquisition	IV or Acquisition or Licensing	VC or VN Or Educ. Acquisition
Base	Internal Base Dev. (or Acquisition)	Internal Prod. Dev. or Acquisition or Licensing	New Style JV
	Base	New Familiar	New Unfamiliar

Figure 19. Optimum Entry Strategies for Business Development.
 (Legend: VC -- Venture Capital; VN – Venture Nurturing; JV – Joint Ventures)

In the case of Cisco, enterprising routing technology can be considered as the Base technology factor, and correspondingly, large Enterprises market would be the Base Market factor. Over the course of 25 years, the company has released products in a variety of other technologies and explored new markets. Analysis of Cisco business development could be done by considering the acquisitions under four sections, similar to the way we analyzed technology trends in the previous sections: LAN, WAN, Access, and Advanced Technologies. We will analyze the familiarity of the technology and market factors of the acquisition from the perspective of Cisco

at the time of acquisition. Thus two acquisitions having a lot of commonality in technology and market perspectives may be viewed differently, because the prevailing conditions from a Cisco perspective at the time of acquisition may be different.

7 Cisco LAN Acquisitions

Enterprise LAN has been one of the fastest growing markets and certainly one where Cisco has market leadership. Although Cisco started out with the base wired routing technology, it had to react quickly to changing technology and market conditions in the LAN business, such as the need for Switched Ethernet and Wireless LAN. Below, we have tabulated some of the interesting LAN acquisitions along with notes on their technology and market factors at the time of acquisition.

Company Acquired	Date Acquired	Technology Factors	Market Factors
Crescendo Communications, Inc ⁴²	September 21, 1993	This marks Cisco's first entry into LAN switching, a technology that was related to Cisco's routing base technology, but added a new dimension to workgroup solutions and performance networking. Rating: New Familiar	Cisco had participated actively in the Enterprise LAN market by virtue of its initial routing solutions, so the larger Enterprise market was familiar. However, switching was a new addition to the portfolio. Rating: Base
Kalpana, Inc ⁴³	October 24, 1994	This acquisition added a new dimension to Cisco's switching portfolio in that it followed stackable architecture, helped increase the throughput of Ethernet Networks, and allowed management via SNMP. However, the	Cisco had familiarity with Enterprise LAN switching market This Acquisition targeted a niche within that market, namely low-end switching solutions. Rating: Base

		general Enterprise LAN switching was a familiar technology Rating: Base	
LightStream Corporation ⁴⁴	December 8, 1994	The technology acquired (Enterprise Class ATM LAN Switching) is reasonably unfamiliar, since ATM is markedly different from Ethernet. Rating: New Familiar	This was a new market and Cisco was the pioneer in providing Enterprise class ATM switch that could support multimedia applications. Rating: New Familiar
Navarro Networks ⁴⁵	May 1, 2002	Navarro's ASIC components technology helped Cisco enhance its internal development of high-end ASICs for Ethernet switching platforms. The technology was familiar to Cisco. Rating: Base	The Ethernet switching market was very familiar to Cisco at the time of acquisition. Rating: Base
Aironet Wireless Communications ⁴⁶	November 9, 1999	Aironet's Wireless LAN access point and access card technology was unfamiliar to Cisco, although Cisco was very familiar with the wired Enterprise LAN Rating: New Unfamiliar	The Wireless LAN market was unfamiliar to Cisco, although it complemented the Wired LAN market. Rating: New Unfamiliar

Table 1. Cisco LAN acquisitions and their familiarity ratings

We have mapped the above observations of technology and market familiarity on to the Familiarity Matrix in Figure 20 below. As we can see, the pattern of LAN acquisitions is in general agreement with the optimum business development strategies of Figure 1; i.e., Cisco

LAN acquisitions seem to be good entry points at the time of acquisitions. Going back to the LAN technology trends discussed in the previous sections, we can see that Cisco reacted to changing market conditions in LAN primarily through acquisitions. This includes the shift to Ethernet switching (Crescendo, Kalpana), and more recently, the use of Enterprise class Wireless LANs (Aironet).

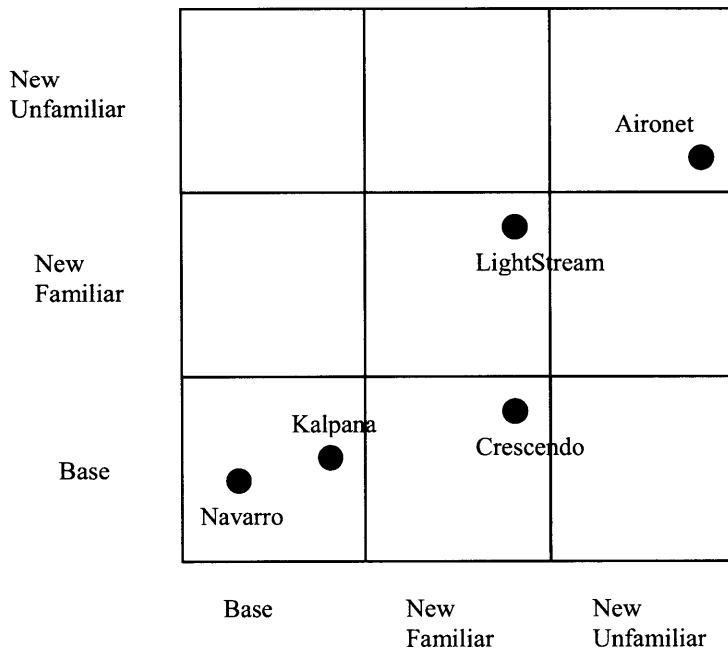


Figure 20. Cisco LAN acquisitions sample on the Familiarity Matrix

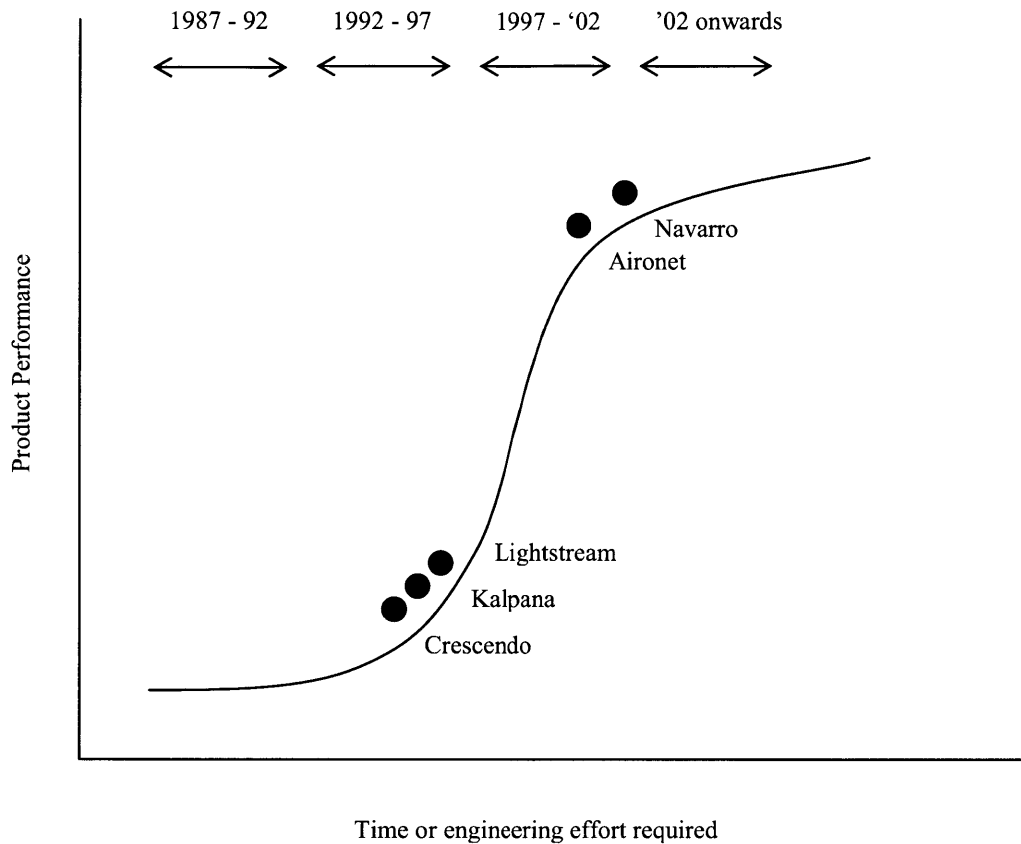


Figure 21. Cisco LAN acquisitions in the context of switched LAN technology S-curve

In Figure 21, we consider Cisco's LAN acquisitions in the context of a technology S-curve as proposed by Christensen⁴⁷. For this purpose we have divided the S curve over periods of 5 years, starting in 1987, when Cisco was developing routing hardware for the enterprise. In our view, the period from 1992 through 1997 saw the highest improvements in Enterprise LAN performance, via the emergence of switched Ethernet. Cisco has made 3 acquisitions in this time period that directly address Enterprise LAN needs. These proved to be very successful in the long run for Cisco. The Navarro acquisition happened as the switching technology matured, and

Cisco sought competitive advantage via the use of high-end ASICs. It is clear from Figure 21 that Cisco's timing of Enterprise LAN acquisitions in the early to mid 90s was critical to its success.

8 Cisco WAN acquisitions

With a strong leadership in the Enterprise LAN market by mid 90s, Cisco looked for growth in the Service Provider segment of the market. The Internet became hugely popular all over the world, providing connectivity to end users and remote branch offices was a multi-billion dollar business. Service Providers demanded speed and ease of configuration. Cisco positioned itself for this opportunity by placing products in three categories: (a) WAN edge routing (b) WAN Switching and (c) Core routing. In parallel, there was an increasing need for optical media to enable higher speeds. The WAN switching nodes had to be fast. The core routers had to be highly available while also providing the capability to store and handle tens of thousands of routing updates.

Cisco's foray into the WAN market was greatly aided by its acquisition of Stratacom, Inc. in 1996. Stratacom's ATM and Frame Relay Switches complemented Cisco's routing products in the WAN market. Cisco has since made other WAN acquisitions that strengthen its optical networking offerings. In Table 2, we have analyzed key Cisco WAN acquisitions.

Company Acquired	Date Acquired	Technology Factors	Market Factors
Stratacom Inc. ⁴⁸	April 22, 1996	ATM and Frame Relay switching for WAN networks were unfamiliar to Cisco, although Cisco had offered Campus ATM solutions. Rating: New Familiar	For the first time, Cisco targeted the service provider market and attempted to distinguish itself with end-to-end offerings. Rating: New Familiar
Skystone Systems Corp ⁴⁹	June 9, 1997	This marked Cisco's commitment to SONET/SDH technology, which it was unfamiliar with. Rating: New Unfamiliar	The niche market for providing integrated data, voice, and video over backbone networks was new to Cisco Rating: New Unfamiliar
PipeLinks, Inc ⁵⁰	December 2, 1998	Cisco built upon its SONET/SDH strengths by acquiring the Pipelinks' router that integrated circuit and packet switching. However, it was already familiar with SONET/SDH technology. Rating: New Familiar	Cisco was already familiar with the integrated services market for service providers. The acquisition strengthened its market position for integrated data, voice and video. Rating: New Familiar
Monterey Networks/Cerent Corporation ⁵¹	August 26, 1999	Cisco acquired optical cross connect technology that would instantly allow service providers to quickly and cost effectively add capacity at the core of an optical network. The general optical networking technology was already familiar to Cisco. Rating: New Familiar	Cisco was already familiar with the long haul optical networking market. With these acquisitions, it added products for the optical transport market. Rating: New Familiar

Seagull Semiconductor Ltd ⁵²	April 12, 2000	Cisco acquired semiconductor technology that would accelerate its ability to develop terabit routers. The technology was familiar to Cisco, which had developed high performance routers for the Enterprise Rating: Base	Cisco was very familiar with the service provider core routing market Rating: Base
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Table 2. Cisco WAN acquisitions and their familiarity ratings

The corresponding Familiarity Matrix for Cisco WAN acquisitions is shown in Figure 22.

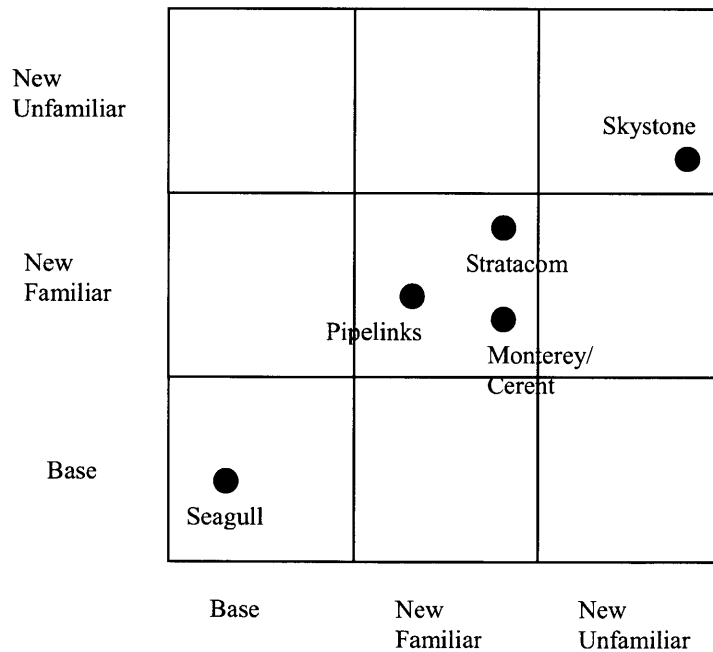


Figure 22. Cisco WAN acquisitions sample on the Familiarity Matrix

As we can see, acquisitions were central to Cisco's growth from WAN. They helped the company compete on all WAN fronts noted above. Optical networking infrastructure and SONET/SDH technologies dominated the WAN acquisitions. The acquisitions were also testament to Cisco's end-to-end growth strategy, as it targeted every segment of the WAN. Cisco has been more adventurous in WAN acquisitions compared to LAN, as we see from the higher concentration of dots away from the base. This is understandable as Cisco's mainstay was the Enterprise routing and switching market prior to its rapid entry into the Service Provider market.

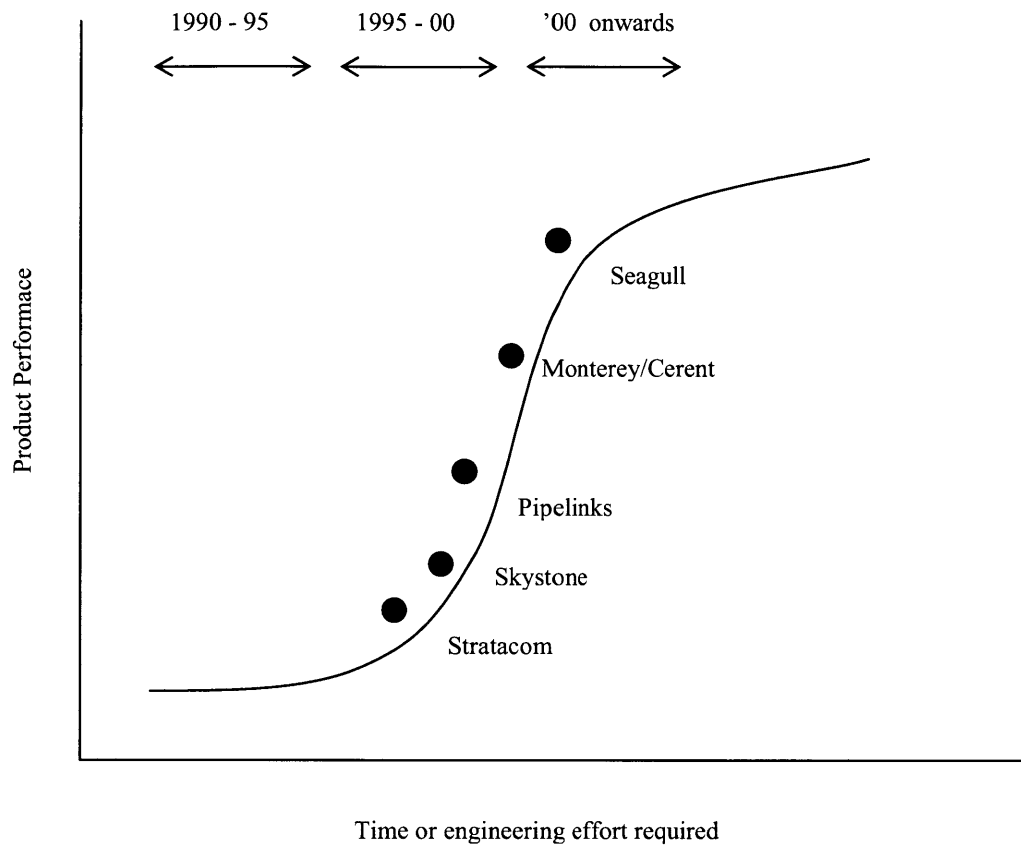


Figure 23. Cisco WAN acquisitions in the context of the WAN optical networking technology S-Curve

In Figure 23, we consider the growth of backbone optical networks in three time periods. The maximum benefit of the optical backbone networks came about in the mid to late nineties, when service providers rushed to add capacity. Cisco's WAN acquisition pattern shows a more evenly spread distribution along the optical technology S-curve, compared to the LAN pattern discussed earlier. Having secured a head start with Stratacom's ATM technology, Cisco's commitment to optical backbone networks remained strong and steady. A string of SONET/SDH acquisitions offered performance advantages for the integrated services market, with relatively low time and engineering effort on the part of Cisco.

9 Cisco Access Technology Acquisitions

Although Cisco focused primarily on the Enterprise and Service Provider network infrastructure, it has had its presence in the small and medium business access market. Broadband access, which provides high speed internet access to small/medium businesses and home offices, has seen several waves of technologies in the past 20 years. Cisco has tried to compete in this space by positioning products for end users and access providers. Its products have incorporated technologies for several access technologies, including ISDN, DSL and Cable.

One aspect of the Small Office Home Office (SOHO) market is that the end user side of it is dependent on higher volumes, and product margins are generally low. For a direct seller of primarily expensive, high margin equipment, the SOHO market was not Cisco's forte. Cisco acquired companies to provide feature sets for the price points of this market. It partnered with local Internet access providers as a channel for selling the products to end users. For example, Pacific Bell, a leading service provider in the San Francisco Bay Area, deployed thousands of ISDN (Cisco 1600 series) and DSL (Cisco 675 series) routers to home users in the mid to late 90s. It has more recently participated in sales through retailers like Best Buy, primarily for its SOHO products acquired by the purchase of Linksys. Below we have analyzed some acquisitions in the Access Technology space that have helped Cisco be more effective in a difficult and sometimes unfamiliar terrain.

Company Acquired	Date Acquired	Technology Factors	Market Factors
Combinet Inc ⁵³	August 10, 1995	Cisco was familiar with the ISDN technology, since it was already incorporated in its products such as Cisco 7000, Cisco 4000, Cisco 2500 and Cisco 1000 series routers. This acquisition would strengthen its expertise in the ISDN technology. Rating: Base	The market for telecommuters and the use of resellers to foster sales was unfamiliar to Cisco. It used the acquisition as a means to access these sales channels. Rating: New Unfamiliar
Dagaz ⁵⁴	September 2, 1997	Cisco was familiar with the DSL technology. It acquired the xDSL access multiplexer products which strengthened its DSL portfolio. Rating: New Familiar	Cisco was familiar with the DSL market, but this acquisition expanded its market with the complementary xDSL assets and intellectual property. Rating: New Familiar
Netspeed ⁵⁵	March 10, 1998	The DSL technology was familiar to Cisco. Cisco mainly acquired the customer premise DSL products to offer an end-to-end DSL access solution to its customers. Rating: Base	Although Cisco had some experience selling its products via resellers, the DSL market meant a new set of access providers that it needed to partner with, such as US West. Rating: New Familiar
Clarity Wireless ⁵⁶	September 15, 1998	This acquisition brought in fixed last mile wireless technology that complemented Cisco's other last mile technologies like DSL and Cable. Rating: New	The market for last mile wireless technology was new to Cisco. The general market for end user access was familiar, though. Rating: New Familiar

		Unfamiliar	
Maxcomm Technologies ⁵⁷	August 18, 1999	Cisco acquired technology that would use existing cable and DSL networks to provide access to public networks, giving consumers more choices for combined data and voice services Rating: New Familiar	Cisco had experience in the last mile access market. This acquisition improved its offerings in that market. Rating: Base
Linksys ⁵⁸	March 20, 2003	The SOHO technologies of Linksys, including wireless, VoIP, print servers, hubs etc were largely familiar to Cisco. Rating: Base	The marketing of SOHO products meant the use of new sales channels such as retail stores, which was unfamiliar turf for a direct seller like Cisco. Rating: New Unfamiliar
ComCom ⁵⁹	September 15, 1999	Cisco acquired the Digital Video Broadcasting (DVB) technology to complement its cable access product portfolio. However, the base technology was familiar to Cisco Rating: New Familiar	The cable access market was already familiar to Cisco. The acquisition was meant to increase Cisco's competitiveness in this market. Rating: Base

Table 3. Cisco Access Technology acquisitions and their familiarity ratings

We have located Cisco Access Technology acquisitions in the Familiarity matrix in Figure 24.

Cisco has once again focused on acquisitions as a major source of growth in Access Networks, an area which has historically not been its core strength.

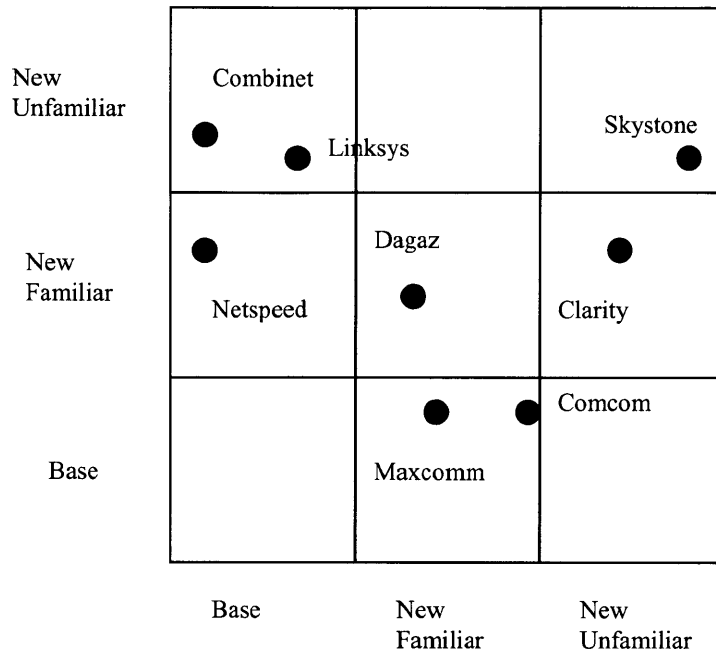


Figure 24. Cisco Access acquisitions sample on the Familiarity Martix

The distribution, with a centre of gravity away from the origin, indicates that Cisco has taken significant risk in offering end-to-end Access solutions. In fact, Access acquisitions exposed Cisco to the retail market for the first time, unlike some of its competitors like 3Com and Bay Networks that had the retail experience much longer than Cisco did. Also, the acquisitions laid the foundation for future opportunities in integration of data, voice, and video. Thus Cisco was not necessarily interested in immediate returns, but it had a long-term network integration focus. For example, with the Maxcomm acquisition, Cisco acquired digital video broadcasting expertise.

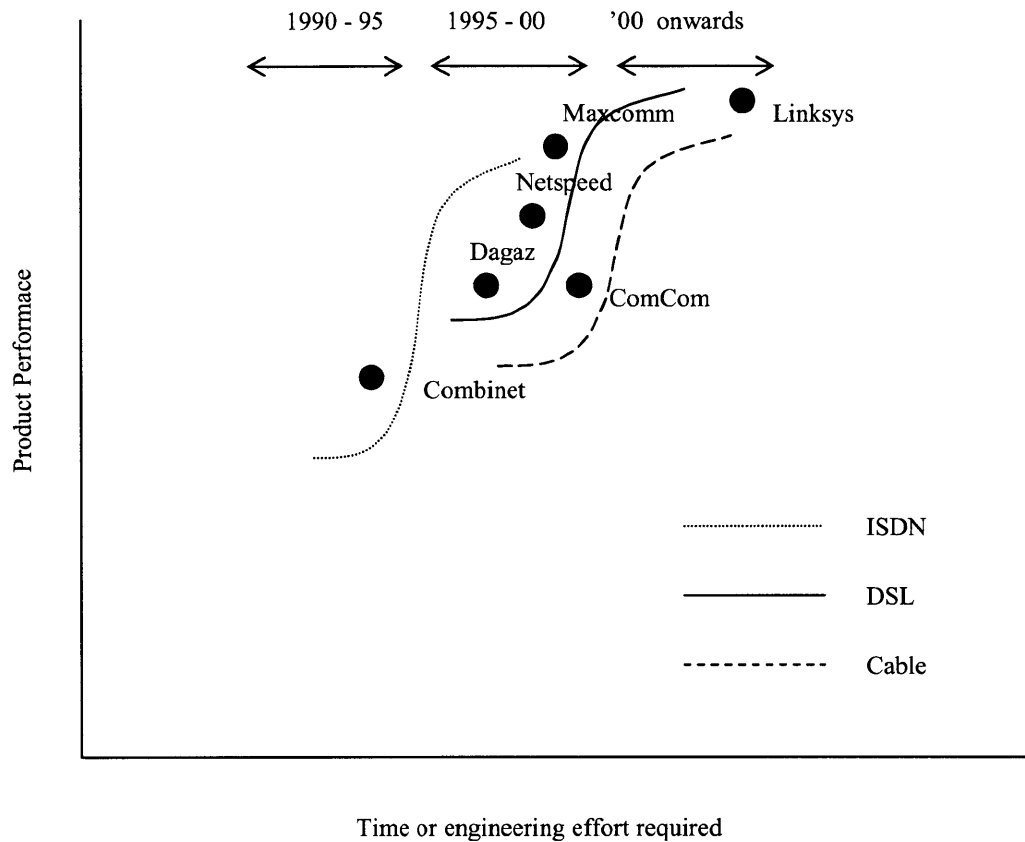


Figure 25. Cisco Access acquisitions in the context of the Access Technology S curves

In Figure 25, we have analyzed the three primary technologies for Internet Access over a period of 10 years, namely ISDN, DSL, and Cable. Cisco acquisitions have happened in all the three areas, with a greater density around the DSL technology. These acquisitions have come about in the early to mid sections of the S-curves. Although one cannot pre-determine the time span of an S Curve for any new technology, Cisco's timing for these acquisitions has generally worked in its favor. Linksys was an exception in the sense that Access side of Linksys' products had already reached the mature state at the time of its acquisition. However, it offered a rich suite of

products tailored for the SOHO network. The acquisition would allow Cisco penetrate the SOHO market quickly, and position itself for end-to-end offerings.

10 Cisco Advanced Technology Acquisitions

With a primary focus on 3 core lines of business, namely Enterprise, Service Provider, and Small-Medium businesses, Cisco has acquired technology companies that offered advanced features. These acquisitions are meant to address one of the following needs:

- (a) Provide product differentiation by offering value added features and services in existing routing and switching platforms that Cisco already sells
- (b) Provide complementary products that result in end-to-end integrated offerings
- (c) Provide an entirely new product line or service that would position the company competitively for a new opportunity

Cisco has made advanced technology acquisitions in a multitude of areas, including Network Manageability, TCP/IP services, Network Security, Voice over IP (VoIP), Video, and Collaboration. A majority of Advanced Technology acquisitions happened in the Voice Technology area. This was expected as Cisco found itself competing with companies such as Lucent Technologies and Northern Telecom (Nortel). Cisco's forte has traditionally been data networks; however, in the mid to late 90s, the priorities shifted to providing end-to-end integrated services whereby a single network would carry data, voice and video. Lucent and Nortel had their strengths and experience in voice networks; however, they had their own challenges in positioning themselves for the integrated network. Below, we have analyzed some Advanced Technology acquisitions made by Cisco.

Company Acquired	Date Acquired	Technology Factors	Market Factors
TGV Software Inc ⁶⁰	January 23, 1996	TGV's Multinet TCP/IP stacks for VAX and Windows platforms brought in Enterprise software application expertise and products. Cisco was familiar with Network protocol stacks as part of Cisco IOS. Rating: New Familiar	As primarily a hardware vendor, Cisco was unfamiliar with the market for shrink-wrapped desktop software for either the VAX or the Windows markets Rating: New Unfamiliar
Telebit Corp ⁶¹	July 22, 1996	Cisco acquired Modem ISDN channel integration technology (MICA). This is a classic example of Cisco acquiring new technology to enhance its existing offerings Rating: Base	Cisco was familiar with the market for ISDN. MICA made its products more competitive Rating: Base
Netsys Technologies ⁶²	October 14, 1996	The Network Infrastructure management and Analysis technology from Netsys complemented Cisco products and helped customers plan and simulate networks Rating: New Familiar	Cisco was familiar with the market where Netsys' products would be deployed Rating: Base
Global Internet Software Group ⁶³	June 24, 1997	Cisco acquired firewall technology for small-medium businesses. By way of PIX firewall, Cisco was already familiar with enterprise class firewalls. Rating: New Familiar	The market for Windows NT based firewalls for small/medium businesses was not familiar to Cisco, although it was familiar with Enterprise class firewalls Rating: New Familiar

Lightspeed International ⁶⁴	December 22, 1997	Cisco stepped up its voice technology by acquiring signaling technology to enable transition from circuit switched to cell/packet switched network. The technology was unfamiliar to Cisco, a predominantly data networking infrastructure vendor. Rating: New Unfamiliar	The market for voice networks based on cell/packet switching was unfamiliar to Cisco. Rating: New Unfamiliar
Precept ⁶⁵	March 11, 1998	This acquisition brought IP/TV technology within Cisco's offerings. Cisco was not familiar with the transmission of live or recorded video over a WAN to a select group of users. Rating: New Unfamiliar	Part of the acquisition targeted the Enterprise and Service Provider markets, which Cisco was very familiar with. However, the market for IP/TV applications such as conferencing and distance learning was unfamiliar to Cisco Rating: New Familiar
Vovida and IPCell Technologies	September 28, 2000	Cisco was familiar with the VoIP technology; this acquisition was meant to help Cisco and its partners provide new data, voice, and video services on an integrated IP network Rating: New Familiar	Cisco was already familiar with the service provider market that these technologies would be placed in. Rating: Base
Scientific Atlanta ⁶⁶	November 18, 2005	Technology of set-top boxes for home use was largely unfamiliar to Cisco. However, it fits into its broader vision of integrated data, voice and video services.	The market for set-top boxes was unfamiliar to Cisco. However, Cisco saw this as an opportunity to penetrate the video distribution market.

		Rating: New Unfamiliar	Rating: New Unfamiliar
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Table 4. Cisco Access Technology acquisitions and their familiarity ratings

In Figure 26, we have located Cisco’s Advanced Technology acquisitions on the Familiarity matrix. Cisco has taken significant risk in these acquisitions, as can be seen in the general density away from the Base. In most cases, Cisco has made bold moves in acquiring technology that fits into its long-term vision of “One IP Network” where data, voice, and video will all be transferred on a packet switched IP Network.

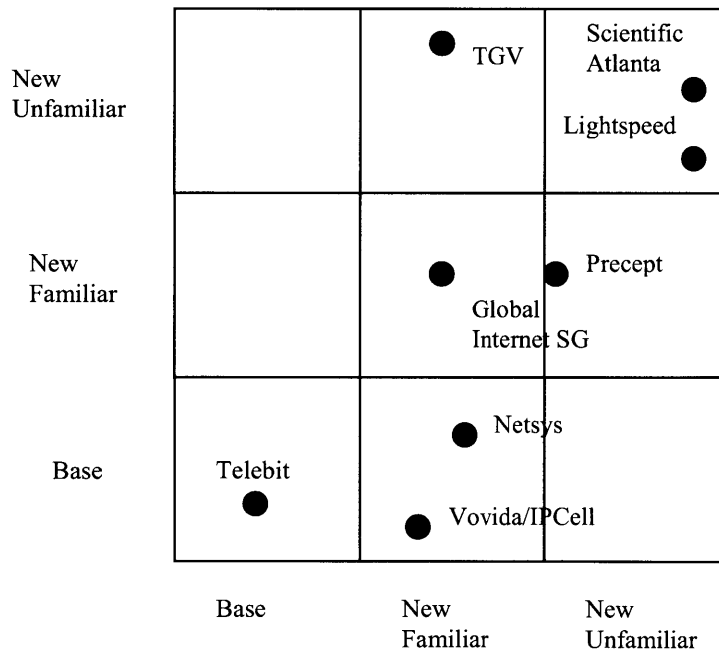


Figure 26. Cisco’s Advanced Technology acquisitions on the Familiarity matrix

11 Conclusions and Expert Opinions

We interviewed several industry veterans who had first-hand experience in being part of acquisitions in the networking sector. Transcripts of these interviews are provided in Appendices. While individual experiences of acquisitions and circumstances vary significantly, we could draw some common conclusions from their responses.

- 1) While large companies may undertake business development via acquisitions at a steady pace, many experts believe that companies are not started with a potential acquisition in mind. All acquired companies want to prove their value independently. An acquisition is often very circumstantial, mostly serving as an exit point. The decision to go public or get acquired can be difficult for many startup companies, and financial return is not the only motivating factor for these companies.

- 2) The most challenging aspect of business development via acquisitions is cultural compatibility. It is also the hardest element to assess in the whole process. While top-level executives can discuss their cultural compatibility, some acquired employees are bound to be dissatisfied with the new environment. Informational sessions where acquired employees are engaged in understanding the history and core values of the acquirer are known to help in the assimilation process. Strategic partnering prior to acquisition can help assess cultural compatibility at individual contributor levels.

- 3) A merger of equals is almost always a high risk proposition. Most experts agree that a merger of equals tends to raise doubts about who should be in charge. Product overlap, mistrust, and downsizing of employees are often an unfortunate fallout of such mergers.

- 4) Geographic proximity can be a contributing factor to cultural compatibility; however, proximity is not a requirement for successful acquisitions and its importance is sometimes overstated. In some cases, geographic proximity can interfere with an acquired company that can operate as an independent business unit and concentrate on its core competencies.

- 5) Quantitative metrics such as incremental revenue, profits, market share, etc are useful in evaluating the success of an acquisition. However, they are not the only metrics that should be used. In some cases, they cannot be measured for acquired technology. Often the intellectual property of acquired employees may result in contributions that are unrelated to the original acquired technology.

- 6) Horizontal and Vertical growth models are both necessary depending on the industry. There could be a shift in the growth strategy due to changing market conditions and competitor's moves

- 7) Companies that have a streamlined acquisition process that emphasizes planning and thorough due diligence are more successful at making acquisitions work. Hasty acquisitions can result in wasteful overlap. Operational integration has generally become

a standard expectation; it is cultural and functional integration that needs concerted effort from both parties.

- 8) Some experts believe that abrupt functional integration into the reporting structure of the acquiring company may be detrimental. The acquired employees may find the new domain to be very demanding. Instead, a phased functional integration helps keep employees motivated as they learn new domain skills.

- 9) Most industry experts seem skeptical about the growth and profitability of companies involved in social networking. While they cannot predict the exact nature of business growth in the future, they all believe in the power of innovation and willingness to question the status quo. A distorted sense of reality may not always result in successful businesses, but it certainly has provided the initial impetus to many.

12 Appendices

12.1 Expert Interview 1

Interviewee: Senior executive whose company was acquired during the 1990's. The transaction was valued to be less than \$100 million, and was financed by stock. Prior to acquisition, the company was in business for less than 5 years. Its typical customer would be a CIO responsible for ensuring competitiveness of an Internet service provider.

Prompt: Briefly describe your overall experience of being acquired.

Response: Overall, it was a very positive experience. The acquiring company had a mature process in place. We were a relatively small company, and the integration went reasonably smoothly. Our company's technology was a little ahead of its time, and it took a while for it to make a noticeable impact on the acquiring company's bottom line. Our people may have felt the effects of changes in management, but they were taken care of very well.

Prompt: What were the major challenges for a company of the size of yours when acquired?

Response: We were a small company with a product that was not considered “mainstream.” Our initial challenge was to get attention. However, over the longer term, we were successful in overcoming that challenge, and were able to use our technology to create a product that has been hugely successful in the acquiring company’s portfolio.

Prompt: Do you strongly believe that geographic proximity is vital to a successful acquisition?

Response: It depends on the size and type of acquisition. If it is an acquisition that is going to be integrated into the company, then geographic proximity to some portions of the company would help with integration, taking advantage of synergies. If it is a stand-alone acquisition that you really want to operate on its own, then geographic proximity can actually be a disadvantage. Pixar not being co-located with Disney in Los Angeles was actually an advantage, in my opinion.

Prompt: How is cultural and industry vision compatibility assessed?

Response: People talking to each other is key. Leaders should talk to leaders and spend time together. There are no objective measures. Spending time together and gut instinct are definitely driving factors. Asking pertinent questions about how they operate, and what the future holds would be very useful. It could take a few meetings or many more. The challenge, however, is that these assessments happen at the executive level and confidentiality measures may preclude

other employees from actively interacting. In that sense, partnerships prior to acquisitions go a long way in assessing culture and vision compatibility.

Prompt: Do you espouse the idea of merger of equals? If so, under what context?

Response: Absolutely not. From my own experience, I have seen problems arise during integration. People feel misled. You need to be clear upfront as to who is doing the acquiring. That does not mean that the acquired company is ignored or dominated over. When Disney acquired Pixar, Pixar's culture became the culture for all of feature animation at Disney.

Prompt: What has your experience been in integration after acquisition?

Response: Operational integration is generally not a challenge when the acquiring company has a mature, stream-lined process. However, cultural integration is the hard part. Some people never feel comfortable with the new culture. So there is no easy way around integration.

Prompt: What are your views on the horizontal and vertical growth models?

Response: I do not have a general opinion. It all depends on the industry and situation.

Prompt: How long did it take before you felt integrated into the acquiring company?

Response: We felt integrated within 6 months. Our experience was not typical, but cultural integration, as I said, is the part that takes time. Partnerships help in that regard – it is like dating before marriage.

Prompt: Do you believe there are quantitative metrics to determine whether an acquisition was a success?

Response: If the company is mature, yes, there are quantitative metrics such as revenue and employee retention. You have to be careful not to get locked into quantifiable metrics.

Sometimes earnings from an acquisition are simply not quantifiable; for example, when the acquired technology gets integrated into existing products. Sometimes an acquisition may not meet the quantifiable metrics of success. However, there could be subjective criteria, which on hindsight seem very important. For example, a piece of technology or key employees that made a significant impact over the years.

Prompt: What do typical acquisition targets look for as part of acquisition deals, and what are some strategies to make sure those goals are met?

Response: It is all over the map. Some simply want liquidity – their investors want an exit. Others want market distribution for their products. Still others want to further their vision, leveraging a larger company’s influence.

Prompt: Did the acquisition come about as a surprise, or was it known and planned for?

Response: Some companies do know they want liquidity at a point in time, and they do plan for acquisitions or work to make acquisitions happen. Others decide to undergo acquisitions because it is the best course, and they don’t really plan for it.

Prompt: For interviewees acquired by multiple co’s: You have been acquired by several different companies. In what ways were these acquisitions similar or different. What made one acquisition better than another?

Response: The crux of acquisitions is integration. During high growth periods, some companies want to do acquisitions hastily and end up making overlapping acquisitions that become wasteful. Discipline is key.

Prompt: We are entering into an era of social networking and collaboration. Yet the so called “cyber anonymity” is making people feel lonely and distanced. In the light of these trends what sort of businesses and acquisitions do you see happening in the next decade ?

Response: Scoping this question around the domain of networking, I think people may feel they are merely “digital inputs” to the underlying infrastructure. In terms of new applications and businesses that can make people feel genuinely closer, I think one of the problems with social networking today is that people tend to overrate the number of connections instead of depth and quality of connections. We could see a new breed of applications that could address the qualitative aspects of social networking.

Prompt: Do you have any other comments on business development that you consider important.

Response: There are two aspects to business development. There is this notion of growth by acquisitions, but there is also growth by partnerships. Partnerships are hard to execute, but some of the best acquisitions happen after partnering. Some large companies tend to bypass partnering, but, in general, companies that have partnership ability in their DNA stand a good chance at successful acquisitions. Also, one needs to be careful about generalizations in business development, as everything is case dependent.

12.2 Expert Interview 2

Interviewee: C-level executive of a technology company that was acquired during the late 1990's. The transaction was valued to be between \$400 to \$500 MM, and was financed by stock. Prior to acquisition, the company was in business for less than 3 years. Its typical customer would be a CIO at a major Internet Service provider.

Prompt: Briefly describe your overall experience of being acquired.

Response: We planned carefully around the general trends in the industry, and we were swift to adapt. It was quite unusual for an acquisition of this sort to happen, but we were there in the right place at the right time. It was positive for all parties involved, particularly from a talent acquisition perspective.

Prompt: What were the major challenges for a company of the size of yours when acquired by another company?

Response: We were absorbed fairly easily compared to other acquisitions I have been part of. We each had our own domain expertise, so getting everybody to the same level took some time.

Prompt: Do you strongly believe that geographic proximity is vital to a successful acquisition?

Response: Generally, geographic proximity can be helpful in a variety of ways such as in integration, but it is not necessary. If a standalone operation is geographically distant, it really does not matter.

Prompt: How is cultural and industry vision compatibility assessed?

Response: Culture to a large extent depends on the industry. You cannot expect the culture you see in technology industries in manufacturing or pharmaceuticals. So it is important to understand the cultural traits of the industry you are in. Following that, the ability to have an open mind so as to be able to synthesize multiple viewpoints determines how compatible companies are going to be.

Prompt: Do you espouse the idea of merger of equals? If so, under what context?

Response: Underlying a successful business is a vision. The vision is usually something that evokes an image in the future, not numbers or text. Further, the vision is generally something you asymptotically achieve. It is easier to achieve a vision, if one person is in charge. In the case of merger of equals, there is always a likelihood of integration problems due to cultural incompatibility.

Prompt: What has your experience been in integration after acquisition?

Response: Our integration was very smooth. The acquiring company had the process streamlined and we did not have any problems in integration.

Prompt: What are your views on the horizontal and vertical growth models?

Response: It depends on the industry. The automotive industry evolves somewhat slowly, and each player tends to control their domain of expertise. The Japanese realized that early on and they grew horizontally by leveraging the expertise of suppliers. You need to be careful about the amount of horizontal and vertical growth you want, and in every industry there is probably an optimal point.

Prompt: How long did it take before you felt integrated into the acquiring company?

Response: It was very quick – within a few months. We did not have cultural or vision issues. We had a few IT related hiccups, but they were addressed relatively quickly.

Prompt: Do you believe there are quantitative metrics to determine whether an acquisition was a success?

Response: Companies have to determine their own criteria for success. Some of them relate success purely to numbers such as revenue and profits; others have a more qualitative outlook. However, regardless of your criteria, you need to be clear about the reasons for an acquisition. You also should review the results periodically, perhaps twice a year.

Prompt: What do typical acquisition targets look for as part of acquisition deals, and what are some strategies to make sure those goals are met?

Response: In the venture model, people typically look for ROI. Sometimes targets look to avoid debt; other get bought out because it is an honorable thing to do. There could be a variety of motivations for both buyers and sellers.

Prompt: Did the acquisition come about as a surprise, or was it known and planned for?

Response: Most businesses have a good understanding of their eco-systems – upwards, downwards and sideways. Acquisitions do not come about as a surprise. However, building a company with a future acquisition in mind is not a good strategy; you need to build a business to be viable and successful in its own right.

Prompt: For interviewees acquired by multiple co's: You have been acquired by several different companies. In what ways were these acquisitions similar or different. What made one acquisition better than another?

Response: Successful acquirers do not discriminate between in-house employees and acquired employees. They have a certain set of expectations in terms of type, location, customer interaction etc., and work hard to evaluate the likelihood of meeting those expectations prior to the acquisition.

Prompt: We are entering into an era of social networking and collaboration. Yet the so called “cyber anonymity” is making people feel lonely and distanced. In the light of these trends what sort of businesses and acquisitions do you see happening in the next decade ?

Response: To be a founder, the most important characteristic in my mind is to have a distorted sense of reality. Sometimes our vision for a company may work, other times it may not. It is important to stick to the vision and pursue it sincerely, though. So, it is really not possible to predict. It is hard for disciplined investors to take an inflexion point and determine what would be the next best investment.

12.3 Expert Interview 3

Interviewee: Senior industry veteran and C-level executive, whose company was acquired during the 1990s. The transaction was valued to exceed 1 billion, and was financed by stock. Prior to acquisition, the company was in business for around 10 years. Its typical customer would be a Functional Director responsible for core Internet service provider infrastructure.

Prompt: Briefly describe your overall experience of being acquired.

Response: I was a strong proponent for the acquisition because of the synergies, long term, and short term wins, and vision. We had a short courting period because of our familiarity, and the overall experience was rewarding.

Prompt: What were the major challenges for a company of the size of yours when acquired?

Response: Integration of our sales force was challenging for us. Our sales people were specialized. We attempted to integrate it functionally, but I think a matrix integration would have been a lot easier and more productive.

Prompt: Do you strongly believe that geographic proximity is vital to a successful acquisition?

Response: All things being equal, geography becomes increasingly important as the number of acquired employees increases. Generally, if the number of acquired employees is higher than 10% of the total, geographic proximity helps avoid the “us-them” mentality that some coast-to-coast acquisitions suffered from.

Prompt: How is cultural and industry vision compatibility assessed?

Response: The vision compatibility is easier to assess. You can quickly sense whether visions are aligned. However, culture is a grey area. It depends a lot on the CEOs. The easiest thing to do would be to note individual cultural attributes, and see whether there is compatibility.

Prompt: Do you espouse the idea of merger of equals? If so, under what context?

Response: No. I think merger of equals almost never works.

Prompt: What has your experience been in integration after acquisition?

Response: Our integration into the acquiring company's organization was very smooth, because we were structured similarly to begin with. In retrospect, I feel that some of our people would have been more productive in a matrix organization, compared to pure functional integration.

Prompt: What are your views on the horizontal and vertical growth models?

Response: I think it is situational. It depends on industry and size. Smaller companies might need to partner and grow horizontally.

Prompt: How long did it take before you felt integrated into the acquiring company?

Response: Most of integration takes about 8 to 12 months.

Prompt: Do you believe there are quantitative metrics to determine whether an acquisition was a success?

Response: There a few metrics. Revenue growth and market share are certainly important metrics. A third one would be profitability and cost reduction by finding synergies. The retention rate is important, too.

Prompt: What do typical acquisition targets look for as part of acquisition deals, and what are some strategies to make sure those goals are met?

Response: Typically people build companies to be leaders in their domain. They look for synergies to get to that goal. At other times, companies look only for exit value.

Prompt: Did the acquisition come about as a surprise, or was it known and planned for?

Response: No, it was not expected. Typically companies don't grow knowing that they will be acquired. They usually want to become industry leaders in their space.

Prompt: For interviewees acquired by multiple co's: You have been acquired by several different companies. In what ways were these acquisitions similar or different. What made one acquisition better than another?

Response: Some companies are agile. They have short cycles on due diligence and engagement. They are also very efficient at integration. They make for good acquirers.

Prompt: We are entering into an era of social networking and collaboration. Yet the so called “cyber anonymity” is making people feel lonely and distanced. In the light of these trends what sort of businesses and acquisitions do you see happening in the next decade ?

Response: Unfortunately, the human element is always lost in a digital world. Going forward, startups are going to have a much harder time because customers are not going to want to take risks. However, I think video, cloud computing, storage, virtual collaboration, and virtualization are going to be very active.

12.4 Expert Interview 4

Interviewee: Seasoned executive and founder of a company that was acquired during the late 1990s. The transaction was valued under 150 million, and was financed by stock. Prior to acquisition, the company was in business for less than 5 years. Its typical customers were service providers.

Prompt: Briefly describe your overall experience of being acquired.

Response: Overall, it was a positive experience. The negotiations were very fair. A company similar to ours was acquired shortly before our acquisition, so we had something to compare our valuations with. In the late 90s, raising money for a startup was not difficult; hiring qualified people was. The acquisition was win-win for both parties in that regard.

Prompt: What were the major challenges for a company of the size of yours when acquired?

Response: The major challenge was the new product validation process. The acquiring company's quality assurance was extremely thorough. This process that involved hundreds of hours of regression testing was somewhat frustrating for some of our personnel.

Prompt: Do you strongly believe that geographic proximity is vital to a successful acquisition?

Response: Yes, I do. People are social in nature, and they like proximity. The ability to meet face to face and have a productive discussion is a huge advantage, whether it happens in the elevator, break room, parking lot, or the meeting room. Proximity also determines cultural compatibility to a large extent.

Prompt: How is cultural and industry vision compatibility assessed?

Response: The acquiring company held several educational sessions where their history and cultural tenets were clearly described. They described how they grew from inception to where they were then. This educational process clarified the core values espoused by the acquiring company and made our rather small employee base comfortable with the dominant culture.

Prompt: Do you espouse the idea of merger of equals? If so, under what context?

Response: No, I do not. I have managed acquisitions where two companies of equal size merged. There is a high likelihood of cultural incompatibility and leadership vacuum. In one instance, it impacted our profits and I had to lay off 60% of the workforce.

Prompt: What has your experience been in integration after acquisition?

Response: The process of assimilation was very smooth. The acquiring company was very cooperative in placing employees in the reporting structure. Some of our processes were antiquated, since we had limited resources. That is probably where our employees felt the difference. Otherwise, everything was very streamlined.

Prompt: What are your views on the horizontal and vertical growth models?

Response: It very much depends on the market. Some companies can do very well when vertically integrated. There are other markets where the horizontal partnering model is better. Sometimes it may be necessary to shift strategy to target new markets.

Prompt: How long did it take before you felt integrated into the acquiring company?

Response: It was not long. In about a month, our employees did feel part of the larger acquiring company, except that some of the new product validation processes seemed very thorough.

Prompt: Do you believe there are quantitative metrics to determine whether an acquisition was a success?

Response: Yes, and it goes back to why the acquisition happened in the first place. They could be targeting product release dates, market share, profit targets etc. These could then be used to assess the success of acquisitions. One could also assess how well positioned the combined company is for future growth.

Prompt: What do typical acquisition targets look for as part of acquisition deals, and what are some strategies to make sure those goals are met?

Response: In most cases it is the exit value, especially if it is a VC funded company.

Prompt: Did the acquisition come about as a surprise, or was it known and planned for?

Response: No, I don't think acquisitions are planned deliberately. Companies are started to be able to make money and provide a good working environment for employees. At some point in its lifetime, liquidity becomes an issue. The management will then have to decide whether to take it public or seek an acquisition.

Prompt: For interviewees acquired by multiple co's: You have been acquired by several different companies. In what ways were these acquisitions similar or different. What made one acquisition better than another?

Response: Companies that are intellectually and emotionally ready to face the fact that they are not going to come up with every good idea themselves will be generally better at making acquisitions. Good acquirers generally value the employees they inherit.

Prompt: We are entering into an era of social networking and collaboration. Yet the so called "cyber anonymity" is making people feel lonely and distanced. In the light of these trends what sort of businesses and acquisitions do you see happening in the next decade ?

Response: I think there is more social networking at present than there needs to be. I am not sure about the future of these companies, a majority of which are not profitable at this time. The future will certainly see consolidation, with acquisitions happening in areas such as energy and infrastructure.

13 Glossary

ARCNET	Attached Resource Computer Network
ATM	Asynchronous Transfer Mode
DOCSIS	Data Over Cable Service Interface Specification
DSL	Digital Subscriber Line
EVC	Ethernet Virtual Connection
HDLC	High-Level Data Link Control
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MPEG	Moving Picture Experts Group
MPLS	Multi Protocol Label Switching
PPP	Point-to-Point Protocol
PSTN	Public Switched Telephone Network
SAN	Storage Area Network
SDLC	Synchronous Data Link Control
SOHO	Small Office Home Office
SONET	Synchronous Optical Network
SSL	Secure Sockets Layer

UNI	User Network Interface
USB	Universal Serial Bus
VOIP	Voice Over Internet Protocol
VPN	Virtual Private Network
VM	Virtual Machine
WAN	Wide Area Network

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