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Dataquest Guide: Public Network Infrastructure Methodologies and Definitions, 2006

Deborah Kish, Frank Fabricius, Sylvain Fabre, Jouni Forsman, Peter Kjeldsen

This document describes the segmentation and forecast methodologies Gartner uses when analyzing the world market for public network infrastructure. It also defines the many terms for equipment, systems and software.

TABLE OF CONTENTS

Gartner

LIST OF TABLES

LIST OF FIGURES

Gartner

STRATEGIC PLANNING ASSUMPTION(S)

Gartner Dataquest strategic planning assumptions state positions and make predictions for key forecasting assumptions. Assigned probabilities express the likelihood of the forecasting assumption in the stated time frame. For 2006, the following strategic planning assumptions apply to public network infrastructure forecasts:

- Through 2008, the main challenge for network service providers planning to adopt Internet Protocol Multimedia Subsystem (IMS) will be interfacing with existing time division multiplexing (TDM) networks (0.7 probability).
- Inconsistent voice over Internet Protocol (VoIP) quality will remain the main complaint and reason for VoIP customer churn through 2007 (0.7 probability).
- Through 2008, the complexity of home networking will be the most common technology obstacle for IPTV deployments (0.8 probability).
- From 2005 through 2010, network service providers' (NSPs') average traffic will triple in the core and increase tenfold in access (0.8 probability).
- NSPs' IP infrastructure won't be convergence-ready until 2010 (0.8 probability).
- Through 2008, NSP in-house skills will be needed to close the vendor capability gap (0.7 probability).
- By 2010, more than three-quarters of the cable operators will offer packet cable and Session Initiation Protocol (SIP)-based VoIP, including videophone (0.8 probability).
- Through 2010, over 50 percent of IPTV deployments will be deployed as point solutions rather than being part of a service delivery platform (SDP)-oriented holistic solution (0.7 probability).

ANALYSIS

1.0 Overview

Each year, Gartner Dataquest surveys and holds ongoing interviews with telecommunications network equipment suppliers and service providers to estimate annual revenue and develop market size assessments for the major market segments worldwide. The information gathered through these sources enables Gartner Dataquest to maintain a dynamic database of public network infrastructure equipment, systems and software shipments. This rigorous approach, supported by a team of experienced industry analysts, provides our clients with the most current and accurate picture of market data and trends.

We survey and provide in-depth market research in the following areas of public network infrastructure systems:

- Switching
- Signaling
- Access
- Transport

- Support systems — operational support systems/business support systems (OSS/BSS)
- Public network outsourcing and services
- Mobile network infrastructure

Gartner segments mobile network infrastructure into a worldwide report and regional markets, including Western Europe, North America, Asia/Pacific and Japan. More detailed definitions can be found in "Mobile Communications Worldwide: Methodology and Definitions, 2005."

These reports are segmented as follows:

- By installed base, shipments of additional equipment and associated revenue for digital transceivers, base stations and core-network elements, as well as by technology standard.
- By industry standard — For example, code division multiple access radio transmission technology and code division multiple access evolution data only (CDMA2000 1xRTT/CDMA 1xEVDO); Global System for Mobile Communications (GSM), general packet radio service (GPRS) and Enhanced Data Rates for Global Evolution (EDGE); time division multiple access (TDMA); wideband code division multiple access (WCDMA) and Time Division-Synchronous Code Division Multiple Access (TD-SCDMA).

The purpose of this document is as follows:

- To describe the methodology and comprehensive segmentation method used by Gartner Dataquest for its 2006 global, regional and country forecasts and statistics for the public network infrastructure hardware and software market.
- To provide detailed network infrastructure market definitions for each of the line items of the forecast and all equipment segments of the segmentation method.

The information gathered from these surveys enables Gartner Dataquest to maintain its database of vendor revenue data for each market segment. The categories for which public network infrastructure hardware and software revenue are reported are comprehensively defined so as to provide clarity and guidance to survey participants, as well as those who use Gartner Dataquest's public network infrastructure equipment market data. These definitions are revised, altered or expanded to reflect changes in the vendor and technology marketplace.

2.0 Market Forecasting Methodology

Gartner Dataquest's market statistics methodology combines primary and secondary sources to produce the Market Forecasts and Market Trends documents. Gartner Dataquest continually surveys major participants within networking infrastructure equipment markets in Asia/Pacific (including Japan), Central and Eastern Europe, North America, Latin America, Middle East and Africa, and Western Europe.

All primary research is supplemented by additional research (primary and secondary) to verify market size, line/port totals and pricing information.

Sources of data used by Gartner Dataquest include:

- Interviews with vendors, suppliers and resellers
- Information published by major industry participants
- Estimates made by reliable industry representatives

- Government data or trade association data
- Published product literature and price lists
- Relevant economic data
- Articles in the general and trade press
- Published company financial reports
- Reports from financial analysts
- Information and data from online and CD-ROM data banks
- End-user surveys by key market segments
- Financial databases that model major carrier revenue on a quarterly basis

Gartner Dataquest believes its market forecasts and statistical information are the most accurate and meaningful available. Despite the care taken in gathering, analyzing and categorizing the data, careful attention must be paid to the definitions and assumptions. Various companies, government agencies and trade associations may use slightly different definitions of product categories and regional groupings, or they may include different companies in their summaries. These differences should be kept in mind when making comparisons between data and numbers provided by Gartner Dataquest and those provided by other research organizations.

The chapters of the full Definitions Book are organized in accordance with the forecast framework used in all the market statistics forecasts at the worldwide, regional and country level.

3.0 Public Network Infrastructure

All types of carrier network infrastructure can be defined through the application of a combination of the following basic functions:

- Switching
- Signaling
- Access
- Transport
- Routing
- OSS/BSS
- Public Network Outsourcing and Services

Because of the fundamental nature of these technology areas, Gartner Dataquest will use them to define the various markets tracked and analyzed in carrier network infrastructure research. In the remainder of this document, each area will be defined in greater detail. For a listing of nearly 400 telecommunications technology providers organized by these areas, see "Directory of Carrier Network Infrastructure Suppliers, Worldwide, 2005."

3.1 Switching and Routing

Switching is defined in its most general sense as functions performed in the network that alter the path, either in real-time or near-real-time, that information takes as it traverses a given network. In

this sense, switching includes traditional circuit-switching and packet-routing (IP, asynchronous transfer mode [ATM], frame relay and so on). As a result, the markets tracked under the switching discipline include well-known ones such as circuit switches, IP routers, ATM switches, frame relay switches, softswitches and media gateways.

3.2 Transport

The transport discipline is the high-capacity system that ties switching nodes in a network together over relatively long distances. In other words, transport provides the paths/pipes to which the switching discipline steers information. In this sense, the transport system includes transport technology forms such as optical transport, fixed or mobile wireless transport, and terrestrial non-optical transport. To the pure transport technology, cross-connect and multiplexing technology is covered under the transport discipline. The cross-connect technology is covered here, rather than in switching, because it is used to patch links that are rerouted as needed and considered "provisioning," rather than in the real-time environment defined by the switching discipline.

3.3 Access

The access discipline is the technology that allows end users to be connected to a public network. As such, the access function provides the initial customer interface and experience. Access is truly the "face" of the service provider to the customer. Access, therefore, plays a critical role in determining the customer experience. The access portion of the network tends to account for a large percentage of network investment because of diverse customer needs and locations. Equipment in this area includes integrated access technology, digital loop carrier (DLC) technology, fiber-to-the-premises (FTTP) technology, wireless access technology and cable technology. Access is often viewed as a bottleneck in many contemporary network implementations.

3.4 Signaling

The signaling discipline defines the control plane of a network and can include in- or out-of-band connections. Signaling is a specialized, rapidly changing and important topic. Signaling deals with the protocols and required technology used to allow equipment in a network to communicate for the purpose of altering network connectivity or to get database information. As such, it includes topic areas such as Signaling System 7 (SS7) common channel signaling, SIP, H.323, Media Gateway Control Protocol (MGCP) and intelligent network/advanced intelligent network (IN/AIN). Data topics include Q.931 (broadband), Multiprotocol Label Switching (MPLS), multiprotocol lambda switching (MPS) and routing protocols such as Open Shortest Path First (OSPF), Border Gateway Protocol (BGP) and Routing Information Protocol (RIP).

3.5 Support Systems

Support systems comprise all processes and software solutions that support the daily operation of a NSP's network infrastructure, both from a customer- and network-facing perspective.

3.5.1 Business Support Systems

BSSs represent the front office and customer-facing applications for service providers using all technologies. Examples of BSS process areas are billing, customer care, marketing and sales tools and fraud management.

3.5.2 Operational Support Systems

OSSs enable public network infrastructure operations, administration, maintenance, and provisioning and network/element management functions such as faults, configuration, administration, provisioning and security, as best described by the International Telecommunication Union (ITU) telecommunications management network model. OSSs usually comprise software systems residing on general-purpose or specialized computer systems that support one or more business processes associated with network operations. Examples of the business processes addressed include planning and engineering, provisioning, performance management, fault management, network configuration and inventory management.

4.0 Switching and Routing

Gartner Dataquest tracks public network voice and data-switching and routing equipment markets to include the following equipment generations:

- Next-generation switching
- Current-generation switching

As network equipment continues to evolve from traditional proprietary, centralized and time division multiplexing and voice-optimized technology to open, distributed and packet-based technology, it is essential to maintain a framework of definitions to keep research outcomes consistent.

Within this context, the next-generation voice softswitch evolution is changing to a network architecture that will combine media gateway controllers (MGCs), media servers, signaling gateways (SGs) and application servers. Similarly, the next-generation data network is evolving toward a converged transport platform that will support a variety of voice, data and video services (see Figure 1). In the next-generation network model, media servers and gateways host services controlled by signaling gateways. These services are transported over the converged broadband packet network.

Therefore, it is critical to have a framework of market segment definitions in place that are narrow enough to allow a solid differentiation between market segments, but broad enough to capture major different product applications. Gartner Dataquest will continuously track these definitions and trends in these market segments and will adjust definitions when required.

4.1 Next-Generation Switching Systems

Gartner Dataquest tracks the next-generation public switching market to include the following equipment segments:

- Softswitch architecture
- Softswitch/MGC
- VoIP gateways
- Voice application servers
- IP/signal transfer point (STP)
- IP Centrex platforms
- Multiservice switches (MSSs), including traditional or legacy ATM and frame relay switches (backbone multiservice platforms [BMSPs])

- Service provider routers (SPRs)
- Signaling gateways

4.2 Market Quantification

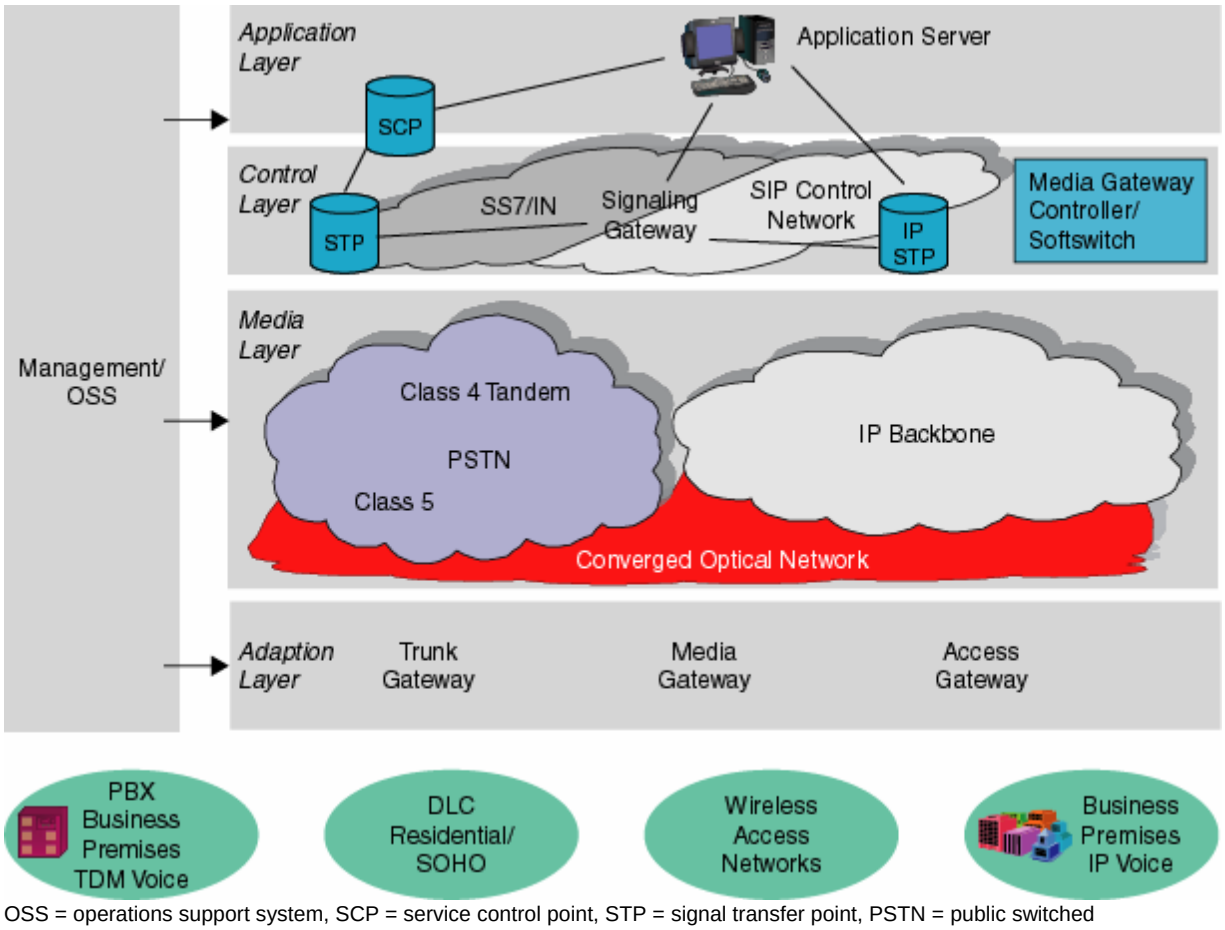
To quantify the market, next-generation switching systems are measured in the following terms:

- Total revenue — Manufacturer revenue from equipment or system sales. Service-related revenue, such as installation, commissioning, training, technical support, spares and repairs, and power, are excluded.
- Shipments include license, unit or port shipments from the manufacturer.
- Average price is the average selling price per license, per unit or per port.

4.3 Network Topology

Network topology is shown in Figure 1.

Figure 1. Network Topology



OSS = operations support system, SCP = service control point, STP = signal transfer point, PSTN = public switched telephone network, SS7 = Signaling System 7, IN = intelligent network, PBX = private branch exchange, TDM = time division multiplexing, DLC = digital loop carrier, SOHO = small office/home office

Source: Gartner Dataquest (April 2005)

4.4 Softswitch Architecture

Softswitch architecture comprises softswitches/MGC, VoIP gateways and application servers. These are among the terms used to identify the major network elements of the softswitch architecture. For our purposes, softswitch and softswitch architecture refer to the softswitch/VoIP gateway/application server approach to distributed switching technology. Softswitch in the cable network is the same product as for the traditional telephone company; however, it must comply with the next-generation Cable Television Laboratories (CableLabs) standards for packetized voice-over-cable networks. CableLabs is located in Louisville, Colorado.

The softswitch architecture provides two major advantages over the public switched telephone network (PSTN) technology and economics. The first is the openness between the subelements of a next-generation switch (media gateway, MGC, SG and application server). This openness promotes the ability to mix components from different vendors, which gives service providers greater flexibility. This model allows a service provider to buy a media gateway, softswitch/MGC, SG and application server from any vendor it chooses. Many of the vendors manufacturing the softswitches manufacture the media gateways and sell them bundled, while others sell them as integrated softswitch/media gateway components. The other components making up the architecture are manufactured by other vendors. However, most of the sales are from one or the other, which is why interoperability is so important. With the migration to SIP, the softswitch architecture renders itself to the Third Generation Partnership Program (3GPP) standards to develop IMS-compliant applications.

The second major advantage is that softswitch architecture claims to offer a faster return on investment and operating expenditure savings. The systems run more efficiently, expand geographical coverage and are far less costly than TDM equipment maintenance and upgrades.

4.4.1 Softswitch

The softswitch is often visualized as the way to provide service without a physical switch. The softswitch is connected to a server (for example, Sun Microsystems or Unix), which runs the application. It is connected to a media gateway, which is the element that connects physically to the PSTN, IP or ATM network.

Known as a call agent, call server or MGC, a softswitch is a device that provides the traditional call control functions of a Class 4 and Class 5 switch. At a minimum, a softswitch provides the following:

- Intelligence that controls connection services for a media gateway or native IP endpoint.
- The ability to select processes that can be applied to a call.
- Routing for a call in the network, based on signaling and customer database information.
- The ability to transfer control of the call to another network element.
- Interfaces to, and support for, management functions, such as provisioning fault-tolerant billing.
- Support for multiple protocols including some subsets of MGCP, media gateway control (MEGACO), SIP, SS7, call processing language, H.323 and Q.931/Q.2931.
- DiffServ, Resource Reservation Protocol, Real-Time Transport Protocol, Real-Time Control Protocol, MPLS and 802.11p.

- Complies/interoperates with some subsets of standards from ITU, Internet Engineering Task Force, Frame Relay Forum, ATM Forum and Institute of Electronic and Electrical Engineers.

Examples of vendors and their softswitch products include:

- Siemens — SURPASS HhiQ 8000 Softswitch/CMS
- Nortel Networks — SuccessionCS2000 (-cCompact)
- Ericsson — ENGINE mMultimedia softswitch, and ENGINE Integral
- Alcatel — "OPEN" 5020 Softswitch
- Lucent — LSS (Lucent Softswitch) and Lucent Session Manager
- UTStarcom — iPAS
- Huawei — SoftX3000
- ZTD — CXSS10 SS1
- Sonus — GSX-GC, Insignus
- Cirpack — Cirpack TN, Cirpack LEN and Cirpack MultiNode (integrated SS/MG)
- Cedar Point— SAFARI C3 (integrated SS/MG/MGC/SG)

4.4.2 Media Gateways

A gateway is an infrastructure network element that converts one or more input protocols or media to one or more output media or protocols for the purpose of transporting network consolidation. A media gateway provides seamless interworking of voice connections between the PSTN and IP/MPLS or ATM networks. Media gateways support VoIP, Voice over ATM (VoATM) or both. The media gateway manages the quality of service (QOS) to ensure that voice traffic has priority and users receive "toll quality" voice service. Manufacturers' revenue is used as a reporting metric.

4.4.2.1 Access Media Gateway

An access media gateway (AMG) serves as the bridge between the circuit-based voice switch and the packet-based IP or ATM access network. AMG takes care of the PSTN-to-packet network transition at the local loop level and is connected to the local exchange or an access node. It has Class 5 switch interfaces and supports VoIP, VoATM or both. Included in the AMG segment are inverse access media gateways, which make the transition from packet-access domain — DSL, cable hybrid-fiber coax, powerline and local multipoint distribution service — to a PSTN Class 5 local exchange via Generic Requirement (GR)-303 or V5.x interface.

Examples of several media gateways are shown in Table 1.

Table 1. Examples of Access Media Gateways

	Gateway
Nortel Networks	MG 9000
Siemens	hiG 1600
Alcatel	7510, 7515

	Gateway
Huawei	UMG 8900
Lucent	PacketStar PSAX Multiservice Media Gateway
Ericsson	Telephony access gateway

Source: Gartner Dataquest (April 2005)

4.4.2.2 Signaling Gateway/IP-STP

This is a next-generation network component, facilitating the crossing of a policy boundary or performing protocol conversion. Next-generation network IP-STP products include products using protocols such as SIP, SIP-T, Parlay, electronic numbering (ENUM) and XML. Signaling gateways use SS7 and SigTran protocols.

Examples of vendors and products include:

- Performance Technologies — SEGway
- Nortel Networks — Signaling Gateway
- Intel — SG430
- Tekelec — EAGLE 5
- Lucent — iMerge network-based call signaling gateway

4.4.2.3 Trunk Media Gateway

A trunk media gateway (TMG) serves as the bridge between the circuit-based trunk switch and packet-based IP or ATM backbone network. In certain implementations, it will completely bypass the tandem switch (Class 4). It takes care of the PSTN-to-packet-network transition at the trunk level and is connected to the local or trunk exchange. A TMG has a Class 4 interface and supports VoIP, VoATM or both.

Examples of TMGs include:

- Nortel Networks — Passport PVG, Succession MG 4000
- Sonus — GSX9000
- Huawei — UMG 8900, Cirpack PTG
- Siemens — hiG 1000, 1100, 1200 and 1600

4.4.3 Voice Application Servers

Voice application servers consist primarily of software, operating on Sun Microsystems or Linux servers located in the service provider network, and functioning in conjunction with other standard network elements such as routers, gateways, integrated access devices (IADs) and telephones. This category is made up of IP/SCPs and IP Centrex platforms.

4.4.3.1 IP-Service Control Point

The IP-service control point (SCP) is a carrier-grade application server using industry-standard hardware, operating systems, open standards and protocols. The application server normally incorporates a real-time database and service logic execution functionality (also known as call

triggers via the service switching point [SSP]), facilitating applications. The application server includes provisioning interfaces.

Examples of application servers include:

- BroadSoft BroadWorks
- Sylantro
- VocalData VOISS
- Cisco CallManager
- Nortel MCS application server
- LongBoard Multimedia Application Platform (LMAP)
- Tekelec 100 application server

4.4.3.2 IP Centrex Platforms

IP Centrex platforms offer a broad range of private branch exchange (PBX) replacement and new services. These products typically work with a variety of end-user devices and interfaces, including analog and digital phones, IP desktop phones, personal digital assistants (PDAs) and mobile phones, all of which are widely used in the enterprise.

These platforms offer a wide range of enhanced features that includes unified messaging, including visual voice mail; click to talk; enhanced find-me/follow-me capabilities; outlook integration, with "click to call" features; returning calls and voice mail from a browser; Web-based call management to monitor and control service features and capabilities; automatic call distribution capabilities; selective call acceptance; collaborative applications; presence management and instant messaging.

Vendors and products in the IP Centrex platform space include:

- NetCentrex CCS softswitch
- BroadSoft BroadWorks
- Sylantro application server
- VocalData application server
- Tekelec 6000 application server

4.4.4 Intelligent Peripheral (Media Server)

An intelligent peripheral is a stand-alone processor coupled with a switch to provide functionality to the SSP. Examples include automated recorded announcements, interactive voice response systems and speech recognition. Intelligent peripheral functionality is being integrated into media server equipment and will be counted in the media server segment.

Media servers are used for voice services and use control protocols, such as MGCP or MEGACO, under the control of the call agent (also known as softswitch/media gateway controller) or application server. Some of the functions provided by media servers include support for three-way calling, playing announcements, fax processing, interactive voice response (IVR) processing and voice activity detection. The media server's function may overlap access gateway functions,

and the elements can be combined. The media server can also be combined with a trunk gateway, signaling gateway or call agent (also known as a softswitch/media gateway controller).

Examples of media servers include:

- Convedia CMS-6000 and CMS-1000
- snom 4S media server
- AudioCodes' IPmedia 2000, 3000, 5000 and 8000 platforms

4.4.5 Session Border Controllers

Session border controllers connect IP networks (enterprise to service provider) and introduce new edge requirements in three major areas — security, service assurance and law enforcement. Session border controllers sit at the edge of the provider's network and complement established routers by their ability to perform required control functions via integrating session signaling and media control. Session border controllers operate as SIP back-to-back user agents, MGCP proxy/network address translations (NATs), and/or H.323 back-to-back gateways and are both the source and destination for all signaling messages and media streams coming into and leaving the provider's network.

Vendors and products in this area include:

- Tekelec Session Border Controller
- Acme Packet Net-Net Session Director
- Ditech PeerPoint
- Netrake nCite Session Controller
- LongBoard Centrex LMAP
- Juniper VoiceFlow
- MediaRing VoizBridge
- NexTone Communications Multiprotocol Session Controllers
- Quintum Technologies Tenor Call Relays

4.4.6 Multi-Service Switch

Multi-service switches (MSSs) are primarily ATM cell-based, Open Systems Interconnection (OSI) Layer 2 switching systems capable of supporting a variety of network edge service interfaces such as frame relay, Ethernet, IP, synchronous digital hierarchy (SDH), Synchronous Optical Network (SONET) and various ATM classes of service such as switched virtual circuits (SVCs) and private virtual circuits (PVCs) on a variable or fixed-rate basis. MSSs also possess strong traffic management, class of service, aggregation, buffering and multiplexing capabilities. Most are carrier-class products, meaning they are fully redundant, fault-tolerant and conform with NSP support systems. Key characteristics include the ability to support IP, ATM, frame relay and MPLS on a single platform, with carrier-class reliability, availability and maintainability, as well as the ability to provision a broad range of switched and routed services over any access mechanism through legacy and IP interfaces. In general, MSSs support SONET/SDH, DS3/E3, T1/E1 and 10/100/1000 Ethernet. These scalable platforms often allow for throughput from 50 Gbps to 500 Gbps.

A mature market, NSPs around the globe have deployed extensive ATM networks as the foundation for their data service offerings. Carrier-class enterprises have deployed MSS as well for their own private converged networks. The MSS segment is expected to be gradually displaced by IP-based multiservice edge gear, which better utilizes IP/MPLS architecture, over the forecast period.

4.4.6.1 Core MSS

Formerly known as BMSP, core MSSs are used to interconnect Edge MSS and/or legacy frame relay switches with high-speed ATM/SDH-SONET interfaces. To be classified as a core MSS, adaptation interfaces do not have to be present. However, the device must permit high-speed switching/throughput while providing differentiated classes of service and appropriate QOS.

This segment is in decline, with increasing use of IP/MPLS edge routers to interconnect edge MSS. This is because ATM technology couldn't scale to projected traffic levels and NSP interest in converging on IP/MPLS technology. As a result, most vendors have retrofitted their core MSS with adaptation interfaces to function as higher-capacity edge MSS.

4.4.6.2 Edge MSS

Edge MSSs reside at the edge of the data network where data service interfaces and protocol translation and aggregation capabilities are needed the most. Formerly known as ATM switches, MSSs have evolved to support and interwork frame relay, transparent LAN and ATM services for enterprises, aggregate and data traffic management Layer 1 access technologies, such as DSL digital subscriber line access multiplexers (DSLAMs) and fiber to the x (FTTx) optical network units (ONUs), and also to multiplex mobile backhaul circuits. Sample vendors and products include:

- Alcatel (Newbridge) 7470, 7670
- Ciena (WaveSmith) DN series
- Cisco (StrataCom, Sentient) MGX, BPX
- Lucent (Ascend) CBX series
- Nortel MSS series
- Tellabs (Vivace) MSR

4.4.7 Carrier Grade Ethernet Switches (10-Gigabit Ethernet Switches and Layer 2 Switches)

New Institute of Electronic and Electrical Engineers (IEEE) Ethernet standards and gigabit transceivers have made Gigabit Ethernet switches possible. By offering an order of magnitude and more bandwidth than Fast Ethernet, Gigabit Ethernet switches have proved popular with businesses that are beginning an Ethernet switch replacement cycle. Recognizing the value of carrier-class features to businesses needing to support mission-critical applications, several Gigabit Ethernet switch vendors have developed products intended for sale to NSPs interested in offering Metro Ethernet service. Pioneer service provider Yipes offered a public Gigabit Ethernet service, as have several NSPs in Asia/Pacific. Public Gigabit Ethernet/Metro Ethernet doesn't require the support of costly SDH, SONET or ATM layers and is suited for deployment alongside legacy service provider access networks.

However, most incumbent carriers are focused on a converged network model, in which all services share an IP/MPLS network, making the prospect of adding another network for Gigabit

Ethernet unattractive. Given that incumbent providers' public Ethernet business cases are predicated on lowered operating expenditures, and Gigabit Ethernet switches are primarily Layer 2 devices, adoption has been slow. NSPs seem more interested in IP-based multiservice edge products that can support both public Ethernet and traditional services over a converged architecture. Legacy-free competitive carriers have different requirements.

Carrier-grade Ethernet switches are Ethernet switches that have been designed with extensive redundancy to meet tough NSP requirements for reliability, fault tolerance, in-service upgrade, thousands of service-level agreement (SLA)-based customers and support system compatibility. The Metro Ethernet Forum is the main advocate for Metro Ethernet service. Example CGES vendors and products include:

- Alcatel — Omni
- Cisco Systems — Catalyst
- Enterasys — Matrix
- Extreme — Black Diamond
- Force 10 — Foundry, Nortel Networks and Riverstone RS

4.5 Routers

Routers are a class of network controller that determines the best routing for data and voice transmission between a transmitter (sender) and receiver. Routers are typically software-controlled and can be programmed to provide the most inexpensive, fastest or least-busy available routes. Routers operate at Layer 3 of the International Standards Organization-Open Systems Interconnection model. This definition concerns service provider routers only.

4.5.1 High-End Routers

These are routers that are typically configured with a minimum of 24 LAN and 24 WAN ports. These devices incorporate multiple media, such as Ethernet, Fast Ethernet, token ring, Fiber Distributed Data Interface (FDDI) and ATM. These devices address the needs of fault tolerance, such as the provisioning of dual-power supplies, hot-swappable cards and redundant buses. An example of a high-end router would be the Cisco 7500. High-end routers are shipped primarily to businesses, but the portion shipped to service providers is included in SPR statistics. The remainder is reported in the enterprise statistics.

4.5.2 Service Provider Routers

Service provider routers are capable of providing multigigabit bandwidth in support of high-speed WAN interfaces. These devices are typically designed for installation in the Internet and support only the IP suite. Supported media types include ATM (OC-3, OC-12 and OC-48), IP over SONET, and high-speed serial interface. Future generations will support wave-division multiplexing interfaces.These devices address the needs of fault tolerance, such as the provisioning of dual-power supplies, hot-swappable cards and redundant buses.

4.5.3 Core Routers

These routers support the IP/MPLS core and have at least 40 Gbps of switching and 40 Mbps of forwarding capacity, and are designed to handle multiple OC-48s and OC-192s for operating the in-service provider's IP core backbone. They handle a subset of edge routers' protocols, such as weighted fair queuing (WFQ), BGP-4, IS-IS, weighted random early detection (WRED) and

MPLS. Examples of core routers include the Cisco CRS-1, 12000, Juniper M160, M320, T640, Avici and Chiaro.

4.5.4 Edge Aggregation Routers

Edge aggregation routers have variable switching capacity, because they can handle thousands of channelized TDM interfaces to DS-0s and support the delivery of multiple IP services. They handle broadband aggregation, leased-line aggregation, advanced IP services and virtual private networks (VPNs). They support the following service provider router protocols: WFQ, BGP-4, IS-IS, WRED, access control lists, MPLS VPN and IPsec. They have subscriber management, bandwidth management, IP switching and VPN provisioning capabilities and additionally support IP/MPLS and Layer 3 traffic aggregation.

Examples include:

- Cisco 7206, 7500, 7600, 10000, 12000
- Juniper M5, M10, M20, M40, M10i, M7i, M40e
- Ericsson AXI 540
- Hitachi GR2000-4S, -2S, -20H, -10H and -6H
- Huawei Quidway NetEngine 08, 16, 50, 80
- Fujitsu R920, R940
- NEC CX4210, CX4220, CX5210, IX5010 and IX5020

4.5.5 Broadband Aggregation/IP Service Routers

Broadband aggregation/IP services routers are a subset of edge routers. They are aggregation and termination systems that accept a high concentration of data traffic from multiple xDSL access multiplexers, cable modem termination systems, wireless headends, dial-access concentrators and routers. In addition to aggregation and termination, these systems offer the following subscriber management services:

- Differentiated classes of service, different priority levels for different classes of network users, dynamic selection and delivery of network services, QOS for data, voice and video applications, and user-based billing.
- Security and random authentication, troubleshooting and remote diagnostics, network management, managed firewalls and secure VPNs. Examples of broadband aggregation systems include: Nortel/Shasta 5000 and Redback SMS.

4.5.6 Multiservice Edge Router

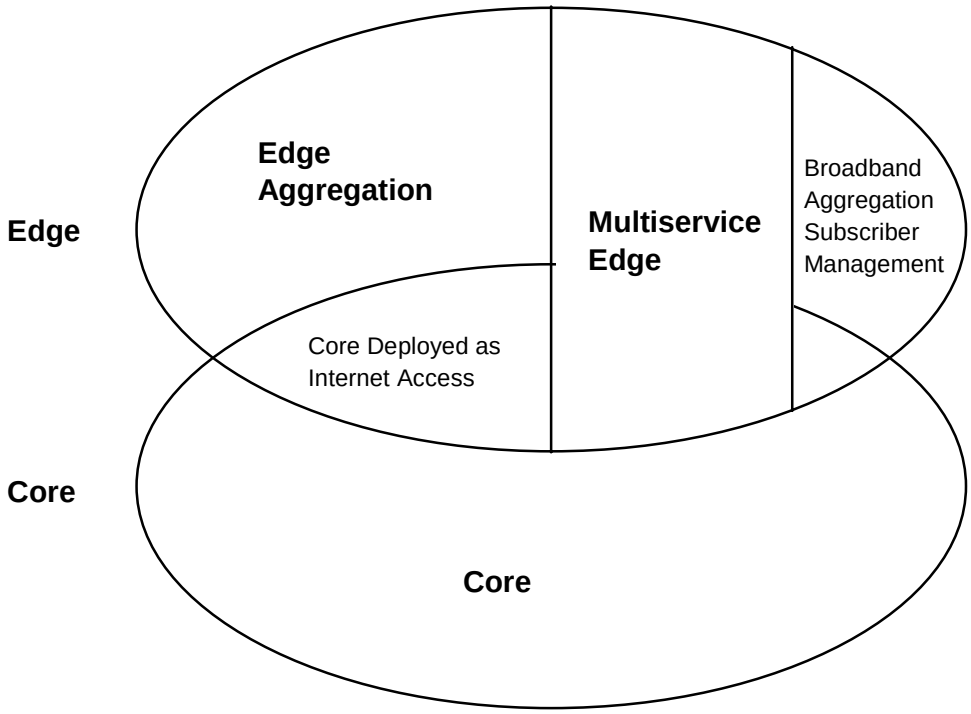
Multiservice edge routers are an emerging category of convergence-class edge routers, which function as IP/MPLS label edge routers and are capable of supporting convergence of disparate traditional networks. Multiservice edge routers have evolved to incorporate multiple services and handle packet processing of ATM/frame relay, Layer 2 and Layer 3 VPNs, leased lines, video applications, broadband aggregation, Ethernet and voice applications. Multiservice edge routers support virtual private LAN service (VPLS) (Lasserre-vKompella) and all major routing protocols and have a virtual IP/MPLS control plane. Multiservice edge routers are a subset of the edge router category.

Examples of multiservice edge routers include:

- Alcatel 7750
- Cisco 7600 with OSM interface and Cisco 12000
- Laurel ST
- Juniper M320
- Nortel MPE 9000
- Tellabs MSR 8800
- Riverstone 15000, RS series
- Redback SmartEdge Router

Figure 2 shows the evolved edge segmentation, which includes a new category of the multiservice edge router. Traditional edge routers will still be tracked and the broadband aggregation and multiservice edge router categories will be broken out as a subset of the total edge market.

Figure 2. Router Segmentation



Source: Gartner Dataquest (April 2005)

4.6 Current-Generation Switching

A current-generation central office (CO) switching system is a circuit-oriented switching system that serves the following functions:

- Interconnects local telephone lines
- Connects local telephone lines to junction or long-distance trunk circuits
- Interconnects trunk and junction circuits

A local CO switch carries out the first two functions. A transit (tandem or trunk) switch carries out the third function. Some CO systems can act as a combined local and transit switch. This analysis excludes mobile cellular switching systems.

4.7 Market Quantification

To quantify the market, systems are measured in the following terms for line shipments:

- Local systems — This is the connection capacity in terms of the quantity of analog or digital local lines, as well as Integrated Services Digital Network (ISDN) B-channels that are terminating on the switch.
- Transit/trunk systems — This is the connection capacity in terms of the quantity of lines terminating on the switch (trunk or junction circuits). This includes trunk lines on a local switch as well as a tandem switch. This does not include trunk lines terminating at a digital local-loop carrier.

4.8 Revenue

CO switching revenue covers equipment or system sales but excludes service-related business, such as installation, commissioning, training, technical support, spares and repairs, and power. Equipment/system revenue includes local line/transit/trunk shipment revenue, which is revenue for the connection capacity provided in terms of the quantity of analog or digital local lines, as well as ISDN B-channels terminating on the switch.

This includes trunk lines on a local as well as a tandem switch. This does not include trunk lines terminating at a digital local-loop carrier. Upgrade revenue comes from software and hardware that are intended to upgrade the functionality of a Class 5 switch.

This category includes the following:

- Online service systems/telecommunications management networks/operations and maintenance cost.
- Buffers for billing.
- Broadband/data.
- DSL, including changes in line interfaces, but not the physical DSL port.
- Exchanges of trunks and cross-connects with direct fiber interfaces.
- Integrating broadband ability and interfaces (ATM and frame relay).
- Integrating IP interfaces/GR-303 connectivity.
- Intelligent network upgrades.
- Adding/replacing hardware for upkeep, including regulatory switch software upgrades.
- Changing links, especially SS7 links.

- Expenditure for software licenses.
- Changing line interface.
- Adding hardware capacity.
- Adding/replacing hardware for upkeep.
- Growth toward system capacity — Revenue from equipment intended to bring the switch to its nominal capacity.
- Transition/evolution — Revenue from adjunct and peripheral servers, as well as cabinets or modules that add next-generation functionality to switches that are in service, resulting in the distribution of the switching architecture that is found in circuit-to-packet evolution switches.
- Other upgrades.

The outcome of the carriers' efforts to pursue convergence of traditional TDM-based networks to an architecture with streamlined ATM- and IP-based voice, data and multimedia traffic are integrated and multifunction switching products. Telecom equipment vendors design these products primarily to do the following:

- Provide end users with solutions that offer bit-wise economy of scale.
- Facilitate a seamless technology migration path for carriers with incumbent network architecture toward next-generation, packet-based architecture concepts.
- Allow the collapsing of network overlay layers to yield operational cost savings, as well as streamlined service provisioning, troubleshooting and customer service management.
- Support "greenfield" deployment by alternative operators or competitive local exchange carriers by offering scalable switching solutions, following the pay-as-you-grow principle, in terms of subscriber numbers and types of services offered.
- Change focus from the technology layer (ATM, TDM or IP) to more revenue-oriented application layers, facilitating service offerings, such as voice over DSL (VoDSL), IP Centrex and VPNs.

5.0 Signaling

5.1 Service Control Point

SCPs are databases that provide a centralized element in the network for service delivery to end users. These databases store IN service logic that is used to provide IN services. Service logic can consist of call routing information, the location of other IN components or instructions for other IN components. Through the use of this service logic, SCPs provide the information necessary for advanced call processing and IN capabilities. SCPs communicate with other network elements over the SS7 network. These communications occur via IN-standardized protocols or by a vendor's or service provider's proprietary protocols.

SCPs have two basic parts. One is the application functionality in which service logic is installed after a service has been created. The application functionality sits on top of the second basic SCP part, which is a set of generic platform functionalities that are provided by SCP vendors. The SCP is connected to the switching system via the SS7 network. SCPs are usually deployed in mated pairs to increase performance and provide redundancy.

5.2 Service Management System

This is the operation management system that supports service creation, testing and provisioning. It is used to update changes to the system, including the introduction of IN service offerings and account information regarding a user's IN services.

5.3 Service Creation Environment

The tools that build the representation of the call flow for each individual customer is the service creation environment (SCE). Many IN software vendors offer service creation software with graphical (icon-based) interfaces to eliminate the need for traditional programming methods. Service providers can use SCEs to quickly and easily create services, customize services to meet their emerging needs or both. An SCE is associated with traditional and next-generation networks. Next-generation network SCEs include those products using protocols including Java-advanced INs, Parlay, HTML and Extensible Markup Language (XML).

5.4 Service Node

Service nodes incorporate the functionality of the SCP with intelligent peripheral functionality.

5.5 Service Switching Point

SSPs are telephone switches equipped with IN software that terminates signaling. To deploy IN services across a carrier's network, the carrier must update its switches to give them SSP functionality (the ability to detect incoming IN calls and begin IN call processing). In a wireless network, the mobile switching center (MSC) provides the SSP function. The SSP provides end users with access to the network and performs any necessary switching functions. The SSP allows access to a set of IN capabilities. The SSP is programmed with the ability to detect requests for IN-based service and establish communications with the IN service logic located at the SCP or IP.

5.6 Signal Transfer Points

STPs are packet switches of the SS7 network. They receive and route incoming signaling messages toward the proper destination and perform specialized routing functions. STPs are usually deployed in pairs for higher performance and redundancy. STPs can also be outfitted with service logic capability and databases to deploy applications, primarily local number portability (LNP) to reduce signaling traffic to the SCPs.

5.7 Location Registry for Wireless Networks

These are used to supplement MSCs with information about a particular subscriber. The number of subscribers that each MSC supports changes as subscribers roam through a wireless service provider's network. Therefore, the database of subscribers can change dramatically. Location registries help MSCs manage subscriber data as subscribers roam. The types of location registries are visitor location registry (VLR), home location registry (HLR) and home subscriber service (HSS). An HLR is a database in the subscriber's home area that contains his or her given service information and usage record. Each subscriber is associated with a single HLR.

VLRs accesses a subscriber's information from an HLR while the subscriber is roaming. The VLR is usually at the given MSC in which the subscriber is roaming. The VLR obtains the information on the subscriber by querying the HLR via the SS7 network.

An HSS is a database used to store IMS subscribers information as well as applications data. It can be deployed as a stand-alone network element or in a hybrid combination of HLR/HSS.

6.0 Access Network Systems

The market continues to see transformation as service providers advance their access network architectures to support an increasing range of services toward triple-, and, ultimately, quadruple-, play of multichannel video, broadband data, and wired and wireless voice.

Gartner Dataquest surveys the market for broadband access products and technologies, including central office/headend broadband access platforms and customer premises equipment (CPE). Products, technologies and market segments are included in the sections as follows:

- Total broadband access systems
  - ATM
  - IP
- Multiservice platforms
  - Purpose-built platforms (IP DSLAMs, IMAP)
  - Evolutionary platforms (from DLC)
- Dedicated
  - Fiber in the loop (FITL)
  - Wireless BB
  - Cable
  - FSO
  - ATM DSLAMs (dedicated for DSL delivery)
- DSL
- FITL
- Cable
- Wireless
- FSO

6.1 DSL

DSL-based access networks provide significant competition to cable broadband access networks in North America, while being the dominant broadband access modality in all other regions of the world. DSL-based access networks also form the underpinning for most carrier multiservice networks around the world.

6.1.1 DSL Technologies

6.1.1.1 Asymmetric DSL

Asymmetric DSL (ADSL) offers downstream maximum data rates up to 9 Mbps on short loops.

6.1.1.2 ADSL2

Among other improvements over basic ADSL, ADSL2 offers downstream maximum data rates up to 12 Mbps on short loops, and extends ADSL's reach about 600 feet.

6.1.1.3 ADSL2+

Among other improvements, ADSL2+ doubles the downstream frequency compared with ADSL2 and enables maximum downstream data rates over 25 Mbps on short loops.

6.1.1.4 Global Standard High-Bit Rate DSL

Global.standard high-bit rate DSL (G.SHDSL) offers maximum data rates up to 2.31 Mbps over a single copper pair and up to 4.6 Mbps over two pairs.

6.1.1.5 Very High-Bit Rate DSL

Very high-bit rate DSL (VDSL) offers speeds from 13 Mbps up to a maximum of 55 Mbps over distances between 1,000 and 4,500 feet — the shorter the distance, the higher the speed. VDSL comes in both asymmetrical and symmetrical flavors.

6.1.1.6 Others

Other technologies include IDSL and other proprietary DSL technologies.

6.2 DSL CO Equipment

DSL CO equipment refers to the carrier network as opposed to CPE side of DSL terminating equipment. This equipment can be located in the CO, a remote terminal or in a basement of a multiple tenant unit/multiple dwelling unit (MTU/MDU). Revenue and port shipments include all DSL line cards, irrespective of location and the platform they are deployed on. Product examples of DSL CO equipment include:

- Alcatel — ASAM, Litespan, ISAM
- Siemens — XpressLink, SURPASS hiX/5300/5500
- Lucent — Stinger, DSLTNT, DSLMAX 20, AnyMedia
- Huawei — SmartAX series
- ZTE — ZXDSL series, ZXA10 MSAN
- ZyXEL — ALC, SLC and VES
- UTStarcom — AN-2000 IP-DSLAM series
- ECI — HiFOCuS platform
- Fujitsu — FDX, GeoStream access gateway
- Paradyne — Bitstorm, Mini DSLAM, 8000 and 12000 and 4000 BLC platforms

6.3 DSL CPE Units

DSL CPE are units that sit at subscriber premises, including the home, business, or other end-user locations receiving xDSL-based broadband service. Gartner Dataquest defines and surveys for the types of DSL CPE products described in the following sections.

6.3.1 CPE Internal Modem

This modem is placed inside a PC. It is not a Personal Computer Memory Card Industry Association (PCMCIA) card (PC card).

6.3.2 CPE External Stand-Alone Modem

This modem does not go inside a PC, but has its own external casing and power supply and is connected to the PC via some type of cabling.

6.3.3 CPE Business DSL Router With Embedded DSL Modem

This is a business-class router similar to an external xDSL modem, but includes additional routing functions. It can be a wired device or include a wireless access point.

6.3.4 Residential/Small Office Gateways/Router With Embedded DSL Modem

This device is part of the home networking solution for residential consumers, but can also be used in the small office/home office (SOHO) environment. It can be a wired device or include a wireless access point. Most residential/SOHO gateways incorporate a built-in DSL modem, routing functionality, and wireless access points and firewalls.

6.3.5 DSL/Cable-Sharing Residential/Small Office Gateways/Router

These devices can be wired or wireless. Similar to residential gateways/routers mentioned previously, this device does not have an integrated DSL modem. It is distinguished by its ability to work with different types of broadband distribution networks, such as cable or DSL, and, therefore, will have a port allowing for a connection with the output of an external modem (either DSL or cable).

6.3.6 Voice Enabled-Residential/Small Office Gateway/Router With Embedded DSL Modem

This device, also referred to as a xDSL IAD, is part of the voice-over-DSL solution. It enables the bundling of multiple derived voice lines, high-speed data and continuous Internet access over a single DSL connection. It typically combines a DSL modem with a router, firewall and varying plain old telephone service (POTS) port configurations. It can be a wired device or include a wireless access point.

Examples of DSL CPE vendors and solutions include:

- Thomson — SpeedTouch series
- Siemens — SpeedStream series
- 2Wire — HomePortal; OfficePortal series
- Zyxel — Prestige 650, 660 series
- Westell — LiteLine, ProLine, UltraLine, VersaLink, TriLink and Media Gateway

In addition to the previously described devices, in Gartner's DSL survey we include a survey for:

- Secure broadband router — VPN enabled.
- Managed router supporting internal or external xDSL or cable modems (external via an Ethernet WAN point-to-point protocol over Ethernet [PPPoE] port) with IP security (IPsec) 3DES VPN at wire speed for the WAN interface. Supporting up to 10 VPN

tunnels and WAN speeds from 512 Kbps to 10 Mbps. May also have dial/ISDN backup port. May also include stateful firewall capabilities, but must provide at least equivalent stateful firewall throughput as the 3DES VPN throughput.

6.4 HDSL, HDSL2 and HDSL4

High bit-rate digital subscriber line (HDSL) enables full-duplex transmission at up to 2 Mbps over ordinary copper twisted pairs in unshielded cable. HDSL products can use up to three copper twisted pairs for transmission. Some products using this technology offer 10 to 12 POTS connections over a single copper pair instead of a T1/E1 interface. These systems are included in this segment.

HDSL2/HDSL4 is an industry-supported standards initiative by the American National Standards Institute (ANSI). The standards-based technology uses one or two copper twisted pairs and is spectrally compatible with T1 alternate mark inversion (AMI) and HDSL in the same bundle.

Products incorporating HDSL2 show a high tolerance for crosstalk from services of adjacent cable pairs, such as ADSL, HDSL, ISDN and T1 AMI. It includes power backup features to reduce interference to other services. HDSL2 products are based on overlapped pulse amplitude modulation (PAM) transmission with interlocking spectra and a 16-PAM line code.

Gartner Dataquest counts HDSL and HDSL2/HDSL4 systems, in which a system comprises headend equipment (located in a CO or street-side cabinet) and subscriber-end equipment (often located at the customer's premises). Gartner Dataquest does not count the number of copper twisted pairs or lines used by the HDSL systems or the number of subscribers connected because these are likely to be different.

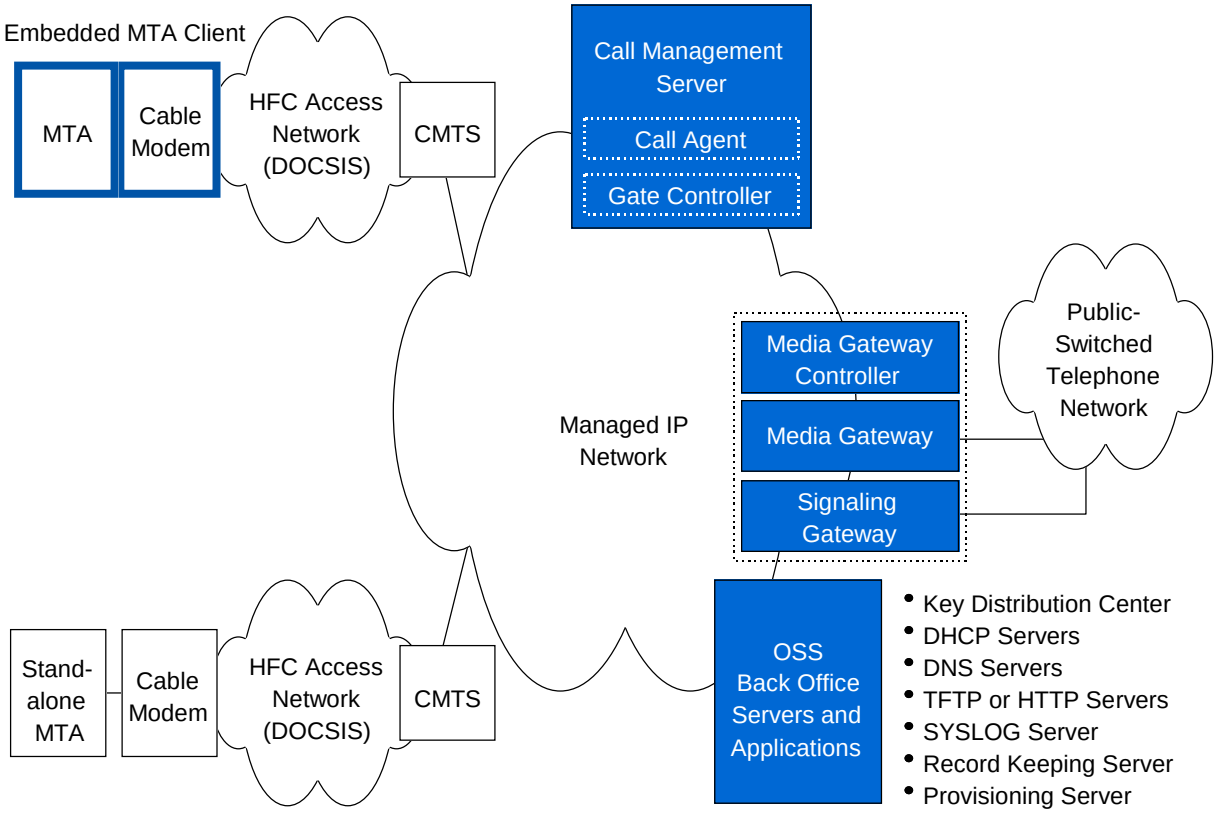
6.5 Cable Broadband Access Systems

Cable system operators are the dominant broadband access service providers in North America and are a significant competitor to carrier DSL services in many other parts of the world. Cable broadband access services are delivered over hybrid fiber/coaxial (HFC) cable networks. An HFC system comprises a headend unit, which is connected via fiber to one or more remote terminals or optical fiber nodes, which are connected to subscriber CPE such as set-top boxes (STBs), cable modems or voice multimedia terminal adapters via coaxial cable to the end-user location.

Downstream data rates for cable modem traffic range from 5 Mbps to 38 Mbps, depending on the Data-Over-Cable-Service Interface Specification (DOCSIS) version of the modem and modulation techniques used. Upstream data rates range from 1 Mbps to 5 Mbps, but many cable data service providers cap or limit upstream data throughput rates to between 256 Kbps and 384 Kbps.

Figure 3 provides an overview of a typical cable broadband HFC network supporting video, PacketCable voice and DOCSIS-based high-speed data services.

Figure 3. Cable Broadband HFC Network



Source: Gartner Dataquest (April 2005)

6.6 Cable Modem Termination System

The cable modem termination system (CMTS) is the primary broadband access routing and aggregation equipment located in the headend or distribution hub of the cable communications system. It interfaces with the CPE cable modem device over the two-way HFC network and creates a virtual LAN-like communications link.

In most cases, the CMTS includes some combination of router, modulator and line cards that fits into a chassis. It allows high-speed communications to be sent from the Internet or intranet backbone data network to the local access cable network over a 6MHz cable channel in North America or 8MHz in Europe. Some vendors use a combination of Layer 2 bridging and switching technology instead of a Layer 3 router, or they connect the CMTS to a separate router.

Most CMTS equipment is based on the CableLabs standard DOCSIS 1.1 or 2.0. CMTS incorporates Layer 2 switching and Layer 3 routing, in addition to broadband cable Internet access aggregation, QOS and data prioritization tools.

Examples of CMTS vendors and their solutions include:

- ARRIS — C4 and C3
- Motorola — BSR 64000 and BSR 1000
- Cisco Systems — uBR 7100/7200 VXR, uBR10012

- BigBand — Cuda 12000

6.7 Fiber Nodes in HFC

In an HFC system, the optical node is the demarcation point where the fiber-optic cable terminates and the coaxial cable starts and terminates at the customer premises subscriber location.

The node converts optical or light impulses to radio frequency (RF) signals for transmission or delivery over coaxial cable to the customer premises device on the downstream path. On the upstream, it converts RF signals to optical signals for transmission back to the distribution hub or head end. The fiber functionality of HFC is counted in fiber revenue and CMTS in cable revenue.

6.8 Downstream and Upstream Channels

Cable network services are delivered via 6MHz channels: one downstream channel and one or more upstream channels. For data services, the downstream channel occupies the equivalent space of a single television transmission channel in the cable operator's channel lineup. It is the communications path from the cable system headend down to the end-user CPE, which include a cable modem device or DOCSIS set-top gateway (DSG) with embedded cable modem.

Upstream channel is the communications return path from the end-user CPE (cable modem or set-top gateway) back to a hub or headend. In DOCSIS 1.0 and 1.1, upstream channels can be up to 3.2MHz wide, and deliver up to 10 Mbps per channel. In DOCSIS 2.0, upstream channels can deliver up to 38 Mbps over channels as wide as 6.4MHz. A media access control (MAC) layer coordinates shared access to the upstream bandwidth.

In the CMTS chassis or single-rack units, channel capacity is allocated in terms of line cards with ratios of 1:4, 1:6 or 1:8 downstream to upstream channels, and increasing densities that support 2:8 or more ratios of downstream to upstream channels.

6.9 Cable Modem CPE

6.9.1 Cable Modem

This device resides at the home, business or end-user location and is connected to a PC that receives cable network-based digital data communications services. Most cable modems connect to PCs through a standard 10Base-T Ethernet card or universal serial bus (USB) connection. Most of the leading vendors' standards-based cable modems incorporate Ethernet and USB in cable modems to enable fast installation.

Internal form factors for DOCSIS modems have not taken off within the industry, either in the form of an internal PCI modem card or an internal host-based, computer-controlled cable modem (CCCM). However, cable modems are being embedded in STBs and bundled together with voice signaling equipment devices that support VoIP over cable networks.

Examples of specific vendor cable modems include:

- Motorola — SB5100 DOCSIS 2.0 cable modem
- Thomson/RCA — DCM 425 digital cable modem, EuroDOCSIS TCM 420
- Terayon — TJ 700x cable modem platform
- D-Link — DCM-202 DOCSIS 2.0 cable modem

6.9.2 External Cable Modem

This cable modem has its own housing and power supply and connects to the PC via a cable. It is an end-user CPE device with 10Base-T Ethernet, USB ports, or both, and may contain network interface card functions. Gartner Dataquest surveys for all form factors of external cable modems. Most stand-alone cable modems are external devices.

6.9.3 Cable Modem Router or Cable Gateway CPE

This is a cable modem device that incorporates routing functionality, and, typically, 4-port Ethernet and USB connections plus wireless access points for home networking.

Examples include:

- Linksys — Wireless-G cable gateway (WCG200)
- Motorola — SBG900/940/1000 wireless cable modem gateway
- Thomson/RCA — DCW 725 wireless cable modem gateway

6.9.4 DOCSIS Set-Top Gateway

This device combines an advanced digital STB with an embedded DOCSIS cable modem. DSG specifies messaging transport between a cable headend and end-user CPE, including digital STBs, two-way; OpenCable Plug and Play consumer electronics devices and residential gateways. DSG benefits include improved upstream capacity and robustness by video client devices using standard DOCSIS signaling instead of proprietary, legacy methods. DSG-based signaling to the digital STB is used to support conditional access, pay-per-view/video on demand, messaging, software downloads, and new services being implemented over the cable operators' cable broadband network.

6.9.5 Embedded Multimedia Terminal Adapter

An embedded multimedia terminal adapter (eMTA) is a device that integrates into a cable modem, typically a packet cable device with RJ-45 ports supporting one or two lines of voice and an Ethernet connection to a PC. Some devices include 4 to 8 hours or more of battery backup in the form of a lithium ion or lithium polymer battery. Battery backup can also be a separate device that a service provider includes as part of the VoIP service package.

Examples of eMTA devices include:

- ARRIS — Touchstone telephony modems models TM402A, TM402B and TM402G
- Motorola — SBV5120 and SBV4200 VoIP cable modems
- Thomson/RCA — DHG525 VoIP Cable Modem
- Terayon — TA 102/202 eMTA
- Scientific-Atlanta — DPX213 and SA DPX2203
- Ambit Microsystems — U10C017

For VoIP, either cable or DSL broadband access customers can also use the devices described in the following sections.

6.9.6 MTA/ATA Devices

Multimedia Terminal Adapter (MTA) devices bring voice services into the premise over an IP network. MTAs are also known as analog terminal adapters (ATAs), which is another industry designation for a device that is essentially the same as an MTA. These devices typically support up to two telephone lines with RJ-11 connections as well as two 10/100 Base-T Ethernet ports (RJ-45) for pass-though functionality. Gartner will survey these devices in the future.

Examples of these devices include:

- D-Link — DVG-1120 VoIP gateway
- Linksys — PAP2 phone adapter with two ports for VoIP
- Motorola — VT1000 voice terminal and VT 2000 voice gateway

6.9.7 Stand-Alone MTA

This is an SIP-based device that connects to a broadband access device (DSL or cable). It typically contains an Ethernet port, and two RJ-45 connections to support two phone lines. Battery backup is not usually part of this device.

6.9.8 Gateway

The MTA gateway is a new emerging class of MTA that incorporates a 4-port wireless broadband access router with wireless access point. In the premises, it typically connects to a cable modem. This device is targeted to the established base of cable modem users who want to add both wireless networking and VoIP capability. We will survey this device in the future.

6.10 Cable Modems Standards

6.10.1 DOCSIS

Cable modem technology has converged around the worldwide standard DOCSIS and all cable modem CPE being shipped complies with some version of DOCSIS, EuroDOCSIS and J-DOCSIS. The standard was developed by worldwide vendors and the U.S. cable industry's R&D organization, CableLabs and European CableLabs, tCom Labs in Ghent, Belgium.

DOCSIS is a set of communications and operations support specifications that define the different interfaces between the RF-based cable network and consumer premises and associated cable data communications headend equipment. DOCSIS was accepted as a worldwide standard by the ITU, with regional annexes or technical variations for Europe and Japan. It enables cross-manufacturer compatibility among all brands of silicon chipsets, cable modem CPE and associated cable headend equipment. DOCSIS 1.0 is the baseline specification adopted between 1995 and 1996 and has become widely deployed around the world.

Successive versions of the DOCSIS cable modem standard govern multivendor interoperability for cable CPE and provide increasing levels of capabilities and functionality, while maintaining full backward and forward compatibility with all versions of the standard. Gartner tracks shipments of cable modems based on DOCSIS versions.

DOCSIS 1.1 specifies improved operational flexibility, security, and QOS features such as packet prioritization and packet fragmentation that enable real-time services — VoIP, interactive gaming and tier-based services.

DOCSIS 2.0 specifies an increase in upstream data speeds for more symmetrical communications and commercial services over HFC networks. DOCSIS 2.0 provides up to 38-

Mbps data rates. DOCSIS 2.0 was originally specified with two modulation scheme options — synchronous CDMA (S-CDMA) modulation and advanced frequency agile TDMA. But most cable network operators have opted not to implement both modulation schemes.

DOCSIS 3.0 is the result of development work underway in CableLabs to extend the capability of DOCSIS by widening the downstream and upstream channel paths by bonding a number of 6MHz channels together to form one large broadband tunnel. This is known as channel bonding, or wideband DOCSIS. The standard is being defined and final specification is expected in late 2005. A number of vendors plan to ship DOCSIS 3.0 equipment into the Asian marketplace prior to the finalization of the specification in 2005. This equipment would be considered pre-standard gear.

eDOCSIS is embedded DOCSIS that allows DOCSIS chipsets to be embedded into other devices, such as STBs.

6.11 Other Relevant Cable Standards

6.11.1 PacketCable

PacketCable is a CableLabs standard defining interoperable interface specifications for delivery of advanced, real-time multimedia services over two-way cable plant. It is also the key standard governing cable's VoIP-based services and defining PacketCable-based VoIP CPE such as eMTAs as well as CMTS access platforms. Built on top of the DOCSIS cable modem infrastructure, PacketCable networks employ IP technology to enable a wide range of multimedia services, such as IP telephony, multimedia conferencing, interactive gaming and general multimedia applications. Future versions of the standard, such as of PacketCable Multimedia, will be important in the support of SIP-based voice services and applications over cable broadband networks, such as videophones.

6.11.2 CableHome

CableHome refers to the CableLabs standard for home-networking equipment, mostly cable modem gateways that incorporate routing and wireless access points for cable operator managed services.

6.12 Broadband Fixed Wireless Systems

6.12.1 Sub-11GHz Proprietary BWA

Sub-11GHz broadband wireless access (BWA) systems are not Worldwide Interoperability for Microwave Access (WiMAX)-certified or 802.16-based products. They include technologies such as IP Wireless, Flarion and Iburst. In most cases, they are deployed in regions to either provide service providers with quick and easy access to business subscribers or to allow the delivery of broadband data service or fast Internet to business and residential subscribers. In addition, it enables cost-effective network access in remote rural areas. Sub-11GHz proprietary BWA systems provide more than 1 Mbps per subscriber.

6.12.2 WiMAX-Certified Sub-11GHz BWA

Gartner defines the WiMAX Forum certified sub-11GHz 802.16-2004 as well as 802.16-2005, as follows.

- Fixed wireless: client terminals are located at a stationary location.
- Semi-mobile wireless: includes:

- Portable: client terminal support for roaming between base station coverage areas at pedestrian speeds.
- Nomadic: client terminal is transportable to secondary fixed locations with no connection while in transit.
- Mobile wireless: client terminal support for roaming while connected at vehicular speeds without dropping a session.

Gartner covers the frequency ranges in licensed and unlicensed bands as shown in Table 2.

Table 2. Frequency Ranges in Licensed and Unlicensed Bands

Spectrum Band	North America	EMEA	Asia/Pacific	Latin America
License Exempt				
900MHz	X	X	X	X
2.4GHz (ISM)	X	X	X	X
5.15GHz to 5.35GHz Lower UNII Band	X	X	X	X
5.47GHz to 5.725GHz WRC	X	X	X	X
5.725GHz to 5.850GHz Higher UNII Band	X	X	X	X
Licensed				
2.1GHz MMDS	X	X	X	X
2.3 WCS	X	N/A	N/A	N/A
2.5GHz to 2.7GHz MMDS and ITFS	X	X	X	X
3.5GHz	N/A	X	X	X
10.5GHz	N/A	X	X	X
X = available, N/A = not available				

Source: Gartner Dataquest (April 2005)

6.12.3 Worldwide Interoperability for Microwave Access

WiMAX opportunity resides within the following network scenarios:

- DSL reach extension
- SMB data services
- Broadband services in developing regions
- Private networks
- Portable broadband, with 802.16e standards ratification expected in 2006

The market analysis will also cover products that follow WiBro standard in South Korea. The WiMAX standards are based on orthogonal frequency duplexing mode (OFDM), that is, transmitting multiple narrow signals in parallel. It is very spectral efficient and immune to multipath interference and noise. It makes bandwidth available for multiservice applications such as VoIP and broadband data. OFDM allows extensive frequency reuse.

Pre-certified products include Aperto Networks PacketWAVE, Alvarion BreezeACCESS, Redline Communications AN100, Airspan's AS.MAX and BWA and SR Telecom's Symmetry and SR 500.

WiMAX-certified products (as of March 2006) are Alvarions' BreezeMAX, Aperto's PacketMAX 5000 base station, Redline Communications' RedMAX AN-100U base station, Sequans Communications' SQN2010 base station reference design and Wavesat's miniMax CPE reference design.

6.12.4 WiBro

A mobile wireless broadband service for both handsets and laptops that will be offered commercially in South Korea from June 2006. WiBro was originally intended as a South Korean standard, but it has now been harmonized with, and accepted by, IEEE as part of the 802.16-2005 mobile WiMAX standard. WiBro was successfully demonstrated at the Asia/Pacific Economic Cooperation (APEC) Forum in November 2005 and at the Torino Winter Olympics in February 2006.

WiBro emerged from a South Korean Ministry of Information and Communications (MIC)-sponsored project to develop a standard for high-speed portable Internet (HPi). MIC hoped HPi would lead to new global opportunities for South Korean industry, similar to those arising from its early adoption of CDMA. Consortium members included South Korea's Electronics and Technology Research Institute (ETRI), Samsung Electronics and four operators of telecom services.

6.13 Free-Space Optics

Free-space optics, also called optical wireless, is a line-of-sight technology that delivers broadband traffic at speeds of up to 2 Gbps via a laser beam across distances of up to two kilometers. This technology is beyond the licensing requirements of regulatory bodies, such as the U.S. Federal Communications Commission (FCC), because free-space optics lasers operate in the electromagnetic spectrum on frequencies that are 190THz or higher.

6.14 Fiber in the Loop

FITL describes a carrier network architecture that includes the deployment of fiber-optic equipment from the location of Class 5 switches in COs or remote terminals to the subscriber side

of the network. Solutions that use fiber in all or most of the end-user connections are included in this definition. Four main product groupings are included in this segment.

6.15 Passive Optical Networks

A passive optical network (PON) system comprises a headend unit at the public network point-of-presence (POP), which is connected to multiple ONUs via a shared-fiber infrastructure. The ONUs may be in customer premises, the basement of large shared-occupation buildings or in street-side cabinets.

The use of passive optical splitters and combiners distinguishes PON systems from other FITL systems. Some PON equipment uses ATM or Ethernet technology to deliver advanced services.

6.16 Point-to-Point FITL Systems

Point-to-point (PTP) FITL systems are optical systems deployed between the public network POP and a single customer location, usually a large business. Systems that provide a protected optical path are included. PTP systems typically provide multiple 1.54-Mbps or 2-Mbps connections.

6.17 Fiber to the Business

Fiber to the business (FTTB) describes the installation of optical fiber from the location of a telephony switch/CO or remote CO to the business site. FTTB usually includes passive optical networking technology.

6.18 Fiber to the Premises

Fiber to the premises (FTTP) describes a network architecture in which there is installation of optical fiber from the location of a telephone switch/CO or remote CO directly to a customer's premises or subscriber's home.

6.19 Fiber to the Node

Fiber to the node (FTTN) describes a network architecture in which fiber is installed in a portion of the network link from the optical line termination (OLT) to the end user. The node is where the optical to electrical (O/E) conversion occurs using an active device. Nodes traditionally serve a neighborhood or geographically similar area and are larger than the typical service area in a fiber to the curb (FTTC) deployment. FTTN networks usually terminate using twisted copper pairs or coaxial cable. Many cable service provider networks and carrier networks employ some form of FTTN architecture.

6.20 FTTC Installations

FTTC describes the network architecture where optical fiber is installed from the location of a telephone switch/CO or remote CO to within 1,000 feet of a home or enterprise. An O/E conversion takes place somewhere near the end user. FTTC networks usually terminate at the customer premises using twisted copper pairs or coaxial cable.

6.21 Multiservice Access Platforms

Multiservice access platforms (MSAPs) include two types of platforms. One type includes products that are a result of an evolution from digital loop carriers (narrowband products) through adding more functionality (previously third-generation digital loop carriers [3GDLCs]). A second type includes purpose-built products that were formerly called Integrated Multiservice Access Platforms (IMAPs). In terms of functionality, the two product families can have similar attributes.

What sets them apart is that the purpose-built products have higher throughput rates, higher capacity backplanes and typically more intelligence.

The most widely deployed product example of evolutionary multiservice access products is the Alcatel Litespan platform.

Other examples of purpose built multiservice access platforms include:

- Adtran — Total Access 3000/3010
- Alcatel — ISAM
- Calix — C7
- Carrier Access — Adit 600
- Catena/Ciena — CNX-100
- Entrisphere — Multi-Service access
- Fujitsu — Flashwave
- Integral Access — PurePacket
- Motorola Broadband — MNLC
- Occam — BLC 6000
- Siemens — XpressPass
- Zhone — MALC
- ZTE — ZXMSAN
- UTStarcom — iAN-8000
- Huawei — Ma5100
- Iskratel — SI2000MSAN
- Lucent — Stinger, AnyMedia
- Nokia — D500
- Teledata — BroadAccess

6.22 Low-Density Access Media Gateway

Low-density AMG serves as the bridge between the circuit-based voice switch and the packet-based IP or ATM access network. Low-density AMG takes care of the PSTN-to-packet network transition at the local-loop level and is connected to the local exchange or an access node. It has Class 5 switch interfaces and supports VoIP, VoATM, or both. Included in the AMG segment are inverse AMGs, which make the transition from packet-access domain — DSL, cable hybrid-fiber coax, powerline and local multipoint distribution service — to a PSTN Class 5 local exchange via Generic Requirement (GR)-303 or V5.x interface. A VoDSL and other voice over broadband gateways are AMGs, according to Gartner's definition. It does not include VoIP line access gateway modules that are integrated in multiservice access platforms, or high-density gateways located in the Class 5 VoIP softswitch architecture.

Products in this category include:

- General Bandwidth — G6 Media Gateway
- Teledata — HighPGate
- Lucent — PSAX 1000, APAX

7.0 Optical Transport Equipment

7.1 Strategic Market Statements

Optical transport system market definitions are gradually changing, partly because of changes in technology and partly because traffic applications are increasingly data-centric.

As traffic continues to increase and optical technology costs decline, optical technologies will migrate toward the cost-sensitive edge of public networks. Ethernet-based access solutions and the emerging market for networks that use wave division multiplexing (WDM) will redefine the transport system market. The bandwidth capacity of optical fiber and the connectivity and easy provisioning offered by Ethernet will be key drivers.

The way that vendors market products will be affected by changes in the global economy, new standards for optical technology, revised carrier business models favoring cutbacks in operational expenditure and the many startup companies offering optical technology. Products and solutions will be increasingly designed to fit the requirements of business cases.

The following definitions explain the terminology used in the optical network equipment market statistics published by Gartner Dataquest. The market statistics may not cover all segments described here, because some segments may be deemed premature or too small for coverage in the various reports. However, all segments mentioned in the market statistics are defined in this document.

7.2 Optical Transport System Market by Equipment Generation

Optical transport systems have evolved through distinct generations of equipment. Gartner Dataquest has chosen to divide optical equipment into 1G, 2G and 3G. The distinction between these generations is based on the value propositions that each offers network operators:

- 1G includes legacy plesiochronous digital hierarchy (PDH) and asynchronous equipment. 2G includes traditional SDH and SONET, digital cross-connects (DXCs) and long-haul dense wavelength division multiplexing (DWDM).
- 3G includes optical equipment optimized for data-centric networks, such as next-generation SDH/SONET, optical switches and metro WDM.

7.3 Optical Transport System Market by Topography

In terms of topography, Gartner Dataquest defines three network categories for optical equipment:

- Core transport systems
- Metro transport systems
- Optical access systems

Optical access systems are characterized by their ability to support services and their use in the local loop. These systems are covered separately in Gartner Dataquest's market statistics for access systems.

There is little distinction between "core" and "metro" transport, because many of the systems in these two segments have the same features. However, core networks typically span great distances, while metro systems span shorter ones. Gartner Dataquest defines core transport systems as systems with in-line amplifiers (but not signal regenerators), and metro transport systems as systems without in-line amplifiers. In addition, metro systems always use less-expensive transmitter components because of their short-distance specifications. Regional or edge systems are included in core or metro, based on the presence of in-line amplifiers.

7.4 Optical Transport System Market by Technology

Gartner Dataquest divides the transport system market into the following technology segments:

- SDH/SONET
- Terminal multiplexers
- Add/drop multiplexers
- Digital cross-connects
- WDM systems
- Long-haul DWDM (including ultra-long haul)
- Metro WDM
- Optical exchange equipment
- Optical add/drop multiplexers
- Optical cross-connects
- Optical switches
- PDH and asynchronous
- Line systems
- Multiplexers
- Digital cross-connects
- Other transport products
- Network management
- Vendor support

7.5 Definitions

7.5.1 SDH/SONET

SDH/SONET differs according to geographic region. SONET is sold only in North America, and SDH is sold in two "flavors." SDH (Japan) is sold in Japan only, and SDH European

Telecommunications Standards Institute (ETSI) is sold in the rest of the world. SDH/SONET supports ring and mesh topologies. Protection of circuits through automatic protection switching (APS) is standard, via various protection programs.

Although specific components differ, they share three generic network elements.

- Terminal multiplexers — A multiplexer in which all tributaries are combined into, or terminated from, a high-speed signal. This type of equipment incorporates both multiplexing and line-terminating function. It assembles SDH/SONET and PDH inputs (tributary signals) into a standard SDH optical output. For example, a terminal for synchronous transfer mode (STM)-1 multiplexers will typically have 63 2-Mbps inputs and a 155-Mbps SDH output. In effect, it replaces a bank of multiplexers and a separate optical terminating unit in the PDH/asynchronous system.
- Add/drop multiplexers — These are similar to terminal multiplexers, but can be considered as flexible intermediate stations that allow both the dropping off and insertion of circuits. They can be deployed either as intermediate stations between SDH terminal multiplexers or in highly flexible ring architectures. Typically, they will use identical hardware subsystems to multiplexer terminals, but include software packages that are far more complex. It is important to note that terminal and add/drop line cards can be mixed and matched in a chassis.
- DXCs — Equipment that provides electronic aggregation and flexible routing. This type of equipment is used to configure and manage circuits in transmission networks and to provide network protection in case of faults. DXCs also serve as access points for service restoration, testing and trouble location. The evolution toward so-called "next generation" SDH/SONET applies to all regions of the world. Typically, next-generation SDH/SONET equipment is data-enabled with Ethernet interfaces and has more-advanced features than traditional add/drop multiplexers. SONET, SDH (ETSI) and SDH (Japan) are identified.

7.5.2 SONET

Terminal multiplexers and add/drop multiplexers are ordered by the bit rate of their aggregated signals. The categories are as follows:

- OC-3 (155 Mbps)
- OC-12 (622 Mbps)
- OC-48 (2.5 Gbps)
- OC-192 (10 Gbps)
- OC-768 (40 Gbps)

DXCs are referred to as digital cross-connect systems (DCS) in the SONET world. They are sorted by the level of cross-connect functionality that they provide, as follows:

- Narrowband DCS — Equipment designed to electronically cross-connect and manage DS0 and DS1, including "fractional T1s." This equipment is often an electronic replacement for manual DS1 patch panels called DSX1. The high-side interface is typically an OC-3.

- Wideband DCS — Equipment designed to electronically cross-connect and manage DS1 (also known as T1 lines or VT1.5) and DS3 lines. This equipment is often an electronic replacement for manual DS1 patch panels called DSX1.
- Broadband DCS — Equipment designed to electronically cross-connect and manage DS3 lines or SONET STS-1 circuits (51 Mbps). This equipment is often an electronic replacement for manual DS3 patch panels called DSX3. Some systems also manage higher-speed SONET circuits.

7.5.3 SDH (ETSI and Japan)

Terminal multiplexers and add/drop multiplexers are ordered by the bit rate of their aggregated signals. The categories are as follows:

- STM-1 (155 Mbps)
- STM-4 (622 Mbps)
- STM-16 (2.5 Gbps)
- STM-64 (10 Gbps)
- STM-256 (40 Gbps)

DXCs are sorted by the level of cross-connect functionality they provide, as follows:

- DXC 4/1: DXC with STM-n interfaces, operates on DS12/E1 granularity
- DXC 4/4: DXC with STM-n interfaces, operates on DS4/STM-1 granularity

7.5.4 Next-Generation SDH/SONET

The next-generation SDH/SONET segment covers equipment that, in addition to traditional SDH/SONET functions, also supports various functions and includes features aimed at increasingly cost-sensitive data-centric applications. It should be noted that the typical specification for equipment in this segment becomes more advanced as new data-centric additions to traditional SDH/SONET become standardized.

Typical features of next-generation SDH/SONET equipment include:

- Smaller form factor and lower power consumption
- Fast Ethernet functionality (International Telecommunication Union Telecommunication Standardization Sector [ITU-T] G.707, or later)
- Generic framing procedure (GFP) defined by ITU-T G.7042 for standardized transport of synchronous storage area network and network attached storage protocols, such as enterprise systems connection (ESCON), Fibre Channel and high-performance parallel interface (HPPI).
- Link capacity adjustment scheme (LCAS) defined by ITU-T G.7041 for efficient handling of dynamic traffic patterns that change over time.
- Increased local cross-connect functionality to reduce backhaul traffic to central cross-connects.
- A control plane for a future optical signaling layer. Three bodies have developed standards — Optical Internet Working Forum (OIF) created the user network

interface/network-to-network interface (UNI/NNI); Internet Engineering Task Force (IETF) created Generalized Multiprotocol Label Switching (GMPLS); and the ITU-T created automatic switched transport network/automatic switched optical network (ASTN/ASON) control plane.

- Resilient packet ring (RPR) is included by some vendors.

7.5.5 WDM Systems

The first WDM systems were made for long-haul transport applications. WDM systems made it possible to split each fiber into a number of "virtual fibers" — one for each wavelength in the system. Given the high cost of long-haul fiber links, it was easy for WDM technology to offer a compelling value proposition — even though it was relatively expensive. In addition, a single optical amplifier for all the channels in a WDM system represented a clear cost advantage compared with the individual amplifiers and regenerators that were used in single-channel systems.

As a result of the very high speed at which WDM technology has matured, it is now the technology of choice for long-haul applications. Commercial DWDM now exceeds 100 channels, and the maximum line rate has, at the same time, been extended from 2.5 Gbps to 10 Gbps. A line rate of 40 Gbps has been widely demonstrated and, in principle, is commercially available. The cost of low-grade WDM systems has fallen, while performance has increased.

Gartner Dataquest tracks the following WDM subsegments:

- Metro WDM (WDM systems without in-line amplifiers).
- Long-haul DWDM (DWDM systems with in-line amplifiers and a maximum link distance of 1,000 km).
- Ultra long-haul DWDM (DWDM systems with in-line amplifiers and a maximum link distance of greater than 1,000 km).
- In-line optical amplifiers are considered to be an integral part of long-haul and ultra-long-haul DWDM systems.

7.5.6 Optical Exchange Equipment

In much of the literature addressing optical networking, terms such as optical cross-connects, optical switches and photonic switches have been used in an ambiguous way. Many companies — including startups — are adding to the confusion about nomenclature when trying to improve their position and make their brand more recognizable in the optical networking arena. To avoid confusion and inaccuracy, Gartner Dataquest uses optical exchange equipment (OXE) as a common term for any type of node equipment that handles traffic in the optical domain without relying on client-layer functionality. While OXE sales figures have been adversely affected by the downturn of the telecom industry, the underlying technology has matured over the past couple of years, especially in standardizing control plane features and associated signaling protocols. The standardization efforts have resulted in:

- GMPLS from the IETF
- ASTN/ASON from the ITU-T
- UNI/NNI from the OIF

7.5.7 PDH/Asynchronous

The PDH/asynchronous segment differs according to geography. The regional differences seen in SDH/SONET equipment reflect the historical differences between the way in which PDH/asynchronous technology was implemented in each region. PDH/asynchronous technology once led the transport system market, but it has been almost completely substituted by SDH/SONET technology for transport applications. However, some PDH/asynchronous products have migrated into the access parts of the networks. In these areas, capacity requirements resemble those that used to exist in the backbone networks, for which the PDH/asynchronous technology was designed.

7.5.8 Other Transport Products

In addition to the previously described equipment, Gartner Dataquest tracks deployments of network management software and the support offered by vendors to operators.

Network management software includes the following three subsegments:

- Network management systems (NMSs) — The central part of a network management software package that provides the network-level overview.
- Element management systems (EMSs) — The parts of network management that relate to individual network elements and which provide detailed information about the status of each element.
- Design tools.

8.0 Support Systems

Support systems are software-based solutions and processes that enable NSPs to build, manage, maintain and monitor their networks, and monetize their infrastructure investments by converting them into marketable products and services. Support systems were originally developed in-house as stand-alone mainframe-based systems. The Telecom Act of 1996 mandated that NSPs open some of their support systems to competitors. Subsequently, competitive pressures necessitated the integration of stand-alone systems to facilitate the exchange and mining of data from disparate systems.

Increasingly, NSPs are migrating from internally developed and maintained legacy solutions toward commercial off the shelf (COTS) products and external professional services.

8.1 External Spending

External spending refers to software and external services.

- Software includes systems/utilities software, network operation software and application software. This component comprises computer programs containing instruction codes that control the operations of the computer and the network hardware to perform certain sequences of operations.
- External services are made up of professional services and support services. They are performed either by the independent software vendor (ISV) an systems integrator (SI) or a combination thereof:
- Professional services encompass all services purchased from external parties for planning through implementation of information systems. Examples include IT

consulting, systems/network design, software development, integration services, education and training, business management and data extraction.

- Support services include all external services purchased for support and maintenance of information systems such as maintenance and IT outsourcing. Support services purchasing is typically a post-sales engagement that entails servicing equipment and software.

- Data processing and outsourcing — Data processing and outsourcing is the hosting of software in a remote data center and processing of records either on a one-to-one (outsourcing) or one-to-many basis (service bureau). Application service providers (ASPs) are a subcategory of data processing and outsourcing.

8.2 Internal Spending

Internal services refers to salaries paid to the IS staff of an NSP. IS staff includes all company employees who plan, develop, implement and maintain information systems.

8.3 Market Segmentation — Communications Industry

Gartner Dataquest has divided the communications industry market into the following main sectors following the Standard Industrial Classification (SIC) codes: wireline, wireless, cable, satellite and Internet service provider/Open Settlement Protocol (ISP/OSP). Other sectors include:

- Wireline — Communications (voice or data) over a fixed-wire network. Includes POTS, value-added services and private networks and ISPs.

- Wireless — Non-fixed-wire communications (voice or data) through paging, cellular and PCS technologies.

- Cable/direct broadcast satellite (DBS) — The business of providing video, text or image distribution services, as well as HFC-based broadband data and VoIP services. This sector includes the cable TV and satellite TV markets.

8.3.1 Business Process and Solution Areas

Gartner Dataquest defines BSS and OSS solutions areas as follows:

BSS facilitates the relationship with NSP customers. BSS can be thought of as customer-facing systems and includes the following solution areas:

- Billing and records includes all the revenue recognition steps that take place after message collection. This includes adjusting pricing and discount tables, rating and calculating, invoice formatting and bill production. Ancillary processes, such as printing, stuffing, remittance processing and collections, are out of the scope of Gartner BSS research.

- Customer assistance and care encompasses all processes and systems that support customer interaction outside of marketing, sales, or collections. Directory assistance, billing inquiry, service questions, adds and changes, 911 calls and repair requests fall into this category.

- Sales and marketing covers all processes and systems from product idea creation to service order entry. Marketing includes market research, product trial and development, product management, advertising, marketing, campaign management, profit analysis

and customer segmentation analysis. Sales include telemarketing, incoming call center sales, commission tracking and management, service negotiation and order entry.

- Message collection/mediation pulls call detail records and other network events off the network switches, standardizes them and stores the data for OSS analysis and billing. Message collection factors in the front-end or prebilling portion of the billing process.

OSS facilitates the operations of the communications carrier's transport network. OSS can be thought of as network-facing systems and includes the following solution areas:

- Planning and engineering includes the steps from network planning to network construction. IT spending in this domain takes into consideration systems such as geographic information system (GIS), computer-aided design (CAD)/computer-aided manufacturing (CAM), budgeting, procurement, and line and service testing.
- Provisioning and activation includes all systems and steps related to the process of implementing a new customer account or service.
- Inventory management covers all network or facilities equipment tracking and management. In this ongoing process, all installed and "on hand" network assets are tracked for efficient inventory, procurement, repair and reuse.
- Workforce management encompasses all activities surrounding work assignment, coordination and tracking. The process involves assuring that personnel with the appropriate qualifications are given the correct equipment at the right time and place. Examples of IT applications and systems supporting workforce management are dispatch, workflow management and project tracking.
- Network management includes configuration management, traffic management, fault management, security management, element management and performance management.

8.3.2 Spending Classifications

The following summarizes the classification system of the three dimensions: components, market segments and process/application areas. Geography is the fourth dimension.

8.4 Components

Components include:

- Software
- Internal services
- External services
- ISV services
- SI services
- Data processing and outsourcing

8.5 Market Segments

Market segments include:

- Wireless

- Cellular (AMPS)
- Digital PCS (CDMA, TDMA, GSM)
- Wireless data
- Cable/satellite
- Cable
- Satellite (DBS)

8.6 Process/Application Areas

Process/application areas include:

- BSS
  - Fraud management
    - Cellular and calling card fraud data accumulation
    - Fraud analysis
    - Corrective action and notification
    - Customer prequalification
  - Billing and records
    - Pricing and discount management
    - Design and formatting
    - Rating, accounting and calculation
  - Customer assistance and care
    - Billing inquiry
    - Service complaints and questions
    - Directory assistance
    - Service adds and changes
  - Sales and marketing
    - Segmentation analysis
    - Product management
    - Profit analysis
    - Field sales force support
  - Message collection, mediation
    - Usage collection

        - Data standardization
- Operations support systems
    - Planning and engineering
        - Network planning and budgeting
        - Network engineering
        - Network construction and testing
    - Provisioning and activation
        - Automated provisioning
        - Database updates
        - Capacity and network testing
        - Service implementation
    - Inventory management
        - Network-related procurement
        - Network asset management
    - Workforce management
        - Dispatch request
        - Workforce assignment
        - Workflow management
        - Project management
    - Network management
        - Configuration management
        - Traffic management
        - Fault management
        - Security management
        - Element management
        - Performance management

9.0 Public Network Outsourcing and Services

Carrier network outsourcing and services includes outsourced operations and functions as well as discrete services procured by carriers in support of their commercial, carrier network infrastructure and networks. These services can be either directly in support of the suppliers' products or relate to the products of vendors other than themselves, but in support of commercial

carrier network functions only. These services relate to the design and planning, installation and deployment, and maintenance services across the wireline, wireless, cable and other sectors.

OSS- and BSS-related services are not included here and are covered in Gartner Dataquest's worldwide OSS and BSS forecast documents. Service definitions are as follows:

Discrete services — These are project-specific contractual arrangements with a predetermined scope of work to be completed within a given period. With discrete services, management responsibility for the delivery of services and outcome is retained by the carrier. Discrete projects may last from a few weeks to several years, depending on the project. Typical projects can include, but are not limited to, custom application development, specific revenue management and assurance projects.

Outsourcing services — Gartner Dataquest defines these as multiyear or annuity-based contractual arrangements whereby a carrier buys services on an ongoing basis at a specified level of competency. Outsourcing involves some degree of transfer of management responsibility for the ongoing delivery of public network-related services to an external provider, with performance of the relevant network elements tied to end-user service levels or outcomes. Outsourcing encompasses the management of network infrastructure, applications and business processes. As part of an outsourcing agreement, the external service provider (ESP) may acquire the physical assets or the employees of a carrier client. Services may be provided at the client site or remotely from a vendor-owned site.

OSS, BSS and Carrier Network Outsourcing segments are not covered in the Carrier Network Infrastructure, but are covered in the Carrier Operations and Strategies research area.

Acronym Key and Glossary Terms

3GDSL third-generation DSL

3GPP Third-Generation Partnership Program

ADSL asymmetric DSL

AIN advanced intelligent network

AMG access media gateway

AMI alternative mark inversion

ANSI American National Standards Institute

ASON automatic switched optical network

APS automatic protection switching

ASP application service provider

ASTN automatic switched transport network

ATA analog terminal adapter

ATM asynchronous transfer mode

BGP border gateway protocol

BMSP backbone multiservice platform

BSS	business support system
BWA	broadband wireless access
CAD	computer-aided design
CAM	computer-aided manufacturing
CCCM	computer controller cable modem
CMTS	cable modem termination system
CO	central office
COTS	commercial off the shelf
CPE	customer premises equipment
DBS	direct broadcast satellite
DCS	digital cross-connect system
DLC	digital loop carrier
DOCSIS	Data-Over-Cable Interface Specification
DSG	DOCSIS set-top gateway
DSLAM	digital subscriber line access multiplexer
DWDM	dense wavelength division multiplexing
DXC	digital cross-connect
EDGE	Enhanced Data Rates for Global Evolution
eMTA	embedded multimedia terminal adapter
EMS	element management system
ENUM	electronic numbering
ESCON	enterprise systems connection
ESP	external service provider
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDDI	Fiber Distributed Data Interface
FITL	fiber in the loop
FTTB	fiber to the business
FTTC	fiber to the curb
FTTN	fiber to the node
FTTP	fiber to the premises

FTTx	fiber to the x
G.SHDSL	global.standard high-bit rate DSL
GbE	Gigabit Ethernet
GFN	generic framing procedure
GIS	geographic information system
GMPLS	Generalized Multiprotocol Label Switching
GPRS	general packet radio service
GR	generic requirement
GSM	Global System for Mobile Communications
HDSL	high-bit rate DSL
HFC	hybrid fiber-coaxial
HLR	home location registry
HPPI	high-performance parallel interface
HPi	high-speed portable Internet
IAD	integrated access device
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IMAP	integrated multiservice access platform
IMS	Internet Protocol Multimedia Subsystem
IN	intelligent network
IPsec	IP security
IS	information services
ISDN	Integrated Services Digital Network
ISP	Internet service provider
ISV	independent software vendor
ITU	International Telecommunication Union
ITU-I	ITU Telecommunications Standards Institute
IVR	interactive voice response
Km	kilometer
LCAS	link capacity adjustment scheme
LNP	local number portability

MAC	media access controller
MDU	multiple dwelling unit
MEGACO	media gateway control
MGC	media gateway controller
MGCP	media gateway control protocol
MPL	Multiprotocol Label Switching
MPS	multiprotocol lambda switching
MSAP	multiservice access platform
MSC	mobile switching center
MSE	multiservice edge
MSS	multiservice switch
MTA	multimedia terminal adapter
MTU	multiple tenant unit
N/A	not available
NAT	network address translation
NG	next-generation
NMS	network management system
NNI	network-to-network interface
NSP	network service provider
OFDM	orthogonal frequency duplexing mode
OIF	Optical Interworking Forum
ONU	optical network unit
OSI	Open Systems Interconnection
OSP	open settlement protocol
OSPF	open shortcut path first
OSS	operations support system
OTE	optical to electric
OTL	optical line termination
OXE	optical exchange equipment
PAM	pulse amplitude modulation
PBX	private branch exchange

PCMCIA	Personal Computer Memory Card Industry Association
PDA	personal digital assistant
PDH	Plesiochronous Digital Hierarchy
PON	passive optical network
POP	point of presence
POTS	plain old telephone service
PPPoE	point-to-point protocol over Ethernet
PSTN	public switched telephone network
PTP	point to point
PVC	private virtual circuit
QOS	quality of service
RF	radio frequency
RIP	routing information protocol
RPR	resilient packet ring
S-CDMA	Synchronous CDMA
SCE	service creation environment
SDH	Synchronous Digital Hierarchy
SG	signaling gateway
SI	systems integrator
SIP	Session Initiation Protocol
SIC	Standard Industrial Classification
SLA	service-level agreement
SOHO	small office/home office
SONET	Synchronous Optical Network
SPR	service provider router
SS7	Signaling System 7
SSP	service switching point
STB	set-top box
STM	synchronous transfer mode
STP	signal transfer point
SVC	switched vertical circuit

TDM	time division multiplexing
TDMA	time division/demand multiple access
TD-SCDMA	Time Division-Synchronous Code Division Multiple Access
TMG	trunk media gateway
UNI	user network interface
USB	Universal Serial Bus
VDSL	very high-bit rate DSL
VLR	visitor location registry
VoATM	voice over ATM
VoDSL	voice over DSL
VoIP	voice over Internet Protocol
VPLN	virtual private LAN service
VPN	virtual private network
VPLS	virtual private LAN service
WDM	wave division multiplexing
WFQ	weighted fair queuing
WiMAX	Worldwide Interoperability for Microwave Access
WRED	weighted random early detection

REGIONAL HEADQUARTERS

Corporate Headquarters
56 Top Gallant Road
Stamford, CT 06902-7700
U.S.A.
+1 203 964 0096

European Headquarters
Tamesis
The Glanty
Egham
Surrey, TW20 9AW
UNITED KINGDOM
+44 1784 431611

Asia/Pacific Headquarters
Gartner Australasia Pty. Ltd.
Level 9, 141 Walker Street
North Sydney
New South Wales 2060
AUSTRALIA
+61 2 9459 4600

Japan Headquarters
Gartner Japan Ltd.
Aobadai Hills, 6F
7-7, Aobadai, 4-chome
Meguro-ku, Tokyo 153-0042
JAPAN
+81 3 3481 3670

Latin America Headquarters
Gartner do Brazil
Av. das Nações Unidas, 12551
9° andar—World Trade Center
04578-903—São Paulo SP
BRAZIL
+55 11 3443 1509

Gartner