BROADBAND ACCESS EQUIPMENT

Foreword

Convergence is becoming a reality in the heart of service provider networks, but in the access network it's more a case of *divergence*, as service providers seek to offer broadband services over an increasing variety of access technologies, so that customers can get connected wherever they are.

That raises a number of challenges for carriers, which are beginning to rethink their network infrastructures to address the heightened bandwidth requirements of services like IPTV and HDTV. Not only do they need to ramp up bandwidth to run these services, but they need to control the quality of user experience. At the same time, they need to devise strategies for supporting legacy, circuit-based services over new packet-based access infrastructure. And all this needs to happen in a way that permits the technology to be deployed and changed easily, cheaply, and rapidly.

The telecom operators and their suppliers are addressing these challenges by developing new technologies such IMS (IP Multimedia Subsystem), carrier-class Ethernet, and pseudowire encapsulation. They're also working together in associations such as the DSL Forum to establish new standards and architectures. And all of this is resulting in a plethora of new products hitting the market -- a market that represents a huge opportunity for vendors. It's sometimes said that for every dollar carriers spend in the core of their networks they spend $10 on metro equipment and $100 on access networking.

Broadband access is evolving at a rapid rate as subscriber rates around the world continue to soar. Carriers are expected to deliver, not only accelerating Internet access over their networks, but a bundle of converged services that include VOIP, video services, gaming, and, increasingly, HDTV – driving bandwidth requirements ever higher.

Carriers have ramped up deployment plans to extend fiber deep into the access network, in some cases as far as the home, and WiMax technology has moved from the trial stage to early commercial launch phase.

The market has also been altered by some major consolidation activity among vendors – the Alcatel-Lucent merger, Nokia Siemens Networks , Ericsson AB acquisition spree, Motorola Inc. buying Symbol Technologies, and so on. Such moves have seen products shift into different vendor portfolios or eliminated altogether. In fact, Alcatel-Lucent has yet to publicly release details of its finalized product portfolio and re-branding.

This report provides an overview of the access equipment market, proposing a broad range of product categories and listing suppliers in each category.

Table 1 is a complete list of vendors and equipment categories featured in the report:

Table 1: Access Equipment Vendors

Vendor	MSAPs/DSLAMs	Ethernet	PON	Home Gateways	Wireless	Free-Space Optics	Powerline
2Wire				YES			
3Com					YES		
Accedian Networks		YES					
Accton Technology					YES		

Actelis Networks		YES					
Actiontec Electronics				YES			
Adaptix					YES		
Adtran	YES	YES					
Air Broadband Communications					YES		
AirFiber						YES	
Airspan Networks					YES		
Aktino		YES					
Alcatel	YES	YES	YES		YES	YES	
Allied Telesis	YES	YES		YES	YES		
Alloptic		YES	YES				
Alpha Networks					YES		
Alvarion					YES		
Ambient Corp.							YES
Amedia Networks		YES		YES			
Amperion							YES
ANDA Networks		YES					
Aoptix Technologies						YES	
Aperto Networks					YES		
Aptilo					YES		
Aruba					YES		
Asotel	YES						
Astoria Networks	YES						
Atrica		YES					
Aurora Networks		YES			YES		
AVM Computersysteme				YES			
Axerra Networks		YES					
Axxcelera Broadband Wireless					YES		
BelAir					YES		
Broadata Communciations			YES				
BroadLight		YES					
Buffalo Technology				YES	YES		

Cablefree Solutions						YES	
Calix	YES		YES				
Cambridge Broadband					YES		
Canon						YES	
Carrier Access			YES				
C-Com	YES						
Celerica						YES	
Ceragon Networks					YES		
Ceterus Networks		YES					
Ciena	YES						
Cisco		YES			YES		
Coastcom	YES						
Colubris Networks					YES		
Communication by Light (CBL)						YES	
Comtec		YES					
Comtrend				YES			
Conklin-Intracom	YES						
Corecess	YES	YES					
Corinex							YES
Corning Cable Systems						YES	
Critical Telecom	YES						
CTC Union	YES						
Current Technologies							YES
Dataflex				YES			
D-Link				YES	YES		
Dominion Lasercom						YES	
DragonWave					YES		
DrayTek				YES			
Echelon				YES			
ECI Telecom	YES						
Enterasys					YES		
Entone Technologies				YES			

Entrisphere	YES		YES				
Ericsson	YES	YES			YES		
Extreme					YES		
Extricom					YES		
Firetide					YES		
FlexLight Networks			YES				
Foundry Networks		YES					
Foxconn Electronics				YES			
fSona Communications						YES	
Fujitsu Telecom Europe	YES						
Furtera						YES	
Gemtek Technology				YES			
Harbour Networks	YES						
Harmonic		YES					
Hatteras Networks		YES					
Hitachi Telecom USA			YES				
Holoplex Technologies						YES	
Huawei Technologies	YES		YES	YES			
InfiNet Wireless					YES		
Infrared Technologies America						YES	
InovaTech							YES
Integral Access	YES						
iRLan						YES	
Iskratel	YES						
Juniper		YES			YES		
Jungo				YES			
KeyMile	YES						
LaserBit Communications						YES	
LG Electronics					YES		
LightPointe Communications						YES	

Linksys				YES			
Loop Telecom	YES						
LSA Photonics						YES	
Lucent	YES	YES			YES		
Main.net Communications							YES
Maxima						YES	
Meru					YES		
Metrobility Optical Systems		YES					
Mitsubishi Electric			YES				YES
Mostcom						YES	
Motorola	YES		YES	YES	YES		YES
MRV Communications		YES				YES	
Narad Networks		YES					
Navini Networks					YES		
Nayna Networks		YES					
NEC	YES				YES		
Nera					YES		
Netgear				YES	YES		
Netopia				YES			
NextNet Wireless					YES		
Nokia	YES				YES		
Nortel Networks		YES			YES		
Occam Networks	YES		YES				
Oki Electric Industry				YES			
Omnilux						YES	
Omnitron Systems		YES					
OrAccess						YES	
Orthogon Systems					YES		
Overture		YES					
PacketFront	YES	YES					
Pandatel		YES					
Pannaway	YES						
Patton Electronics	YES	YES					

PAV Data Systems						YES	
Pirelli				YES			
Plaintree Systems						YES	
Posdata					YES		
Proxim Wireless					YES		
RAD Data Communications		YES			YES		
Radionet					YES		
Redback		YES					
Redline Communications					YES		
Resolute Networks		YES					
Riverstone		YES					
Royal Philips Electronics				YES			
Ruckus Wireless				YES			
Sagem Communications	YES			YES			
Salira			YES				
Samsung Electronics	YES		YES		YES		
Sceptre Communications						YES	
Sequans Communications					YES		
Siemens	YES	YES	YES	YES	YES		
Silcom Manufacturing Technology						YES	
SkyPilot					YES		
SMC Networks				YES	YES		
Solectek					YES		YES
SR Telecom					YES		
Strix Systems					YES		
Sumitomo Electric	YES		YES				YES
Sunflower Technologies						YES	
Symbol Technologies					YES		
System Engineering International (SEI)							YES

Telco Systems		YES		YES			
TeleData Networks	YES						
Telindus	YES						
Tellabs	YES	YES	YES				
Telsey				YES			
Telsima					YES		
Telspec	YES						
Telstrat	YES						
Terawave Communications			YES				
Thomson Electronics				YES			
Tilgin				YES			
Trango Broadband Wireless					YES		
Trapeze Networks					YES		
Tropos Networks					YES		
US Robotics				YES	YES		
UTStarcom	YES		YES		YES		
Wave Wireless					YES		
Wave7 Optics			YES				
Westell Technologies				YES			
Wi-LAN					YES		
WiNetworks					YES		
World Wide Packets		YES					
XAVi				YES			
Xirrus					YES		
Zhone Technologies	YES	YES	YES	YES			
ZTE	YES			YES	YES		
ZyXEL	YES	YES	YES	YES	YES	NO	YES

This report covers the main access technologies that are used to provide broadband services, then goes on to define the various types of equipment -- where they sit in the network and which vendors sell them. It focuses on basic transport infrastructure. A separate report will cover higher-level equipment such as broadband remote access servers, broadband policy traffic managers, session border controllers, and so on.

Here's a summary:

- **Access Technologies**
  Copper (DSL), coax (cable/MSO), fiber, wireless, free-space optics, and powerline
- **Access Architectures**
  DSL Forum's work, CableLabs, circuit emulation, IMS, PON
- **MSAPs, DSLAMs & CMTSs**
  DSL and cable access devices
- **Ethernet Access Devices**
  Ethernet over fiber, copper, and pseudowire
- **Fiber & Passive Optical Networking**
  Optical network terminals (ONTs) and optical line terminals (OLTs)
- **Home Gateways**
  Access equipment for the home
- **Wireless**
  Wireless LAN, fixed wireless, and WiMax
- **Free-Space Optics**
  Broadband using lasers
- **Powerline**
  Ethernet over electricity grid

Access Technologies

Copper (DSL)

The key thing about DSL is that it can be used to boost bandwidths on a large proportion of the billions of copper local loop connections that already exist in telephone networks around the world. As such, it holds the key to incumbent carrier hopes of generating an increasing proportion of their revenues from video-based services.

DSL services are moving away from providing basic broadband Internet access to multiple high-bandwidth applications with quality of service (QOS) demands, as service providers attempt to find new revenue streams. Subscriber numbers are on the increase worldwide – up by 42 percent last year.

To achieve the higher data rates they need, operators are coming up with plans to build out their networks with newer generations of DSL, including ADSL2 and VDSL. Deutsche Telekom AG, for example, is deploying VDSL2 equipment from ECI Telecom Ltd., which will provide bandwidths of up to 50 Mbit/s downstream and 10 Mbit/s upstream.

Coax (cable/MSO)

Cable/multiservice operators are in the midst of a protracted battle with telcos for customers – a battle that has ramped up with the crossover into voice via VOIP services and the telcos' move into video. The number of cable broadband subscribers worldwide rose 14 percent last year despite the growth of DSL, and operators share the need for higher data rates to support triple-play. Vendors are adding enhanced capabilities and bandwidth to their platforms, and the CMTS market continues to grow at a steady clip. Like the telcos, cable operators are taking a hard look at fiber as an alternative access technology as demand for bandwidth increases.

Fiber and PON

Fiber-to-the-whatever (FTTx) aims to displace DSL and cable as the fixed-line technology of choice for carriers with ever-growing bandwidth requirements. The "x" denotes how far the fiber is installed in the access network – as remote as the curb (FTTC) or node (FTTN) or all the way into the subscriber's home (FTTH).

A number of service providers are beginning the migration to fiber in incremental ways. As noted above, Deutsche Telekom has started deploying remote VDSL equipment, but the network will also use fiber access equipment for FTTC.

PON (passive optical networking) is a point-to-multipoint architecture that uses passive splitters so that a single optical fiber can serve multiple buildings, reducing the amount of fiber required in a network and thereby reducing the cost of buildouts. The three largest telcos in the U.S. – AT&T Inc., BellSouth Corp., and Verizon Communications Inc. – have put out a request for proposal (RFP) for gigabit PON (GPON).

Wireless

Wireless LAN, or WiFi, while a local-area networking technology, is fast becoming hip, as public access hotspots explode into metro area deployments, often as municipal networks. The aim is to provide access to users on the move so they can connect to the Internet and corporate networks wherever they are – an important asset in the age of telecommuting.

Fixed wireless is touted as an alternative to wireline broadband, one that can connect users in remote locations without the need for laying new cable. Being wire-free also makes it easier for service providers to increase bandwidth capacity, as all the equipment is located above the ground.

WiMax is the buzzword *du jour* in the wireless space, but, as an alternative access technology for large-scale deployments, it is still very much a work in progress. The first wave of certification for fixed WiMax products was completed in January, while certified mobile WiMax gear is expected to hit the market by early 2007.

Like fixed wireless, WiMax is especially attractive in emerging markets, where demand for broadband services is exploding and service providers calculate that laying new copper or fiber cabling would be too expensive and time-consuming.

Free-space optics

Free-space optics (FSO), also called free-space photonics (FSP), uses lasers or light-emitting diodes to provide optical high-speed bandwidth. The technology is often used to network buildings over distances of several kilometers, but the connections can be disrupted by poor atmospheric conditions like fog, heavy rain, snow, or smog.

Powerline

Broadband over powerline (BPL) is a technology that provides high-speed Internet access through electrical outlets. Also referred to as powerline Ethernet, it's viewed as a somewhat eccentric niche market, but it has attracted service providers that like the idea of using existing infrastructure to roll out high-speed services. Like wireless, it bypasses the need to lay new cable, and it can substitute for wireline in remote areas where cabling isn't feasible. It's worth noting that Google has an interest in the technology, having invested in powerline carrier Current Communications Group LLC last summer.

Access Architectures

DSL

The DSL Forum was initially focused on standardizing the access network, but it has increasingly taken an interest in the in-home broadband network, launching the DSLHome initiative to concentrate on device and management requirements as well as back-end integration.

Among the suite of standards coming out of the DSLHome division, TR-069 has emerged as a key requirement in creating a standardized means for service providers to manage residential gateways. Published at the end of 2004, TR-069 is designed to allow autoconfiguration servers to acquire information on the status of the gateway – for example, wireless or PPPoE settings – and change them if necessary. It includes initial remote configuration of the gateway; upgrades to software or firmware; status and performance monitoring; and troubleshooting and diagnostics. Other key texts will be approved this year to extend management inside the home to a range of devices and improve interoperability among vendors.

The Forum is in the process of expanding its remit further to encompass Layer 3 specifications that are applicable to FTTP and FTTN (PON) in addition to DSLAM-based platforms. The focus of DSLHome now also covers management of common CPE and devices for all types of wide-area networks and consumer electronics networking requirements.

Cable

In the cable/MSO space, CableLabs has taken international IP routing, Ethernet, VOIP, and softswitch standards and adapted them for cable's HFC networks and distributed headend/central office architecture. Its PacketCable architecture adds softswitch call management extensions to DOCSIS (Data Over Cable System Interface Specification), which incorporates QOS controls for high-speed cable equipment and software. PacketCable MultiMedia (PCMM) supports video, gaming, and other real-time applications beyond voice.

As a parallel to the DSLHome initiative, CableLabs has come up with a set of standards that address convergence. These include: OpenCable, DOCSIS Set-top Gateway (DSG), CableHome, and Open Cable Applications Platform (OCAP).

The International Telecommunication Union (ITU) has approved a suite of 16 CableLabs PacketCable specifications as international standards, covering topics such as architecture, network call signaling, quality of service (QOS), support for multimedia, and other functions for providing interactive services over a cable television network using IP.

Circuit emulation/pseudowire

According to the Internet Engineering Task Force (IETF) , pseudowire emulation edge-to-edge (PWE3) is a mechanism that emulates the essential attributes of a service such as Asynchronous Transfer Mode (ATM), Ethernet, or Frame Relay over a packet-switched network.

This makes pseudowires a powerful tool for convergence, now that operators worldwide have built big Internet Protocol (IP) core networks and are extending Multiprotocol Label Switching (MPLS) towards the edge of those networks. The basic idea is that an operator has a Layer 3 MPLS network but still wants to transport legacy services, including Layer 2 services.

By using pseudowires, operators can transport legacy services that are already generating revenues, while at the same time taking advantage of the high speed and wide connectivity of IP/MPLS networks to lower the cost of legacy services and to extend them into new markets. In addition, they can support new IP services that provide new sources of revenue.

IMS

IMS (IP Multimedia Subsystem) is the latest overhyped acronym in telecom, but nonetheless an important one. Although it has its roots in the 3G mobile community, IMS is now seen by many wireline service providers as the key to migrating legacy wireline networks towards IP, next-generation networks, voice over IP, and fixed/mobile convergence.

IMS builds on the Session Initiation Protocol (SIP) to enable the creation and control of real-time IP applications like telephony, conferencing, messaging, and multiplayer games. The aim is to separate the application layer from the network layer, enabling telcos to launch new services quickly and more cheaply than before. Thus, IMS is being heralded as a savior for service providers from the onslaught of the likes of Google and Skype Ltd. .

PONs

Faced with the bandwidth limitations of copper-based broadband technologies such as DSL, telecom operators are moving towards the deployment of fiber-based infrastructure using passive optical networking that can support high-bandwidth services such as video. Several different standards have emerged as PON has continued to evolve over the last 20 years or so:

- **APON** (ATM PON) has been largely replaced by **BPON** (broadband PON), which adds features such as survivability, WDM support for video overlay, higher upstream bandwidths, and dynamic upstream bandwidth allocation.
- **EPON** (Ethernet PON) was standardized in 2004 and is the Institute of Electrical and Electronics Engineers Inc. (IEEE) 's Ethernet in the First Mile (EFM) standard. It runs at 1.25 Gbit/s symmetric and is suitable for data services.
- **GPON** (Gigabit PON), which runs at 2.5 Gbit/s downstream and 1.2 Gbit/s upstream, is being developed as a successor to BPON, and there are some suppliers delivering early versions of GPON gear. GPON will support Ethernet in addition to ATM for Layer 2 data encapsulation, and it will offer enhanced security.

Ethernet PON (EPON) is already widely deployed in Japan, with more than one million subscribers connected. Meanwhile, GPON is catching on in North America, where operators are looking at it as an upgrade path for BPON networks.

MSAPs, DSLAMs & CMTSs

DSL technology continues to dominate the broadband market worldwide. According to research firm Point Topic Ltd. , at the end of 2006 DSL accounted for a 65.7 percent share of the 281 million global broadband subscribers. Service providers are continuing to deploy DSL as a baseline access technology to meet growing demand for Internet service.

As triple-play services put ever larger demands on bandwidth, more carriers are opting to extend fiber from the central office to the street cabinet or curb, using DSL to bridge the final few hundred meters to the customer. With broadband connections moving into the tens and even hundreds of megabits, vendors are seeing increasing demand for ADSL2+ and VDSL2+ equipment.

MSAPs

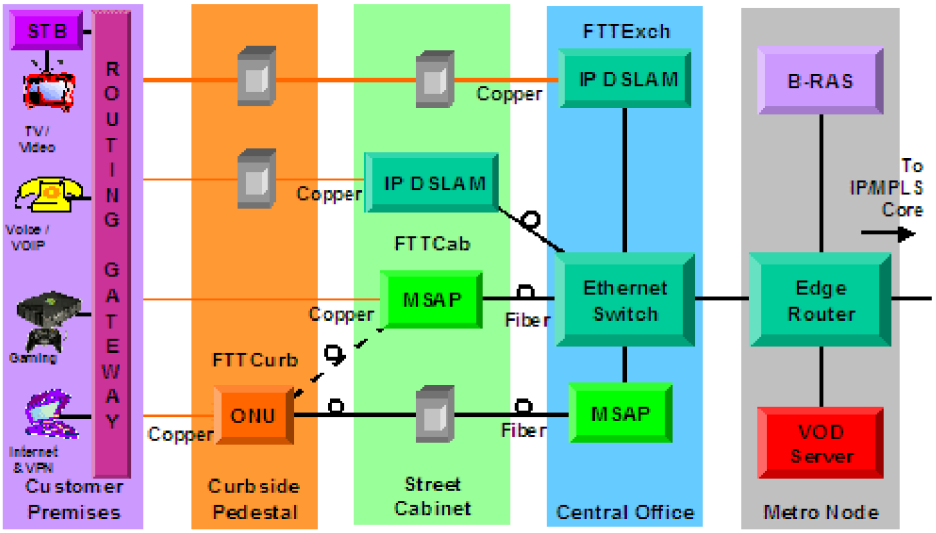
Multiservice access platforms – also known as broadband loop carriers (BLCs) or multiservice access nodes (MSANs) – have emerged as the product of choice in broadband access network buildouts. MSAPs integrate IP DSLAMs with other functions, such as VOIP media gateways, FTTx optical line terminals (OLTs), and packet transport, to handle multiple traffic types. In general the term MSAP can

refer to any DSL platform that delivers a range of services, based on IP, ATM, or TDM technology, over copper or fiber loops.

U.S.-based CLECs in particular are expected to increase their deployment of MSAPs to build out their broadband access networks in coming months, as FCC rule changes regarding unbundled network elements go into effect.

DSLAMs

DSL access multiplexers sit at the edge of carrier networks, where DSL access lines fan out to customer sites. The basic components are a stack of linecards plus an ATM switch, which helps set up and control the quality of virtual circuits running between customers and the upstream B-RAS (broadband remote access server). (See **Figure 1**)



DSLAMs

DSL access multiplexers sit at the edge of carrier networks, where DSL lines fan out to multiple customer sites. The DSLAM multiplexes the voice and data signals from customer modems/routers into a single signal that it feeds into the carrier's backbone. The basic components are a stack of multiple aggregation cards, upstream links, and power converters.

DSLAMs can be deployed in the central office (CO) or in remote terminals in the outside plant (OSP), but since DSL bit rates depend on the length of the line, carriers are ramping up deployment of remote DSLAMs in street cabinets.

IP DSLAMs

Vendors generally refer to any DSLAM with IP Layer functionality and non-ATM backhaul as an IP DSLAM. This includes not only Ethernet DSLAMs with a minimum of IP functionality, but also ATM DSLAMs with minimal or high IP functionality. The move to next-generation services and faster speeds has IP DSLAMs edging out ATM DSLAMs.

With service providers looking to boost the speed of DSL services so they can carry video, IP DSLAMs have become increasingly hot products. They can be deployed in the central office (CO) or in remote terminals in the outside plant (OSP), but since DSL bit rates depend on the length of the line, carriers are ramping up deployment of remote DSLAMs in street cabinets.

MSAPs

Multiservice access platforms – also known as broadband loop carriers (BLCs) or multiservice access nodes (MSANs) – integrate IP DSLAMs with other functions, such as VOIP media gateways, FTTx optical line terminals (OLTs), and packet transport, to handle multiple traffic types. In general, the term MSAP can refer to any DSL platform that delivers a range of services, based on IP, ATM, or TDM technology, over copper or fiber loops.

According to Windsor Oaks Group LLC , DSL ports represented 35 percent of total MSAP shipments last year, up 10 percent from 2005.

Table 2 lists vendors of MSAPs, central office DSLAMs, and outside plant DSLAMs:

Table 2: MSAP & IP DSLAM Suppliers

		IP DSLAM Central Office	IP DSLAM Outside Plant	Multiservice Access Platform
Adtran	Total Access 1200	NO	YES	NO
Alcatel	7300 ASAM	YES	YES	YES
Alcatel	7301 ASAM	YES	YES	YES
Alcatel	7302 ISAM	YES	YES	YES
Alcatel	7330 ISAM FTTN	YES	YES	YES
Alcatel	1540 Litespan	NO	NO	YES
Allied Telesis	TN9000	YES	YES	YES
Allied Telesis	TN7000	YES	YES	YES
Avilinks	Avicenia	YES	YES	NO
Avilinks	Avivid	YES	YES	YES
Asotel	Dynamix SmartDSLAM	YES		
Astoria Networks	NGNAxs 2000	YES	NO	YES
Astoria Networks	NGNAxs 2100	YES	YES	YES
Calix	C7	YES	YES	YES
C-Com	IPAM-1600			
C-Com	IPAM-2400			
Ciena	CN 1000	YES	YES	YES
Coastcom	R632	YES	NO	NO
Conklin-Intracom	FlexAccess 9000	YES	YES	YES
Conklin-Intracom	FastMux Model 2004	YES	YES	NO
Conklin-Intracom	IBAS	YES	NO	YES
Corecess	6800 APC/MPC	YES	NO	NO
Corecess	7200	NO	YES	NO

Critical Telecom	Gemini	NO	YES	NO
CTC Union	IP DSLAM			
ECI Telecom	HI-FOCuS 4	YES	YES	YES
ECI Telecom	HiFOCuS MiniRAM	YES	YES	YES
ECI Telecom	HiFOCuS MiniCAB	NO	YES	YES
Entrisphere	BLM 1500	YES	YES	YES
Ericsson	EDN 312	YES	YES	NO
Ericsson	EDA 288	YES	YES	NO
Fujitsu Telecom Europe	Geostream Access Gateway	YES	NO	YES
Harbour Networks	Hammer 10000			
Huawei	SmartAx MA 5100	YES	NO	YES
Huawei	SmartAx MA 5300	YES	NO	YES
Huawei	SmartAx MA 5600	YES	NO	
Integral Access	PurePacketNode	YES	NO	NO
Iskratel	SI 2000	YES	YES	YES
KeyMile	KEYNode	YES	YES	YES
KeyMile	UMUX	YES	YES	YES
Loop Telecom	IP 6324			
Loop Telecom	H 3780			
Lucent	Stinger FS+	YES	NO	YES
Lucent	Stinger RT	NO	YES	YES
Lucent	Stinger MRT	NO	YES	YES
Lucent	Stinger Compact Remote	NO	YES	NO
Lucent	V-16	NO	MxU	NO
Marconi	AXH 2500	YES	NO	YES
Marconi	AXH	NO	YES	YES
Motorola	USAM	YES	NO	NO
Motorola	USAM SSE 2	NO	YES	NO
NEC	AM 31	YES	NO	YES
NEC	AM 32	YES	NO	YES
NEC	AM 34	NO	YES	NO
NEC	AM 35	NO	YES	NO
Nokia	D500	YES	YES	NO
Occam	BLC 6000	YES	YES	YES
PacketFront	IPD 1000	YES	NO	YES
Pannaway	BAS	YES	YES	YES
Patton Electronics	3224 IP DSLAM	YES	YES	NO

Patton Electronics	ForeFront AIS	NO	NO	YES
Sagem	3P@c 4400E	NO	NO	YES
Sagem	3P@c 4450E	NO	NO	YES
Samsung	AceMAP IP DSLAM	YES	NO	NO
Samsung	AceMAP MS DSLAM	YES	NO	YES
Siemens	SURPASS HiX 5620	YES	YES	NO
Siemens	SURPASS HiX 5630	YES	YES	NO
Siemens	SURPASS HiX 5635	YES	NO	NO
Siemens	SURPASS HiX 5625	NO	YES	YES (from Sept. 2007)
Sumitomo Electric	MegaBit Gear CU4000 series	YES	YES	NO
TeleData Networks	BroadAccess	NO	NO	YES
Telindus	Mini DSLAM			NO
Tellabs (AFC)	Telliant 5000	YES	NO	NO
Tellabs (AFC)	DMAX 1120	YES	YES	YES
Telspec	Telmax			
Telstrat	Inteleflex	YES	YES	YES
UTStarcom	AN-2000 B-1000	YES	NO	NO
UTStarcom	UBS 4848-1GE	NO	YES	NO
UTStarcom	iAN 8000	NO	NO	YES
Zhone	2600	YES	NO	NO
Zhone	4200 IP	YES	YES	NO
Zhone	4800	YES	NO	NO
Zhone	4900 IP	YES	YES	NO
Zhone	8000 IP/ATM BLC	YES	NO	YES
Zhone	IPD 4000 IP BLC	YES	NO	YES
Zhone	IPD 12000 IP BLC	YES	NO	YES
Zhone	MALC	NO	NO	YES
Zhone	Raptor 300	YES	YES	YES
Zhone	Raptor 700	YES	YES	YES
Zhone	Raptor 100	NO	YES	NO
ZTE	ZXDSL 8200	YES	NO	YES
ZTE	ZXDSL 9200	YES	NO	YES
ZTE	ZXDSL 9800	YES	NO	YES
ZyXEL	IES 6000	YES	NO	YES
ZyXEL	IES 5000	YES	NO	YES
ZyXEL	IES 5005	NO	YES	YES
ZyXEL	IES 1248	NO	YES	NO

ATM DSLAMs

The main difference between ATM and Ethernet DSLAMs is the interior switching technology. The former use ATM switching and an ATM uplink to a B-RAS in addition to ATM in the DSL link to the subscriber. Some vendors offer ATM DSLAMs with Gigabit Ethernet backhaul capability so that they can compete on capex and opex. In some cases, incumbent network operators have used these to deploy new services using a cheaper backhaul network without disrupting their installed base of DSLAMs.

As operators shift to ADSL2+ and VDSL, demand for ATM DSLAMs is expected to continue its decline.

Cable modem termination systems

CMTSs are the equivalent of DSLAMs for the cable/MSO world. The CMTS is located in the cable headend and receives digital signals from the cable modem, which it converts into IP packets to be transmitted to an IP router.

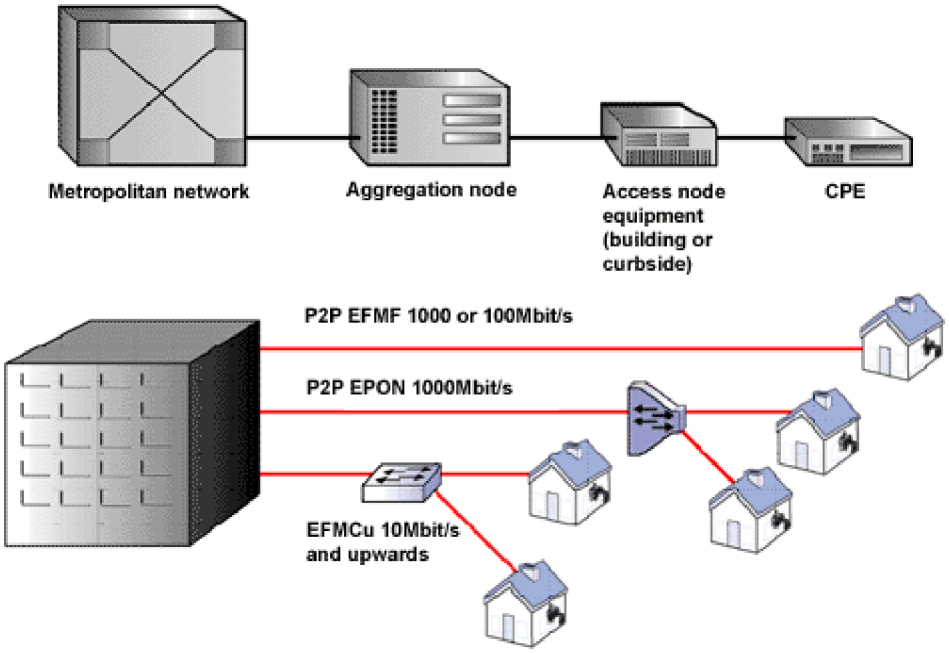
CMTS manufacturers include:

- Arris Group Inc. (Nasdaq: ARRS - message board)
- BigBand Networks Inc. (Nasdaq: BBND - message board)
- Cisco Systems Inc. (Nasdaq: CSCO - message board)
- Motorola Inc. (NYSE: MOT - message board)
- Terayon Communication Systems Inc.

Ethernet Access Devices

Ethernet has been embraced as an access technology thanks to its gigabit speeds and scaleability. The lower cost of equipment stems from the technology's overwhelming market presence and its existence as a well defined standard under the IEEE. The IEEE 802.3ah standard specifies Ethernet PON, fiber, and copper in the first mile.

In the local loop, the access node resides at a CO or point-of-presence (POP), acting as the gateway to the public network and directing data to and from the network core. (See **Figure 2**). The subscriber equipment sits on the other end of the loop.



Ethernet access devices (EADs) are a fast-growing market segment, enabling carriers to deploy high-speed services over existing infrastructure. Ethernet access is defined by the Ethernet in the First Mile (EFM) standard, IEEE 802.3, and allows carriers to expand the reach of their Ethernet services beyond fiber to copper-fed locations where high-speed services were previously unavailable.

In the local loop, the Ethernet access node resides at a central office or point of presence (POP), acting as the gateway to the public network and directing data to and from the network core. The subscriber equipment sits on the other end of the loop.

There is a broad array of vendors offering devices that provide Ethernet access over fiber or copper or via pseudowires (circuit emulation). The adoption of Ethernet over copper has been slow to take off, but carriers are eyeing the technology as a way to reach small enterprises that are outgrowing T1 lines, and as a way to differentiate their services from the panoply of Ethernet offerings on the market.

There is a broad array of vendors offering devices that provide Ethernet access over fiber, copper, or using pseudowires (circuit emulation).

Ethernet over fiber

- Accedian Networks Inc.
- Adtran Inc. (Nasdaq: ADTN - message board)
- Alcatel (NYSE: ALA - message board; Paris: CGEP:PA)
- Allied Telesis Inc.
- Amedia Networks Inc. (OTC: AANI - message board)
- ANDA Networks Inc.
- Atrica Inc.
- Aurora Networks Inc.
- Cisco Systems Inc. (Nasdaq: CSCO - message board)
- Corecess Inc.
- Foundry Networks Inc. (Nasdaq: FDRY - message board)
- Harmonic Inc. (Nasdaq: HLIT - message board)

- Juniper Networks Inc. (Nasdaq: JNPR - message board)
- Lucent Technologies Inc. (NYSE: LU - message board)
- Metrobility Optical Systems
- MRV Communications Inc. (Nasdaq: MRVC - message board)
- Narad Networks Inc.
- Nayna Networks Inc.
- Nortel Networks Ltd. (NYSE/Toronto: NT - message board)
- Omnitron Systems Technology Inc.
- PacketFront AB
- Pandatel AG (Frankfurt: PDE - message board)
- Patton Electronics Co.
- RAD Data Communications Ltd.
- Redback Networks Inc.
- Telco Systems (BATM)
- Tellabs Inc. (Nasdaq: TLAB - message board; Frankfurt: BTLA)
- World Wide Packets Inc.

Ethernet over copper

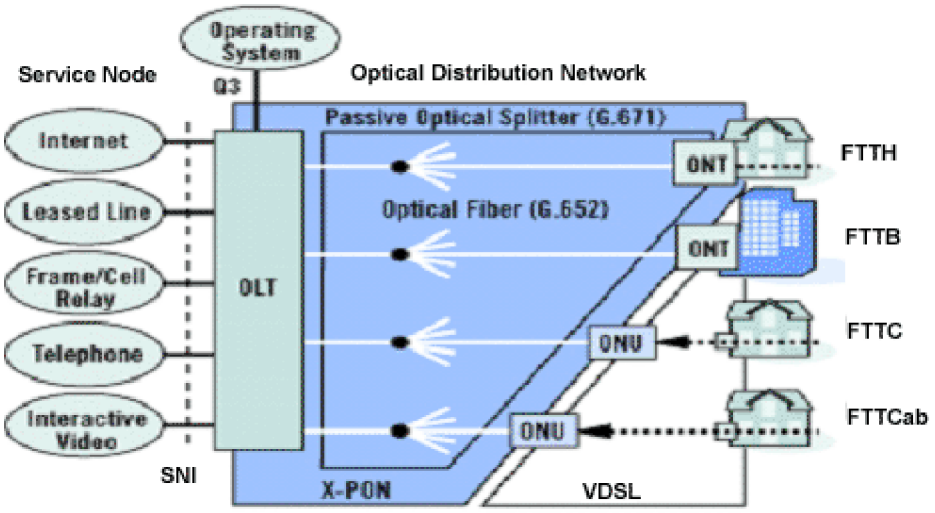
- Actelis Networks Inc.
- Aktino Inc.
- Alloptic Inc.
- ANDA Networks Inc.
- Ceterus Networks Inc.
- Ericsson AB (Nasdaq: ERIC - message board)
- Hatteras Networks Inc.
- MRV Communications Inc. (Nasdaq: MRVC - message board)
- Narad Networks Inc.
- Overture Networks Inc.
- Pandatel AG (Frankfurt: PDE - message board)
- Patton Electronics Co.
- RAD Data Communications Ltd.
- Zhone Technologies Inc. (Nasdaq: ZHNE - message board)

Circuit emulation/pseudowire

- Axerra Networks Inc.
- BroadLight Inc.
- Comtech Group Inc.
- Overture Networks Inc.
- RAD Data Communications Ltd.
- Resolute Networks Ltd.

Fiber & Passive Optical Networking

The three main elements in point-to-multipoint passive optical networking are the optical line terminal (OLT), passive optical splitters, and the optical network terminal (ONT). Depending on where the PON terminates, the system is referred to as fiber-to-the-curb (FTTC), fiber-to-the-building (FTTB), fiber-to-the-premises (FTTP), or fiber-to-the-home (FTTH). (See **Figure 3**.)



The transition to fiber in the local loop is transforming the access network. Carriers in several countries have begun the migration away from copper to high-speed fiber networks, in some cases bringing it all the way from the central office to the home.

Fiber is deployed in the access network using either passive optical network (PON) or active optical (typically Ethernet) approaches. Passive optical networking is a point-to-multipoint architecture that uses an optical line terminal (OLT) at the central office, passive optical splitters to distribute a single fiber to multiple locations, and optical network terminals (ONTs) to terminate the fiber.

There are several different types of fiber deployment, depending upon where the PON terminates:

- Fiber to the node (FTTN) – up to 1,500 meters from the premises
- Fiber to the curb (FTTC) – to street cabinets up to 150 meters from the premises
- Fiber to the premises (FTTP) – to any kind of building
- Fiber to the building (FTTB) – to an office/apartment block
- Fiber to the home (FTTH) – to individual houses or apartments

PON technology comes in three different flavors: broadband PON (BPON), Ethernet PON/Gigabit Ethernet PON (EPON/GEPON), and gigabit PON (GPON). See **Table 3** for a comparison.

Table 3: Comparison of PON Technologies

	BPON	GPON	(G)EPON
Standard	ITU-T G.983	ITU-T G.984	IEEE 802.3ah
Maximum bandwidth	622 Mbit/s symmetrical	2.5 Gbit/s asymmetrical	1.25 Gbit/s symmetrical
Supported bandwidth combinations	155 Mbit/s down - 155 Mbit/s or 622 Mbit/s up	1.25 Gbit/s down - 155 Mbit/s, 622 Mbit/s, 1.25 Gbit/s, or 2.5 Gbit/s up	1.25 Gbit/s down - 1.25 Gbit/s up
	622 Mbit/s down - 155 Mbit/s or 622 Mbit/s up	2.5 Gbit/s down - 155 Mbit/s, 622 Mbit/s, or 1.25 Gbit/s up	--
Network interfaces	ATM	ATM, TDM, Gigabit Ethernet	Gigabit Ethernet
Maximum distance*	20km	60km	20km

OLT:ONT split ratio	1:32	1:32, 1:64, or 1:128	1:16 or 1:32
* Varies in real-world deployments as the number of users on the network grows			

The battle lines for fiber access deployments are drawn on a regional basis: Carriers in North America have been using BPON; EPON has dominated in Japan; and in Europe, where local loops tend to be shorter, carriers are using active point-to-point Ethernet. But most carriers are looking to GPON and GEPON as the next step up as bandwidth requirements continue to increase.

WDM-PON is also catching on, particularly in South Korea, and being served by equipment vendors like Novera Optics Inc. WDM-PON uses multiple optical wavelengths to provide dedicated capacity of 100 Mbit/s per subscriber.

According to Infonetics Research Inc. , worldwide PON equipment sales grew 71 percent in 2006, reaching $965 million. The analyst firm reports EPON and GPON sales are growing rapidly, while BPON equipment sales are on the decline. GPON is the mostly hotly contested segment, and Siemens AG dropped out of BPON in October 2006, selling its ONT business to TXP Corp. and Siemens Sells ONT Biz.) Infonetics projects GPON equipment revenue and ports will rise at triple-digit compound annual growth rates between 2006 and 2010.

In North America, Verizon Communications Inc. is deploying BPON in its FiOS fiber-to-the-home network, but recently announced plans to switch to GPON.

A number of European incumbents are deploying FTTC and using VDSL2 over copper to reach the home for the final connection. KPN Trials VDSL2, and DT Flings Billions at Fiber Access.) The exception is France, one of the more competitive and innovative markets in Europe, where several alternative operators have embraced fiber access, and incumbent France Telecom SA is deploying FTTH.

ONT and OLT vendors are listed in **Table 3**:

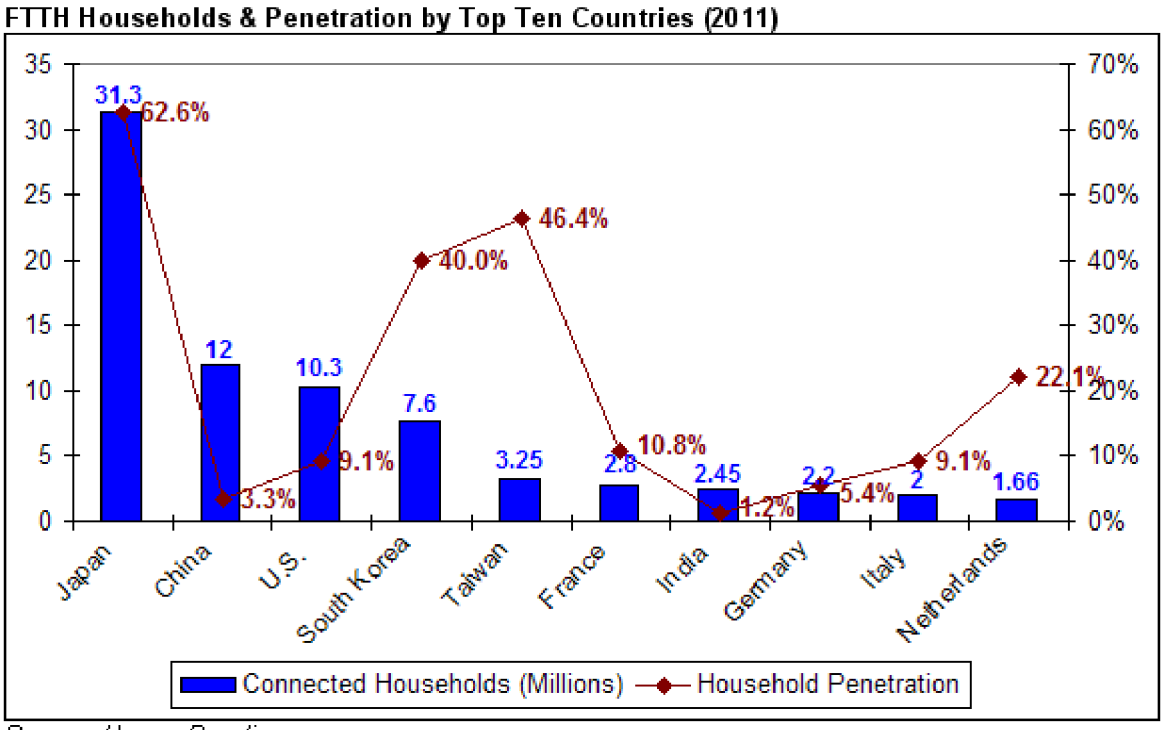
Table 3: ONT & OLT Suppliers

Company	ONTs	OLTs
Alcatel	YES	YES
Allied Telesis	YES	YES
Alloptic	YES	YES
Broadata Communciations	YES	YES
Calix	YES	YES
Carrier Access	YES	NO
Entrisphere	YES	NO
FlexLight Networks	YES	YES
Hitachi Telecom USA	YES	NO
Huawei	YES	NO
Mitsubishi Electric	YES	YES
Motorola	YES	NO
Occam Networks	YES	YES
Salira	NO	YES

Siemens	YES	NO
Sumitomo Electric	YES	YES
Tellabs	YES	YES
Terawave Communications	YES	YES
UTStarcom	YES	YES
Wave7 Optics	YES	YES

Figure 1 breaks out FTTH connectvity and penetration for the top 10 countries worldwide by 2011.

FTTH Penetration



Source: Heavy Reading

Table 4 lists PON vendors:

Table 4: PON Vendors

	BPON	GPON	(G)EPON
AFL Telecom			YES
Actiontec		YES	

Alcatel-Lucent	YES	YES	YES
Allied Telesis			YES
Alloptic			YES
Alpha Networks			YES
Alphion		YES	
Askey Computer		YES	
Broadata Communications			YES
Calix	YES	YES	
Carrier Access			YES
Centillium			YES
Comtech Systems			YES
Corecess			YES
Dasan Networks			YES
ECI Telecom	YES	YES	
Ericsson	YES	YES	
FiberHome Technologies			YES
FlexLight Networks		YES	
Fujikura			YES
Fujitsu Network Communication		YES	YES
Furukawa Electric			YES
GW Technologies			YES
Hitachi Telecom USA	YES	YES	
Huawei		YES	YES
Iamba		YES	
Matsushita			YES
Mitsubishi Electric			YES
Motorola	YES	YES	
LS Cable		YES	YES
Nayna Networks	YES		YES
NEC		YES	YES
Nokia Siemens		YES	
Oki Electric Industry			YES
Raisecom Technology Development			YES
Salira			YES

Samsung			YES
Samwoo Communications			YES
Sumitomo Electric			YES
Tecom			YES
Teknovus			YES
Tellabs	YES	YES	
Tellion			YES
Telstrat		YES	
Terawave Communications		YES	
TXP	YES		
Ubiquoss			YES
UTStarcom			YES
Wave7 Optics		YES	YES
World Wide Packets			
Zhone Technologies	YES	YES	
ZTE		YES	YES
ZyXEL Communications			YES

GPON equipment makers include:

- Actiontec Electronics Inc. - ONT
- Alcatel-Lucent (NYSE: ALU - message board) - 7342 Intelligent Services Access Manager (ISAM) FTTU
- Alphion Corp. - AOLT-4000 and AONT
- Askey Inc. - AMV4011SD GPON ONT MxU
- Calix Networks Inc. - F-Series GPON Access System
- ECI Telecom Ltd. (Nasdaq: ECIL - message board) - Hi-FOCuS
- Ericsson AB (Nasdaq: ERIC - message board) - EDA 1500
- FlexLight Networks Inc. - Optimate 2500LT, Optimate 1000NT, and Optimate 500NT
- Fujitsu Network Communications Inc. - Flashwave 6100
- Hitachi Telecom (USA) Inc. - AMN1220
- Huawei Technologies Co. Ltd. - SmartAX OFA5920
- Iamba Networks Inc. - iamba GPON Eco-System (iGES)
- Motorola Inc. (NYSE: MOT - message board) - AXS2200 OLT and ONT1000GT
- LS Cable - GPON System
- NEC Corp. (Nasdaq: NIPNY - message board; Tokyo: 6701) - SpectralWave PON
- Nokia Siemens Networks - SURPASS hiX 5700
- Tellabs Inc. (Nasdaq: TLAB - message board; Frankfurt: BTLA) - 1600 ONT and 8865 OLT
- TelStrat International - Inteleflex
- Terawave Communications Inc. - TW-800 OLT, TW-124G ONT, TW-148G ONU, and TW-500 ONU
- Wave7 Optics Inc. - Trident7

- Zhone Technologies Inc. (Nasdaq: ZHNE - message board) - MALC GPON OLT
- ZTE Corp. (Shenzhen: 000063 - message board; Hong Kong: 0763) - ZXA10
-

Home Gateways

Residential DSL gateways have begun to take center stage as broadband service providers roll out services such as VOIP and video. As the range of services on offer in broadband packages has grown, these gateways have become increasingly complex. A gateway comprises a chipset, software such as firmware and applications stacks, and various kinds of additional intellectual property, along with the physical housing for the device.

Key gateway functions include: DSL support, voice support, QOS, video support, security, remote and automatic configuration and management, and networking (Ethernet, WiFi, etc.).

Residential DSL gateways – access devices that sit in the home – have taken center stage as broadband service providers roll out converged services including Internet access, VOIP, video, and wireless LAN.

As the range of services on offer in broadband packages has grown, these gateways have become increasingly complex. A gateway comprises a chipset, software such as firmware and applications stacks, and various kinds of additional intellectual property, along with the physical housing for the device.

Key gateway functions include: DSL support, voice support, QOS, video support, security, remote and automatic configuration and management, and networking (Ethernet, WiFi, etc.).

With the growth of IPTV services and online gaming, set-top boxes and networked games consoles such as the Xbox are also serving as home gateways, but the focus here is on broadband routers.

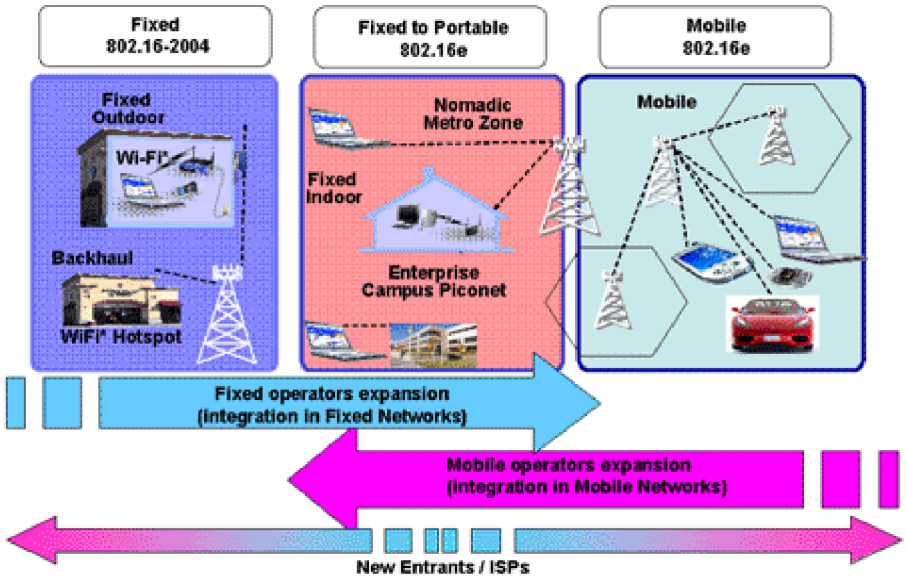
Home gateway vendors include:

- 2Wire Inc.
- Actiontec Electronics Inc.
- Allied Telesyn International Inc.
- Amedia Networks Inc. (OTC: AANI - message board)
- AVM GmbH
- Buffalo Technology (USA) Inc.
- Comtrend Corp.
- Dataflex
- D-Link Systems Inc.
- DrayTek
- Echelon
- Entone Technologies Inc.
- Foxconn Electronics Inc.
- Gemtek Systems Inc.
- Huawei Technologies Co. Ltd.
- Linksys
- Motorola Inc. (NYSE: MOT - message board)
- Netgear Inc. (Nasdaq: NTGR - message board)
- Netopia Inc. (OTCBB: NTPA - message board)
- Oki Electric Industry Co. Ltd.
- Pirelli SpA (Milan: PECI.MI)
- Royal Philips Electronics N.V. (NYSE: PHG - message board; Amsterdam: PHI)
- Ruckus Wireless Inc.
- Sagem SA

- Siemens AG (NYSE: SI - message board; Frankfurt: SIE)
- SMC Networks Inc.
- Telco Systems (BATM)
- Telsey SpA
- Thomson (NYSE: TMS - message board; Euronext Paris: 18453)
- Tilgin AB
- U.S. Robotics Corp.
- Westell Technologies Inc.
- XAVi Technologies Corp.
- Zhone Technologies Inc. (Nasdaq: ZHNE - message board)
- ZTE Corp. (Shenzhen: 000063 - message board; Hong Kong: 0763)
- ZyXEL Communications Corp.

Wireless

Wireless access equipment comes in several flavors, scaling up from local-area networking (wireless LAN) and fixed wireless to citywide WiMax. WiMax is being hyped as an alternative last-mile technology that eliminates the costly trenching and cabling of new wireline/fiber networks, while providing high-speed, carrier-grade Ethernet data communications over long distances. (See **Figure 4**.)



Wireless LAN

Wireless LAN is based on the IEEE 802.11 standard that enables devices to connect to the Internet when in range of an access point.

Access points (APs) are the radio transmitters/receivers that form the basic building blocks of a WLAN network. WLAN switches sit either at the edge of an Ethernet LAN in the wiring closet or in the corporate data center, controlling security, management, and radio functions for a network of access points. Wireless bridges provide connections among access points and can also connect multiple wired networks.

WLAN suppliers include:

- 3Com Corp. (Nasdaq: COMS - message board)
- Accton Technology Corp.
- Air Broadband Communications Inc.
- Allied Telesyn International Inc.
- Alpha Networks Inc.
- Aptilo Networks AB
- Aruba Wireless Networks
- Aurora Networks Inc.
- BelAir Networks Inc.
- Buffalo Technology (USA) Inc.
- Cisco Systems Inc. (Nasdaq: CSCO - message board)
- Colubris Networks Inc.
- D-Link Systems Inc.
- Enterasys Networks Inc. (NYSE: ETS - message board)
- Ericsson AB (Nasdaq: ERIC - message board)
- Extreme Networks Inc. (Nasdaq: EXTR - message board)
- Extricom Ltd.
- Juniper Networks Inc. (Nasdaq: JNPR - message board)
- Lucent Technologies Inc. (NYSE: LU - message board)
- Meru Networks Inc.
- NEC Corp. (Nasdaq: NIPNY - message board; Tokyo: 6701)
- Netgear Inc. (Nasdaq: NTGR - message board)
- Proxim Wireless Corp.
- Radionet Oy
- Siemens Communications Group
- SMC Networks Inc.
- Symbol Technologies Inc. (NYSE: SBL - message board)
- Trapeze Networks Inc.
- Tropos Networks Inc.
- USRobotics
- Wi-LAN Inc. (Toronto: WIN - message board)
- Xirrus Inc.
- ZyXEL Communications Corp.

Fixed/broadband wireless

Fixed-wireless access provides broadband connectivity over the air using microwave radios rather than cabling. Local Multipoint Distribution Service (LMDS) operates in the upper frequency, while MMDS uses the lower frequencies. OFDM (Orthogonal Frequency Division Multiplexing) splits up the radio signal into smaller signals that are then transmitted simultaneously over different frequencies to the receiver.

Fixed-wireless suppliers include:

- Airspan Networks Inc. (Nasdaq: AIRN - message board)
- Alvarion Ltd. (Nasdaq: ALVR - message board)
- Aperto Networks Inc.
- Axxcelera Broadband Wireless
- Cambridge Broadband Networks Ltd.

- Ceragon Networks Ltd. (Nasdaq: CRNT - message board)
- DragonWave Inc. (AIM: DWI - message board; TSX: DWI)
- Ericsson AB (Nasdaq: ERIC - message board)
- Firetide Inc.
- InfiNet Wireless Ltd.
- Navini Networks Inc.
- Nera Networks AS
- NextNet Wireless Inc.
- Nortel Networks Ltd. (NYSE/Toronto: NT - message board)
- Orthogon Systems
- Proxim Wireless Corp.
- RAD Data Communications Ltd.
- Radionet Oy
- Redline Communications Inc.
- SkyPilot Networks Inc.
- Siemens Communications Group
- Solectek Corp.
- SR Telecom Inc. (Toronto: SRX - message board)
- Trango Broadband Wireless
- UTStarcom Inc. (Nasdaq: UTSI - message board)
- Wave Wireless Networking
- Wi-LAN Inc. (Toronto: WIN - message board)
- WiNetworks Inc.
- ZTE Corp. (Shenzhen: 000063 - message board; Hong Kong: 0763)

WiMax

A number of fixed wireless vendors are expanding their product lines to include WiMax equipment – fixed and mobile – while others are getting into the game with a view to exploiting WiMax's potential in remote and emerging markets.

WiMax suppliers include:

- Adaptix Inc.
- Airspan Networks Inc. (Nasdaq: AIRN - message board)
- Alcatel (NYSE: ALA - message board; Paris: CGEP:PA)
- Alvarion Ltd. (Nasdaq: ALVR - message board)
- Aperto Networks Inc.
- Axxcelera Broadband Wireless
- Cambridge Broadband Networks Ltd.
- LG Electronics Inc. (London: LGLD - message board; Korea: 6657.KS)
- Motorola Inc. (NYSE: MOT - message board)
- Navini Networks Inc.
- Nera Networks AS
- Nokia Corp. (NYSE: NOK - message board)
- Nortel Networks Ltd. (NYSE/Toronto: NT - message board)
- Postdata Co. Ltd.
- Proxim Wireless Corp.
- Redline Communications Inc.
- Samsung Electronics Co. Ltd. (Korea: SEC - message board)
- Sequans Communications
- Siemens Communications Group
- SR Telecom Inc. (Toronto: SRX - message board)
- Strix Systems Inc.
- Telsima Corp.
- Wi-LAN Inc. (Toronto: WIN - message board)
- WiNetworks Inc.

- ZTE Corp. (Shenzhen: 000063 - message board; Hong Kong: 0763)

Free-Space Optics

FSO is a line-of-sight technology capable of sending up to 1.25 Gbit/s of data, voice, and video communications simultaneously through the air. Equipment takes the form of pairs of devices, often mounted on rooftops, that provide high-speed links over relatively short distances, normally using low-powered infrared lasers.

Free-space optics (FSO), also called free-space photonics (FSP), uses lasers or light-emitting diodes to provide optical high-speed bandwidth. FSO is a line-of-sight technology capable of sending up to 1.25 Gbit/s of data, voice, and video communications simultaneously through the air.

Equipment takes the form of pairs of devices, often mounted on rooftops, that provide high-speed links over relatively short distances, normally using low-powered infrared lasers.

The technology is often used in cities and difficult terrains where laying fiber in the ground is expensive or impractical. FSO has the potential to reach up to 10km, but connections can be disrupted by poor atmospheric conditions like fog, heavy rain, snow, or smog.

FSO vendors include:

- Alcatel-Lucent (NYSE: ALU - message board)
- Aoptix Technologies
- Cablefree Solutions Ltd.
- Canon Inc.
- Celerica
- Communication by light GmbH (CBL)
- Corning Cable Systems (CCS)
- Dominion Lasercom Inc.
- fSona Communications Corp.
- Furtera Inc.
- Holoplex Technologies Inc.
- Infrared Technologies America
- iRLan Ltd.
- LaserBit Communications Corp.
- LightPointe Communications Inc.
- LSA Photonics
- Maxima Corp.
- Mostcom Ltd.
- MRV Communications Inc. (Nasdaq: MRVC - message board)
- Omnilux
- OrAccess Ltd.
- PAV Data Systems Ltd.
- Plaintree Systems Inc. (Toronto: LAN - message board)
- Sceptre Communications (UK) Ltd.
- Silcom Manufacturing Technology
- Solectek Corp.
- Sunflower Technologies

Powerline

Broadband over powerline (BPL) is a technology that provides high-speed Internet access through electrical outlets. Also referred to as powerline Ethernet, it has attracted service providers that like the idea of using standing infrastructure to roll out high-speed services. Like wireless, it bypasses the need to lay new cable, and it can substitute for wireline in remote areas where cabling isn't feasible.

Google (Nasdaq: GOOG - message board) in particular has shown an interest in powerline: The company invested in Current Technologies LLC in 2005 and is said to be exploring BPL technology as a way to solve interference problems with its Mountain View, Calif., WiFi network. (See Current Comms Raises $130M and Google's Powerline Play.)

Powerline has faced a mixed reception as service providers begin to trial services. There are fewer than 10 commercial deployments in the U.S. and a lack of clear standards remains a large barrier to the development of the equipment market. But the HomePlug Powerline Alliance now has more than 50 member companies and is broadening its scope to work towards interoperability, while investment is flowing into the BPL equipment sector. (See First Large BPL Network Powers Up.)

Powerline equipment makers include:

- 3One Networks Inc.
- Allied Telesis Inc.
- Ambient Corp.
- Amperion Inc.
- Asoka USA Corp.
- China Gridcom Co Ltd.
- Corinex Corp.
- Current Technologies LLC
- DefiDev
- Develo AG
- Dimat
- EBA Powerline Communications LLC
- ElectroLinks Corp.
- Enterasys Networks Inc. (NYSE: ETS - message board)
- GigaFast Inc.
- International Broadband Electric Communications (IBEC) Inc.
- InovaTech
- LEA SAS
- Main.net Communications Ltd.
- Mitsubishi Electric Corp. (Tokyo: 6503 - message board)
- Motorola Inc. (NYSE: MOT - message board)
- Panasonic
- Pirelli SpA (Milan: PECI.MI)
- RFL Electronics Inc.
- Sumitomo Electric Industries Ltd.
- System Engineering International Inc. (SEI)
- Telkonet Inc. (OTC: TLKO.OB)
- VIPA GmbH
- Xeline Co. Ltd.
- Yitran Communications
- ZyXEL Communications Corp.

Source: Light/Heavy Reading

From another source:

DSLAMs, Next Generation DLCs, Fiber-to-the-User, and Fiber-to-the-Premise equipment.

DSLAMs					
	ADC	Edge RAM		Motorola	Multi-Service Access Platform
	ADTRAN	Total Access 1200, 3000/3010		NEC	AM31 Multi-Service Access Platform
	Alcatel	7300/7301 ASAM		Nokia	Nokia D500 Multi-Service Access Platform, D50
	Allied Telesyn	7000 Series, 9000 Series		Pedestal	Universal Broadband Server
	ECI Telecom	Hi-FOCuS IP, MiniRAM ODU		Samsung	AceMAP Multi-DSLAM+, AceMAP Multi-Service DSLAM
	Ericsson	Ethernet DSL Access		Siemens	SURPASS hiX 5300
	Huawei	MA5100/MA5300		Spediant	EML 8000
	Lucent	Stinger FS+		WWP	Lightning Edge
	Marconi	AXH		Zhone	Raptor ATM/IP DSLAM
NG DLCs					
	AFC	AccessMAX		Marconi	AXH
	Calix	Calix C7		Motorola	Multi-Service Access Platform
	Huawei	HONET		NEC	FA2000 Integrated Access Node
	KEYMILE	UMUX 1500/1200		Samsung	AceMAP NG DLC
	Lucent	AnyMedia Line Access Gateway		Siemens	SURPASS hiX 5500
FTTU					
	Alcatel	7340		Optical Solutions	FiberPath 500
	Alloptic	GigaForce E-PON Access System		Salira	Salira 2000 Platform - FTTU
	ECI Telecom	Hi-FOCuS FTTP		Wave7 Optics	Last Mile Link
	FlexLight	Optimate		WWP	Lightning Edge
	Hitachi	AMN1210			
FTTP					
	AFC	FiberDirect		Motorola	ONT1000 Residential ONT
	Amedia	QoStream AS 5000, PG1000		Motorola (Quantum Bridge)	QB3000/5000 OLT, QB622/155 Business ONT
	Hitachi	AMN1200		Salira	Salira 2000 Platform - FTTP
	Huawei	ST2000		Terawave	TW-600 OLT, TW-300 ONT