

# 2

## Internet Service Providers

Today, the Internet service provider (ISP) market is characterised by a huge diversity of offered services and business connections, differing significantly from the traditional telecommunications market. The further progression of Internet technologies, business innovations and regulatory and policy factors are adding to the complexity. The diversity of ISP market services and interactions is also reflected by the companies involved, ranging from niche market ISPs to global players. Their business portfolios vary from one to multiple services.

In this chapter, we investigate the Internet service market and the different types of ISPs that exist. We identify a subset of ISPs that we call Internet *network* service providers (INSPs). INSPs provide packet-forwarding services and operate Internet Protocol (IP) networks; they form the main focus of the rest of this book.

The term *Internet Service Provider*, or *ISP* for short, is commonly found in literature, with a lot of different definitions. However, most of the classification models discussed in the literature are not detailed enough for technical analysis, or they cover only a limited sub-market of the whole Internet service market as we understand it.

A common perception of the Internet service provider is that of “*an organisation that sells access to the Internet*” – an access provider, see Norton (2002). Huston (1998) defines the ISP also as an access provider that may additionally “*provide various value-added services, such as email, bulletin board services and others*”.

This notion can be found in the work of Greenstein (1999) as well. According to his study, ISPs are selling basic (smallband) Internet access and some optional services. The services provided by ISPs fall into five broad categories: *basic access, frontier access, networking, hosting and Web page design*; see Table 2.1 for the results of the survey in Greenstein (1999).

A general classification of service providers from an industry point of view shows, for example, the service provider’s initiative from Sun Microsystems (2000); it is summarised in Table 2.2. This is a more complete approach but is quite unstructured for technical analysis, as it is mixing Internet access and hosting, which are technically very different. Also, it basically ignores that many companies act in many different roles.

Lakelin *et al.* (1999) give a different classification of ISPs and their services. It is based on the size of the company and its business model, see Table 2.3.

**Table 2.1** ISP Services as in Greenstein (1999)

Service	No. of Companies
Basic (Smallband) Access	3816 (100%)
Frontier (High Speed / Broadband) Access	1059 (27,8%)
Networking	789 (20,6%)
Web Hosting	792 (20,7%)
Web Design	1385 (36,3%)

**Table 2.2** Service Provider as in Sun Microsystems (2000)

Role	Services	Companies
Internet Service Provider	Access, Hosting, Email	AOL, Mindspring, @Home
Network Service Provider	High Bandwidth, Backbone Services, VoIP, VPN	Level (3), Concentric, Qwest, UUNet
Application Service Provider	Storefront, Help Desks, Enterprise Resource Planning, . . .	Digex, GTE, Savvis, Vantive, Siebel, Oracle, Corio
Full Service Provider	Turnkey Enterprise Services, Supply Chain, IT Services	EDS, AT&T Worldnet, Exodus
Portals	Aggregate Content, Destination	Yahoo, Excite@Home, AOL

**Table 2.3** Service Providers as in Lakelin *et al.* (1999)

By Business Model		By Size
Online Service Providers	Cable Operators	Local ISPs
Incumbent Telecoms	IT companies	National ISPs
New entrant Telecoms	Brand driven ISPs	International ISPs

The approaches shown above are not comprehensive and structured enough to express the variety of the diverse ISP business – from access providers over Content Delivery Networks (CDN) to Communication Service Providers (CSP) – and at the same time the technical functions of the ISPs. Most of them focus too strongly on the Internet access market, neglecting other important Internet services, for example, caching and hosting services.

We propose a role model that describes the different technical roles that can be found in the business portfolio of actual ISP companies. Each role is used to provide a well-defined set of services; therefore, the individual roles and their relationship form a solid basis for scientific, technical or economical studies. Real-world ISPs typically act in more than one role of the role model. Therefore, the role model can also be used to classify existing ISPs, to describe the differences between two ISPs or to describe and analyse market trends.

Our role model and definition of ISPs is introduced in the next section, it is then used in Section 2.2 to classify a selection of well-known real-world ISPs.

## 2.1 A Classification Model for ISPs

We will now describe the relationship between a (real-world) company with its services and/or support functions and a role. It is essential to separate a role and a (real-world) company. A **company** is defined as a real-world entity that is taking on one or more roles. A **role** represents a group of functions to provide a set of related services to customers (see Figure 2.1). **Functions** can be divided into internal functions, which do not directly affect the customers and **services** (external functions) that are offered to the customers.

*Example:* Real-world ISPs like AOL (America Online) are often engaged in more than one role. AOL, for example, provides Internet access to its subscribers. This is its core role. However, AOL also offers web space, email, online games and a marketplace for other companies to sell their products.

One role, for example, that of offering Internet access, consists of several services, like the Internet dial-up access by modem, ISDN (Integrated Service Digital Network), cable or DSL (Digital Subscriber Lines). Internal functions in that context involve authentication and accounting actions by the provider or the operation of a routing protocol; they are transparent to the customer.

Using Constantiou and Altmann (2003) as basis, we derive the following detailed role model.

### 2.1.1 Definition of Internet Service Providers

The term **Internet service provider (ISP)** is used as an umbrella term for information providers, server service providers, Internet network service providers (INSP):

- An **ISP** is a company whose core business consists of at least one of the ISP roles of Figure 2.2.  
Similarly, an **Information Service Provider** is defined as a company whose core business consists mainly of one or more of the information provider roles of Figure 2.2. **Server service providers** and **Internet Network Service Providers (INSPs)** are defined accordingly.
- **Information Service Provider roles** provide services that offer different kinds of information via the Internet. **Storage Service Provider Roles** provide basic and sophisticated services for storing and distributing this information. **INSP roles** provide services to forward this information via IP packets towards their target.

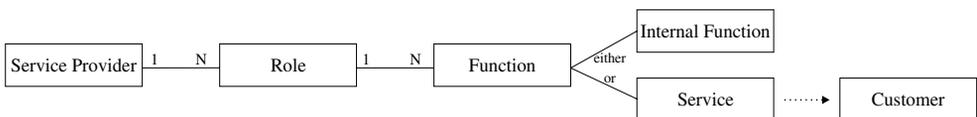
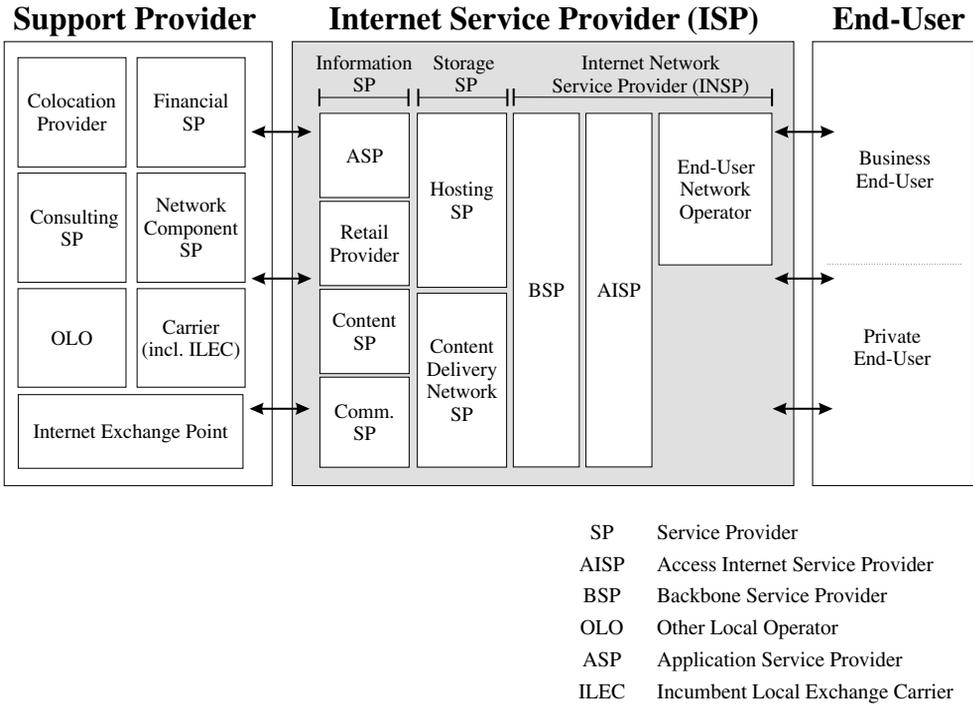


Figure 2.1 General Role Model



**Figure 2.2** ISP Role Model

*Examples:*

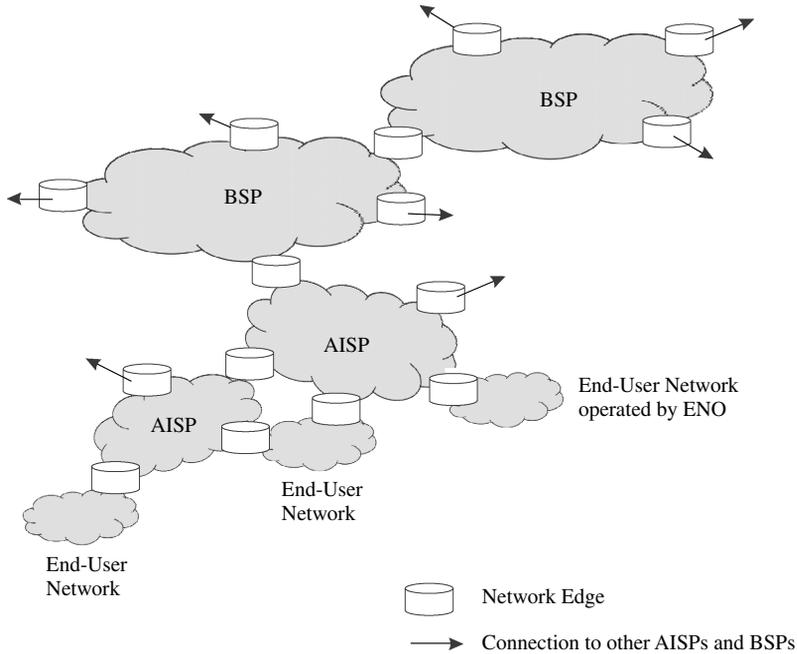
- AOL is an ISP because by offering content and communication services, it acts in the information provider role. By offering access service, it acts at the same time in the INSP role.
- Deutsche Bank offers online banking service and is therefore acting as content provider, which is a role of information providers. But as the core business of Deutsche Bank includes different roles (banking and brokering roles), Deutsche Bank itself is not an ISP. For more examples, see Section 2.2.

Next, a detailed description and a short discussion of the different roles found in Figure 2.2 is presented.

*2.1.2 Internet Service Provider Roles*

The ISP roles can be classified as follows (see Figure 2.2).

- The **Internet Network Service Providers (INSPs)** are responsible for the Internet connectivity; they operate a network and offer packet forwarding services. There are three types of INSPs:
  - The **ENOs (End-user Network Operators)** operate end-user network edges,



**Figure 2.3** INSP Roles

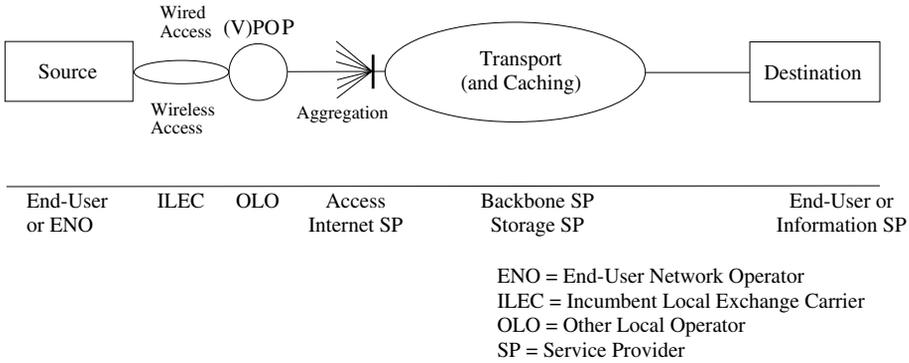
- the **AISPs (Access ISP)** aggregate and forward the traffic of network edges and
- the **BSPs (Backbone Service Providers)** forward traffic without direct contact to end-user network edges (see Figure 2.3).
- The **Storage Service Providers** offer server and storage space in the Internet. Other ISPs might depend on this to be able to offer their own service or employ the storage services (e.g. caching) to improve the performance of their own services.
- **Information Service Providers** offer information. They cover the higher Internet layers. Their information is carried by INSPs to the end-user.

How the information flow is affected by different ISPs is described exemplarily in Figure 2.4:

- End-users, for example, access the access provider's network via a modem or DSL connection to a point-of-presence (POP) or a virtual point-of-presence (VPOP) of the access provider.

A POP can be described as a node in the INSP's network topology. The routers, switches, servers and other equipment of an INSP are located at its POPs. Typically, these POPs are geographically distributed to keep the distances to customers and interconnection partners short. The size of an INSP is often measured by the number of POPs it is operating.

The difference between a POP and VPOP is that the latter does not actually belong to the ISP; it is only a leased access to another company's POP.



**Figure 2.4** Information Flow from Source to Destination (Example)

- The access medium (e.g. voice line, cable, radio transmission) from end-user to the (V)POP is usually owned by an Incumbent Local Exchange Carrier (ILEC).
- The AISP aggregates the data from many end-users and transports it via its own network and that of other connected AISPs' and BSPs' networks to the destination. The destination can be other end-users or information service providers.
- Depending on the type of the application used, storage service providers (SSPs) may provide caching space.

### 2.1.2.1 Internet Network Service Provider (INSP)

#### *End-user Network Operator (ENO)*

An *End-user Network Operator (ENO)* manages the network of an end-user and the network edge<sup>1</sup>.

The services include forwarding the packets within the business end-user's network to the access point of the access ISP (AISP) as well as administration and support services. In the layer reference model (Figure 4.1), most of these services would be considered as layer 3 services. Supplementary services include the administration of an IP address pool, the operation of DNS servers and web caches as well as managing security issues.

The role of the ENO is usually filled out by a department of the business user's company or by a facility within a university.

#### *Access Internet Service Provider (AISP)*

The *Access Internet Service Provider (AISP)*<sup>2</sup> connects end-user networks with the Internet and forwards their IP packets toward their destination.

<sup>1</sup> The network edge is a connection between two networks. For a detailed definition, see Section 9.

<sup>2</sup> As shown above, in related works, the term *ISP* is often used as a synonym to *AISP*, to the combined portfolios of AISPs, OLOs, ILECs or sometimes to application service providers. In this book, we distinguish between the AISP role and the generic term ISP.

AISPs aggregate traffic from network edges and forward it directly to the destination host, if that host is reachable from within their network. Otherwise, the traffic is forwarded to other AISPs and BSPs (see Figure 2.4).

The ownership of local infrastructure is not a prerequisite to accomplish this as they can lease the needed infrastructure from OLOs and ILECs. This has been the case, particularly in the past, and for small AISPs. As the tendency of today's AISPs is to build up their own local networks to minimise costs and increase profit (see Lakelin and Wood (2000)), the OLO support role becomes more and more irrelevant.

The AISP market is going through a consolidation phase, in which business failure, mergers and acquisitions have all been important factors. Today, the top 10 AISPs in the United States account for almost three out of four Internet users. Only a year before, the top 10 accounted for less than half of them, see Boardwatch (2004), (i). The stiff competition in the market forces the AISPs to search for possibilities to stand out from the crowd, by acting in other roles as a content provider, for example.

### ***Backbone Service Provider (BSP)***

A *Backbone Service Provider (BSP)* provides packet forwarding services without direct contact to the end-user networks; typically across long distance.

BSPs operate large Internet backbone networks, aggregate the traffic from AISPs and transport them over their networks. A backbone network is supposed to have large capacities while concurrently spanning large geographical areas. There are only a few BSPs that operate worldwide, but almost every country with former state monopolies has at least one big national backbone provider (e.g. Deutsche Telekom AG in Germany).

The difference between AISPs and BSPs is that BSPs do not offer services directly to end-users. The most clearly defined BSPs, in the sense of our definition, are the *tier 1* BSPs. They operate large backbones that interconnect solely by peering (see Section 9.2.2) and do not need to purchase transit (see Section 9.2.3) from any other backbones. We will further discuss these thoughts in Chapter 9. Major worldwide BSPs include MCI<sup>3</sup>, AOL, Qwest and Sprint.

Another difference between AISPs and BSPs is their revenue drivers. AISPs have to make revenue with a relatively small number of users, whereas BSPs' revenue driver is the volume transferred over their network. The distinction between both categories is becoming more and more blurred, however, as BSP companies are also starting to act in the end-user market by offering Internet access and added services to business users, see Huston (1999a).

## **2.1.2.2 Storage Service Providers**

### ***Content Delivery Networks***

A *Content Delivery Network (CDN)* provides a platform based on overlay networks operating on top of the actual IP infrastructure. This allows information service providers to distribute their content without having to manage infrastructure.

---

<sup>3</sup> Previously called WorldCom respectively MCI WorldCom.

CDNs use specialised web-caches or video-caches to push replicated content close to the end-users. This service can be important for information providers if their services depend on very short retrieval times. For example, content providers who have to transfer large data volumes like videos to their customer in a short time could use this type of service.

CDNs get their revenue in most cases directly by charging the information provider that produces the data, not the end-user. A famous example for company offering CDN services is Akamai Technologies Inc. (2006).

As new services are offered in the CDN role, the market is further developing; one new service is enterprise CDN (eCDN). Different from content delivery or basic caching in that it goes beyond the traditional methods, eCDN allows enterprises to preposition specific content in certain caches for specific users and user groups. Akamai, Sprint, Qwest, Equant and IBM offer eCDN services, see, for example, Boardwatch (2003), (iii) or Akamai Technologies Inc. (2002).

### ***Hosting Service Provider***

The *Hosting Service Provider* offers housing, serving and maintaining storage space and files for customers. The services range from maintaining pure storage space over offering shared file systems to hosting Web sites and maintaining FTP servers. The services typically use layer 5 protocols.

The services also include periodic backup and archiving as well as consolidation of data from multiple customer company locations. This enables efficient data sharing. To realize the offered services, most hosting service providers use server farms<sup>4</sup> and the services of colocation providers (see below).

The hosting services can be divided into virtual and dedicated hosting. Often, “hosting” and “virtual hosting” are used as synonyms. *Virtual hosting* is the provision of hosting services so that a company does not have to buy servers with permanent connection to the Internet. Some virtual hosting service providers make it possible for customers to have more control of their files and Internet connection by providing a virtual server. *Dedicated Hosting* on the other hand provides customers with a dedicated server. The dedicated server can be rented at the provider’s location or a customer can place his own equipment at the provider’s location.

The spectrum of the offered services ranges from subscriber free space (as value-added service of AISPs like AOL for private Web pages) to extensive business solutions for other ISPs and business customers. For a complete hosting service, fast connections to the web pages are needed. Therefore, more and more hosting service providers engage in the CDN business field, see Boardwatch (2003), (iv).

---

<sup>4</sup> A server farm is a group of computers acting as servers and housed together in a single location, often under the control of a colocation provider. Server farms need a huge amount of power, typically 10 to 20 megawatt of power, to keep their servers running and cooled (see Abreu (2001)).

### 2.1.2.3 Information Service Provider

#### *Application Service Provider*

The *Application Service Provider* offers access over the Internet to applications and related services that would otherwise have to be executed and managed locally.

The applications are normally accessed via a Web browser interface. The service of an application service provider<sup>5</sup> enables companies to move applications from desktops to dedicated application servers, having now only a centralised server to maintain instead of a larger number of workstations. The applications offered range from high-end enterprise resource planning and supply-chain management systems (such as those offered by Oracle and PeopleSoft) to simpler groupware and officeware applications. Service level agreements, covering bandwidth availability, software mechanisms and technical support, are also typically offered, see Lakelin and Wood (2000).

Essentially, the application service provider business model works by reducing infrastructure and management costs (using economies of scale) as it aggregates the infrastructure of multiple IT companies.

#### *Retail Provider*

The *Retail Provider* can be seen as a merchant that offers its products or provides a marketplace for other companies' products over the Internet.

Often, retail providers simply use their Internet presence to increase the sale of their regular business. This method is often referred to as *multi-channel retailing*. However, there are a lot of companies that are only engaged in the retail provider role (e.g. Amazon or Ebay).

Internet marketplaces can be classified by defining whether the two involved parties are of the business type (B) or of the customer type (C) (see Table 2.4).

#### *Content Provider*

The *Content Provider* creates or augments content. That content can be news, audio and video content, etc.

**Table 2.4** Classification of Internet Markets

		Demand	
		B (=business)	C (=consumer)
Supply	B (=business)	<b>B2B</b>	<b>B2C</b>
	C (=consumer)	<b>C2B</b>	<b>C2C</b>

<sup>5</sup> A list of the top 25 application service providers from January 2004 can be found at ASPnews (2004).

Usually, content providers operate a central server to store their content or use the service of storage service providers. The services of this role range from offering company and product information on web pages to offering video-on-demand. Another type of content providers is comprised of information services like search engines (e.g. Google) and encyclopaedias (e.g. WhatIs?com) that are published on the Internet. Typically, content providers either charge the end-user directly or more commonly try to finance themselves by advertising.

### ***Communication Service Provider***

The *Communication Service Provider* offers Internet-based communication service like email, chat, e-cards and voice over IP (VoIP).

For example, companies such as GMX are offering unified messaging services to enable their customers to combine the vast communication options in one service; a customer can thus combine non-Internet-based services like fax or SMS with the Internet service platform.

Communication service providers currently expand their offered services to gain a higher market share and to increase their per user profit. Some of the added services are spam protection and anti-virus applications. Most of the companies are performing in more than just the pure communication service provider role; typically, they are also engaged in the application and hosting service provider roles.

#### ***2.1.3 Support Provider Roles***

The support provider roles offer services that support and keep the ISP roles running. The services include layer 2 connectivity services, financial transactions and the supply, maintenance and service of technical equipment.

##### **2.1.3.1 Carriers**

###### ***Incumbent Local Exchange Carrier (ILEC)***

The *Incumbent Local Exchange Carrier (ILEC)* closes the local loop to the end-user by offering layer 2 connectivity between the edge router of the end-user to a POP of the AISP.

The ILECs are telecommunication providers with their own circuit-switched local-loop networks. Originally, many ILECs did not have any IP infrastructure and therefore no possibility to connect directly to the Internet; they needed OLOs (see below) to do so (see Figure 2.4). The offered services are layer 2 and layer 1 services (see Figure 4.1). In most countries, ILECs are affected by telecommunication regulations, as they normally use voice lines that underlie additional regulation. An exception is modern broadband connections like ADSL, which are only used for data transportation. This has a big influence on the number of players in this segment. In the past, there was normally only one big state-owned monopolist per country. This was especially true in Europe. With a

growing deregulation of the telecommunications market in Europe, this type of service is offered by a growing number of companies.

The ILECs used to play a very important role in the Internet service market, for without the local-loop infrastructure of the ILECs, Internet access would not have been possible for so many people, and the prices would have been higher. In the future, it will probably be difficult to find companies offering ILEC-only services, as they will tend to enhance their portfolio to act as a combined ILEC/OLO/AISP role, see Lakelin and Wood (2000).

The trend in the ILEC market goes towards broadband access, thus replacing the Plain Old Telephone Service as the access medium. However, the revenue is mostly gained by POTS and not by broadband service. This is not expected to change in the near future, thus making ILECs depend on POTS in the short to medium term, see Boardwatch (2004), (ii). Deutsche Telekom AG in Germany and the Regional Bell Companies in the United States provide the services of the ILEC role.

### ***Long-Distance Carrier***

*Long-Distance Carriers* provide INSPs with layer 1 and 2 connectivity, for example, leased lines, between two POPs.

This service is needed as not all INSPs can afford or want to buy the infrastructure for their own networks. In some countries, the telecommunication sector is still regulated and INSPs are not allowed to own the layer 2 infrastructure for their networks. Leased lines range from POTS telephone cables to optical lines. The players in this segment are generally the former telephone monopolists who also provide the ILEC service like Deutsche Telekom AG in Germany and the Regional Bell Companies in the United States as well as new players providing high-bandwidth infrastructure.

High-bandwidth services also include dark fibre services, see, for example, Dominion Telecom (2004). The dark fibre service offers customers fibre strands to which they can apply their own optronics to light the fibre. Today, dark fibre services are usually available in MAN markets, as only 5–10% of office buildings have fibre access. Nevertheless, the dark fibre market is expanding because of the dramatic price reductions and the increasing flexibility of dark fibre contracts.

### **2.1.3.2 Other Local Operator**

*Other Local Operators (OLOs)* typically offer translation services from the ILEC's telecommunication layer 2 networks to the AISPs layer 3 (IP) networks.

The OLO service portfolio includes services like termination of calls, indirect access and number translation. The reason for the existence of the OLOs lies within the offered portfolio of the ILECs. At the beginning of the Internet, a lot of telecommunication-based ILECs were very slow in investing in IP technology. This opened a market segment for the OLOs that connected the ILECs to the Internet by providing the modem banks to translate between the circuit-switched Plain Old Telephone Systems (POTS) and the IP backbone infrastructure. With increasing competence in IP technology in the telecommunication companies, the importance of pure OLO services has decreased rapidly. The OLO role

will instead be part of the ILEC or AISP service portfolio (like Deutsche Telekom AG, which provides switching services for small ISPs), see Lakelin and Wood (2000). The trend towards broadband access, in particular, makes OLOs pointless, as the medium itself is digital and therefore does not need any translation services.

### **2.1.3.3 Internet Exchange Points**

The *Internet Exchange Point (IXP)* provides an exchange point in which ISPs can connect with one another in interconnection arrangements.

The structure of the exchange point can range from one exchange facility to several exchange facilities, connected with each other. The IXPs are a key component of the Internet backbone as they offer the possibility of global connectivity. Typically, an INSP is connected to a number of IXPs and these IXPs to a large number of peering partners. The IXP and interconnection topic will be discussed in more detail in Part III of this book.

### **2.1.3.4 Colocation Provider**

A *Colocation Provider* provides carrier-neutral data centre services as well as management services.

The data centre, also called *colocation* facility, is a network-connected secure commercial facility for the housing of carrier and IT infrastructure. Colocation providers also offer services such as equipment housing, on-site engineering and maintenance. The carrier-neutral data centres enable ISPs to manage their own connectivity by negotiating directly with underlying carriers. Two players of this role are Telehouse Europe and Interaxion.

### **2.1.3.5 Financial Service Provider**

A *Financial Service Provider* provides services around the money transfer between the provider and the customer.

The most typical form of the financial service provider role is that of a service provider who takes over the billing for his customers. An example of such a provider is the billing specialist Aurora UK Ltd, see Boardwatch (2003), (vi).

### **2.1.3.6 Consulting Service Provider**

The *Consulting Service Provider* offers consultant services to their customers. Its services cover help on how to run an ISP through all of the company life phases.

Network-specific consulting services are especially appealing for small ISPs that often cannot afford to build up the specialised know-how needed to run their business.

There are two kinds of companies performing the consulting service provider role in the Internet market. The first are independent companies, like Accenture, that specialise in the consulting business. The others are companies that offer a product in a different segment. SAP, for example, has their own consulting department to implement their products.

### 2.1.3.7 Network Component Service Provider

The *Network Component Service Provider* offers and maintains hardware and software components that are necessary to operate the Internet infrastructure.

They can be differentiated by the type of components they sell to hardware component service providers (e.g. Cisco) and software component service providers (e.g. Oracle). Examples of the offered components are routers, line cards and web servers. Providers that offer installation and maintenance services for these components are also classified as network component service providers.

### 2.1.4 End-users

Another key part of the Internet market, besides support providers and ISPs, are the end-users who consume the offered Internet services. End-users are classified into *business end-users* and *private end-users*.

The **business end-users** are business entities that use Internet services to generate revenue. The offered services possess the character of investments. The **private end-users**, on the other hand, consume the offered Internet services while using the Internet for private purposes.

## 2.2 Classification of Selected Providers

Today, the top 10 AISPs in the United States account for almost three out of four Internet users. AOL and MSN, the top two ISPs, alone account for 41% of the Internet users, see Boardwatch (2004), (i). The stiff competition in the market, mainly on the DSL and flat rate markets, forces the AISPs to search for possibilities to stand out from the crowd. The trend goes to generating more revenue from e-commerce transactions and advertising. AOL, for example, offers among other services, a news portal, online gaming, online shopping, and Services For Mobile Phones (SMS), additionally to their access service, see America Online (2006). So AISP companies rarely act solely in the AISP role, they tend to add services to their business portfolio to gain a better market position, see Lakelin and Wood (2000). This expansion trend of AISPs tends to be towards the information provider roles at the moment and can be found throughout the market. Cooperations between AISPs and other ISPs are common as well, for example, AOL has Google's search service embedded within their homepage.

This is just an example from the AISP market and can be found in most of the other markets as well. The tense economic climate in the world forces the competition in almost all of the ISP markets to heat up, thus forcing the companies to find new revenues by differentiating themselves from others. A common possibility to accomplish this is by providing additional value-added services. As can be seen in the following Figure 2.5, most companies act in more than one role. To show that the described role model complies

	Internet Service Provider							Support Provider							
	INS P	SSP	IP												
End-User Netw. Op.	Access ISP	Backbone SP	Content Delivery Netw.	Hosting SP	Application SP	Internet Retailer	Content Prov.	Communication SP	Carrier	OLO	IXP	Colocation Prov.	Financial SP	Consulting SP	Network Comp. SP
Akamai			●	○											
Amazon, Ebay						●									
AOL	●			○	○	○	○	○							
Cable&Wireless	○	●		○										○	
T-Online	●	○		○	○	○	○	○							
DFN	○	●													
GMX	○				○		○	●							
Google							●								
HRZ	●														
MSN	●				○	○	○	○							
Oracle, SAP					●									○	○
Sprint		●	○	○					○	○		○			
WorldCom	○	●		○											
Aurora													●		
Cisco															●
T-Mobile	○														
T-Com		○							●	○					
Interaxion												●			
LINX, DE-CIX											●				

Abbr	Kind of Role
●	Core Role
○	Additional Role

**Figure 2.5** Classification of Selected Providers

with reality, actual companies and their services in the Internet market are classified using the role model derived above.

*Akamai*

Akamai Technologies offers software and services to enable companies and government agencies to deliver Web content and applications (including video and other high

bandwidth content). Through its network of more than 14,000 servers in 70 countries, Akamai services analyse and manage Web traffic, transmitting content from the server geographically closest to the end-user using Akamai's EdgeSuite product. The company also offers audio and video streaming services, content targeting applications and consulting services. According to the introduced role model, Akamai's main role is that of a content delivery network service provider.

### *America Online*

America Online (AOL), the Internet division of Time Warner, is the world's largest AISP with more than 30 million subscribers using its services. AOL customers are mainly private end-users. The revenue mix of subscription, advertising, e-commerce services and Internet sales also reflects the ISP roles involved. According to the introduced role model, AOL is an AISP company, which incorporates the following roles.

- Access ISP: This is the core role. AOL offers dial-up service as well as broadband to end-users.
- Hosting Service Provider: AOL offers web space and hosting services on its servers for end-user homepages.
- Application Service Provider: Online gaming is one example for the application services offered by AOL.
- Internet Retailer: AOL offers on its homepage a marketplace for other Internet retailers to sell their products. AOL gets a commission on total sales revenue.
- Content Provider: Videos, news and various other content are offered mainly for AOL subscribers, but some content is offered for the public as well.
- Communication Service Provider: AOL offers email services as well as mobile services such as sending mobile messages.

### *Amazon and Ebay*

Amazon offers millions of books, CDs, DVDs and videos, as well as toys, tools and electronics. It has a large market share, especially in the Internet book sales market. According to the introduced role model, Amazon is a classical Internet retailer.

Ebay offers a marketplace for all kinds of used and new products. As a marketplace provider, it is also classified as Internet retailer according to the introduced role model.

### *Deutsche Telekom and T-Online*

Deutsche Telekom is the biggest telecom company in Europe and one of the largest in the world. It is divided into four subsidiaries. Its **T-Mobile International** division serves wireless phone customers. The **T-Com** unit is one of the largest carriers in Europe with about 58 Million connections. The company's **T-System** division is specialised in IT services. And finally, the **T-Online** subsidiary, with 13.1 million customers, is one of the leading ISPs in Europe:

T-Online has a diverse business model with both access and non-access businesses in its portfolio. According to the introduced role model, T-Online is, like AOL, an Access ISP that incorporates the following roles.

- Access ISP: This is the core role. T-Online offers dial-up service as well as broadband to end-users.
- Hosting Service Provider: T-Online offers web space and hosting services on its servers for end-users' homepages.
- Application Service Provider: The web-based organiser is one example for the application services offered by T-Online.
- Content Provider: T-Online offers videos, news and various other content to its subscribers. Part of the content is also publicly available.
- Communication Service Provider: Email services as well as international roaming access are offered by T-Online in its role as communication service provider.

### *DFN*

DFN – Deutsches Forschungsnetz – is Germany's National Research and Education Network (it is similar to other nations' research networks). Its main tasks are to provide backbone infrastructure to the German research and education community and to create a testbed for science and development of new techniques. According to the introduced role model, DFN is a backbone service provider company that incorporates the following roles:

- Backbone Service Provider: This is the core role. DFN operates a backbone network, the *G-WiN*. Considering the size and geographical spread of the *G-WiN*, DFN can be considered as a national BSP.
- Access ISP: DFN offers the *DFN@home* service for students and scientists who want to access the network of their institution from their home computers.

### *GMX*

GMX offers paid and free email services. To differentiate itself from other companies and to gain more revenues, it added new services like Internet access, online virus scans and an online organiser. GMX is one of the top five email service providers in Germany, see ECIN (2003). According to the introduced role model, GMX is a communication service provider company that incorporates the following roles.

- Communication Service Provider: This is the core role. GMX's main services are the different email services. Included in their ProMail service are additional Communication Service Provider services like fax and voice messages.
- Access ISP: GMX offers access to Internet, using different price schemes like flat rate, volume-based and time-based pricing.
- Application Service Provider: The applications provided by GMX are, for example, an online organiser.

- Content Provider: News and Information about sports, entertainment, lifestyle and much more are provided on the GMX portal.

### *Google*

Google offers a targeted search engine that indexes and ranks Web sites according to the number of links leading to that site. Google is the most-used site in the world for Web searches, it serves more than 80 million users per month<sup>6</sup>. Other Google offerings include newsgroup sites and the web-based email service Googlemail; in addition, it licences its technology to other companies like America Online. According to the role model, Google is a content service provider but also active as communication service provider.

### *University Network Centres*

University Network Centres like, for example, the “Hochschul-Rechenzentrum”, of the Darmstadt University of Technology operate university networks and manage the network edge (connection) to the universities’ AISPs. According to the role model, these network centres are end-user network operators.

### *Sprint*

Sprint is a global communications company that operates a tier 1 Internet backbone. Sprint is one of the largest BSPs, serving 26 million business and end-users in more than 100 countries. According to the introduced role model, Sprint is a backbone service provider company that incorporates the following roles.

- Backbone Service Provider: The core role. Sprint operates a Tier 1 Internet backbone network.
- Content Delivery Network/Hosting Service Provider/Colocation Provider: Spring also provides global voice, video, data and Internet communications services, web hosting and colocation services.
- Carrier/ILEC: The company’s telecommunications operation provides local telephone service through over eight million access lines in 18 states.

## **2.3 Summary and Conclusions**

The Internet service provider (ISP) business is a complex, relatively new and quickly evolving business. This book deals with INSPs, which are ISPs that offer packet forwarding services. The different types of INSPs were discussed in this chapter, also supporting providers like Internet exchange points and carriers that are relevant, for example, for interconnections (see Part III of this book) were discussed here.

For the discussion, a role model for ISPs was introduced. The main advantage of this model is that it reflects the real world and can thus be used to classify and compare actual

---

<sup>6</sup> According to Nielsen/NetRatings 06/03 cited at [www.google.com/corporate/facts.html](http://www.google.com/corporate/facts.html).

ISP companies with each other. This was demonstrated towards the end of the chapter, in which several ISPs were classified using the model. At the same time, the individual roles the model contains describe exact sets of closely related technical services and can be used for analysis of individual services, for example, in technical and scientific works. We make reference of these roles in the rest of this book.