

Telecommunication Service Providers

This lecture provides an overview of the technologies used by telecommunication service providers. These technologies are the focus of this course.

After this lecture you should be able to: explain the role of access, switching and trunk technologies and give several examples for each. You should also be able to define the terms and acronyms described in this lecture.

Telecommunication Service Providers

Telecommunication service providers (“carriers”) include companies that started as telephone companies (Telus, AT&T), as cable television companies (Shaw, Comcast), as providers of internet services (Google) and as providers of long-distance data links (Level3).

Public service provider’s networks operate under very different conditions than LANs that usually provide service only for the network’s owners and are located inside one building.

Some of these differences include:

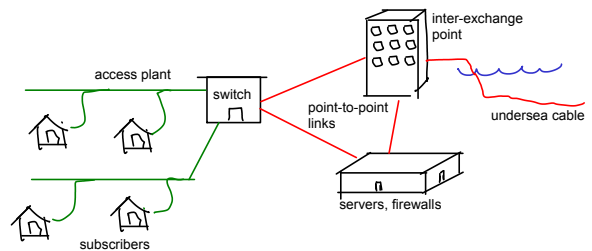
- the geographic scope of the networks is much larger. These networks usually provide worldwide connectivity, often through agreements to exchange data or connect calls with other service providers.
- aggregate data rates are much higher than on a LAN.
- the number of users is much larger. Many service providers have tens of millions of subscribers and addressable devices.
- usage must usually be tracked for billing purposes
- large amounts of remotely-located equipment must be monitored and redundant equipment activated when problems are detected
- government regulations often constrain the types of services that can be provided and often the pricing
- equipment is often installed in locations where vandalism and environmental extremes are an issue

- subscribers usually have expectations of communication privacy and data security

Exercise 1: Make a (very) approximate estimate of the revenue generated by telecommunication service providers in Canada based on an estimate of the population and your estimate of the average revenue per person. Compare your answer with other student’s estimates. Make a similar estimate for another service industry or utility and compare them.

Network Architecture

Service provider’s telecommunication networks are organized hierarchically as in the example below:



- a local access technology connects subscribers to a location owned by the service provider over the access plant (equipment) which can be twisted pair, co-axial cable, or fiber optics, either buried or aerial
- a switching function at this location connects the subscriber to one or more high-capacity point-to-point links. The service provider’s location is usually a large nondescript windowless building.
- high-capacity links interconnect to the service provider’s locations, and possibly to other carriers or to server, filtering or monitoring facilities

This course is divided into roughly three parts, each covering one of the above aspects. Each of these parts is described in more detail below.

Access Technologies

The purpose of an access technology is to connect a subscriber with the service provider's location. The most common access technologies include:

- plain old telephone service (POTS). These carry analog voice-band signals over twisted-pair cable for distances of up to a few km. We will study basic POTS call signalling.
- Asymmetric Digital Subscriber Line (ADSL). These carry data signals at frequencies above the audible range. The subscriber uses an ADSL modem to connect to a DSL access multiplexer (DSLAM) at a telephone company's "central office". We will study some of the ITU ADSL standards.
- cable modems. These use the co-axial cable infrastructure originally installed to distribute community antenna television (CATV or "cable TV"). These networks are now typically a hybrid of optical fiber and co-axial cable links (HFC). The subscriber uses a cable modem to connect to a cable modem termination system (CMTS) at the cable companies "head end". We will study the Data Over Cable Service Interface Specification (DOCSIS) cable modem standards.
- cellular radio systems. These are familiar to many people and use frequencies in the 1 to 2 GHz range to connect subscribers wirelessly to the cellular company's base station. We will study some of the digital cellular wireless standards.

With the exception of POTS service, modern access technologies are digital. They often carry digitized speech or video signals to support telephone and TV broadcast services. We will study how speech and video signals are digitized, compressed and protected for transmission over packet-switched networks.

Switching and Routing

At the service provider's site (CO or Head End), equipment is installed to support the other side of the access link and to aggregate data into a smaller number of lines that connect to the service provider's other locations.

For the PSTN the service provider's equipment is called a telephone switch and the point-to-point links are called trunks. Digital trunks carry multiplexed digitized speech signals.

For digital subscriber access services the DSLAM or CMTS is connected to an IP router which in turn is connected to high-speed fiber-optic point-to-point links carrying multiplexed data streams.

Service providers have migrated from circuit switching to store-and-forward packet-switching using IP protocols. We will study the various algorithms and protocols used by service providers to maintain IP routing tables.

Today much telecommunications infrastructure is also used in dedicated commercial "server farms" to supply content and in government facilities that monitor and filter telecommunications services.

Multiplexed Data Links

High-speed (multi-Gb/s) fiber-optic links carry multiple logical data streams in a time-multiplexed manner between service provider premises. Undersea cables are used for intercontinental links.

The most common standards for these links are SONET (Synchronous Optical Networking) and SDH (Synchronous Digital Hierarchy). We will study how different types of data streams are multiplexed into these formats.

Exercise 2: Highlight or underline the acronym definitions and any unfamiliar terms introduced in this lecture.