Chapter 44
Communication Infrastructures in Access Networks

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ABSTRACT

Access networks are usually termed "last-mile/first-mile" networks since they connect the end user with the metro-edge network (or the exchange). This connectivity is often at data rates that are significantly slower than the data rates available at metro and core networks. Metro networks span large cities and core networks connect cities or bigger regions together by forming a backbone network on which traffic from an entire city is transported. With the industry achieving up to 400 Gbps of data rates at core networks (and increasing those rates [Reading, 2013]), it is critical to have high-speed access networks that can cope with the tremendous bandwidth opportunity and not act as a bottleneck. The opportunity lies in enabling services that can be of benefit to the consumers as well as large organizations. For instance, moving institutional/personal data to the cloud will require a high-speed access network that can overcome delays incurred during upload and download of information. Cloud-based services, such as computing and storage services are further enhanced with the availability of such high-speed access networks. Access networks have evolved over time and the industry is constantly looking for ways to improve their capacity. Therefore, an understanding of the fundamental technologies involved in wired and wireless access networks will help the reader appreciate the full potential of the cloud and cloud access. Against the same backdrop, this chapter aims at providing an understanding of the evolution of access technologies that enable the tremendous mobility potential of cloud-based services in the contemporary cloud paradigm.

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1. INTRODUCTION

Evolutionary and revolutionary technologies ranging from integrated photonics, optoelectronics, and electronic devices, to subsystems, ubiquitous and high-performance networking, computing and storage elements, along with sophisticated software platforms, have enabled the usage of the "nebulous cloud." This technology explosion has resulted in highly reliable access to information from anywhere at any time. In daily life, the access to information has become an absolute requirement. Whether applied to a business environment, an educational institution, social media, or our homes, without information access, we feel lost.

Within the Information and Communication Technology (ICT) industry, the ever-increasing data rates supported by diverse and evolving access networks are playing a significant role in making information accessibility from the cloud a reality. Due to the availability of high-speed wired and wireless access in the last mile (metro-edge to user) coupled with ultracapacity high-speed core networks, large amounts of data can be transported, stored, and disbursed. According to some reports, a trillion gigabytes of new data was forecasted to be generated in 2012 (Manyika et al., 2011). Every day an unprecedented amount of information is communicated between large organizations, research labs, governmental agencies, social media, and consumers. Easy cloud access has resulted in tremendous growth within the cloud-enabling technologies. As large organizations move toward cloud-based solutions for multimedia and document storage, the need for faster, more efficient, and greener communication networks is becoming evident. According to a recent industry-driven survey of 150 network providers worldwide, 60.7% concluded that customer interest in cloud is growing (Perrin, 2012b).

Thanks to various forms of wireless access technologies, while one is walking through the streets of Tokyo or waiting for a flight at John F. Kennedy Airport in New York City, one cannot help but notice the fingers clicking away to access streaming audio/video contents, e-mails, social networking, or remote office servers. The broadband mobility indeed has been enabled by fiber-based backhaul, leaving wireless capacity to be shared and reused more effectively.

High-speed wired access is also playing a significant role in higher learning and research institutions, where at any given hour the students, faculty, researchers, and technical staff members are collaboratively striving to solve complex problems and share new findings. Companies such as Microsoft, Google, Amazon, and Apple are pushing the boundaries of access network capacities by allowing subscribers access to information stored in the cloud. Information including office documents, medical and satellite imagery, audio files, and video files can now be stored and accessed on the go. Multiple devices remain synchronized with updated information and collaborative models can be executed when multiple Cloud Service Users (CSU) access the same file from the cloud for remote meetings. Cloud services have made data sharing easy and effortless. We find ourselves at the forefront of technology where devices are reducing in size and increasing in connectivity speeds.

Owing to recent advances in hybrid (wired and wireless) access technologies, cloud computing is primed to see significant adoption. Figure 1 depicts notional network architecture view of access networks used for cloud access. It illustrates the abstract interfaces that can be mapped to a diverse set of physical and logical interfaces that are implemented within the network infrastructure. The interfaces–which are logical and are shown for the purpose of explanation–provide reference points through which the information flows in and out of a network and can be elaborated as:

- **I_{an}:** *Interface between access network and individual client user devices*. I_{an} enables client devices to connect to the Internet. Such devices allow users at homes or small