

Metropolitan Ethernet Network: A move from LAN to MAN

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Abstract

Ethernet has been the indisputable technology of choice for the local area networks (LANs) for more than 30 years. Its popularity is due to its versatility, plug-n-play feature, and low cost. It has transformed from a CSMA/CD technology providing low throughput to a full-duplex link increasing the throughput 1000-folds. Despite these improvements, Ethernet is still restricted to local area networks, and is not ready to become a carrier-grade technology for wider areas. However, there are efforts to assist the transformation of Ethernet from the mainstream LAN technology to the possible adoption for metropolitan area networks (MANs). This paper will introduce the movement from basic Ethernet to the carrier grade Ethernet for MANs. The paper describes the underlying technology, offered services, the state-of-the-art, and the comparison between various technologies. In the context of the move from LAN to MAN, various problems and their corresponding solutions are discussed, along with the future of Metro Ethernet Network.

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1. Introduction

Traditionally, Ethernet is a plug-n-play technology at the link layer intended for Local Area Network (LAN). Its success is in parts due to its standardization that enables the interoperability among different equipment vendors. Thus, mass production drives down the cost of Ethernet and also advances the popularity of basic Ethernet further. From the earlier Ethernet that uses CSMA/CD and runs at 10 Mbps on the coaxial cable,

Ethernet now can run full-duplex 10 Gbps links with backward compatibility. It does not need any special device to convert between equipments running at different speeds displaying a true plug-n-play system.

Initially, Ethernet was designed to operate on a bus topology using the coaxial cable at 10 Mbps. It was a broadcast environment where there is the possibility of frame collision. Using the CSMA/CD, Ethernet successfully sent frame to other hosts while entering the exponential backup phase if there is a collision. Several versions of Ethernet technologies existed ranging from 10 Mbps to 10 Gbps running on coaxial cable, twisted pair copper cable, and fiber optic line. However, all of the different

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Ethernet versions kept the same frame structure for backward compatibility.

Ethernet evolves from a LAN service interconnecting an enterprise workgroup to running the enterprise backbone. Now extending to the Metro Area Network (MAN), Ethernet provides Ethernet services across MAN. MAN makes up of a metro core network and several access networks. The access networks border with the subscribers networks. Subscribers include business enterprise networks and residential network such as DSL and cable services. The metro core is the backbone of MAN where it interconnects the access networks hauling large trunk of traffic. In addition the metro core provides the subscribers with access to the Internet.

Ethernet in MAN is an alternative to the traditional Time Division Multiplexing (TDM) technology. Although TDM is used to delivered voice and leased-line services, it is inefficient for delivering the emerging data oriented applications. Ethernet services can offer the point-to-point line service or multipoint-to-multipoint LAN services. LAN services connect multiple sites belonging to the same enterprise across different physical locations into a virtual LAN as if all sites exist in a local building.

An example of emerging data oriented applications running over Metro Ethernet Network (MEN) is LAN to network resources [51]. LAN to network resources can offer services such as the backing up data of enterprises at a remote and secured site for disaster recovery. Customers can backup and recover their data constantly across the metro. For residential areas, LAN to network resources can distribute multimedia services. For example, video servers can be deployed at a Points of Presence (POP) where the residents can access for broadband video on demand over an Ethernet connection. Other services that MEN can offer include [51] Internet connection, Extranet, Storage Area Networks (SANs), Metro Transport, and VoIP. Around the world, different applications are the main driving force for MEN. For example, in Korea, the growing game parlor business is the bandwidth hog. Japan focuses on the inter-office connection between large multi-sites enterprises that span across remote physical location. China and India are building a common platform for the residential triple play: voice, video, and data.

In addition, the advantages of Ethernet such as cost effectiveness, flexibility, rapid provision on demand, and ease of interoperability drive the adap-

tation of Ethernet into MAN. The mass production of Ethernet equipments and the simplicity of Ethernet technicality keep the cost of having Ethernet relatively low compared to others competitive protocols. Another factor in cost saving is the ease of interoperability without third party converter or sometime without purchasing new equipments. The same Ethernet interface can support a variety of bandwidth unlike legacy technologies. One feature that makes Ethernet stands out than the rest is the flexibility in bandwidth upgrade. With bandwidth increment as fine granularity as 1 Mbps, Ethernet offers better bandwidth efficiency than TDM. Therefore, it is able to have rapid provision on demand.

Ethernet in combination with VPLS is the convergence technology that brings mass traffic together from diverse platform. Besides the high speed wired networks, MEN is the cost effective backhaul for the mobile carriers. The Carrier Ethernet will become the common “transport layer” to deliver multiple services over a single connection.

In the remaining parts of this report, we will introduce the basic Ethernet to the carrier grade Ethernet for MEN. We will explore the underlying technologies, offered services, and architectures from both the industry and the academia literatures. Challenges and corresponding solutions are also discussed.

2. Demand for Metro Ethernet Network

We are on the verge of witnessing the transformation of Ethernets from the traditional local area networks within buildings to wider metropolitan areas. This gradual expansion of the scope is guided by the growing needs as well as the versatility of the protocol. In this section, we overview the motivations and the characteristics of Ethernet that make it a suitable candidate for this broadening scope of usage.

2.1. Motivation for the MEN transformation

Incumbent technologies such as Private Line (PL), Frame Relay (FR), and Asynchronous Transfer Mode (ATM) cannot respond as fast as Ethernet to the high volume demand for new connections because of the long waiting period to establish a dedicated physical connection. For example, an incumbent carrier takes three to six months to deploy a T1 circuit [51]. In addition, upgrading the current connection exposes the inefficiencies in Time Divi-

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