Ethernet in the First Mile

Extending Metro Ethernet Services Into the Access Network

A White Paper Presented by:
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ABSTRACT

Improving the performance of the access network connecting subscribers to service providers is critical for the successful rollout of next generation telecom services. Metro Ethernet allows service providers to build efficient, flexible, cost effective, high performance networks to support a variety of new applications and services. But bottlenecks caused by poor performance in the access network are stalling the deployment of these next generation telecommunications services. Legacy access methods do not provide the high performance required to effectively link subscribers to the rich set of Ethernet services available in the core metro networks. Building new access networks based on fiber optic cabling or wireless technology is proving to be cost prohibitive and is inhibiting the delivery of Ethernet services to subscribers.

The recently ratified IEEE 802.3ah, Ethernet in the First Mile (EFM), standard specifies a set of protocols and interfaces for using Ethernet over the access or first-mile network. EFM allows carriers to extend the reach of their high performance Ethernet networks over existing infrastructure as well as new media. This allows them to extend the reach of their Ethernet services to a high percentage of potential subscribers.

As an access technology, Ethernet offers three significant advantages over legacy first mile technologies:

- EFM provides a native interface between private subscriber Ethernet LANs and the Carrier Ethernet network
- Ethernet provides a future-proof transport for existing data services , as well as emerging packet video and voice applications
- Ethernet is a simple, globally accepted standard that ensures interoperability across a broad set of products from many suppliers

This paper discusses the advantages of deploying Carrier Ethernet over EFM technologies, the three EFM technologies that are part of the IEEE 802.3ah standard, and specific deployment and application opportunities. Additionally, the paper investigates specific implementations and the advantages of deploying particular EFM technologies in specific scenarios

ABOUT Actelis Networks

Actelis Networks® is the leading provider of Carrier Ethernet over Copper networking equipment. The company's award winning products combine high performance Ethernet in the First Mile technology for copper networks with standard Carrier Ethernet switching. Actelis' EFMplus technology delivers a fiber-like experience of resilient multi-megabit performance over copper. Actelis' Carrier Ethernet over Copper solutions are fully compliant with global communications standards and have already been deployed in more than 25 countries world-wide. Actelis Networks allows carriers to extend their Carrier Ethernet network beyond the fiber footprint using the existing copper infrastructure. Actelis Networks is a privately held company headquartered in Silicon Valley, California. For more information visit our web site http://www.actelis.com

Ethernet in the First Mile
Extending Metro Ethernet Services

INTRODUCTION

Traditionally service providers have called it the “last mile”. It is the link between the provider’s central office (CO) and the customer premise (CP). In 2001 the IEEE began a project named “p802.3ah” to define a set of technologies to make Ethernet a viable technology for the access network. During the proceedings of the meetings the term “First Mile” was coined to signal a change in attitude towards customers…by putting the subscriber first rather than last! Whether you call it the “access network”, “first mile” or “last mile” network, it remains the critical link to the delivery of high performance broadband services to both residential and business subscribers. Until now, a variety of technologies have been tried in the first mile network, but none have broken through the bandwidth bottleneck.

The use of standard Ethernet technology in carrier networks is revolutionizing metro networking. Now Ethernet being deployed in access networks to extend Metro Ethernet services deep into the subscriber network. Ethernet is already becoming the networking protocol of choice for carrier’s networks just as it did for the enterprise LAN over the past two decades. Ethernet is a protocol that is used everywhere, by everyone. Ethernet in the First Mile (EFM) provides a standard way to deliver a seamless link between subscribers and the carrier network with Ethernet technology end-to-end. The Ethernet revolution in the access network enables carriers to offer profitable next generation applications and services to both business and residential subscribers.

As an access technology, Ethernet offers three significant advantages over legacy first mile technologies:

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- Ethernet provides a future-proof transport for existing data services , as well as emerging packet video and voice applications
- Ethernet is a simple, globally accepted standard that ensures interoperability across a broad set of products from many suppliers

This white paper describes the advantages of EFM, the three EFM technologies being defined, and EFM's deployment and application opportunities. Additionally, the paper investigates specific implementations the advantages for deploying particular EFM technologies in specific scenarios

THE FIRST MILE BOTTLENECK

The first mile network refers to the connection between the subscriber and the public carrier network. Also called the last mile, the subscriber access network, or the local loop, the first mile network is the communications infrastructure located in the business park or the neighborhood as well as the infrastructure located within a single building, such as an office building, hotel or apartment. In reality, the first mile is a figure of speech for the link from the subscriber to the carrier network and can be less than or greater to one mile.

On one end of the first mile is the network operator's equipment, the Access Node, which resides in a Central Office (CO) or at a remote location site (curb or building). Acting as the entrance or exit to the public network, the Access Node equipment receives, concentrates and directs data to and from high-speed core networks.

On the other end of the first mile is the business or residential subscriber, who may be located in a home, in an office or on a campus. Currently, the subscriber connects to the public network by a variety of access technologies: PSTN/ISDN, Digital Subscriber Line (DSL), cable, T1/E1, T3/E3, or OC3/STM-1.

With the introduction of EFM technologies in the market, the subscriber will have a familiar Ethernet interface connecting directly to an Ethernet LAN or via a terminal that offers legacy interfaces, such as the ones described above. (See Figure 1.)

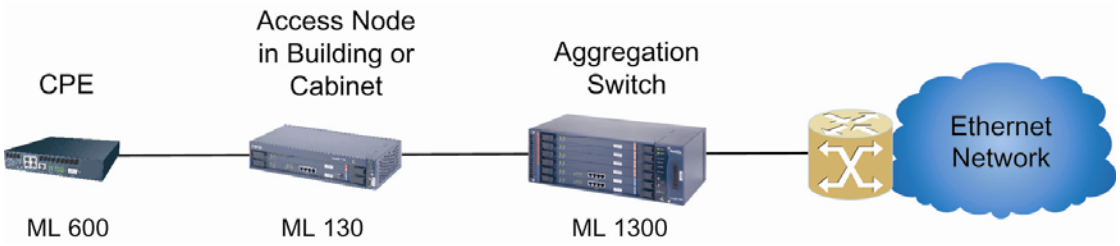

Figure 1: With EFM, the end user connects to the public network with a simple, familiar Ethernet interface.

CARRIER ETHERNET IS CREATING THE NEED FOR EFM ACCESS

Residential and business users, equipment suppliers, and network operators are demanding solutions to the first mile bottleneck. From the subscriber's point of view, there are several problems with current access technologies. These problems include bandwidth constraints, availability, ease of use, and high cost.

The majority of residential users today have access speeds of less than 56 Kbps, while many business subscribers still have T1/E1 (1.5 Mbps) or lower speed access. At these

speeds, traffic flowing to and from high-speed metro core networks and within the business LAN, at Gigabits per second, slows to a crawl over the access network. Even subscribers with faster cable, DSL access connections are likely to experience slowdowns when using bandwidth-intensive applications due to the various protocol conversions that must take place between Ethernet and legacy technologies (such as ATM), which consume the user's bandwidth.

From their perspective, network operators are looking for ways to lower operational expenses, create new revenue sources, and scale networks more efficiently. At the heart of this research is identifying ways to eliminate the complex, access network provisioning process which currently requires the deployment of new physical media (facilities) each time the subscriber moves to a new higher bandwidth service. Using existing systems tailored to the various access technologies deployed, network operators must configure the different types of access network equipment, such as Digital Crossconnect System (DCS), Channel Banks, and CSU/DSUs, in multiple steps. This makes provisioning a cumbersome, error-prone, expensive, and time-consuming process. At the same time, network operators and equipment and component manufacturers are questioning how to reduce the investment uncertainties that are associated with a diversity of protocols and equipment in the current access networks.

With increasing demand coming from both the users and providers of services over first mile networks, the time is right for an access technology that offers a cost-effective native interface for data services, future-proof transport for data, video and voice applications, and a simple global standard that will ensure interoperability.

ETHERNET IN THE FIRST MILE - HIGH PERFORMANCE ACCESS

Why will Ethernet succeed when other broadband access technologies have fallen short? Today, there are nearly 2 billion Ethernet ports deployed worldwide. Just as Ethernet revolutionized enterprise networking, it is now becoming the single technology that will deliver access to next generation services for a variety of new user applications, and it will enable a true end-to-end, seamless technology for communications.

As a network access technology, Ethernet offers a long list of quantitative and qualitative advantages over legacy first mile technologies. These advantages can be grouped into three important benefits:

- EFM provides a native interface between private subscriber Ethernet LANs and the Carrier Ethernet network
- Ethernet provides a future-proof transport for existing data services , as well as emerging packet video and voice applications
- Ethernet is a simple, globally accepted standard that ensures interoperability across a broad set of products from many suppliers

A Native Ethernet Interface between Subscriber and Service Provider Networks

Today, Ethernet is well known in both business and residential networks. The majority of local area networks deployed in business use Ethernet, and most residential broadband connections (DSL and cable) have an Ethernet connection to the PC or LAN. EFM will bring this familiar technology to the access network, eliminating the conversion that was required between Ethernet and other technologies.

Ethernet will provide the most effective infrastructure for data services in the access network, and it will be end-to-end from the subscriber through the network and at the far end. This important benefit will result from three factors: the EFM infrastructure will be scalable; it will create a single end-to-end protocol; and network operators will be able to use a single approach for different network architectures.

Scalability

The circuit-switched telephone infrastructure is rigid in terms of how bandwidth is provisioned. A subscriber can order a DS0 (64 Kbps), T1/E1 (1.5 Mbps), T3/E3 (45 Mbps), or an OC3/STM-1 (155 Mbps). The bandwidth choices are limited, and obtaining a new service is often complex. In addition, the various types of access network equipment involved in service provisioning must be configured in multiple steps. All these factors combine to make provisioning a cumbersome, lengthy, and costly process.

EFM scales easily and it allows for simplified, flexible provisioning. Ethernet scales in small increments over the same physical media, yet still allows the service provider to control the rate to the subscriber by means of software. Providers can provision additional bandwidth as soon as the subscriber requests it. They can also provide a dynamic bandwidth service if a subscriber temporarily needs additional bandwidth. With EFM, provisioning changes from a single, static service to dynamic provisioning of multiple services using a common management scheme and methodology.

Not only does Ethernet scale well to meet the subscribers' bandwidth needs, it also scales easily and cost-effectively to meet market penetration demands. Current access network solutions, such as DSL and cable, are good for low level market penetration, for example, in neighborhoods, where the subscribers are spread out over a large geographical area. However, for multi-tenant/multi-unit residential or office buildings, where there are large numbers of users densely located, an EFM access solution is better suited. In short, while today's access solutions focus on coverage, EFM focuses on penetration.

Ethernet End-to-End from Subscriber to Provider

Considering Ethernet's huge installed base, it is easy to see that most residential and business subscriber traffic begins and ends as IP over Ethernet. Currently, as the traffic flows through the first mile to the central office and out over the wide area network (WAN), it must travel through an array of protocols and over a variety of equipment. Protocols may include point-to-point (PPP), asynchronous transfer mode (ATM), and synchronous optical network or synchronous digital hierarchy (SONET/SDH). End-to-end networking equipment includes modems, digital subscriber line access multiplexers

(DSLAMs), routers and switches. As the complexity of protocol translations and equipment increases, so does network cost.

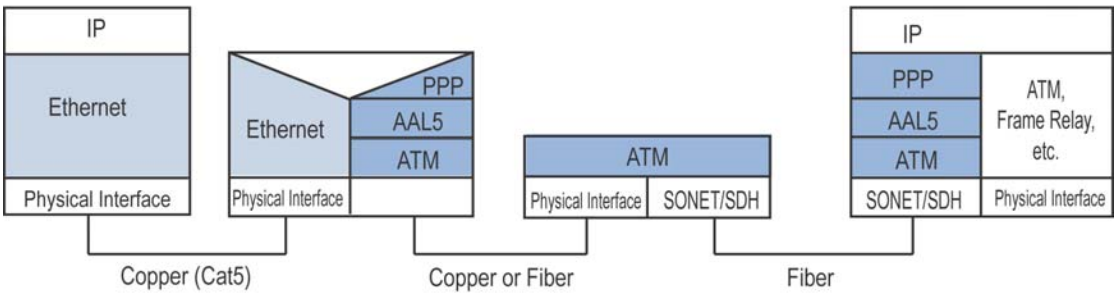

Figure 2: An example of the first broadband wave.

An EFM solution flattens the access network and provides a unifying medium throughout the LAN and the WAN. With EFM, one single, end-to-end transmission protocol – Ethernet – simplifies the access equipment and network nodes while reducing or eliminating protocol translations. (See Figure 4.) This enables network operators to reduce equipment costs and operational expenses within their networks. In addition, as fewer protocol translations consume less bandwidth, networks may realize efficiency gains.

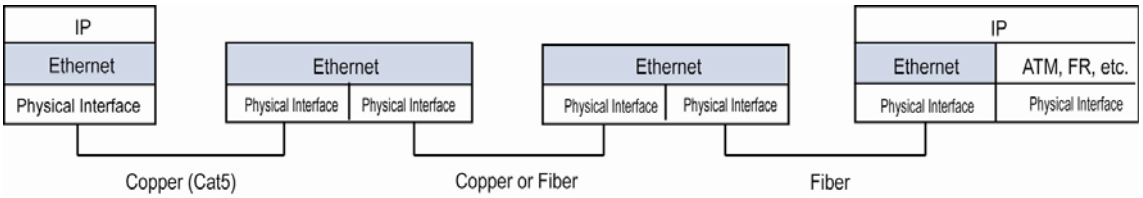

Figure 3: EFM is the most effective infrastructure for data services.

Supports a Wide Variety of Network Topologies and Architectures

A wide range of media currently exists in the first mile: twisted-pair copper wire in various grades (Category 1-5), fiber optic cable and coaxial cable. The first mile is also unique in terms of the environments and the distances involved. The first mile may be within a neighborhood, a business park, a campus, or a single building.

EFM supports all these situations. The EFM standard will provide a single approach for transmitting Ethernet traffic over three different architectures: copper cabling, fiber optic point-to-point networks, and fiber optic point-to-multipoint networks. This approach will give network operators the flexibility to deploy different architectures in different parts of their networks and to manage them with a single set of tools and processes. All these

issues will not be addressed in the P802.3ah standard, but will be addressed by other IEEE, Internet Engineering Task Force (IETF), or Metro Ethernet Forum work. The result will be gains in efficiency, operational savings, and new opportunities for revenue. (The section "Three Topologies in One Architecture" provides further detail.)

EFM scales easily while allowing for simplified, flexible provisioning. EFM provides a unifying medium between the LAN and the WAN, and between the user and the network. Furthermore, the EFM standard will provide a single approach for transmitting Ethernet traffic over three different topologies. These factors make EFM the most effective infrastructure for data services in the access network, an important benefit for subscribers and network providers alike.

Future-proof Transport for Existing Data, and Packet Voice and Video Services

EFM offers the ultimate connectivity and bandwidth for multimedia applications. For most residential and business users today, faster speed equates to faster Internet access. Service providers are beginning to bundle packet voice, and video service along with Internet and data services to launch new digital entertainment services, such as DVD-quality movies-on-demand and interactive games. Similarly, increasing the performance of the access network will enable business users to work collaboratively on-line, use their IP networks for telephony, affordable video conferencing and effective off-site data storage. And media-rich learning experiences will offer high value for both types of users. Network operators will have limitless opportunities to deliver new applications and services, and therefore will increase their sources of revenue.

The key is access. Current broadband technologies are a bottleneck for users who want to access bandwidth-hungry, media-rich applications and services. EFM will change all that. The promise of EFM is future-proof transport for all data, video and voice applications that can be foreseen.

Global Interoperability Based on a Well Known Standard

EFM will be a single global standard enabling complete interoperability worldwide. EFM will follow the IEEE's Ethernet tradition of being a clear, comprehensive, and complete standard, designed for very high volume applications. EFM's capabilities will reduce investment uncertainties for all stakeholders in the access network value chain, from technology providers to application developers to end users.

Summary

For Carrier Ethernet providers, network operators, equipment and component manufacturers, and ultimately, for subscribers, Ethernet in the First Mile delivers high performance Ethernet access with a universal set of interoperable components. For the first time, everyone will benefit from the most effective infrastructure for data services, future-proof transport for existing and next generation services and applications, and the global standard that will ensure interoperability across a wide set of products.

EFM - THREE NETWORKING TOPOLOGIES IN ONE STANDARD

The IEEE P802.3ah Ethernet in First Mile standard defines three subscriber access network topologies and physical layers that can be used in combination to create a number of hybrids:

- EFM Copper (EFMCu) over the existing copper wire has two implementations:
  - Long Reach over a single pair of category 3 POTS cable at speeds of at least 2 Mbps with a reach of up to at least 3000 meters. This implementation also includes an optional pair bonding scheme that enables significantly higher performance by using multiple pair of copper cabling together over a single link
  - Short Reach over a single pair of category 3 POTS cable at speeds of at least 10 Mbps with a reach of up to at least 750 meters
- EFM Fiber (EFMF) over Single Mode Fiber at speeds of 100 and 1000 Mbps up to at least 10 kilometers
- EFM PON (EFMP) – optical fiber at a speed of 1000 Mbps up to 20 kilometers.
- EFM Hybrid (EFMH) topologies will be created through network operators inter-mixing the three topologies listed above.

The EFM standard will also define operations, administration, and maintenance (OAM) aspects of the technology, which local carriers and network operators will use to monitor, manage, and troubleshoot access networks. The same management protocols and architecture will work across all EFM topologies.

EFM Copper (EFMCu)

Twisted-pair copper wiring dominates the first mile. So the primary objective for the IEEE 802.3ah Task Force was to develop a technology to exploit the existing voice-grade copper infrastructure in the first mile – within residential neighborhoods as well as within buildings. Millions of subscribers are currently using xDSL technology for moderate-speed Internet access. While DSL solutions today rely on cell-based ATM transport, EFMCu standardizes the delivery of bandwidth-efficient, Ethernet packets directly over copper at speeds of 2Mbps for long reach and 10 Mbps for short reach in both directions (symmetrically).

Using the existing voice wire infrastructure keeps deployment costs to a minimum, as there is no requirement for new cabling inside or outside the residence or business. By reducing service provider capital expenditures for implementation, EFMCu will serve as the easiest, lowest-cost, and immediately deployable solution for providing feature rich, high-speed access and services to subscribers.

For the first time service providers, governments and private enterprises have a cost effective solution for extending their Ethernet networks without having to deploy fiber. Eliminating the need to install fiber optic cable removes a fundamental barrier that has inhibited the adoption of Ethernet in the public network. Using the multi-pair bonding options discussed earlier service providers can offer high performance (10-70 Mbps) service over a reliable infrastructure with resiliency (by distributing the signals over

multiple copper pairs) build right in! EFMCu using multi-pair bonding provides the subscriber with a fiber-like experience and gives the service provider the ability to universally offer Ethernet services over both fiber and copper media.

Deployments for this application have been taking place for some time. However, the EFM standard eliminates the proprietary nature of these early pre-standard implementations and guarantees the vendor interoperability required for large public networks and mass volumes. EFMCu is an attractive access solution for both residential and business users and is spectrally compatible with other legacy PSTN/ISDN, T1/E1 and DSL serivces so they can co-exist in the same cables.

EFM Fiber (EFMF)

A secondary objective for the IEEE P802.3ah Task Force is standardization of a physical layer specification for point-to-point fiber with Ethernet at speeds of 100 Mbps and 1 Gbps spanning lengths of at least 10 km over Single Mode Fiber. This aspect of the standard is really not much more than minor modifications to the existing standards for Ethernet over optical media. The 10 km reach allows for a broad range of applications to be supported without requiring costly infrastructure builds. EFMF will specify a 100 Mbps and 1 Gbps, full-duplex Single Mode Fiber transport for the access network – a direct point-to-point connection from the CO to the customer premises. In addition, EFMF will specify support for both single and dual point-to-point fiber for 100 Mbps access. The EFMF topology will provide business subscribers cost-effective opportunities for replacing expensive T1 and T3 links. EFMF is also the candidate to be used for Fiber to the Home (FTTH) applications.

EFMF could drive down costs of Single Mode fiber access to a point where it will replace Multi Mode Fiber and allow operators to build a complete network based on solely on Single Mode Fiber, although this may be slow to develop. The limited deployment of fiber in public networks (less than 4% coverage as of 2005) will significant restrict the ability of service providers to offer Ethernet services if they rely solely on fiber infrastructure, unlike EFMCu which reaches over 90% of potential subscribers.

EFM PON (EFMP)

A final EFM access network topology specifies the use of passive optical splitters to build a point-to-multi-point fiber topology. A rate of 1 Gbps is specified with a reach of up to 20 km. This topology is known as EFM PON (EFMP). EFMP is the IEEE P802.3ah standard version of the architecture commonly referred to as the Ethernet PON (EPON).

A PON (Passive Optical Network) is a single, shared optical fiber that has inexpensive optical splitters that split the single fiber into individual strands feeding each subscriber. While subscribers are connected via dedicated distribution fibers to the site, they share the Optical Distribution Network (ODN) trunk fiber back to the Central Office.

PONS are called "passive" because, other than at the CO and subscriber endpoints, there are no active electronics within the access network. Eliminating the need for electrical

equipment in the first mile network is one of the advantages of the EFMP topology. The PON network architecture is much different from any other Ethernet network and much work to extend the PON architecture to support Ethernet was needed.

A fundamental difference between EPON and Ethernet is that EPON is a shared asymmetrical technology. EPON has a high speed downstream broadcast transmission, and allocates individual (TDM) time slices to active uses for their upstream transmissions. In order to support standard Ethernet bridging, as is required by the standard, a bridging proxy protocol was developed. Additionally since the downstream transmission is a broadcast, a security mechanism to protect subscribers privacy was developed.

EPON extends the EFM standard with a unique solution that enables fiber deployment in places where due to distance or environmental issues point to point fiber deployments ,requiring active components in the network, is impossible. However the restrictions on network design and the limited topologies that can be deployed may relegate EPON to a niche technology that will not be widely deployed in the access network.

EFM Operations, Administration and Management Capabilities

IEEE P802.3ah also includes important Operations Administration and Maintenance (OAM) features and methods for both copper and fiber EFM networks. Local carriers, service providers and network operators will use OAM procedures to manage and monitor links and troubleshoot problems. Although many Ethernet OAM definitions already exist in the management information base (MIB) structures, IEEE will extend and adapt them for use in the first mile network, thus facilitating EFM's use by network operators. OAM procedures will include performance monitoring, loop-back testing, fault detection and isolation.

Network operators will have the freedom to choose and mix the three EFM topologies based on their business models, network architectures, and subscriber needs. Many network operators will build or upgrade their access networks with multiple EFM topologies and manage them with a common set of tools and OAM procedures.

FLEXIBLE DEPLOYMENT – Which is Right for Your Application?

The three EFM technologies, EFMCu, EFMF and EFMP, are complementary and competitive at the same time. Carriers deploying Ethernet in their networks will have the option of deploying EFM solutions over a variety of first mile infrastructures. As stated earlier the fact that existing voice grade copper links over 90% of subscribers makes EFMCu a compelling option for reaching a high percentage of prospective subscribers with Ethernet services. In "Greenfield" applications, areas with new networks build outs, where fiber networks exist, EFMF may be an used. An EFMF or EFMP fiber solution may be well-suited to newly built office parks with fiber installed outside and inside the buildings as well as for new residential subdivisions with fiber to the home (FTTH).

Ethernet over copper wire is the best fit for existing neighborhoods and business parks where a voice-grade copper infrastructure exists. This also holds true for multi-tenant units (MTUs) or multi-dwelling units (MDUs), collectively called MxUs. MxUs include apartments, hotels and office buildings. However, there may be a mix of EFM service feeds into or between buildings, and within larger buildings. Extending Metro Ethernet services from the optical core into the copper access network is a cost effective and fast way to reach potential customers with high value Ethernet services. Leveraging the existing copper infrastructure allows carriers to reach subscribers without the delay and expense of deploying new fiber optic facilities.

In some cases, a combination of technologies will exist in the first mile. For example, in a new "Greenfield" build-out, in overbuild or rehabilitation situations, where new water, electrical, sewer or gas infrastructure is being installed, fiber cable can also be laid in the trenches at the same time. However, many of the buildings may still require access via copper wiring. In these deployments, known as fiber to the building (FTTB) or fiber to the curb (FTTC), the network operator can supply a hybrid fiber and copper EFM solution, EFMH. Combining high speed fiber with universally available copper EFM technologies represents a promising way to reach a large percentage of potential subscribers.

The flexibility of EFM deployments will allow service providers and network operators to market their EFM access solutions to a broad base of users, including those with fiber to their homes and business offices, those with only copper wiring in the first mile, and those with a combination of fiber and copper.

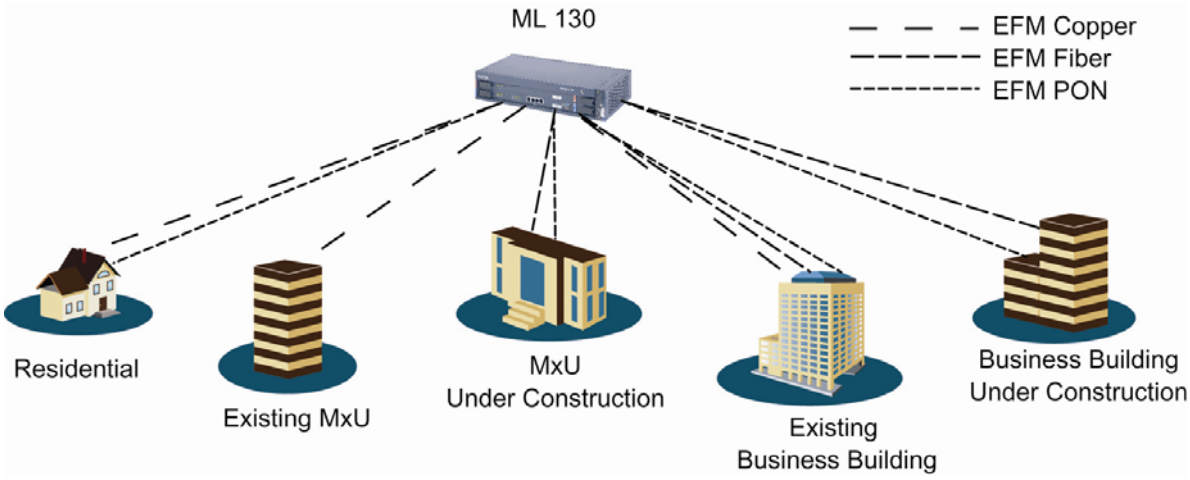

Figure 4: The three EFM topologies offer flexible deployment

FUTURE-PROOF SERVICE DELIVERY

Ethernet in the First Mile enables data, emerging packet video and voice services to be delivered to universally to end-users fed by either fiber or copper facilities. Two factors are critical for such a converged access network: quality of service (QoS) and bandwidth.

While Ethernet was originally developed as a data-oriented protocol, it has evolved to support a full range of services; including voice and video, across the enterprise network and WAN. A number of existing and future IEEE standards focusing on prioritization, Virtual LAN (VLAN) tagging, traffic shaping, bandwidth management, and resource reservation will enable network operators to provide guarantees for time-sensitive packet delivery on the EFM network.

In addition to QoS, Ethernet will provide the bandwidth that voice, video and high-speed data access requires. Offering speeds up to 1 Gbps, EFM will significantly improve connectivity speed over current "broadband" access technologies, such as DSL and cable.

EFM is truly a "future-proof" access technology for transport of all applications and services, including:

- Digital Video: MPEG 2 or 4; encoded digital video for DVD quality video-on-demand services all the way up to High Definition TV (HDTV) streams.
- Digital Voice: packetized voice over IP (VoIP).
- Data: high-speed Internet access; Metro Ethernet Forum defined E-Line or ELAN Transparent LAN Services; Ethernet Virtual Private Networks (L2 VPNs); remote data storage; e-commerce; customer support.
- By eliminating multi-protocol conversions, low bandwidth links, and by creating a universal technology, EFM will be future-proof for any application. The selection of interoperable, inexpensive equipment will be substantial, and the network design will be flatter, enabling more services at lower deployment costs. In addition, by specifying a simple OAM approach, EFM will reduce network management complexity, and therefore the driving need for constant changes and upgrades to integrate mixed services.

CONCLUSION

Ethernet in the First Mile has revolutionized the subscriber access network with standards that are able to extend high performance Metro Ethernet services deep into the access network. The goal is a simple, cost-effective infrastructure for data; future-proof transport of data, video and voice; and a global standard for interoperability.

It was an aggressive goal, perhaps, but was achieved through the efforts of IEEE 802.3ah Task Force and the companies and individuals who participated in the standardization process. The end result is a documented standard which puts the subscriber first, and enables carriers and service providers to offer a host of next generation services using standard technology. This is clearly a victory for everyone.

Today a flexible variety of EFM technologies exist to support wide ranging deployment topologies and network architectures. With the overwhelming majority of potential subscribers served by existing voice grade copper, the EFMCu standard is set to lead the way by providing Ethernet services over legacy infrastructure. As more and more fiber is deployed the EFMF, point to point and EFMP multi-point (or EPON), may find increased popularity as well. Hybrid networks leverage both fiber optic and copper facilities will also be popular as service providers rush to meet their subscribers demands for high performance Ethernet services.

The IEEE 802.3ah standard will ensure global interoperability and common management across all the EFM technologies and puts both the subscriber and provider in a position to benefit. Ethernet in the First Mile changes the paradigm of the access network. It is no longer the last thing that carriers think about, it's the first. EFM is an important consideration for extending the reach of Ethernet services to subscribers anywhere in their network.

ABOUT Actelis Networks

Actelis Networks® is the leading provider of Carrier Ethernet over Copper networking equipment. The company's award winning products combine high performance Ethernet in the First Mile technology for copper networks with standard Carrier Ethernet switching. Actelis' EFMplus technology delivers a fiber-like experience of resilient multi-megabit performance over copper. Actelis' Carrier Ethernet over Copper solutions are fully compliant with global communications standards and have already been deployed in more than 25 countries world-wide. Actelis Networks allows carriers to extend their Carrier Ethernet network beyond the fiber footprint using the existing copper infrastructure. Actelis Networks is a privately held company headquartered in Silicon Valley, California. For more information visit our web site http://www.actelis.com

A SHORT HISTORY OF THE IEEE 802.3ah STANDARDS PROJECT

In November 2000, the IEEE 802 LAN/MAN Standards Committee (LMSC) formed the P802.3ah EFM Task Force chartered to develop the technical standard for Ethernet in the first mile. The P802.3ah EFM Task Force is part of the IEEE 802.3 Working Group, which is responsible for the development of all Ethernet-related standards. More than 200 individuals from over 80 companies participated in the study group, which preceded the formation of the Task Force.

After carefully considering a number of proposals that will eventually be used to create the baseline standard for each topology, the document that specifies the protocols and interfaces needed to achieve the goals for Ethernet in the First Mile. This is an iterative process of drafting, reviewing and refining. Next, the Task Force tested technical feasibility of various options using simulations, lab, and field tests.

Finally, after verifying that all aspects of the technology have been defined, the Task Force presented its document to the IEEE 802.3 Ethernet working group for technical review, editing, and eventual ratification by 802.3. The Ethernet in the First Mile standard was ultimately approved, ratified and published standard by the IEEE 802 Task Force in June of 2004. The ratification of the standard was publicly announced by the Ethernet in the First Mile Alliance at the SuperComm trade show in Chicago, IL in 2004.

GLOSSARY

Access Node: the network side of the first mile where an operator's access equipment is located. Options exist to deploy the Access Node in a Central Office (Telephony Local Exchange) or remotely at the curbside or in a building.

Ethernet: a packet-based protocol that is used universally in local area networks (LANs) and strong candidate for cost efficient deployment in access and metropolitan networks.

Ethernet in the First Mile (EFM): a forthcoming standard that will specify the protocols and interfaces for use of Ethernet as an access network technology.

EFM Copper (EFMCu) refers to the EFM topology for voice-grade copper.

EFM Fiber (EFMF) refers to the Point-to-Point Fiber EFM topology.

EFM PON (EFMP) refers to the Point-to-Multipoint EFM topology, and is based on Passive Optical Networks (PONs).

Ethernet in the First Mile Alliance (EFMA): an alliance of companies whose goal is to focus the necessary resources to make IEEE P802.3ah a successful industry standard.

First Mile: also called the last mile, the subscriber access network or the local loop, the first mile is the communications infrastructure of the business park or the neighborhood.

Institute of Electrical and Electronics Engineers, Inc. (IEEE): standards setting body responsible for many telecom and computing standards, including the Ethernet in the First Mile standard, IEEE P802.3ah. http://www.ieee.org

MDU: multi-dwelling unit, such as an apartment house or hotel.

MTU: multi-tenant units, such as an apartment house or office building.

MXU: the collective name for MDUs and MTUs.

Network operators: also called service providers and local exchange carriers, they provide access network services to subscribers.

Passive Optical Network (PON): a single, shared optical fiber that has inexpensive optical splitters located near the subscribers.

PSTN: Public Switched Telephone Network.