Carrier Ethernet Is Ready for Expanding Ethernet Services
The Government, Education, and Medical Opportunity in the US

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I. Introduction

Major service providers, including RBOCs and IXCs in North America, currently support a large entrenched base of SONET, frame relay, ATM, and IP networks, built over many years to provide voice services to business and residential customers and data services to businesses. These providers are aggressively entering the fray for residential data services, served up over xDSL and FTTP, and deploying Gigabit Ethernet (GE) as the principal aggregation technology. These service evolution trends accentuate the urgency and necessity of a new Ethernet-oriented metro network, and, as we argue in this paper, Carrier Ethernet is the most promising universal transport solution in support of solutions for many of the prime industry verticals: government, education, and medical, which we will abbreviate at times as “GEM”. As providers begin to accelerate the deployment of GEM solutions, it becomes compelling to examine Carrier Ethernet as the principal delivery vehicle supporting GEM applications.

II. Carrier Ethernet—Ready for Prime Time

To reduce costs and to create competitive differentiation, service providers are driving network convergence as well as service convergence in order to support the delivery of traditional as well as non-traditional data services, such as IPTV, VoD, and VoIP. With fewer overlay networks, a carrier significantly reduces operational expenses associated with their service offerings.

Carrier Ethernet technology is quickly becoming a primary enabler for service integration at the edge of the network, facilitating the economic transport of Layer 2 and Layer 3 services within a converged service matrix. Changing the nature of Ethernet from connectionless to connection-oriented utilizing MPLS technologies as a universal control plane allows service providers to deploy Carrier Ethernet as a reliable, carrier grade transport medium and to extend the ubiquitous nature of Ethernet from the LAN into the metro.

Traditionally, Layer 2 services from service providers have been predominantly deployed in a point-to-point manner. With new Layer 2 architectures like Carrier Ethernet, the multipoint nature of the Ethernet LAN can be extended over a WAN or MAN network. Carrier Ethernet solutions appeal to subscribers who run their own Layer 3 networks over the wide area and require Layer 2 transport to connect Layer 3 endpoints.

Through 2001, Ethernet platforms were predominantly designed to meet the requirements of the Enterprise. The lack of appropriate resiliency mechanisms and mission critical redundancy limited its deployment within the exacting environment of the metro network.

The dot.com revolution assisted a number of Ethernet LECs (or ELECs), such as Yipes and Cogent, to enter the market. The ELECs and others used the most robust LAN equipment available to form metro Ethernet networks. While this approach had limited success, due primarily to the small scale of the deployments, many challenges emerged that could be traced to the enterprise origins of the deployed equipment.

Meanwhile, IXCs, RBOCs, and other large providers chose to meet their enterprise customer demands for Ethernet services by deploying Ethernet interfaces and services on existing SONET networks to supply the QoS, resiliency, and connectivity required for mission critical applications. The large carriers found that SONET offered a workable solution, but that it came with certain limitations. The design center of SONET is connection-oriented TDM, which is suitable for voice and private line TDM traffic, but it traditionally does not support point-to-multipoint or multipoint-to-multipoint services. Many carriers also found that SONET was not a particularly cost-effective technology to deliver Ethernet services, especially in a business environment where customers expect Ethernet services at lower prices in comparison to TDM-based DS-3 services.

As Ethernet and Ethernet services began to permeate the metro network, the application requirements of those services drove the need for a new type of Ethernet product that is purpose built for service providers, with features such as high availability, resilient link / mesh / ring architectures, QoS options, and the ability to support certain legacy traffic. Many manufacturers over the past two years have met this challenge by producing a new genre of carrier class Ethernet products. The industry variously calls these products optical Ethernet, carrier Ethernet, or carrier class Ethernet—we choose for the purposes of this white paper to call them Carrier Ethernet products. We believe this new class of product is proven in carrier production networks around the globe, and is undeniably ready for prime time deployment.

III. The GEM Market Segment

Governments and government agencies are addressing urgent directives to reduce costs, ensure continuity of government services, conform to the security directives of the Patriot Act, and improve effectiveness. Traditional government network solutions fail to support these goals.

Public safety agencies face unique challenges related to Homeland Security. Like most government agencies, their budgets are being cut. But they are being asked to provide more services with fewer resources. In the past, public safety agencies were often at the forefront of communications technologies. Today's requirements are forcing more governmental agencies to build—or contract out—their own communications networks from start to finish. While these custom networks may provide some limited advantages, proprietary, custom-built networks have many intrinsic shortcomings, so manufacturers developed standards-based networking solutions. These standards-based, converged network solutions offer many advantages over proprietary systems:

- Secure, high bandwidth networks that support rich voice, video, and integrated data IP applications
- Inter-agency collaboration and parallel work flow
- Real-time information integration, synthesis, and dissemination
- GPS or other location information to identify agents in the field
- Vendor and technology flexibility
- Future-proof architecture with investment protection

Recent state and federal legislation (such as the "No Child Left Behind Act") require school districts to provide students with the best education environment possible. This objective requires compelling curriculum delivered in an engaging learning environment by qualified teachers. Computer technology is now integrated into the basic curriculum and students expect rich media content and highly interactive educational programs. Integration of video and multimedia can support a range of student needs with various learning requirements.

School districts depend very heavily on communications for school operations and administration. IP telephony and videoconferencing can enhance and extend district meetings allowing staff to share ideas and best practices.

The mission-critical requirements of the medical sector preclude the selection of an off-the-shelf network. Although the medical sector shares many requirements with other enterprises, a healthcare organization has some unique needs that require special network design features. The first two depend on reliable systems:

- Extreme availability: A hospital network must be operational all the time, to the standard of 99.999 percent uptime, even to the wiring closet that serves an individual floor, ward, or work group.
- Efficient use of expensive resources: Human and machine resources in a healthcare facility are costly, and the facility must use them efficiently. Personnel must have the resources they need to work as productively as possible. Equipment such as MRI and CAT scanners may operate 24 hours a day and the supporting HIS systems must be operational all the time.

The next three special requirements depend on a carefully designed network architecture:

- Well-planned bandwidth: The network must have the bandwidth for all the applications it needs to support now and in the future. The capacity must be designed so it is immediately available to all applications, regardless of how much bandwidth they use.
- Widespread sharing of data throughout the facility: One x-ray or scan may need to be sent to half a dozen different departments or HIS systems; every individual drug order goes to a patient chart, a nurse, pharmacy, inventory, billing, insurance claims, and perhaps elsewhere. The network must facilitate extensive data interchange capabilities.
- Adoption of new technology: Some facilities now use handheld PDAs with barcode scanners to track supplies from the loading dock to the patient room. Wireless nurse call systems get nurses out of the nursing station and into patient rooms. Remote surgical consults and remotely directed surgery are being developed. The network must accommodate new applications.

Two more requirements depend on the skill with which the network is implemented:

- Quality of service: Some applications are crucial. Hospitals must be able to ensure that voice communications take precedence over data transfers, and physician e-mail messages take precedence over accounting.
- Security: Keeping patient data secure has always been important, but the HIPAA has stricter requirements when electronic communications are involved.

It is difficult for a provider to support the new requirements of GEM applications with legacy services on SONET and frame relay networks. We contend that a realistic—and cost effective—approach is to deploy Carrier Ethernet. It is our belief that Carrier Ethernet not only lowers the operational costs associated with supporting GEM applications, but it is the best alternative to drive service convergence over a single converged network.

Once Carrier Ethernet is deployed for the GEM applications, service providers gain valuable experience with network equipment, network design, operations procedures, market programs, and customer feedback. Now the hidden benefit emerges: these GEM experiences and the knowledge gained can be leveraged in other verticals, to offer new services to attract new customers and retain the existing base of customers, while experiencing lower operational expenses.

A secondary benefit is that the GEM customer can be used as a "anchor tenant" for the Carrier Ethernet build-out, with the Core transport being economically overbuilt in order to support additional Enterprise customers. This approach significantly reduces the turn-up cost for additional business customers, who can be supported on the infrastructure due to the CIR/EIR and end-to-end service levels that can be supported by Carrier Ethernet.

IV. Problem, Background, and Opportunity

A. Ethernet Services, a Growing Addressable Market

The telecom industry buzz surrounding the growing Ethernet service market is not just hype. That Ethernet service revenue is growing can be measured in at least two ways: growth in expenditures on the carrier equipment necessary to offer Ethernet services and transport Ethernet traffic, and in Ethernet service revenue itself.

In Infonetics' March 2005 *Metro Ethernet Equipment* biannual worldwide market share and forecast report, we reported that spending on all types of metro Ethernet equipment hit $3.8B in 2004, and will double by 2008 to $7.6B. Within this equipment is the Carrier Ethernet switch and router category, with $61M in spending in 2004, reaching $2.6B in 2008.

In Infonetics' April 2005 *Ethernet Services* biannual worldwide market size and forecast report, we report that spending on all types of North American Ethernet services hit $523M in 2004, and will increase ten-fold by 2009 to $5.7B, a 5-year accumulation of over $16B.

Ethernet services are a growing market, important not only for the revenue they represent, but for their ability to retain customers. Or, said another way, since many service providers are offering Ethernet services and using them to win the customers of other providers, it is important to be able to have Ethernet services in your stable of offerings, at a minimum as a defensive strategy against competitors. There are many types of Ethernet services, and they can be used to serve a variety of applications.

B. Business Applications

The two basic types of Ethernet services for businesses are point to point, or P2P (a single connection between two locations) and point to multipoint, or P2MP (the interconnection of three or more sites).

P2P business applications include the popular Internet / WAN access (customer site to service provider), site-to-site LAN or extranet connection, and storage backup site connections for BC / DR (business continuity, disaster recovery).

Ethernet can also be used for multicast services (non-video) and video distribution by MSOs and IOCs (and soon RBOCs), or by your government, education, and medical customers over your network. The most popular use of P2MP is for extended LAN or transparent LAN service to deploy customers' multi-site LANs.

C. Wholesale and Applications

Service providers are buying wholesale Ethernet services from other providers, usually in a P2P mode, using GE for POP-to-POP or COLO-to-COLO connection.

Residential markets are served over DSL and FTTP, which are aggregated using GE uplinks. This traffic tends to be inefficiently transported over SONET; the statistical multiplexing and SLA characteristics of Carrier Ethernet are more suitable as a transport medium for this traffic, and this helps to establish Carrier Ethernet as a viable choice for a universal transport architecture, or EAN (Ethernet aggregation network), as defined by ITU Draft TR123.qos[4].

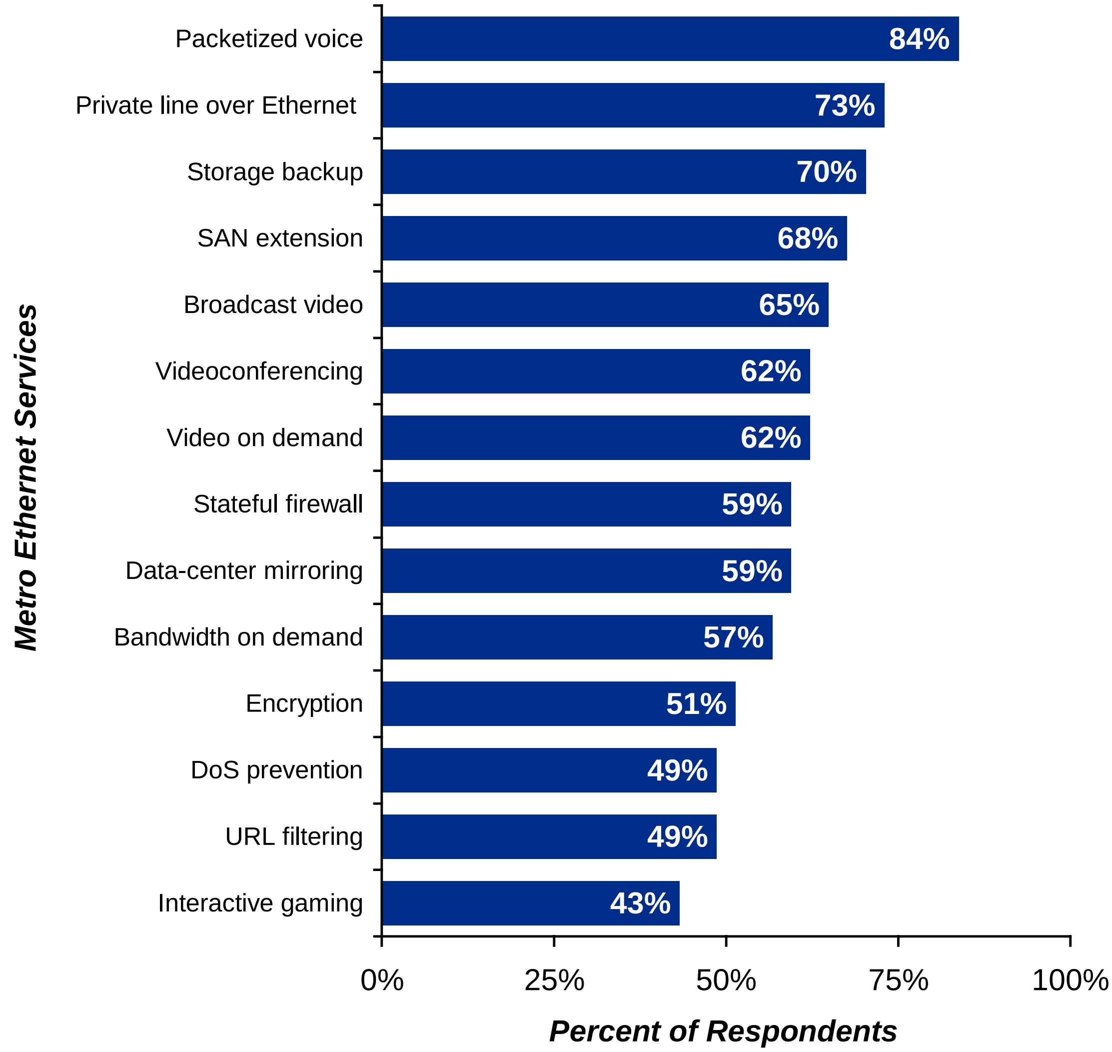
By far, most Ethernet services are sold to business, yet there is a small, growing market for residential services, today typically served by IOCs or by local city or county governments. These are almost all for DIA (direct Internet access), a P2P connection from the residence to the provider. What makes the residential segment interesting is the opportunity to add other services on top of basic Ethernet connection, including VoIP, broadcast video, video on demand (VOD), and gaming, which is becoming increasingly popular, even in North America.

D. Services over Ethernet for Business and Residential

The business and the residential segments are ripe for additional services riding over the basic Ethernet connection for Internet / WAN. This is not lost on most carriers, as we can see in Exhibit 1, as measured in *Service Provider Plans for Metro Optical and Ethernet: North America, Europe, and Asia 2005*, our study of 37 service providers worldwide.

We asked respondents what Ethernet network-based services, in addition to connectivity and bandwidth, they sell to their business and residential customers. Nearly all applications are growing, with packetized voice the leader, offered by 84% in 2006, followed by private line over Ethernet at 73%. The leading services, including storage and video, indicate that service providers are reacting to the business challenge of revenue growth, and seeking the payback / benefit of customer satisfaction. (Please see chart, next page.)

Exhibit 1 **Ethernet Services for Business and Residential Customers**



Source: Service Provider Plans for Metro Optical and Ethernet: North America, Europe, and Asia 2005 *by Infonetics Research, Inc.*

Bandwidth on demand (the ability to turn up / down bandwidth as desired) can be offered to business and media-intensive residential users. Video services grow appreciably, and although technologically challenging, offer sexy new revenue sources. Security applications grow, as operators prioritize the rollout of potential value-added services. These services are part of the prime requirements for GEM applications.

E. GEM Applications

As previously discussed in Section 2, there are many special requirements for the government, education, and medical segments, involving guaranteed bandwidth, quickly provisionable bandwidth on demand, delay sensitive QoS for various video and voice applications, high reliability, and security. The GEM requirements are a super set of most other vertical segments, so that once Carrier Ethernet is used for GEM, it can also be used for other industry segments as well as for most Enterprise-centric mission-critical applications.

Underlying any set of requirements for GEM or other applications is the need for competitive pricing and flexibility both in the range of services offered and in ability to quickly provision those services. The ability to put all applications on a single network gives the service provider such flexibility, while simplifying operations procedures, and reducing operational expenses.

Government applications span federal, state, and local, and include homeland security, which takes many forms, some of which are: airport, bridge, building, and highway monitoring; city and county fiber to the home initiatives used to attract new business and increase economies; budget reduction measures in the face of increasing connectivity and bandwidth needs; videoconferencing for command and control missions or for inter- and intra-departmental communications.

Education includes primary and secondary school districts, university campuses, and statewide multi-campus university systems. The highest priority applications are basic high speed Internet connectivity for large numbers of students and educators, for individual research as well as for drawing Internet video content to classrooms. The regulatory requirements of No Child Left Behind require VoD and computer-assisted education curriculums. Higher learning institutions also use networks for distance learning and VoD. When deploying a new Gigabit Ethernet network, most tend to also deploy VoIP, videoconferencing, and other new applications which facilitate efficiency.

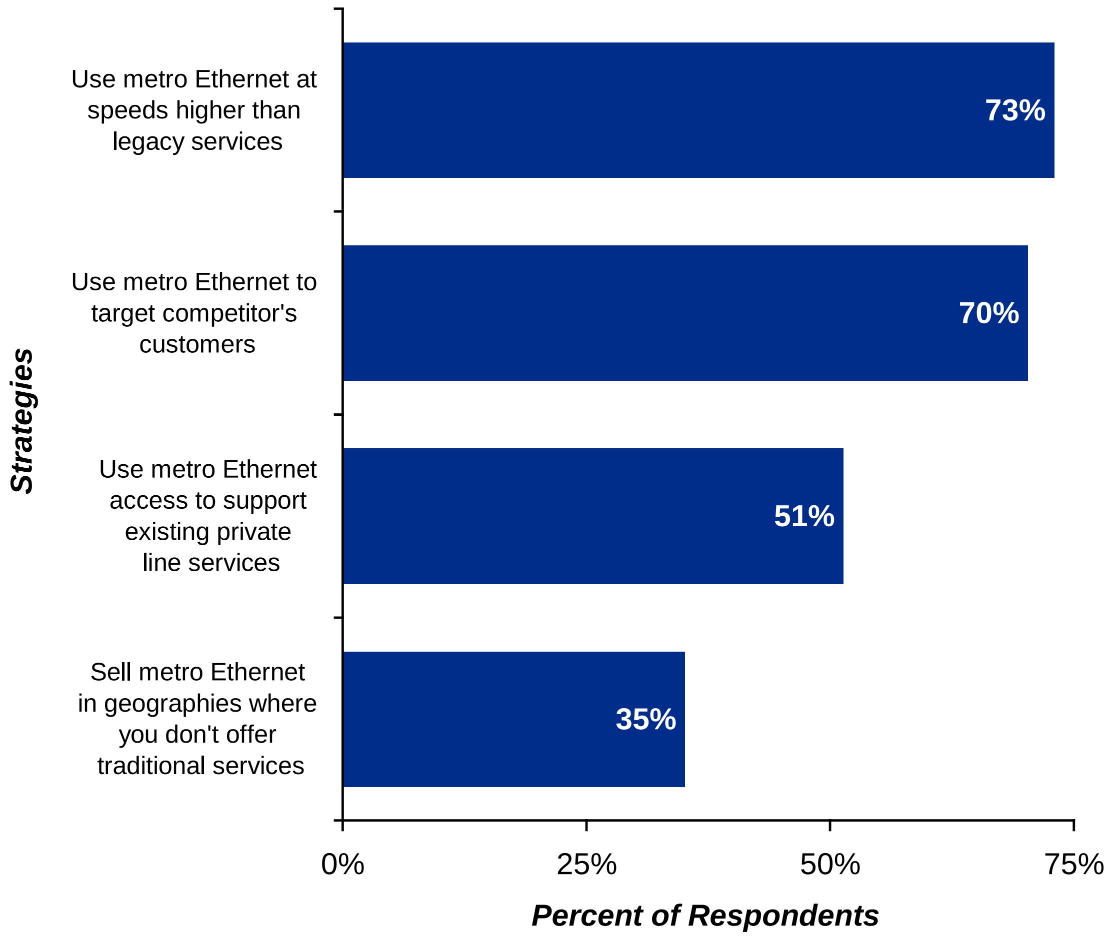
The medical sector has bandwidth, high reliability, and security needs. Due to HIPAA requirements, security is required in sharing patient data among hospitals, primary care doctors, outside experts, pharmacy, x-ray, and insurers. Diagnostic imaging involves large files that must be shared with remote specialists or other hospitals. Many medical centers have started using outside experts to consult with during live operations.

F. Service Provider Strategies for GEM Applications

Technical and business considerations for service providers for GEM applications are somewhat different from those encountered in other vertical segments, as we have described in the previous section. Carriers typically have a stable revenue base of their current customers using a plethora of existing legacy data services (frame relay, ATM, and private line services). It is not natural for the incumbent to offer new Ethernet services without fear of cannibalizing their major revenue sources, so carriers tend to be more comfortable going after their competitor's customers with Ethernet services.

Carriers use two main Ethernet strategies to offset cannibalization: 1) overcome a legacy limitation by using metro Ethernet at higher speeds than those available with the legacy services, and 2) increase revenue by targeting competitors' customers.

Exhibit 2 **Provider Strategies for Countering Cannibalization**



Source: Service Provider Plans for Metro Optical and Ethernet: North America, Europe, and Asia 2005 *by Infonetics Research, Inc.*

Using Ethernet services as a solution for GEM applications can gain the service provider multiple revenue opportunities for the price of one deployment. A well-thought out GEM deployment can be the learning ground and model for the deployment of business class services to other vertical segments, as well as for residential services, with new managed services offered on top of the Ethernet connectivity service. This approach optimizes the learning curve and builds competency, before emerging on a widespread Ethernet deployment.

When deploying Carrier Ethernet, there is an obvious opportunity to reuse and repurpose existing equipment within the network, and this can be a significant risk mitigation factor. Carriers are doing this now; one, for example, is gradually dedicating its SONET gear to TDM voice traffic over time, as the Carrier Ethernet equipment is used to carry Ethernet, IP, and legacy services, retaining existing revenue and adding new services, including video on demand.

Service providers usually employ two general methods of accessing GEM customers: they may lease access from other providers (i.e., wholesale), or they may build their own networks. These are discussed briefly below.

- Wholesale, or leasing from other providers: Service providers of all sizes and footprints populate the landscape, from national and international, to large regional, small regional, and city-centric carriers. One option to expand services to new GEM customers is to buy connectivity or services wholesale from other operators, with the targeted advantage of speed; i.e., reaching a new customer location either locally or in a new region within a reasonable amount of time, with little up-front investment, and targeted to specific revenue opportunities. Although this may be the only option in many situations, the downside of adopting this strategy is clear: the possibility that the provider's gross margin potential is punished, and the customer satisfaction risk occasioned by the lack of control over QoS and other key service attributes.

- Build your own network: Financial considerations and technical expertise vary by service provider, and many prefer to build their own network, with the obvious cost and operational advantages of owning and operating the network—no one to pay, no one to interface with in the customer-facing relationship, no third party service order process to get services provisioned, and no third party to deal with when network degradations or outages occur. Depending on many variables, considerations of time to market may dictate leasing, including but not limited to the PDIO process, the process to obtain right of way, install and test the network, and the incursion of CAPEX and OPEX for the greenfield Ethernet services network (as compared to an extension of the existing network).

V. Expansion of Ethernet Services: Value Proposition and Technical Status

A. Why Carrier Ethernet Is Ready for Prime Time

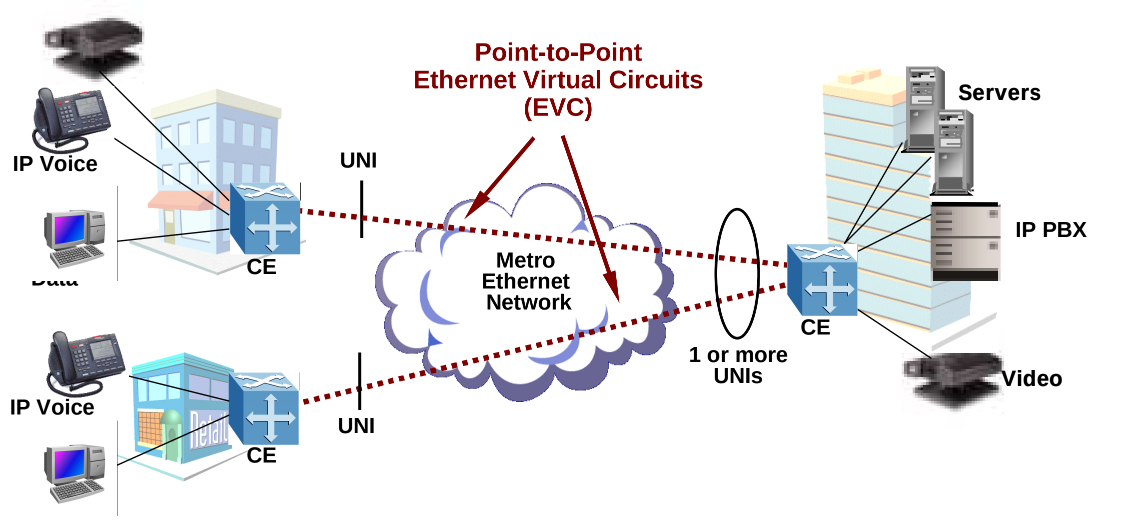
The focused efforts of service providers, manufacturers, and industry groups have combined to produce momentum behind a substantial body of work that defines Ethernet services, Carrier Ethernet equipment, and operational support tools.

The MEF (Metro Ethernet Forum) plays the key role in this work. The MEF is in the leadership position by virtue of the major service providers and manufacturers that populate its membership and help define common Ethernet services (e.g., E-LINE and E-LAN), service attributes (e.g., to define QoS, CoS, CIR, EIR), OAM&P functions, and Carrier Ethernet equipment requirements. Virtually all manufacturers of metro Ethernet gear, test equipment, and OSS/operations software are contributing members. Service providers are represented on the MEF by SBC, BellSouth, Verizon, France Telecom, NTT, Bell Canada, Korea Telecom, and many more.

Carrier driven MEF basic services, illustrated in Exhibits 3 and 4 (courtesy of the MEF) are:

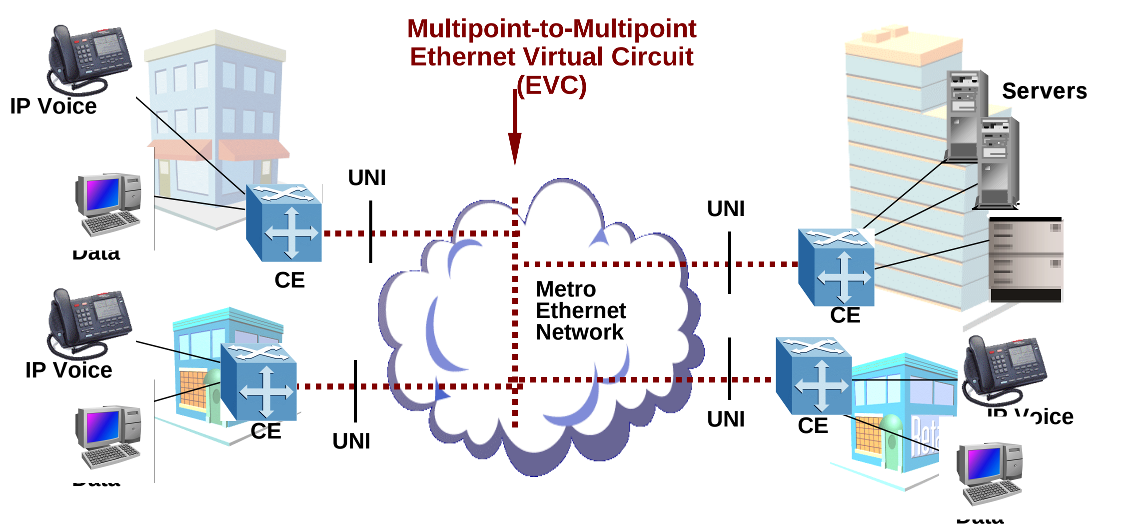
1. Ethernet line (E-Line) service, a P2P service
2. Ethernet LAN (E-LAN) service, a P2MP service

Exhibit 3 **Ethernet Line (E-Line) Service**



Source: The MEF (written permission granted)

Exhibit 4 **Ethernet LAN (E-LAN) Service**



Source: The MEF (written permission granted)

These are the umbrella categories, since providers can create a large variety of distinctly different services based on one service type, say, E-Line, by assigning service attributes (more about attributes in the next subsection).

Once a provider defines a service with attributes and Ethernet service definitions, the next area for standardized agreement is how to operate a metro Ethernet network. The carriers in the MEF, ITU, and IEEE helped define the OAM&P (operations, administration, maintenance, and performance) functions necessary to deploy carrier class metro Ethernet services. Categories of the Ethernet OAM&P cover the service layer, the connectivity layer, and the access link layer, and include functions such as link quality and performance, traffic classes, discovery, remote fault detection and isolation, traceroute, continuity checking, etc. Many of these same facilities are standardized in the ITU, a bastion typically controlled by large European service providers.

The final cog in a working carrier class metro Ethernet is the equipment itself. The MEF defined a category of Carrier Ethernet with the qualities, capabilities, and functions that service providers require for a successful metro Ethernet network and services. Carrier Ethernet switches and routers have MPLS functions that offer:

- Ability to deploy end to end SLAs
- End-to-end sub-50ms protection
- Layer 2 point-to-point MPLS VPNs (Martini / PWE3)
- VPLS: Layer 2 point-to-multipoint MPLS VPNs (Kompella / PPVPN)
- Ability to transport TDM (e.g., private line, voice) over Ethernet

A number of manufacturers produce Carrier Ethernet products, and operators around the globe use many of these products for in production networks.

Carriers have become operationally familiar over the past few years with Ethernet switches, Ethernet on routers, and MPLS functions; meanwhile, their customers are familiar with Ethernet. This familiarity with the many aspects of Ethernet, along with carrier defined Ethernet services, OAM&P, and carrier class Ethernet products, provides the necessary proof points to establish that Carrier Ethernet is ready for prime time deployment.

B. Service Attributes Driven by Service Providers

We introduced the topic of carrier defined MEF service attributes that are used to define differentiated services and potential pricing advantages. To completely define an E-Line or E-LAN Ethernet service, the service provider defines a unique service by choosing from an array of service attributes for the UNI (user network interface) and for the EVC (Ethernet virtual circuit). Ethernet service attributes include:

- Ethernet physical interface
- Traffic parameters
- Performance parameters
- Class of service (CoS)
- Service frame delivery
- VLAN tag support
- Service multiplexing
- Bundling
- Security filters

These attributes implemented in products make tasks and activities easier, for example, to define services quickly, to provision quickly (shorter time to revenue), and report on SLAs to customers.

Metro Ethernet services can be designed using the MEF mechanisms to support many types of applications more easily, cost effectively, and efficiently than other network services such as frame relay, ATM, and private lines. Standard Ethernet interfaces (10/100M, GE, 10GE) can be used for secure, private Ethernet VCs across a city or a country to interconnect many corporate sites, or connect business partners, or access the Internet. E-Line P2P and E-LAN MP2MP services can be used to connect one site or many. The attributes can be used to define bandwidth on demand, a way for customers to easily and quickly buy the amount of bandwidth they need for the duration they need.

The flexibility of MEF service definitions and service attributes give service providers carrier class tools to create, deploy, provision, and operate Ethernet services that create competitive advantage, lower cost of operations, and attract lifetime customers.

VI. Carrier Ethernet versus Alternatives

A. GEM Applications: Business Case Introduction

In the business case of Carrier Ethernet, there are two common alternatives for delivering Ethernet services: Ethernet over IP / MPLS and the tried and true Ethernet over SONET. In this representative analysis of Carrier Ethernet versus the alternatives, we discuss equipment capex, operational expenses, and typical revenue generation. The analysis and business case presented in this paper was generated through the cooperative efforts of Infonetics Research, Fujitsu, and Atrica.

Providers reaching for GEM applications will not win if they bring to market the same value as the current network services suppliers: it is necessary to bring a niche or a stronger value proposition. Recognizing the necessity to address a variety of unique demands, the strategic decision must be made in terms of choosing the right technology which is matched to the required service attributes.

Most providers currently support a number of overlay networks for different types of services or applications. But to successfully support GEM applications, it is not efficient to deploy these services over multiple networks; if a single network solution can satisfy multiple customer needs, it is a better choice.

B. Business Case Applications and Equipment

We look at government, education, and medical organizations, and assume each has needs for Ethernet access. We examine three typical types of services, listed here from most to least stringent requirements:

A. **Dedicated SONET equivalent:** 100% guaranteed bandwidth, protection

B. **A mix of QoS and CoS:** CIR / EIR mix, protection

C. **Best effort:** with or without rate-limiting, no protection

Three technologies, using industry representative platforms, can satisfy services A, B, and C:

- **Carrier Ethernet** (Atrica optical Ethernet) to satisfy to all three, A, B, C
- **Next-Gen SONET** (Cisco, Fujitsu mix of next gen SONET) to satisfy A and B
- **Ethernet over Native Transport (EoNT)** (Traditional IP, or Spanning Tree-based Ethernet using the Cisco OSR or Catalyst) to satisfy C only

It is important to understand the relationship between the three technologies and which service types each can support.

In the next chapter, we will see that the ROI analysis reflects the cost of using each technology in support of the service definitions outlined immediately above.

C. Capital Costs and Operational Expenses

In capital costs, we include equipment, element management systems, and spares, as well as installation costs. Operational expenses include:

- Cost of sales (equipment & cable, network / customer operations)
- Corporate operations (G&A), customer operations (S&M)
- Customer service expense
- Environmental expense (power, land and building)
- Access charges
- Depreciation

We use standard definitions of

- Operational P&L = revenue – opex
- ROI = (operational P&L + depreciation) / capex

D. Customer and Service Models

In our business case, 50 successful deals are expected in three years. Each customer will have access to dedicated network assets not shared with other customers. The table below shows our customer model / requirements forecast matrix to reach the 50 deals. We have 6 network models, each of which represents a customer network configuration (# sites, types of sites). Three of these models are described in Appendix A, one each of government, education, and medical.

Exhibit 5 **Revenue Model for GEM Business Case**

Requirements		Number of Customers: Model Gov 1	Model Gov 2	Model Ed 1	Model Ed 2	Model Med 1	Model Med 2	Total
A: Dedicated SONET equivalent (100% guaranteed bandwidth, protection)	1st year					1	2	**3**
	2nd year	1				2	3	**6**
	3rd year	1				2	4	**7**
B: CIR/EIR mix (protection)	1st year				2	1		**3**
	2nd year	2		2	4	1		**9**
	3rd year	2		4	4	2		**12**
C: Best effort (w/ or w/o rate limiting, no protection)	1st year		1		1			**2**
	2nd year		1		1	1		**3**
	3rd year		2		2	1		**5**
Year-by-year total	**1st year**	**0**	**1**	**0**	**3**	**2**	**2**	**8**
	2nd year	**3**	**1**	**2**	**5**	**4**	**3**	**18**
	3rd year	**3**	**2**	**4**	**6**	**6**	**4**	**24**
3-year total		***6***	***4***	***6***	***14***	***11***	***9***	***50***

Source: Infonetics Research, Fujitsu Network Communications, and Atrica

VII. GEM Business Case

A. Start Small and Grow

It makes sense for a service provider offering new services to the GEM verticals to start with a small set of customers and grow to full deployment in leveraged increments. The business case reflects this pragmatic approach, as more customers and applications are added each year.

B. Capital Requirements for Three Years

The table below shows the total capital cost required for each technology option over a three-year period:

1. Carrier Ethernet for 50 deals responding to the three types of service requirements (A, B, C)
2. Next gen SONET for dedicated SONET and CIR/EIR mix type (A, B) of service requirements for total 40 deals
3. Ethernet over Native Transport for best effort (C) service requirements 10 deals

Exhibit 6 **Total Capital Cost for GEM Business Case**

Technology		Total Capital Required	# Deals	Capital per Deal
Optical Ethernet	1st year	$3,224,872	7	$460,696
	2nd year	$10,638,886	18	$591,049
	3rd year	$23,470,408	25	$938,816
	Total	***$37,334,165***	***50***	***$746,683***
Next Gen SONET	1st year	$3,754,435	6	$625,739
	2nd year	$13,227,132	15	$881,809
	3rd year	$27,475,607	19	$1,446,085
	Total	***$44,457,174***	***40***	***$1,111,429***
EoNT	1st year	$893,776	1	$893,776
	2nd year	$2,993,665	3	$997,888
	3rd year	$7,566,158	6	$1,261,026
	Total	***$11,453,599***	***10***	***$1,145,360***

Source: Infonetics Research, Fujitsu Network Communications, and Atrica

C. Business Case

Combining the capex, opex, and revenue models, we see the obvious advantages of choosing Carrier Ethernet for GEM applications in total operation expenditures, the operational P&L, the all-important ongoing business success measure of operational P&L as a percentage of revenue, in capital investment, and finally in the decision-makers metric—ROI. One of the principal ingredients in the success of Carrier Ethernet is its ability to handle the range of requirements from best efforts to the most stringent SONET-like resilient, high performance applications that bring in high revenue. A single network with this versatility not only brings in more revenue, it brings the operational efficiencies of a simpler network. Please see Appendix B for a detailed table showing these metrics. Carrier Ethernet can be used to capture all the revenue cases shown in that table, and neither next gen SONET or EoNT can be used alone to do so. Carrier Ethernet takes less capital investment, and returns positive triple-digit (160% to 377%) ROI in all three years, easily superior to both next gen SONET (-17% to 170%) and EoNT (-124% to 29).

D. Network and Service Upgrades

Networks are not static—it is only a matter of time until a newly built network needs upgrading due to higher traffic capacities, new types of traffic, new applications and services to support them, or new technology that can reduce opex. In an expansion of our business case, we follow this fact of life into the third year.

We assume that network and service upgrades begin to occur in the third year of the deployment. For some networks, upgrades may begin in the fourth or fifth year, but the point is that they will occur, and it is convenient for our examination to show their somewhat dramatic effect on the life cycle costs of the three technology choices: Carrier Ethernet, next gen SONET, and Ethernet over Native Transport.

Service upgrade happens in many ways, and in particular for our models, activating new user ports and / or bandwidth upgrade on existing active ports. We assume that each of the six models has unique service demands which are typical to the industry vertical it is representing. There are times when no service demands are expected for the specific model. We assume no new customers after the third year. As shown in Exhibit 7 (next page), the capital costs of Carrier Ethernet continue to be lower, and can fulfill all customer applications, rather than the alternative of using both next gen SONET to fulfill part of the customer applications and Ethernet over Native Transport to fulfill the rest.

Exhibit 7 — Capital Expenses Including Upgrades

		Initial + Upgrade Total						
		Model Gov 1	Model Gov 2	Model Ed 1	Model Ed 2	Model Med 1	Model Med 2	Total
Carrier Ethernet	1st year	$0	$458,883	$0	$1,092,295	$1,356,600	$317,094	**$3,224,872**
	2nd year	$700,880	$458,883	$3,559,545	$2,730,738	$2,713,200	$475,641	**$10,638,886**
	3rd year	$700,880	$3,434,620	$7,119,090	$6,668,405	$4,715,940	$831,473	**$23,470,408**
	4th year	$6,946,410	$2,516,855	$2,881,100	$8,478,800	$1,292,280	$295,928	**$22,411,373**
	5th year	$6,946,410	$5,033,710	$5,762,200	$10,174,560	$1,938,420	$394,570	**$30,249,870**
	Total	**$15,294,579**	**$11,902,950**	**$19,321,935**	**$29,144,798**	**$12,016,440**	**$2,314,706**	**$89,995,407**
Next gen SONET	1st year	$0	$0	$0	$1,666,474	$1,801,646	$286,314	**$3,754,435**
	2nd year	$1,376,773	$0	$5,446,135	$3,332,949	$2,641,804	$429,471	**$13,227,132**
	3rd year	$1,376,773	$0	$10,892,271	$8,980,695	$4,915,422	$1,310,447	**$27,475,607**
	4th year	$8,551,053	$0	$3,314,367	$11,295,493	$1,977,930	$1,106,728	**$26,245,571**
	5th year	$8,551,053	$0	$6,628,734	$11,295,493	$2,624,259	$1,475,637	**$30,575,175**
	Total	**$19,855,651**	**$0**	**$26,281,507**	**$36,571,103**	**$13,961,061**	**$4,608,598**	**$101,277,920**
EoNT	1st year	$0	$893,776	$0	$0	$0	$0	**$893,776**
	2nd year	$0	$893,776	$0	$988,174	$1,111,715	$0	**$2,993,665**
	3rd year	$0	$3,366,381	$0	$1,976,347	$2,223,430	$0	**$7,566,158**
	4th year	$0	$1,578,828	$0	$1,180,825	$245,795	$0	**$3,005,449**
	5th year	$0	$3,157,657	$0	$2,361,651	$491,590	$0	**$6,010,898**
	Total	**$0**	**$9,890,418**	**$0**	**$6,506,997**	**$4,072,530**	**$0**	**$20,469,945**

Source: Infonetics Research, Fujitsu Network Communications, and Atrica

VIII. Conclusions

There are two principal considerations in offering new services as the solution to GEM applications. We believe that the first consideration is one of survival, for in these days of constant change and jockeying for position among RBOCs, IXCs, and MSOs, service providers with major customers cannot sit within a vacuum. Other players, such as the ELECs also present competitive threats, so the battle for the heart, minds and wallets of the prime GEM customers will continue unabated into the future.

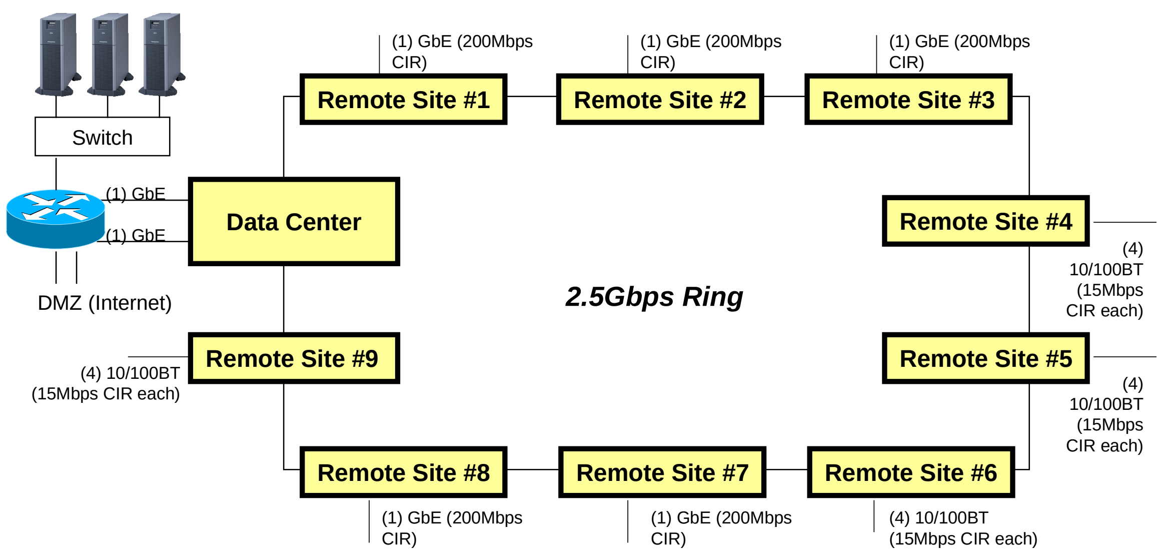
Secondly, providers are faced with the problem of moving to the next gen metro, where customers in nearly all verticals are demanding higher bandwidth Ethernet services at lower costs per bit, where data traffic overwhelms TDM voice, and where current and future competitive threats bring great pressure to significantly reduce operations costs.

In our estimation, it is a smart move borne out by our business case to use the GEM verticals as the proving ground for transition to the next gen metro network. Carrier Ethernet is ready for prime time, and in our calculations, it is the practical, cost efficient weapon of choice. As an added benefit, after the wrinkles have been worked out, all the experience and knowledge of deploying Carrier Ethernet for GEM can be leveraged to the broader marketplace verticals to deploy the next generation metro network.

Appendix A: Network Diagrams

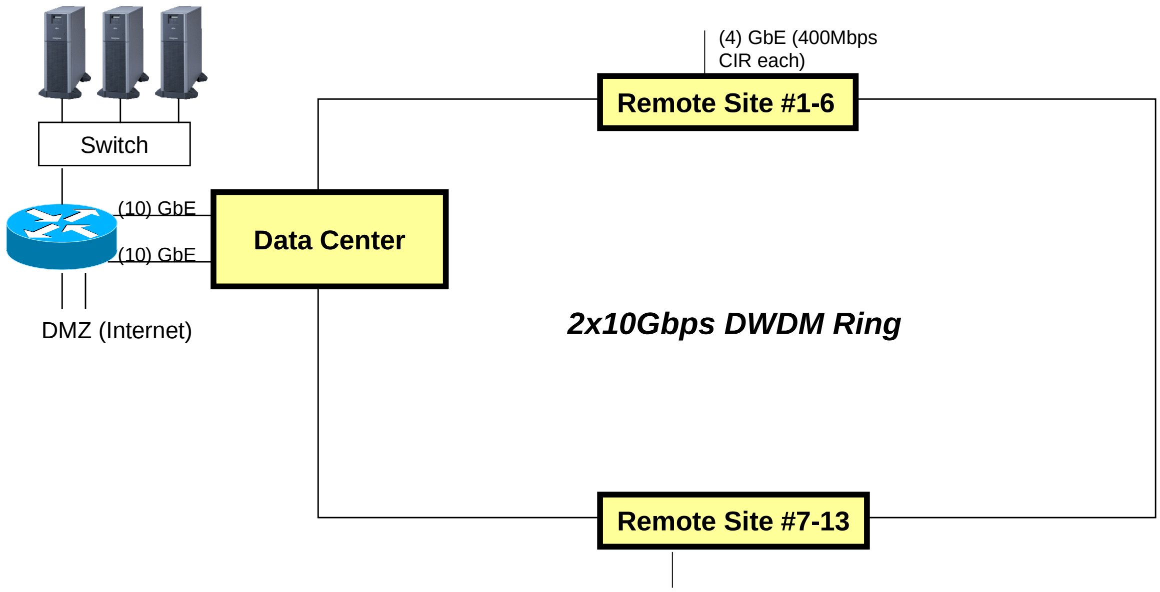
Model 1: Government Network

- 10 sites (1 data center, 9 remote sites)
- All remote traffic goes into data center for application access and Internet hand-off
- Own fiber to be used



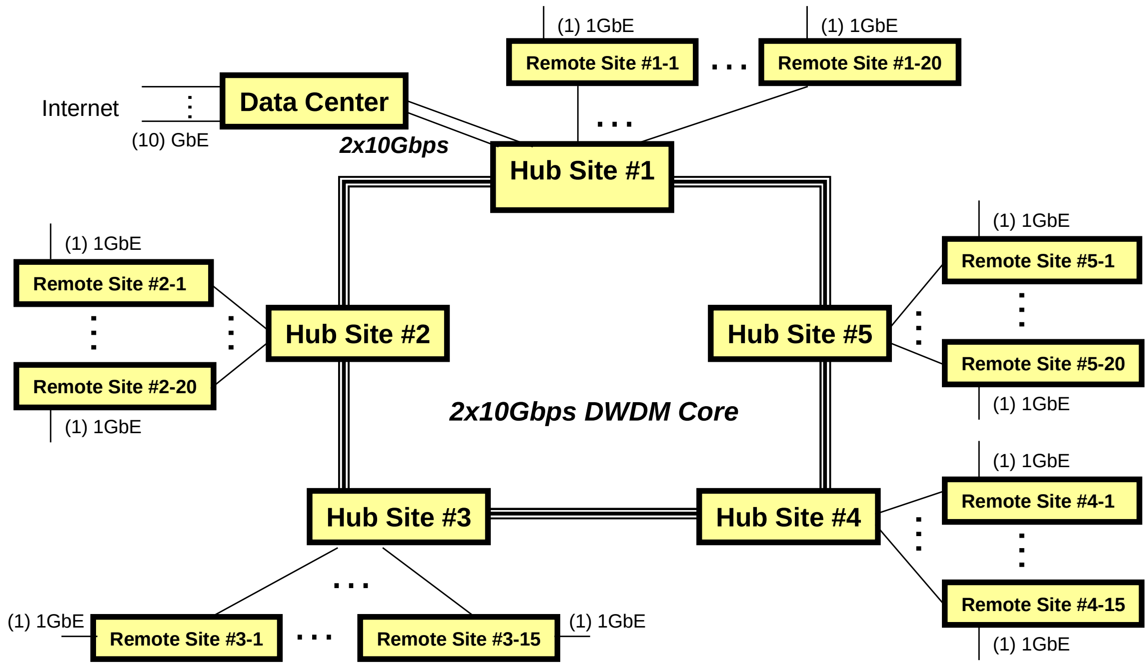
Model 1: Government Network Upgrade

- Additional 4 remote sites to existing 10 sites (1 data center, 13 remote sites)



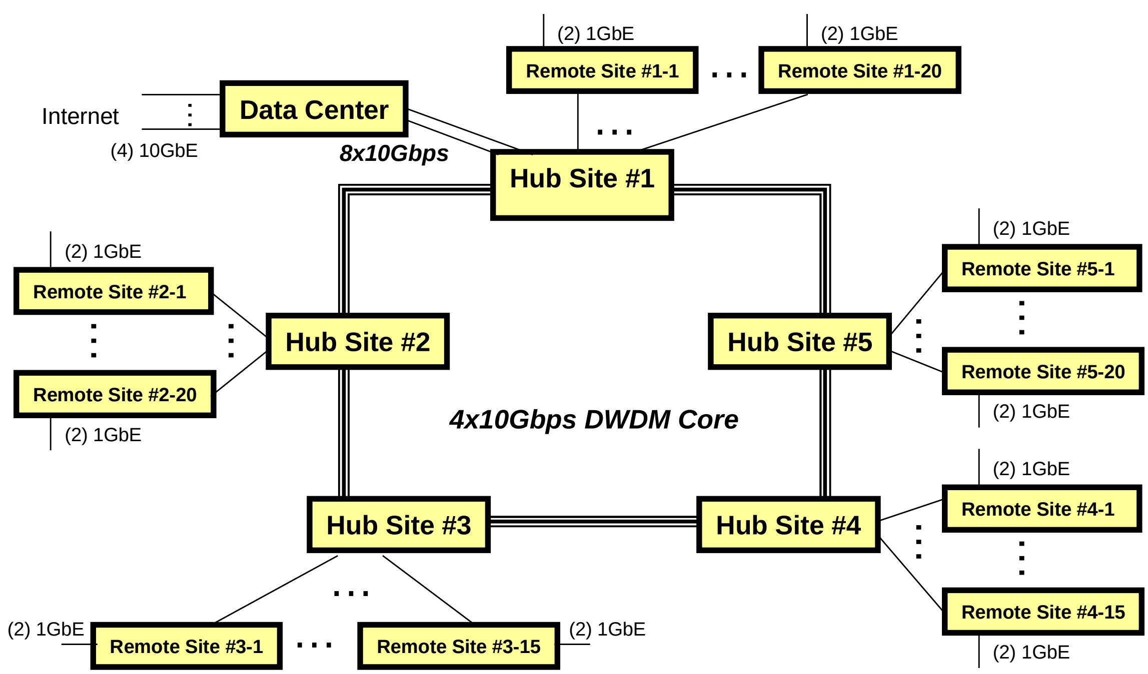
Model 2: Education Network

- 106 sites (1 data center, 5 hub and 90 remote sites); direct connect between hub and remotes
- Each remote site is equipped with (1) 1G Ethernet drops for aggregation switch (150M CIR, 1G EIR) for Internet access and site-to-site LAN interconnection
- Internet hand-off at data center
- Fiber leased from provider (including DWDM core)



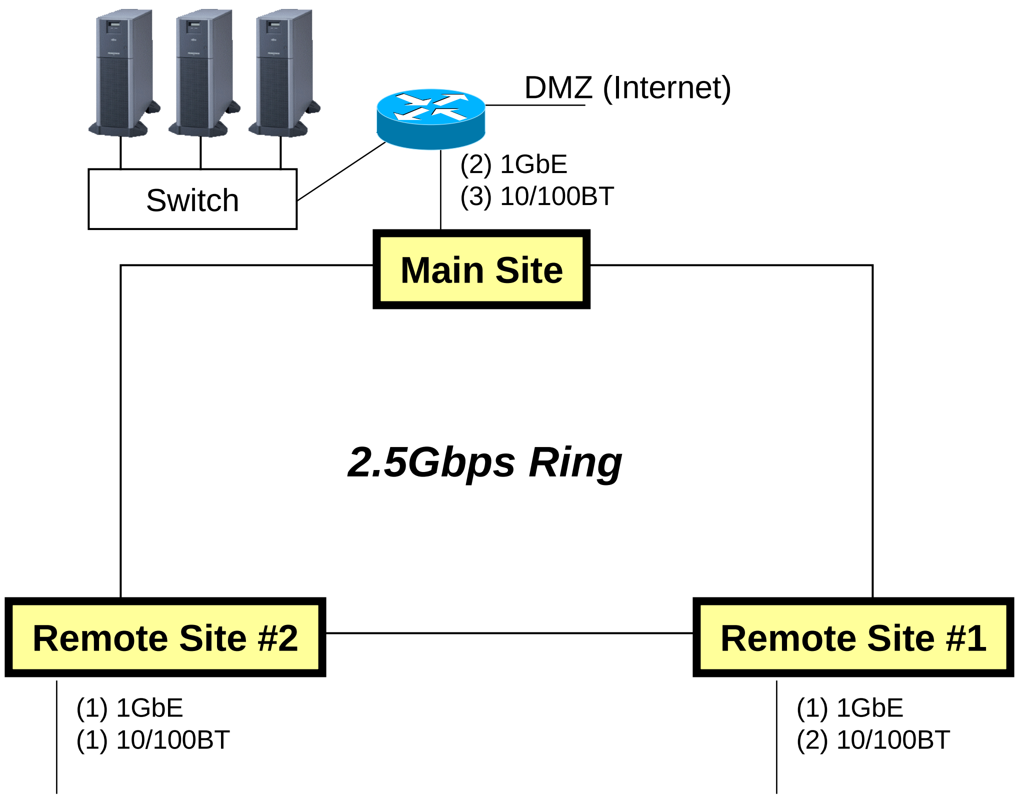
Model 2: Education Network Upgrade

- No additional sites to the existing 106 sites
- Each remote site is upgraded to 2 1G Ethernet connections with increased bandwidth (200M CIR, 1G EIR)



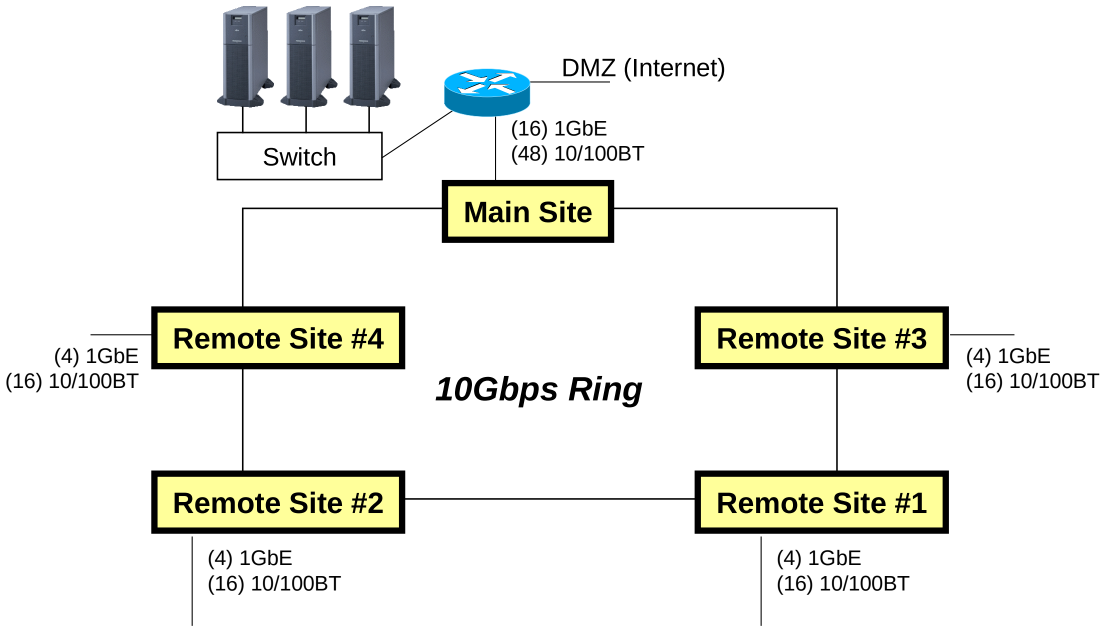
Model 3: Medical Network

- 3 sites (1 data center, 2 remote sites)
- All remote traffic (full-rate 1G / 100M) goes into data center for application access and Internet hand-off
- Fiber is leased from provider



Model 3: Medical Network Upgrade

- Additional 2 sites to the existing 3 sites
- All remote traffic (full-rate 1G / 100M) accesses data center


DMZ (Internet)
Switch
(16) 1GbE
(48) 10/100BT
Main Site
Remote Site #4
(4) 1GbE
(16) 10/100BT
Remote Site #3
(4) 1GbE
(16) 10/100BT
10Gbps Ring
Remote Site #2
(4) 1GbE
(16) 10/100BT
Remote Site #1
(4) 1GbE
(16) 10/100BT

Appendix B: GEM Business Case

	US$K								
	Optical Ethernet			Next Gen SONET			EoMPLS		
	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Revenue									
Implementation	$89	$307	$628	$70	$268	$487	$19	$40	$142
Dedicated transport charge	$14,593	$59,355	$167,974	$12,934	$53,010	$135,693	$1,659	$6,345	$32,282
Bundled Internet service charge	$2,189	$8,903	$25,196	$1,940	$7,951	$20,354	$249	$952	$4,842
NOC remote maintenance service	$547	$2,226	$6,299	$485	$1,988	$5,088	$62	$238	$1,211
Total	***$17,418***	***$70,791***	***$200,098***	***$15,429***	***$63,217***	***$161,622***	***$1,989***	***$7,575***	***$38,476***
Operation Expenses									
Cost of Sales									
Equipment and cable	$419	$1,802	$4,853	$488	$2,208	$5,779	$116	$505	$1,489
Network operations	$635	$680	$730	$1,729	$1,865	$2,014	$635	$680	$730
Customer operations	$5,072	$14,664	$36,675	$8,162	$21,082	$42,236	$2,692	$4,457	$9,901
Access charges	$1,776	$8,826	$23,218	$1,676	$8,029	$20,033	$100	$797	$3,186
Environmental cost	$1,424	$5,242	$13,795	$1,462	$7,538	$18,764	$340	$1,084	$3,537
Other (support contracts)	$286	$945	$2,099	$219	$849	$1,812	$65	$218	$552
Total	$9,612	$32,160	$81,370	$13,736	$41,571	$90,638	$3,948	$7,741	$19,394
Other Operation Expenses									
Corporate operations (G&A)	$1,568	$6,371	$18,009	$1,389	$5,690	$14,546	$179	$682	$3,463
Customer operations (S&M)	$1,045	$4,247	$12,006	$926	$3,793	$9,697	$119	$454	$2,309
Other expenses (training)	$35	$63	$126	$35	$70	$98	$35	$35	$35
Depreciation	$645	$2,773	$7,467	$751	$3,396	$8,891	$179	$777	$2,291
Depreciation, % of revenue	3.7%	3.9%	3.7%	4.9%	5.4%	5.5%	9.0%	10.3%	6.0%
Total	$3,293	$13,454	$37,608	$3,100	$12,949	$33,233	$512	$1,949	$8,097
Total	***$12,905***	***$45,615***	***$118,978***	***$16,836***	***$54,520***	***$123,871***	***$4,460***	***$9,690***	***$27,491***
Operational P&L									
Dollars	$4,513	$25,177	$81,120	-$1,408	$8,697	$37,751	-$2,471	-$2,115	$10,985
% of Revenue	26%	36%	41%	-9%	14%	23%	-124%	-28%	29%
Capital Investment	**$3,225**	**$10,639**	**$23,470**	**$3,754**	**$13,227**	**$27,476**	**$894**	**$2,994**	**$7,566,158**
Return on Investment	**160%**	**263%**	**377%**	**-17%**	**91%**	**170%**	**-256%**	**-45%**	**175%**

Source: Infonetics Research, Fujitsu Network Communications, and Atrica

Service providers interested in obtaining more details of the business case may contact Fujitsu in the following ways:

- http://www.fujitsu.com/us/services/telecom/categ/datasolutions
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About Infonetics Research

Established in 1990, Infonetics Research (www.infonetics.com) is an international market research and consulting firm specializing in emerging technologies and critical infrastructure in the data networking and telecommunications industries. We help our clients design, market, and sell products and services more effectively by providing:

- Accurate and timely market size, market share, and forecasts
- Objective, in-depth analysis of end-user and service provider buying plans
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- Enterprise Voice & Data
- Network Downtime
- Optical & Metro Ethernet
- Service Provider Capex
- Service Provider Next Gen Voice
- Service Provider Routers & Switches
- VPNs & Security
- Wireless LANs

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