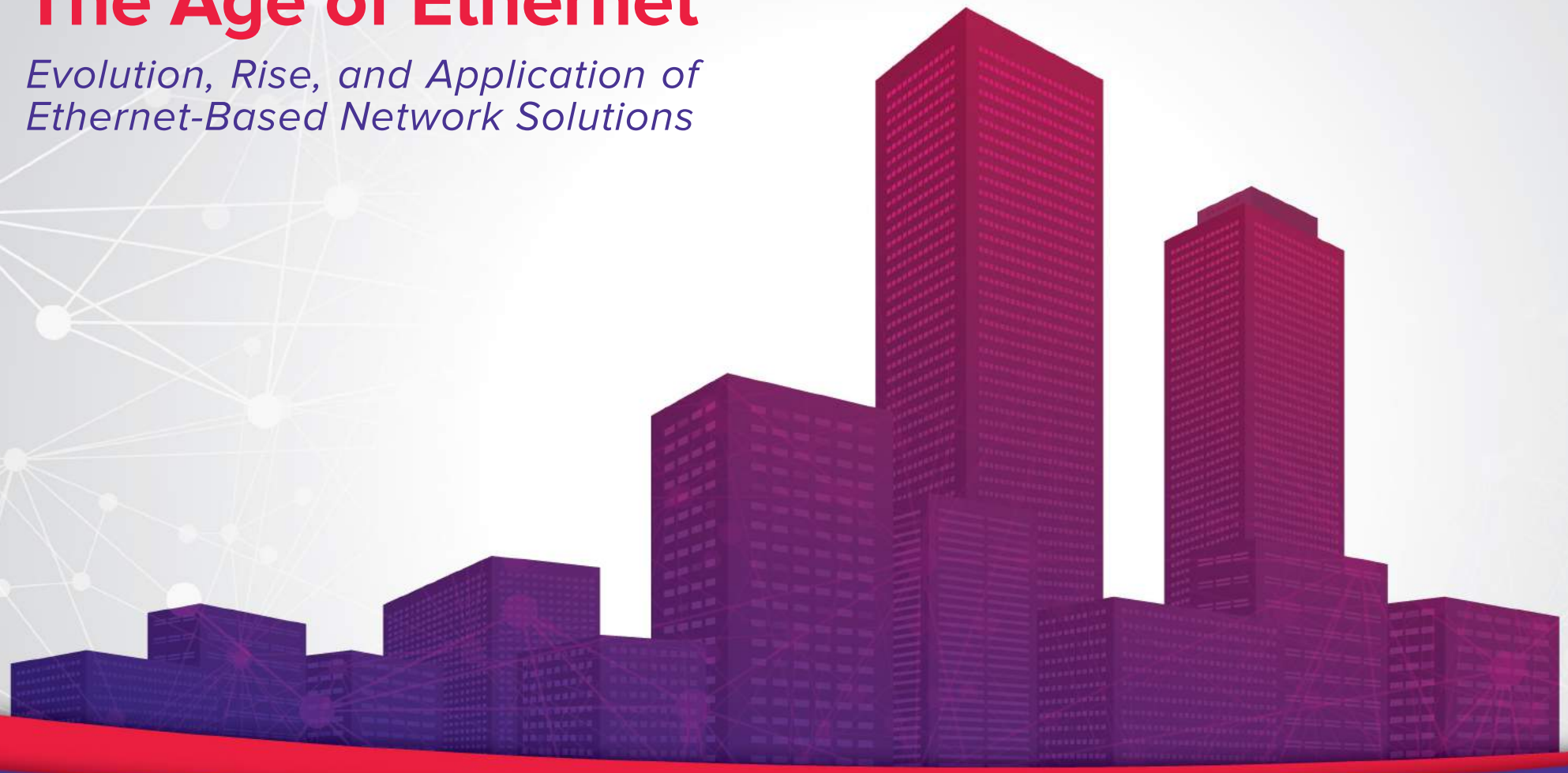
The Age of Ethernet

Evolution, Rise, and Application of Ethernet-Based Network Solutions



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THE AGE OF ETHERNET

Thanks to Ethernet technology, business networks have reached levels of speed, redundancy, reliability, and sophistication that were unimaginable a generation ago. But how did this advanced protocol evolve to become the standard in local and wide area networks, and what are its benefits for your communications infrastructure?

I The Evolution – Understanding the beginnings of Ethernet as a technology

II The Rise – Raising the Ethernet standard

III The Application – Standing up Ethernet as a solution

IV The Age of Ethernet - Conclusion

I. THE EVOLUTION OF ETHERNET

Bob Metcalfe wasn't trying to change the world in 1973 when he devised a network system for connecting computer workstations. But he did.

There was no grand plan. Metcalfe simply developed a technology model to solve a problem for his employer. He worked at Xerox PARC (Palo Alto Research Center Incorporated), where they gave him the challenge of connecting a building full of personal computers to a laser printer. From that experiment, the local area network (LAN) was born.

The LAN was a great solution for communicating or exchanging data between users within a building or campus. However, a company couldn't lay wire beyond its property line. So the next step was for businesses to connect multiple LANs into wide-area networks (WANs) through carrier services such as point-to-point leased lines, frame relay services or Multiprotocol Label Switching (MPLS).

I. THE EVOLUTION OF ETHERNET

MID 1970s
3 Mbps Ethernet invented.

LATE 1970s
10Mbps Ethernet introduced.

LATE 1980s
First Ethernet switch introduced.

EARLY 1990s
100Mbps Ethernet introduced through Fiber Distributed Data Interface.

1998
Gigabit Ethernet introduced.

2001
Metro Ethernet Forum (MEF) forms.

2002
10Gbps Ethernet introduced & IEEE standard adopted.

2005
MEF launches Carrier Ethernet 1.0 Certification.

2006
10GBASE-T standard published.

2010
Standards for 40Gbps & 100Gbps Ethernet created.

2012
MEF launches Carrier Ethernet 2.0 Certification.

2017
400Gbps standard testing.

Category 8 is in the development stages.

I. THE EVOLUTION OF ETHERNET

Evolving Internet Connectivity

Metcalfe and others finalized an open Ethernet standard in 1980. After the **Institute of Electrical and Electronics Engineers (IEEE)** published its Ethernet standard in 1985, the technology continued to evolve and encompass higher bandwidth speeds. With the proliferation of PCs throughout the '80s and '90s, the need for connectivity spread beyond major data centers to remote branch offices and to a new and growing public network called the Internet. This public network rapidly achieved widespread adoption by businesses in the late '90s for email and Web browsing, and as users and applications grew, businesses needed faster and more efficient methods of Internet access.

Dial-up speeds for Internet access became obsolete, and businesses began adopting another form of connectivity called Integrated Services Digital Network (ISDN). This new kind of Internet connectivity bonded two analog lines to give a maximum speed of 128Kbps. However, the initial costs of setting up ISDN lines limited average businesses from obtaining this speed.

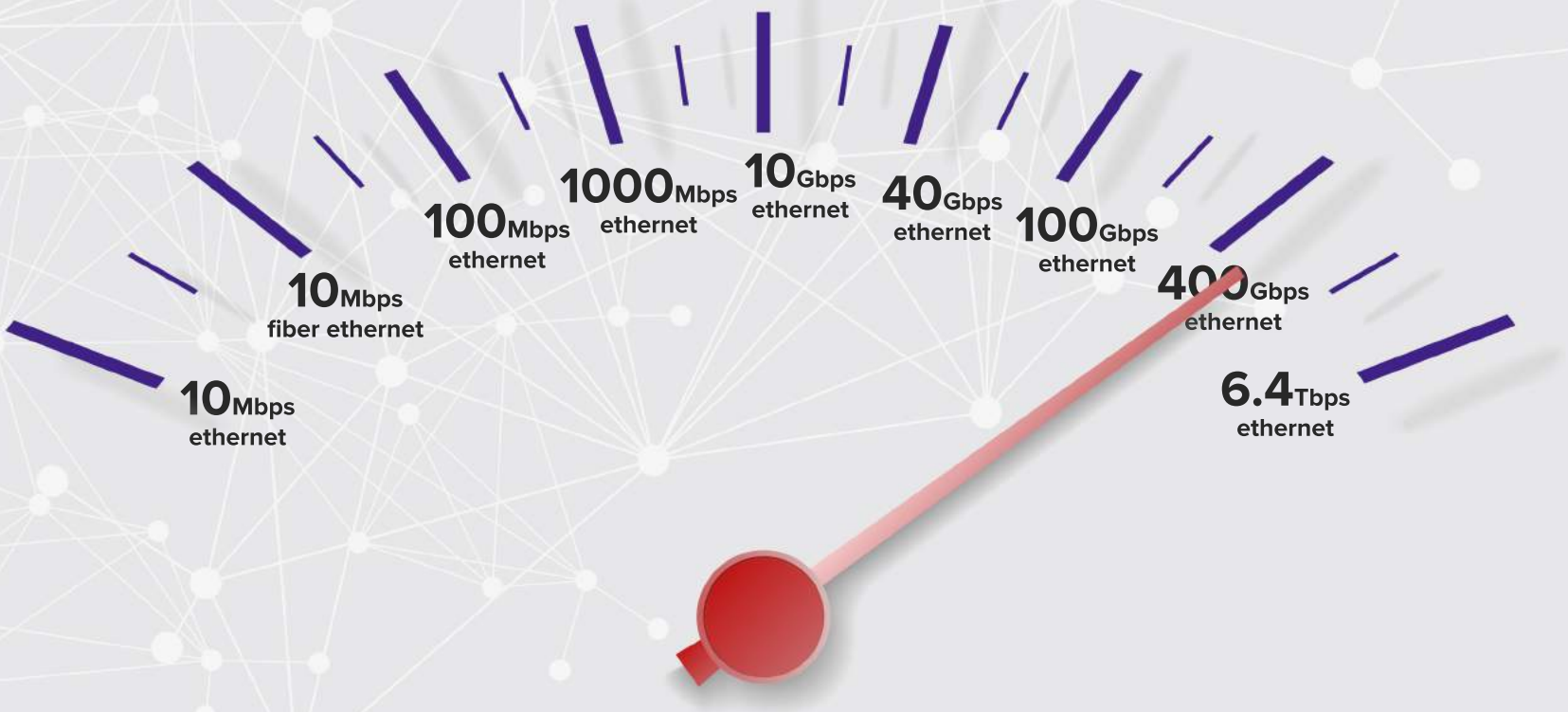
Enter a new flavor of Internet connectivity known as Digital Subscriber Line (DSL). DSL was cost-prohibitive for most customers until the late '90s and started gaining popularity in the early 2000s.

It operated through a special modem that pulled signals across traditional copper telephone lines on a different frequency. Speeds ranged between 128Kbps and 6Mbps depending on the distance between the end user and the phone company's closest central office.

At about the same time that DSL rolled out, cable television providers also began providing broadband Internet access. Cable and DSL continued to be the primary platforms for residential and small and medium business Internet access. However, large and enterprise businesses with geographically dispersed locations needed an enterprise WAN solution that could be faster, more reliable, and offer more security.

I. THE EVOLUTION OF ETHERNET

Those requirements made fiber the optimal solution for businesses that need to extend an Ethernet network beyond the LAN. Today's top fiber-based providers offer symmetrical speeds between 10Mbps and 100Gbps through Ethernet-based services such as Dedicated Internet Access (DIA), E-Line (point-to-point), and E-LAN (multipoint). These connectivity options allow for increased productivity and enhance computing connectivity for companies with high-bandwidth data needs. Of course, as data demands continue to grow, so will bandwidth options. Testing is already underway for 400Gbps service, and the Ethernet Alliance predicts that 6.4Tbps connections will be available by 2020.



II. THE RISE

Raising the Ethernet Standard

Most people go through their day blissfully unaware of how Ethernet makes life easier and more productive. They don't realize Ethernet is much more than just a cable that someone from the IT department plugs into a computer.

CFOs and operations managers rely on Ethernet technology for managing remote assets and evaluating budget needs. From water treatment plants to remote pipelines, Ethernet-based data monitoring brings new capabilities and unprecedented access to process measurement and control.

Ethernet is a fundamental component when transferring mission-critical data for industries like healthcare, education, hospitality, financial, and telecom. None of these industries could successfully function with their high capacity needs without the standards that allow interoperability to occur across networks.

Even the Wi-Fi networks that we connect to in our offices, at public hotspots and in our homes are Ethernet based and comply with a whole series of Ethernet wireless standards.

LANs and WANs route data through a series of network devices including bridges, hubs, switches, and routers. Collectively, these devices control traffic, connect different types of networks with different protocols, and deliver data to the right destination by way of IP addresses. This traffic management is possible because network devices interact through a common set of parameters. Strict standards created by the IEEE define equipment and network protocols, which translates to efficient communication and elevated reliability.

The good news for budget-conscious CTOs is that when all hardware manufacturers adhere to a standard, it allows IT teams to configure networks and data centers with devices from multiple vendors. This brand-agnostic approach results in networking systems that are customized to a company's needs while also being as cost-efficient as possible.

An organization called the **Metro Ethernet Forum (MEF)** complements the IEEE by making recommendations to the standards bodies and creating specifications that are not under development elsewhere. Largely due to the MEF efforts, Ethernet services became more standardized over the past few years.

II. THE RISE

When selecting an Ethernet vendor, you can be confident in a communications provider that has received the Metro Ethernet Forum's Carrier Ethernet 2.0 certification. That designation indicates the provider is recognized for delivering higher quality, reliable, scalable, and most advanced Ethernet services.

The MEF Technology Certification Program enables network equipment manufacturers to certify that their Carrier Ethernet products comply with the relevant MEF specifications.

CE 2.0 MEF CERTIFIED

Metro Ethernet Forum
Carrier Ethernet 2.0 certification

III. THE APPLICATION

Standing Up An Ethernet Solution

It is clear that Ethernet-based technology is the preferred solution when you are designing large-scale LANs and connecting dispersed locations across a WAN. After identifying your requirements, building your network with an Ethernet solution will ensure that you have an architecture with flexibility and scalability to adapt as needs change in the future.

Applying Ethernet for Large Scale Business Networking

High-performing networks don't happen by accident. However, with a thorough needs assessment and a comprehensive project plan, you can design a system that meets four fundamental network design goals:

Scalability – The network can grow to accommodate new users, locations, and applications with minimal or no downtime.

Availability – The system is accessible to all users and provides reliable performance 24 hours a day, seven days a week even when a single device or link goes offline.

Security – Security devices, filters, and firewall features are designed into a network natively, not added as an afterthought.

Control – Good network design minimizes complexity to yield a system that the support staff can manage effectively and efficiently.

On the surface, it might seem daunting to meet all those objectives. But deploying a large-scale network is simpler and less expensive than ever before. What hasn't changed is the need for a comprehensive plan that supports your company's evolution. A flexible system design ensures that you will be able to easily scale bandwidth or add additional sites as the organization grows.

You might have the in-house expertise to design your business network, or maybe you will rely on your Ethernet provider to plan the system. Regardless of your approach, you can streamline the process by starting with the following worksheet.

III. THE APPLICATION

Network Design Checklist

After answering the questions below, you will be better prepared to deploy a properly designed Ethernet-based network:

APPLICATIONS

- [ ] Do you need to integrate voice and video services?
- [ ] How many attendees will participate in video conferences, and from how many locations?
- [ ] What is the volume and amount of data associated with file transfers?
- [ ] Is large file upload as important as download?
- [ ] Do you work with CAD/CAM or other data-intensive apps?
- [ ] How many total users across how many locations?

SPEED & CAPABILITY

- [ ] What are the speed options?
- [ ] Can I connect securely to the cloud?
- [ ] Can I run my phones with the same provider/lines?
- [ ] Do I need support for remote offices & can the provider connect to them?

SCALABILITY

- [ ] Will the offered speeds allow scalability in the future?
- [ ] Will the scalability interface correctly with my network?

PRICE

- [ ] Is the Ethernet solution priced competitively?

PROVIDER

- [ ] How responsive is the provider?
- [ ] How reliable is the provider and service they provide?
- [ ] What is the responsiveness of the vendor, and how long would it take to fix or restore service?
- [ ] Is the provider locally based and supported?
- [ ] Do they have local teams and dedicated account managers?
- [ ] What do their SLAs entail?
- [ ] Is the Ethernet provider MEF certified?
- [ ] Does the provider offer end-to-end network monitoring?
- [ ] Is the provider available to support 24 hours a day, 7 days a week, 365 days a year?

REDUNDANCY

- [ ] Have you looked for single points of failure (SPOF) with hardware, services, and people?
- [ ] If you identify an SPOF, can you implement a backup or failover to take its place?
- [ ] Is the provider helping with the architecture of the network – ensuring redundancy and scalability?
- [ ] Are you or the provider responsible for providing redundant network devices, power supplies, racks, etc?
- [ ] Do their SLAs address redundancy?

III. THE APPLICATION

Consultation and Typical Deliverables

During the consultation and design phase, you should receive a service level agreement (SLA), which defines the level of performance that the subscriber can expect from the service provider. An SLA is the provider's commitment to supply a reliable and secure connection for your business. The most common aspects of an SLA include:

Availability

Latency

Repair

Packet loss

Customer support is critical to any business. Therefore, you should only trust your data needs to a provider that offers end-to-end network monitoring and dedicated local support teams that are available 24 hours a day, seven days a week, 365 days a year.

Standing up a network is a relatively linear process that follows a predictable pattern of design and mapping followed by pre-installation and site preparation. However, the completion time for those last two portions is harder to predict due to several variables:

Physical state of the building and surrounding area

Access agreements and approvals

Power availability

Scheduling limitations when you are required to use a particular contractor

Coordinating logistics between all parties

After completing the pre-installation and site prep, final installation time can also vary depending on the type of network and Ethernet solution you choose.

III. THE APPLICATION

Typical Deliverables for Ethernet as a Solution

For more information about finding the perfect Ethernet solution to fit in the network architecture for your business, **click here**.

III. THE APPLICATION

Network Construction

A constant network connection is not something that just happens. It is a result of carefully-constructed networks. There are several important considerations when designing local or wide area networks. Two critical factors are making sure the network is diverse and redundant to protect against single points of failure. While some providers will use these words interchangeably, they are not the same as one can exist without the other. For example, a network's fiber connections could be redundant, but if those connections are within the same conduit system, the network is not diverse. There are three different types of network diversity:

Carrier diversity - When a business selects two different carriers to provide network connectivity.

Access diversity - The capability of a network to provide backup protection for a local access circuit.

Transport diversity - Provides alternative transmission paths in the network core or cross-market section of the connection.

Other important considerations when designing and building a network:

Transmission Paths - There should be at least two separate paths to alleviate traffic congestion, accommodate for traffic demand or prepare for redundancy. These paths can be the physical cabling that connects the nodes on a LAN, the signal that is communicated over the pathway in a LAN or WAN, or a subchannel in a carrier frequency.

Hardware - With LANs, hubs are used when repetition of traffic on all ports is desired. If virtual connections between receiving and transmitting ports are needed switches will yield better performance. While switches provide connectivity, routers forward data between different network segments. Ideally, with a carrier, at least two hubs should be used from the service provider that supports separate circuit transmission paths.

Equipment Placement - Redundant equipment and electronics should be present in both the business and service provider networks. In the instance of a LAN, the equipment should be located throughout the building to reduce failure opportunities.

Uniformity - Whether developing a LAN or WAN, the network architecture and physical build should be similar from one location to the other to ease problem-solving.

III. THE APPLICATION

Many interconnections now include “dark fiber,” which is additional optical fiber put in place to accommodate future growth and requires the business to provide and maintain the equipment to activate the fiber. By laying more lines than are currently needed, a company can increase bandwidth at a later time without incurring installation costs. With dark fiber, the service providers’ responsibility lies in maintaining the fiber. Whereas, “Lit Fiber” is another way of leasing fiber, and is essentially a full turnkey services as the service provider owns and maintains the equipment, allowing for an easy upgrade.

These are general scheduling guidelines that can be influenced by multiple factors including network design, building features, and construction schedules. At this stage, before the system is locked down, it’s the ideal time to step back and consider how to integrate contingency planning into your initial build-out.

Time to Market & Stand Up Times for Ethernet as a Solution

Building already LIT

As few as **10-15** days to completed implementation

Building not already LIT

As few as **30-45** days to completed implementation

III. THE APPLICATION

Redundancy and Disaster Recovery

Redundancy planning ties back to the SLAs you should have received from your service provider during the consultation phase. If there is an outage, the network management and monitoring systems should rapidly identify the point of failure, and your local teams should be available to remedy the situation.

Analysis is critical to building a good redundancy plan. Take a close look at your network, and note common components that could be subject to failure. Your failover systems should engage automatically in the event disaster strikes. Redundancy in a network can take many forms. However, best practices suggest:

Put network hardware on a dedicated backup battery system or a generator that automatically engages when it detects a power outage.

Have an automatic failover system that responds quickly to eliminate downtime. This system should create an environment in which users won't notice any change in functionality.

Configure a hot spare switch that can be implemented in the event of hardware failure.

Contract with a secondary carrier to obtain automatic redirection of data and voice traffic if service from the primary data provider fails.

When designing a network, try to standardize on similar switches and routers. By using devices from the same manufacturer across your setup, you will simplify configuration and troubleshooting. That will expedite recovery time when you need to swap out a failed device for a spare.

Service outages can occur at any time due to either internal or external influences. Typical contributing factors include:

Power outage

Natural disaster

Environmental issues such as water intrusion or overheating

Damaged or defective hardware/feeds from provider

Human error such as improper routing, damaged fiber lines, or bad paths

The best offense against a service outage is a good defense. As referenced earlier, the first step in avoiding these situations is to eliminate single points of failure. By applying forward-thinking to your planning and provider choice, you should never find yourself scrambling to recover your services.

IV. THE AGE OF ETHERNET

Enter Your Business Into The Ethernet Age

Ethernet is an efficient, cost-effective, and scalable computer networking technology ideally suited to meet the ever-growing needs of today's businesses. With the Metro Ethernet Forum (MEF) as the driving force, Ethernet services have become increasingly standardized and are considered the preferred networking protocol to connect higher bandwidths across longer distances.

Despite the standardization, not all Ethernet service providers are the same. As your business plans to build an Ethernet network, it is crucial to partner with a provider that is a tech-forward thinker, customer-support focused, and has the capacity to meet data-intensive performance demands.

RCN Business's MEF Carrier Ethernet 2.0 certification indicates our ability to provide today's most advanced Ethernet-based options. Couple that with reliable, scalable, and customizable products and services, and your business can expect exponential growth and success. For more information and to learn how we can help you leverage Ethernet in your network architecture, please visit **rcn.com/business** or call **1-877-726-7000**.

CE 2.0 MEF CERTIFIED

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