



Wireless business internet

Support legacy/Time Division
Multiplexing services without copper.

Table of contents

2 Executive summary

3 Wireless business internet solutions

4 Wireless business internet best practices

**6 Comparison:
Wired and wireless connectivity**

8 References

Executive summary

General Services Administration (GSA) is sunsetting Local Services Agreements (LSA), Networx and Washington Interagency Telecommunications System (WITS3)

Time Division Multiplexing (TDM) services on legacy contracts need to be transitioned. In some cases, "like-for-like" migration to new contracts such as Enterprise Infrastructure Solutions (EIS) will be sufficient. In many other instances, this won't be a viable option as the legacy service is either not available or pricing is not supportable.

Communication Service Providers (CSP) like Verizon are decommissioning legacy TDM services

Across the country, CSPs, both national and regional, are decommissioning copper. There are several reasons for this. TDM services are expensive to maintain and the plant is at the end of its useful life. Copper is incapable of supporting the high bandwidth services required by new applications and architectures.

The net impact to agencies of both contract sunsetting and copper decommissioning: Many legacy services won't be supported and/or be supportable in the relatively near future.

Mitigation strategies

There are a host of mitigation strategies that agencies might consider as legacy contracts are discontinued in the months ahead. One promising option involves leveraging new and enhanced wireless cellular data networks and services. Verizon offers such a service called Wireless business internet (WBI). In most cases, this service is capable of supporting TDM/voice and internet services with surprising bandwidth and performance. This is because the



networks utilize either 5G Ultra Wideband or Long-Term Evolution (LTE) Advanced, broad new spectrum and sophisticated frequency aggregation technologies to support high bandwidth services with low latency.

WBI is capable of supporting TDM services, voice services and internet services at attractive price points.

Additionally, when deployed in a "private network" configuration, WBI may also support agency data applications. WBI augmented with Virtual Private Networks (VPN) and private wireless gateways can often provide the security needed to support agency specific applications.

WBI market is heating up, as businesses

seek faster speeds over reliable networks and quicker deployment of access services to both public and private networks. The global WBI market is projected to register a Compound Annual Growth Rate (CAGR) of 73% between 2021 and 2026,¹ as carriers make significant investments² to overcome the restrictions of legacy broadband networks, including speed, reliability and availability of wireline access.

In this white paper, we explore the challenges associated with wired broadband and discuss how WBI may help to mitigate these challenge.

Wireless business internet Solutions.

Primary access to public and private networks

- 5G Business Internet (with 5G receiver)
- 4G LTE Business Internet

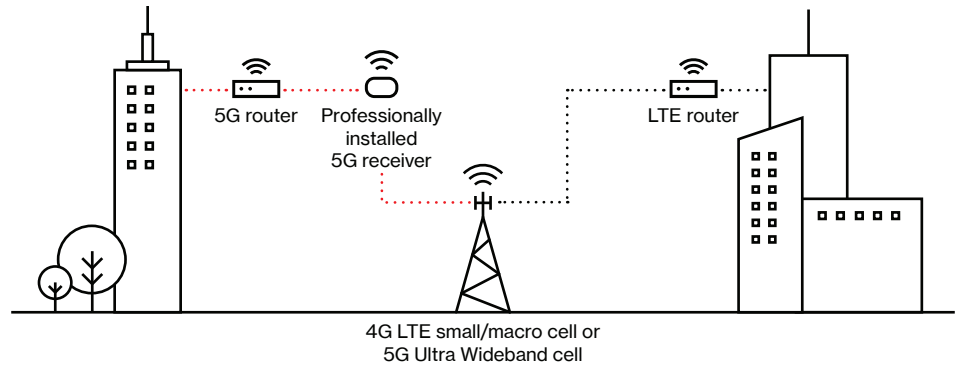


Figure 1. Primary access to public and private networks

Wireless business internet applications

Cellular internet connectivity that can be deployed virtually anywhere and ready within a few days rather than weeks.

Application	Use Case
Office in a box	Connectivity for new, temporary, or home offices. Often paired with voice over IP system Example: Portable plug and play router with VPN access for remote workers that is quick to deploy
Network resiliency	Secondary or Tertiary network backup. Especially crucial with a single point of entry for redundancy Example: Use a cellular router configured into wide area network for seamless connectivity failover to protect from wireline downtime
Remote locations	Branches or offices with lack of, or old and expensive, wired connectivity options Example: Enterprise grade router or adapter paired with a high gain Omni/ Directional antenna for improved bandwidth
Parallel network	Connectivity that is not connected to internal networks for security reasons, such as public or private internet Example: Primary connectivity for segmenting traffic to manage bandwidth consumption on core network
Mobile connectivity	Single point of connection in any vehicle Example: Mobile connection in vehicles to provide primary connectivity to devices inside (MDT for Law Enforcement)
Copper replacement	Plain Old Telephone Service (POTS)/TDM Replacement for elevators, fire alarms, security, remote monitoring, T1 replacement Example: Used for DSL/T1 line replacement with low bandwidth to speeds higher using our 4/5G network
Emergency connectivity	Rapid deployment and internet connectivity for emergency response Example: Portable, low cost, and long battery life for a Pop Up Network Kit

Wireless business internet best practices.

Practices include:

1. Proper equipment placement:

Ensure that WBI equipment, such as antennas or receivers, are positioned in a location that maximizes signal strength and minimizes obstructions. This includes placing them at a height that avoids interference from obstacles like trees or buildings.

2. Signal optimization:

Regularly monitor signal strength and quality to identify any issues and make necessary adjustments. This may involve adjusting antenna angles, upgrading equipment firmware, or using signal boosters or repeaters if needed.

3. Security measures:

Protect your WBI network by implementing strong encryption, using unique and secure passwords, and enabling firewalls. Regularly update firmware and security patches to guard against potential vulnerabilities.

4. Bandwidth management:

Prioritize critical applications and devices to ensure optimal performance for tasks such as video streaming, gaming, or video conferencing. Use Quality of Service (QoS) settings to allocate bandwidth accordingly.

5. Regular maintenance & monitoring:

Perform routine maintenance tasks, such as inspecting and cleaning equipment, checking for interference sources, and monitoring network performance to address any issues promptly and maintain consistent service.

Remember, specific best practices may vary depending on the WBI equipment and network setup, so it's recommended to consult the manufacturer's guidelines and seek professional advice if needed.

QoS router configuration

Broadband networks – including WBI – are generally known to offer best-effort traffic handling with variable and asymmetrical speeds. These characteristics require special consideration when it comes to



providing real-time and mission-critical traffic. While broadband internet lacks QoS features to honor packet tags (with the exception of Verizon Private Network Traffic Management), QoS mechanisms will still benefit the egress of traffic from your network, from both the client edge and data center perspectives.

Traffic egress from the data center will likely use traditional Low-Latency Queuing (LLQ) techniques to allow real-time and mission-critical traffic to leave the network first. Here, it is important to estimate the client edge site's average download and upload speeds. (Only an estimate is possible, as broadband network connections are variable speed.)

The QoS egress policies from client edge locations, however, should consider alternative options to traditional LLQ. Router vendors handle QoS for variable-speed internet connections differently, with options such as Auto QoS or Adaptive QoS. An interesting queuing algorithm, Controlled Delay (CoDel),³ offers a no-knobs configuration that handles variable bandwidth and Round-Trip Time (RTT), and a simple active queue management (AQM) and packet scheduling algorithm. We used this approach in our lab testing and found it both effective and easy to use.

WBI router selection

Router choice for WBI should be carefully considered. In addition to normal routing functions, you will want to determine if you want the cellular modem internal to the router, what types of QoS are supported by the router and what management features are specific to cellular.

Internal modem vs external modem/bridge

Having the modem internal to the router is convenient, as you manage a single device. However, when routers are located behind thick walls with metal cabinets surrounding them, cellular signals may be inhibited. For situations where signals have difficulty penetrating data closets, consider using an external modem/bridge. This option is helpful because the modem/bridge can be located remotely from the router via Ethernet, in a location with a better signal.

Router QoS capabilities

Variable-speed connections are a challenge for traditional LLQ techniques. As noted, cellular router manufacturers have created unique

queuing tools that are effective at handling the variable nature of WBI (and wired) internet connections. Furthermore, the CoDel standard for buffer management can be effective at the network edge in place of traditional LLQ QoS. This can simplify network edge administration and accommodate the variable speeds characteristic of broadband.

Tunable cellular parameters

Cellular routers vary greatly in the number of parameters that you can set. These settings may include items such as keep alive timers or connection dormancy. Some routers do not offer any settings for cellular performance. Research carefully to avoid unfortunate surprises later on.

Management software

Consider how well the management portal or router Internetwork Operating System (IOS) supports the reporting of cellular stats, modem configuration and management of multiple devices. Cellular feature sets in router IOS and management systems vary in maturity and should be chosen to suit your specific needs.

Omnidirectional antennas

Omnidirectional antennas radiate and receive energy equally in all horizontal directions. These antennas are best suited for applications requiring all-around coverage and are used both indoors and outdoors.

Directional antennas

Directional antennas are more commonly used outdoors, when all-around coverage is not required, or the focus of available energy needs to be radiated by the antenna in a particular direction.

Cellular booster

If the outdoor signal is weak even with an antenna, a cellular booster (aka amplifier or repeater) can be used to strengthen the signal within a frequency range. The amplified signal can be directly connected to a single device, or broadcast within a specific area, such as a large building. Keep in mind that when boosting signals within a frequency range, you might also be boosting radio frequency (RF) noise. Boosters only work when receiving a consistent signal from the macro network.



Comparison: Wired and wireless connectivity

Broadband access services

The most widely used broadband internet access services span both wired and wireless technologies, and fall into four categories: Digital Subscriber Line (DSL), cable, fiber and cellular. Each has different performance characteristics, transport technology and download vs upload speeds, and they are generally asymmetrical, which can make comparison challenging.

Most broadband services are also considered variable speed, meaning various environmental conditions may impact their speed at any time.

The median performances for wired broadband DSL, cable and fiber referenced in the chart reflect the aggregate of the major U.S. carriers, as measured by the Federal Communications Commission (FCC).⁶ The average performance for mobile wireless referenced reflects the aggregate of major U.S. carriers as measured by Speedtest.⁶ Verizon LTE Business Internet performance is based upon the average of lab tests at a single location. Verizon 5G Business Internet speeds are based upon customer trials at nine locations. Note that these performances offer only a sample reference, and factors network load, distance to data centers and environmental factors may impact performance on any connection at any time.

Wired broadband access services

DSL and cable internet service, come with challenges that can inhibit the rapid deployment of quality network service, which include:

- Determination of service availability
- Deployment agility
- Reliability and diversity of last-mile access
- QoS features
- Access to private networks
- Remote management and automation
- Cost of multi-vendor coordination

	Transport technology	Download (Mbps)	Upload	Latency (ms)
Wired	DSL (median) ⁴	8.90	1.05	35.33
Wired	Cable (median) ³	163.81	16.06	20.94
Wired	Fiber (median) ³	174.43	103.40	9.42
Mobile wireless	Mobile cellular (average) ⁵	76.15	13.42	40.00
Business internet	Verizon LTE Business Internet (avg, 50 Mbps)	41.65	12.09	89.47
Business internet	Verizon 5G Business Internet (avg, 400 Mbps)	386.33	100.33	26.37

Figure 2. Sample performance references

Determination of service availability

Determining the availability of wired broadband service at locations across the country is a challenge. For offices located in multiple states, establishing service entails engagement of multiple providers with unknown success for service availability, delivery and network speed performance. A typical wireline broadband connection could require any or all of the following steps:

- Placing an inquiry with a local provider to determine a “desktop estimate” for an initial indication of service availability and network speed
- Placing an order with the local provider to make a more definite service availability determination
- Scheduling a site visit to validate service availability, determine the actual speed based upon distance from a central office and provide cost estimates for wired installation, if service is not available in the desired part of the building
- Construction of wire installation to the site, if service is unavailable

Performing each of these steps for a variety of locations across several local providers is a complex endeavor. Many organizations in this position will rely upon service aggregators to mitigate these efforts.

Deployment agility

The wait for wireline broadband services can be lengthy. If a wired

infrastructure already exists at the site, it can take several weeks for deployed service. If wired infrastructure does not exist, deployment can take months.

Reliability and diversity of last-mile access

The last mile is the relatively expensive and complex delivery of cables or wiring from the service provider’s facility to a customer’s location.

Last-mile diversity describes the physical separation of access wires traveling this distance. This level of diversity is typically unavailable to small office locations, or too costly to provide. When seeking high network availability for a critical location, enterprises will oftentimes order a redundant circuit from an alternate service provider.

However, obtaining wireline services from different carriers can give a false sense of security. It is often very difficult to ascertain the fiber-optic routes between carriers; paths may cross or even use the same conduit to the customer premises. When more than one local access circuit travels in the same path for the last mile, there is a lack of local access diversity. This creates business risk, as both network connections can be severed at the same time at a single point of failure.

QoS features

QoS is a set of technologies that work across local area and wide area

networks to support high-priority applications and traffic under limited network capacity. However, wired broadband service providers generally lack network QoS features to support mission-critical applications.

Access to private networks

The lack of inherent privacy features and complex Internet Protocol (IP) Virtual Private Network (IP-VPN) configurations may be a challenge when deploying wired broadband services.

To achieve privacy over the internet, companies often leverage Internet Protocol Security (IPsec) VPN technologies as a less expensive alternative to Multi-protocol Label Switching (MPLS) networks and dedicated access. Wired broadband is inherently an Internet-based service and does not offer privacy service features. Therefore, an IPsec VPN-capable router is required. In addition, if full-mesh communications are needed, IPsec VPN configurations can be complex and increase the cost requirements of the on-premises router.

Remote management and automation

Legacy broadband service activations, deactivations and speed changes are generally configured by central office administrators, and generally don't happen immediately. But today's consumers have come to expect agile, cloud-based services, along with Application Programming Interfaces (API), to support changing network requirements and gain competitive advantage.

Cost of multi-carrier coordination

Terrestrial broadband service providers are regulated in the U.S. and allowed to provide services in specific, limited geographic areas. As such, procuring terrestrial broadband services across a wide geography from a single provider is rarely possible. Enterprises with widespread locations often turn to ISP aggregators to relieve the burden of dealing with multiple service providers, but the markup fees for aggregation services can range from 20% to 30% of the broadband connection. These overlay services required often include purchasing, billing, customer service, location tracking and service portals to facilitate the complex commercial management of multiple internet connections.^{6, 7}

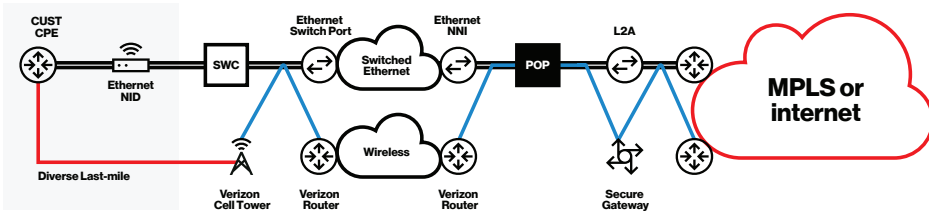


Figure 3. Creating last-mile network access diversity.

Achieving last-mile network access diversity as a strategy for business application resilience

WBI provides diversity for last-mile access as depicted in the reference diagram. This diversity is valuable for keeping critical locations and applications up and running and can complement other wireline access methods to provide resiliency. The diagram illustrates diversity of the last mile, as well as transparency for potentially shared network elements.

Help ensure security of corporate data with private networks

Verizon Wireless Private Network⁸ is a security service solution using Verizon 4G LTE technology (and, where available, 5G). Private network enables wireless devices to send and receive data to and from the customer's IP network without traversing the public internet. It provides a fast, direct connection to internal systems and applications, without compromising network control and manageability, giving organizations a competitive edge to fuel growth and privately integrate wireless devices into their network.

With Private network, enterprises can deliver mission-critical information to workforces and connected devices on the largest high-speed wireless network in America, while reducing security

concerns and reliability issues related to the public internet. Having data communications segregated from the public internet blocks unsolicited traffic and unauthorized devices, thereby reducing security risks.

With private network, the organization has its own network, where traffic is kept isolated from the public internet.

- Devices are authenticated and authorized for each private network (only authorized data can traverse the designated network)
- Data is routed per customer-specific IP pools
- Dedicated private network gateways are designated
- A direct connection is created between Private Network gateways and the customer

Conclusion

With Verizon's WBI, a revolutionary solution for high-speed, reliable connectivity, customers can enjoy seamless internet access using advanced wireless technology, either eliminating or complimenting traditional wired connections.

Covering over 99% of the US population, experience faster speeds and exceptional performance, empowering you to connect, work, and stream with confidence almost anywhere our 4G and 5G network is available.

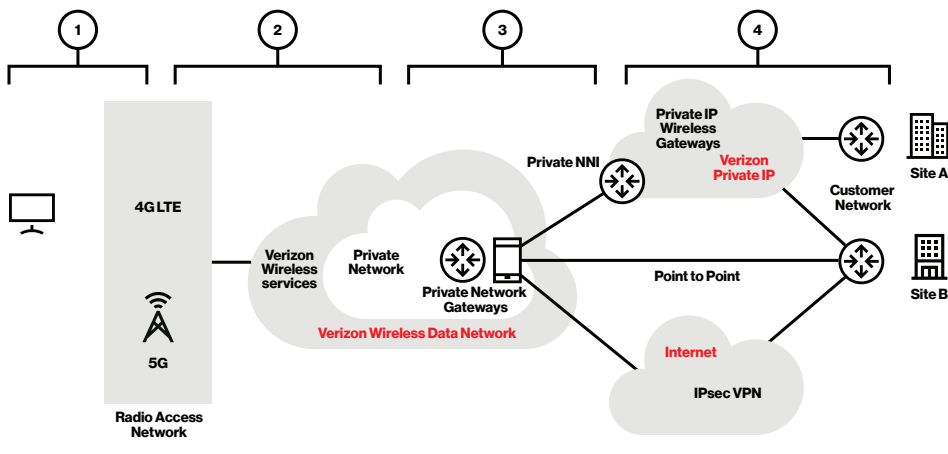


Figure 4. Private Network isolates traffic from the public internet.

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