Introduction

The term "broadband" refers to what is commonly known as high speed internet access. Reliable broadband access is an increasingly important asset for communities, nearly a necessity in the modern age. The proliferation of broadband access of today is often paralleled with the great public infrastructure projects of the Twentieth Century, such as the expansion of the electricity and telephone networks or the creation of the interstate highway system. Like those monumental public works projects, increasing access to broadband services creates economic development opportunities, provides greater educational opportunities, improves the ability of emergency responders and government officials to effectively do their jobs and generally improves the quality of living.

However, the expansion of high speed broadband access can be slowed by factors such as low population densities and geographical barriers. Oftentimes it is not economical for internet service providers to extend the necessary broadband infrastructure to homes and businesses in remote locations. In fact, as of 2011 only 60 percent of Americans living in rural areas use broadband internet service.[1]

The goals of this chapter are to:

- Provide a brief overview of broadband technology,
- discuss the regulatory context of broadband technology
- identify strengths and weaknesses in North Hampton's broadband coverage,
- identify barriers to access for coverage expansion,
- recommend actions and policies to improve broadband access throughout town.

What is Broadband?

The US National Broadband Plan of 2009 defined broadband as "Internet access that is always on and faster than the traditional dial-up access". Broadband is a high-speed connection to the Internet that may use wireless or wired infrastructure. Among the wired infrastructure solutions are traditional copper telecommunications lines (used in the telephone network), coaxial lines (used by cable TV networks), fiber optic lines (used by telephone/cable/internet networks), and a technology called Broadband over Power Lines ("BPL"). Among the wireless solutions are *fixed wireless services* (provided by wireless internet service providers or "WISPs") to the home and office, and *mobile wireless services* ("cellular" services to the home, office, highway, and outdoors).

[1] "Digital Age Is Slow to Arrive in Rural America," New York Times, February 17, 2011

The one thing all broadband internet services have in common is the ability to deliver data connections to and from the subscriber that are substantially faster than what can be achieved on dial-up internet connections using regular phone lines. This is referred to as "broadband" because the communications links must have wide ("broad") spectrum ("bands") to move information so quickly. For example, cable TV systems divide the radio spectrum that is carried on the cable into several segments: TV channels; an internet connection from the subscribers' homes to the cable company's internet server (the "uplink"); an internet connection from the company's internet server to the subscribers (the "downlink"); and a two way voice telephone channel. The amount of spectrum that each channel occupies is called the bandwidth. In general, the greater the bandwidth allocated to a link, the faster the data rate it can deliver. This is especially important as internet traffic becomes more and more reliant on high bandwidth services such as video streaming, gaming, video telephone services, music and movie downloads, and machine-to-machine ("M2M") communications.

The term "broadband" itself is relative: it denotes that the range of frequencies available is wider, or broader, than that of other signals or services. These "other" signals or services are sometimes referred to as "narrowband" and typically include dial-up connections that use voice telephone lines that achieve a maximum data rate of 56 kilobits per second (Kbps) and one-way or two-way paging services with similar data rates. Today's broadband is hundreds of times faster than narrowband and is often measured in megabits (a million bits) per second rather than kilobits (a thousand bits) per second. The term "bit" is a unit of data, while kilobits per second (Kbps) and megabits per second (Mbps) are rates of data transfer. The National Telecommunications and Information Administration (NTIA) has set minimum rates (also called "speeds") for a service to be considered as broadband: download speeds (to the subscriber) of 768Kbps and upload speeds (to the network) of 200Kbps. The FCC has upped the ante, defining Broadband service as running at more than 4 Mbps in the downlink.[2]

Residential and small business broadband is typically delivered through either telephone or cable lines, or by antennas provided by WISPs. A Digital Subscriber Line (DSL) uses conventional telephone lines with special equipment to deliver broadband service. Cable-based broadband utilizes available bandwidth on cable television lines, which have greater bandwidth than DSL. Fiber optic lines deliver information using pulses of light through optical fiber and are able to deliver the highest bandwidths of any transmission medium. Fiber optic lines also can deliver their speeds over longer distances than DSL or cable. DSL, cable and fiber optic internet services all provide a broader, higher capacity spectrum of service than traditional dial-up. Fixed wireless internet services can rival DSL and cable in their

[2] *"The [FCC] National Broadband Plan [www.broadband.gov] recommends as a national broadband availability target that every household in America have access to affordable broadband service offering actual download (i.e., to the customer) speeds of at least 4 Mbps and actual upload (i.e., from the customer) speeds of at least 1 Mbps.... this speed threshold provides an appropriate benchmark for measuring whether broadband deployment to all Americans is proceeding in a reasonable and timely fashion."* FCC, Sixth Broadband Deployment Report, July 20, 2010.

maximum data speeds. Mobile wireless services are increasing in their bandwidths, with the latest 4th generation technologies ("4G") beginning to surpass the maximum DSL speeds.

Commercial users and large institutions oftentimes choose dedicated T-1 broadband links to connect among their various sites or directly to the internet. A single T-1 link runs at only 1.544 Mbps and they can be bundled into a DS-3 to deliver 44.736 Mbps systems, which provide a guaranteed connection using copper wire and fiber optic lines. While T-1/DS-3 offers high speeds and capacities, it is considerably more expensive to operate than other delivery methods and is typically unavailable in remote locations. Dedicated fiber optic links provided by telecommunications services can be purchased to interconnect remote offices/campuses and to connect directly to the internet. For instance, an OC-3 connection runs at 155.52 Mbps, while a very high capacity OC-255 can deliver 13.21 Gbps (gigabits per second, where a gigabit is one thousand megabits).

Broadband infrastructure

Information is transmitted between the internet and the end user in three general steps – from the internet backbone to middle mile infrastructure and finally to last mile infrastructure. The internet backbone refers to the main trunk "super highway" connections of the Internet, which is made up of a large collection of interconnected commercial, government, academic and other high-capacity data routes and routing devices that carry data across the US and the rest of the world.[3] The middle mile portion of the broadband network essentially connects the main trunk lines at a "telecom hotel" to the local ISPs' central exchange locations. From there, the (Internet Service Provider) ISP delivers broadband service over the last mile (sometimes referred to as the first mile) to its final destination at the subscriber's home or business. The term "last (or first) 100 feet" is used occasionally to describe a fourth and final link in the process – the connection from the utility pole *into* the subscriber's home or business. There is a simplified diagram showing this process after the glossary section.

Access problems to broadband band lie in the middle and last mile segments. More remote communities often lack middle mile infrastructure, meaning that broadband lines are not present in the town and ISPs have no economical place to connect to the internet. It is also common that many communities have middle mile infrastructure, but large segments are not serviced by last mile.

In many places it may not be economical to extend broadband lines to individual homes in moderately to sparsely populated areas, resulting in large areas with no wired broadband service, or poor quality broadband service at best. WISPs often find small remote communities to be an opportunity to provide services where there is little wired competition. The WISP installs one or more *access points* on towers, hilltops or rooftops that have excellent *line of sight* to residences and businesses. As long as there is a place where the subscriber can have an antenna installed that has a line of sight to the access point, the subscriber can obtain reliable broadband service from a WISP. The WISP must be able to connect the access point to the middle mile facilities in an area, if there are any available.

[3] North Florida Broadband Authority, http://nfba-fl.org/MiddleMile.asp

The third category of broadband services is the mobile wireless service. In remote areas it is increasingly likely that wireless (cellular) telephone service is available. From their existing cell sites, mobile wireless service providers can provide broadband and near-broadband wireless internet services. Like the WISP and the wireline internet service provider, the mobile wireless provider must have access to middle mile resources. Cell sites in rural areas are often relatively remote from utilities and telecommunications resources, resulting in limited data speeds between the cell site and the internet. Also, just as it may be uneconomical for a wireline internet service provider to deliver broadband service to homes in sparsely populated area due to the high capital costs per unit of population, mobile wireless service providers may defer building out the highest capacity services to sparsely populated areas until more developed areas have been provisioned.

New Hampshire Broadband Mapping Program

The State of New Hampshire is currently working on the New Hampshire Broadband Mapping Program (NHBMP), a multi-agency initiative funded by the American Recovery and Reinvestment Act (ARRA) through the National Telecommunications and Information Administration (NTIA). It is part of a national effort to expand high-speed internet access through data collection, mapping and identification of service shortfalls. The University of New Hampshire's GRANIT program was granted $1.7 million to manage the program which will inventory and map current and planned broadband coverage available to the state's businesses, educators, and citizens.

The project is comprised of two components: a two-year broadband availability inventory and mapping effort, and a four-year planning initiative.

The inventory, now in its second year, uses service-area landline and wireless data collected from the 60-plus public and commercial entities that provide broadband services in the state. This data shows service availability, type, and technology and will help to identify areas of the state that are without service or underserved by the current broadband infrastructure. Data is also being collected on broadband availability at individual community anchor institutions such as schools, libraries, medical/healthcare locations, public safety offices, and state, county, and municipal buildings.

Coordinated by the state's nine regional planning commissions, the planning component of the NHBMP will incorporate the information collected into regional broadband plans throughout New Hampshire. It will establish regional broadband stakeholder groups to: identify barriers to broadband deployment; promote collaboration with service providers; facilitate information sharing regarding the use of, and demand for, broadband services; and develop broadband plans such as this one. Additional support for the program will be provided by a variety of state agencies, including the Division of Economic Development, the Office of Energy and Planning, and the Public Utilities Commission.[4]

[4] NH Business Resource Center, http://blog.nheconomy.com/?tag=new-hampshire-broadband-mapping-program

Land Use Regulation of Broadband Related Technology

Most land use permitting processes relate to the placement of mobile wireless facilities. Mobile wireless facilities often called *cell sites*. While the familiar *cell tower* is a common way to mount mobile wireless facility antennas, more and more cell sites are installed on/in existing buildings and structures or are camouflaged to be less intrusive to the purpose and intent of local zoning. Church steeples in New Hampshire have become popular sites for concealing wireless facility antennas. Similarly, silos, smokestacks, water towers and tanks, electric transmission towers and poles, and even utility poles are relied upon for the placement of wireless facility antennas.

Cable and DSL internet service primarily use existing infrastructure along utility poles or ways and therefore do not often require action from land use boards. Wireless facilities, including but not limited to cell towers, on the other hand present significant visual impacts and siting challenges, requiring more regulation and scrutiny by land use boards. The following is a brief summary of legislation surrounding wireless facility development.

Federal Telecommunications Act of 1996

The Federal Telecommunications Act of 1996 ("TCA"), enacted by the Federal Communications Commission (FCC) modifies the seminal Communications Act of 1934, which is the comprehensive federal law that regulates the telecommunications industry. Section 704 of the TCA specifically preserves the right of municipalities to regulate the placement of wireless facilities through local zoning, stating "Nothing in this Act shall limit or affect the authority of a State or local government or instrumentality thereof over decisions regarding the placement, construction, and modification of personal wireless service facilities." There are several exceptions limitations to this statement outlined in the Section 704, however, and include:

- Land use development standards may not unreasonably discriminate among the wireless service providers and may not prohibit the provision of personal wireless services.
- Local governments must act upon applications for new wireless infrastructure within a reasonable period of time after the request is filed according to the nature and scope of the request.
- Local governments cannot deny an application for a new wireless facility or the expansion of an existing facility on the basis of the environmental effects of radio frequency emissions, provided such facilities comply with the FCC's emissions regulations.
- Local governments must place their decisions in writing and those decisions must be based on substantial evidence in a written record.

Section 704 also states that "Any person adversely affected by any final action or failure to act by a State or local government or any instrumentality thereof that is inconsistent with this subparagraph may,

within 30 days after such action or failure to act, commence an action in any court of competent jurisdiction."

Additionally, Section 706 of the Act requires states to encourage increased availability of broadband service, which was not widely available in 1996 when the Act was initially released. Section 706(a) states:

> The Commission and each State commission with regulatory jurisdiction over telecommunications services shall encourage the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans (including, in particular, elementary and secondary schools and classrooms) by utilizing, in a manner consistent with the public interest, convenience, and necessity, price cap regulation, regulatory forbearance, measures that promote competition in the local telecommunications market, or other regulating methods that remove barriers to infrastructure investment.[5]

Local Ordinances and Regulations and Broadband Infrastructure

The Town of North Hampton adopted a Wireless Communications Facilities Ordinance (Section 329) in March 1997 (subsequently revised) in accordance with the authority granted by the New Hampshire RSA 674:16 and 21, II. The purpose of this ordinance is to establish general guidelines for siting towers and antennas and fulfill the following goals:

- Enhance the ability of providers of telecommunication services to provide such services to the community effectively and efficiently.
- Reduce the adverse impacts such facilities may create on, including, but not limited to: migratory bird flight corridors, impacts on aesthetics, environmentally sensitive areas, historically significant locations, health and safety by injurious accidents to person and property, and diminution of property values.
- **Preserve the Town's unique view**-sheds, scenic values and natural resources in particular **those identified in the Town's recently completed Open Space Plan.**

Furthermore, the ordinance limits placement of towers to within an overlay district defined as the land within 1,000 feet of the center of the median on the west side of Interstate 95, as well as all unrestricted Town-owned land, land on which the Town owns the right to develop a tower and land on which an existing Alternative Tower Structure can be used.

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[5] All information in this section is taken from the Federal Telecommunications Act of 1996 and FCC sources. A copy of the TCA is at http://transition.fcc.gov/Reports/tcom1996.pdf

Current Broadband Status in North Hampton

Wireline Broadband Services

DSL and Cable services are currently available in North Hampton. Fairpoint Communications is the only "land-line" telephone service provider (Some grandfathered AT&T service contracts are still honored, however Fairpoint is the only service accepting new customers). Fairpoint uses an all-copper infrastructure for the last mile and last 100 feet, therefore performance and availability of DSL can be affected by the quality of lines as well as the distance to the subscriber. For instance, DSL has 18,000 foot wireline limit. Fairpoint currently advertises download speeds ranging from 768 Kbps to up to 15 Mbps.

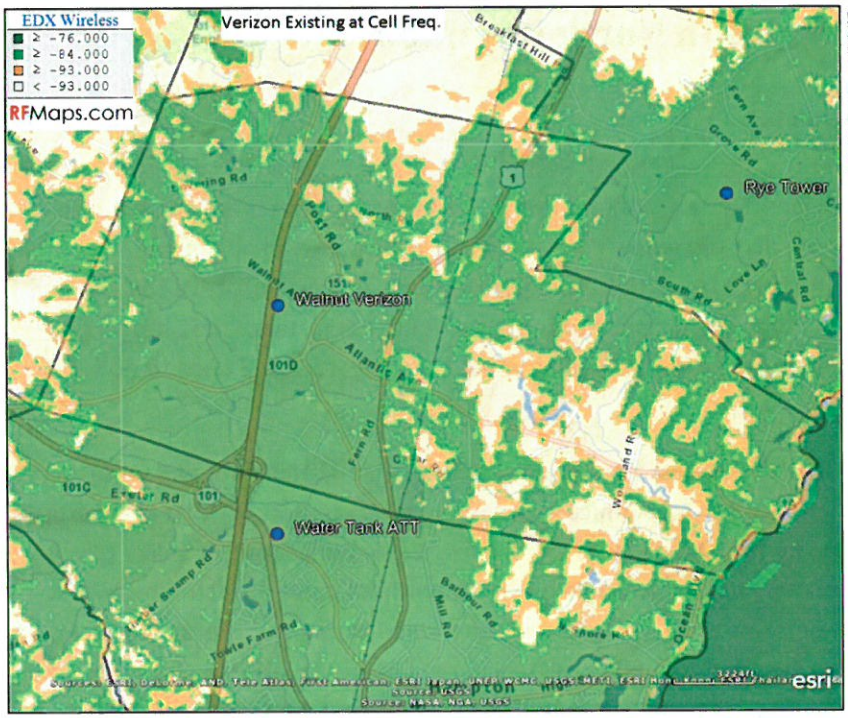
Cable Broadband service is provided by Comcast Xfinity, which offers cable TV, internet and voice telephone service. Within their internet service, Comcast also offers a "Powerboost®" that is advertised to increase download speeds from up to 15Mbps to up to 25Mbps. Cable performance, unlike DSL, is not limited by distance; however it may not be available on streets without cable infrastructure. Comcast uses fiber optic cable in portions of its last mile and converts to copper for the last 100 feet. Some residents in town have been required to fund the extension of Comcast's infrastructure from the street to their homes, adding additional cost and a potential barrier to access, particularly in rural or suburban areas where driveways are often long and would carry a high price tag.

Currently there is not a continuous network of fiber optic cable in North Hampton, thus barring the availability of Verizon FiOS or similar fiber optic broadband services.

Wireless services available

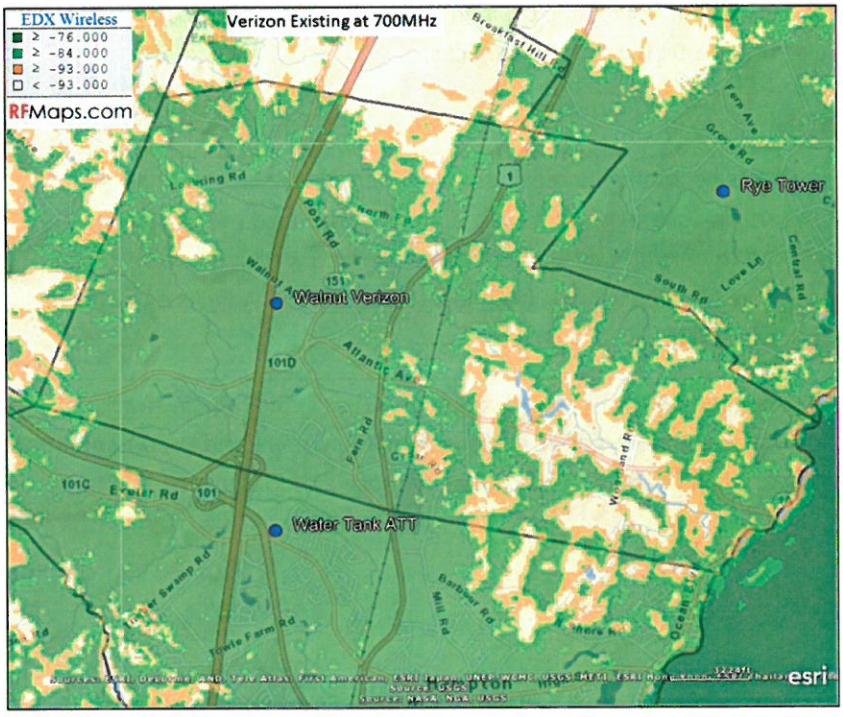
As discussed earlier, broadband service is becoming increasingly available via wireless technologies. North Hampton has substantial cell service coverage, with limited areas of reduced performance. This may be attributed to the location of cell towers as well as the topography and wooded nature of the landscape. North Hampton currently has two cell towers, both located near I-95. Adjacent towers in Hampton and Rye also provide service in town.

The maps below show current and proposed (with the introduction of 4G) cell coverage in North Hampton by Verizon and AT&T. It is evident that large areas along Atlantic Avenue and Woodland Road are currently underserved in the eastern half of town. Even under proposed conditions, North Hampton will not have 100% coverage.



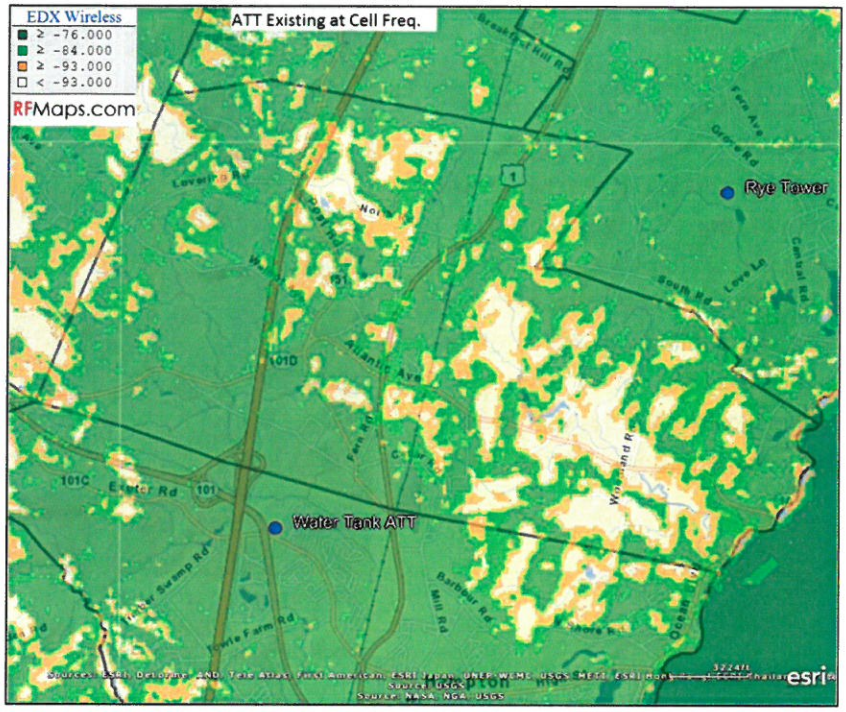
Verizon Coverage - *Current*

Credit: Isotrope, LLC; RFMaps.com



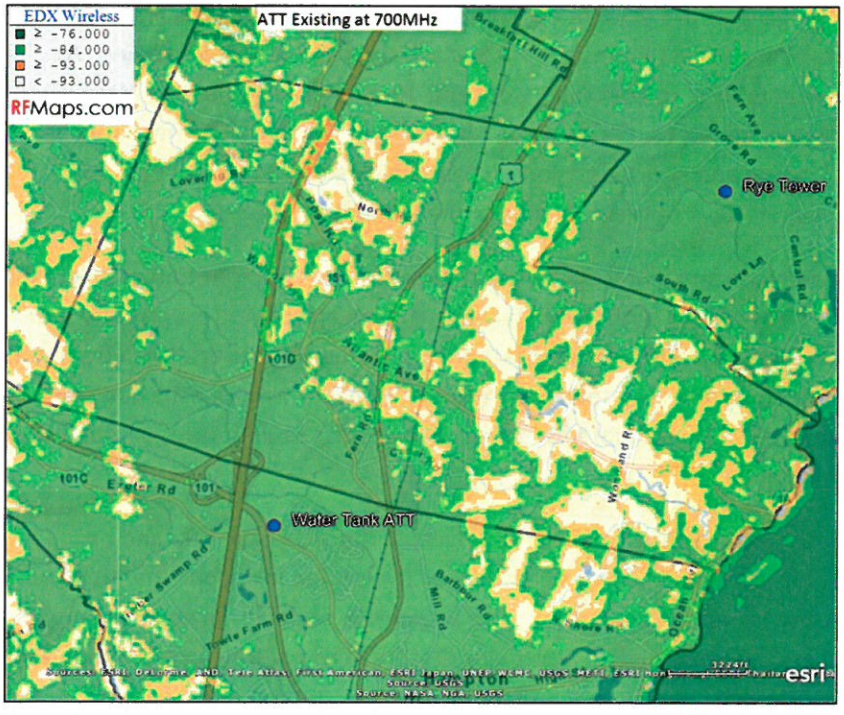
Verizon Coverage - *Planned under 4G*

Credit: Isotrope, LLC; RFMaps.com



AT&T Coverage – Current

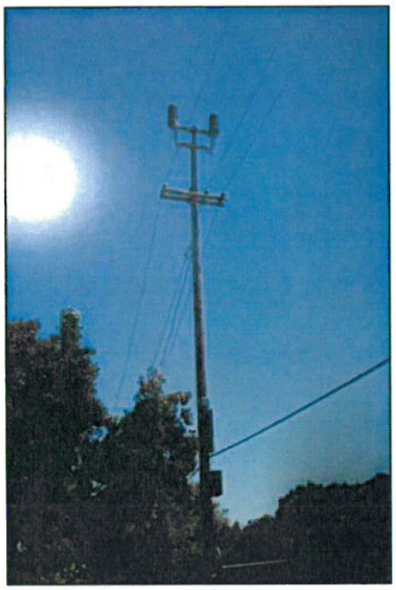
Credit: Isotrope, LLC; RFMaps.com



AT&T Coverage - *Planned under 4G*

Credit: Isotrope, LLC; RFMaps.com

An alternative to further construction of cell towers to improve coverage is a Distributed Antenna System, also known as "DAS." DAS is a network of antenna nodes, typically mounted on utility poles, connected to a common source, typically by way of fiber optic cable. The antennas extend wireless service into areas not reached by the conventional cell tower. The "common source" is typically a hub building that houses the provider specific technologies. In October 2011, the Planning Board voted unanimously to extend the approval of a Conditional Use Permit for a DAS hub building on Atlantic Avenue. A network of antenna nodes would not be built until one or more service providers commit to using the facility. DAS systems are an efficient solution to filling in coverage gaps without constructing additional cell towers.



DAS antenna on utility pole.

Credit: Alejandro Lopez de Haro

Future Considerations

Wired broadband technology, in its current form, is widely available in North Hampton. Wireless broadband is available, although large gaps are evident east of Lafayette Road. While it is important to address these gaps, it also behooves the town to consider the scalability of various technologies. As technology evolves, demand for data is likely to continue its ascent. Retaining a high level of data service and anticipating future data demands for residents and business of North Hampton should be considered as the town makes planning and policy decisions. Maintaining a high standard of data delivery service is an asset to economic development, quality of life and public safety.

Most wireline and wireless providers are constantly upgrading their systems as competition and demand requires. Fiber optic systems can be upgraded with the installation of converters, and is currently the highest quality wireline broadband service aside from dedicated T-1 systems. However, North Hampton is not outfitted with fiber optic infrastructure. The town may want to evaluate whether the current level of service provided by Cable and DSL is adequate for now and the foreseeable future, or if investing in fiber optic infrastructure is worthwhile.

The Wireless Communications Facilities Ordinance allows cell towers in the vicinity of I-95 and on unrestricted town-owned land. Therefore, a DAS system is an attractive option for supplementing and improving North Hampton's wireless broadband capacity. Such a system is scalable, as equipment with the hub building can be replaced and/or upgraded. It also helps preserve the natural, forested appeal in many of North Hampton's neighborhoods.

Recommendations

1. Monitor contractual obligations between the Town and service providers to ensure quality service and competitive rates.
2. Evaluate the feasibility and capital investment costs of a fiber optic network.
3. Monitor and foster service provider interest in employing the DAS system.
4. Consider requiring fiber optic infrastructure in new subdivisions.
5. Consider requiring new subdivisions to identify potential DAS antenna node locations.
6. Consider requiring site plan applications to identify potential DAS antenna node locations.