Village of Oak Park
&
Oak Park Elementary School District 97
Broadband Plan

Phase 1 Report

Contents

EXECUTIVE SUMMARY

The Village of Oak Park and Oak Park Elementary School District 97 are collaborating to examine the implementation of common data infrastructure that will provide scalable, reliable and cost effective connectivity between both Village of Oak Park and SD97 facilities. This collaboration includes the engagement of Northern Illinois University's (NIU's) Broadband Development Group to provide a phased analysis, recommendation and request for proposal (RFP) process that is planned to culminate in implementation of a broadband infrastructure that will provide high capacity data connectivity for both entity's anchor institutions.

Phase 1 of this work effort examines the anchor sites for each entity and the key applications that are creating the ever-increasing demand for data transport between these key facilities. The current data paths serving these facilities provide support for local server based applications, for voice over Internet protocol (VoIP), and for access to Internet-based resources. The demand for scalable Internet access significantly increases as email and office applications, educational one-to-one programs, and other Cloud and Internet hosted systems linked through common gateways replace existing systems and new applications require additional bandwidth to support functionality.

Many logistical and technological factors have been included in this analysis. The proximity of existing facilities for both Village of Oak Park and SD97 suggest that a common infrastructure may serve both entities effectively. Consideration of micro-duct technology would define discreet fiber pathways and connectivity for each public sector entity while fully realizing the benefit of shared common path components and installation costs. Fiber is a long-term investment with an expected useful lifetime of greater than 30 years. Fiber (single-mode) is inherently scalable with continued advances in technology extending the value of installed fiber base. Moreover, at this point in time, there is no other transmission medium with the bandwidth, scalability and long-term durability as fiber optic infrastructure.

NIU believes the investment in a common fiber infrastructure will provide the greatest value to the greater Oak Park community for data connectivity and transport. The benefit of fiber infrastructure includes the ability to immediately realize exponential increases in bandwidth between locations, increased reliability of the data transport solution, and the provisioning of a long-term asset that offers many additional public sector and economic development opportunities at significantly reduced costs for each participant. These benefits enhance the value of a fiber based solution well beyond the current data transport needs identified by the Village and School District.

Village of Oak Park

The Village of Oak Park has already realized the value of a fiber infrastructure as its primary data connectivity between anchor facilities routes across a primarily multi-mode fiber optic cabling system that provides their data transport connectivity. Installed and operated in conjunction with Village traffic signal controllers the fiber system has provided a reliable backbone capability with low operating and maintenance costs.

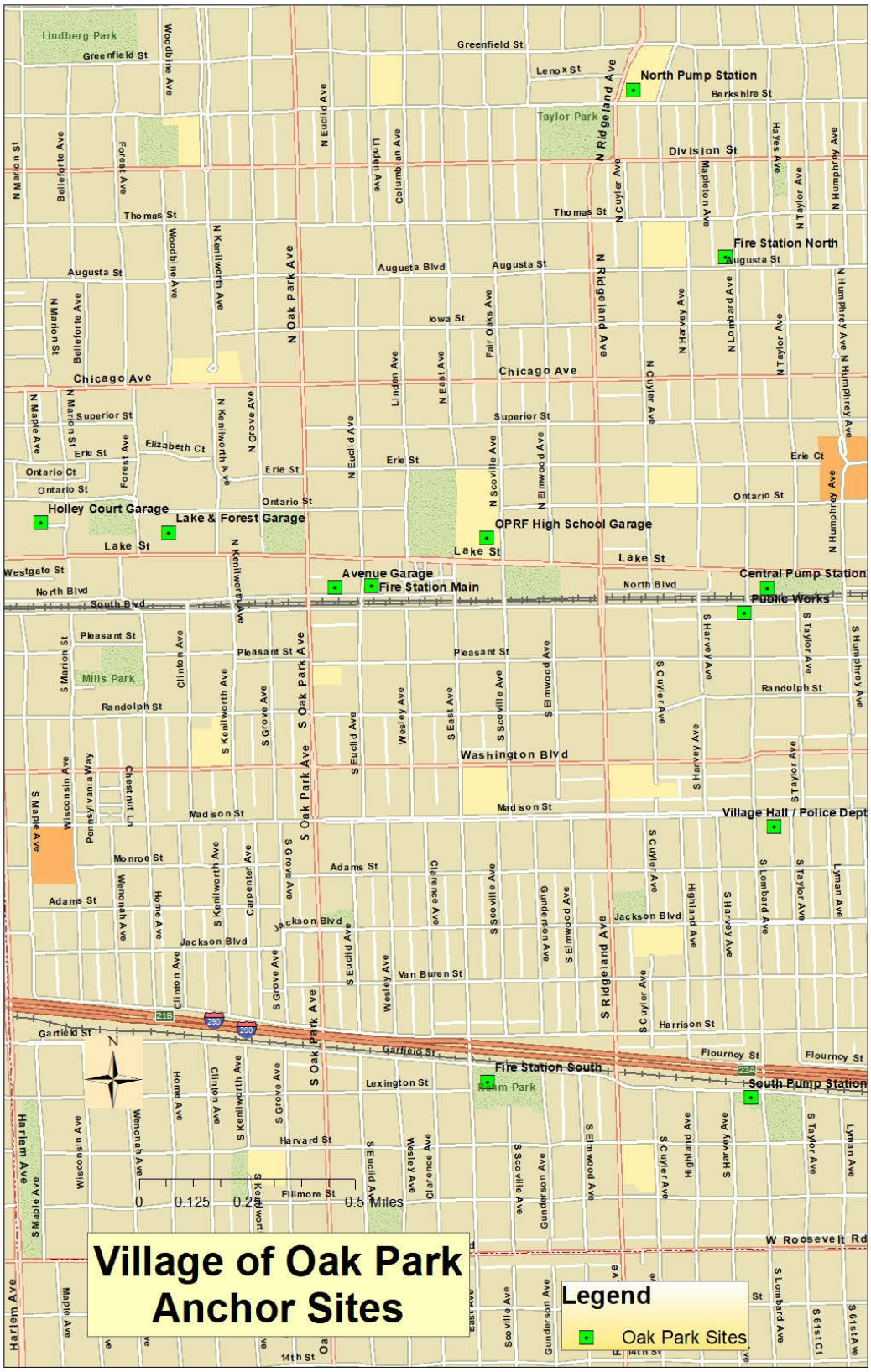
The existing fiber system does have several drawbacks that prevent it from continuing to be the primary backbone infrastructure for Oak Park. The multi-mode fiber is already operating at the limits of its data transport capacity and will not support the higher data rates required for normal Village operations. The multi-mode fiber, currently running a 100 Megabit data rate, will not scale to a Gigabit link between the Village facilities.

The existing fiber infrastructure does not have redundancy nor the ability to configure a redundant network between facilities. The ability to create a ring architecture or provide path diversity is key to the creation of highly reliable networks in support of critical applications and systems.

Network system electronics for Oak Park have reached the end of their expected useful life and are no longer supported by the manufacturer. The lack of support, along with availability of spare parts, places the network at risk. These systems will require replacement, but the key value proposition for the investment will be to increase capability of the network system concurrent with hardware upgrades. This will only be accomplished through provisioning of a new fiber infrastructure for connectivity. And, new generation equipment should be considered that also addresses fault tolerant operations.

The Village of Oak Park has identified 12 anchor facilities to be considered for upgraded data connectivity infrastructure:

1. Village Hall / Police – 123 Madison St
2. Public Works Center – 201 South Blvd
3. Central Pump Station – 102 N Lombard Ave
4. North Pump Station – 1010 N Ridgeland Ave
5. South Pump Station – 207 Garfield St
6. Fire Station Main – 100 N Euclid Ave
7. Fire Station North – 212 Augusta St
8. Fire Station South – 900 S East Ave
9. Holley Court Garage – 1125 Ontario St
10. Avenue Garage – 720 North Blvd
11. Lake & Forest Garage – 938 Lake St
12. OPRF High School Garage – 137 N Scoville Ave


Village of Oak Park
Anchor Sites
Legend
Oak Park Sites
North Pump Station
Fire Station North
Holley Court Garage
Lake & Forest Garage
OPRF High School Garage
Avenue Garage
Fire Station Main
Central Pump Station
Public Works
Village Hall / Police Dept
Fire Station South
South Pump Station
Lindberg Park
Taylor Park
Mills Park
Ream Park
Greenfield St
Lenox St
Berkshire St
Division St
Thomas St
Augusta St
Augusta Blvd
Iowa St
Chicago Ave
Superior St
Erie St
Erie Ct
Ontario Ct
Ontario St
Lake St
Westgate St
North Blvd
South Blvd
Pleasant St
Randolph St
Washington Blvd
Madison St
Monroe St
Adams St
Jackson Blvd
Van Buren St
Harrison St
Garfield St
Flournoy St
Lexington St
Harvard St
Fillmore St
W Roosevelt Rd
14th St
N Ridgeland Ave
S Ridgeland Ave
N Oak Park Ave
S Oak Park Ave
N Euclid Ave
S Euclid Ave
N Kenilworth Ave
S Kenilworth Ave
N Grove Ave
S Grove Ave
N Marion St
S Marion St
N Maple Ave
S Maple Ave
N Belleforte Ave
Forest Ave
Woodbine Ave
Linden Ave
Columbian Ave
N East Ave
S East Ave
Fair Oaks Ave
N Scoville Ave
S Scoville Ave
N Elmwood Ave
S Elmwood Ave
Wesley Ave
Clarence Ave
Gunderson Ave
N Cuyler Ave
S Cuyler Ave
N Harvey Ave
S Harvey Ave
N Lombard Ave
S Lombard Ave
N Taylor Ave
S Taylor Ave
N Humphrey Ave
S Humphrey Ave
Highland Ave
Maplewood Ave
Lyman Ave
Clinton Ave
Home Ave
Wenonah Ave
Carpenter Ave
Wisconsin Ave
Pennsylvania Way
Chestnut Ln
Harlem Ave
S Maple Ave
0
0.125
0.25
0.5 Miles

Existing Computing Environment

The computing environment driving data flow between Oak Park facilities supports a broad range of applications and communications activities that serve functions critical to Public Safety and daily operations for the Village. All data paths converge back to Village Hall for connection to local applications or are forwarded to the Internet for off-net resources and Cloud based applications.

Installed network electronics were introduced into operation to meet organic technology deployment and as network demand increased. Equipment configuration, operation and management is made unnecessarily complex by the mixture of devices with no migration path viable for upgrade based on obsolescence of existing platforms

The active data equipment providing connectivity is a mixture of HP and Allied Telesis electronics with 100 Mb data transport between anchor locations. The Allied Telesis equipment is at “end of life” and no longer supported by the manufacturer.

The multi-mode (62.5 micron) fiber plant (linking 10 of the 12 anchor sites) provides reliable transport for the 100 Megabit data path but will not support higher data transmission bandwidth or capacity across these paths. If bandwidth is increased from 100 Mb to 1 Gigabyte, the next incremental Ethernet network standard interface, the distance that data can be transmitted over Oak Park’s multi-mode fiber is reduced from over 6,500’ to just over 700’ eliminating the ability to increase the data rates across these existing paths.

Some key Public Safety operation that utilizes network services include:

- Fire Safety video training to all Fire Stations
- Dispatch data information to Police and Fire Stations
- Police in-car video transfer
- Water operation and alarms to all Pump Stations
- Video monitoring and access security to sensitive facilities
- Emergency Operation Center (EOC) services
- Telephone and email communication services

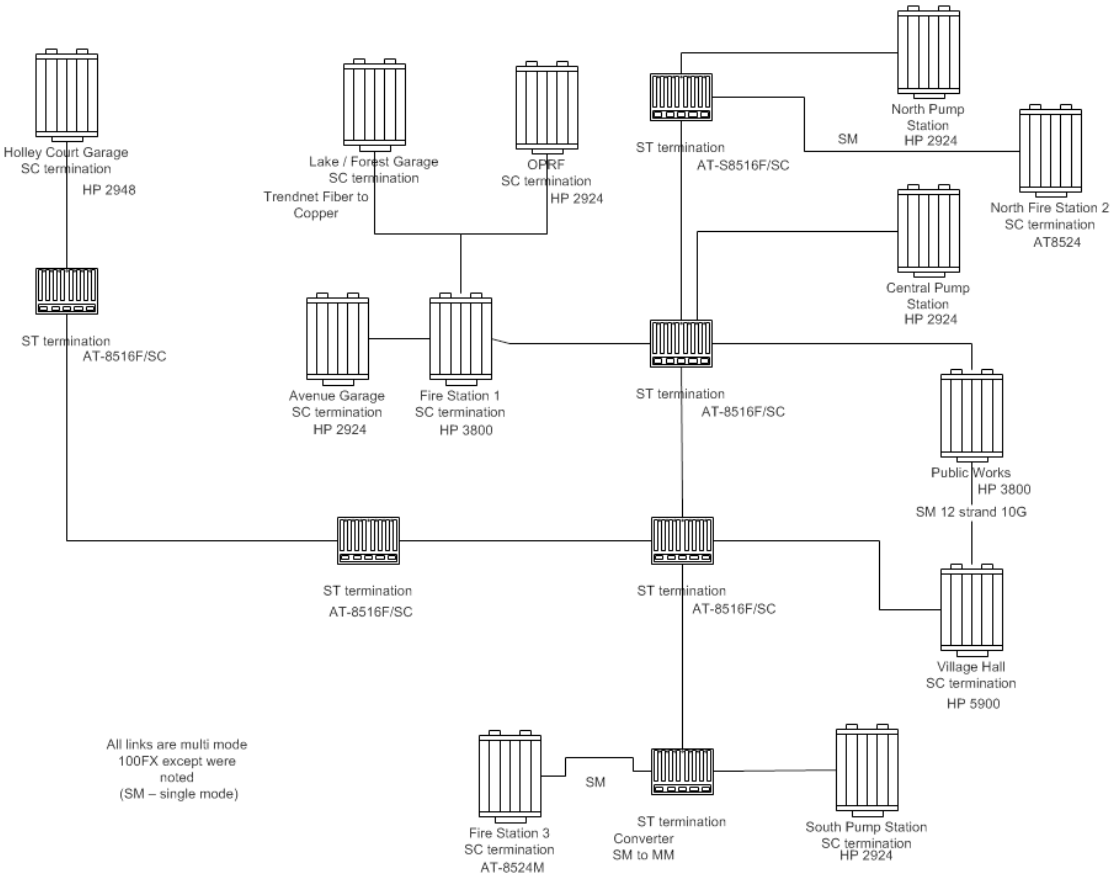
Other applications supported by the network include:

- Database and ERP functions
- GIS and mapping systems
- Intercom services between garages.
- Permit, License and Inspection system
- Parking Citation, Permits, Pass and Garage services
- File, print, Internet, Intranet and other application systems
- Timeclock, payroll and Administrative services

Equipment Re-use

The HP and Allied Telesis electronics currently in use at Oak Park facilities have the capability continue to support data connectivity on the device-side connection for most facilities. The Allied Telesis electronics has reached its "end of life" increasing Oak Park network vulnerability due to lack of repair and software support for the network hardware. The existing network hardware will not support data rates above the current 100 Megabit capacity blocking the ability to scale up bandwidth between facilities to meet increased transport loading demands. Local network hardware ports are also limited to 100 Megabit blocking the ability for workstations and servers systems to maximize their efficiency to transmit and receive data with minimal latency.

Implementation of a fiber ring architecture providing redundant fiber paths to all facilities, and the addition of electronics that provides the fault-tolerant approach will greatly increase network reliability and availability. The current equipment does not support ITU G.8032 or provide alternative fault tolerant operation.



Village of Oak Park – Current Fiber Network

Oak Park Elementary School District 97

School District 97 receives network connectivity for all of the district anchor facilities through a LIT transport system provided by Comcast. Each of the remote sites is connected with 1 Gigabit per second data path with a 10 Gigabit per second link connecting the Comcast virtual switch with the District Headquarters. The Internet access backhaul is connected to both SD97 Administration and Brooks Middle School.

Through the new implementation of fiber optic cable to each facility, the District will put in place an infrastructure that will scale to meet current and future bandwidth requirements. Also, the implementation of fiber provides the District the ability to manage applications and connectivity to meet changing demands without a secondary process of changing contracts for vendor services or delays caused by a vendor contract cycle.

The investment in fiber connectivity puts in place a long-term asset with a near-term payoff. Based on bandwidth services procured from incumbent providers, the payoff of a fiber infrastructure investment is estimated to be 5[1] to 8 years with the follow-on cost of connectivity limited to equipment maintenance and refresh cycles.

Fiber infrastructure implemented across SD97 facilities would prepare the district for incremental increases in broadband required to support each student in the classroom. In the rules adopted by the FCC (*E-rate Modernization Order* adopted on July 11, 2014), the long-term goal of 1 Gigabit per 1,000 students was established, up from the previous goal of 100 Megabit per 1,000 students. Many education advocates are already pursuing the establishment of 10 Gigabit per 1,000 students as the appropriate standard that best supports deployment of current technologies in schools.

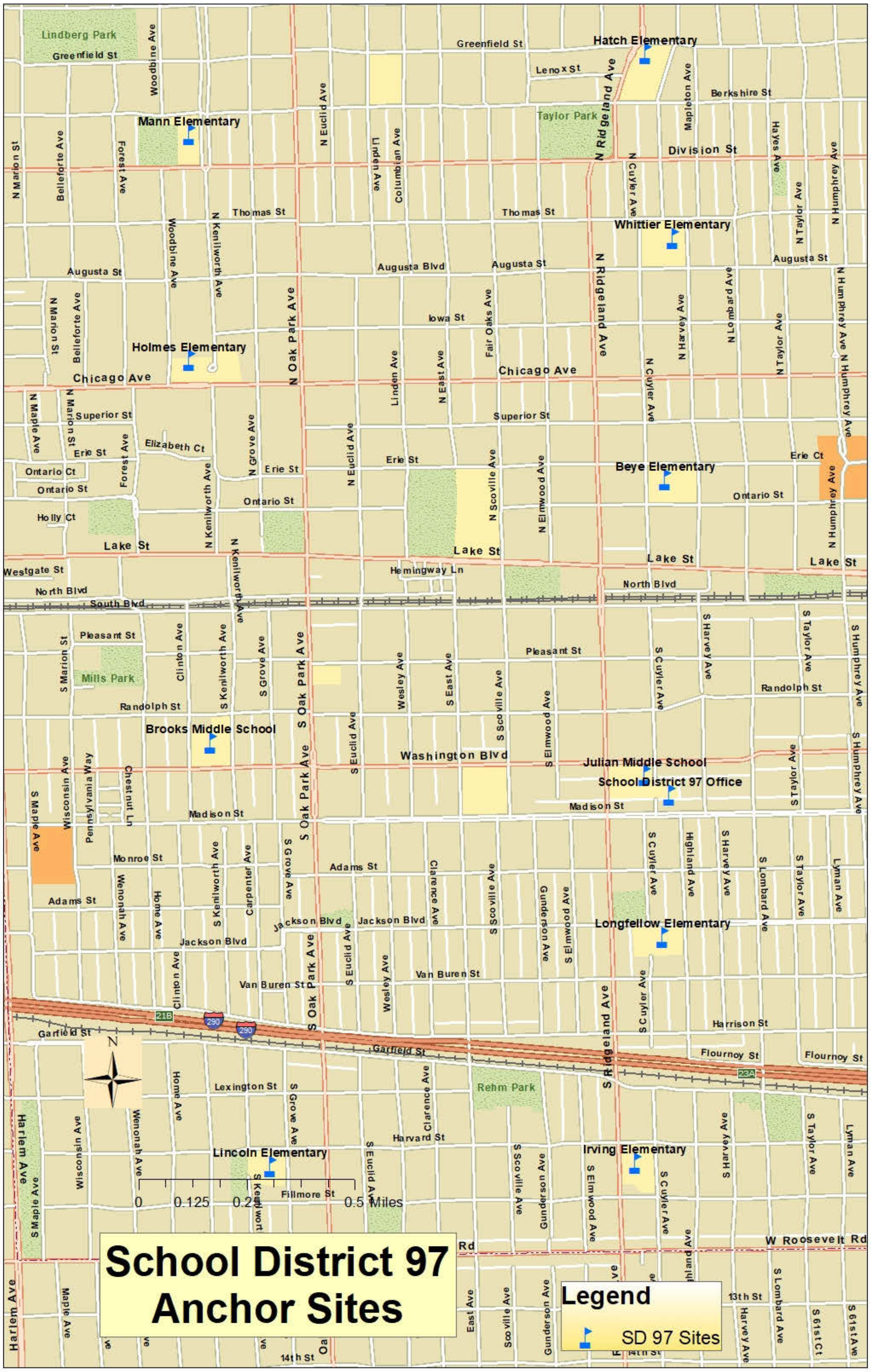
Implementation of owned fiber optic infrastructure by SD97 will facilitate management of the network environment to maximize responsiveness to district needs. With the establishment of active equipment monitoring systems, network slowdowns and impairments can be identified and staff deployed to address or repair without dependency on 3rd party vendors. Working in conjunction with the Village of Oak Park, repair and maintenance of fiber plant will be managed and monitored locally to insure responsiveness of the process.

[1] NIU's fiber project experience indicates a payback of 5 to 8 years from the investment in fiber optic infrastructure when moving from incumbent service provider model to owned infrastructure. Development of a business case (not in scope for this phase of work) will be required to quantify current costs, capital project approach and costs, operational methodology and projected bandwidth growth.

With deployment of an owned network transport system, some data transport system vulnerabilities will be minimized but most will remain. No internal data will be flowing through 3rd party equipment and accessible to casual hacking. Emphasis and training on systems security and continued diligence to interrupt the human and socially engineered hack will provide the most comprehensive results.

Elementary School District 97 has identified 11 anchor facilities to be included in the connectivity and broadband data transport study.

1. School District 97 Office – 260 Madison St
2. Beye Elementary – 230 N Cuyler Ave
3. Hatch Elementary – 1000 N Ridgeland Ave
4. Holmes Elementary – 508 N Kenilworth Ave
5. Irving Elementary – 1125 S Cuyler Ave
6. Lincoln Elementary – 1111 S Grove Ave
7. Longfellow Elementary – 715 S Highland Ave
8. Mann Elementary – 921 N Kenilworth Ave
9. Whittier Elementary – 715 N Harvey Ave
10. Brooks Middle – 325 S Kenilworth Ave
11. Julian Middle – 416 S Ridgeland Ave


School District 97
Anchor Sites
Legend
SD 97 Sites
Hatch Elementary
Mann Elementary
Whittier Elementary
Holmes Elementary
Beye Elementary
Brooks Middle School
Julian Middle School
School District 97 Office
Longfellow Elementary
Lincoln Elementary
Irving Elementary
Lindberg Park
Taylor Park
Mills Park
Rehm Park
Greenfield St
Division St
Thomas St
Augusta St
Augusta Blvd
Chicago Ave
Superior St
Erie St
Ontario St
Lake St
North Blvd
South Blvd
Pleasant St
Randolph St
Washington Blvd
Madison St
Adams St
Jackson Blvd
Van Buren St
Harrison St
Garfield St
Flournoy St
Harvard St
Fillmore St
W Roosevelt Rd
N Oak Park Ave
S Oak Park Ave
N Ridgeland Ave
S Ridgeland Ave
Harlem Ave
N Humphrey Ave
0 0.125 0.25 0.5 Miles
N

Existing Computing Environment

School District 97 supports over 9,000 networked devices across its eleven anchor facilities. Over 4,100 of those connected devices are student 1-to-1 devices that require network connectivity to reach textbooks and reference material, educational resources and cloud storage supporting homework and assignment work products.

Video use in the classroom and significant deployment of creative applications for both students and teachers alike is driving increased bandwidth use for both download and storage of media. Video applications are increasing overall demand for bandwidth by approximately 10% per year.

Most district applications are cloud based including Business Services and Business Support applications. The reliance on network availability heightens district sensitivity to single points of failure in the system and loss of visibility and control of network components and functionality.

VoIP phones are deployed across all facilities and linked through the central gateway at the Admin Center.

A video surveillance system is in use in all anchor facilities with data storage and management centralized at Administration. 211 cameras are currently deployed with the potential addition of 75 to 100 cameras.

The key network driven systems and applications for School District 97 include:

- Database, financial and employee Systems
- VoIP Telephony
- Email services
- Core business services and print production centers
- Student information systems
- Client endpoint management services
- Video surveillance
- IP-enabled intercom systems
- Network support and disaster recovery applications

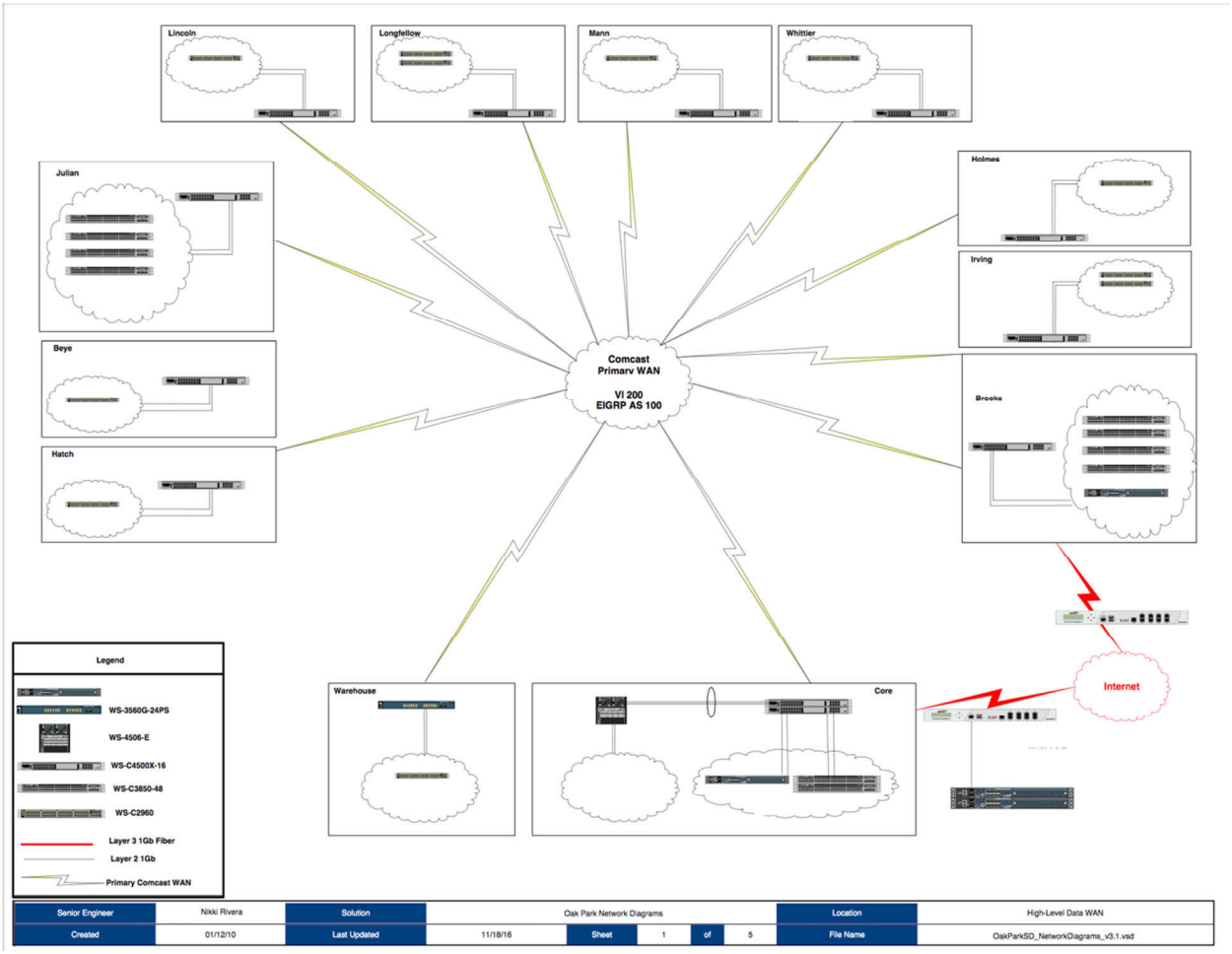
Equipment Re-use

The primary network equipment currently deployed to each of SD97's anchor facilities are Cisco WS-4500X-16s aggregation switches. These switches provide 10 Gigabit non-blocking connectivity on each SFP+/SFP ports and will continue to be a reliable platform for each school facility with the deployment of dark fiber connectivity. Since Comcast provides the primary WAN connectivity for the District, the Cisco switches are assumed not to have single-mode fiber transceivers installed in the uplink SFP ports to connect back to Administration.

The current network transport services solution from Comcast provides 1 Gigabit links from each school facility to a central virtual switch with a 10 Gigabit port from that virtual switch linked back to SD97

Administration. This model creates a single connection from each facility to the network with the network providing aggregation and distribution of the data traffic.

With the implementation of an owned fiber network, provisioning 10 Gigabit laterals to each school facility becomes costs effective and enhances the overall efficiency of the network and computing platforms. A 10 Gigabit path from each school removes the network as a bottleneck as systems and aggregated demands from multiple devices exceed the current 1 Gigabit limitation.



School District 97 – Current Network

Economic Development Opportunities

Fiber optic connectivity is listed as a "requirement" for greater than 35% of property searches seen by economic development organizations throughout the Chicagoland region. The availability of fiber connectivity at a development site indicates that broadband resources can be accessed at that site at data rates that fully supports the business seeking a site or facility for operations.

Municipal and publicly owned networks are seen as a neutral service provider and are viewed more favorably by prospective tenants than if that fiber connection is offered by the local incumbent provider. In most cases, municipal networks have availability or connectivity to multiple bandwidth or Internet service providers increasing competitive options and the ability to choose the best solution for the prospective business.

The initial Oak Park system architecture (See, Technology and Data Transport section below) envisions, at a minimum, a separate duct available across the municipal fiber optic footprint where fiber can be installed to serve potential subscribers. The Village can elect to place fiber optic cable in the duct assigned to economic development during initial construction to serve potential private sector clients quickly upon deployment. On the other hand, with the duct installed, the cost for placing a new fiber optic cable is minimal so fiber can be deployed to sites when a customer requests services in the future.

The availability of fiber capacity for economic development in the community will, at a minimum, allow that Development Customer Services Director the ability to check the "fiber available" box on the request form. The long-term benefit will be to bring new companies to Oak Park that depend on fiber optic and broadband connectivity technology.

Technology and Data Transport

The collaboration between Village of Oak Park and Elementary School District 97 seeks to establish a common data connectivity infrastructure to serve both constituencies as each solution currently in use reaches either capacity or cost limits.

The Village of Oak Park has invested in owned infrastructure and leveraged investments made in street light controller fiber to also interconnect Village facilities and anchor sites. With multi-mode fiber as the primary medium for transport, that infrastructure is at its limit for data capacity and will not scale to meet the increasing future demand.

The School District has worked through traditional service providers, currently using LIT data services from Comcast, the incumbent CATV service provider. With LIT data transport representing significant costs for the school district and with USAC (E-Rate) funding viable to establish a scalable data infrastructure to serve all District schools, implementation of a USAC compliant network will allow and support delivery of bandwidth and services to all SD97 facilities while minimizing ongoing costs.

Technology Considerations

The decision to focus on fiber optic communications infrastructure is driven by several factors including environmental and alternative access considerations, to cost effective, scalable bandwidth.

Wireless

A primary method often used to provision point-to-point (PtP) data paths for municipal and public sector site connectivity is wireless technology. These deployments require line-of-sight between antennas without obstruction of trees, buildings, poles or other impingements. Current wireless technology can offer up to 10 Gigabit per second data transport on a single radio with the ability to aggregate radios for even higher throughput.

Key drawbacks for consideration of wireless for Oak Park include:

1. No existing antenna infrastructure – Neither the Village nor SD97 facilities are tall enough to mount radio antennas higher than tree tops and other obstructions for clear line-of-sight between facilities. Construction of towers or other mounting structure costs drive costs to greater than the costs for a fiber based solution.
2. Distance limitations - High bandwidth radios, greater than 1 Gigabit, will be limited to under 1 mile by normal weather cycles.
3. Technology refresh – 7 to 10 year replacement of active electronics, normally including tower based radios and interconnect. (Towers and structures not included)
4. Fault tolerance – Significant addition investment required to establish path diversity or fault tolerant operating environment.
5. Limited collaboration - Wireless would focus all activity between discrete entities without opportunity for shared cost and increased benefits of shared fiber infrastructure.

Fiber Infrastructure

The opportunity for shared fiber optic infrastructure between Village of Oak Park and SD97 is largely created through the proximity of the facilities for each entity; fiber paths built between facilities from the Village would route past, or very close to facilities from SD97 with the converse also true.

A preliminary route has been outlined for a plan to establish a 10-mile fiber ring routing past all 23 of the Village and School District locations. The route selected is the most direct path between locations, providing fiber connectivity into each anchor site. A full design analysis of obstacles or difficulty of installation will be required prior to permitting or implementation.

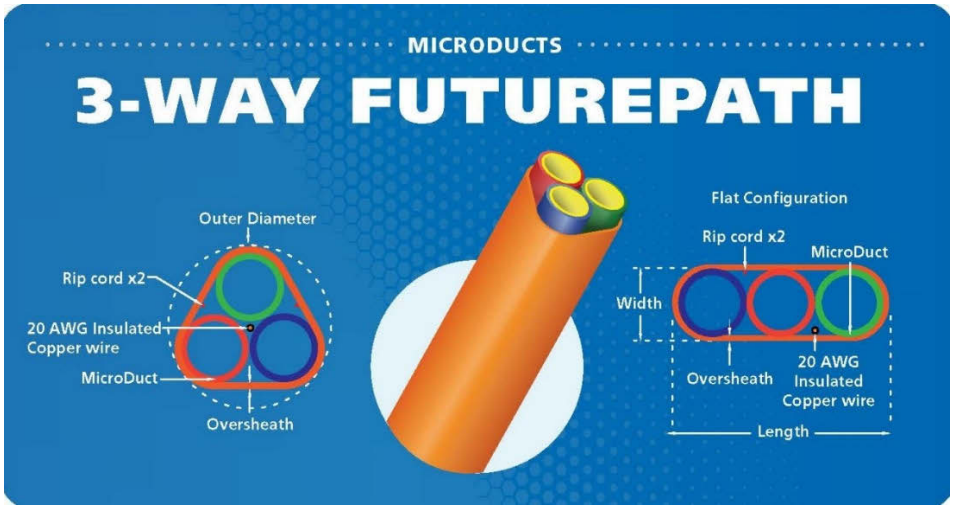
As part of the path analysis, a short fiber path that runs west from the Avenue Garage and ends the Village border at Harlem Avenue would provide anchor sites along North Avenue and Lake Street with a redundant path for data connectivity. The path for this fiber would be constructed as a part of the Lake Street streetscape project in 2019, greatly reducing the cost for placement of duct for fiber optic cable along this route segment. Additional opportunities for co-implementation of duct with public works projects, street reconstruction or other utility work enabling fiber access to other key facilities or potential clients will keep construction costs low and maximize the value of the fiber infrastructure to the community.

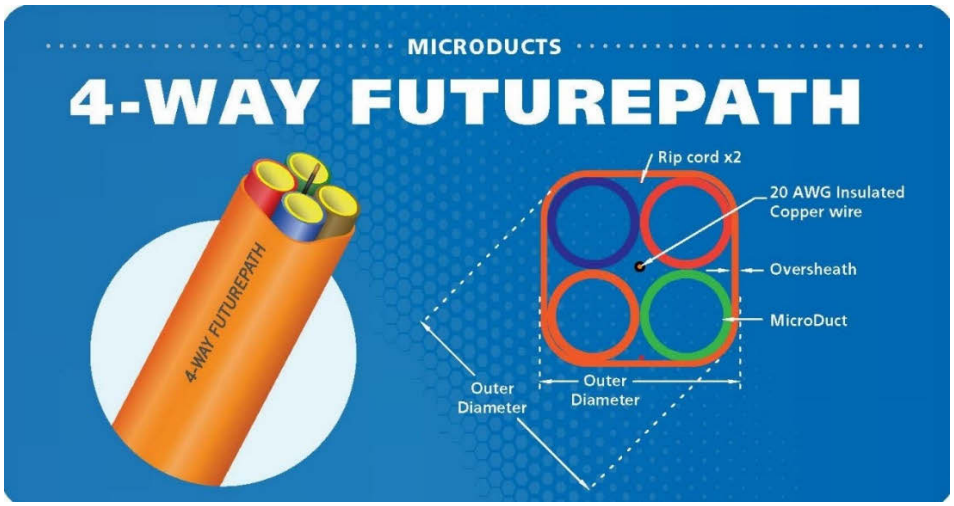
Micro-duct

A key financial goal of the fiber project is to keep each individual public entity's (Village and School District) costs low through installation of common elements supporting both entities with a single work effort.

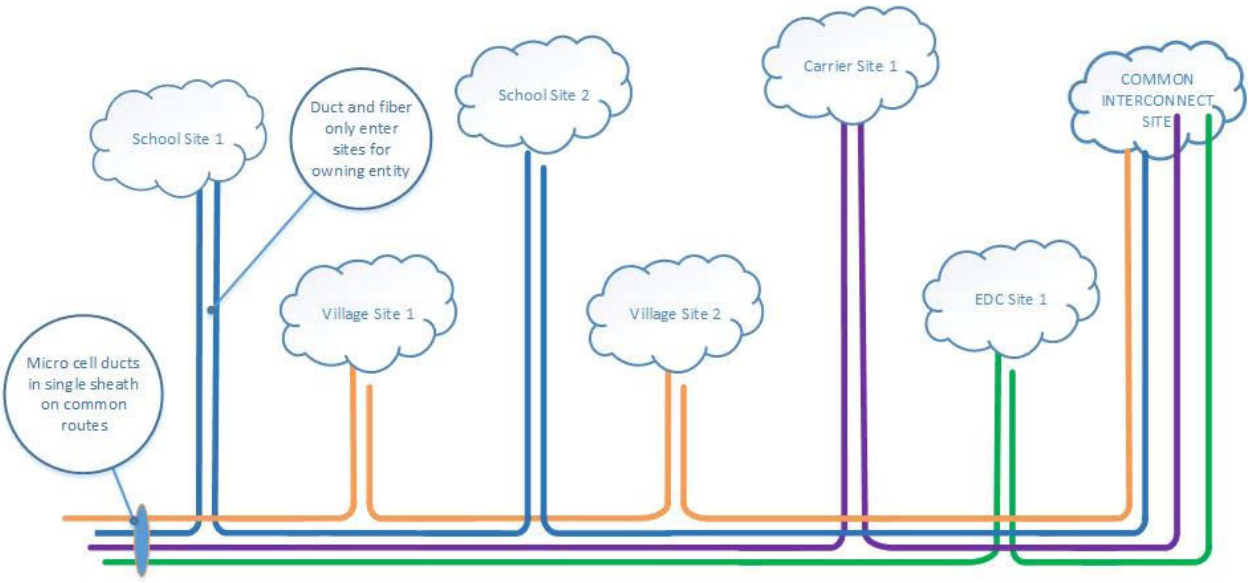
The ability to establish ownership of fiber and fiber support infrastructure for assets built on a common path or platform, is critical, especially when USAC funding for public school data infrastructure is heavily scrutinized by the FCC.

The micro-duct technology offers the ability to install a single sheathed duct system with the ability to assign, route, and populate those ducts independently with fiber cabling. The 3 and 4 micro-duct systems outlined below are only two of the packaging options that would offer the ability to assign discrete capacity to each participant in a common infrastructure build. Through routing of only the assigned micro-duct at each anchor site, a discrete fiber path is implemented that is populated, terminated and available, only to the owning entity.


MICRODUCTS
3-WAY FUTUREPATH
Outer Diameter
Rip cord x2
20 AWG Insulated Copper wire
MicroDuct
Oversheath
Flat Configuration
Rip cord x2
MicroDuct
Width
Oversheath
20 AWG Insulated Copper wire
Length


MICRODUCTS
4-WAY FUTUREPATH
4-WAY FUTUREPATH
Rip cord x2
20 AWG Insulated Copper wire
Oversheath
MicroDuct
Outer Diameter
Outer Diameter

The diagram below indicates full separation between capacity assigned to each participating entity. When cross connections are anticipated between participants, a common site is established where all assigned ducts and installed fiber is brought to a frame or patch bay to facilitate the interface.



Micro-duct Concept

Conclusion

The network and computing environment at the Village of Oak Park and Elementary School District 97 define bandwidth capacity, future growth scalability and flexibility demands that only a fiber infrastructure can fulfil. The ability to place common infrastructure linking all anchor facilities, while lowering cost of implementation and preserving ownership strengthens the value of the collaboration between the Village and School District and provides additional urgency to move forward toward implementation.

Additional equipment costs are anticipated, especially for Village sites, to support the redundant fiber ring capability or to scale the backbone above the current 100 Megabit per second speeds. The school district will have limited costs for new optical interfaces but can migrate to a new fiber infrastructure without significant upgrade. Opportunity created by an owned fiber path will help to drive future investment in new network electronics without any limitations on connectivity between facilities.

There is additional definition required to clarify management roles, funding for anticipated costs for economic development or carrier capacity, and maintenance and monitoring roles that will focus refinement of an implementation model for the fiber network. Participation of Oak Park Public Works in the fiber project may provide the maintenance and monitoring structure required for reliable operations.