KCFN Feasibility Study
Swope Corridor

Isaac Wilder, Tyrone Greenfield
The Free Network Foundation
{imw, tyrone}@thefnf.org

Clint Wynn, Michael Liimata, Rick Deane
Connecting for Good
{clint, michael, rick}@connectingforgood.org

November 8, 2013

Abstract

The object of this study is to provide the information necessary for The Upper Room, and other prospective participants to make an informed decision about cooperating on a 'free network' in the Swope Corridor.

In Part I of the study, we give an overview of the motivations, methodologies and design patterns behind free networks, their component technologies, and potential applications. In Part II, we explain the architecture and current footprint of the Kansas City Freedom Network. Finally, in Part III of the study, we examine the feasibility of extending the KCFN to the Swope Corridor area, propose a plan for doing so, and give estimates of cost.

Our finding is that launching such a network is certainly feasible, and would provide significant benefits to The Upper Room and its constituents, neighborhood residents and businesses, and the community at large.

1 Introduction

1.1 Network Models – Proprietary, Private, & Free

The vast majority of people think of 'The Internet' as a monolith. In actuality, however, The Internet is made up of some 40,000 carrier networks, interoperating via shared protocols, and with the autonomy to run their networks as they see fit. While some of these networks are state-run or designed for research and education, the vast majority are 'proprietary' networks. Proprietary networks have many advantages, including large geographic reach, access to wholesale connectivity markets, and the ability to peer with other networks. With these advantages, however, come some significant limitations. Proprietary networks are owned by telecom companies, and their use comes at a steep cost to the user. Moreover, users have little to no say over how the network is run, meaning that they are perpetually at the mercy of the operator to upgrade or troubleshoot the network.

At the same time, countless private networks extend connectivity into homes and businesses worldwide. While these networks are limited in their reach, they offer their owners the freedom to decide when, where, and how the network functions. Home users establish private networks (generally referred to as Local Area Networks) for a variety of reasons, including added security, the ability to serve multiple devices via a single gateway, and to enable wireless connectivity. In corporate and public sector IT environments, private networks (generally referred to as intranets) are used to support a wide array of business-critical applications.

Until recently, there was a sharp distinction between proprietary networks and their private counterparts. Networks were either large, commercial enterprises or small, private undertakings meant to augment an existing Internet connection. Over the past few years, however, advances in network technology have led to the emergence of a new sort of network. These new networks, refered to as 'free' networks, represent a middleground. They are capable of achieving significant geographic reach and of peering with other networks, yet they also give their owners the freedom to build, upgrade, and utilize connectivity as they see fit. This blend of capabilities and freedoms is achieved by a model in which ownership is distributed amongst many parties under a common license.

Using powerful, low-cost microwave equipment and the free network model, communities throughout the world have been able to save money and spur economic development, while at the same time working to ensure that none are left without lifeline access. Such networks now span major cities and entire regions, participate in large Internet Exchange Points (wholesale markets where carriers exchange traffic), and enable innovative and community-driven applications.

The basic principle behind free networks is the same principle that has catapulted the Internet to its profound success - that when networks join together, the sum is much greater than its parts. In networking theory, this principle is known as *Metcalf's Law*.

The upshot for individuals and community institutions is that owning part of a common network is a much better value proposition than owning all of a private one. In exchange for contributing their resources, participants are allowed to utilize those resources contributed by others. While contributors retain complete and total ownership of their infrastructure, they license its use to other participants in exchange for a reciprocal agreement. This is the purpose of the *Network Commons License* — a legal framework for governing free networks maintained by a global consoritum including The Free Network Foundation.

This framework works particularly well in computer networks, where technical measures can be used to make sure that participants don't utilize more than their fair share of the network's resources. In this way, we can avoid the *tragedy of the commons* and bolster the long-term sustainability of the network.

Yet, technical measures are not enough to guarantee success. In order for the network to thrive, it is essential that it be coupled with a significant educational effort. The free network model requires that participants and prospective participants actually be able to take advantage of the freedom to expand and improve the network. The skills to do so are easily attainable, but the fact remains that they must be attained. In the end, the only way to achieve a sustainable model is for those who use the network to be its primary stewards.

Many high-profile municipal networks have failed precisely because individuals and businesses were not allowed, were not able, or were not willing to make necessary improvements. To this end, it is critical that the network be built with free and open technologies, that it be as simple as possible to operate and maintain, and that community egagement be made a priority at every turn.

Using open technologies and providing ample educational opportunities fosters a highly distributed ownership model. It is this model that gives free networks their strength — empowering communities to own their own networks, *without* requiring outsized commitments of capital, and *with* a boundless potential for good.

1.2 Free Network Advantages

Free networks are more than just the Internet — they're an opportunity for a new sort of connectivity, rooted in community. While significantly reducing barriers to access is certainly one of their primary benefits, they are also designed to serve as a platform for community media, local applications, and advanced functionalities.

It is important to understand that while free networks can (and should) be connected to the global Internet, they are first and foremost independent networks. Aside from the electricity required to run the network equipment (less than a lightbulb per home), there is no cost for moving data *within* the network. Because free networks function as a commons, participants can communicate with one another directly, without ever having to pay an ISP for service. With this in mind, here are just a few of the potential applications:

- By connecting the network to an Internet Exchange Point or other wholesale connectivity market, it is possible to provide all those who wish to access the Internet with significantly less expensive options for getting online. In this regard, the network essentially functions as an Internet co-op — by pooling their purchasing power, participants are able to get much better prices than they ever could on the retail market.
- By connecting the network to a school or business intranet, students and faculty or employees can be granted secure, authenticated access to an organization's digital resources, including an Internet gateway.
- Educational and cultural institutions can easily make content archives and learning materials available to the community without having to pay for web hosting. This is especially beneficial when the content is multimedia, which requires significant amounts of bandwidth.
- Network participants can make video and voice calls to one another without having to pay for cellular or Internet service.
- Organization of the network by neighborhood and block encourages the establishment and use of bulletin boards and chatrooms that connect

neighbors and strengthen communities.

- Youth can learn valuable skills by building and maintaining the network. These system administration skills are highly sought after by employers. The use of free and open tools means that anyone can understand and improve the network.

1.3 Wireless Communications

In Internet-speak 'Layer 1' refers to the physical medium used to transmit information. A variety of Layer 1 technologies exist, such as hybrid-fiber-coax (Cable), copper (DSL and Ethernet), fiber optics (Active Ethernet), and microwave (WiFi, Cellular). Most free networks use microwaves as their primary medium, though larger freenets also make use of copper and fiber optics. Each of these media has its own set of benefits and drawbacks — the choice of which to use is driven by the interplay of geography and economics. It is our opinion that microwave represents the optimal choice for this project.

In large part this is due to the fact that microwave infrastructure is by far the least expensive to install and maintain. It does not require the trenching or hanging of cables, nor does it require expensive or proprietary equipment. Since it first came to the consumer market twenty years ago, the cost of microwave network capacity has decreased by a factor of more than 1000x. This trend continues today, with a host of significant advances achieving commercial viability.

At the same time, microwave is not without significant drawbacks. In the United States, unlicensed microwave communications is restricted to three specific frequency bands. As more and more WiFi devices come online, these bands are becoming increasingly congested. Left unchecked and unmanaged, this interference has the potential to significantly reduce network performance.

In addition to congestion, it is important to consider the fact that microwaves are significantly weakened when passing through opaque materials such as earth, wood, concrete, and steel. While some penetration of these materials is possible, backbone network links demand a clear path, and repeaters will be required to cover the insides of buildings.

Despite these limitations, microwave technology ultimately represents the best choice of medium due to its long range, small cost, and ease of use. As the network grows and capacity demands increase microwave links can be reinforced with copper, fiber, and advanced wireless technologies such as milimeter-wave and laser.

1.4 Free Network Architecture

The architecture employed by the KCFN was developed by the Free Network Foundation between 2011 and the present, in collaboration with networking groups from around the world, including guifi.net, Freifunk, WLAN Slovenia, and Connecting for Good.

1.4.1 Physical Plant

Before any network devices are powered on, there is a significant amount of engineering and effort that must go in to making sure network hardware is safely installed. Here are a few of the best practices in device installation:

Cabling It is important that all outdoor cable installation be done with UV-rated, shielded ethernet cables. We recommend Ubiquiti ToughCable Carrier Grade, for its low cost and outstanding durability. Indoor installations should always use plenum-rated cable, to ensure that cables do not become a health hazard in case of a fire. We also recommend that all cables be installed out of the public eye, and out of the public reach.

Mounting Devices mounted to the sides of building should be anchored into masonry or studs, and should be mounted using UFL approved brackets. Self-tapping screws ease installation, and provide for a secure brace.

Masts The two primary methods for mast construction are hold-offs and non-penetrating roof mounts. Hold-off mounts should be secured in at least three places, and anchored into masonry. Roof mounts should use UFL approved bases, dense masonry ballast, and a non-conducting mast, such as EMT conduit. The weight of the ballast, in ounces, should exceed the wind-bearing surface area of any antenna elements, in square inches, by a factor of five.

Power Delivery For safety and ease of installation, we recommend that power be delivered to all devices using IEEE 802.3 Power-over-Ethernet.

In this way, no electrical cabling has to be installed, and electrical hazards are significantly curtailed.

Grounding Any installations that exceed their surroundings in height should be grounded. This can be achieved by running a ground wire, or by using grounded RJ-45 ethernet jacks, and cable that has an integral ground wire, such as Ubiquiti ToughCable.

Gear Security Gear such as switches, dedicated routers, servers, and power distribution units should be located indoors or in a weather-rated outdoor enclosure. Indoor installations should be placed in a utility closet or other secure room.

1.4.2 Hardware

Through lab and field testing, we have selected components and developed a suite of four network devices. All of the hardware employed is readily available, off-the-shelf equipment, selected for performance, durability, and software support. We call this suite of devices the 'FreedomStack':

FreedomNode The node is the smallest of the four devices, and is designed to connect a single family or small business to the network. For optimum performance, the node should be located indoors, such that it has a view of the nearest relay. The suggested hardware for a node costs under $50. In case a home or business already has a router, the cost can be reduced to less than $25.

Technical Details: The recommended hardware for a FreedomNode is the Netgear WNDR3800, though any WRT-compatible dual-band router can be used. By using a dual-band device, the node is able to connect to the Freedom Network on the 5.8GHz band, while using the 2.4GHz band to provide access to clients devices such as laptops, tablets, and phones. In this way, the node functions as a wireless modem, and as a wireless router. For modem functionality alone, we recommend the TP-Link 703n.

FreedomRelay The relay is a block-level network anchor. It serves to connect a group of nodes to the neighborhood-wide network. Relays should be placed outdoors, such that they can be seen by as many nodes as possible, and so that they can see a neighboring relay or tower. The suggested hardware for a relay costs under $500.

Technical Details: The recommended hardware for a FreedomRelay is a ALIX 2D2 Motherboard with two Ubiquiti SR71-15 SuperRange radio modules, four 5GHz 8dBi omni antennae, MMXC to SMA feed cables, outdoor enclosure, passive Power-over-Ethernet adapter and associated mouting hardware. The use of a dual-radio setup enables the relay to perform as a full duplex device, avoiding the need for a single radio to split its time between receive and transmit cycles. The relays and nodes in any given neighborhood form a mesh network, meaning that devices can move around or power off, and the rest of the network will adapt and continue to function. The use of duplex devices is critical for the performance of the mesh.

FreedomTower The tower is a neighborhood-level network hub. It acts as a bridge between a neighborhood network and the city-wide network of towers. Towers must be located on roofs or hilltops with line of sight to at least two other towers. The baseline cost for a tower is roughly $1300.

Techincal Details: The recommended hardware for a FreedomTower is two Ubiquiti Rocket M5's equipped with 30 dBi dish antennae, three Rocket M5's equipped with 16 dBi 120-degree sector antennae, and a Ubiquiti ToughSwitch8-Pro.

FreedomLink The link is intended to serve as a city-wide Internet gateway, content server, network controller, or all of the above. Links must be placed in a datacenter environment, with roof access for the radio gear and line of sight to at least two towers. While the suggested hardware for a link costs $3000, link operation requires an ongoing capital expenditure of at least $250/month.

Technical Details: The recommended hardware for a FreedomLink is two Ubiquiti Rocket M5's equipped with 30 dBi dish antennae, four Dell PowerEdge 2950 rackmount servers, and one Cisco Catalyst WS-C2960S-24TS-S 24-port 10/100/1000 switch.

1.4.3 Firmware

Of the devices listed above, the majority are classified as ‘embedded devices’ — low-power computers responsible for a very specific task. These particular devices are designed to establish wireless links and make decisions about network routing. In order to function, they require an operating system for embedded systems, otherwise known as a ’firmware’.

In addition to their performance and reliability, the selected hardware was chosen because it is capable of running OpenWRT, a significantly stripped down version of the GNU/Linux operating system that powers most web servers. Free networks run on free software, because access to the source code makes it possible to know exactly what is going on inside the machine, and to make any modifications one desires.

OpenWRT comes in many varieties, each with its own set of features. The Kansas City Freedom Network uses a customized version of *quick mesh project* or qmp. qmp is mesh network firmware that leverages recent advances in network routing and management, and is maintained by The guifi.net Foundation. In addition to the basic utility of OpenWRT, it has the following advanced functionalities:

Address Management IP address management is handled automatically, without user or administrator intervention. The default behaviour is to assign each device a block of addresses capable of supporting 255 clients.

Techincal Details: During the device initialization process, a unique address is generated by cryptographically hashing the MAC address of the primary network adapter. The chosen hash function is the CRC-16 cipher.

Routing The routing protocol employed by qmp is BMX6, developed by Axel Neumann of Freifunk Berlin. The protocol is used to dynamically determine the best path for traffic.

Technical Details: BMX6 is an IPv6 native, distance-vector protocol. It is designed to automatically respond not just to changes in the network, but to the actual quality of the links between devices. BMX6 has excellent loop avoidance and route convergence properties, but perhaps its greatest strength is extremely low overhead, especially when compared to other mesh systems.

Instrumentation & Management qmp includes tools for collecting information on usage and device status through a command and control server. It also includes tools for remotely managing device configuration, reducing the need for on-site management.

Technical Details: The snmp and collectd libraries are used for instrumentation, and rUCI is used for remote management.

1.4.4 Software

While the combination of hardware and firmware above enables network devices to effectively communicate, other pieces of software are required to make the network truly useful. While all common software can be used over the network, here are some of the particular free software utilities that we recommend:

Firewalling For connecting the network to other large networks, such as ISPs or intranets, we recommend pfSense. It is strong on security, and has a host of enterprise-grade features

Tunneling TunnelDigger, developed by the Slovenian free network, can be used to create VPN tunnels between devices. In this way, a device can be strictly associated with a particular gateway router, or can be linked directly to any other device.

Media Publishing GNU MediaGoblin is designed to publish photos, videos, and text in a clean, presentable way. It supports community contributions, as well as bulk uploads.

Distributed File Storage Tahoe is a way for neighbors to store files on each others' computers while maintaining complete privacy. This way, if somebody's computer crashes, their important files can be recovered from the storage grid.

Community Mapping TidePools is a mapping application that allows communities to crowd-source map information. The neighborhood knows itself best, and can share information about what is going on, and where.

2 The Kansas City Freedom Network

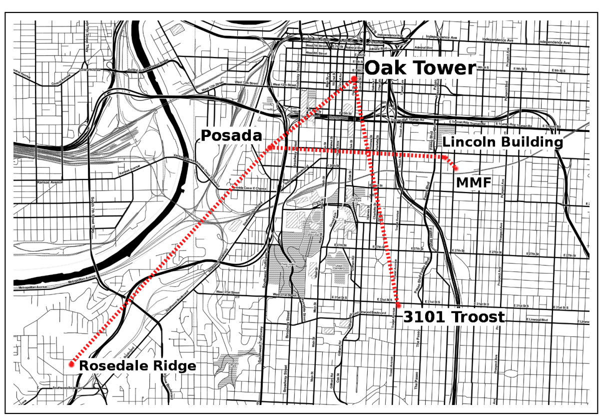
2.1 Governance & Operations

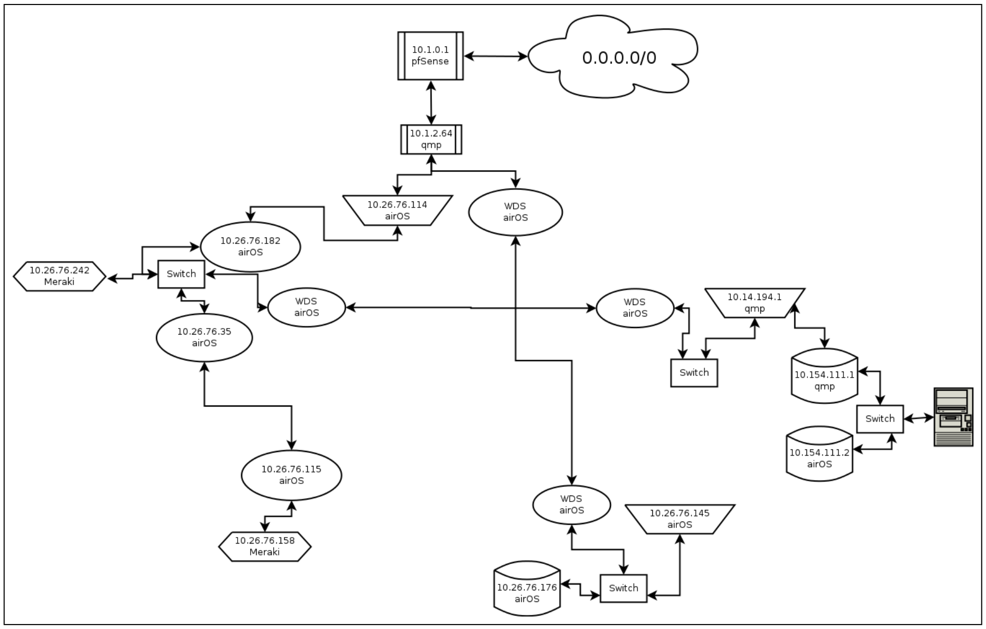
The Kansas City Freedom Network was established in December of 2012, when Connecting for Good and The Free Network Foundation joined forces to bring connectivity to the Rosedale Ridge Housing Project in Kansas City, KS. Since that time, the KCFN has welcomed the Mutual Musicians Foundation and Reconciliation Services to the coalition, and expanded to serve several hundred families and a number of organizations around the metro.

While participants are free to do as they like in accordance with the Network Commons License, cooperation amongst operators is central to keeping the network running smoothly. As such, the KCFN holds a weekly meeting to coordinate its activities, make decisions that have network-wide implications, and plan for the future. Decisions at the network level are made using a consensus process.

2.2 Existing Infrastructure

The Kansas City Freedom Network extends accross Kansas City, Kansas and Kansas City, Missouri. It serves residential and enterprise clients with symmetrical, high-speed connectivity. Figure 1 is a to-scale map of the network as it exists today, while figure 2 is a logical map, showing network devices and their connectivity:





While the figures above paint a decent picture of our current footprint, it is equally important to understand the social and economic infrastructure that supports these devices. The best way to understand the network is to review the installations that are in place today:

Oak Tower Oak Tower, at 11$^{\text{th}}$ and Oak, hosts the FreedomLink that currently serves as KCFN's primary Internet gateway. The link is owned by Connecting for Good, which purchases colocation, radio rights, and Internet service from Joe's Datacenter on a monthly basis.

Technical Details: This link consists of a single Dell server running pfSense, connected to two Rocket M5's on the 27th floor via a Netgear 3800 running qmp. One Rocket is equipped with a 30 dBi dish antenna, while the other is equipped with a variable beam-width sector antenna. Both radios shoot through storm windows to connect with the towers at 3101 Troost and Posada del Sol.

Posada del Sol The FreedomTower at Posada del Sol, on the 1700 block of Summit Street in KC, MO serves as an important distribution point in the network. The Mutual Musicians Foundation owns a dish that connects to the Lincoln Building. Connecting for Good owns two dishes, with one connecting to the sector antenna at Oak Tower, and the other connecting to the tower at Rosedale Ridge. Six access points serve residents inside the building. The owner of the building, Westside Housing, provides space to Connecting for Good and the KCFN in exchange for network access.

Technical Details: CFG owns two Rocket M5's with 30 dBi dish antennae. The MMF owns a NanoBridge M365. All three radios are mounted to a 10' non-penetrating mast atop the seven story building. Six Meraki access points — one on each floor — distribute access throughout the building. All three dishes, along with one of the indoor access points, are linked to a five-port ToughSwitch and Uninterruptible Power Supply located in a utility closet on the seventh floor.

Lincoln Building The FreedomTower at the Lincoln Building serves the area surrounding 18^{th} & Vine. Of the two radios at the Lincoln Building, one connects to Posada del Sol, while the other anchors a neighborhood mesh. The tower is owned and operated by the Mutual Musician's Foundation, which receives space from the Black Economic Union.

Technical Details A NanoBridge M365 and Nanostation M5 are mounted to a 10' non-penetrating mast atop the roof of the three story building. They are connected to a TouchSwitch and UPS inside a utility closet on the third floor.

Mutual Musicians Foundation The MMF hosts a FreedomRelay, serving the 1800 block of Highland Ave, portions of 19th Street, and the Foundation itself. In addition to a powerful mesh repeater, there is a dedicated media server, and a WiFi hotspot for the use of musicians, administrators, and neighbors.

Technical Details: A Rocket M5 with 10 dBi dual-omni, and a Bullet M2 with 9 dBi horizontal omni are attached to a 10' hold-off mast anchored into roof cornice of the two story building. These radios are attached to a ToughSwitch in the first floor office via an alloy conduit anchored into exterior brick face. A Dell XPS in the office runs Debian GNU/Linux, and is also attached to the switch.

Rosedale Ridge The FreedomTower at Rosedale Ridge connects to Posada del Sol, and serves residents of the complex via four access points. While the eqipment there is currently owned by Connecting for Good, it is to be given to the complex owner, Yarco, in December of 2013.

Technical Details: A Rocket M5 with 30 dBi dish is mounted on a 10' non-penetrating mast atop the three story building at the north of the complex. Four Meraki access point in the courtyard distribute connectivity through the complex.

3101 Troost The FreedomTower at 3101 Troost is jointly owned by Reconciliation Services and Connecting for Good, and connects directly to the FreedomLink at Oak Tower. In addition to one device dedicated to anchoring a neighborhood mesh, there is a WiFi hot spot that serves the bus stop at 31^{st} & Troost.

Technical Details: A Rocket M5 with 30 dBi dish is mounted on a railing atop the five story building, and connects to Oak. A nearby non-penetrating boom holds the Nanostation M2 Loco that lights up the bus stop. The Rocket M5 and variable beam sector that anchors the neighborhood network is mounted on a railing atop the belfry, one story up.

3 Study Results

3.1 Objectives

In order to assess the feasbility of extending the KCFN to the Swope Corridor, it is essential to define well-established targets for any potential work. The proposal that follows is intended to satisfy the following parameters:

Purpose This proposal is for a project intended to improve the state of connectvity for businesses and residents within the Swope Corridor, establish the Mary Kelley Center as a local hub for connectivity and digital skills education, and demonstrate an organizing model that can be replicated in other communities.

Scope The geographical area under consideration is bounded by Volker Boulevard and Swope Parkway on the North, Swope Parkway/Cleveland Street on the East, 63^{rd} Street on the South, and The Paseo on the West – a total area of 7km^2. In addition to The Upper Room, it should involve an array of area residents, businesses, non-profits, and community groups.

Coverage Outside of bringing a cost-effective ultra-broadband connection to the Kelly Center, the paramount concern is improving the availability of affordable residential Internet service for those within the designated geographic scope. While it isn't possible to guarantee coverage to 100% of residences with a community network approach, our objective should be to allow any and all blocks within the area to participate. This will not be possible without significant investment and involvement from within the community itself.

Functionality Those that elect to participate in the network, in addition to gaining access to resouces published on the KCFN, should have the ability to purchase low-cost Internet access.

Performance While exact performance figures will depend case-by-case on a number of factors, the KCFN should enable broadband connectivity capable of supporting telephony, web 2.0, and multimedia applications.

Cost The total cost of accessing the Internet via the KCFN, including hardware, should be lower than existing alternatives over the course of one year.

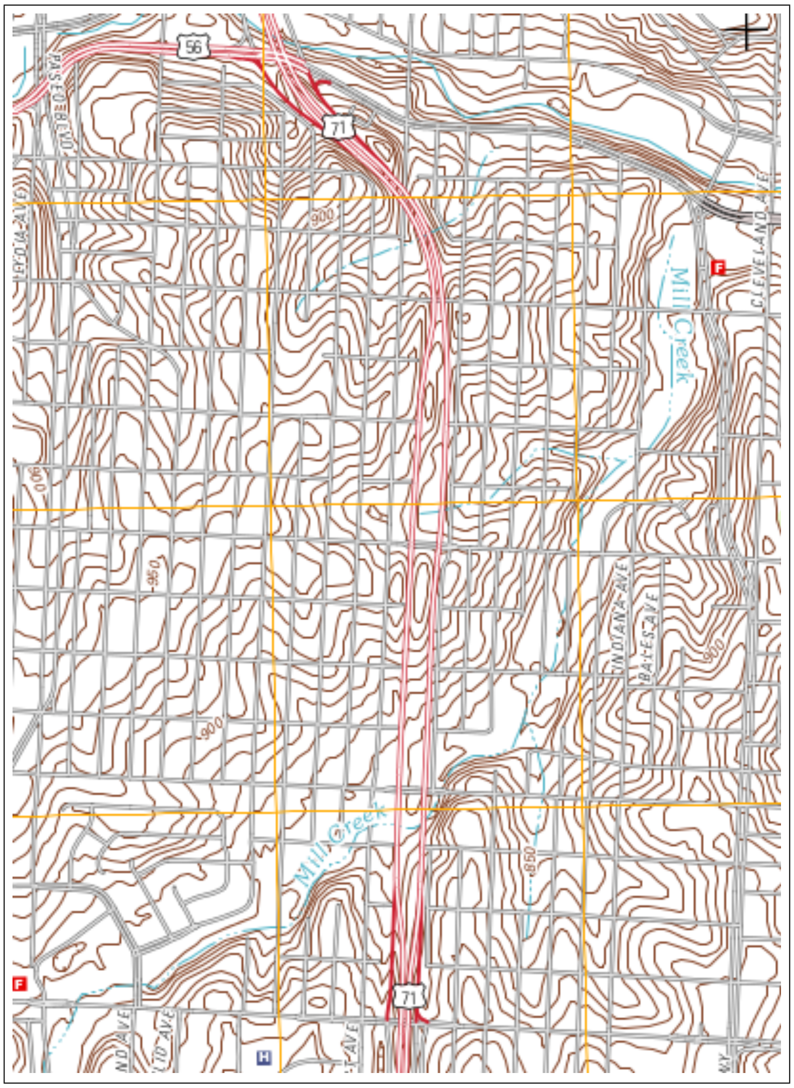
Sustainibility Above all, this effort should aim to foster a digital commons that is sustainable in the long term — focusing first and foremost on education, grassroots support, and the capacity for ongoing, organic growth.

3.2 Survey Information

The primary physical considerations in determining build feasibility and an appropriate course of action are topographic terrain and RF environment. We surveyed the target area in October and November of 2013, analyzing the lay of the land and assesing spectrum availability.

3.2.1 Terrain

The terrain in question presents certain significant challenges to network deployment. The Kelly Center's vista over the Town Fork Creek neighborhood will significantly aid in deployment there, covering a great many points south and east. The challenge will be in Blue Hills neighborhood, especially west of Wabash Avenue. While Blue Hills' terrain does not preclude network deployment it will necessitate an effort to establish relays in the vicinity of 49th & Euclid and/or 57th & Woodland.

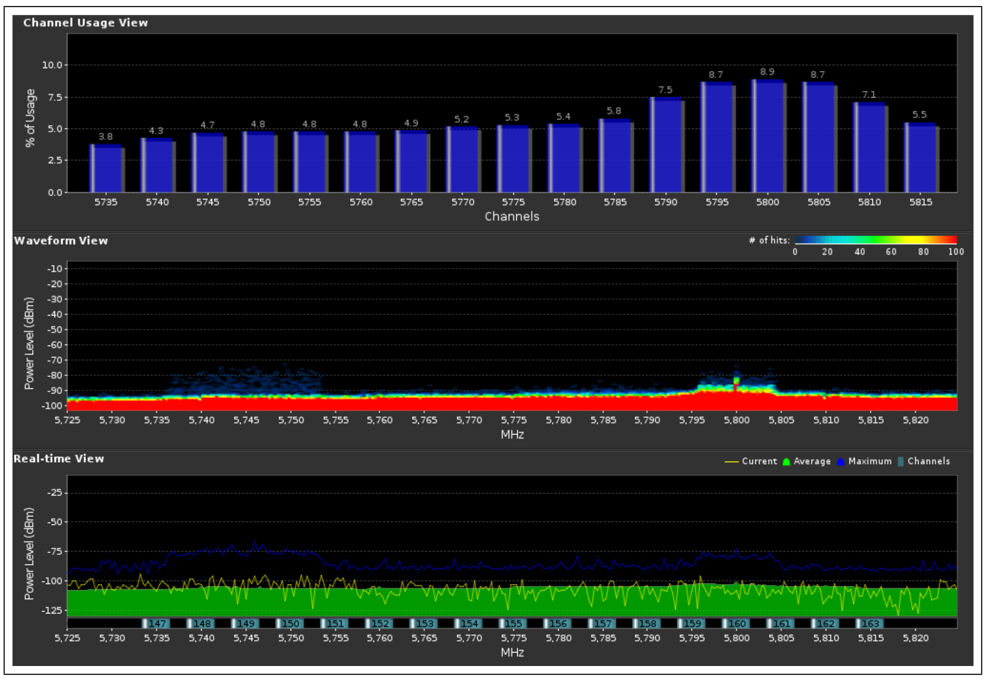


While a band of dense foliage running from the northeast corner of the corridor to 63rd & Woodland presents another obstacle, 71 Highway will allow for some longer distance north-south cross connections.

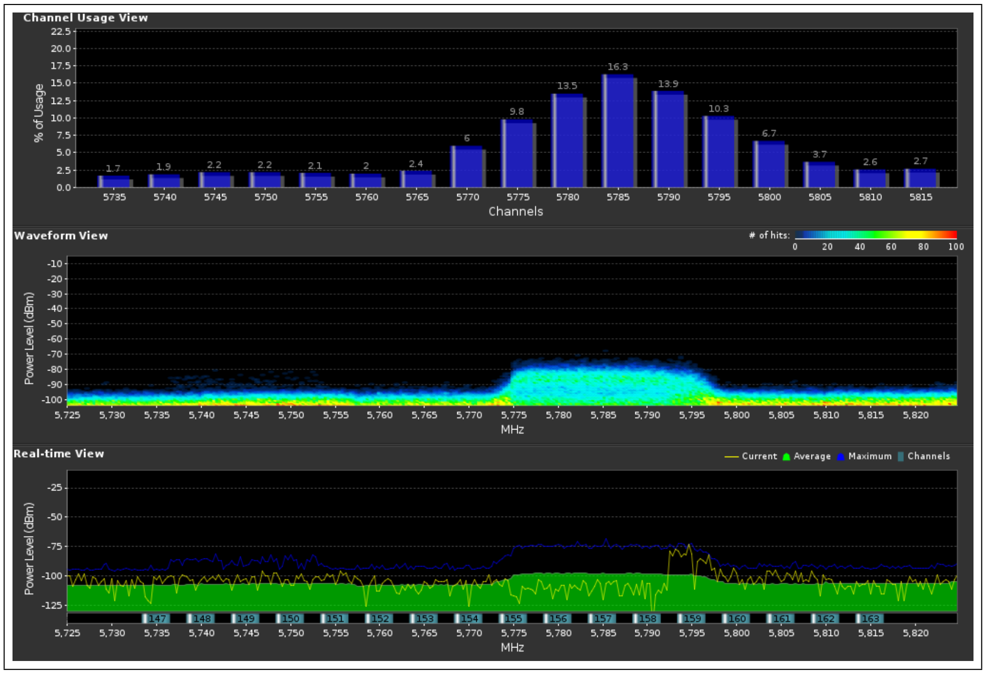
3.2.2 RF Environment

The RF enviornment shows light to moderate utilization in the 5GHz band. Our finding is that while appropriate channel selection and efficiency will be critical, there is ample spectrum available for use in the target geography. In order to assess spectrum health, we conducted sector surveys from the roof of the Kelly Center.

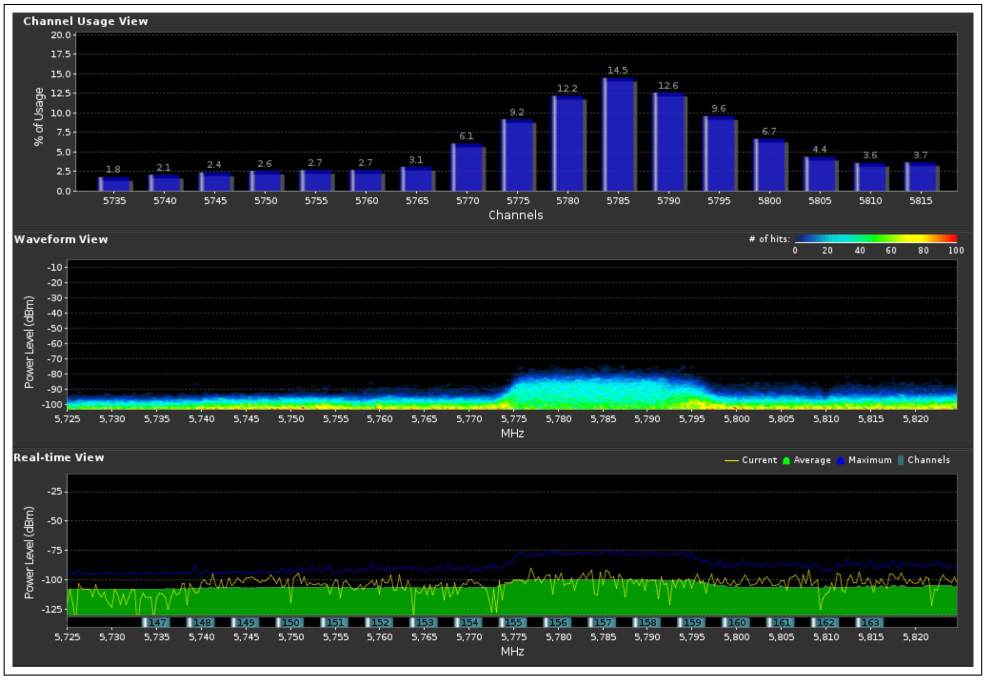
The graph below reflects the noise and signal levels in the 5GHz spectrum in the direction of St. Mary's Church, at 31st & Troost. All but 20MHz worth of spectrum is deemed usable, with a noise floor well below 90dBm:



The next graph shows the situation in the direction of the DuBois Learning Center, at 55th & Cleveland. The spectrum from 5.775GHz to 5.8GHz is not usable, but the rest of the band remains usable:



Next, in the direction of AC Prep, we see the same sitation as above, with the band from 5.775GHz to 5.8GHz saturated, but the rest of the available frequencies in good shape:



Finally, looking due west, towards Blue Hills, we see that the entire spectrum is usable, though it does have a slightly higher noise floor, generally approaching 90dBm:

We did not survey the 24GHz spectrum that we plan to use for backhaul, because it will be precisely aligned, and should not suffer from interference, as it is not widely deployed.

3.3 Findings

On the basis of our survey results and prior field experience, we have devised a proposed plan of action and associated cost estimates. These projections are intended to serve as a starting point for collaboration, and certainly do not reflect the only viable path towards accomplishing the stated objectives.

3.3.1 Proposed Plan

Phase I - Spring 2014 As a first phase, we recommend the construction a FreedomTower atop the Mary Kelly Center, and the institution of a community education program designed to teach computer skills. This would immediately create opportunities for block-level organization across much of the footprint. The tower would connect to existing KCFN infrastructure at 31st & Troost, and would require reengineering 31st & Troost's existing infrastructure to increase capacity. St. Mary's

Church has expressed an openness to such an arrangement, contingent on a roof-rights contract to be negotatiated between The Upper Room and St. Mary's.

Ideally, this work would be completed by students and residents, as part of the aforementioned education program, under the guidance of The Free Network Foundation and Connecting for Good. As part of this first phase, it would be necessary to lay the social and political groundwork for further growth. Those involved with the project and education program would reach out directly to potential partners identified in subsequent phases, and to the community at large

Phase II - Summer/Fall 2014 Once the Kelly Center tower has been functioning for some time, and a small corps of network volunteers has been stablished, additional towers should be built to expand coverage to the rest of the area. We have identified the DuBois Learning Center and Southeast High School as ideal sites for Phase II construction. With these three towers, virtually all of the blocks in Town Creek, and as many as third of the blocks in Blue Hills would have the abiliy to opt in by constructing a FreedomRelay. Community campaigns to encourage and enable relay construction will be especially important in Blue Hills, where the challenging terrain and lack of tall structures will require the network to expand block-by-block.

While it certainly makes sense for community anchor institutions to fund construction of core network infrastructure such as FreedomTowers, and potentially to subsidize the relays and nodes necessary to serve their constituents, long term success depends on a highly distributed ownership model. As such, it will be of critical importance that the network coalition engage in a concerted effort to publicly demonstrate the benefits of the network, and encourage participation.

Phase III - 2015 & Beyond After the network backbone has been constructed in Phases I and II, the focus should shift entirely to community stakeholdership and organic growth. Those students and community members that have been trained as network technicians should be charged with maintain existing infrastructure and facilitating the construction of new network on a voluntary of commercial basis.

At this point, the network would be well situated for expansion to areas outside the scope of this study, espcially to the south and east.

Future partners could include libraries, community centers, neighborhood association, additional schools, and all those who recognize the opportunity for mutual benefit inherent in the free network model.

3.3.2 Costs & Figures

While the community-driven model has its definite strengths, it can also make it difficult to give precise estimates of cost. Below we present those costs that would be incurred in Phase I, which *can* be immediately quantified.

Phase I one would have the following hard costs:

Item	Q'ty Req'd	Unit Cost	Total Cost
Ubiquiti ToughCable	2000ft	$.22/ft	$220
Ubiquiti ToughConnectors	20	$.53	$10.60
Ubiquiti ToughSwitch-8	1	$188	$188
Ubiquiti AirFiber 24	4	$1,500	$6,000
Ubiquiti NSM5 Loco	4	$70	$280
Glen-Martin 26' Tower	1	$2,561	$2,561
Soekris Net6501-50	2	$360	$720
Equipment Rental	1	$2,500	$2,500
Total Hardware	-	-	$12,479.60
Labor	-	-	$10,000
Support & Bandwidth	1 Year	-	$12,950
Total	-	-	$35,429.60

Build funders reatain complete wonership of all hardware, in accordance with the Network Commons License. The general labor for builds should come from volunteer and student technicians under the supervision of Connecting for Good engineers. Such a volunteer corps would also constitute the first tier of operational support for the network. Connecting for Good will maintain responsibility for keeping the infrastructure up and running, including the provision of gateway bandwidth, for a period of 12 months. After that this responsibility could be transferred to community operators, or a new support contract could be negotatied.

By completing Phase I of the above plan, we would lay the groundwork for a high-performance community network in the Swope Corridor. Further investment would necessarily come from a diverse coalition of community stakeholders. By laying the groundwork for the network, and establishing a source of low-cost connectivity, it will become possible to demonstrate the system and bring new participants onboard. We have identified a number of key locations and potential partners, highlighting their locations on the following map:

A small upfront investment in backbone infrastructure and education, if properly channeled, has the potential to enable massive, distributed community improvement. Investing primarily in know-how, rather than in infrastructure itself, sets the stage for commercial opportunity, and long-term sustainability.

4 Conclusion

Few would argue with the idea that connectivity creates opportunity. The real challenge lies in figuring out how to fight for access in a way that is both sustainable and effective. We believe that the key to success lies not in technology alone, but in technology and education enabling communities to invest in themselves.

By stewarding the emergence of a network with no single owner or operator, we can help make sure that Kansas City's core doesn't depend on budget policy or grant funding just to get online. The Network Commons License provides a framework for building just such a network.

We urge you to examine the NCL, and ask you to consider the ideas and proposals in this document. We know that they are not exactly conventional, but they have proven themselves effective time and again.

Together, we have the opportunity to demonstrate a powerful new model for digital inclusion and profoundly impact the future of our community, our city, and our society.