Seeking Alternative Models of Connectivity

Philip Bain

M.A. Project Proposal

Emergent Digital Practices

November 10, 2014

Advisor: Conor McGarrigle PhD

ABSTRACT

Through various projects, I intend to study different means of reclaiming networked spaces. The Internet as we know it exhibits a small fraction of the potential benefits of computer network technology. Its use has been commandeered by Government spying agencies and the perpetuated ideals of commercial entities. Internet Service Providers are simply one way to utilize technologies such as web design, media sharing, and communication. ISPs provide “last mile” access to the Internet for consumers. However, networking architecture can be built without requiring access to the Internet. My goal is to study possible configurations of devices, protocols, and programs to provide a framework for network technologies to exist without the necessary connection to the Internet. After utilizing the above technologies and applications of services, I will present an analysis of the viability of various technologies to specific applications. This will take the form of “toolkits” featuring installation media and instruction materials, which will be disseminated on the web and through discovered network alternatives.

Introduction and Description

A key question of consideration regarding the presence of information networks is understanding where they reside. It is easy to take for granted the existence of networks, but recognizing their location in our reality can provide insight about their significance and function. When discussing the placement of networks on the Internet, there are two different spaces that are being referred to. The first, of course, is the physical space occupied by nearly unfathomable distances of cables, the antennas, large and small, broadcasting radio waves, and the facilities devoted to housing and maintaining this infrastructure. This is the corporeal Internet; however there also exists a meta-space that can be useful to understand some more intangible aspects of the function of digital information. More often labeled Cyberspace, or virtual space, this meta-space has different rules of proximity and time. Web content is hosted on servers located physically all over the world. Our senses cannot perceive the transfer of data at the speed which electrons travel through copper or fiber-optic cable, which perpetuates the illusion of near-instantaneous communication. Still, the meta-space of the Internet is looked upon as a whole, complete space. I am investigating the possibility of conceiving separate spaces, or "worlds," that exist beside the unified meta-space of the Internet.

One of the oft-championed features of the Internet's protocols is the ability to connect smaller networks together to form a larger network.("Howstuffworks 'How Internet Infrastructure Works'" 2014) It may be an overlooked point, but the appellation given, "the Internet," is in fact an accurate descriptor of its function.

Local area networks (LANs) exist nearly everywhere in the modern world. The function of the Internet is to connect these networks into a greater whole. I say this is overlooked because at times it may seem as though the Internet is one great web of connected nodes, similar to the distributed style network described by Paul Baran(Galloway 2007). It is easy to imagine our interaction with network as a series of simple point-to-point connections. In reality, it is comprised of thousands of smaller networks that are connected at various levels in a hierarchy known as tiers. These tiers are controlled by major Internet companies and made up of actual, physical wires that connect points, for example there are dozens of trans-Atlantic cables that connect the United States and Europe.("Submarine Cable Map" 2014)

The purpose of my research path is to investigate networks that do not have the desire to connect to the Internet. These could range from something as small as a single access point with no other nodes, to a community network in a neighborhood or even a major city. I hope to find applications that can function on these networks just as they would on the Internet.

The Internet protocol suite is an example of complexity due to its many interacting layers of communication. The suite itself is comprised of four independent modular functions that operate independently, yet as part of a whole. The four layers are called the data link, Internet, transport, and application layers.("The Internet Protocol Stack" 2014; "Internet Protocol Suite" 2014)

The standardization of these protocols was very important in the development of the Internet. Without it, the Internet might have developed balkanized from the get-go, with different geographic regions creating their own

"Internets" to serve their own purposes. But, due to the interoperability of the four layers, this connection of many smaller networks grew into what we know it as today. The Internet should continue to be able to connect all parts of the world, but there is also a place for separate networks.

Up until recently it seemed clear that unification of computer networks should be the assumed correct policy moving forward with the cultural development of the Internet. However, privacy and security on the Internet are becoming more widely accepted topics of consideration for entities that utilize the Internet. Because of this, I think the efficacy of developing network alternatives will become a relevant subject for exploration in the near future.

The revelations of the National Security Agency's PRISM program have ignited concerns of privacy, leading some countries to consider balkanization.(ianapperley 2014) Balkanization of the web is when countries choose to store the private data of its citizens within its own borders. Rather than using services such as Google and Dropbox, these nations develop their own similar services that can be controlled and maintained by themselves. Because Google and Dropbox (and many other similar service providers) are United States corporations, they are considered insecure due to NSA snooping concerns.

There is a strong opposition to the balkanization of the net, mainly by the corporations and interests of technology companies.(Meinrath 2013) Balkanization of then net would result in difficulty for the tech giants to continue providing the type of unified services that they specialize in. This would result in a lessened ability to collect user data, which is their main economic commodity. The data that these

corporations harvest provide incredibly detailed information on people's habits, which is then used to produce targeted marketing and advertisements.

My research is exploring the emergence of network alternatives to the global Internet. I would like to find new spaces for computer networking to exist. This could be through new and updated protocols, and also through the use of advanced new technology. Wireless routing hardware is becoming more specialized and can be adapted to use for smaller, private network solutions. With these tools, the paradigm of the Internet can be re-evaluated.

If I can provide a template for people to develop and deploy networks rapidly, there could be a movement of many small independent networks materializing. What is special about this is that individuals or groups that participate in this concept will be bringing their own interests, skills, and motivations to the table.

Literature Review

The Internet started out as an effort to connect data centers at research facilities that were geographically hundreds of miles away. The first attempted at a long distance link between two data centers was October 29, 1969; the two facilities involved were the University of California at Los Angeles and Stanford Research Institute.("History of the Internet" 2014) In the first demonstration of this technology, UCLA Professor Leonard Kleinrock and his graduate students initiated the computer connection and began typing a message. The system crashed after three keystrokes.("History of the Internet" 2014) The experiment was a success however, and many similar experiments followed it. Before 1970, there were four

institutions across the nation connected by the data network known as ARPANET.(“History of the Internet” 2014)

Packet switching is the name of the method that enabled data communications between networks, and it is the principle that the entire Internet is built upon. This technique breaks data down into smaller chunks, or packets. The packets are sent across the network, each taking its most efficient route (which may not all be the same) to the destination where the message is properly reassembled. It is important to note that this method is perhaps the oldest feature contributing to the Internet, and is still used today. All the advances that have come subsequently build on this idea. Many of the shortcomings of the Internet are due to early adoption and perpetuation of this method within the Transmission Control Protocol and Internet Protocol (TCP/IP).(Moloisane and Ganchev 2013) As noted in their book “Internet Tomography: An Introduction to Concepts, Techniques, Tools and Applications” authors Abia Moloisane and Ivan Ganchev explain that with TCP/IP “a route from source to destination will be found if it exists at all.”(Moloisane and Ganchev 2013) While reliable, this method is also inefficient and can be the cause of network congestion. However, it is exactly this standard of reliability—treating each packet with equal importance—that shaped the Internet as an open and non-discriminatory force.

Eventually this feature would become a great contention of the Internet today, known as net neutrality. The central question of this concept asks, “Who can regulate the Internet?” Is it the ISP’s who own the last-mile access? Is it the public, who subsidized the installation of the actual infrastructure with their taxes? Is the

Government? I hope to side-step this question by promoting the option to form your own networks. The protocols, which govern the data communication, are free. Free, in that anyone can learn how they work, and apply the language to their own applications.

This open and decentralized nature of the Internet is a core component that facilitated its widespread adoption in the 1990's.(Varnelis and Annenberg Center for Communication (University of Southern California) 2008) There was no single body or organization that determined its trajectory, and therefore smaller groups were able to innovate on top of its architecture. This openness is responsible for many of the services that developed "such as Amazon.com, Google, and eBay, as well as… communication applications such as VoIP, BitTorrent, and other P2P services."(Varnelis and Annenberg Center for Communication (University of Southern California) 2008)

In fact, the successful performance of these new-media corporations gave rise to the commercial revolution that occurred on the Internet at the turn of the millennium. Ad agencies in the early 90's were slow to pick up on the commercial opportunities of the Internet, but new-media companies like Google and Amazon plowed their way to fortune by taking advantage of the technological possibilities offered via the web.

Advertisers seek to understand market demographics in order to craft enticing messages that lead consumers to make purchases. If advertisers know your interests and habits, they can target you with the types of ads most likely to make an

impression and convince you to make a purchase. Because of this there has been an emergence of technical tools designed to track your behavior online.

Aside from the web browser itself, no other technological advancement has served to commoditize the Internet than the "cookie."(Turow 2011) First developed in 1994 by Netscape programmer Lou Montulli, cookies are small files that are saved to your computer by your browser. These files can collect and catalog events performed by you while online. Acting as an identifier, the cookie "phones home" to its originator about your activities, such as clicks, referrals, and duration spent on a page.(Turow 2011)

It wasn't long before a web search company named Google saw the value in tracking user behavior and managed to use its own services toward this end. What better way to develop a profile on user behavior than a collection of searches performed? With the ability to connect IP address with search history, Google is in a unique position to sequence and track all of its users. Other major web companies such as Amazon and Facebook would eventually adopt this ability as well, signaling an end to the openness of the web.

Formed in 2002, the search engine Google "in two years… made $2.08 billion from the advertising that appeared next to its search engine results."(Turow 2011) Leading the pack in the "paid search" business that was emerging, Google offered services to advertisers that shape how we surf the Internet even today. By offering "free" products to consumers, such as email, word-processing programs, and its flagship web search, Google collects data its users. Google uses this data to form user

profiles, which can then be grouped into advertising categories and sold to ad agencies.

Similarly, Facebook, the most popular social networking site, has an even tighter grip on your identity. Users willingly proclaim their interests and relationships to the public by creating unique profiles and building a network of connections with other users. Facebook analyzes all of this personal data, and works with advertising agencies to provide you with the most relevant commercial content pertaining to your interests. Even if you choose to be stingy about what you share by limiting personally identifiable information, Facebook can form an accurate profile of you by analyzing data from your closest friends.("How Facebook Uses Your Data to Target Ads, Even Offline" 2014)

Using your willingly provided (or at least knowingly provided) data to deliver advertising content is fairly intrusive. But, it is nothing compared to the NSA revelations that were exposed by Edward Snowden in June 2013. Snowden's revelations exposed a state of mass surveillance that is unprecedented for our time.

One of the most important programs that were disclosed by Snowden is called PRISM. We've already established how companies like Google and Facebook store the personal data of its users; PRISM allowed the NSA nearly carte blanche to the data, if requested.(Steven Levy 2014) These companies, which branch out to include Microsoft, Apple, Verizon, and more, have little choice but to comply with the PRISM requests for data.(Steven Levy 2014)

If morally dubious, PRISM operated under auspices of legality. Another NSA program, MUSCULAR, did not.(Steven Levy 2014) A joint effort with Great Britain's

NSA analogue, the GCHQ (Government Communications Headquarters), MUSCULAR involved hacking into the servers that connected Google's private networks with the rest of the web. In doing so, they falsified security settings to prevent Google or its users from detecting their presence.(Hruska 2013)

In light of such a dire situation, what are the alternatives for citizens to seek refuge from the types of practices outlined above? Believe it or not, many alternatives exist. However, they are fragmented and unorganized. Therein lies the both strength and weakness of these models. Decentralization is the key buzzword shouted by opponents of consolidated networking.

Alternative networks come in a wide variety of forms and purposes. Mesh networks are one of these, as are Ad Hoc wireless networks. Each of these is considered part of the Multihop Wireless Network classification, because they specifically operate with wireless connectivity using the distributed node form of structure.(Loo, Mauri, and Ortiz 2011)

The distributed manner in which mesh nodes are arranged can provide a wide, blanket-like coverage area for connectivity. Mesh networks are very effective when used in apartment buildings, offices, and other settings where the goal is to permeate a large area with network connectivity. This is because each node can act independently as a router and repeater.(Held 2005) In a traditional network, data has to travel to a centralized routing point, where it is then sent out to its destination. In a mesh network, each node is capable of transmitting data to its destination without having to check with a central server for instructions.

Mesh nodes are enabled with the ability to self-configure, which means when a new node enters the network, it becomes incorporated without the need of intervention from a network administrator.(Held 2005) This is beneficial because it allows for the network to scale-up easily as nodes are added.

Ad Hoc wireless networks are similar in some ways to wireless mesh networks, but there are a few key differences. Whereas wireless mesh networks "are characterized by static wireless relay nodes providing a distributed infrastructure for mobile client nodes," Ad hoc wireless networks are "generally designed for high mobility multihop environments"(Loo, Mauri, and Ortiz 2011) This makes ad hoc networks more suitable for emergency and tactical scenarios than wireless mesh networks.(Zhang, Luo, and Hu 2007) Nodes in an ad hoc wireless network use protocols that allow it to quickly locate and connect to its nearest neighbors. In the type of scenario that would call for use of an ad hoc network, nodes would potentially be moving around in an unpredictable pattern. This means they have to be easily reconfigurable to one another on the fly.

Because wireless mesh networks need so few access points in relation to their nodes, they are perfect for bringing larger-scale Internet access to rural areas, or places where the cost of Internet access is prohibitive. They can even be used to create standalone, or federated, networks for communities that don't need or wish to be connected to the wider Internet, as we know it. Community driven wireless mesh networks are becoming more and more common. As technology gets cheaper, and the knowledge spreads, feasibility for this type of network grows.

Guifi is a community driven, mostly wireless mesh network located in Spain. It has evolved over the years to be one of the largest community networks in the world. At this time there are over 20,000 functioning nodes in the network.("Guifi.net World | Guifi.net" 2014) It is also stressed that the participants and contributors of the network are its true owners, but the Guifi.net Foundation coordinates and monitors the project. Anyone local can join the project by providing his or her Internet connection and thus expanding the network. The goal of the Guifi.net project was to provide ubiquitous Internet access for a low price to people in parts of Spain that did not have reliable and affordable access.

In the United States, Hyperboria is another networking initiative whose goals are slightly different than Guifi.net, but share the same values of open access for all. One key departure point from Guifi is that Hyperboria uses the CJDNS protocol. CJDNS is a newly developed networking protocol that it is not compatible with TCP/IP. What this means is, you cannot access Hyperboria sites directly from the "surface web." It may help to think of Hyperboria as just one of many potential networks that utilize the CJDNS protocol to communicate.

The Hyperboria project is multi-layered. It incorporates wireless mesh networking, encryption and security, and decentralization, seeking to unify these concepts. The stated goal of the project is "to provide an alternative to the Internet."("Hyperboria" 2014) Like many other open network projects, mesh architecture is implemented. However, with Hyperboria, you must be using the CJDNS protocol in order to connect to the network.

The main security feature lies in the fact that each node (representing an end-user) uses its own, unique IPv6 address as a security key to communicate. This key, also known as its fingerprint, cannot be impersonated. When one node sends data to another node, only the sender and recipient can decrypt it.("Cjdelisle/cjdns" 2014)

Because of the small scale of the project, it is difficult to find a connection locally in some places. This, of course, lends itself to community projects! Many cities have meshnet user groups where you can meet people and get involved.

Alternatives to the Internet exist, and are gaining popularity. There are methods of reclaiming our autonomy on computer networks, and there are many groups that are advocating for our security. Wireless mesh networking and Ad Hoc networking will likely see an increase in acceptance among the digital community. As these technologies become more accessible and easier to use, viable solutions will present themselves to the public.

Timeline

November 14 – Proposal Presentation

December – Develop research CMS further and begin self-hosting project.

January 11 – Deadline to apply for Spring 2011 Graduation.

January-February – Mesh networking project development.

February-March – Long and Medium range antennae project development.

March 23 - Deadline to Submit Oral Defense Committee Recommendations.

March-April – Communicate with online communities for feedback.

April 1 – Technical Demonstration Day.

April 16 – Deadline to schedule oral defense.

April (end) – Oral defense.

April-May – Further dissemination and finalization of projects.

May 14 – OGS Terminus (Final day to hand in materials).

May (end) – Symposium.

May-June – Finalize all projects.

June 5 – Graduation.

Materials and methods

In order facilitate the ease by which impromptu networks should be able to be deployed, the componentry should be small and portable. This helps in management of the hardware. Just as the trend in computing has been towards devices of smaller form, the tools used for creating networks are also becoming smaller.("Moore's Law" 2014)

One product that I would like to experiment with during my research is called the Pinoccio Mesh Router. These microcontrollers are about the size of your thumb and have similarities to the Arduino Mega.("Frequently Asked Questions" 2014) There are two main types of Pinoccio units, the Lead Scout, and the Field Scout. In order to create a mesh network, you can use Field Scouts and connect them to one another. The Lead Scout is necessary to communicate on the Internet, but for a typical network configuration, you would only need one of them. These devices seem to be the easiest way to get started with mesh networking. I have not yet had a chance to utilize them for projects, but obtaining a few of these is one of the next assignments I would like to begin working on.

The device that I have had the most hands on experience with so far is the Raspberry Pi. It is not strictly a networking tool, but rather a full-featured Linux computing environment. As such, it can run hundreds of programs, and interact with other hardware via its four USB ports and Ethernet port. The Raspberry Pi is both versatile and relatively easy to use. Also, at only $35, its price point gives it perhaps the highest return on investment of the devices I have been researching.

I have already initiated a project using the Raspberry Pi, which has produced some interesting results. I had seen examples of some people using their Raspberry Pi as a lightweight web server. Using a pared-down version of the popular Debian Linux distribution called Raspbian, it's not difficult to install some open source web server software.("RaspbianImages - Raspbian" 2014) The most widely used web server software in the world is called Apache.("Web Server Survey | Netcraft" 2014) This open source development tool would work just fine for this project, but I wanted to utilize something more cutting edge. Nginx is an up and coming server software developer, which focuses on low memory usage. I chose Nginx because this feature would make it run smoother on the Raspberry Pi.

In addition to being a web server, I also wanted to see if the Raspberry Pi could act simultaneously as an access point, or in other words, become a Wi-Fi hotspot. I found some tutorials outlining this procedure, modified them to incorporate my Nginx web server. While working on this, I also discovered the Raspberry Pi could be configured to act as a router as well. Using its Ethernet port, I was able to successfully pass the wired Internet connection to any other devices connected wirelessly.

I wanted to continue to push the small device to add even more networking features to see what it is capable of. I was introduced to a networking environment called Node.js, which in some ways is similar to Apache and Nginx as it can serve HTML pages, but it is even more lightweight and mainly used for responsive, real-time applications over the traditional static HTML and CSS pages.("Why The Hell Would I Use Node.js? A Case-by-Case Tutorial" 2013) I used Node.js as an

environment to install a new blogging application. Because I am motived in my studies to adopt the latest technology, I chose Ghost Blogging platform. Ghost is a newcomer to the blogging arena and is up against the likes of Wordpress and Joomla. Referring to itself as “Just a blogging platform,” Ghost eschews many unnecessarily complex plugins and features to present simple, yet responsive and elegant pages.(“About Ghost - The Open Source Blogging Platform” 2014)

The purpose of creating a completely portable web server/access point/wireless router is to illustrate the ease and mobility of serving web projects on such a small and affordable devices. Also I think there is an interesting concept there based on the ideas embodying space. Websites are developed to be displayed on the Internet, but what happens when you take a website “off” of the Internet? You now have limited access website, static-geo-locative projects. To web content with a real-world portability gives the technology an entirely new dimension it didn’t used to have when “on the Net.”

Another branch of research I would like to pursue is the use of emerging network protocols. Right now, approximately 90% of Internet traffic uses the IPv4, with IPv6 being the (newer) alternative.(“Measurements | World IPv6 Launch” 2014) CJDNS is one project, which implements an encrypted IPv6 network, and is intended to be a viable and secure alternative connection method than IPv4. Another interesting attribute of CJDNS is that it treats each node non-hierarchical. This lends itself to being used in mesh networking applications. Indeed, the stated goal is “to have every node connected directly by physical means; be it wire, optical cable or radio waves.”

As I continue my research, I would like to develop new terminology for concepts like, webpage, web-design, and networking. I feel it is important to differentiate the concept of alternative networks, by attaching new semiotic descriptors that represent it better.

The final product of my research will take the form of a toolkit designed to facilitate ease of use, and a knowledge base for the involved technologies. When deploying a network, there are a number of logistical concerns that must be addressed which may not be immediately apparent.

For example, will these devices be powered? At one's home, power outlets are commonplace for powering and charging devices. But in the field, power becomes a difficult issue to manage. Some devices come with a portable battery pack that can power the device using a micro USB connection. It will be necessary to determine the duration a full charge can last for the low-powered device. I will gain experience with the technology and develop a better understanding of how geographic elements come into play with network topology. I hope to discover more potential needs and uses for setting up networks in this fashion.

An environmental concern involves understanding the ecological footprint for the devices. Obviously, as they become more prolific, the possibility of waste increases. It would be worth devoting a portion of my research to gaining knowledge on the possibility of sustainable materials used in micro computing. The field of "energy harvesting sensors" is gaining recognition.(Tan 2013) This will be an important topic to look into, and I am collecting prior research on this topic.

I would like to dedicate equal weight to the critical understanding of my topic and the implementation of projects that will include the creating and deployment of network scenarios. There are four major ideas that will dictate the types of projects that I will pursue in my research.

The first of these is one that I get questioned about most often. People wish to know how the existing Internet will be incorporated into these alternative networking projects. At times, I vacillate between embracing and abandoning Internet connectivity for my projects. Ultimately, I feel that these alternative networks should be able to stand apart from the Internet and be able to function as separate entities. However, in some examples it may be desirable to connect to the Internet, and therefore I do not wish to actively exclude this feature. Fortunately, due to the interoperability of the Internet protocols, it is usually a small feat and will be a minor consideration.

Another extremely important issue I will tackle is the use of existing Internet protocols. Looking at the viability of alternate networks must include a discussion of alternative protocols. CJDNS is one that I have mentioned, and I wish to gain a full understanding of its potentials. Also, mesh network and Ad Hoc networking require advanced protocols that are often not compatible with TCP/IP.(Zhang, Luo, and Hu 2007) These too will be necessary for me to learn.

The third is the type of hardware that I will have available. Again, hardware is becoming cheaper, smaller and easier to use. This will be beneficial for the project and allow me to try out a larger scope of utilities for my research. There are several

devices that I have been testing so far, and I look forwards to incorporating many more.

The fourth question involves what type of services will be available to provide to users of the toolkit. I have already found ways to integrate web-page serving, access point creation, and IPv4 routing. The next steps I will pursue will be media distribution and communication, initially setting up an Internet Chat Relay (IRC) server, and eventually deploying voice over IP (VOIP). The services I am able to provide will arguable the most important aspect of my project, as it will dictate how widespread and beneficial it will be to the tech community.

Intended outcomes

One of the outcomes that I seek to achieve with my project is to change people's perception of what "the Internet" really is. In today's culture, the term "Internet" is used to define a large set of technologies that have varying levels of interconnectedness and contribution to the perceived meaning of the word. "The Internet" is in a state of flux where it exists within the boundaries of two separate ideals.

One of these ideals presupposes that the Internet is a unified thing, which operates under the same principles all around. In this model, everything is connected and can be linked to everything else. There is little varying scope of service and performance of the Internet.

The second ideal understands that the Internet is comprised of a vast amount of large and small networks of the three types defined by Paul Baran. Different network types have different purposes, and may not always communicate or be connected to one another. There are many large portions of networks that are not connected to the Internet. For instance, Google's cataloging scripts do not scrape business or government intra-networks, so they would not appear within search results.

Large technology corporations are working together to spin the narrative that the Internet is settled and stable. That they are guiding it and us along with its development, while serving us as much as is possible. They would like us to think that their services are the only means of achieving or obtaining the fruits of the Internet. Communication and information gathering is the exclusive domain of Google and Facebook, so it would seem.

I would like to change that concept by giving people the power or knowledge to create their own networks-- networks that can perform similar and new functions that people are used to having now with the Tech Giants.

The media has always had a parabolic relationship with computer networking. At times it is "cool" and other times "nerdy" or even dangerous. In the late 2000's and early 2010's I think computer technologies experience a huge,

unprecedented growth in popularity, this coincided with the so-called web 2.0. But now I feel we are on a backslide away from equating computer culture from being cool and desirable.

The upshot of this is that people are going to be less likely to embrace different technologies and move away from their comfort zone. The addiction to the Tech Giant's services coupled with less interest in technology innovations are locking into a feedback loop that will make widespread adoption of alternative networking more difficult. But that's OK, because pushing this kind of stuff underground is where it thrives anyway. Sub-cultures of alternative networks and enthusiasts already exist all over the world. Catalina, Spain and Seattle, Washington, USA both have thriving alternative network scenes.

I am excited to reach out to the wider tech community to seek opinion and suggestions on my project. Collaboration is one of the beautiful qualities that have informed the direction of the Internet since its inception. Codes, protocols and methodologies have been adapted and reused again and again. I would like to see this project become coopted and remixed accordingly. By moving the concept of networking into a more creative and playful sphere, developers and programmers could easily find novel ventures that could utilize advances in networking.

Communication, art, design, music can all find a place in new network spaces. One application of I can think of for creative networks would be public installation with augmented reality content. I would like to see artists mixing public art like sculpture, with networking. The digital material could provide expanded content or visual aids to co-align with the corporeal art. This could take the form of interactive

visualizations whose properties are informed in real-time by the presence of the audience for example, by pinging cellphones.

Therefore, part of my research will be probing online communities and attempting to get some feedback regarding potential uses for alternative networking. I've outlined some of the more evident possibilities, but I believe relying on the wider tech community for different perspectives will be very beneficial to the future of this project.

Potential dissemination

During my research on Unix language commands and Raspberry Pi customization, I consulted dozens of blogs, guides, discussion forums and manual pages to gain on the spot training. A beautiful thing about these technical items is that you can find an abundance of information on many topics. Because this, it is easy to vacillate between hands on work, and research. Whenever you are confronted with a problem, or a need for explanation, you can perform a search for

the solution. In addition to a research blog, I would also like to create a production blog, which will be a repository for the knowledge and finished projects for others to contribute to and take on for themselves.

Something that appealed to me as I poured over many of these blogs was a common style of web design that seemed to be shared by many of the bloggers. This is particularly evident in instructional guides for newer technologies such as the Raspberry Pi and the more popular Linux distributions, as well as the newer blogging platforms like Ghost.

The look and feel of these blogs displayed very clean layouts, foregoing the all too common sidebars and over complicated navigation schemes, which have reigned in popularity in the recent past. Instead, the text takes up a much wider portion of the field, usually centered between flanking margins. This layout shares a similar view as letters and Word documents such as the one you are reading now. As such, it may seem like a regression in style due to the historical precedent of which it emulates. But rather than appear flat and boring, the designers include pieces of flair that set the style apart from its “wall of text” ancestors.

Because they are mainly intended as educational guides of sorts, there is a need to separate text-based instruction from the code elements. These bits of code presented to the reader are precise commands that need to be accurately presented to the machine which will parse it or incorporate it into its program. For instance, you may be required to enter commands into a terminal window to update packages of an operating system, which will need to be downloaded from an online repository to an exact location on your hard drive. The guide will provide you with the exact

commands and sequence in which they will need to be executed. The user can copy and paste these easily if the code is distinguishable from the instructional text.

To achieve this, web developers use a special code tag, which tells the browser how to display the text in a frame that stands out from the page. This is called “mark up” and is a fundamental part of web developing. The code text is usually also displayed in a different text font than the body of the document. This server to further distinguish itself as important code.

For the guides that I will develop and include in my toolkit, I would like to adopt this style of web design. I have had much success in learning complex procedures for the technology I have been working with thanks to the clarity and simplistic presentation of this style of design. I believe it will be an optimal mode of disseminating the, at times, tedious portion of the instructional side of coding. By utilizing the elegant and direct style cues that have been effective for me personally in the past, I hope to facilitate the execution and embracing of my networking projects.

Among the technologies I will be experimenting with, not all are stand-alone platforms that work independently. For instance, it is important to understand the distinction between the Raspberry Pi and the Arduino, for example. The Raspberry Pi is a mini computer that is meant to run an operating system on it. Because of this feature, it performs many of the same functions as a PC, which is mainly running programs, which are built on top of the operating system. This operating system is installed onto and run from an SD card (or micro SD card). You must have another

computer with which to load the operating system (sometimes referred to as flashing). The file that contains all the data for the OS is called an image, and typically has the file extension of ISO or IMG. One the most attractive features of the Raspberry Pi is its ability to swap SD cards, and therefore swap operating systems, rapidly and repeatedly. Additionally, creating SD cards is a relatively simple task, so a wide variety of choices exist for the type of OS that is available to it. Individuals often share their image if that have made some notable changes or unique configurations to an operating system.

It is this characteristic of the Pi that I will take advantage of when disseminating the fully configured OS for my alternative networking experiments. The image will contain all the programs and customized config files that are necessary for the various tasks I'd like to make available for download.

There are dozens of repositories that will host files for free online; some common ones are MediaFire and Megaupload. One repository that is immensely popular among technology enthusiasts is called GitHub. Making my project files available on GitHub is a priority for a few reasons. While it has a noticeable learning curve, once you get over that it becomes quite easy and efficient to use. There are a few commands that you must memorize, and the web interface can appear a little daunting at first glace. Soon the complexities become obvious and you will begin to make full use of its features. Another distinctive aspect of GitHub is its social qualities. It was developed during the web 2.0 era, and as such is strongly based on social interaction.("Build Software Better, Together" 2014) Users can contribute to

one another's projects as well as offer advice and form relationships that can assist in your own development.

References

"About Ghost - The Open Source Blogging Platform." 2014. *Ghost*. Accessed November 10. https://ghost.org/about.

"Build Software Better, Together." 2014. *GitHub*. Accessed November 10. https://github.com.

"Cjdelisle/cjdns." 2014. *GitHub*. Accessed November 10. https://github.com/cjdelisle/cjdns.

"Frequently Asked Questions." 2014. *Support for Pinoccio*. Accessed November 9. http://support.pinocc.io/hc/en-us/articles/201464300-Frequently-Asked-Questions.

Galloway, Alexander R, and Thacker. 2007. *The Exploit a Theory of Networks*. Minneapolis: University of Minnesota Press. http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=216667.

"Guifi.net World | Guifi.net." 2014. Accessed November 10. https://guifi.net/en/guifi_zones.

Held, Gilbert. 2005. *Wireless Mesh Networks*. Taylor & Francis.

"History of the Internet." 2014. *Wikipedia, the Free Encyclopedia*. https://en.wikipedia.org/w/index.php?title=History_of_the_Internet&oldid=631984327.

"How Facebook Uses Your Data to Target Ads, Even Offline." 2014. *Lifehacker*. Accessed November 10. http://lifehacker.com/5994380/how-facebook-uses-your-data-to-target-ads-even-offline.

"Howstuffworks 'How Internet Infrastructure Works.'" 2014. Accessed November 10. http://web.stanford.edu/class/msande91si/www-spr04/readings/week1/Howstuffworks.htm.

Hruska, Joel. 2013. "When Legal Surveillance Isn't Enough: NSA Hacked the Fiber Optic Links between Google, Yahoo Datacenters." *ExtremeTech*. October 31. http://www.extremetech.com/internet/169924-when-legal-surveillance-isnt-enough-nsa-hacked-the-fiber-optic-links-between-google-yahoo-datacenters.

"Hyperboria." 2014. Accessed November 10. http://hyperboria.net/.

ianapperley. 2014. "The PRISM Debacle Is Speeding up the Balkanization of the Internet." *Whatisitwellington*. Accessed November 10. http://whatisitwellington.com/2013/11/20/the-prism-debacle-is-speeding-up-the-balkanization-of-the-internet/.

"Internet Protocol Suite." 2014. *Wikipedia, the Free Encyclopedia*. https://en.wikipedia.org/w/index.php?title=Internet_protocol_suite&oldid=632499551.

Loo, Jonathan, Jaime Lloret Mauri, and Jesús Hamilton Ortiz, eds. 2011. *Mobile Ad Hoc Networks: Current Status and Future Trends*. Boca Raton Fla.: CRC Press.

"Measurements | World IPv6 Launch." 2014. Accessed November 10. http://www.worldipv6launch.org/measurements/.

Meinrath, Sascha. 2013. "We Can't Let the Internet Become Balkanized." *Slate*, October 14. http://www.slate.com/articles/technology/future_tense/2013/10/internet_balkanization_may_be_a_side_effect_of_the_snowden_surveillance.html.

Moloisane, Abia, and Ivan Ganchev. 2013. *Internet Tomography: An Introduction to Concepts, Techniques, Tools and Applications*. United Kingdom: Cambridge Scholars Publishing.

"Moore's Law." 2014. *Wikipedia, the Free Encyclopedia*. https://en.wikipedia.org/w/index.php?title=Moore%27s_law&oldid=632897959.

"RaspbianImages - Raspbian." 2014. Accessed November 10. http://www.raspbian.org/RaspbianImages.

Steven Levy. 2014. "How the U.S. Almost Killed the Internet- And Why It Still Could..." *Wired Magazine*, February.

"Submarine Cable Map." 2014. Accessed November 10. http://www.submarinecablemap.com/#/landing-point/pennant-point-ns-canada.

Tan, Yen Kheng. 2013. *Energy Harvesting Autonomous Sensor Systems Design, Analysis and Practical Implementation*. http://www.crcnetbase.com/isbn/9781439894354.

"The Internet Protocol Stack." 2014. Accessed November 10. http://www.w3.org/People/Frystyk/thesis/TcpIp.html.
Turow, Joseph. 2011. *The Daily You: How the New Advertising Industry Is Defining Your Identity and Your Worth*. New Haven: Yale University Press.
Varnelis, Kazys, and Annenberg Center for Communication (University of Southern California). 2008. *Networked Publics*. Cambridge, Mass.: MIT Press.
"Web Server Survey | Netcraft." 2014. Accessed November 9. http://news.netcraft.com/archives/category/web-server-survey/.
"Why The Hell Would I Use Node.js? A Case-by-Case Tutorial." 2013. *Toptal Engineering Blog*. August 13. http://www.toptal.com/nodejs/why-the-hell-would-i-use-node-js.
Zhang, Yan, Jijun Luo, and Honglin Hu. 2007. *Wireless Mesh Networking: Architectures, Protocols and Standards*. Boca Raton: Auerbach Publications.