Project Constellation Proposal

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Constellation[1]

[kon-st*uh*-**ley**-sh*uh* n]

noun

1. *Astronomy.*
   (a) any of various groups of stars to which definite names have been given, as Ursa Major, Ursa Minor, Boötes, Cancer, Orion.
   (b) the section of the heavens occupied by such a group.
2. *Astrology.*
   (a) the grouping or relative position of the stars as supposed to influence events, especially at a person's birth.
   (b) *Obsolete.* character as presumed to be determined by the stars.
3. a group or configuration of ideas, feelings, characteristics, objects, etc., that are related in some way.
4. ***any brilliant, outstanding group or assemblage***

[1]Citing Dictionary.com on the definition of Constellation with an added example for the third entry.

In the last 10 years or so the internet has grown exponentially and begun to invade our every day lives. We rely on it for entertainment, news, and even for our business affairs. Many businesses rely heavily on the internet for their inner workings, and even some businesses make their money by providing and facilitating connections to the wider internet. For the vast majority of users on the world wide web, knowing how the inner works of the internet happen are simply not necessary and maybe even above their knowledge level. But for many engineers working with all forms of emerging technologies, having a better understanding of the inner workings of the world wide web is either a necessity, or would be a significant help to their work.

The concepts and technologies employed on the world wide web can be taught in classrooms and even explored in labs in a very basic sense. But to actually see the world wide web in action would require the observer to be an active part in the network. This is an incredibly daunting challenge for anyone acting on their own behalf. Therefore it is very difficult to study how the world wide web functions in it's entirety.

1 Purpose

It is the purpose of project Constellation to provide a unique learning experience for many students on campus. Project Constellation will also provide a solid base for other experiences and exploration to take place.

In detail, project Constellation will create the framework and the seed for a large scale, student driven, network that acts in a manner similar, if not simulating, the world wide web. The result of this framework will be a network and a platform that can be used to study in depth the inner workings of the world wide web. As this network will exist in a much more controlled environment than the world wide web, students will be able to directly interact with the systems involved in this network in a way that would require expensive licensing and numbering as well as a direct connection to at least one other router connected to the "backbone" of the world wide web.

While the inner workings of the world wide web could be simulated in software, this frame work would spawn a dynamic system with variables that would be less predictable than what may be simulated. This is the nature of a physical implementation of a system versus a virtual simulation of such a system. The primary ever changing variable in this case would be the students who participate in this project. As they become more familiar with the concepts used they may wish to implement their own sub-systems and sub-networks and continue to grow the larger network with their contributions.

At the heart of this project is education. The end goal of this project is to provide a sort of sandbox for students to play in and learn in, in a way that they otherwise would not be able to. We at the Information Technology Club know that sometimes learning topics can be difficult without a hands on session. We also know that these hands on sessions are often fun and are always valuable experience. Nothing in the real world ever just happens in theory, there is always the practice that follows. While the IT Club can currently give the theory behind many things, having a large physical sandbox will allow us, and many others, a place to provide the hands on.

2 Who Is This Project For?

The great beauty of this project is that it is designed for everyone. It will provide a place for the casually interested to play and learn casually. It will provide the IT Club a massive white board for exploring the many topics in information technology. It will provide a place for the many great educators here are Oregon State University a place to extend lessons involving internet topics. It will allow researchers a view of the world wide web in a way they may not get otherwise. It can provide a test bed for new technologies to be developed to interact with the world wide web, but without the dangers of full development on a public network.

It is truly a project for everyone who would take interest. The nature of the networks that would be formed through this project allow them to easily be expanded so that all who wish to participate will be able to do so easily.

3 Project Constellation Overview

Project Constellation aims to emulate the world wide web on a much smaller scale and in a more controlled environment. The creation of such a network for academics would allow students to directly interact with a network very similar to the world wide web in order to study the technologies and processes that create the larger world wide web.

While the world wide web consists of thousands of very expensive routers all interconnected, such a network can be emulated using inexpensive off-the-shelf hardware that could be supplied by each participant of the project.

Through collaboration on the part of all participants a large network acting very closely to the world wide web can be achieved. Such a network could provide a complete platform to allow further exploration of the topics involved with the world wide web such as: DNS, Various routing protocols, multi-homed networks, and many others.

4 Challenges and Barriers

Like all networking projects there will be challenges to overcome and barriers that can halt this project. The primary issue that this project will face is the problem of complete isolation. The nature of this project will require all of the systems in use to be completely isolated from all university networks. A network of this nature presents a big security risk to the university if it were to ever make contact with the university's network. On top of a security risk there is also potential from collateral damage if the two networks were ever to cross. The major daunting potential is that a campus computer is connected to this network either intentionally or unintentionally and then becomes non functional during class time. Such an event would be incredibly disruptive to academics and as the project is being presented with the goal of academics, it will be imperative to preemptively solve this problem before it ever happens.

5 Materials and Methods

There are many different systems and methods that can be used to interconnect routing devices on the internet. However the primary protocol used to stitch together the internet appears to be the Border Gateway Protocol (BGP). For this project we will focus on using BGP as the core networking protocol to form the backbone, but many other protocols can be used for edge routers or specific connections between peers for the purpose of learning.

5.1 Border Gateway Protocol

The protocol known as Border Gateway Protocol (BGP) is a very powerful yet easy to employ routing protocol that is widely used between routers on the world wide web. It uses the concept of peering to connect routers as neighbors. In this concept each neighbor may have many other neighbors, and each neighbor is communicates the routes on the network it has learned to all of its other neighbors. This allows a router on one side of the world to propagate it's advertised addresses across the entire internet.

Entities acting on the internet are referred to as Autonomous Systems (AS). An AS encapsulates a single entity on the network and may be a single router connected to the internet, or a small interconnected cluster of routers each connected to the internet in different locations. In order to keep track of all this, each AS needs a special and unique number (an ASN) so that all systems on the network can differentiate other systems. Multiple interconnected routers owned by the same entity can employ the same AS number to create one large AS instead of using a single system per ASN.

When connecting (called peering) two routers via the BGP protocol, each router must be assigned an ASN. The two routers then must be connected via some ethernet capable medium and each interface in that connection must exist within the same subnet as the other router. Then each router must be configured to add the other as a neighbor. Once both routers have been configured with each other as a neighbor the BGP connection has been completed and the two routers can now share their routes. BGP is a very easy to implement protocol but carries significant power in the routing world.

This project will not be limited to just BGP and may incorporate connections using RIP, OSPF, and even static routes. However the primary transport layer of this project should use BGP.

5.2 VyOS

In order to use off-the-shelf hardware for this project a routing operating system must be chosen for each node on the network. Ultimately the routing platform choice will be up to the person or entity implementing the router on the network. There are many choices that can support BGP, some do so out of the box, and others require additional software updates to support BGP.

The officially suggested routing platform for this project is VyOS. VyOS is a fork of the Vyatta project which uses the Quagga routing engine. VyOS is capable of implementing routes via all of the major routing protocols out of the box from installation. It is light weight and capable of running on minimal hardware. It has a powerful command line interface that is loosely based on JunOS from Juniper. The command line syntax is easy to pick up and learn quickly. It can also easily be virtualized for easy testing and simulation of a full network from a single virtualization host.

As VyOS is so lightweight and simple to implement it will allow participants to select cheap hardware for their physical routing platform.

5.3 Physical Hardware

Physical hardware selection will ultimately be up to the person or entity implementing the network segment just as with the routing OS. However do to physical and power constraints of physical placement of such devices there are a few guidelines that should be considered for physical hardware.

First and foremost the hardware selected should be able to effectively run the selected routing OS. It should be able to successfully perform it's routing and switching duties as well as be able to hold the routing table of the entire network. The host should also be power friendly. All hosts should not consume more than 500W of power. The host should be quiet enough that you could comfortable take a test with the host running on the next desk over from you. The host should also be as small as possible while still being able to meet all of the other criteria. A small footprint for a host will allow it to be placed in such a way that it will remain out of the way of any day to day activities that may take place in the area it occupies.

While those guidelines exist to ensure that no piece of this network would interfere with any on campus activities, there are other guidelines to consider for an effective router. It is suggested that each node acting as a router have more than 2 network ports. 3 network ports would allow for each node to peer with two other systems on the network and still provide network connectivity to some form of internal network maintained by the owner of the node. For long distance connections to other peers a fiber optic networking card may be required and is highly suggested.

Some suggested systems are:

- Dell Optiplex 755 SFF
- Dell Optiplex 760 SFF
- Dell Optiplex 780 SFF
- Dell Optiplex 790 SFF
- HP Elite 8200 SFF
- Lenovo E71 SFF

5.4 Physical Links

One of the primary barriers of this project is physically connecting the routers on the network. Hosts that reside within the same room would be capable of utilizing standard copper UTP cables to create links. However signals over UTP copper cables may begin to degrade past 100 meters (about 300 feet). For longer distances it will be necessary to utilize fiber optic

connections. The suggest fiber cabling type for this entire project is OS2 Single Mode fiber cables with LR optics. This will ensure that all fiber connections can travel any distance required by the network.

References

[1] Constellation - Dictionary.com