The Steelie Link Project

Overview and Specification

by Jackson Huff

This is Steelie Link

Steelie Link is a revolutionary new mesh networking system unlike any other one. To put it simply, Steelie Link uses a standards-based approach with established networking technologies combined in an easily accessible way.

All Steelie Link networks have these benefits:

→ Connection-based load distribution

→ Automatic failover for enhanced reliability

→ Dynamic network growth and decay through

→ Affordable initial setup and expansion with common hardware

→ IPv4 and IPv6 compatibility

All of these factors combine to create the ultimate user experience. No matter if you're someone in a bad situation or an ISP providing access to whole communities, Steelie Link is there for you. Get rid of Internet problems like spotty reliability and poor speeds all at once!

What Does Steelie Link Solve?

The typical Internet user has a good, maybe great, experience. Many users suffer from spotty reliability, sluggish speeds, and poor utilization. These problems have persisted ever since modern computer networking came about in 1980 with the introduction of IEEE 802.3 Ethernet. Even with modern network infrastructure, the issues keep coming back as if they were cockroaches.

To solve these problems, many network engineers have come up with new ideas to combat bad experiences. For example, public high-speed WiFi has made getting connections accessible to the masses. Other ideas such as wide-scale optic fiber have made gigabit-plus speeds affordable to many. However, just as cockroaches can keep coming back after an extermination, many people still have a bad experience despite these engineers' hard work. Here are just some of them.

Problem 1: Bad Reliability

Imagine that you're living in some household doing some Internet-dependent task, such as a video call. It's storming outside. Minutes, maybe hours, pass with the globs of rain and gales of wind exerting themselves on the rickety house and whatever dares to surround it. Luckily, you've got an optic fiber connection so you never notice a thing because its sheer speed has distracted you from the (not so) great outdoors. That is, until the storm brings a nearby tree to its last straw and its thick, dense trunk snaps in half and hammers immediately onto the optic fiber right where it enters your house. Disaster has struck. You're now without any connection at all until whoever owns the fiber can repair it.

Imagine a similar situation, but this time with better weather. It is a clear sunny day and you are streaming TV and watching your favorite content. All of a sudden, the video freezes. Maybe a loading indicator has showed up. You may think this is typical, and it is. In reality, your Internet provider mistakenly put in a faulty coaxial cable somewhere upstream and this cable randomly works depending on what time of day it is.

You can find these scenarios in all parts of the world. No matter if it's the United States, Canada, Belgium, Bolivia, Botswana, or Japan, many, if not most, Internet outages fit one of these two templates. Barring exceptions like governmental or global network shutdowns, these outages are generally localized at the disaster point.

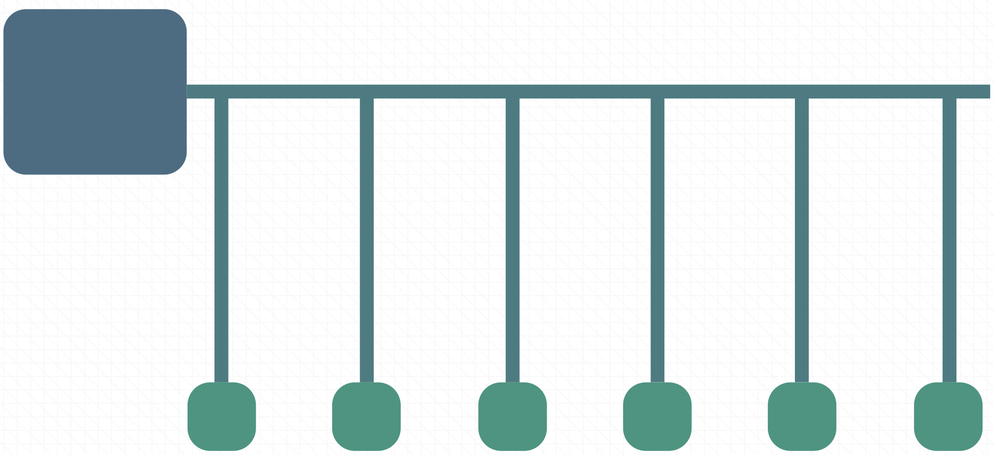
Problem 2: Bad Speeds

The phenomenon of poor speed exists in all countries on planet Earth. Despite the many advancements in networking technology, high cost and difficult distribution have left people in the dust with dilapidated, obsolete connections that would make eating frozen molasses feel like riding a roller coaster. The users with poor speed demand a better experience.

Today's websites and other Internet services make use of more bandwidth than ever. With the introduction of high-resolution displays on PCs and smartphones alike, multimedia content keeps engorging on the connections that serve it up. Meanwhile, compression technologies such as AV1 and HEIC have not kept pace. Furthermore, in the interest of penny pinching, content distributors have jumped on the Internet streaming bandwagon and are abandoning physical media. All these factors contribute to bottlenecks in the networks present today.

Problem 3: Unoptimized Utilization

All else equal, you can get a good user experience by having great speeds and great reliability. After all, in most cases, trees are not crashing down on cable lines and many have access to gigabit-plus links. However, one hidden problem remains: the entire paradigm of distribution. The problem lurks in the ISPs' ways.



This above diagram shows how a typical ISP might distribute its Internet service to its customers. The blue box represents a central connection point such as an edge router. The green squares represent individual clients. The turquoise lines represent the layer-1 connections; they can be anything from coaxial cables to cutting-edge fiber optics. Each client receives one connection from the connection point, which we'll assume to be an edge router. This edge router contains multiple interfaces, each with its own bandwidth limit, each connecting to one client.

This setup normally works perfectly. However, the edge router's interfaces represent a choke point. If one client were to saturate its connection, all of the other clients are unaffected. The client that is saturating its connection can very likely go further in its bandwidth consumption, but it could never in this case. Given this scenario, it’s clear that there remains opportunity for one client to utilize the connections of other simultaneously in such a way so that the overall experience for the other clients remains unaffected.

In Conclusion

Steelie Link aims to resolve the three problems outlined above with a mesh network. “This isn’t new!” you shout. As it turns out, the concept is almost as old as networking itself. Many have found that a mesh network is the ideal fit to fix the three problems outlined above. So many mesh networks exist already, too many to list here! However, most, if not all, of these mesh networks have some non-negligible drawback that limits their adoption. One example I found is very attractive option from Spain, called “guifi,” that is cheap and easy to implement. The problem is that you have to use certain hardware using custom software. That alone is a non-starter. Further, this kind of mesh uses WiFi extensively in order to create its links, which isn’t a suitable option everywhere. Looking at another example of a mesh network, take Terragraph from Facebook. On a high level, Terragraph seems to fit the bill of what you’d want in order to create the best user experience. However, it comes with an even bigger catch than guifi, and it’s the prerequisite of 802.11ay, a unique wireless communication standard that uses the 60GHz band to ensure high bandwidth. The problem here is protocol lock-in, not to mention a few others not covered here. In short, the world of mesh networks is in dire need of a usable solution.

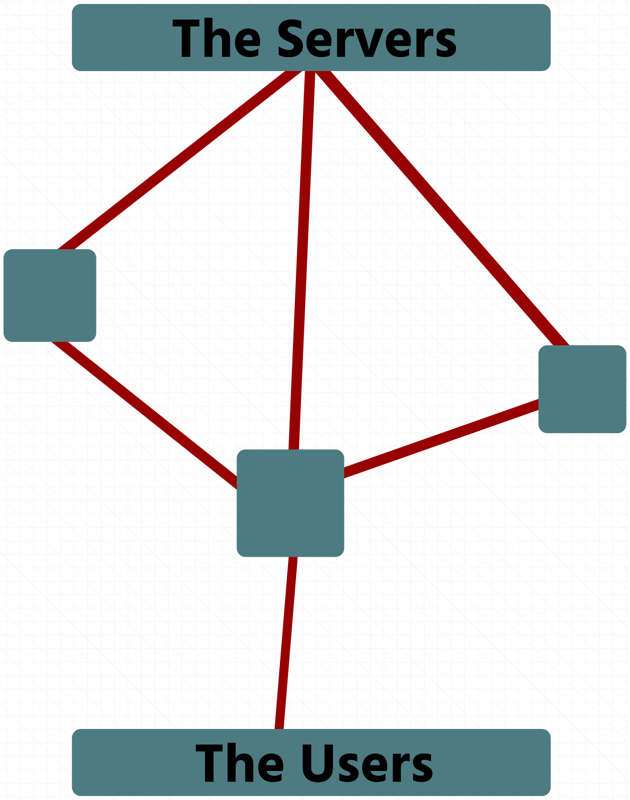
Enter Steelie Link. On a low level, Steelie Link brings few to no new technologies. Many network engineers are familiar with them already. They include OSPF, NAT, PCC, and several others. What is new, however, is the implementation, the grand plan, of these technologies. What you get is a standardized implementation of features that many mass-market routers already support, flexibility to use whatever connection is the most suitable, and instruction on putting it all together. Together, these aspects form a powerful combination that takes into account the most common problems associated with mesh networks and provides a workable solution to enable everyone to have an ideal user experience.

How Does Steelie Link Work?

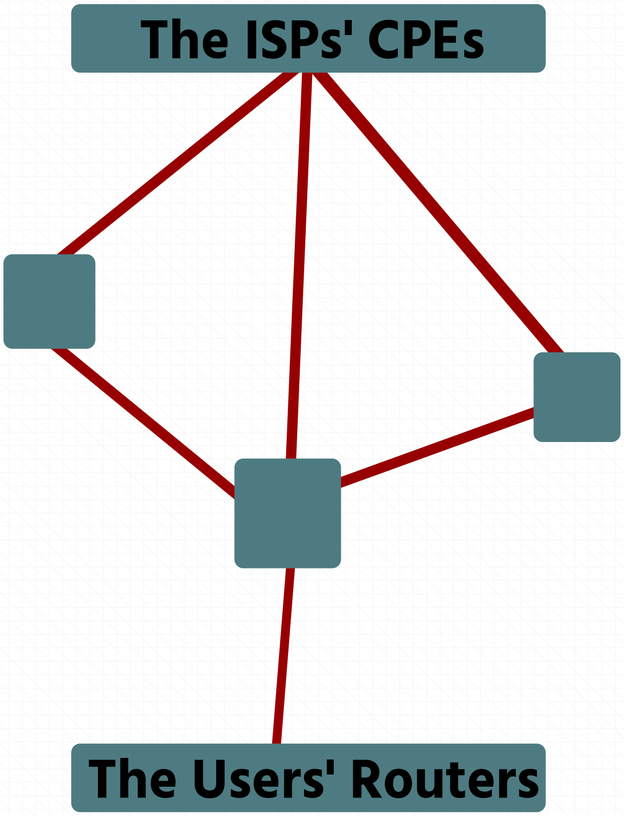
Steelie Link uses a standard-based approach to the three main problems that it aims to solve. Also mentioned is the usage of OSPF and other networking technologies. How do these play together? As it turns out, it's simpler than you might think.

All Steelie Link networks consist of nodes connected with links. A node is any kind of router, and links can be any network connection that provides layer-2 connectivity.

On the right is an extremely simplified diagram of a hypothetical Steelie Link network. On the top, we have all accessible services on the Internet. On the bottom, we have all end users with their own networks. In the middle we have all Steelie Link nodes and links.

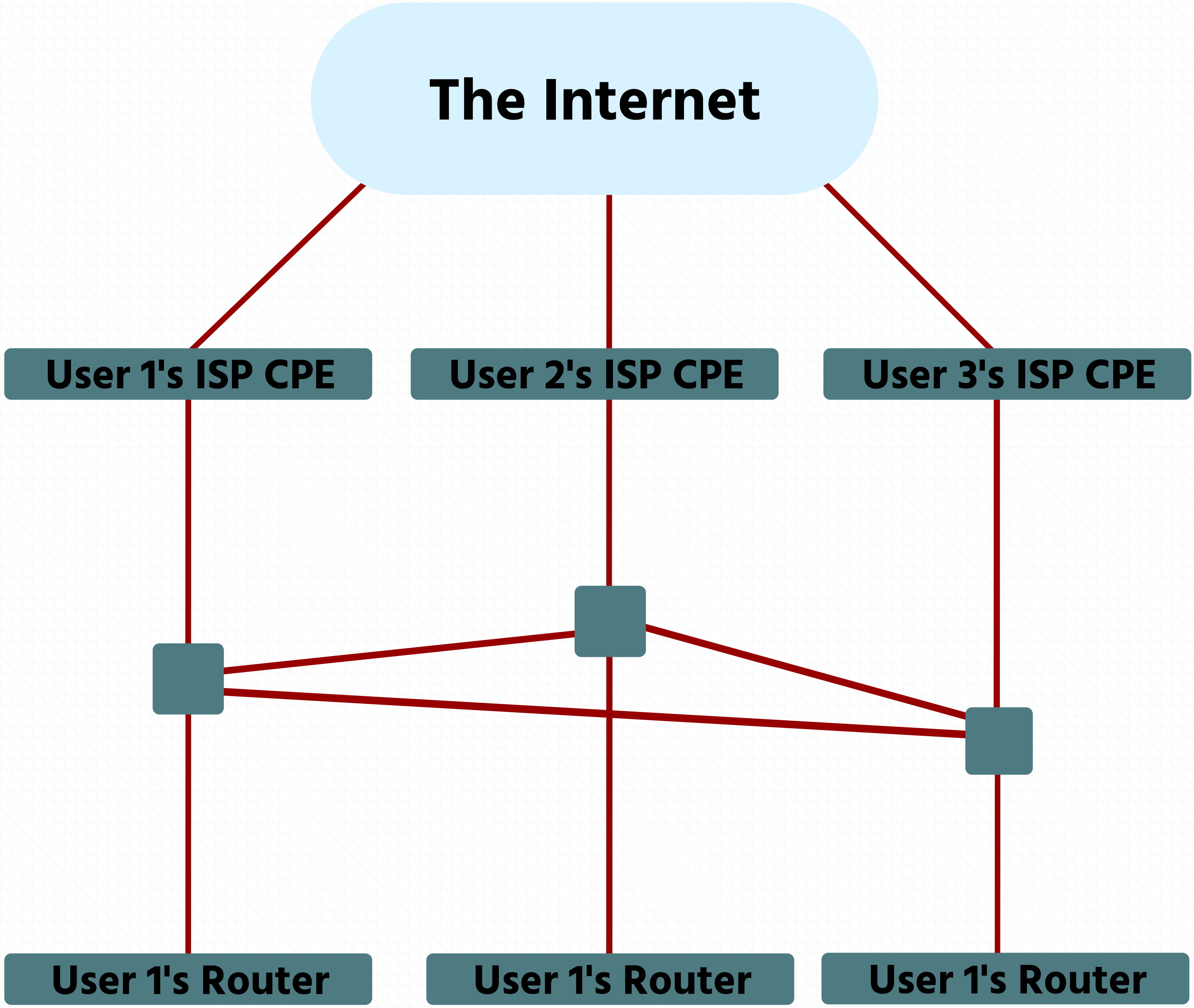


Within the end users' networks, they can be any typical residential or commercial network that has existed before. A typical home user may have a consumer WiFi router connected to a DOCSIS modem. However, what part of this overall connection does SL actually deal with?



On the left is another diagram showing exactly where Steelie Link connects in the scope of a typical residential setup. The end user's consumer router connects into a Steelie Link node and can connect directly into a CPE which is present on-site, or connect to other nodes which in turn link to other ISP CPEs.

Now here is a complete diagram of a typical Steelie Link network.



Now you can see how exactly Steelie Link solves the three problems above. If the link between the leftmost node and User 1's ISP CPE were to fail, there are two backup links ready to go. Even if there are no bad links, Steelie Link can transparently distribute connections from User 1, 2, or 3 among all the CPEs. This also eliminates underutilization. If User 1 were to saturate their link while Users 2 and 3 used no bandwidth, then the network as a whole would be saturated because User 1 is using three times the amount of bandwidth than without Steelie Link.

Steelie Link is nothing more than a clever arrangement of routers in an intermediary transport network that can distribute arbitrary traffic. This is what makes it so easy, flexible, and inexpensive.

How to Make a Steelie Link Network

This section gives a generic, template of a tutorial of how to create a Steelie Link network from scratch.

Step 1: Assess the Situation

Determine the topology of the existing network. Determine all "possible links," or methods of linking nodes such that the solution balances cost, reliability, and speed. Determine the best locations to place each Steelie Link node. Determine the final topology of the network after node and link installation.

Step 2: Procure Equipment

Purchase cables or devices for the links. Purchase suitable routers for use as nodes. Every node must fit the requirements listed in the Steelie Link Specification.

Step 3: Install Equipment

Install the purchased equipment so that it replicates the planned final topology.

Step 4: Configure Equipment

Configure the equipment so that it follows the Steelie Link Specification.

The Specification

Definitions

"Intermediary transport network" refers to a network consisting of nodes and links.

"User" refers to any person or computer than can consume or provide content on the Internet.

"Node" refers to any full router, freeloader user, full user, access router, or intermediary router.

"Router" refers to any full router, intermediary router, access router, or unlinked router.

The following table defines types of nodes depending what services they provide:

provides Internet access	contains user(s)	can use a routing protocol	defined as
no	no	no	nothing
no	no	yes	intermediary router
no	yes	no	freeloader user
no	yes	yes	freeloader user
yes	no	no	Internet connection
yes	no	yes	access router
yes	yes	no	unlinked user/router
yes	yes	yes	full router

"Link" refers to any layer-2 connection between two nodes.

General Requirements

All routers in a Steelie Link intermediary transport network must have an IPv4 address within the subnet 10.0.0.0/24. All addresses within this subnet must have a /32 subnet mask. Example: A router has the address 10.0.0.4 with the subnet mask of 10.0.0.4/32.

All routers must be able to use the OSPFv2 and OSPFv3 routing protocols.

The IPv4 OSPF router ID must match the assigned IPv4 address within the 10.0.0.0/24 subnet.

All routers using OSPFv2 or OSPF v3 must use the point-to-point OSPF mode for all links.

All routers must support the IPP or GRE protocols.

All routers with end-users must support PCC. PCC is defined as "Per-Connection Classification," where every connection has a hash value calculated upon its source and destination IP addresses and ports.

All routers must have at least four layer-1 connections. For example, a copper ethernet-based router must have at least four ethernet jacks.

Links

All links have an OSPF link cost value associated with them. This formula provides the method to determine the cost:

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cost = 10,000 / (nominal link speed in megabits per second)
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For example, a gigabit ethernet link would have an OSPF cost of 10. For a 400 megabit 802.11 link, its cost would be 25.