

Analytics and Automation in the Future Federal Government

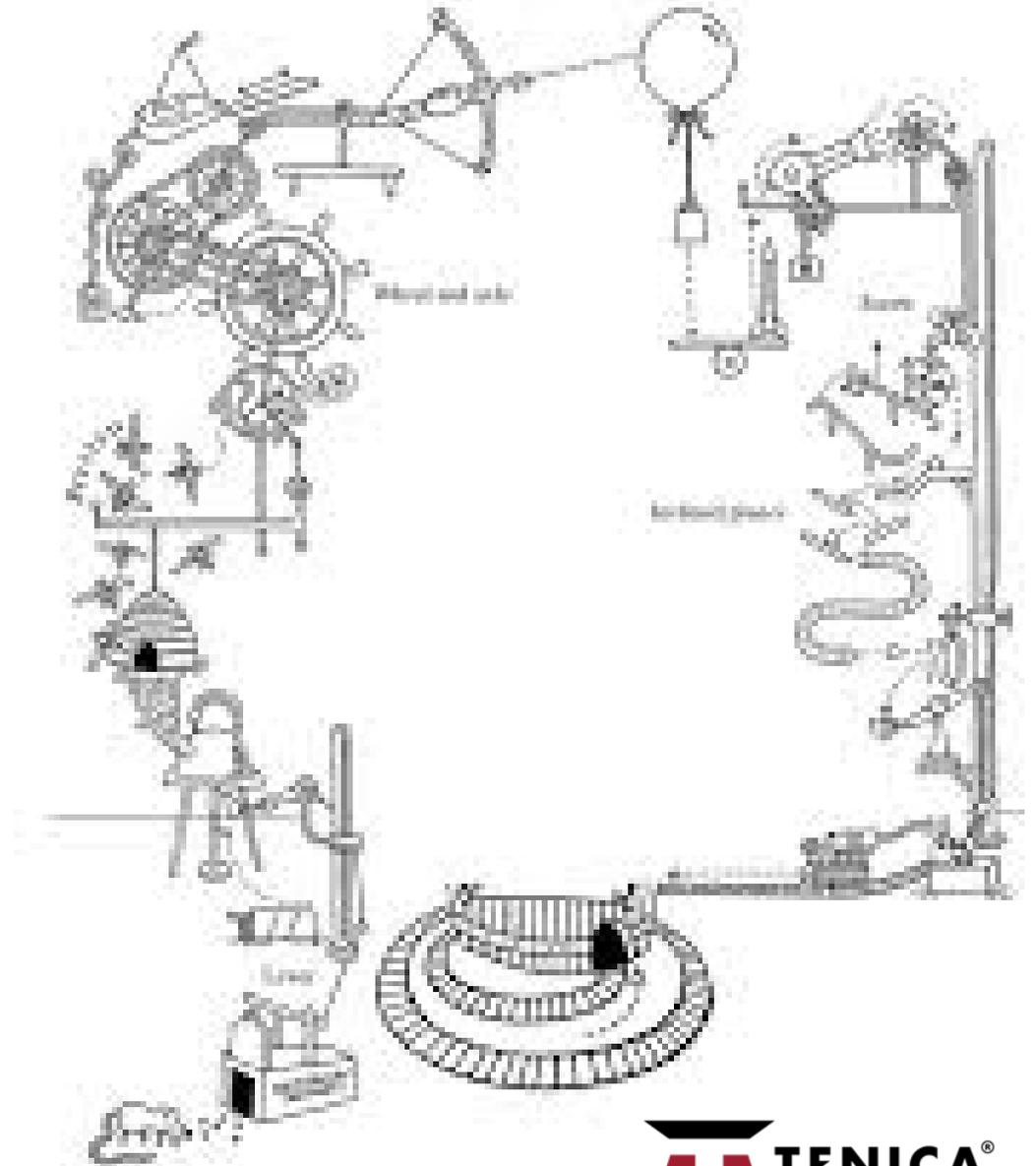
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May the 4th (B w/ U)

Long ago,
in a galaxy not far away...

- Network optimization
- But network capacity was being sold faster than you could build it
- Meanwhile, technology drives down cost and drives up bandwidth
- Then we let networking get complicated

Rube Goldberg Design Project



Meanwhile, technology continued...

- Vanishing margins, increased complexity, more bandwidth for killer apps, all strained the network...until it split: SDN, NFV, Apps.
- And now a flood of new ideas to sift through.
 - Analytics and Big Data
 - Orchestration
 - The fragmentation of NMS, OSS
 - But
 - How do we know what to do?
 - How do we know it's the right thing to do?
 - Where is the Intelligence?



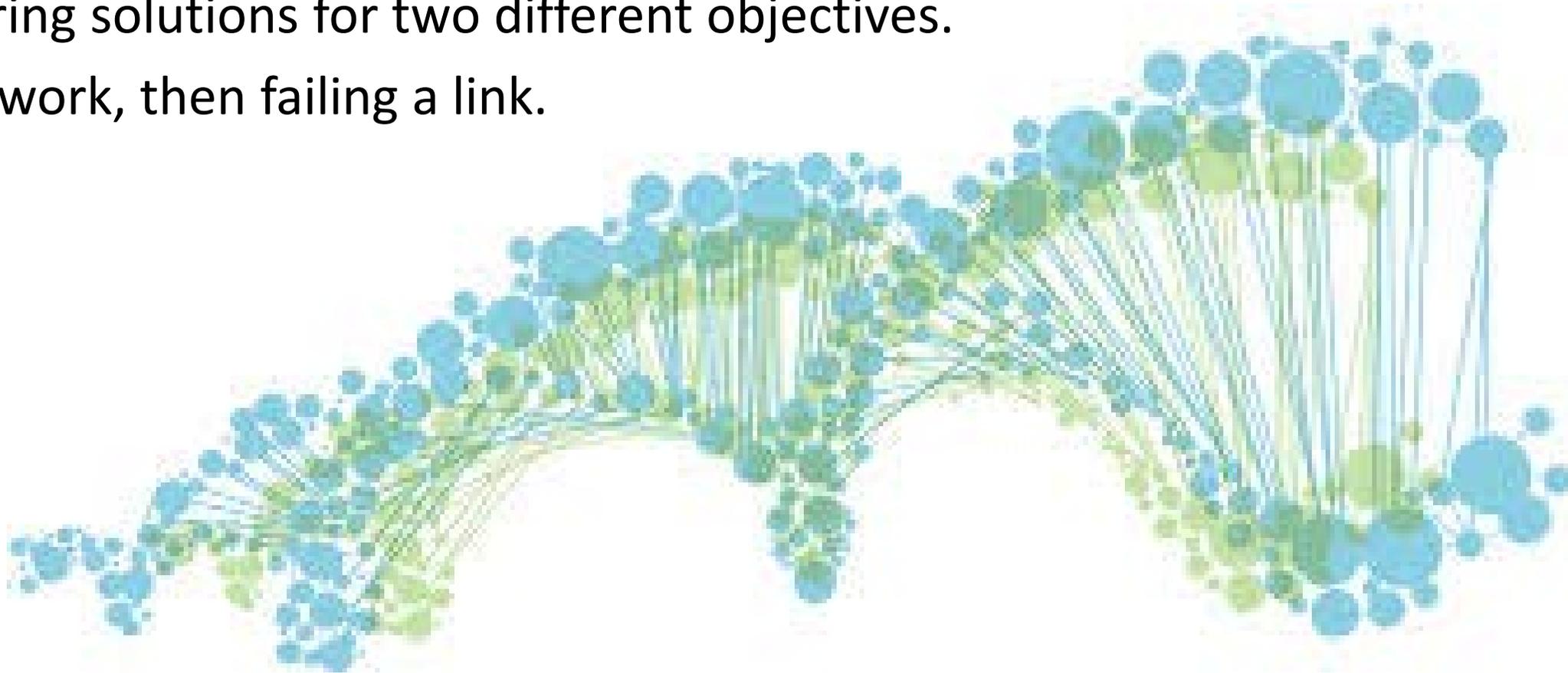
Help me AI; you're my only hope.



- What if the network acted aware (AI-like)?
- Now we have a use case for some of these new ideas and capabilities.
 - networks that can move traffic to not only protect it, but to reduce the risk of another failure impact.
 - networks that can request capacity and repair before they need it.
 - networks that can understand shifts in demand (spike in hosting use), risks from maintenance, or what is needed to support a newly provisioned service (newly hosted app), but let you know what the risk is and minimize that risk.
- We don't need AI or any new technology to do this, but those advantages make it feasible to do more with less.

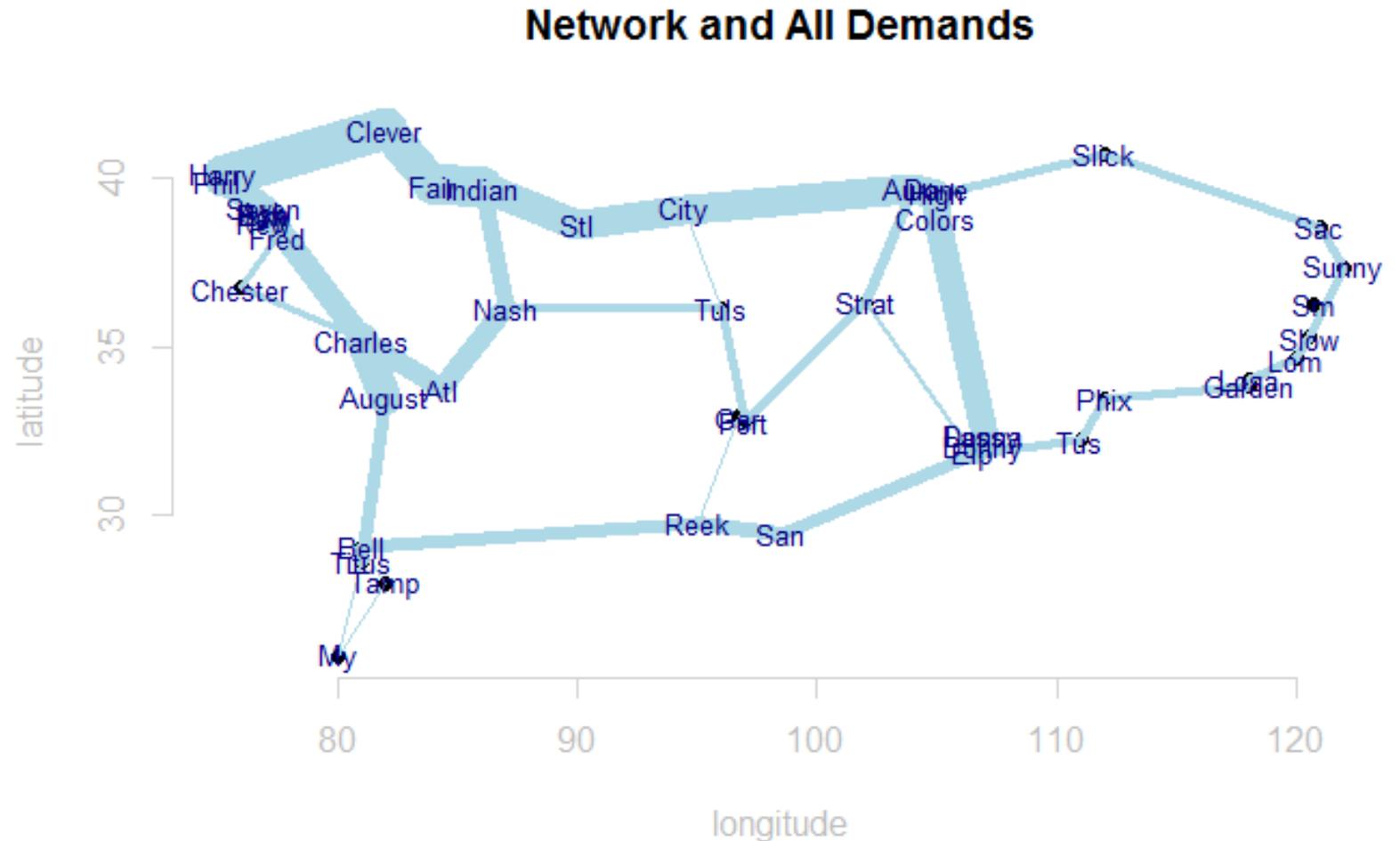
Application

- Genetic Algorithm in the R language.
- Comparing solutions for two different objectives.
- Full network, then failing a link.



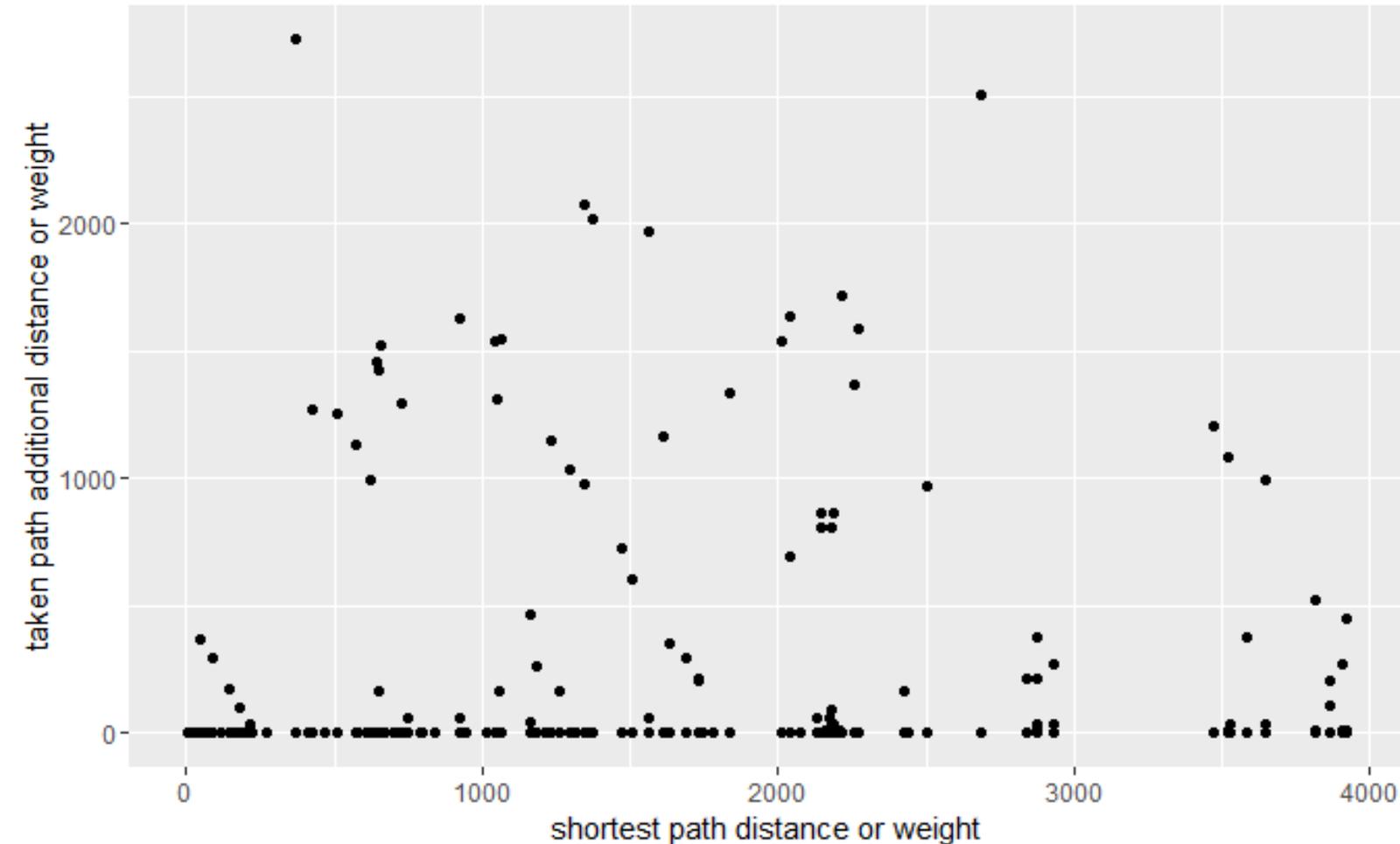
Network favoring shortest path

- Make the distance traveled by demands in total be as short as possible
- Shortest path uses the least capacity
- That is, until you consider protect traffic
- But you still have to try to meet bandwidth constraints



Shortest path favored... but not always met

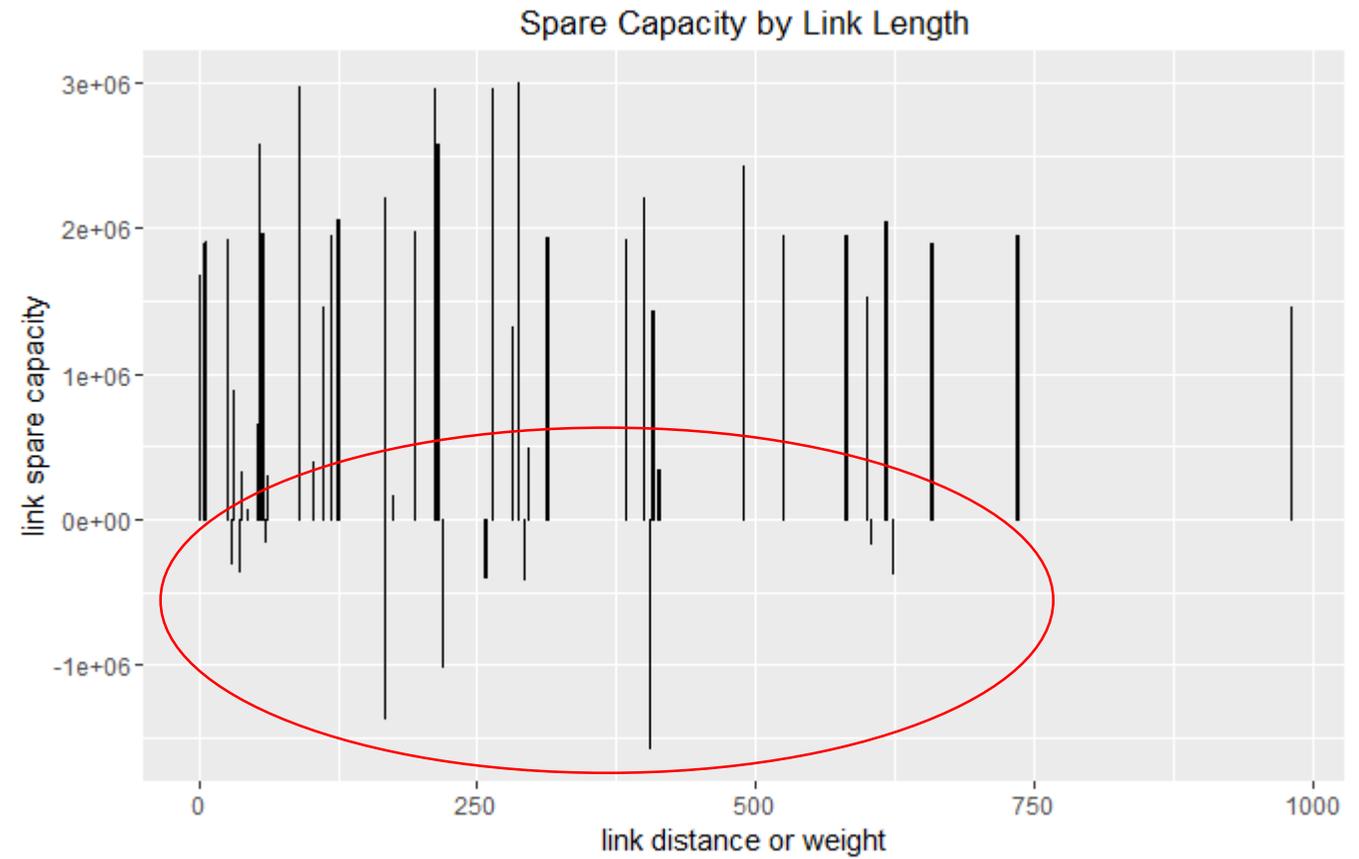
Additional Path Distance by Shortest Path Distance or Weight



- We don't always find the shortest path, because some times we need protect paths to be disjoint

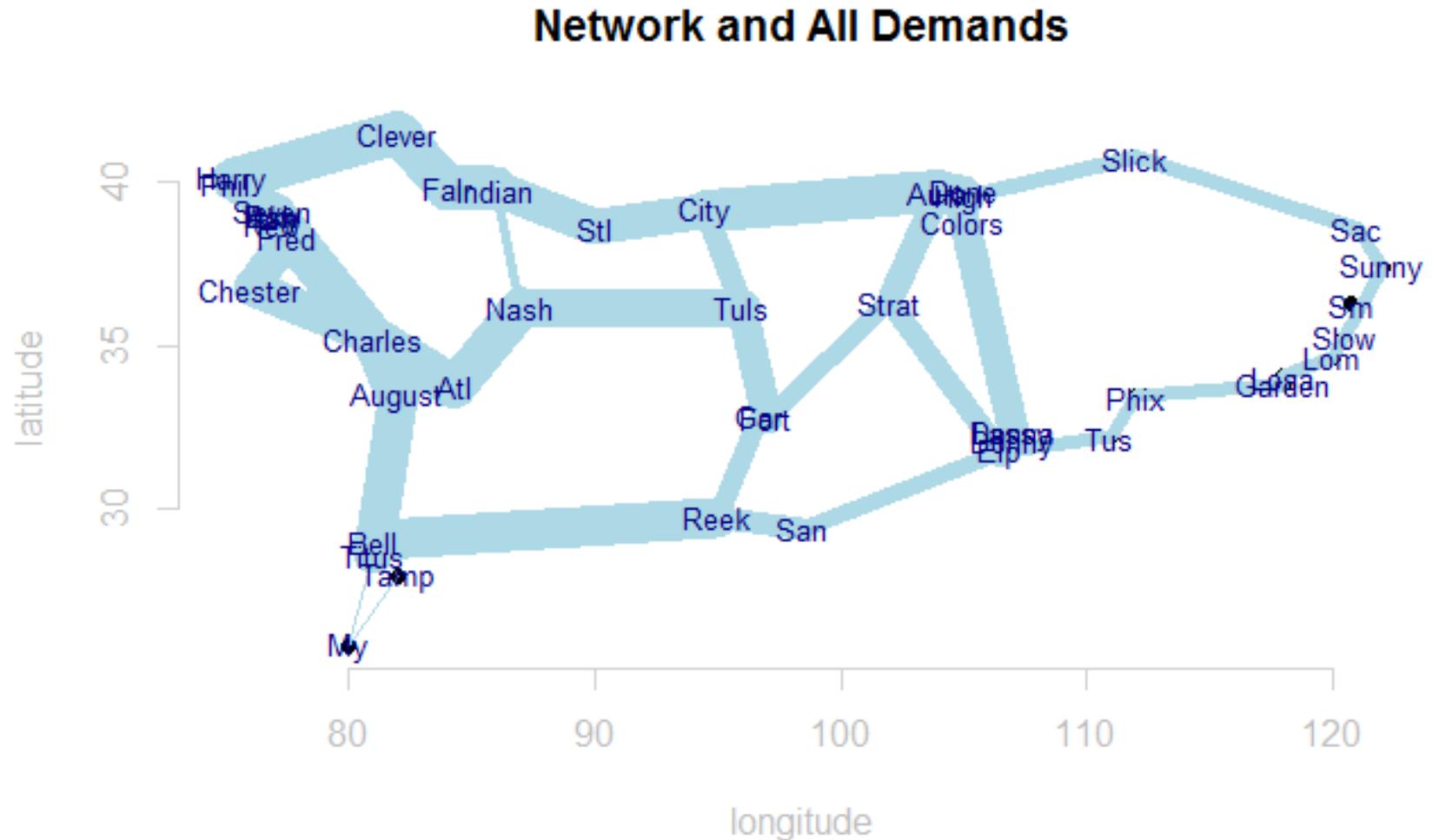
It doesn't always fit

- Some links get over allocated to favor shortest path because the network is oversold, underbuilt.



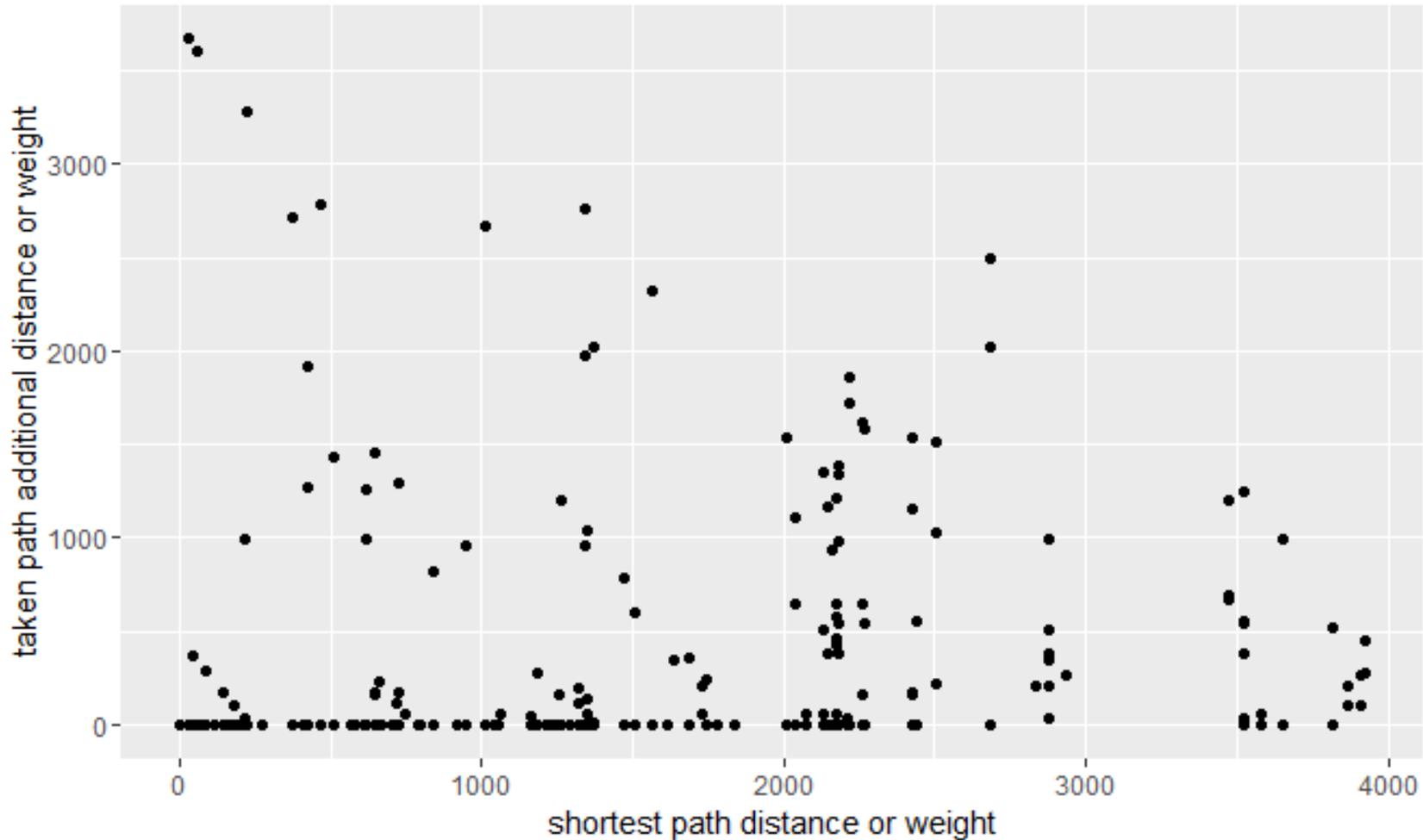
How about a more balanced objective

- Favor shortest path, but stress fitting capacity first



Use what you have, sparingly

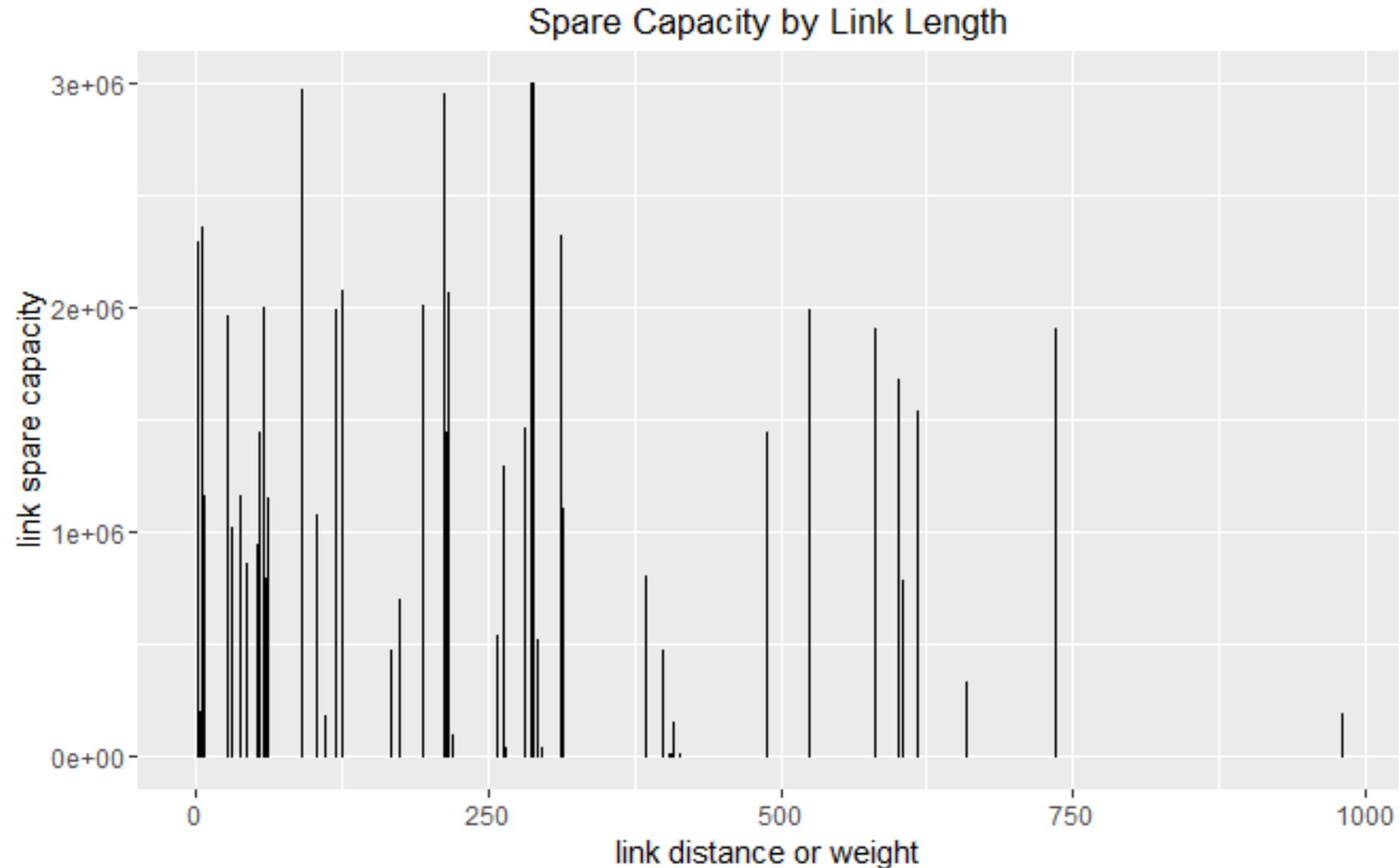
Additional Path Distance by Shortest Path Distance or Weight



- More paths are much longer than shortest path

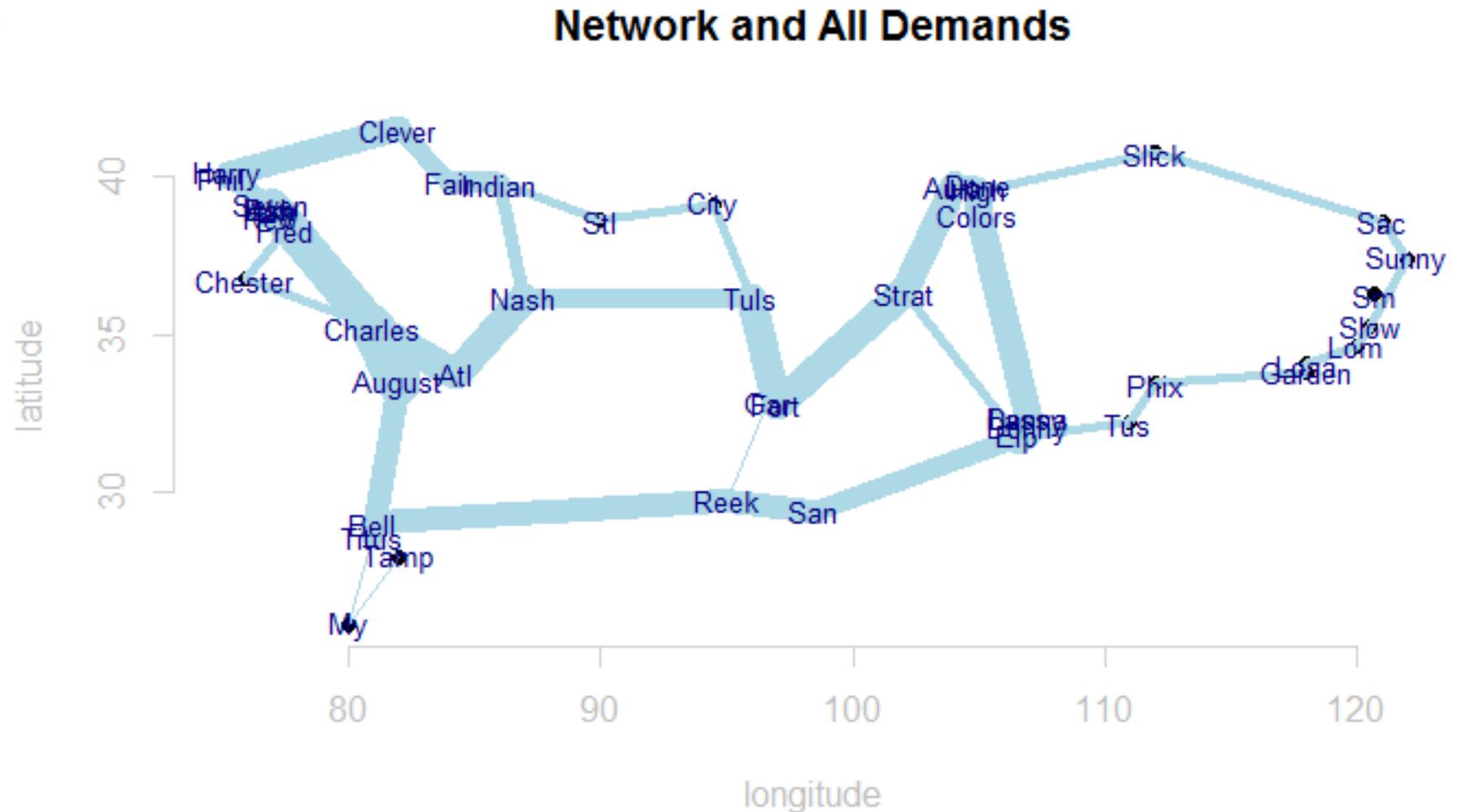
But it fits!

- No negative spare capacity means we can support all our demands on the currently built network



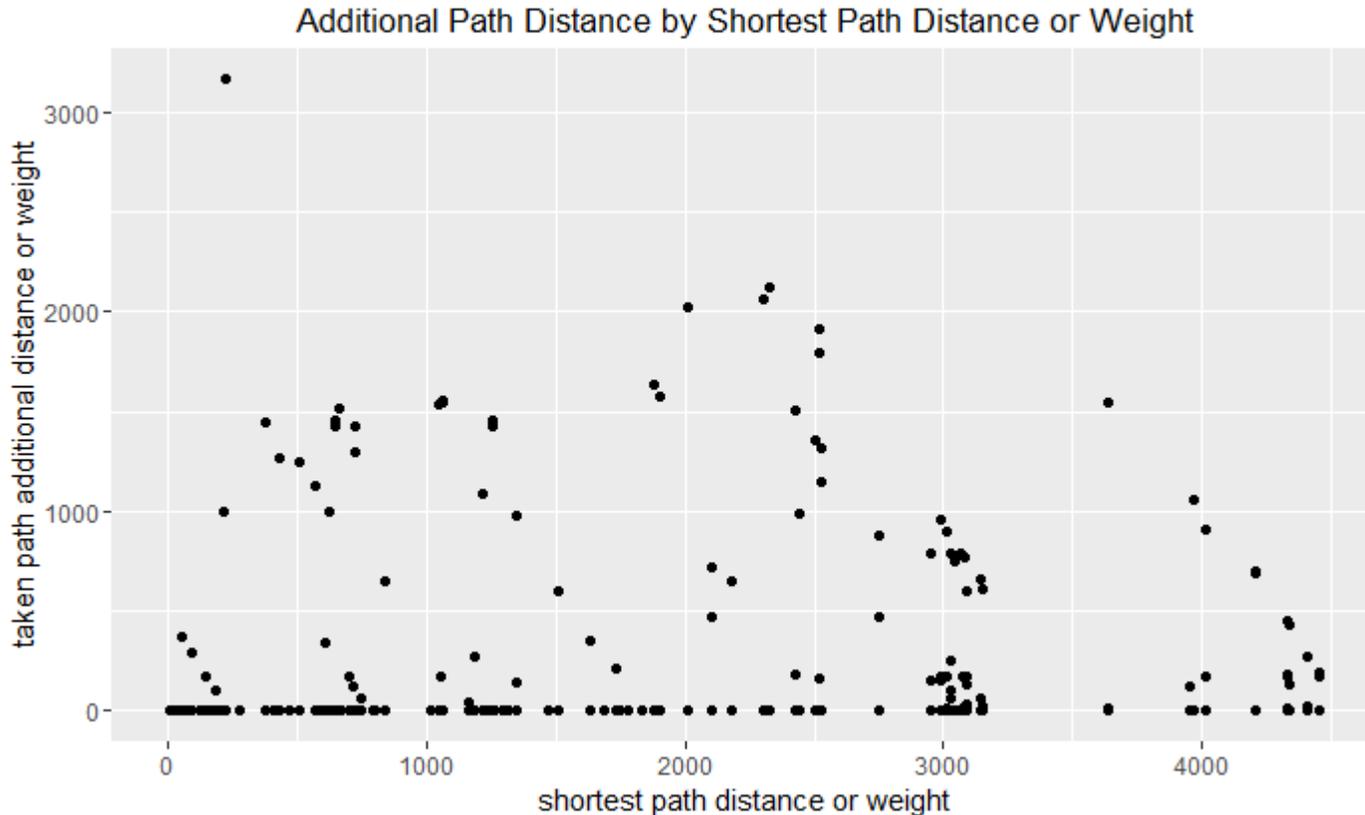
But what if a cable gets cut on the first network design?

- Now we have to reroute a lot of demands



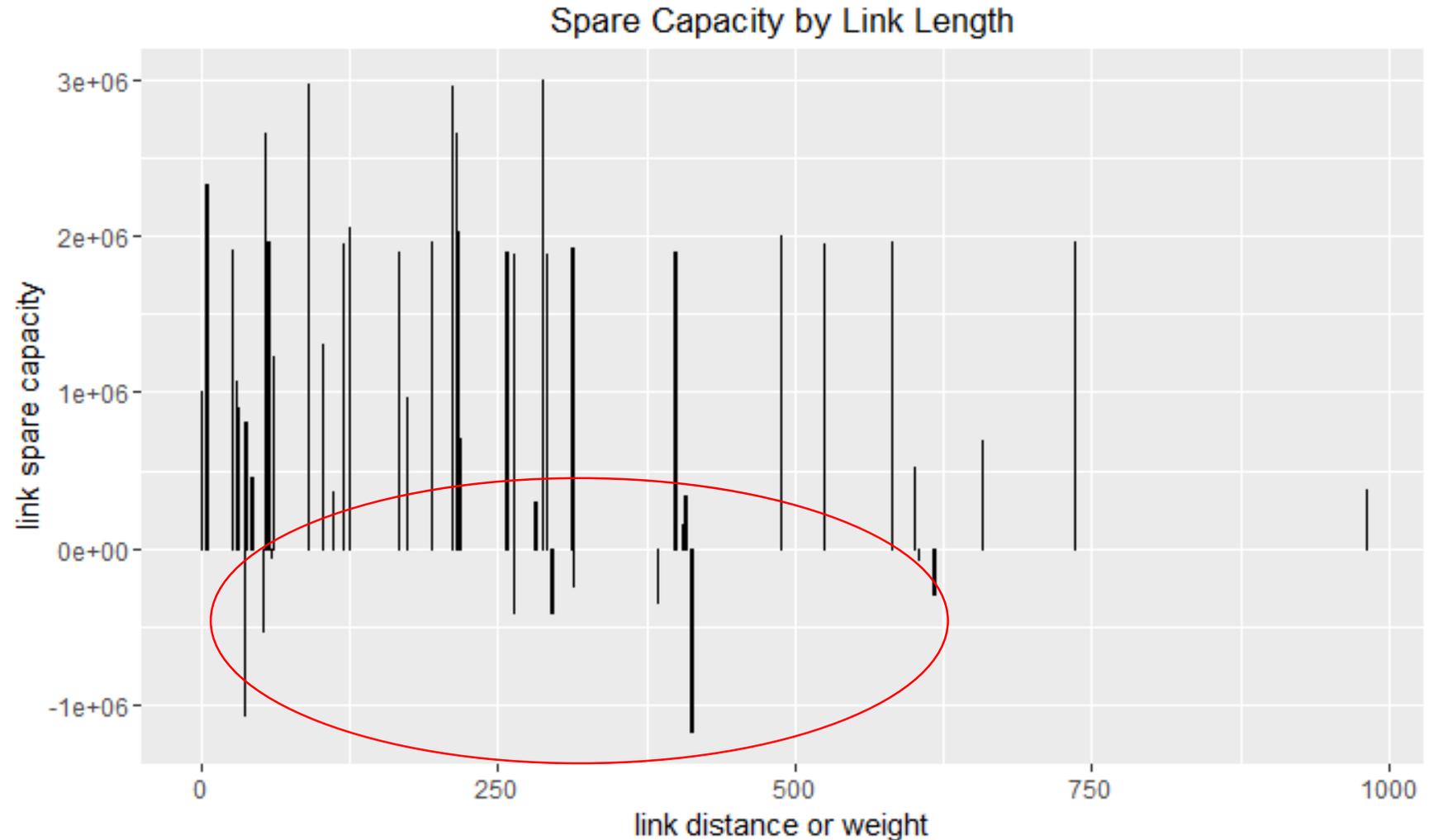
A lot of demands have to go around the cut

- Now we have to reroute a lot of demands



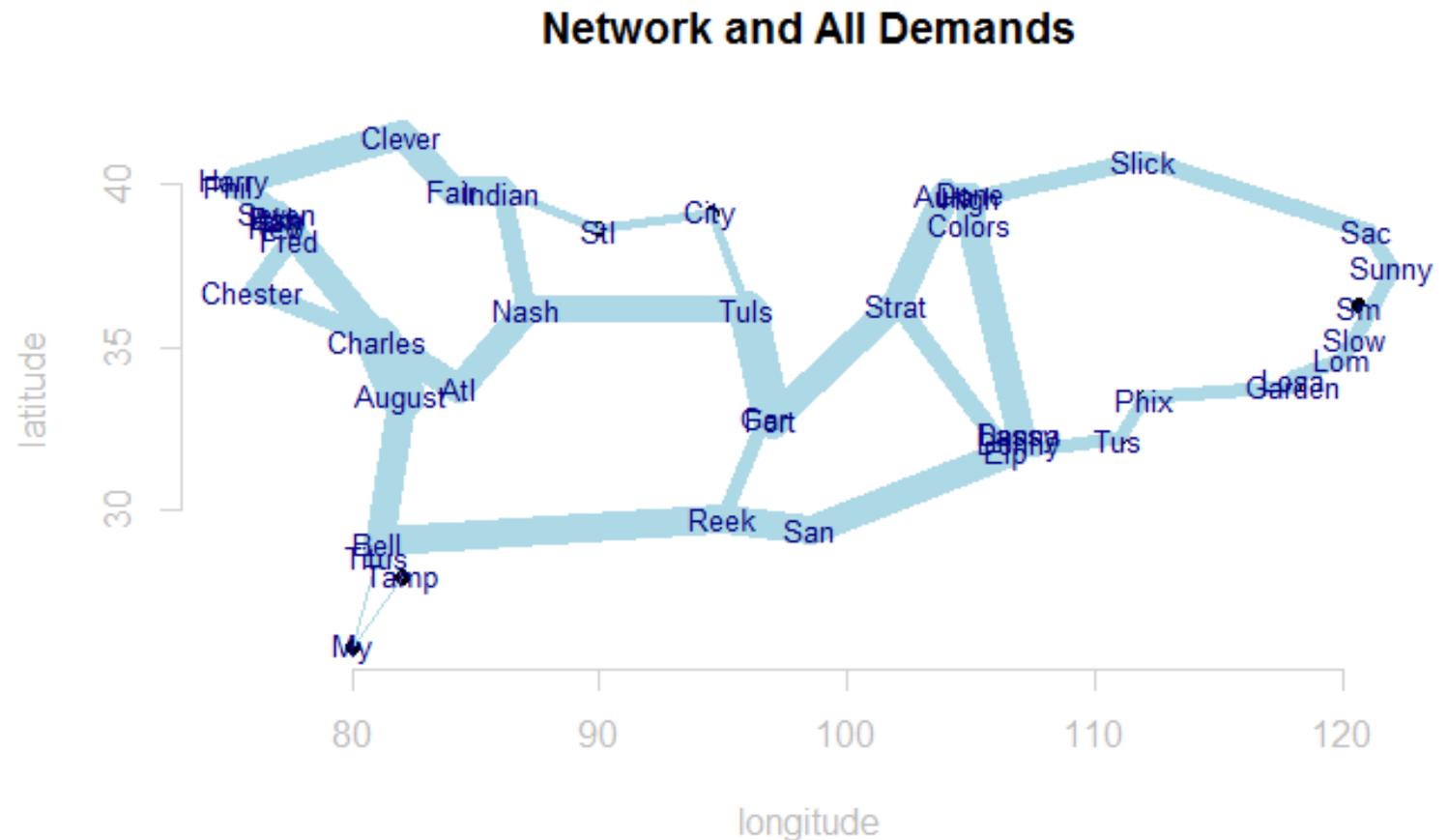
This is not the network you're looking for

- We oversold the network again



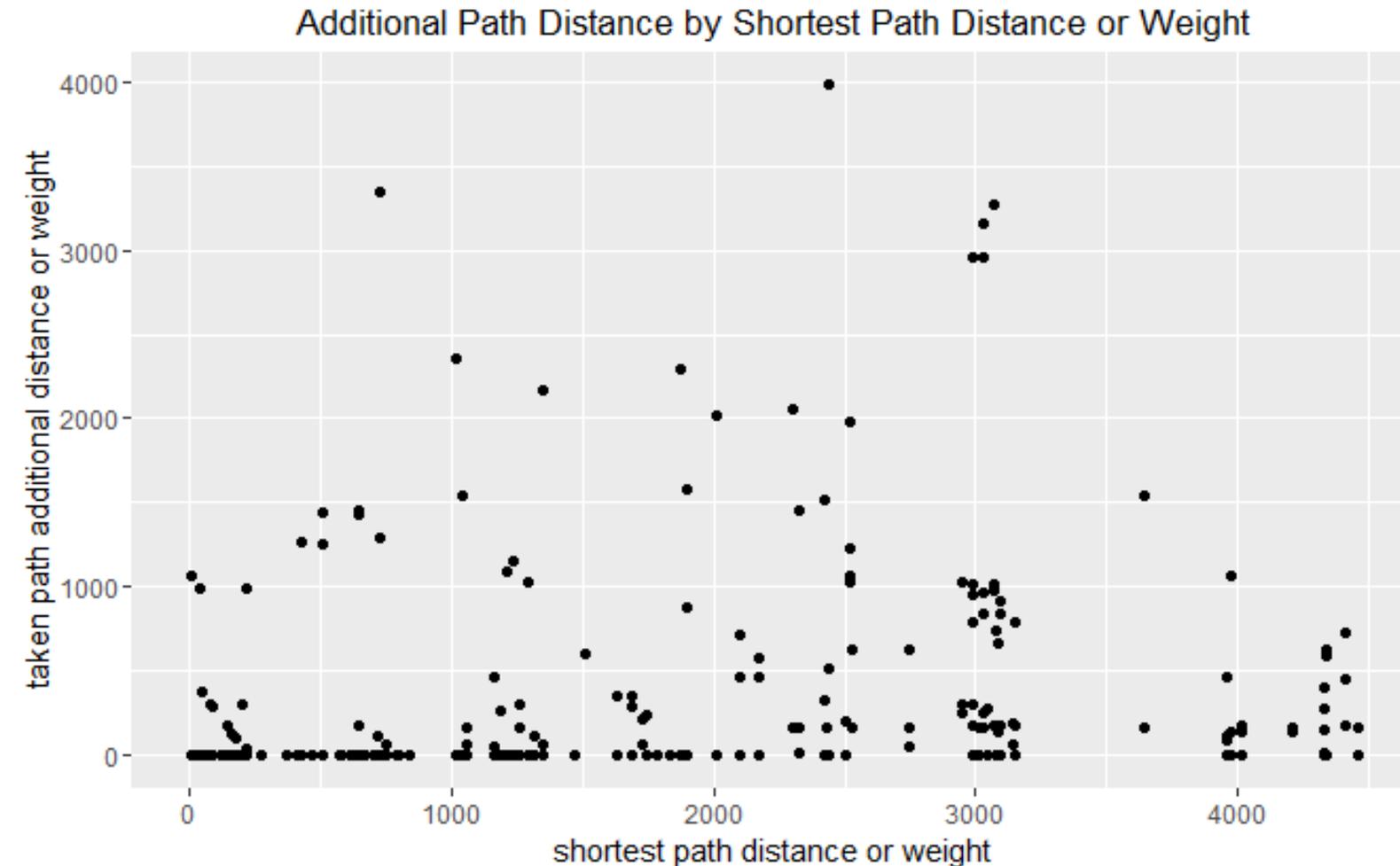
Cutting that same cable on the second design

- Not perfect, but it is more balanced than the other design



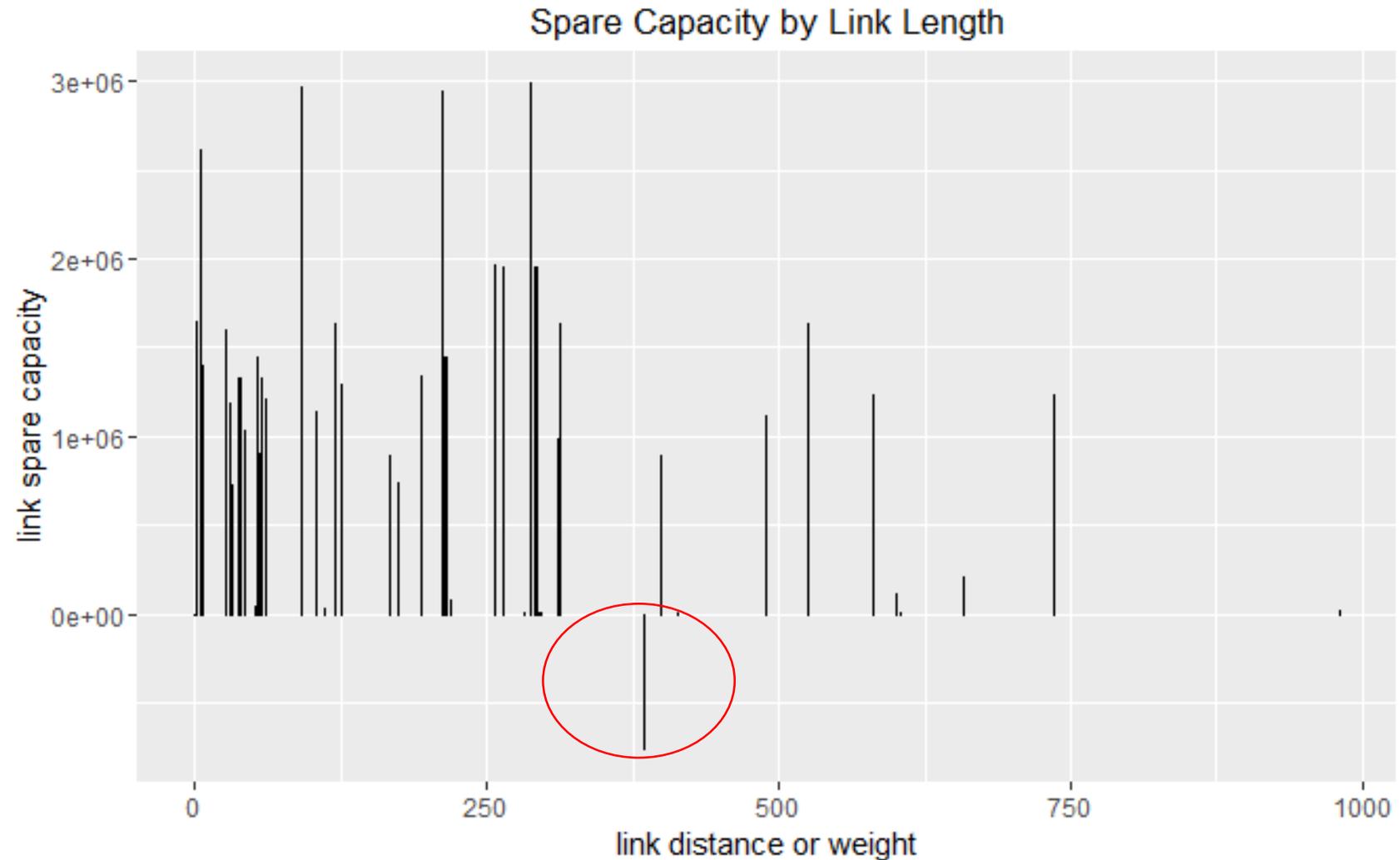
Some of these paths are even longer

- But there are some very long paths, maybe too long for some customers



Almost, but not quite

- We are overallocated on at least one link in the network



What do we know?

- The objective is very important to the network design... so what is the right objective for each customer, for the network, for the ISP?
- If a single failure can make the result not feasible, how do we plan for all possible failures?
- This stuff is not easy. How are we ever going to automate any of this?
 - Automation is now the easy part. How to apply it properly is the problem!
 - How do I translate what I want the network to do into an objective function that the software can understand?

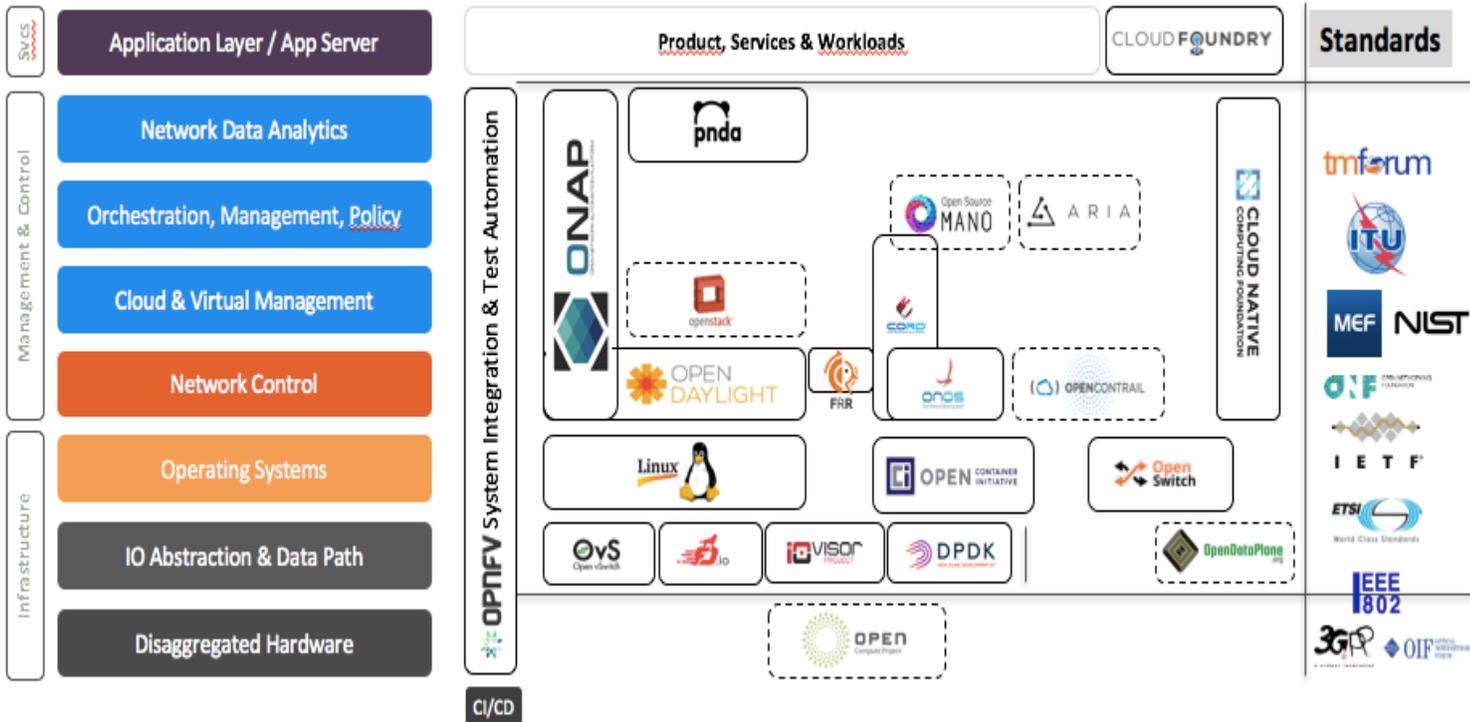
“The force...it binds the galaxy together.”

- We know how to build and run networks, and how to write heuristics and algorithms to find network solutions.
- We now have far more visibility and control of networks.
- The new technology we need to understand and use better is the stuff between: NMS, EMS, BSS, OSS, aka *the force*.
- Software and data mostly, *but it is contextually rich*: real time, high reliability, complex requirements, mission critical!



“There is a difference between knowing the path and walking the path.” - Oh wait, wrong movie, sorry.

Open Source Networking



- Navigating the data stack
- What objectives do we target?
- Roles for operations personnel
- Testing, operating, procurement will be different too

App Example

- A customer needs to use an application for processing data.
- Network controller finds the closest available instance of the app, then decides the best approach based on the context of the request.
- The right elements of application and data meet where the best available hardware resides, potentially redundantly.
- The mission is complete.
- The network logs the event, folds the information into resource forecasts, and periodically moves resources as needed; the network is a cloud, aka fog computing.
- The network also predicts risk:
 - Given current load, what is the risk of a resource contention?
 - Should the network make a request for capacity relief of hardware?
 - Given the failure state of the network, should resources be moved to more robust parts of the network?
- The network doesn't just communicate; it serves.

Given the possible, what is reasonable?

- Move the data to the user, or the user-app to the data? And what about the results?
- Where does the network end and the user or app begin?
- Redundant processing? By redundant, diverse software? From different vendors?
- Networks used to be for communicating, then they became for moving data, and now they are ingrained in our reality.
- In this paradigm, what is the meaning of security and trust? Availability and reliability?

Qualities of a Jedi master

- Knows the network, and how it behaves: rich in context knowledge
- Must be very good with software and data
- Can model the data and the network
- Still has to be a good engineer too
- Can be obtained through effective communicators with some of these qualities working together



Exploding Developments

- Condition and risk indication mechanisms
 - Analytics
 - Pervasive monitoring
 - Supported by applied mathematics to determine signal from noise, actionable from just curious
- Precomputed solutions
 - Modeling
 - Prediction
 - Heuristics
- Network Action
 - Intelligence (including AI, and more)
 - Mix of automated and manual
 - Risk-based decision

Revenge of the Sith: some challenges remain

- Decisions still have to be made, and translated into action
 - How far do we trust automation, and how far do we push that into the network, now that these things are possible?
- How should the network be designed?
 - What are the right objectives?
 - What do we want a network to do for us?
 - Do we even have the right language for designing networks?
- How should the network respond to events, risks, etc.?

The End...?

