

Networking for research

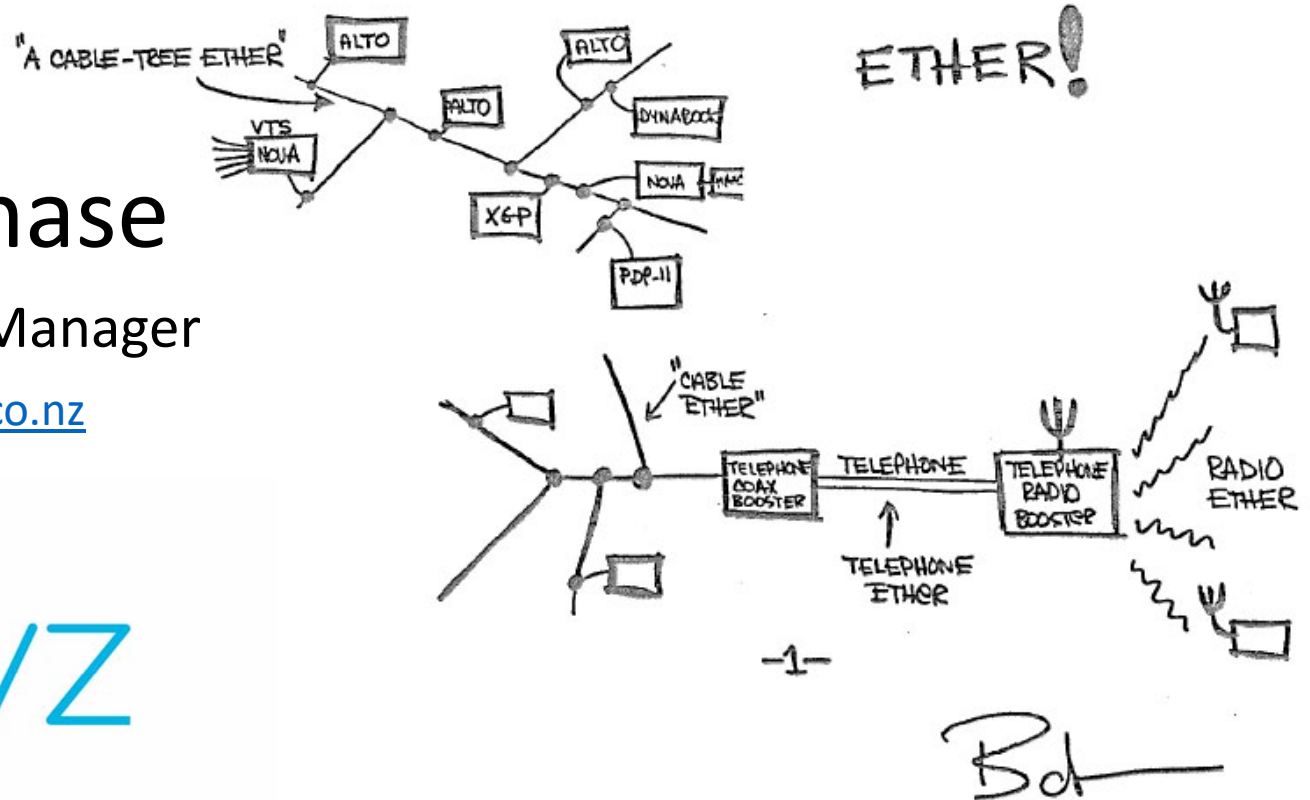
# Wallace A. Chase

Technical Engagement Manager

[wallace.chase@reannz.co.nz](mailto:wallace.chase@reannz.co.nz)

 @bmtfr

## REANNZ











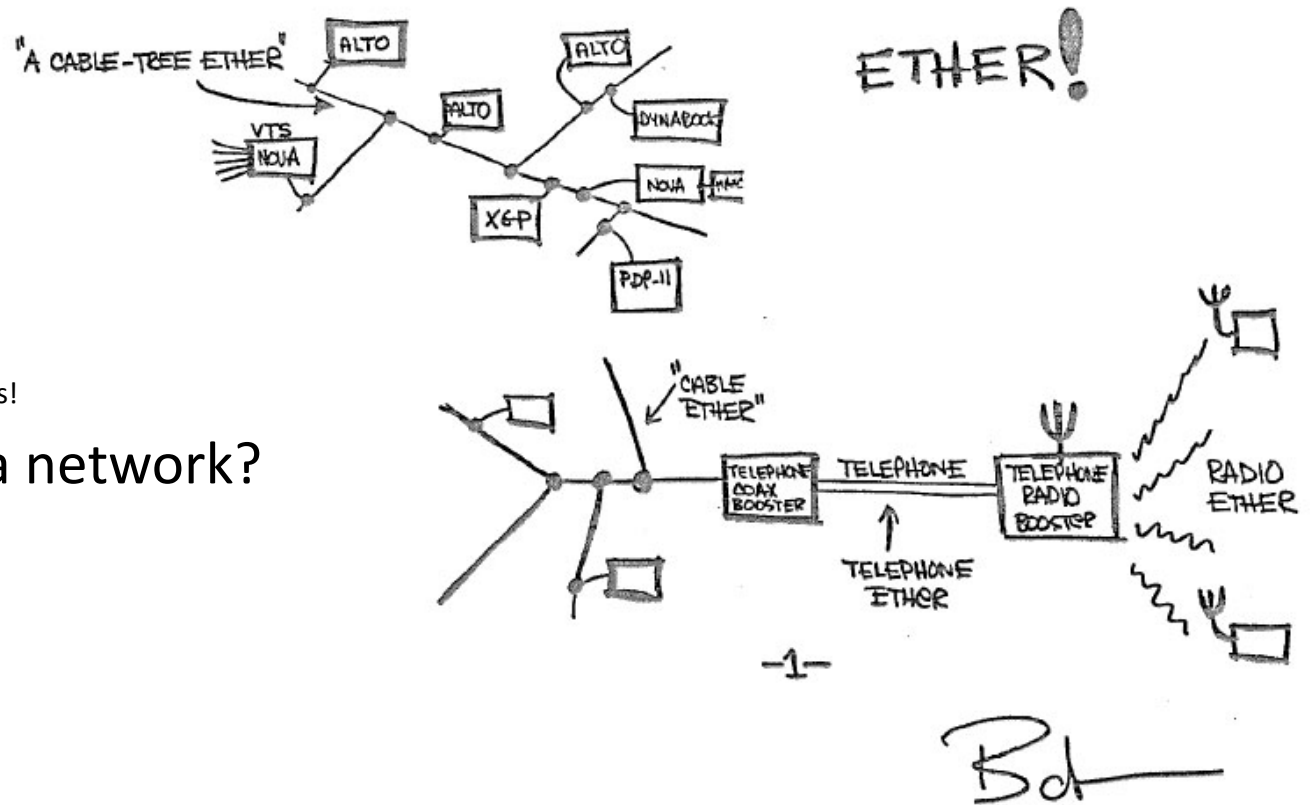




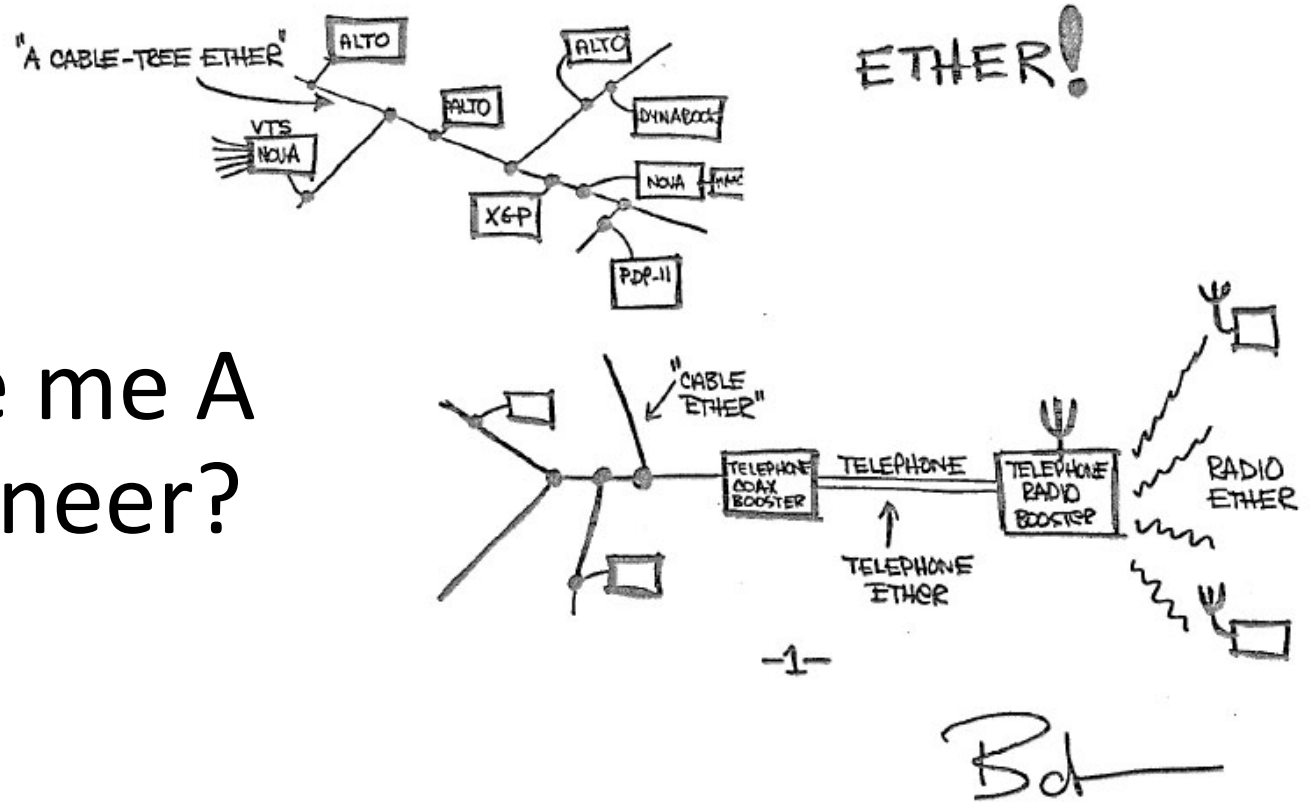




- What is an R&E network?
  - Returning by popular demand – velociraptors!
- Why isn't a network just a network?
- Specialization
- Build yourself a picture

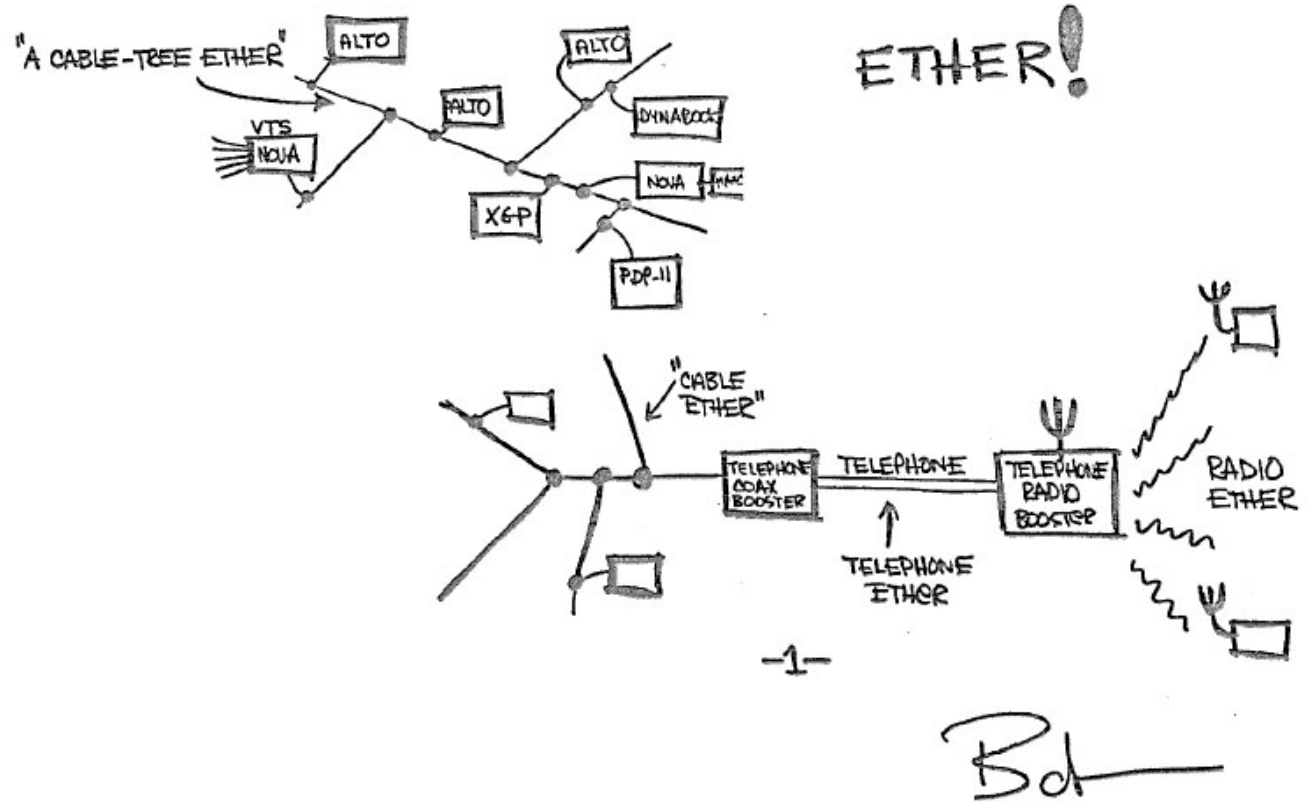


Will this make me A  
Network Engineer?

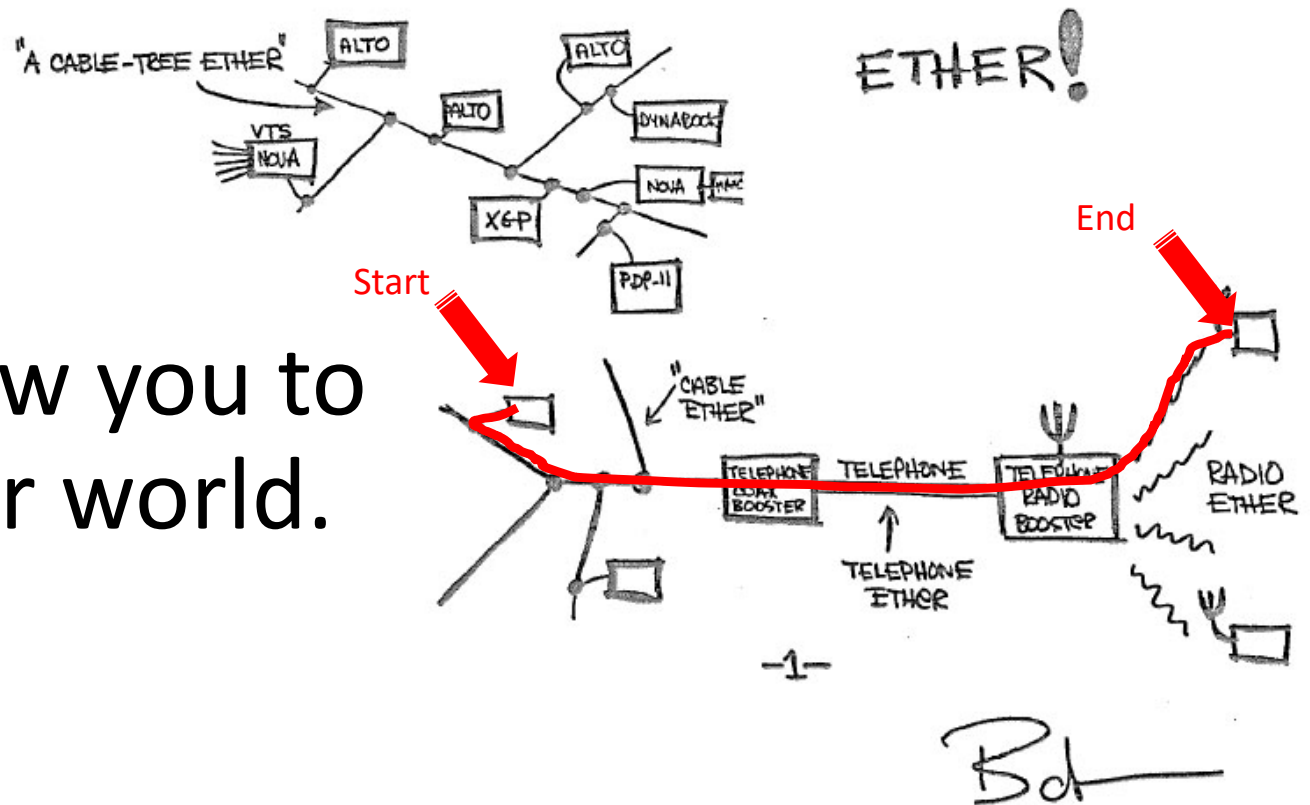




No.



But it will allow you to  
navigate their world.

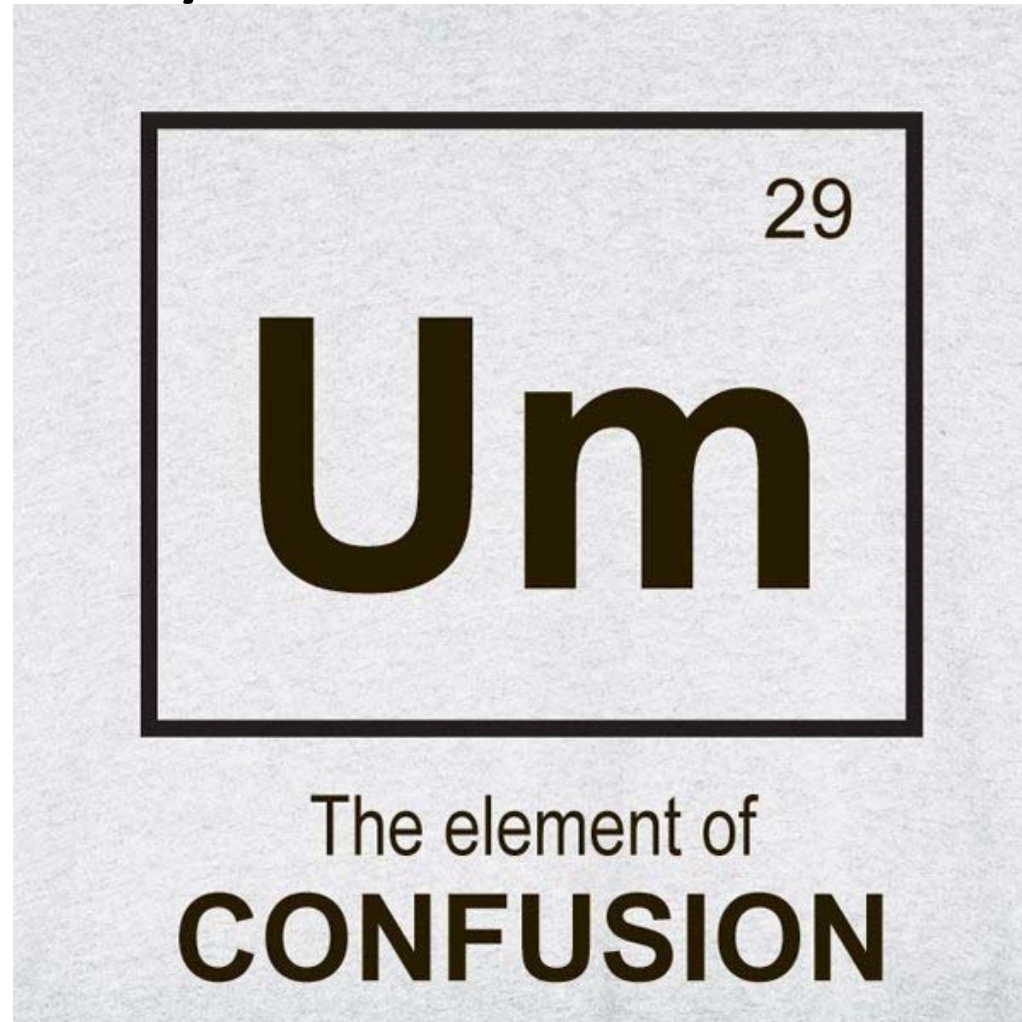




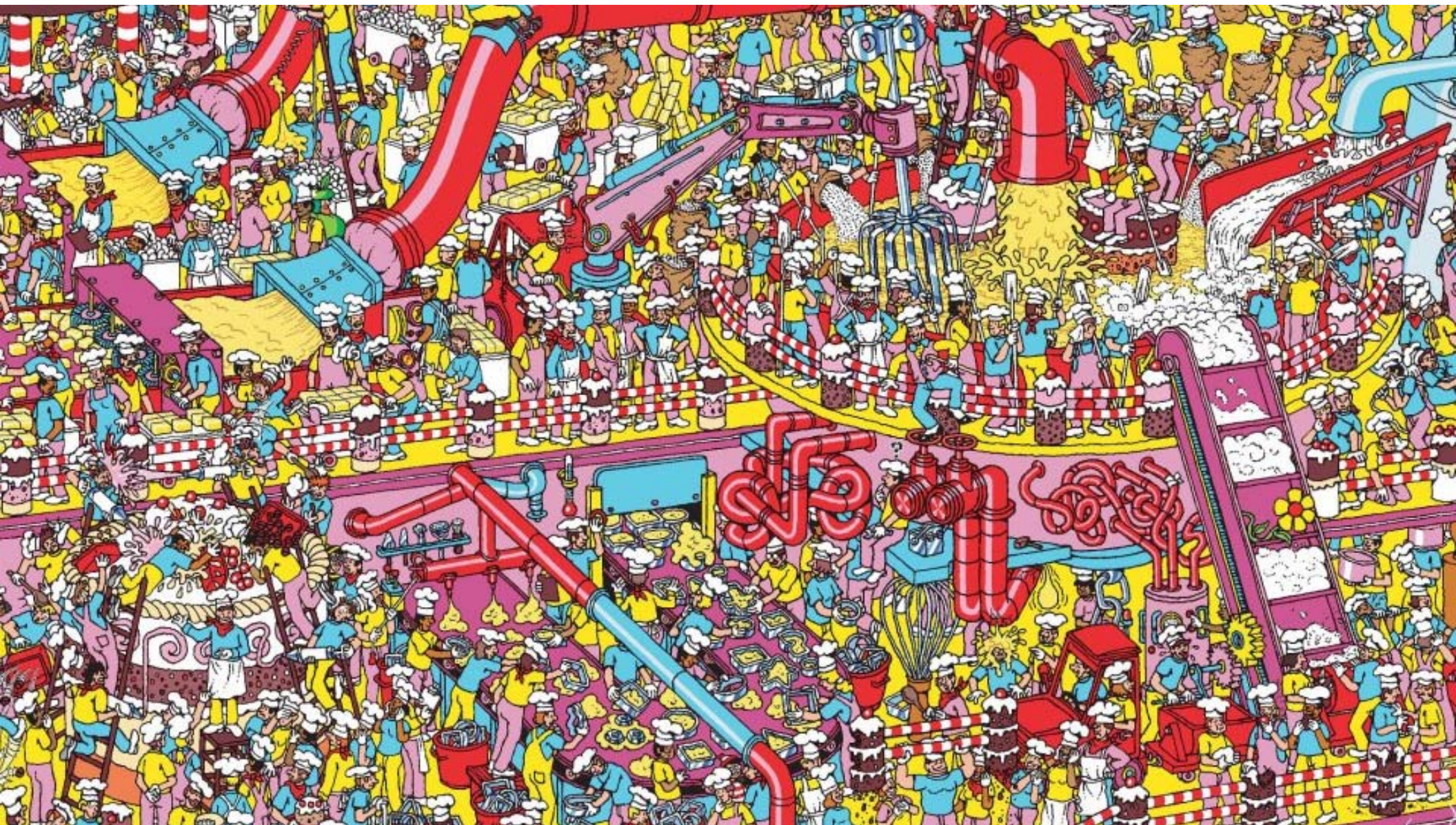
Maybe even understand  
them...



But why do I need to know this?









So what makes this so complex anyway?



# Commodity/commercial Networks



But they go  
about it in  
different ways...

They both eat  
the leaves...





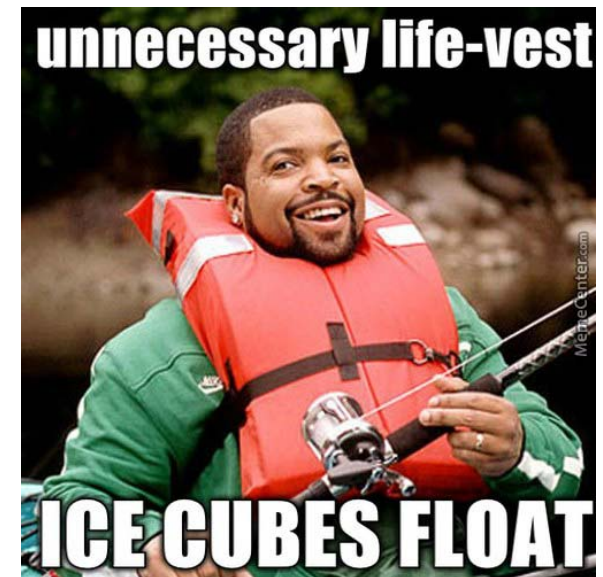


# Commodity/commercial Networks



# Commercial Networks

Works great for traffic such as



So why do commercial networks work well for this?



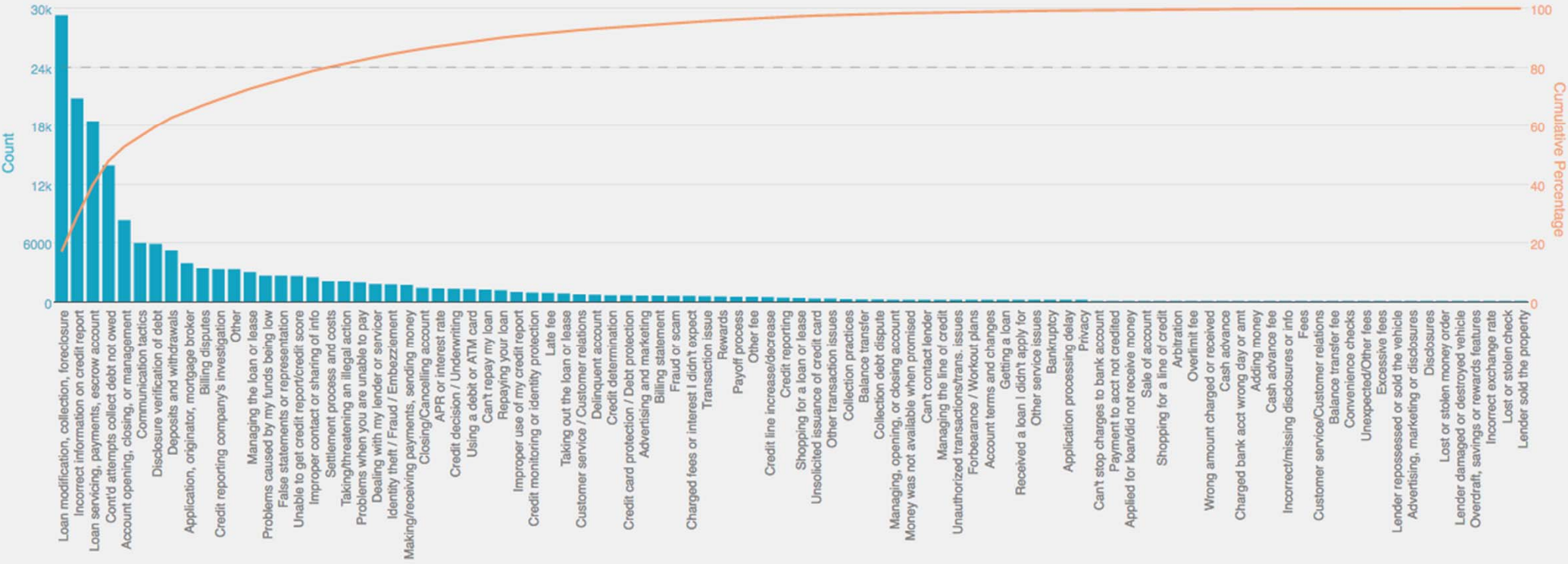
 tastefullyoffensive

Further proof that cats are liquid. (via jabbathechav)



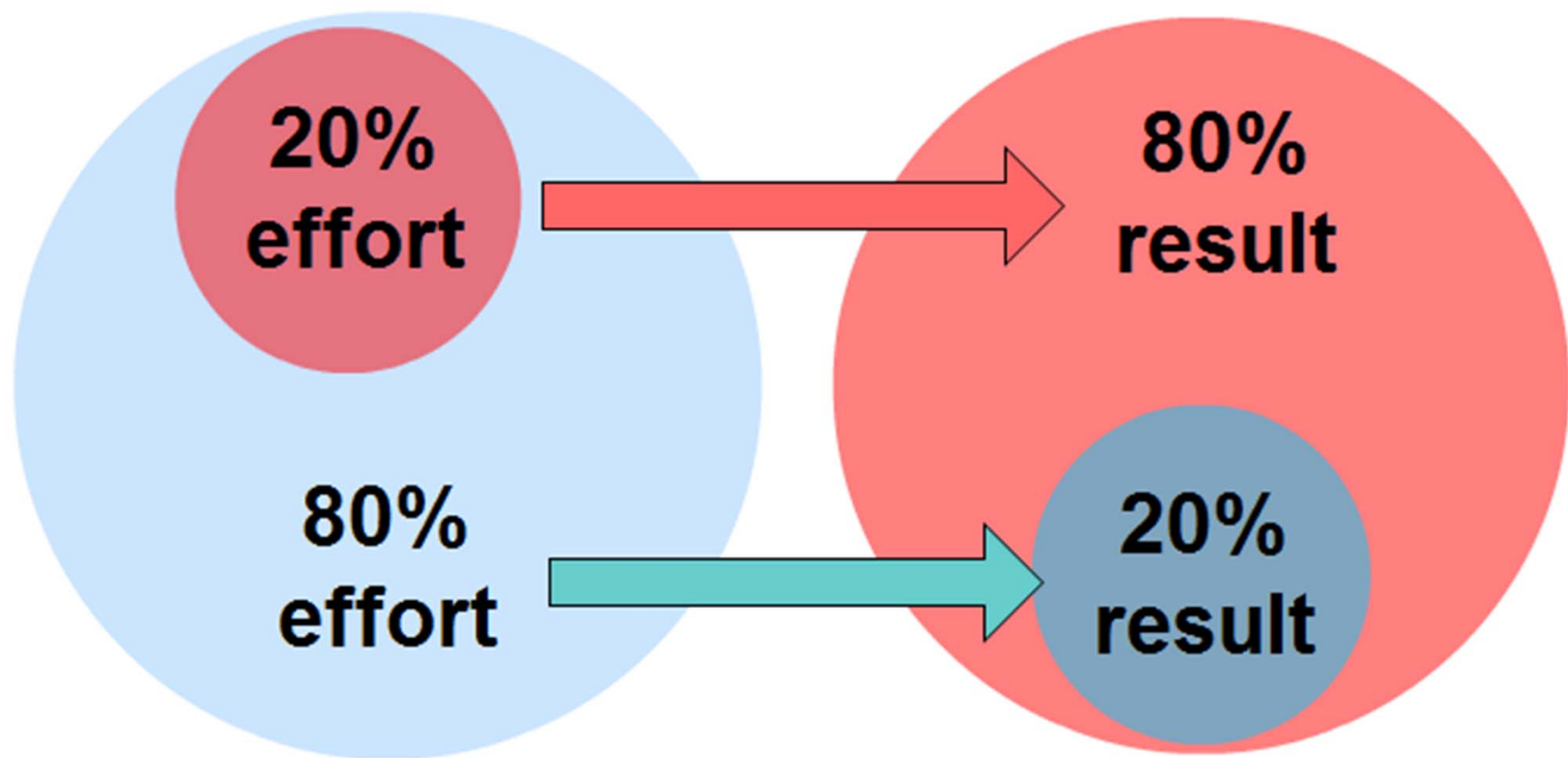
Consumer Financial Protection Bureau: Consumer Complaints

Count  
Cumulative Percentage  
80%



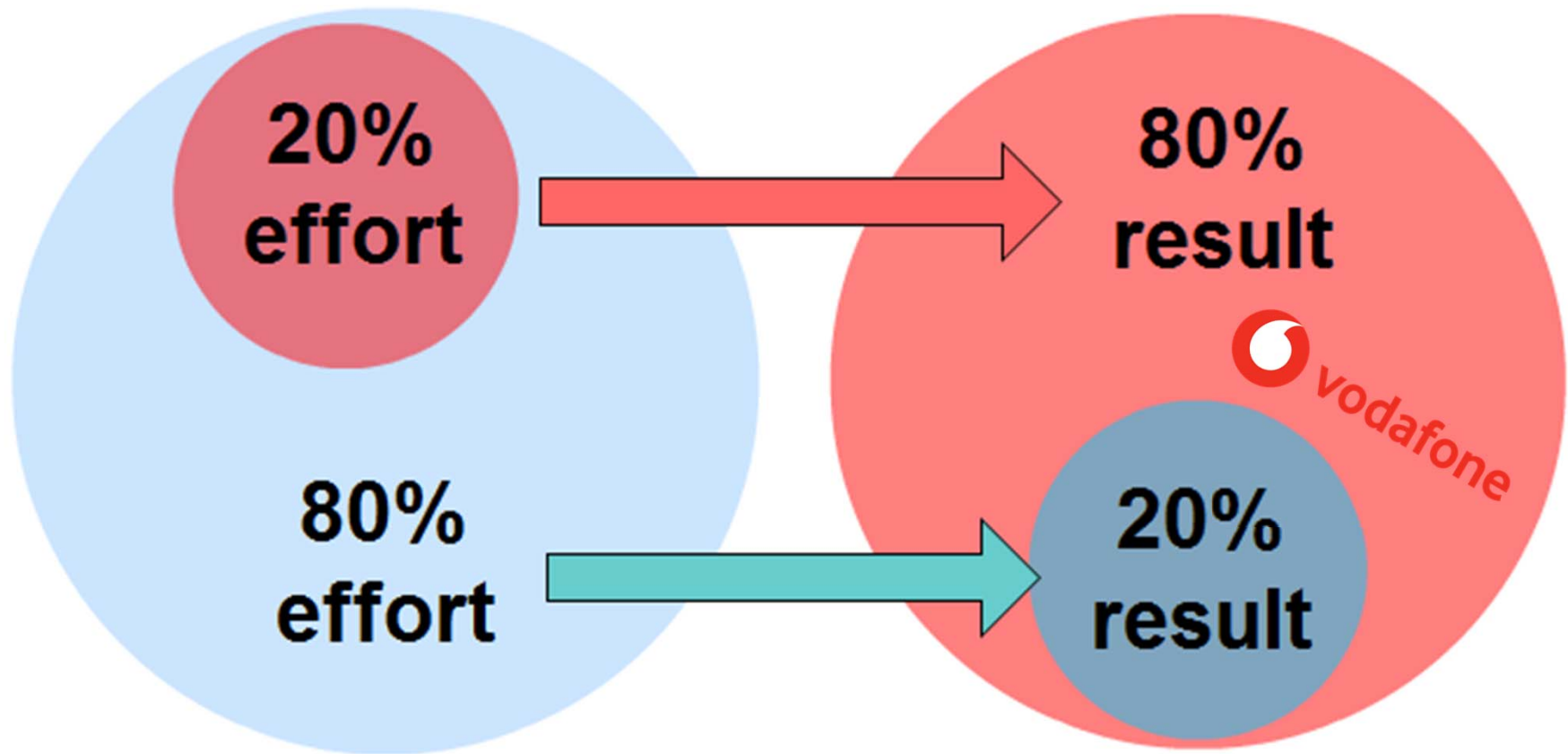






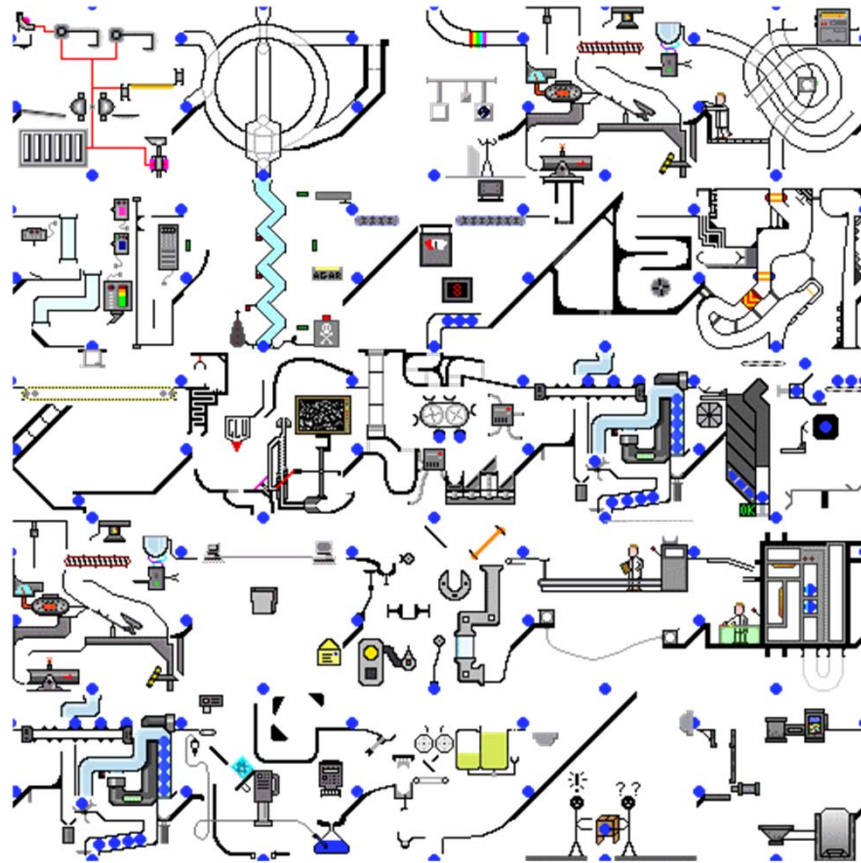


## Commercial Networks

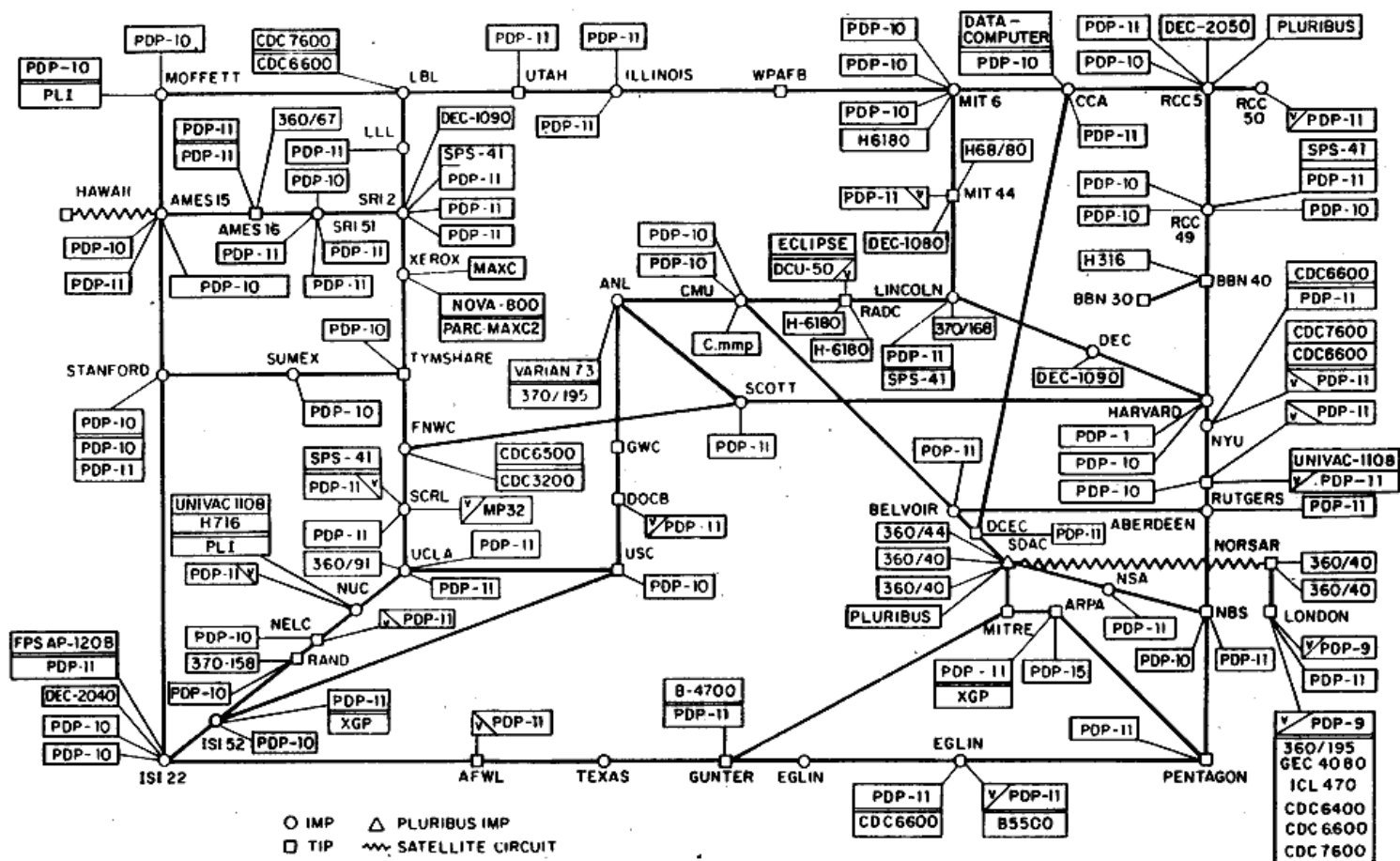


REANNZ

Now to the technical reasons...



# ARPANET LOGICAL MAP, MARCH 1977



(PLEASE NOTE THAT WHILE THIS MAP SHOWS THE HOST POPULATION OF THE NETWORK ACCORDING TO THE BEST INFORMATION OBTAINABLE, NO CLAIM CAN BE MADE FOR ITS ACCURACY)

NAMES SHOWN ARE IMP NAMES, NOT (NECESSARILY) HOST NAMES



The goal was to exploit new computer technologies to meet the needs of military command and control against nuclear threats, achieve survivable control of US nuclear forces, and improve military tactical and management decision making.

Stephen J. Lukasik



Lukasik, Stephen J. (2011). "Why the Arpanet Was Built". *IEEE Annals of the History of Computing*. 33 (3): 4–20. doi:[10.1109/MAHC.2010.11](https://doi.org/10.1109/MAHC.2010.11)

The image features a dark, curved horizon of a globe at night, with the Earth's surface showing city lights and landmasses. Overlaid on this is a complex, glowing blue network of lines and nodes, resembling a global communication or data network. The lines connect various points across the globe, creating a web-like structure. The overall color scheme is dominated by deep blues and bright, glowing blues, with the city lights providing a warm, yellowish-orange contrast.

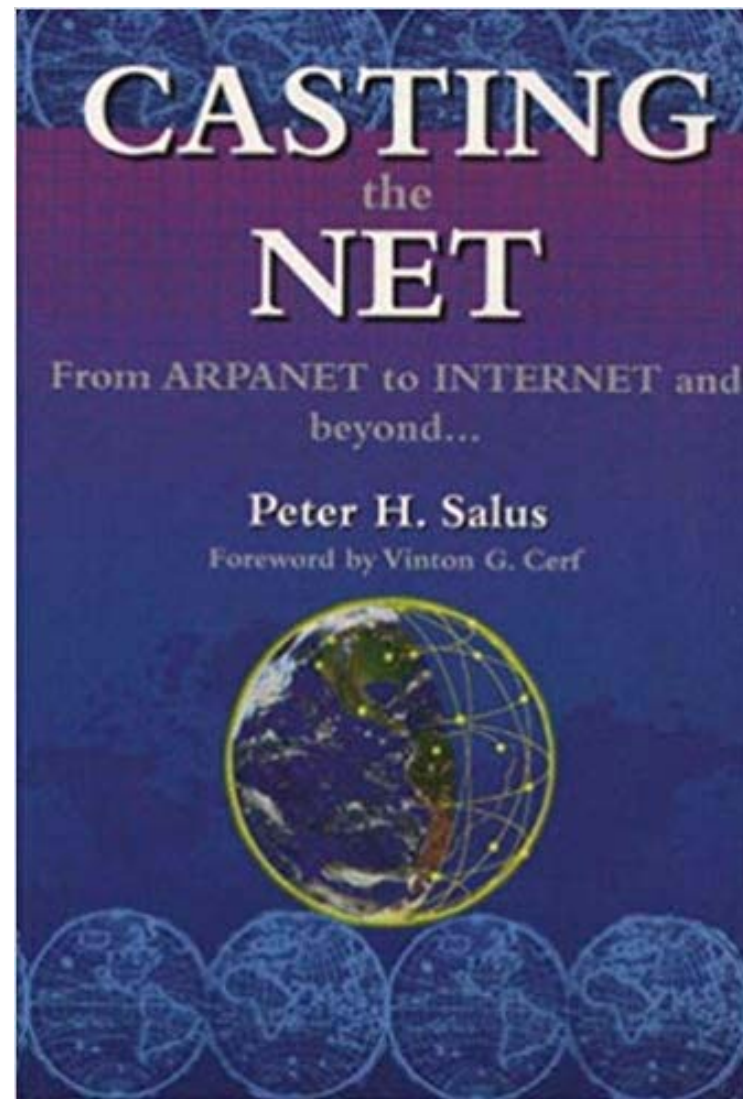
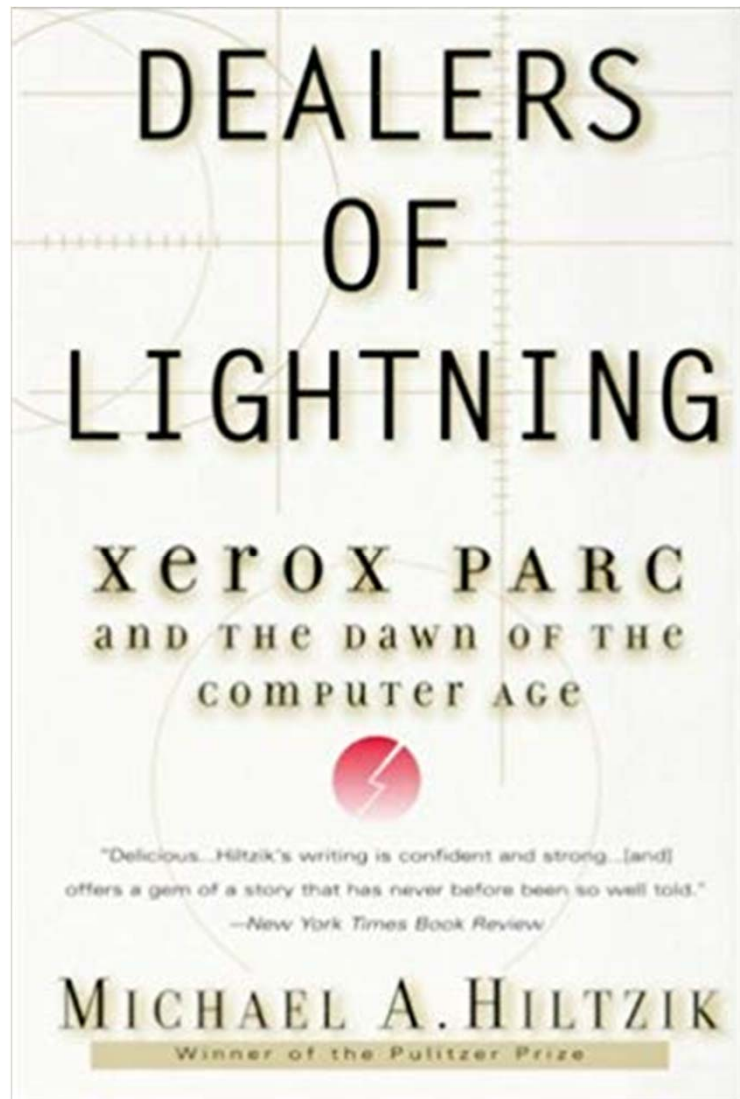
Autonomous systems, interconnecting using  
standardized protocols...





<https://media.kasperskydaily.com/wp-content/uploads/sites/92/2015/11/06023824/internet-map-FB.jpg>





- ISBN-10: 9780887309892
- ISBN-10: 0201876744

# Commodity/commercial networks

## The good

- Great for “normal” traffic
- Resilient by design
- Can move lots of “small” things moving around
- Great if what you are doing is accessing and on a CDN (Content Delivery Network)
- Available almost everywhere

## The not so good

- Not at all optimized for large flows
- Can be very expensive at scale
- **Often sub optimal routing and peering for point to point research traffic**
- Throttling , queuing, traffic shaping destroy throughput (and “they” don’t care)
- Commodity networks assume, and are designed for, “lots of small stuff”
- High speeds are not always available, or cost effective (10G, 40G, 100G)
- **If you have issues, good luck getting help**

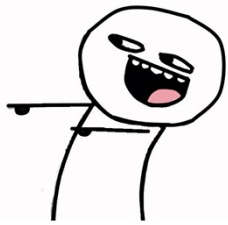
Lets take a smaller network and use as an example of this issue...



# The academic network

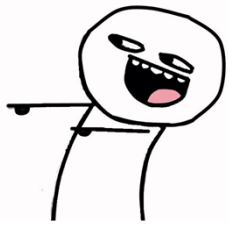


# What makes up an academic network?



Student  
access

# What makes up an academic network?



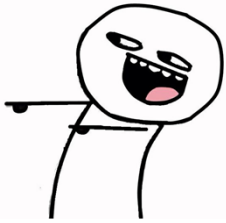
Student  
access



Intellectual  
Property



# What makes up an academic network?



Student  
access

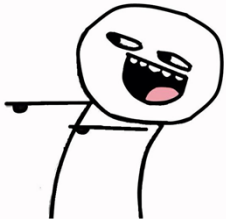


Intellectual  
Property



Payroll &  
Accounting

# What makes up an academic network?



Student  
access



Intellectual  
Property

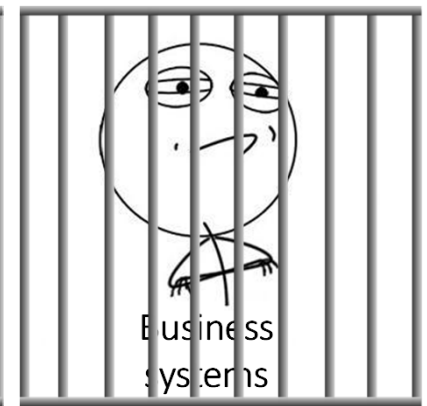


Payroll &  
Accounting



Business  
systems

# What makes up an academic network?

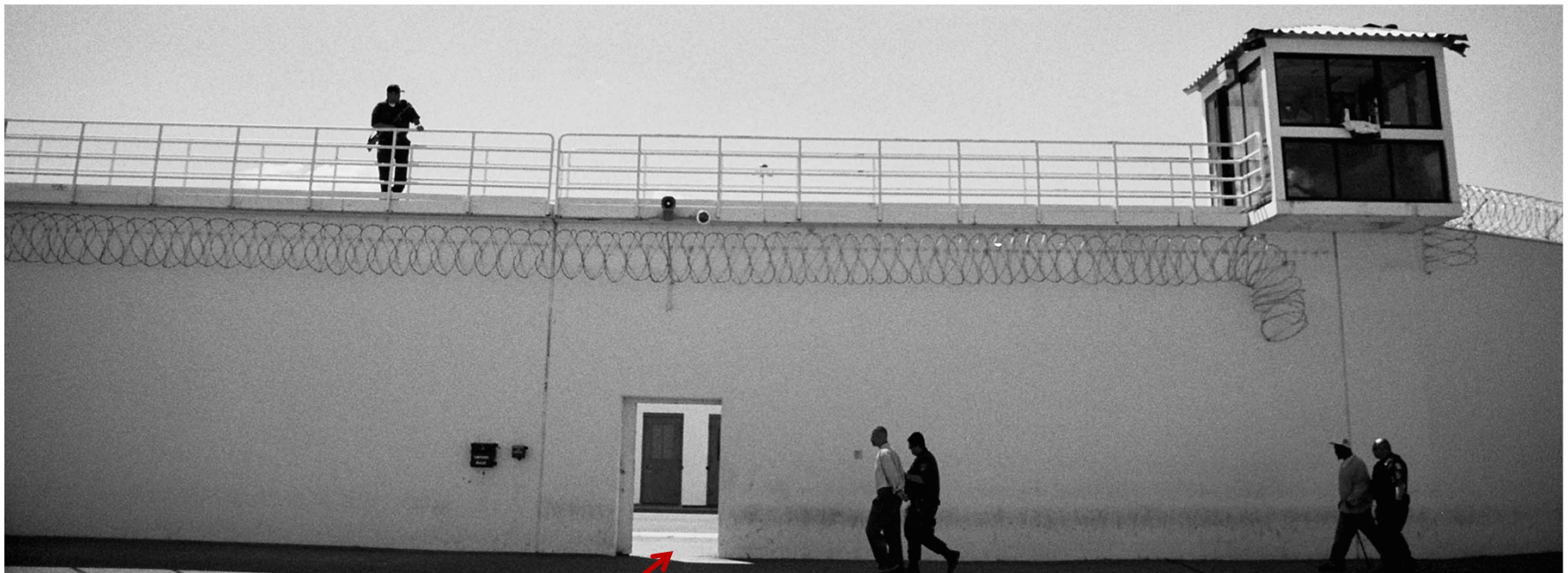




The academic network...



The academic network...



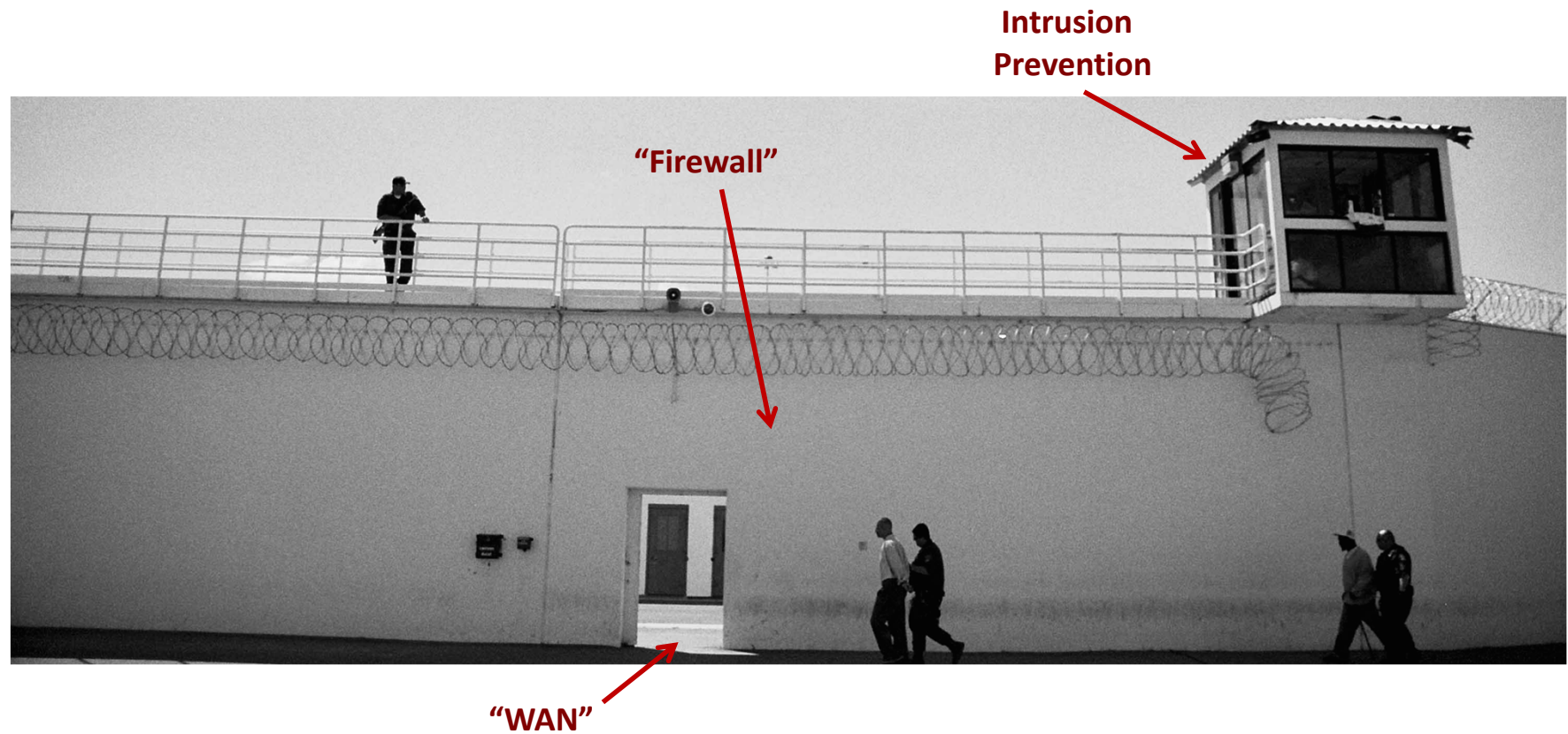
“WAN”

# The academic network...





# The academic network...



# The academic network...

Bureaucracy  
(aka "Paperwork")

Intrusion  
Prevention

"Firewall"

"WAN"



# CAUTION

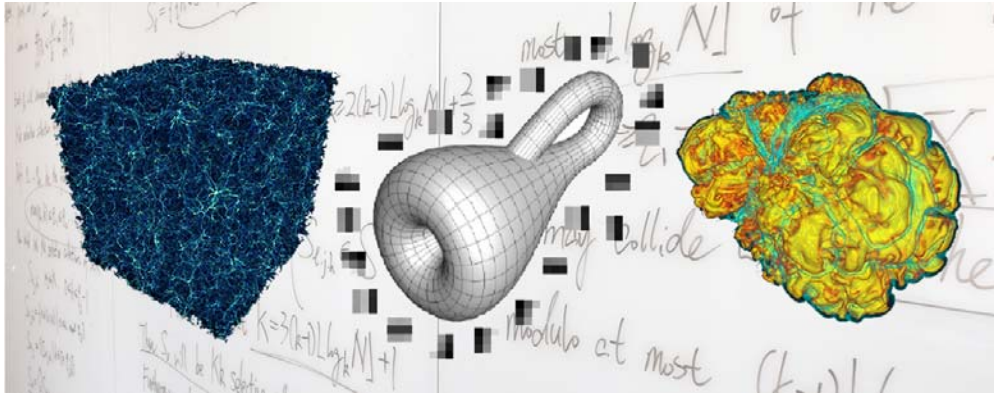
## ANALOGIES AHEAD

PROTECTIVE HEADGEAR MUST BE WORN IN THIS AREA

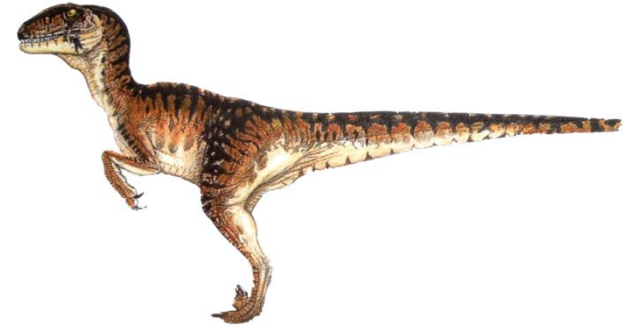




# Data Intensive Science, an analogy...

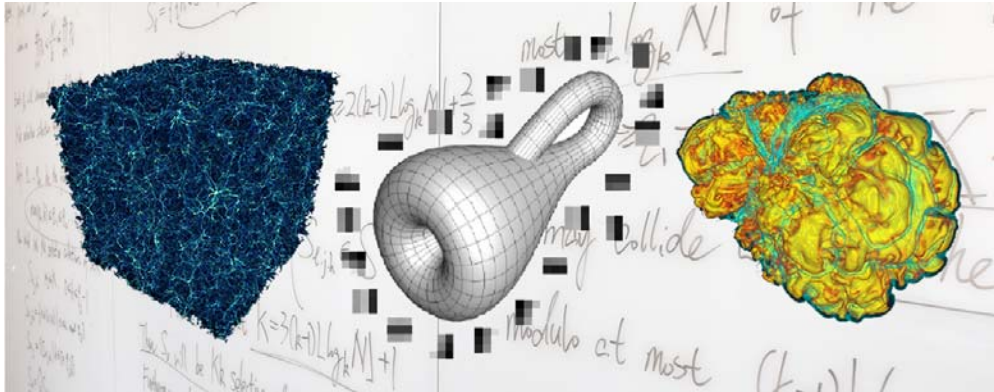


## Computational Research



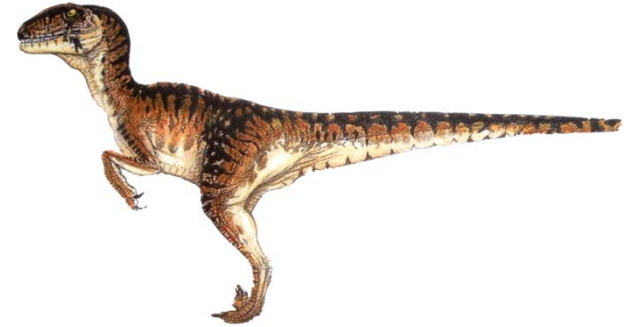
## Velociraptor

# Data Intensive Science, an analogy...



Data Intensive Science

211



Velociraptor

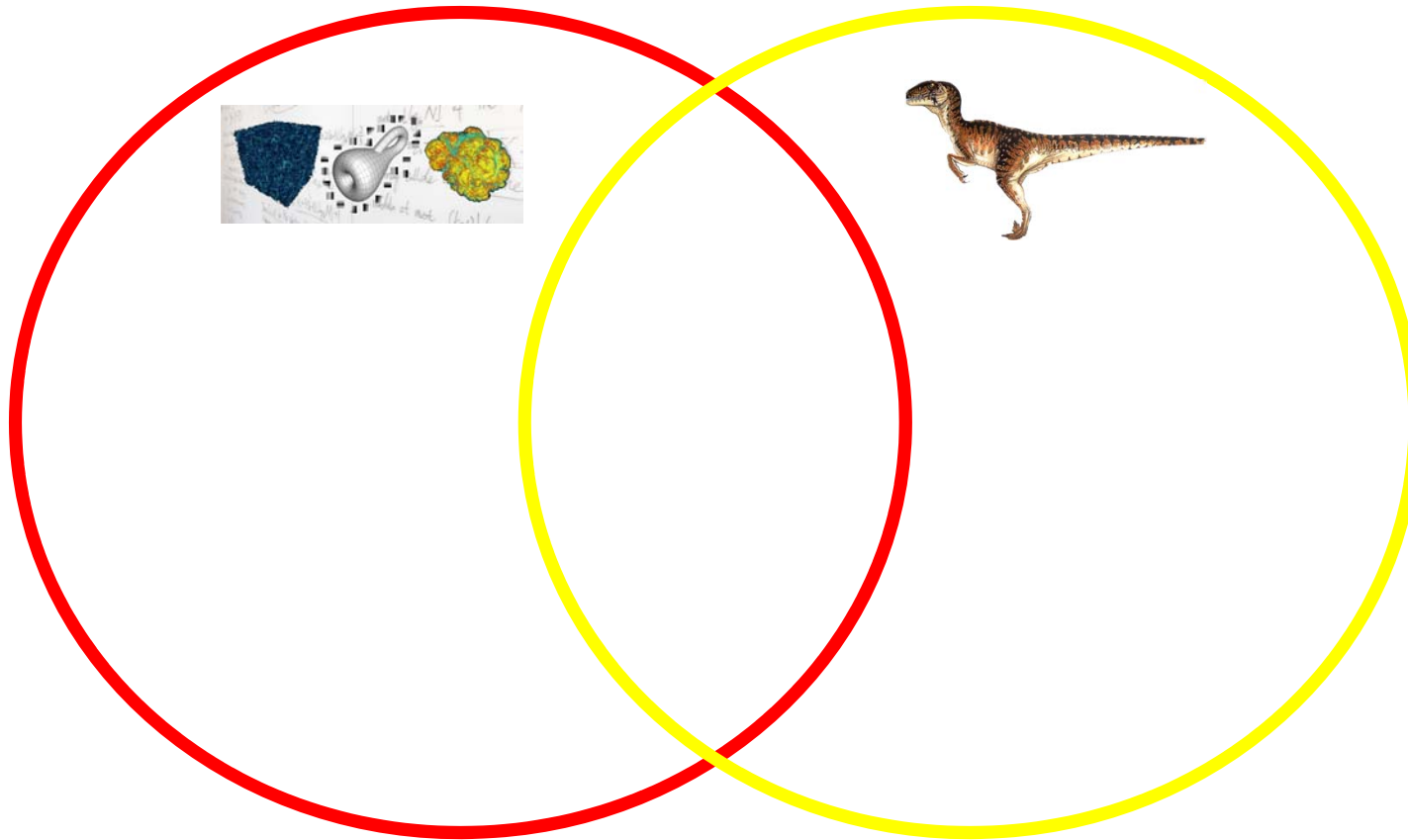
# Data Intensive Science, an analogy...



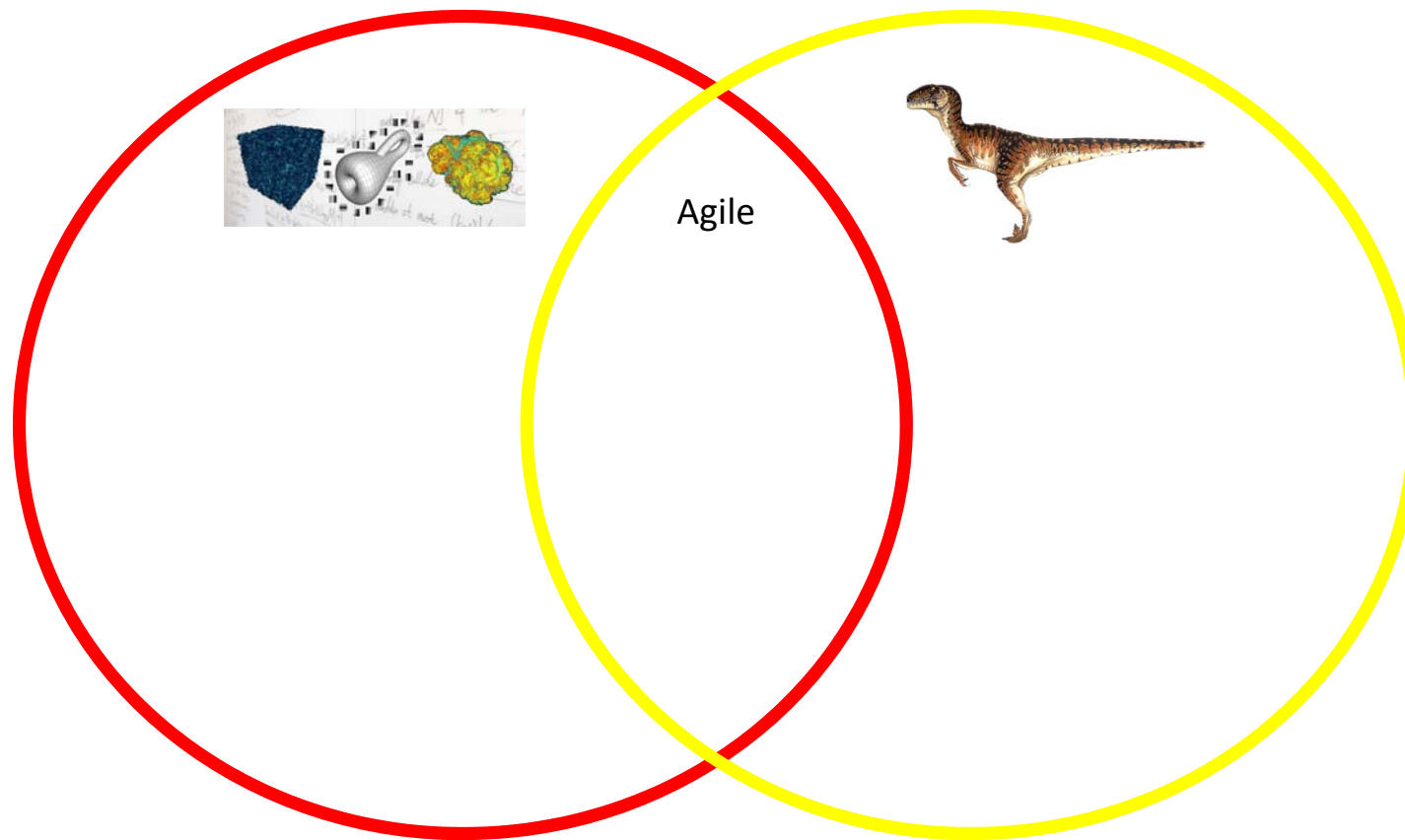
Irrefutable proof the analogy is valid...



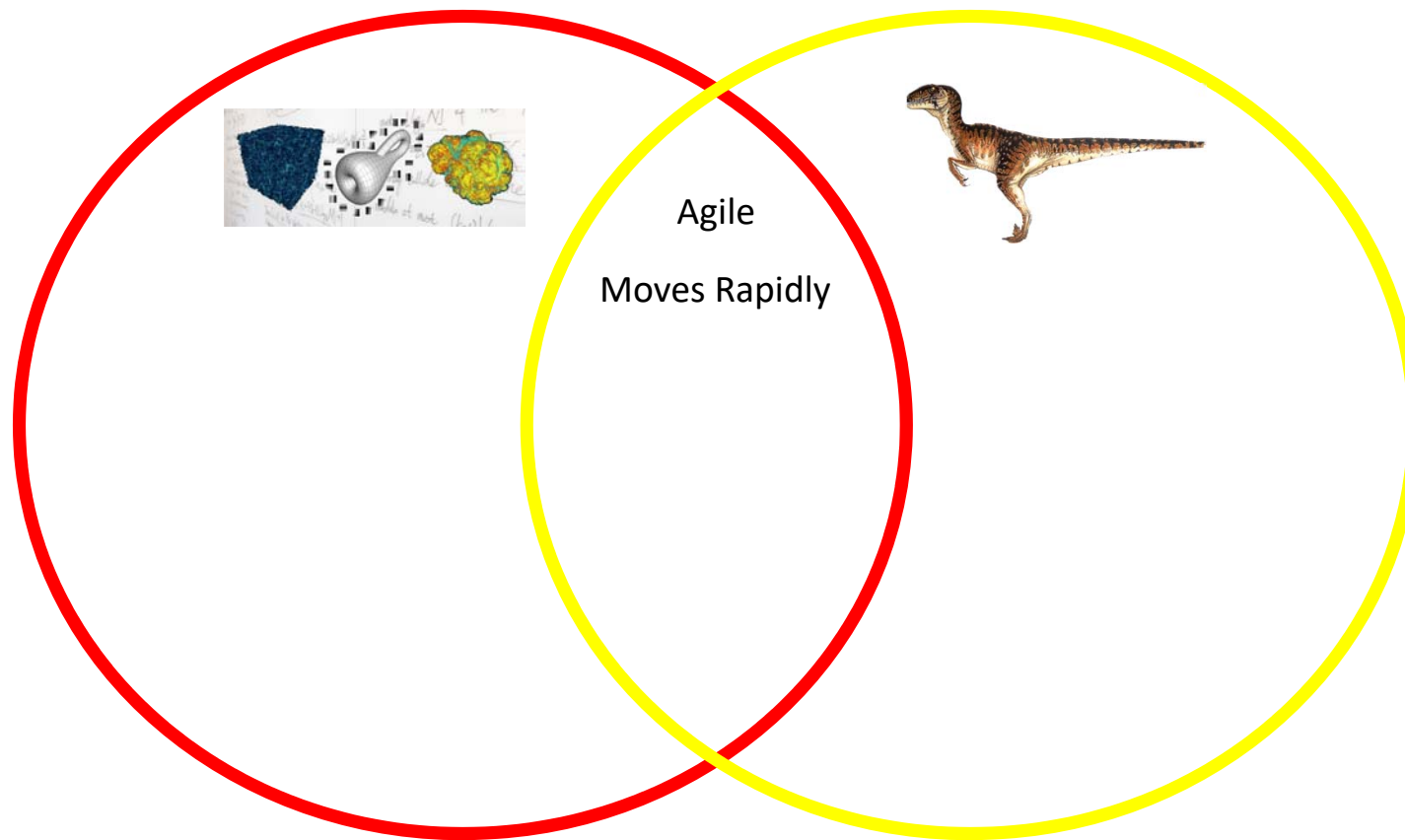
# Data Intensive Science, an analogy...



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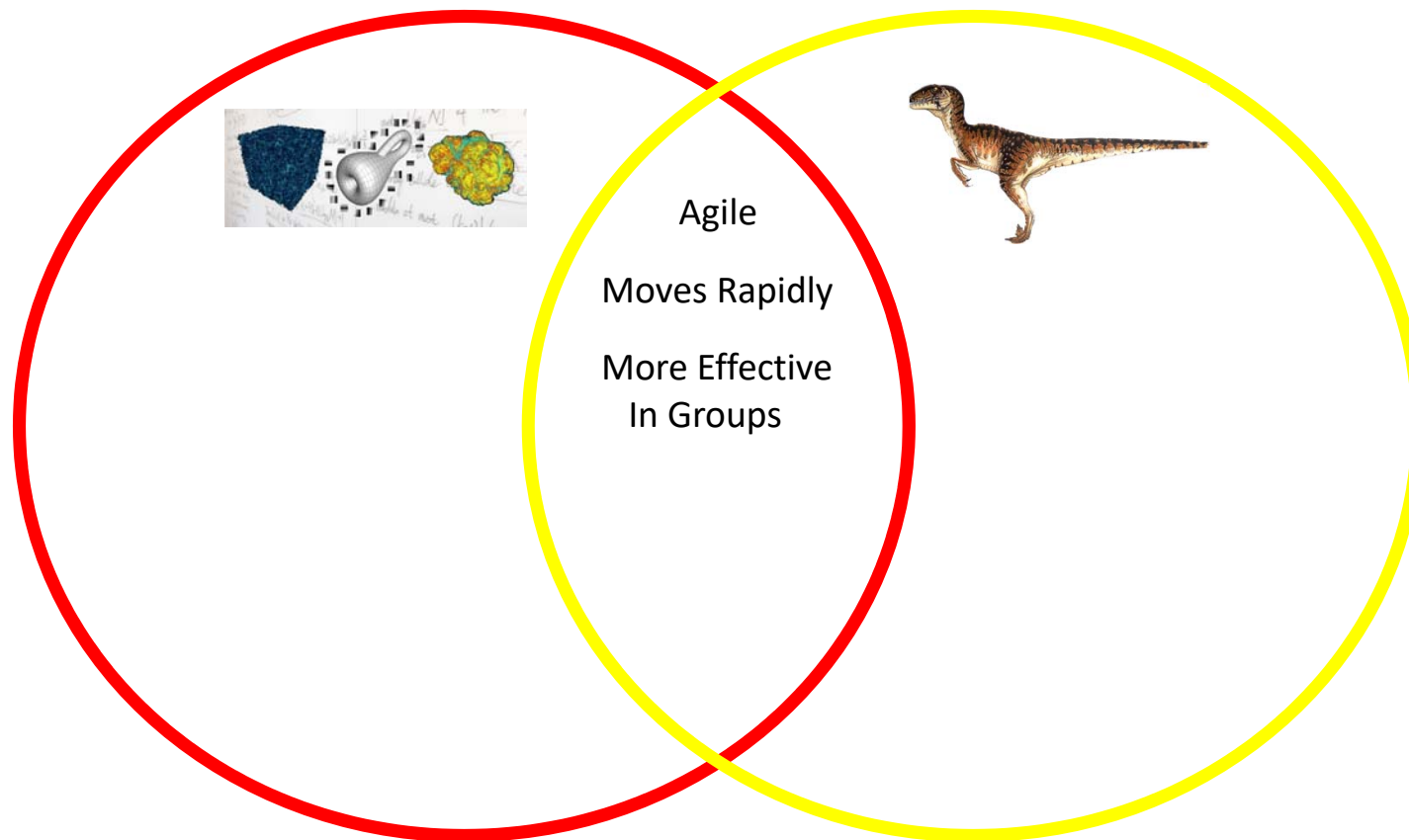


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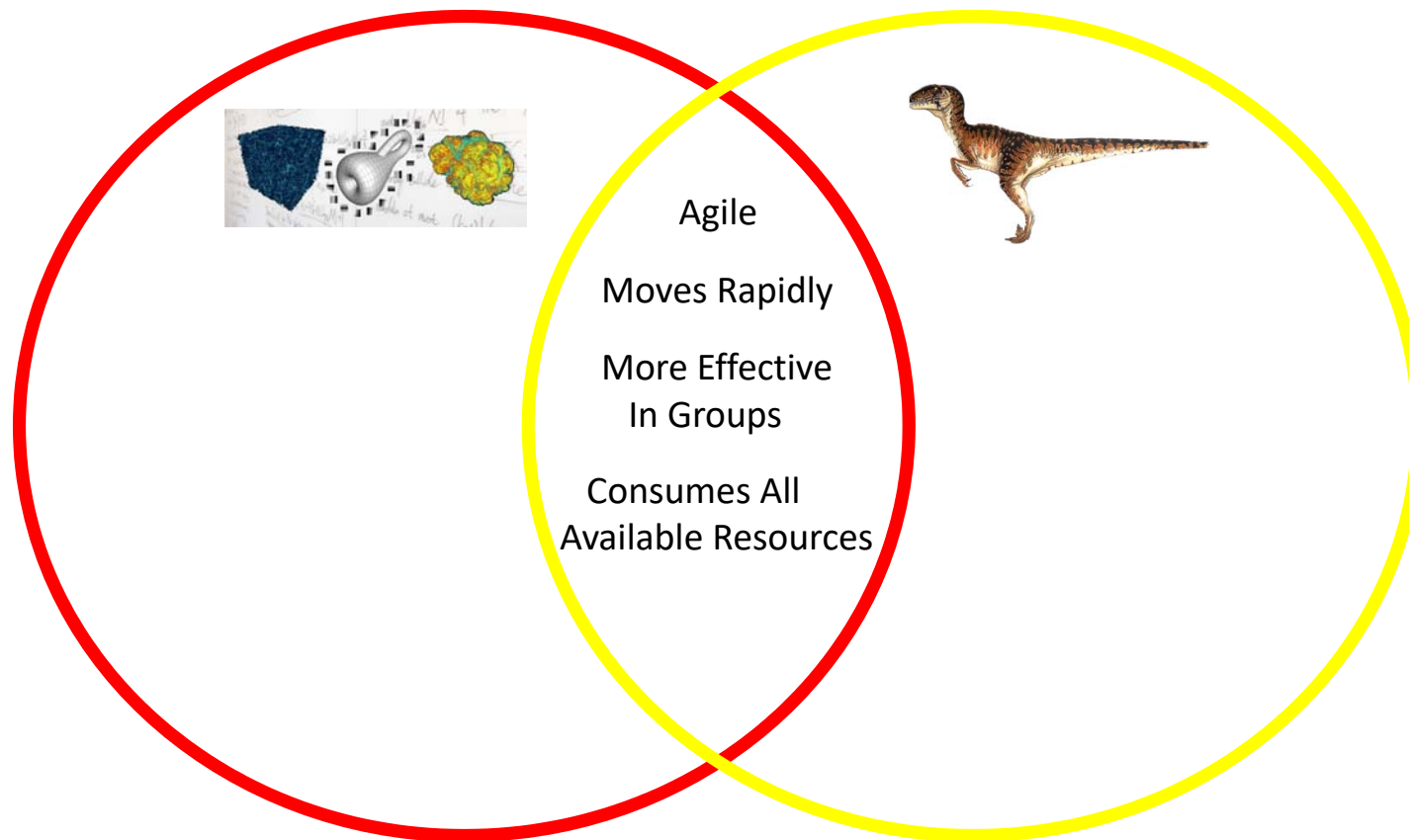




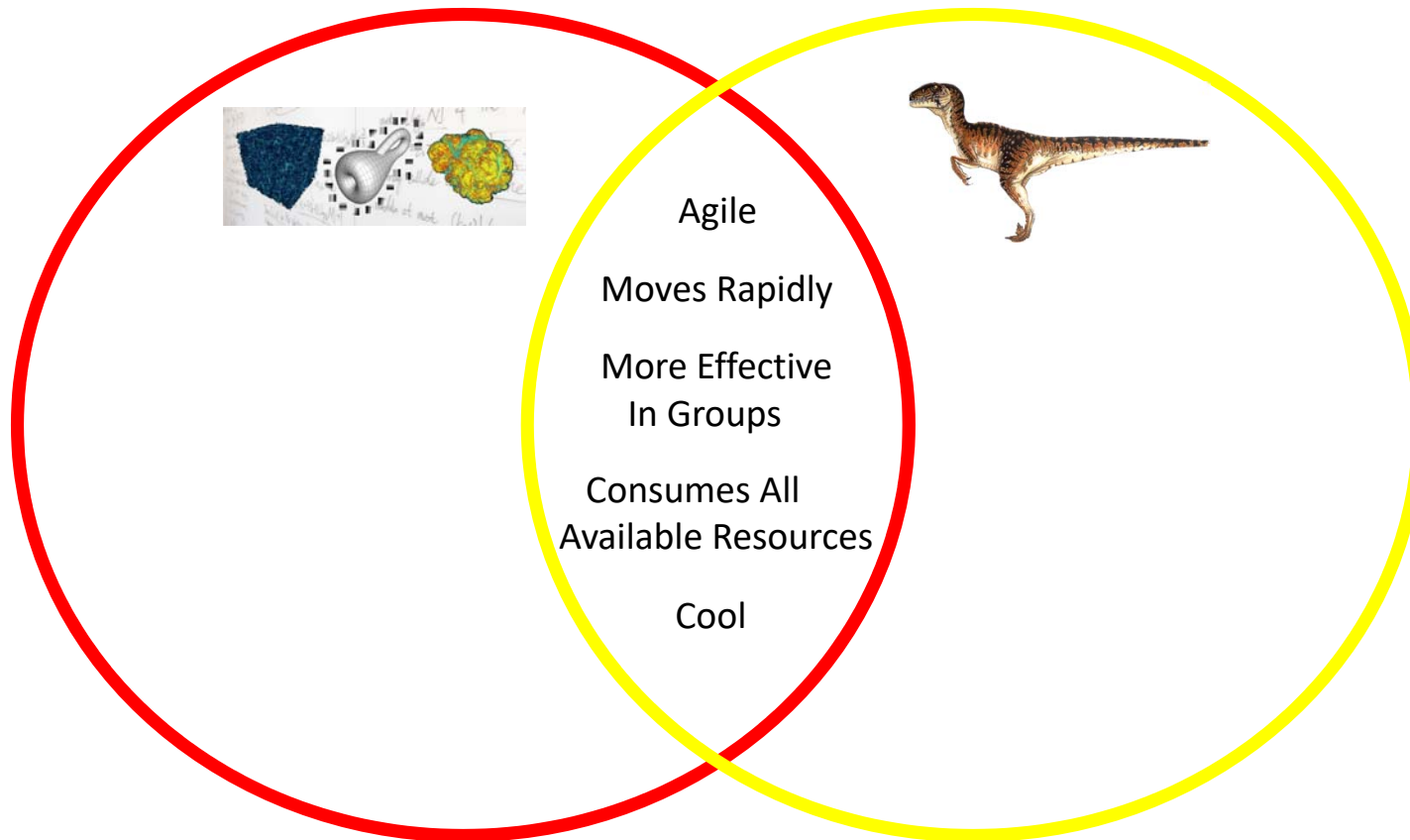
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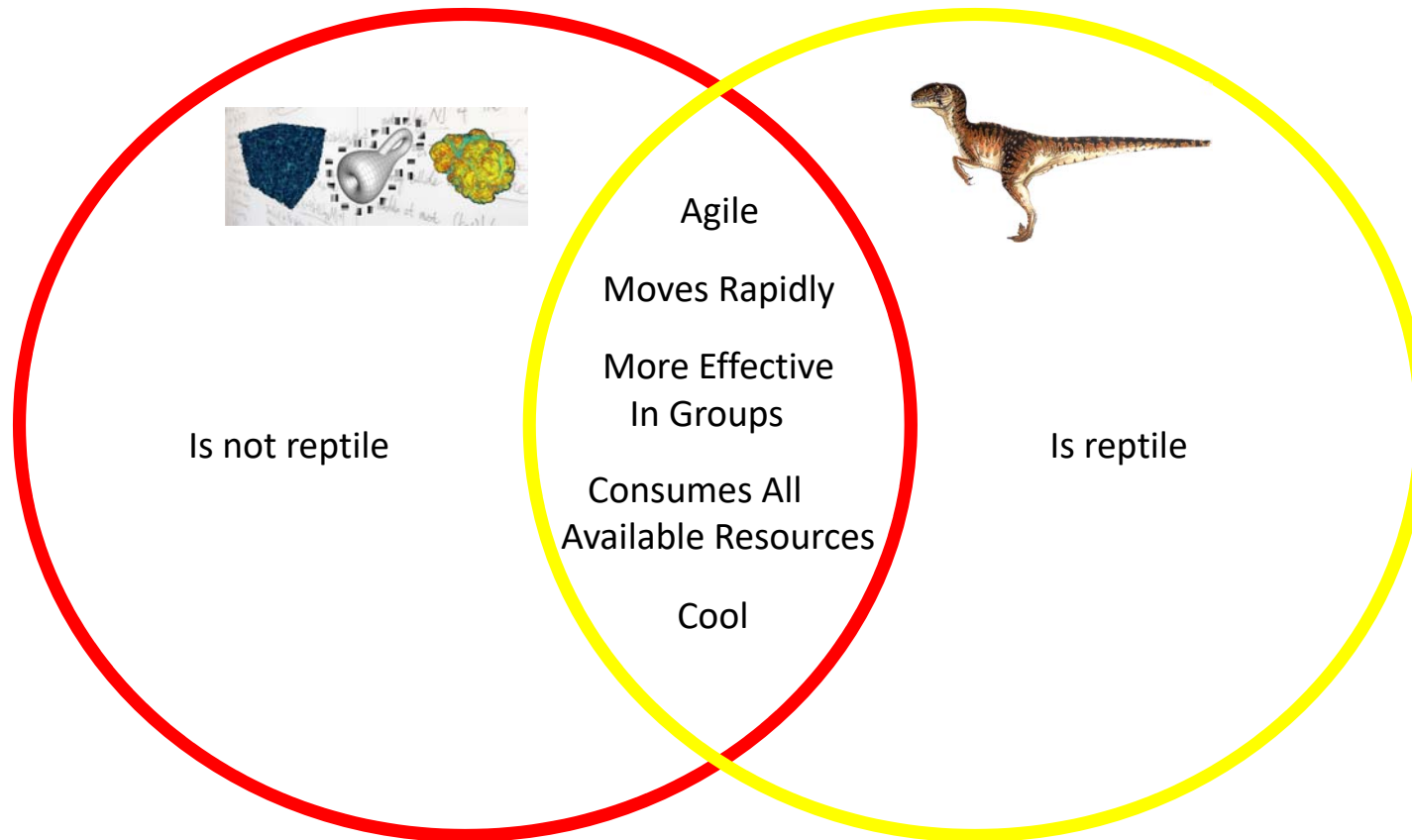


# Data Intensive Science, an analogy...





# Data Intensive Science, an analogy...



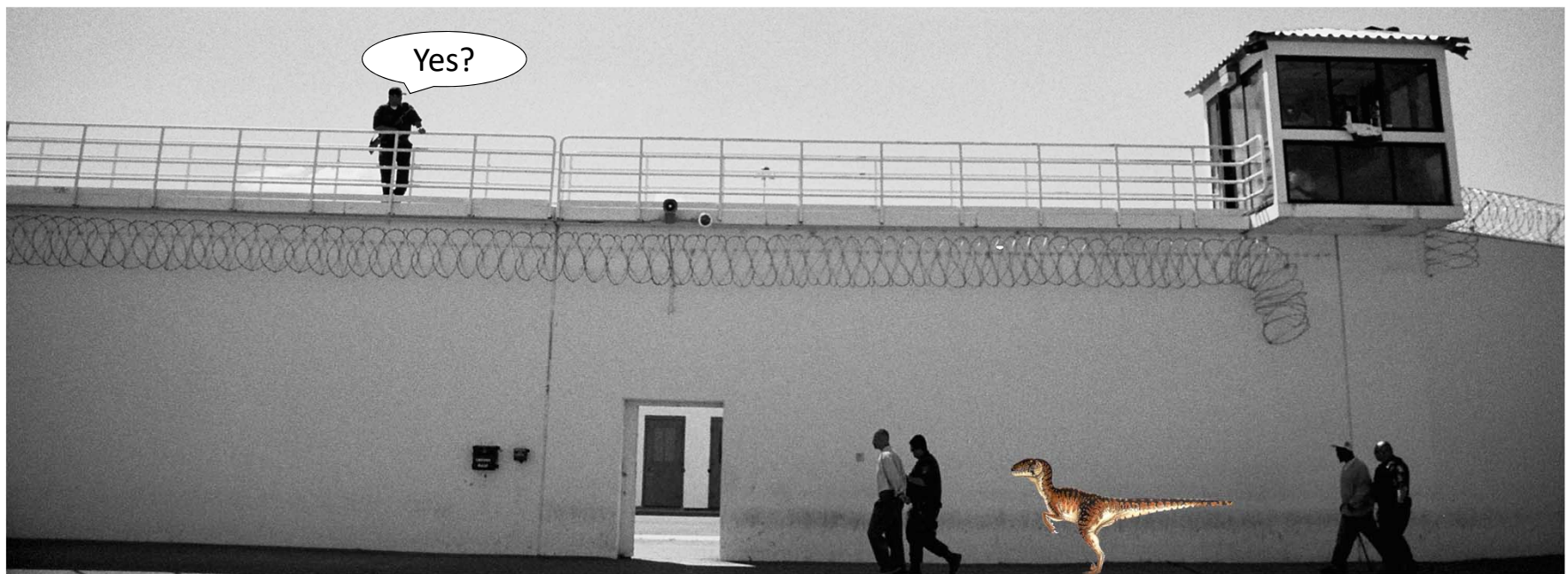
# When Data Intensive Science Meets Traditional Networks



# When Data Intensive Science Meets Traditional Networks



# When Data Intensive Science Meets Traditional Networks





# When Data Intensive Science Meets Traditional Networks



# When Data Intensive Science Meets Traditional Networks

...that is highly important to myself, the educational community, and all of mankind as a whole. It is imperative that this data be *reasonably secured*; yet, *available* to my research peers. The *datasets are rather large*, and they may need to be shared across institutions.

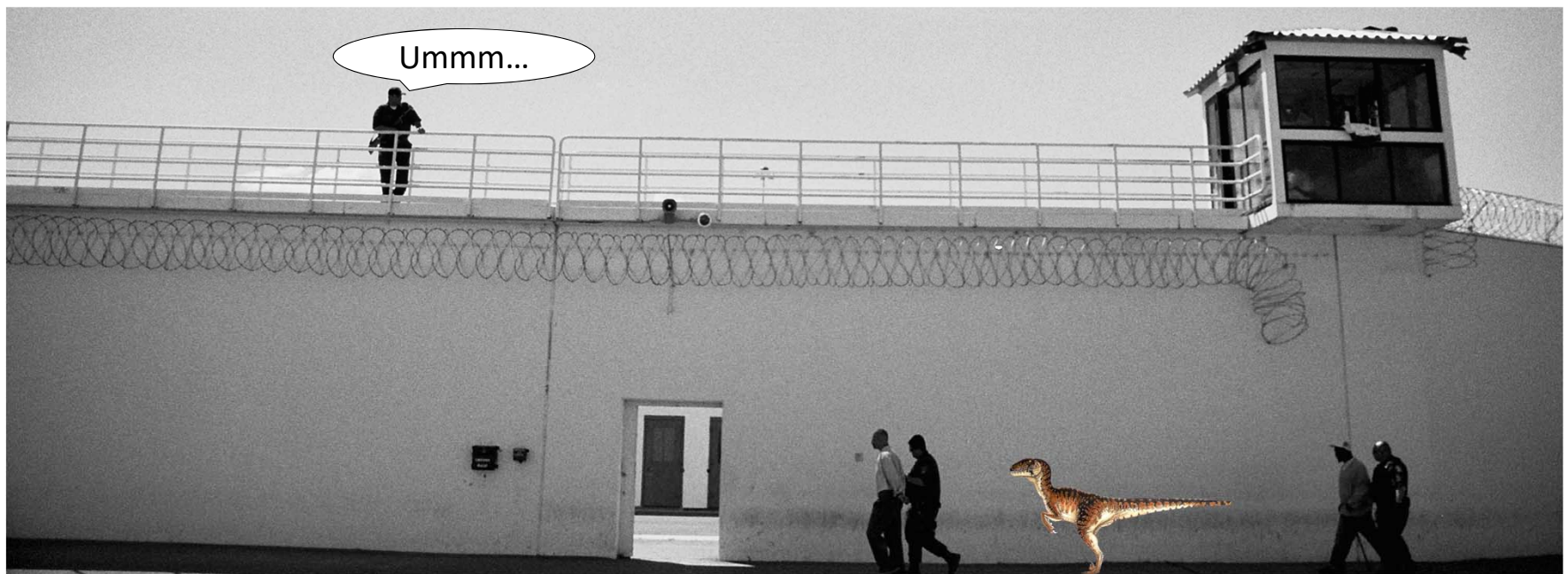


# When Data Intensive Science Meets Traditional Networks

Would it be possible to place this in a *secure, reliable, flexible, accessible*, as well as *high performing* infrastructure?



# When Data Intensive Science Meets Traditional Networks

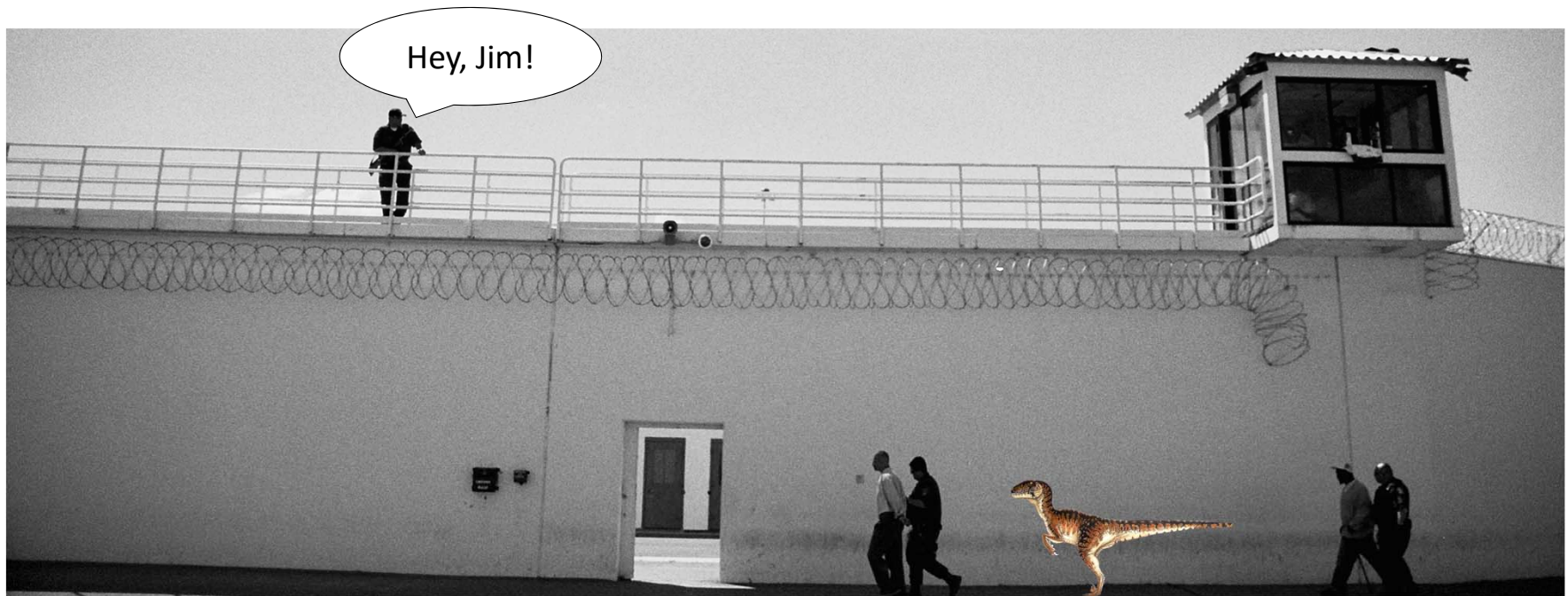




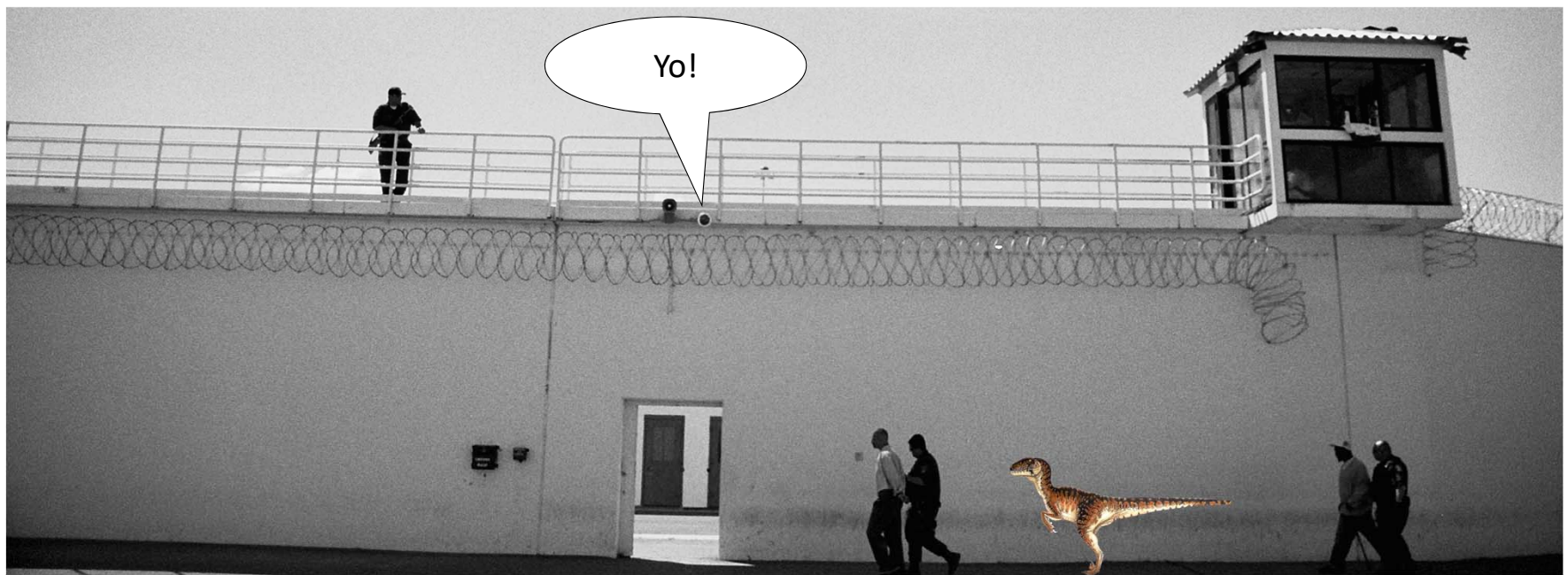
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# When Data Intensive Science Meets Traditional Networks





# When Data Intensive Science Meets Traditional Networks





# When Data Intensive Science Meets Traditional Networks



# When Data Intensive Science Meets Traditional Networks

Something about  
security and  
connectivity (maybe).

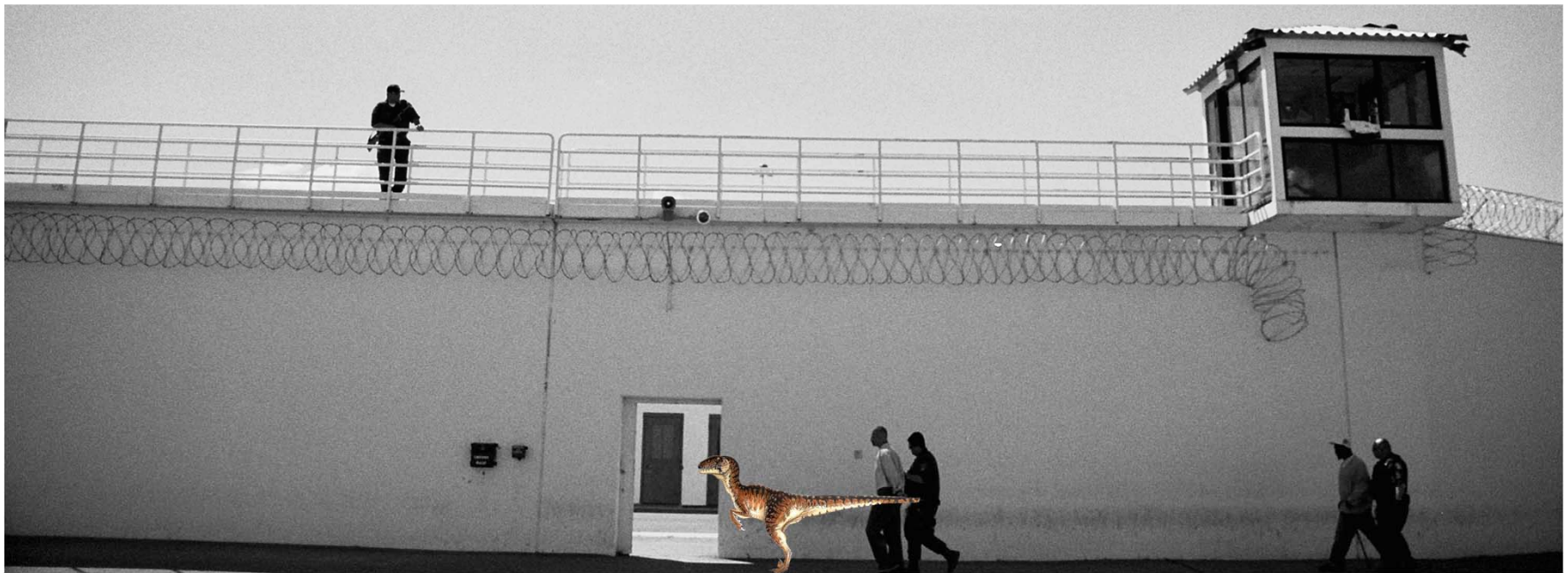


# When Data Intensive Science Meets Traditional Networks



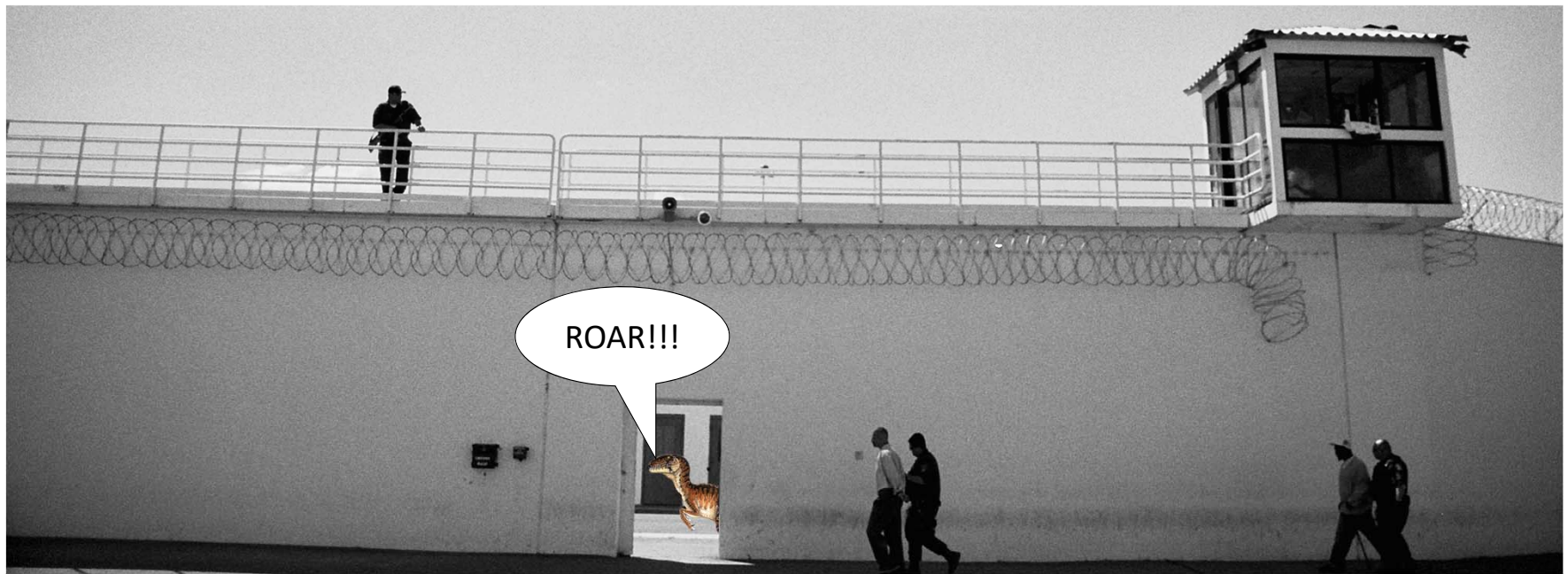


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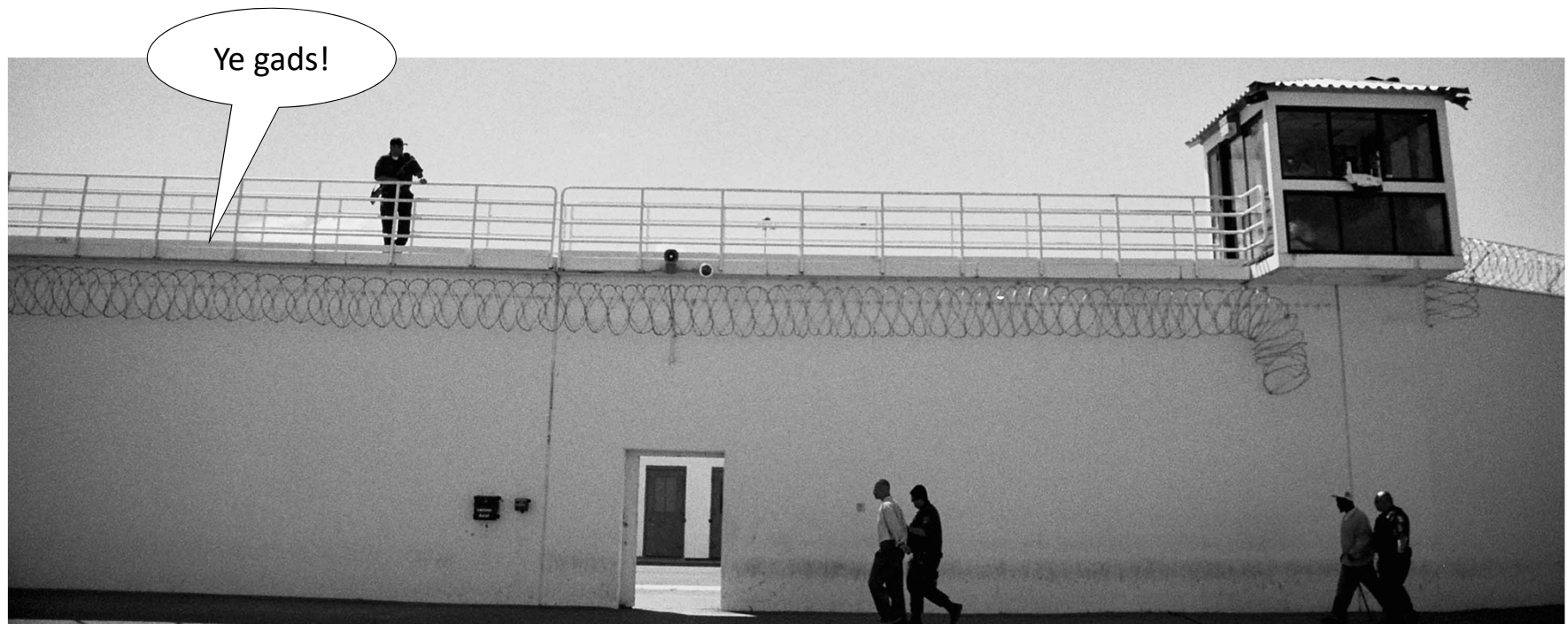




# When Data Intensive Science Meets Traditional Networks



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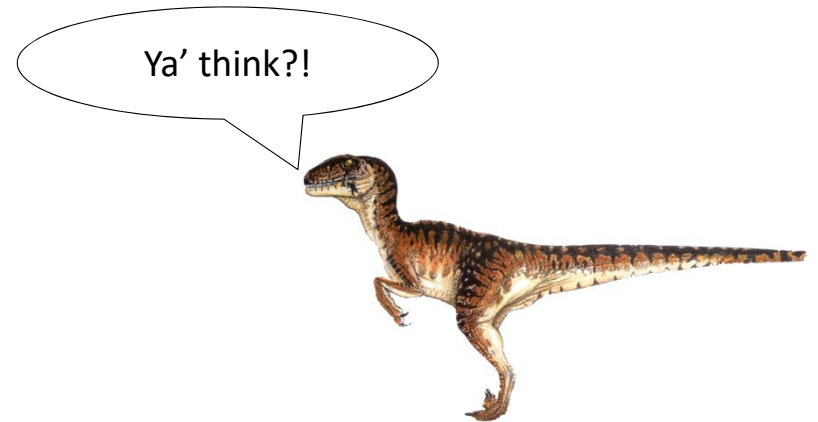




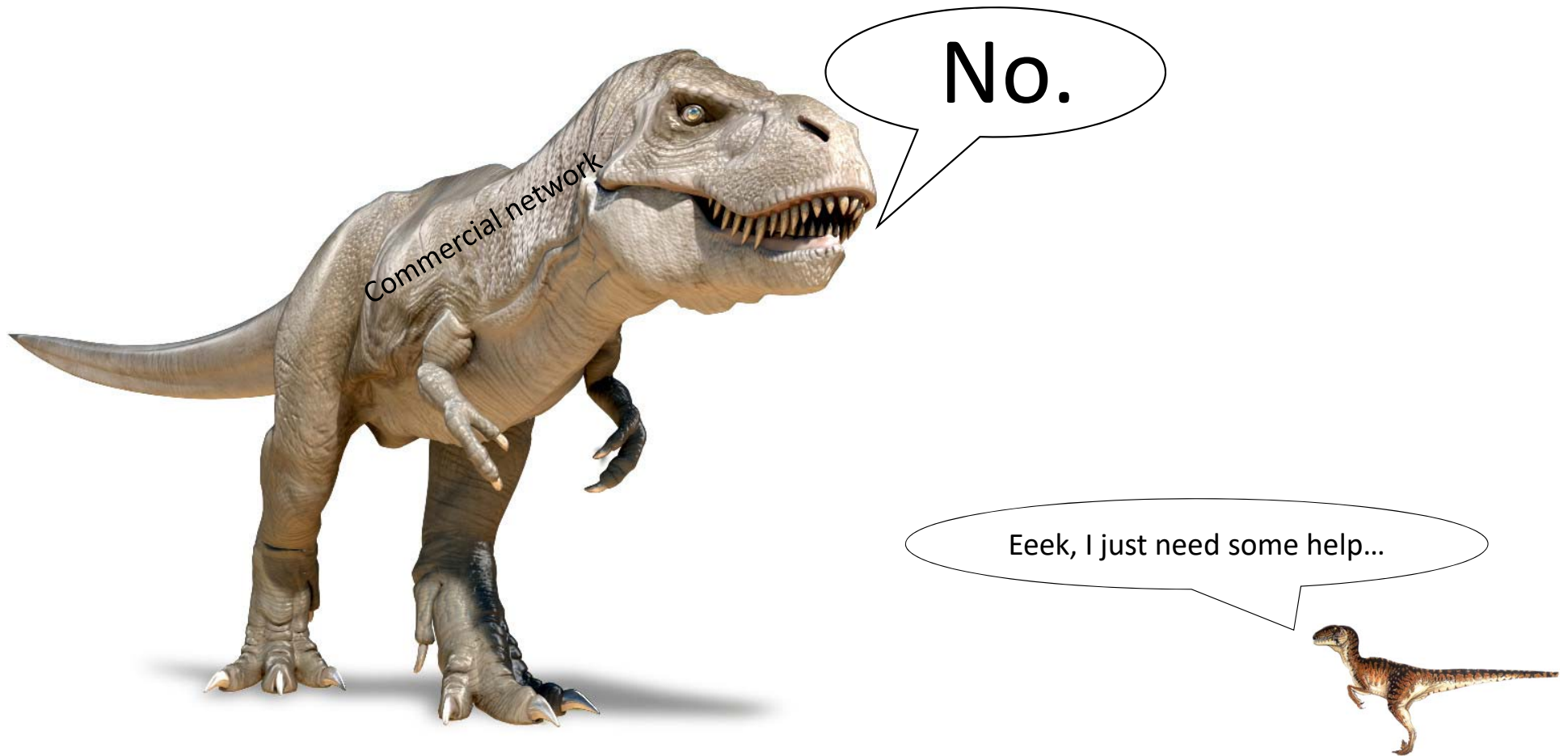
# When Data Intensive Science Meets Traditional Networks



OBSERVATION: The **requirements** of the data intensive researcher and the **service profile** of the traditional campus computer network (or commercial networks) do not always align!



# When Data Intensive Science Meets Commercial Commodity Networks



# When Data Intensive Science Meets Commercial Commodity Networks



On second thought,  
how much money yah  
gots and how may friends  
do you have I can eat,  
um, I mean meet?

Umm...





# When Data Intensive Science Meets Commercial Commodity Networks

This can result in adverse consequences:

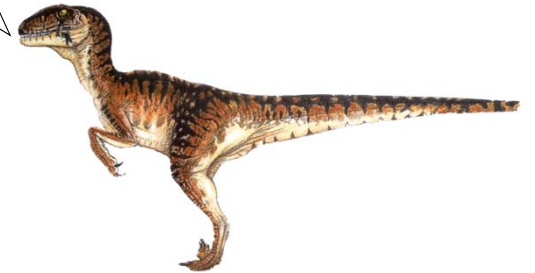
- Performance issues for the researcher
- Performance issues for everyone else
- Frustration for the researcher
- Frustration everyone else
- Frustration for the IT staff



# When Data Intensive Science Meets Commercial Commodity Networks

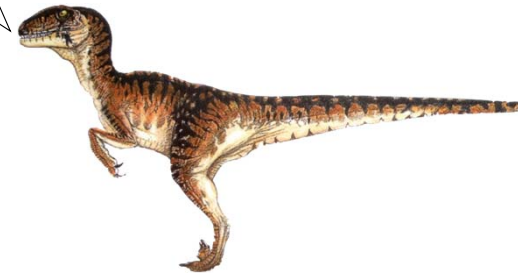


Sigh. I guess  
cancer cures  
can wait.



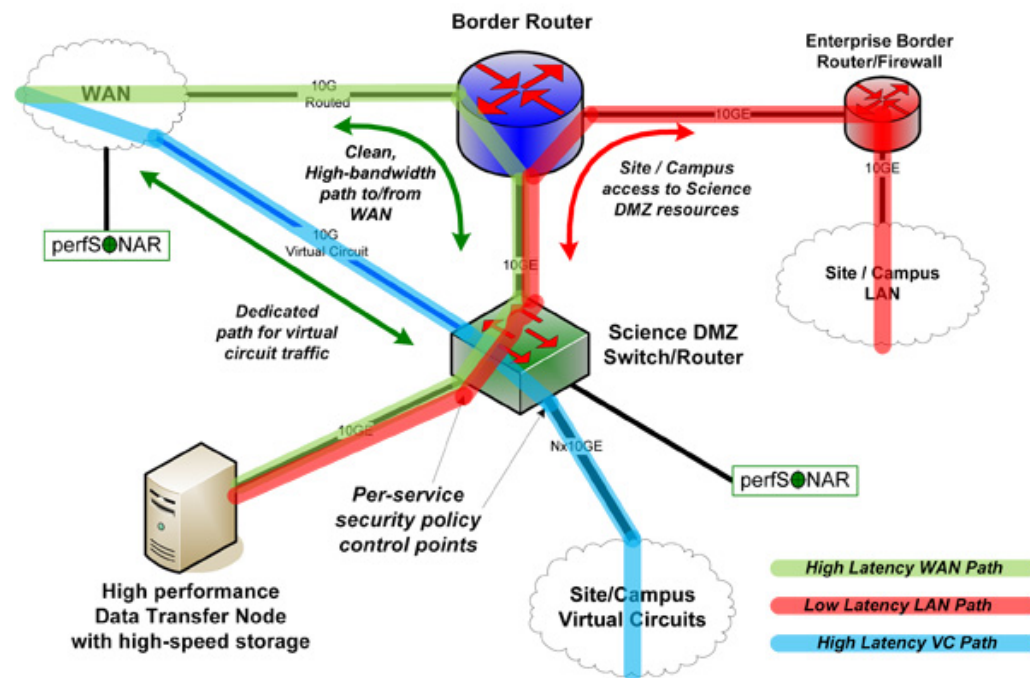
# When Data Intensive Science Meets Commercial Commodity Networks

But how do we overcome this? /  
*can't stop my research* just  
because **the network can't keep**  
**up!** Being able to collaborate is  
the future of science!



# Specialty networks to the rescue!

- Both internally to your organization and externally
- Science DMZ is an example of a specialty network





# Parts of the puzzle...

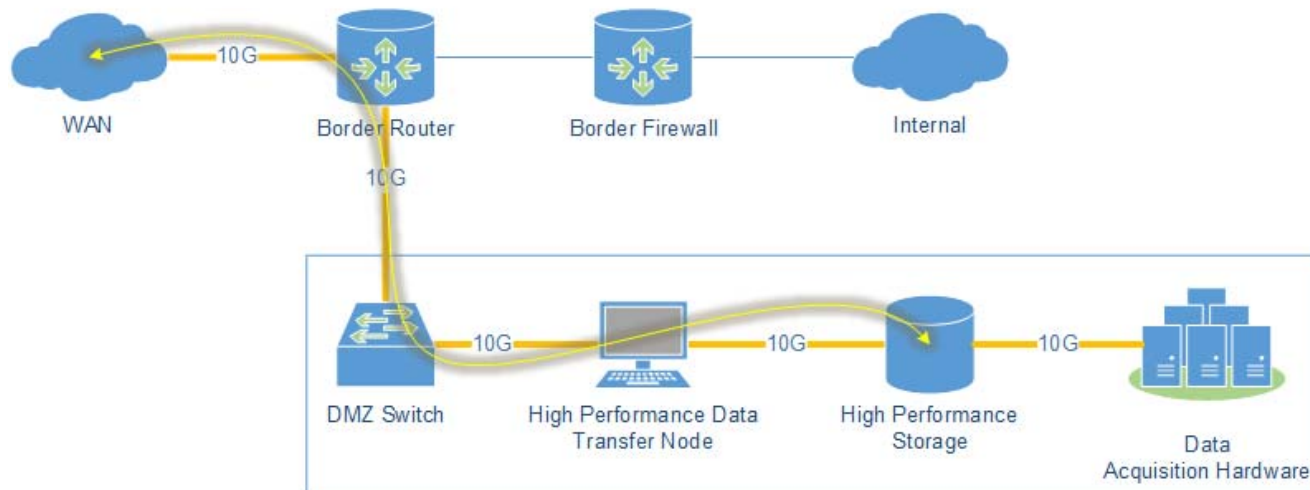
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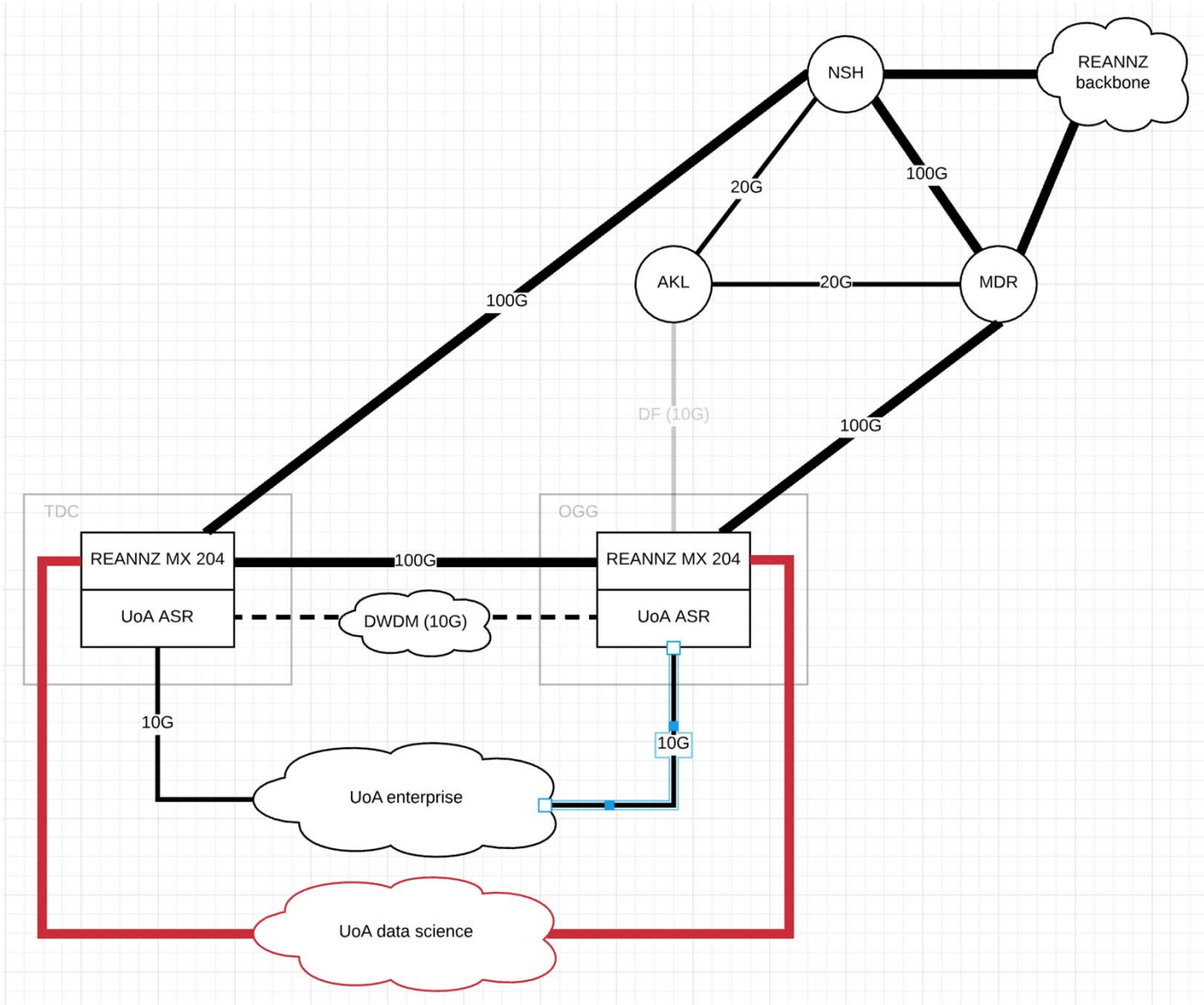
- Science DMZ
- DTN (Data Transfer Node)
- Storage
- Research and Education networks
  - NREN (National Research and Education Network)
  - RON (Regional Optical Network)
  - R&E Network (Research and Education Network)



# Data Transfer Nodes (DTN)

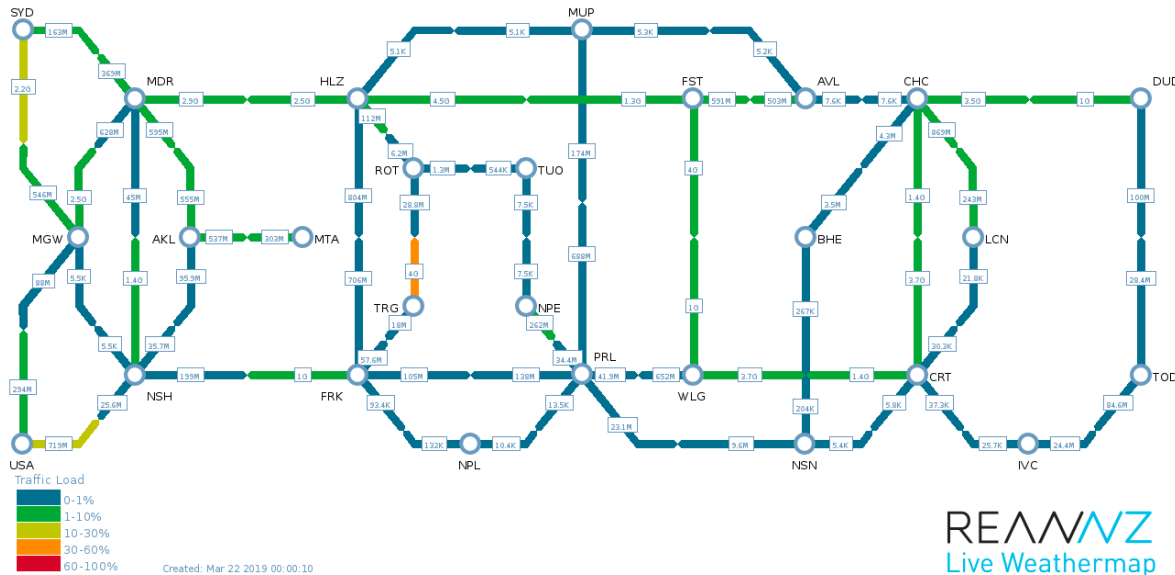
- Simply put, a DTN is a server that is specially designed to move data from disk to a network at speed.





# REANNZ

100G network with 360+ member connections



REANNZ  
Live Weathermap





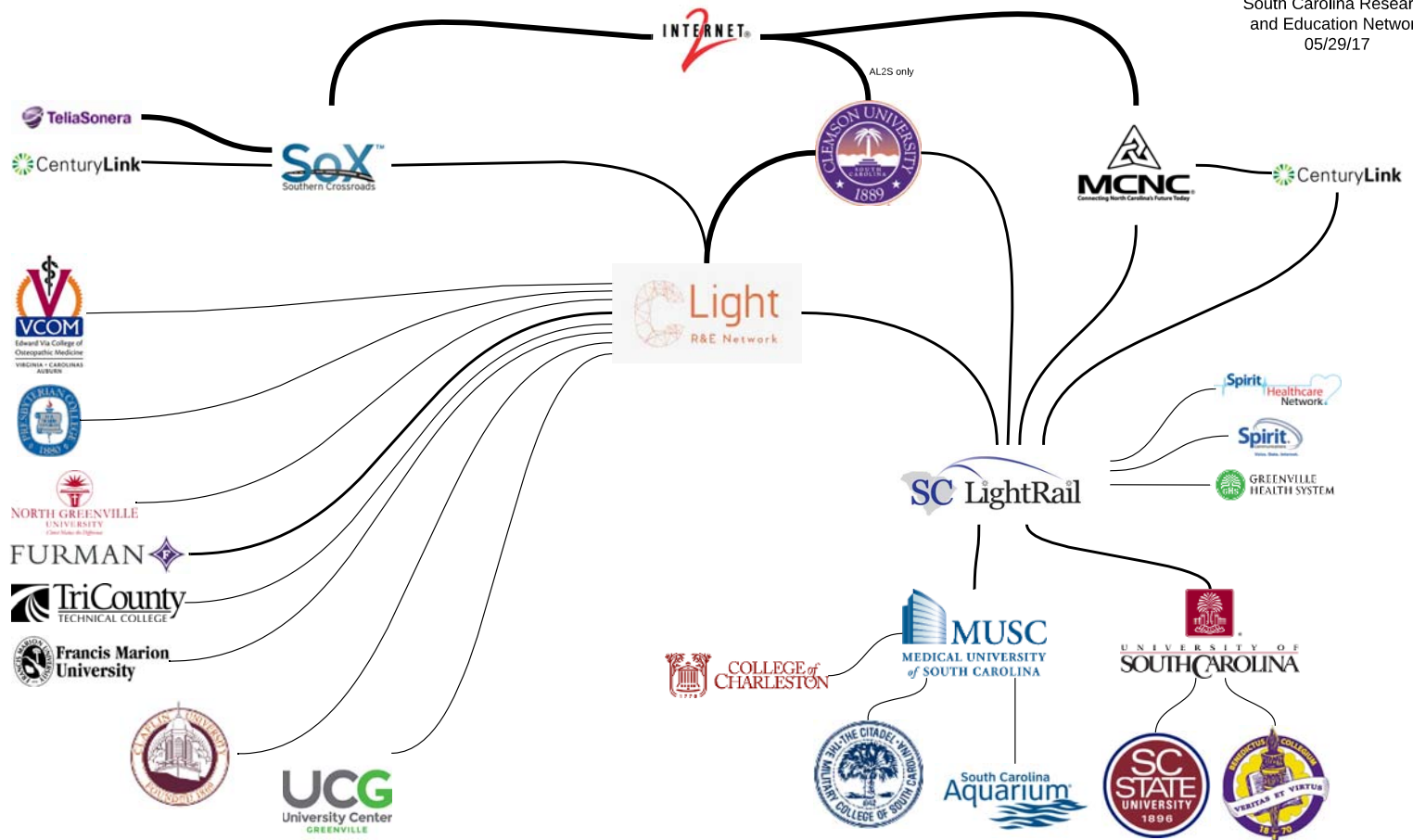
Relationships make the packets flow...



# Relationship can be complex...

## C-Light

South Carolina Research  
and Education Network  
05/29/17









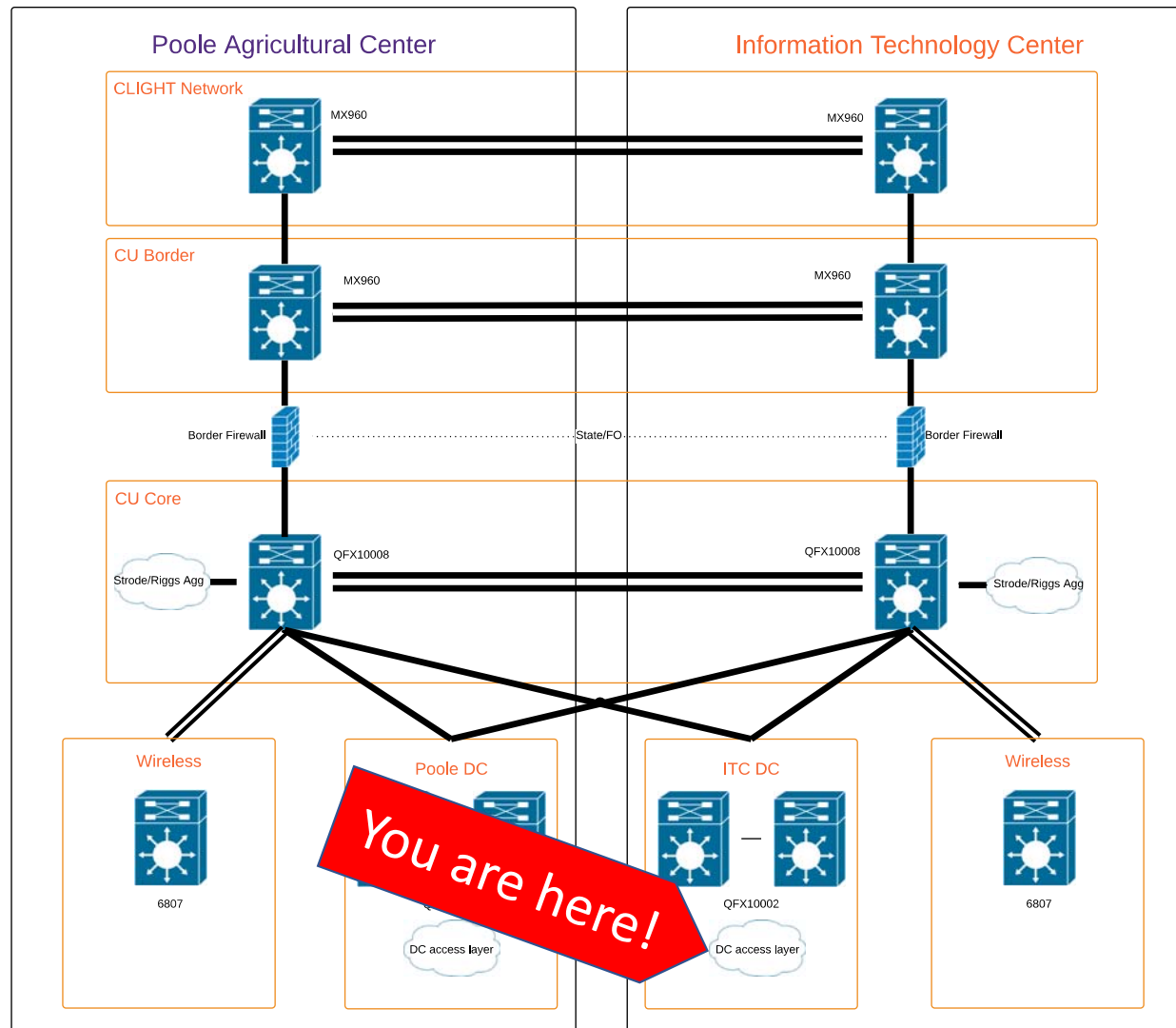
# Local networks



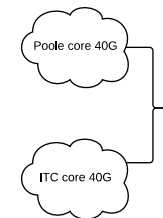
(Insert your logo here)

**Key**

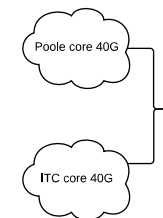
Dual links   
100G   
40G   
10G   
1G   
Other 



**Strode Hall aggregation**



**Riggs Hall aggregation**





State/regional networks  
aka “your ISP”

Charter  
COMMUNICATIONS

REANNZ



merit  
NETWORK

CAAREN  
Capital Area Advanced Research and  
Education Network | Powered by GW



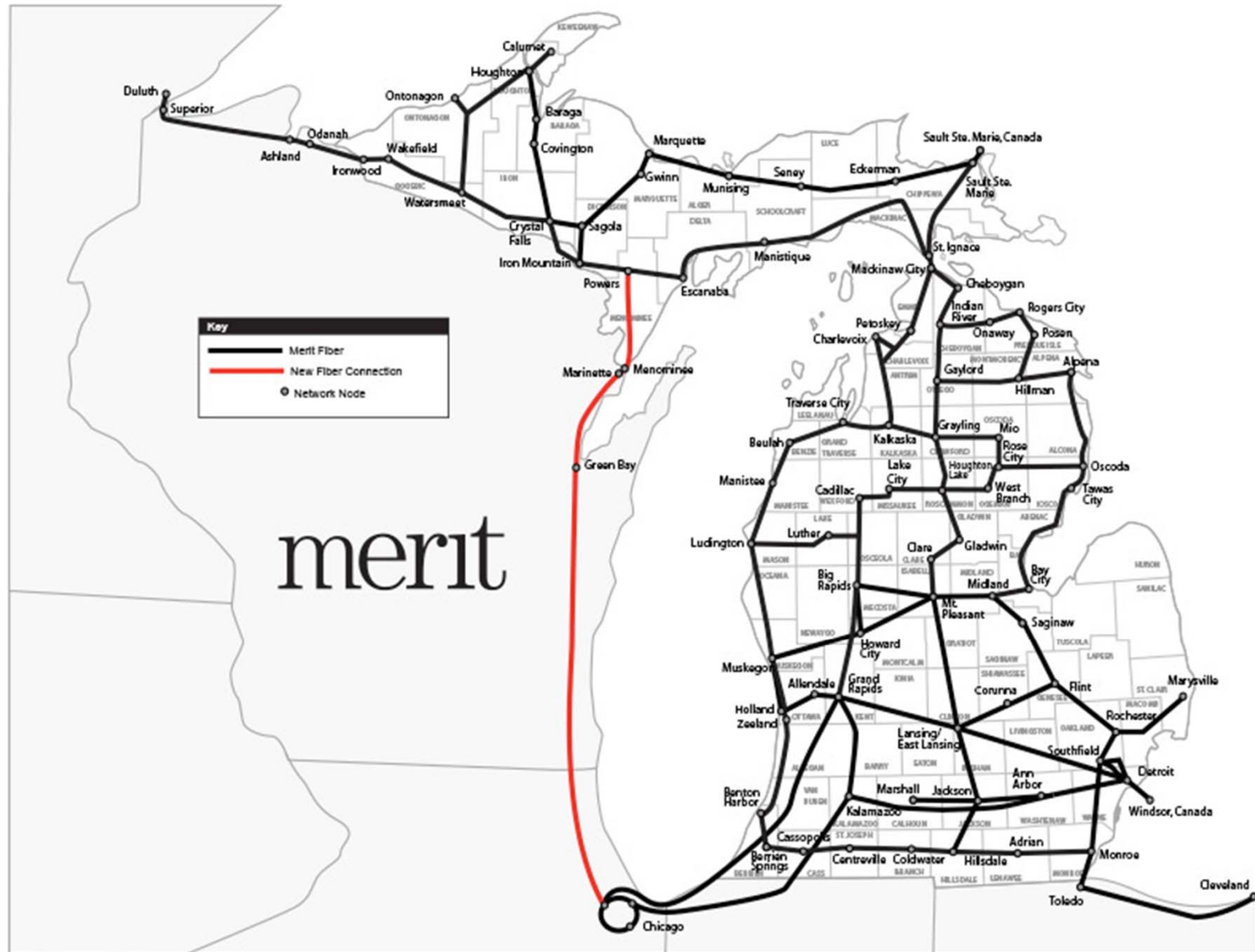
K-20  
Education  
Network

CENIC



uen  
UTAH EDUCATION NETWORK  
WWW.UEN.ORG

LEARN  
LONESTAR EDUCATION AND RESEARCH NETWORK



# Exchanges and PoPs



REANNZ



# National Networks (US)



REANVZ



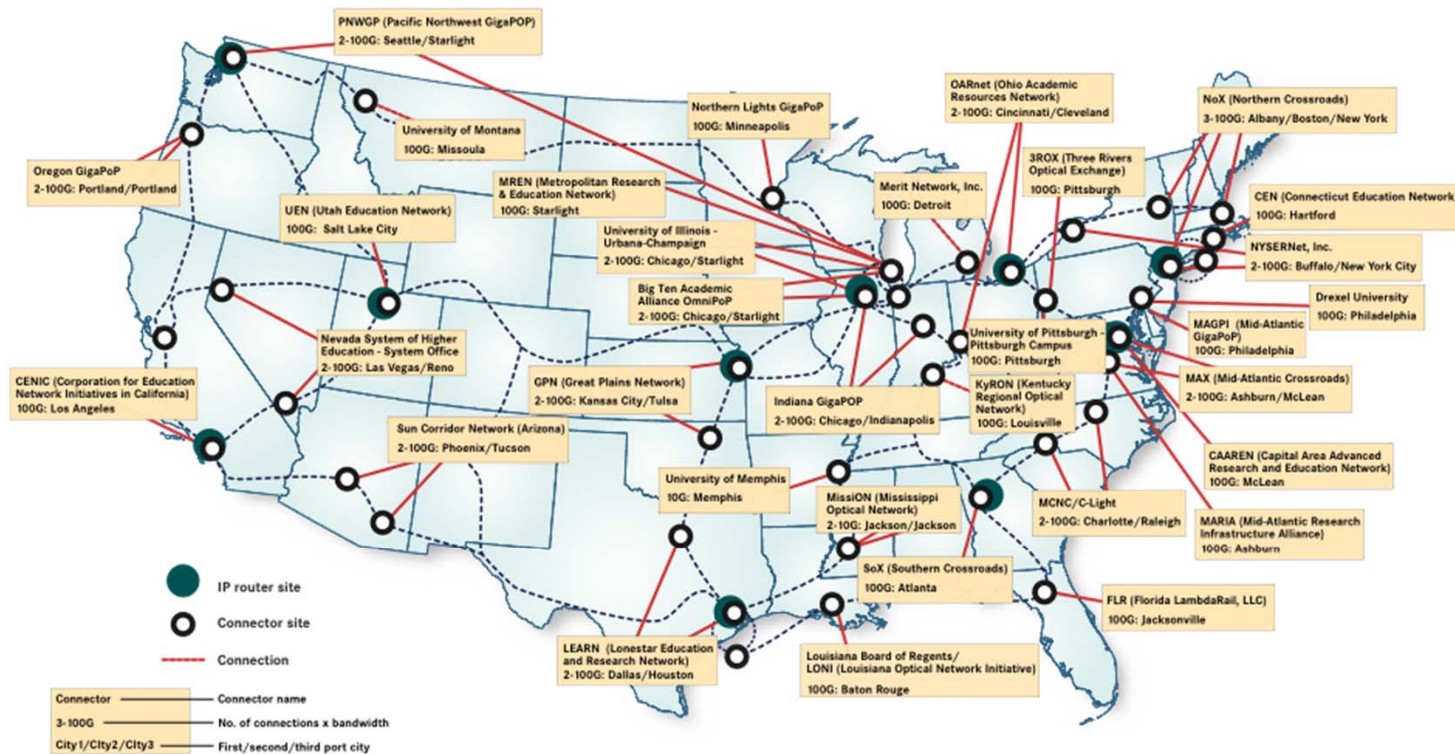
**ESnet**  
ENERGY SCIENCES NETWORK





## INTERNET2 NETWORK CONNECTIONS

WWW.INTERNET2.EDU/CONNECTORS - MARCH OF 2017



NETWORK  
PARTNERS

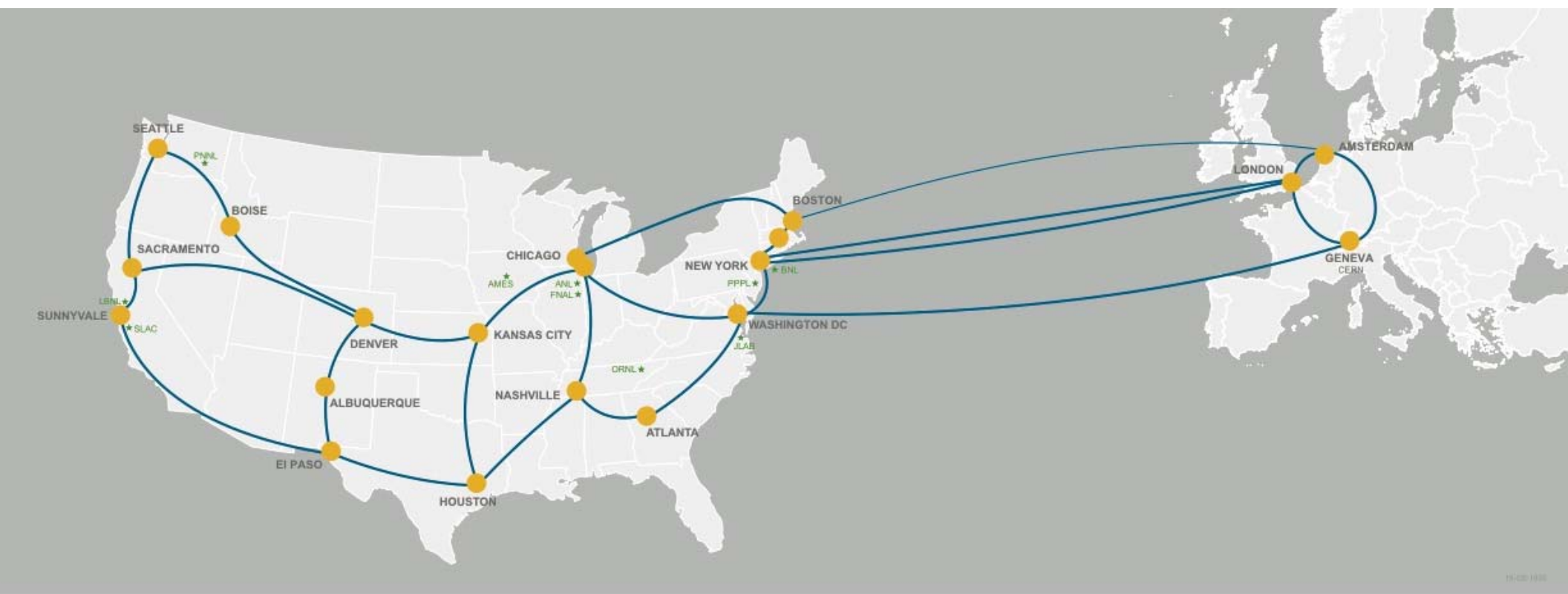
ciena

INDIANA UNIVERSITY

BROCADE

JUNIPER  
NETWORKS

Level(3)



# ESnet

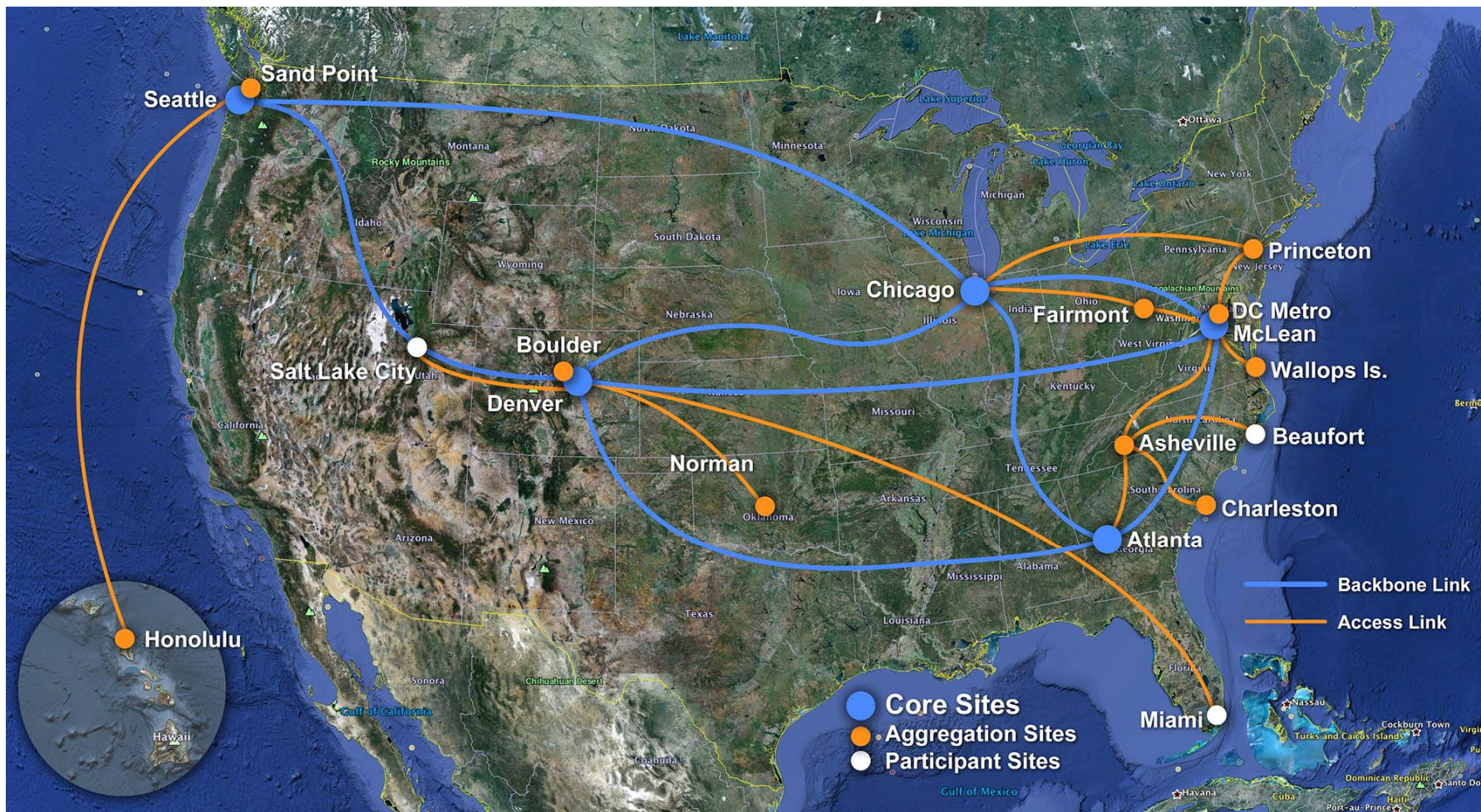
ENERGY SCIENCES NETWORK

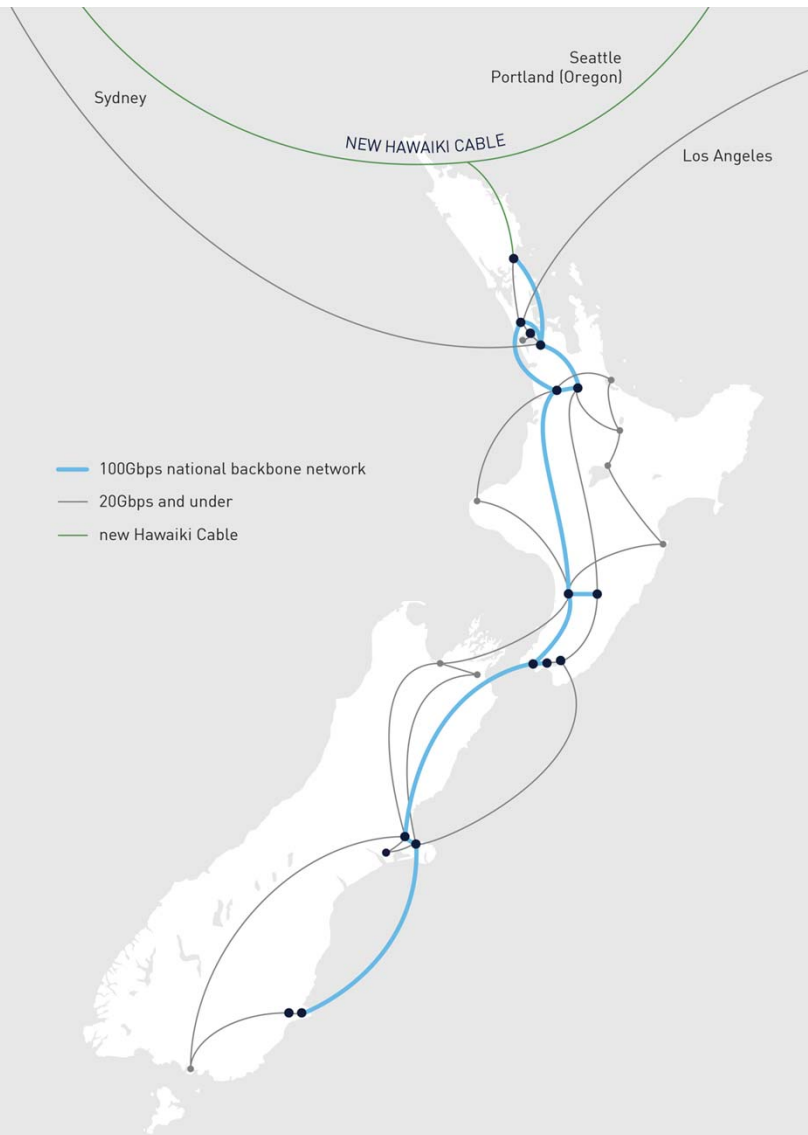
## ★ Department of Energy Office of Science National Labs

- Ames** Ames Laboratory (Ames, IA)
- ANL** Argonne National Laboratory (Argonne, IL)
- BNL** Brookhaven National Laboratory (Upton, NY)
- FNAL** Fermi National Accelerator Laboratory (Batavia, IL)
- JLAB** Thomas Jefferson National Accelerator Facility (Newport News, VA)

- LBNL** Lawrence Berkeley National Laboratory (Berkeley, CA)
- ORNL** Oak Ridge National Laboratory (Oak Ridge, TN)
- PNNL** Pacific Northwest National Laboratory (Richland, WA)
- PPPL** Princeton Plasma Physics Laboratory (Princeton, NJ)
- SLAC** SLAC National Accelerator Laboratory (Menlo Park, CA)









# International Networks

REANZ



SCReN

TEIN3

SANReN  
South African National  
Research Network

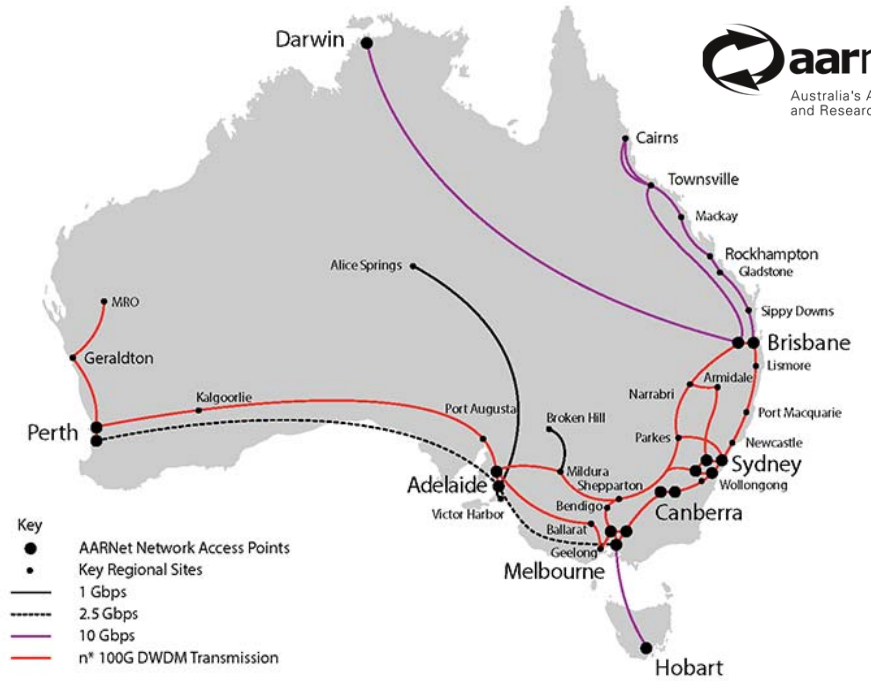
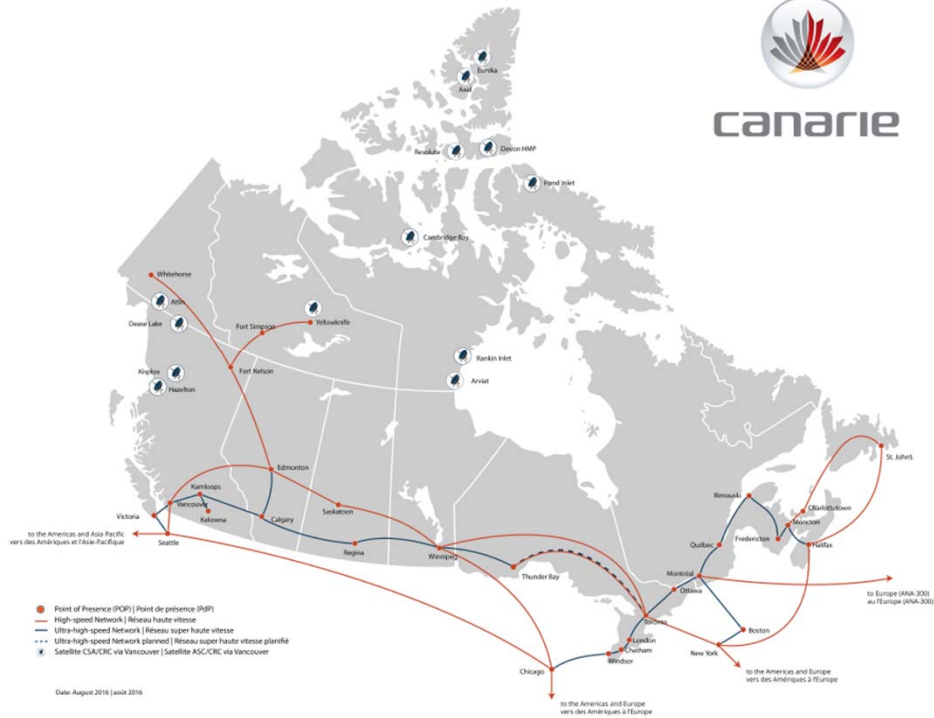
GÉANT  
Networks • Services • People

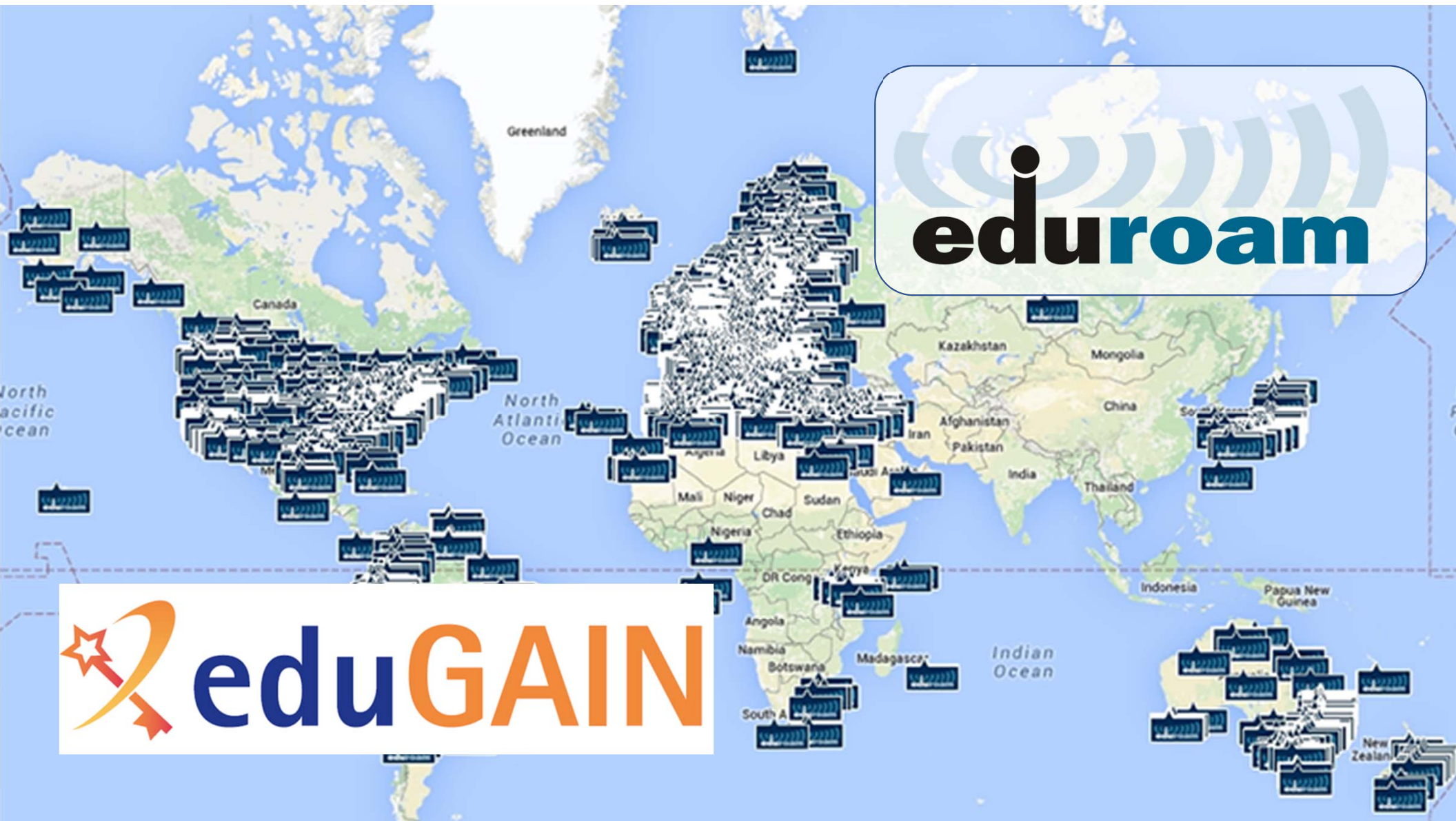
canarie



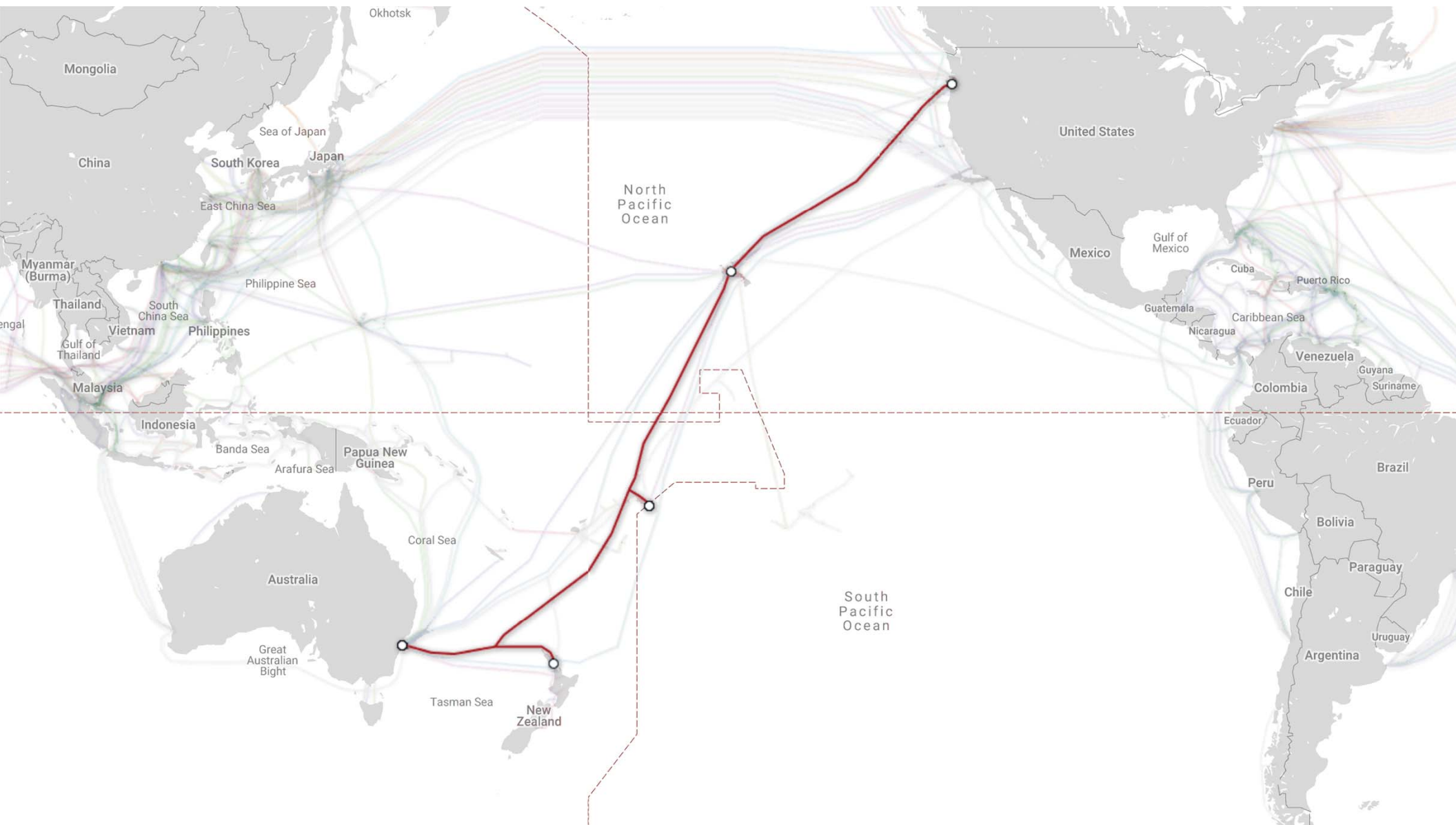
ERNET  
Indian Research & Education Network

aarnet  
Australia's Academic  
and Research Network

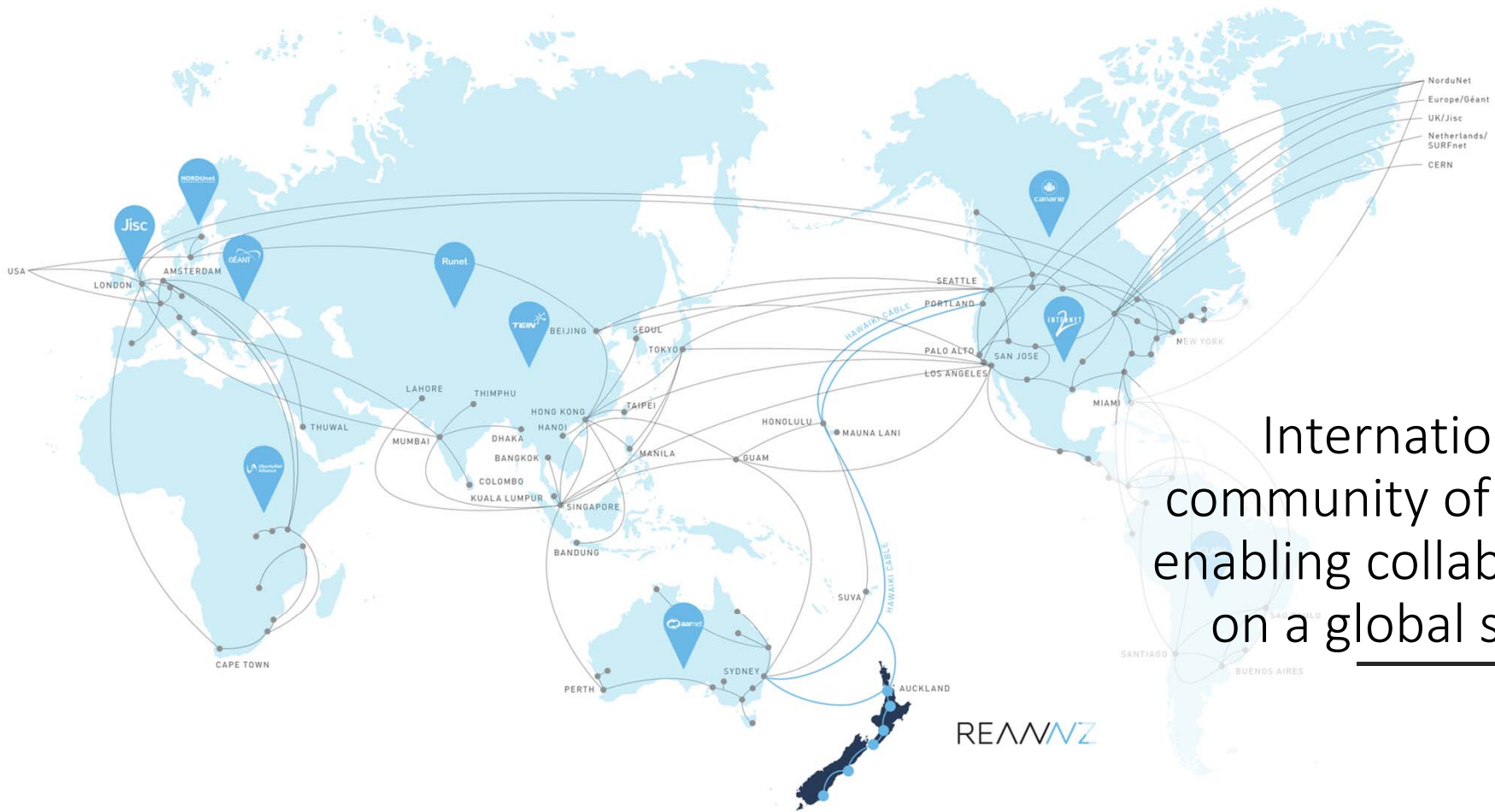




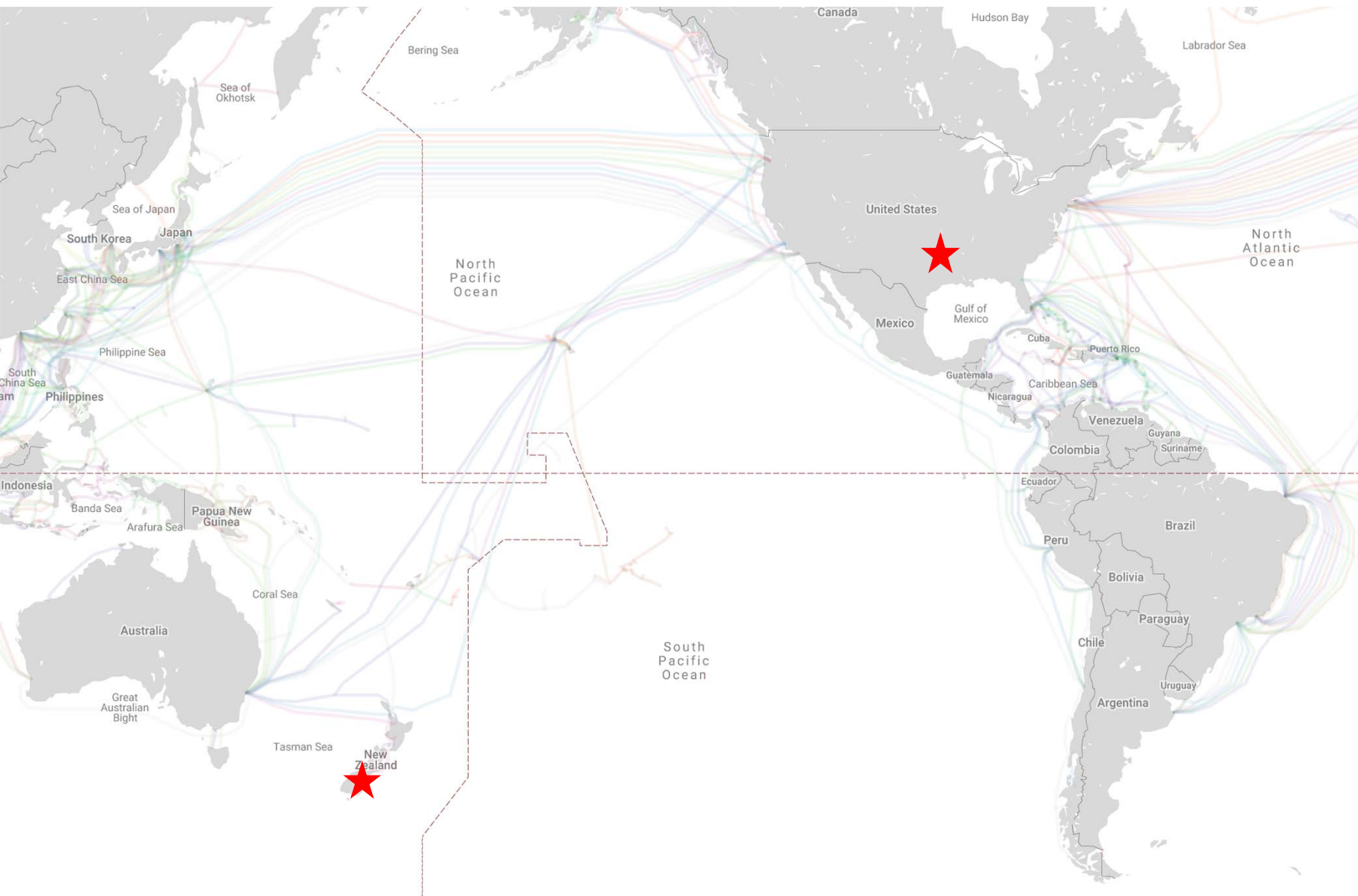


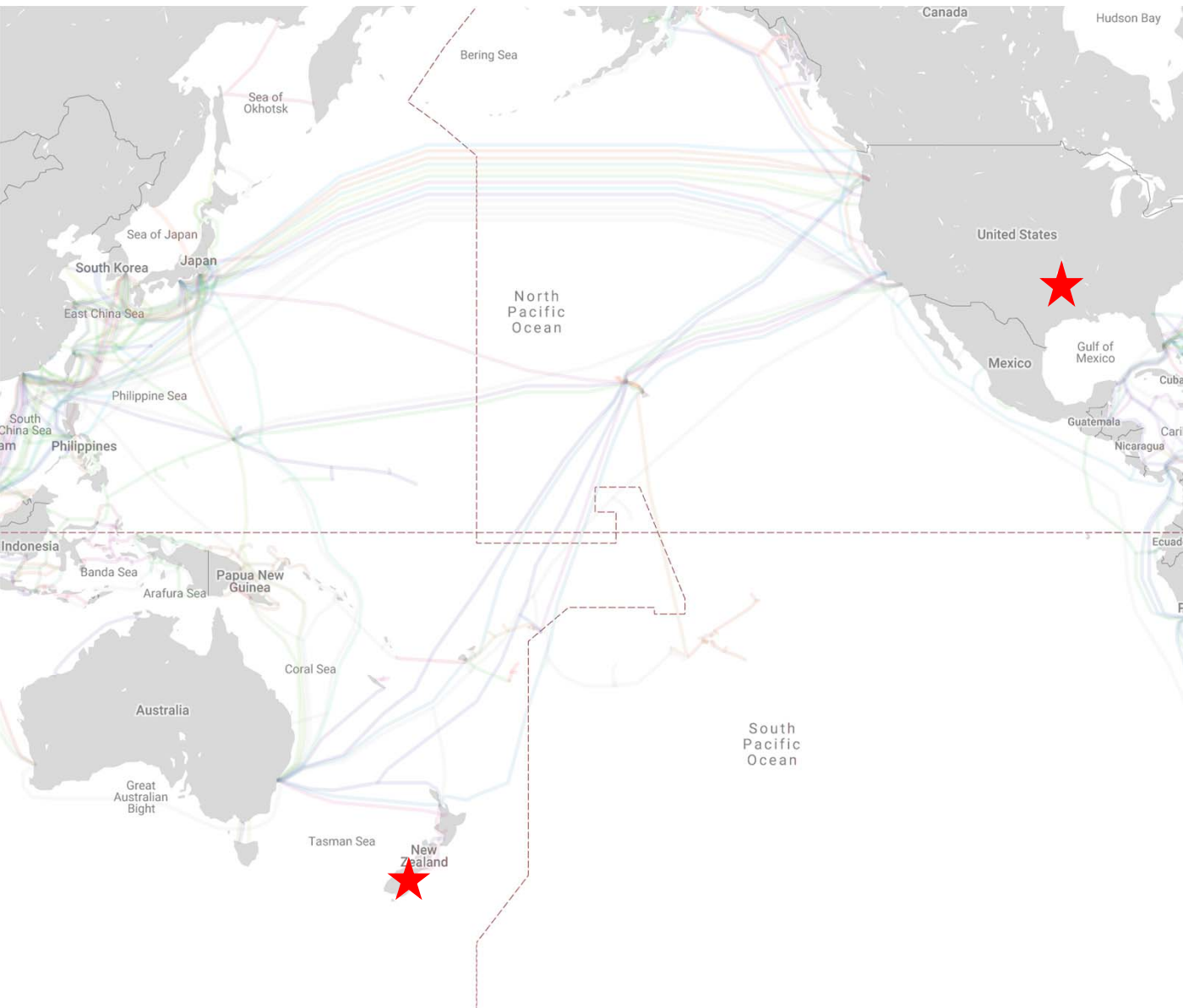






International  
community of NRENs  
enabling collaboration  
on a global scale!



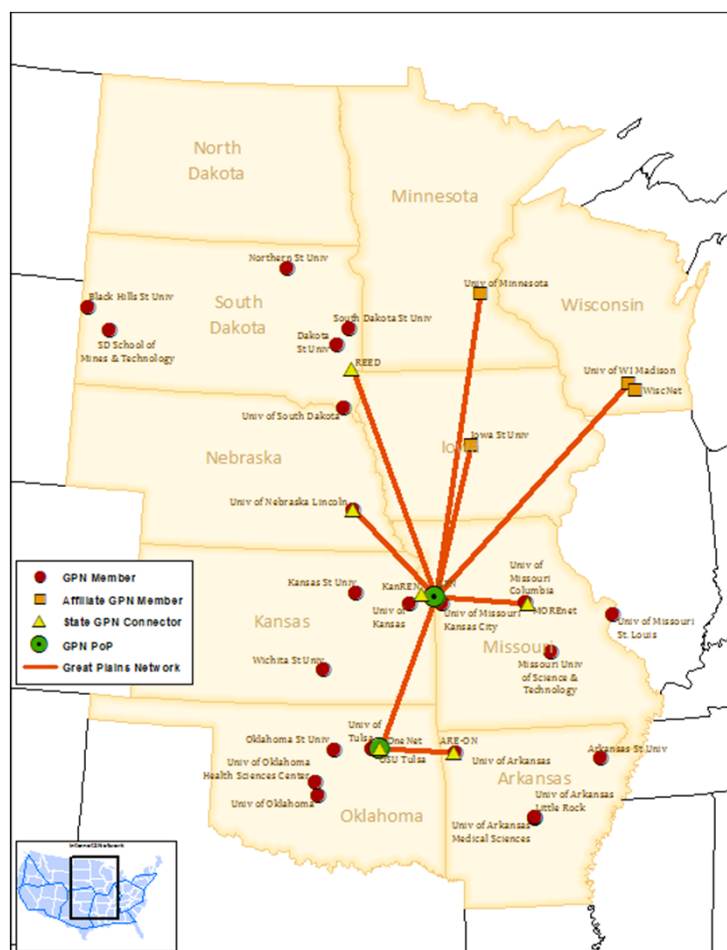




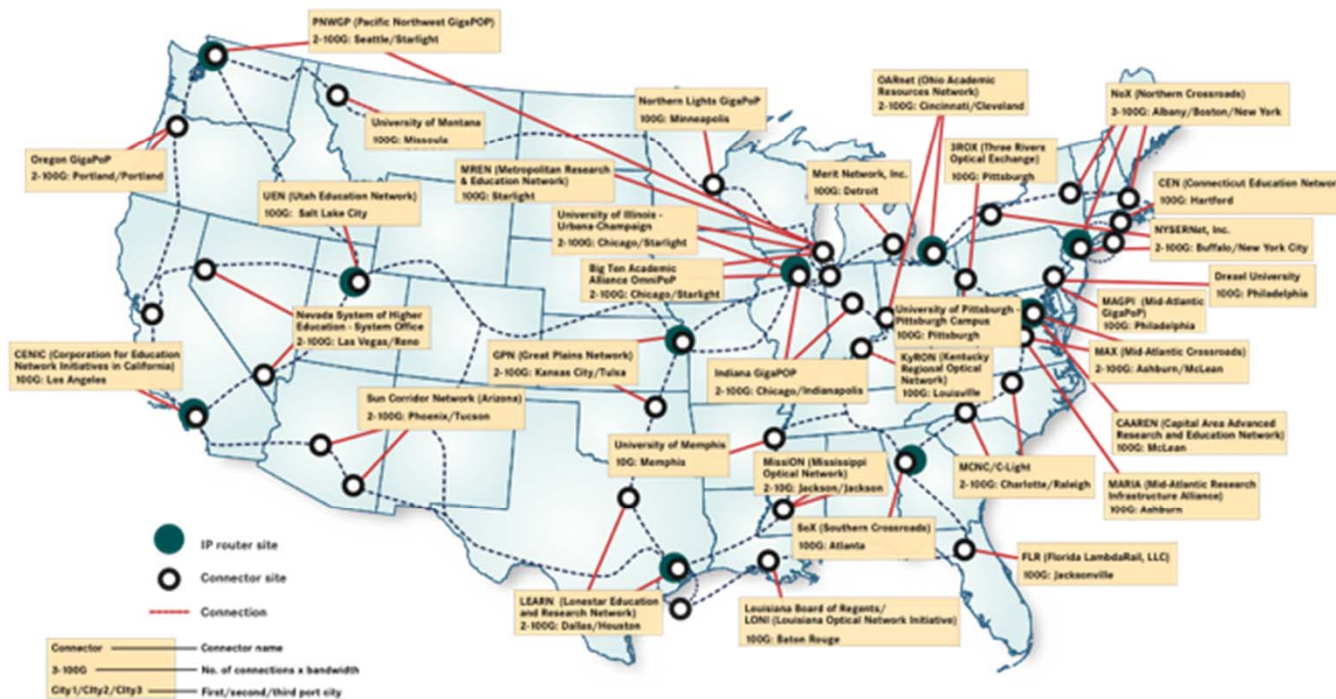
**OneNet Points of Presence**







**INTERNET<sup>2</sup>**  
**INTERNET2 NETWORK CONNECTIONS**  
 WWW.INTERNET2.EDU/CONNECTORS - MARCH OF 2017



NETWORK  
PARTNERS

ciena

INDIANA UNIVERSITY

BROCADE

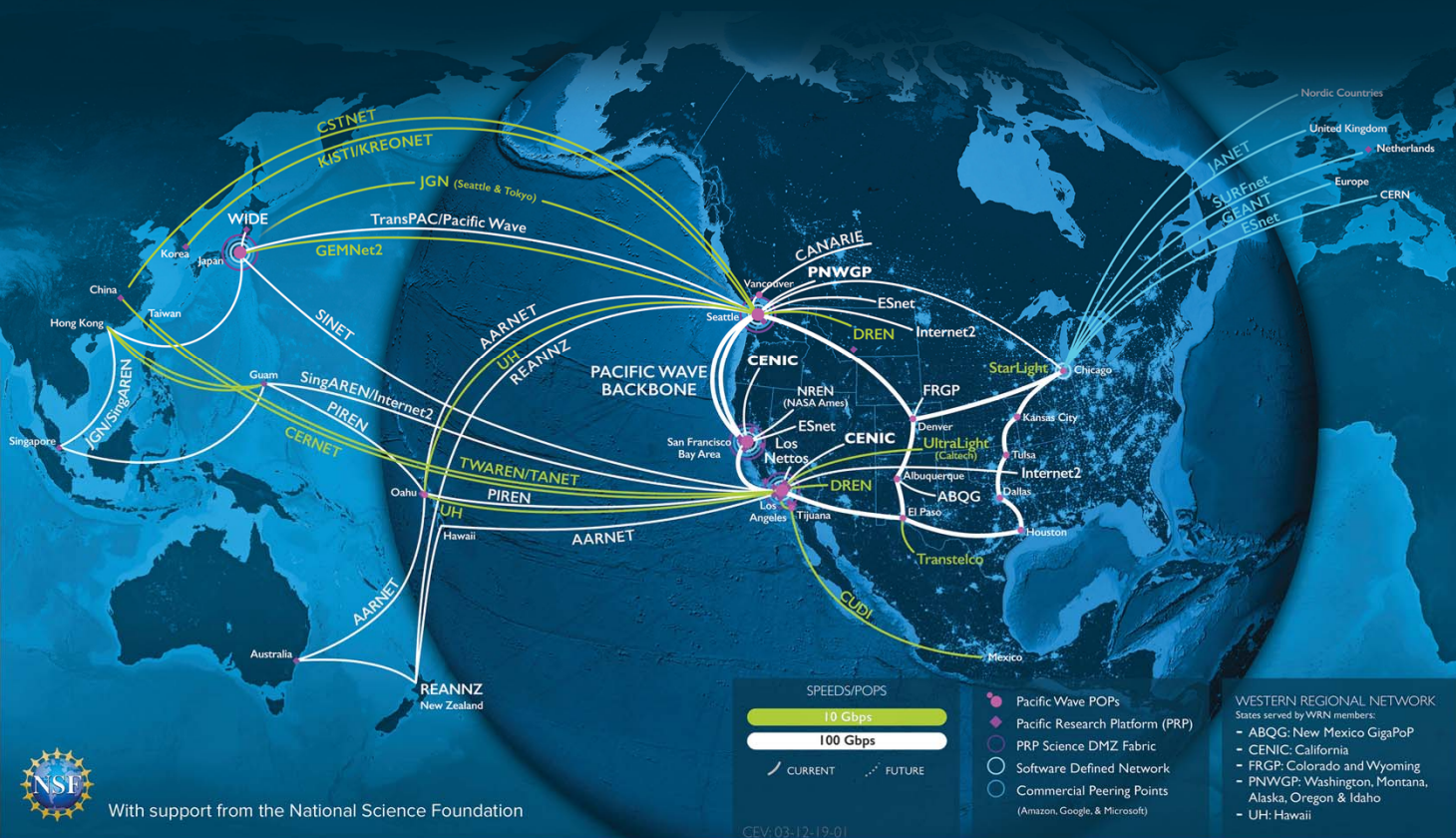
JUNIPER

Level(3)

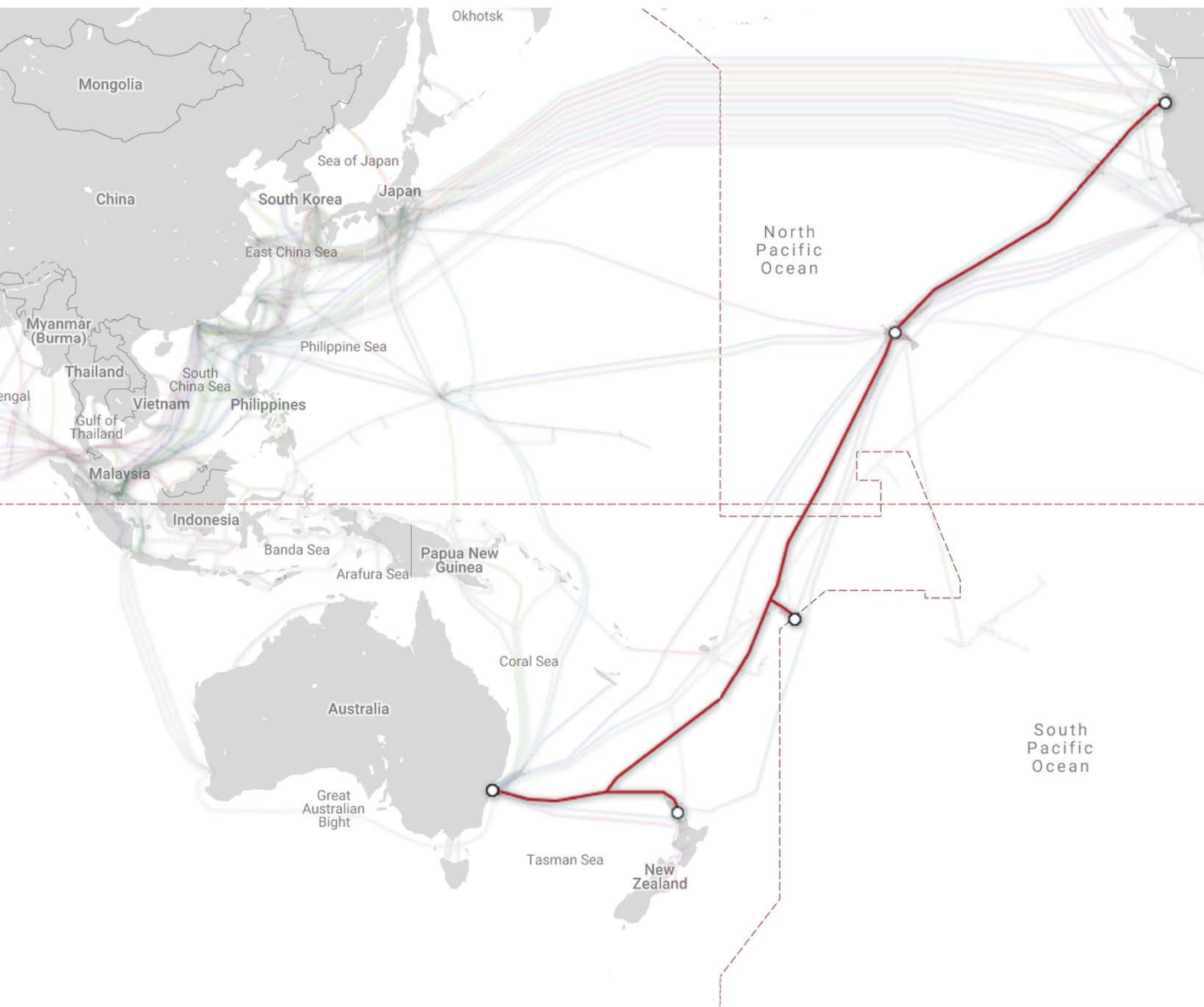


## NATIONAL & INTERNATIONAL PEERING EXCHANGE

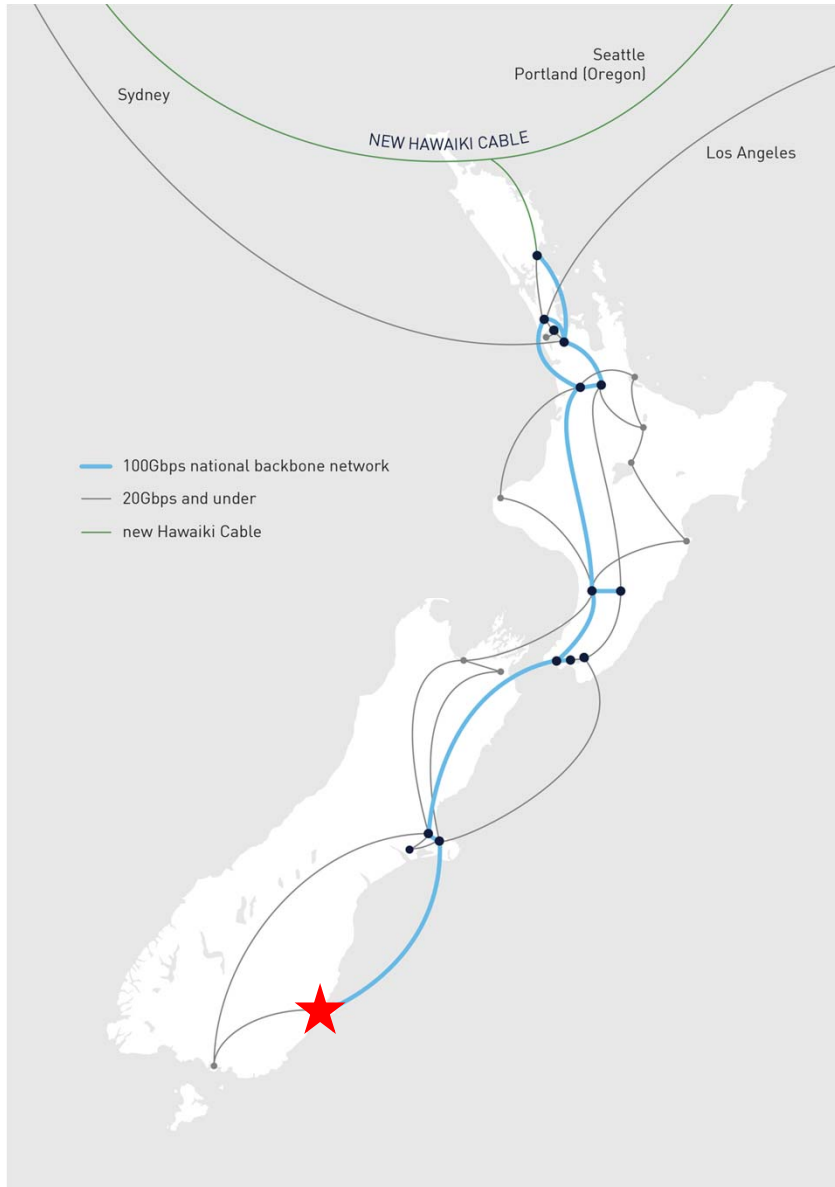
Pacific Wave is a project of CENIC & PNWGP





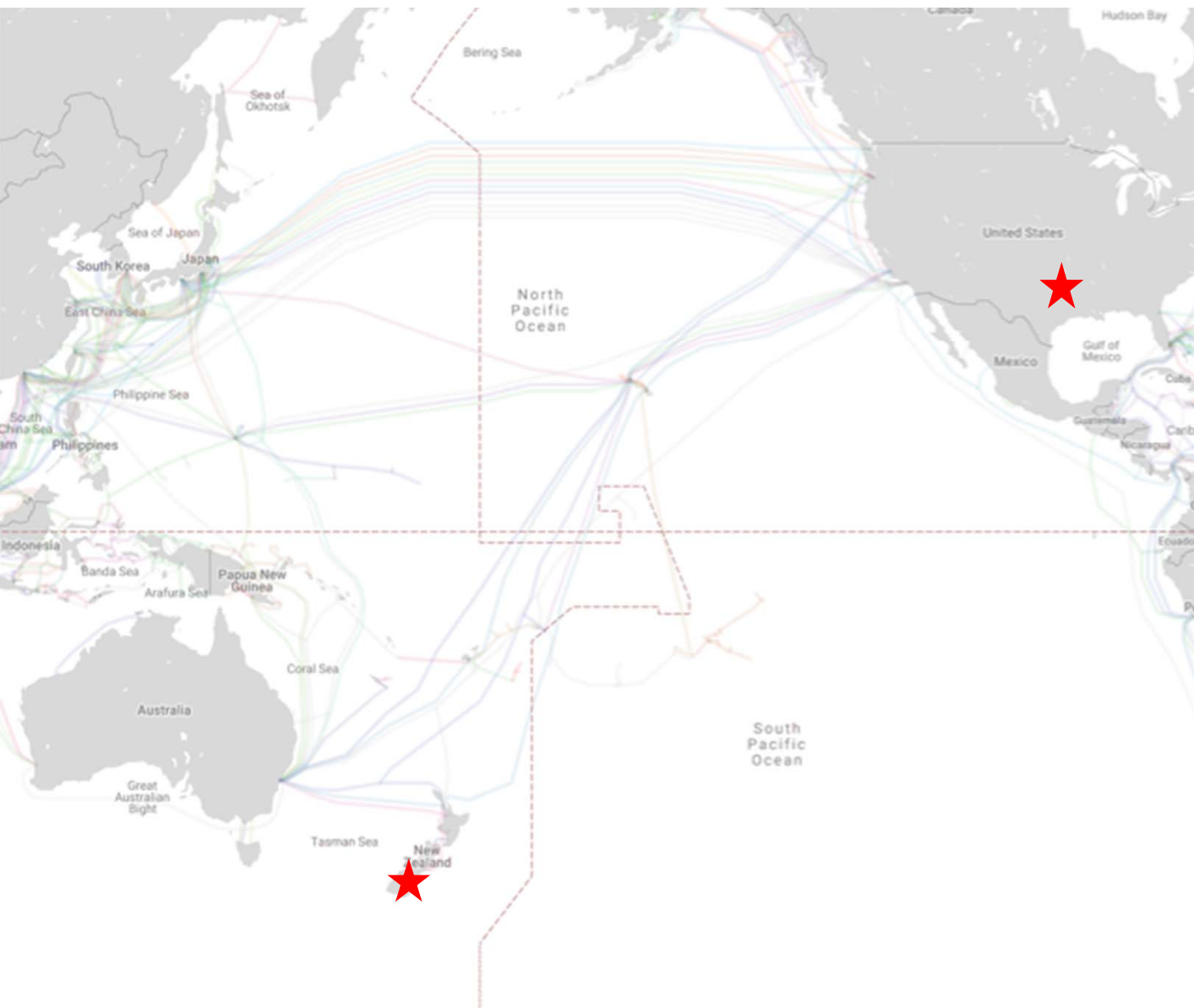






REALNZ





# So... what does all this mean for me?

- The **requirements** of the data intensive researcher and the **service profile** of the traditional campus computer network (or commercial networks) do not always align!
  - Networks interconnect to make more networks
  - Networks get exponentially complex the more connections you have
  - NRENs are at the core of an international community supporting data intensive science!
- 
- Research networks are there to facilitate YOUR transfers. If its not working ask for help!

**If your data has to transit it - its “your” network!**



Our goal.



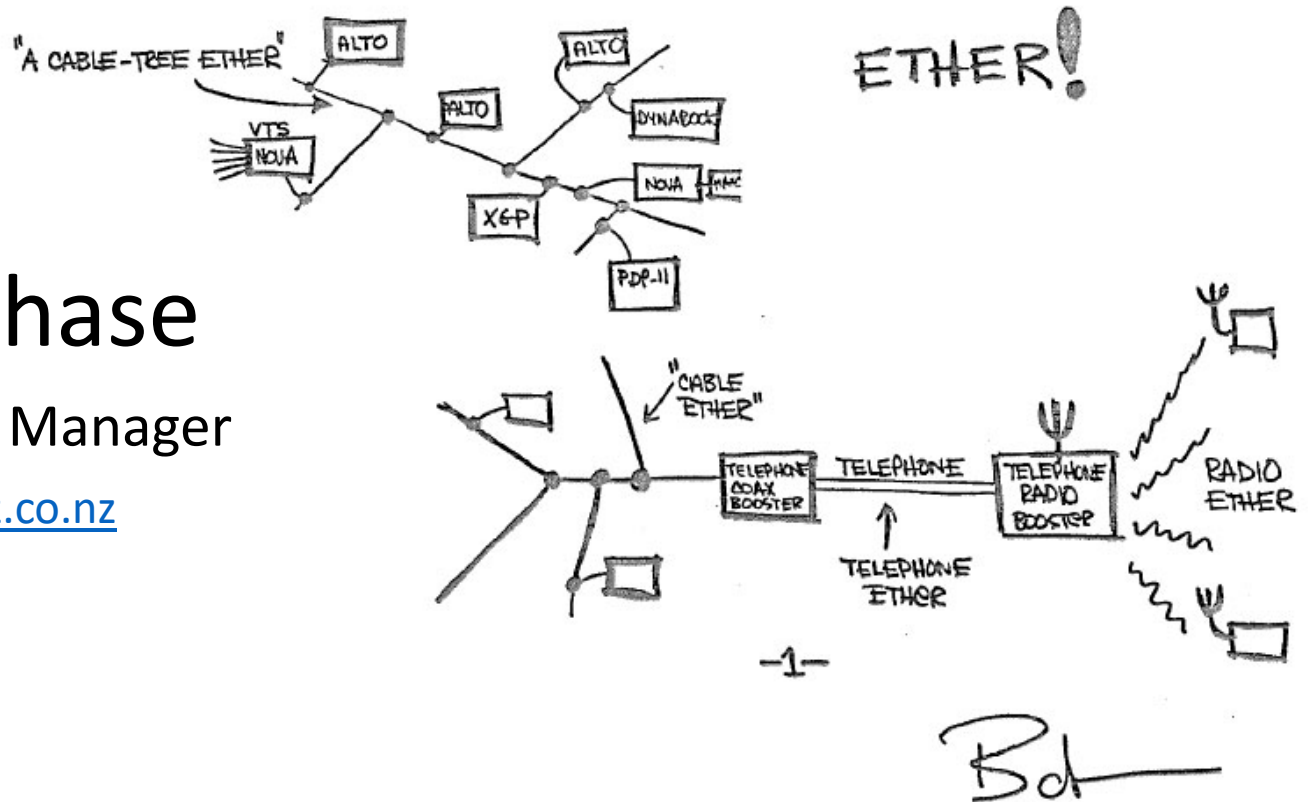
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A very special thanks to Matt Younkins at OU, as the raptors are on loan from him!

