Broadband in Indian Country "Nilch' bee naa alkaa go ohooa doo eidii t'įį. Translation: Using air (technology) to learn and understand new things.

Navajo Technical University, 2019

NTU and Broadband

- Navajo Technical University (NTU) is a research university and the largest and most technologically advanced tribal college or university in the United States.

- NTU operates a campus network and a microwave point-to-point network for the surrounding community. It also supports Navajo Nation information technologies collaborations in support of improving the quality of life for tribal members, and makes constant improvements to external connectivity to support faculty and research projects.

- NTU serves as an organization that introduces innovation and capacity building for the region and within the community.

Project Objectives

- Prepare for and contribute to tribal colleges' and universities' participation in regional and national networking.

- Improve access to external national resources for NTU faculty, researchers, and students.

- Prepare Navajo Nation to advance tribal broadband infrastructure.

- Contribute to the design and implementation of campus networking for small institutions in support of science-driven outcomes.

- Build collaborations between NTU and regional tribal colleges, centers, and organizations to advance campus network redesign.

- Plan and implement a campus/external network design that is sustainable, redundant, and scalable for NTU's needs and requirements.

- Plan for advanced alternative wireless solutions that reduce the "homework gap" on the Navajo Nation to deliver science-oriented academic programs.

Regional Deliverables

- NTU will deliver research network planning for small institutions (e.g., other tribal colleges and universities).
- NTU's Tribal Consortium will be engaged in planning and network planning deliverables for New Mexico and Arizona
  - Dine College (informational)
  - Ashiwi College and Learning Center
  - Institute of American Indian Arts
  - Southwest Indian Polytechnic Institute
  - Tohono O'odham Community College
- Front Range GigaPoP (FRGP) leadership to deliver workshops, planning, design, management and support.
  - Peering Service, Commodity Service, and Internet Service Caching (i.e. Google, Akamai, Netflix, etc.
- Active collaborations with Western Regional Network (WRN), Internet2 and Sun Corridor Network (SCN)
  - Research Education Networks (REN),
  - WRN (Access to FRGP, CENIC, ABQ-G, Univ of Hawaii, PNWGP, and Internet2)
  - SCN (Access to Arizona, ASU, NAU, UofA, and Internet2)
- NTU will expand the Internet to the Hogan (ITTH) Project.
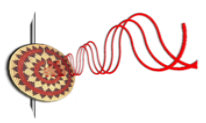
NTU / Current ITTH Infrastructure

- **4 redundant links out of Crownpoint to external resources.**
  - **3 Licensed Microwave links**
    - **East = 155Mbps**
    - **West = 177Mbps**
      - **Both microwave links land on UNM network for NM state peering and Commodity Internet access**
  - **1 Licensed Microwave/Fiber Optic Link**
    - **100 Mbps**
      - **Navajo Tribal Utility Authority (NTUA) to ABQ-G**
  - **1 Fiber Optic link through Frontier Comm.**
    - **Crownpoint to St Michaels**
    - **1Gbit**

Navajotech North
Connect Proposal Through Utah

Denver/Colorado
Connection

Future Projects -

Completed Projects -

Red Mesa, AZ (Qwester transfer to NTC) Navajotech

Marsh Pass, AZ (Qwester transfer to NTC) Navajotech

Navajo Technical University, Teec Nos Pos, Arizona

Proposed Fiber connection through WestNet peering service

Cow Springs, AZ (Qwester transfer to NTC) Navajotech

NTUA - Chinle Connection

Navajotech North Central
Connect Proposal

Navajotech Wireless
Microwave and Wired
Infrastructures

Navajo Technical University, Chinle, Arizona

NTU-NTUA
L2-30Mbps

Cameron, AZ (Qwester transfer to NTC) Navajotech

Full 1 Gbps ISP services

EPSCOR Funded 2012

Crownpoint - NTU
Navajotech
Main

Planned 3 Gbps Full
Duplex Hard Upgrade

Planned 3 Gbps Full
Duplex Hard Upgrade

Planned Full 10
Gbps Layer 2
Service to FRGP

Gallup UNM

Microwave Infrastructure

UNM Funded

UNM-ABQ

Navajotech-
A:shiwi College

NTU-NTUA-TRI-State-UNM
L2-100Mbps

Current ITTH Infrastructure

- **Internet 2 Members**
- **ARIN IPv4 Members (applying for autonomous system numbers) Currently announced by UNM. (/22~1024 Public IP-4 Addresses)**
- **Applying for an Autonomous system number for BGP aggregations for NTU, Navajo Nation, and partners**

NTU: Research Cyberinfrastructure

- **NTU is building a dedicated research infrastructure for Crownpoint researchers, faculty, and students.**
- **Funded by the National Science Foundation, Campus Cyberinfrastructure (CC*) Program.**
- **NTU, with engineering assistance from the FRGP, will implement a Science DMZ in Fall 2019.**
- **A Science DMZ design allows for large network payloads or "elephant flows" to leave campus and transfer data to external locations.**
- **Today, these "elephant flows" fail or time out.**
- **Science and research is hindered or neglected.**
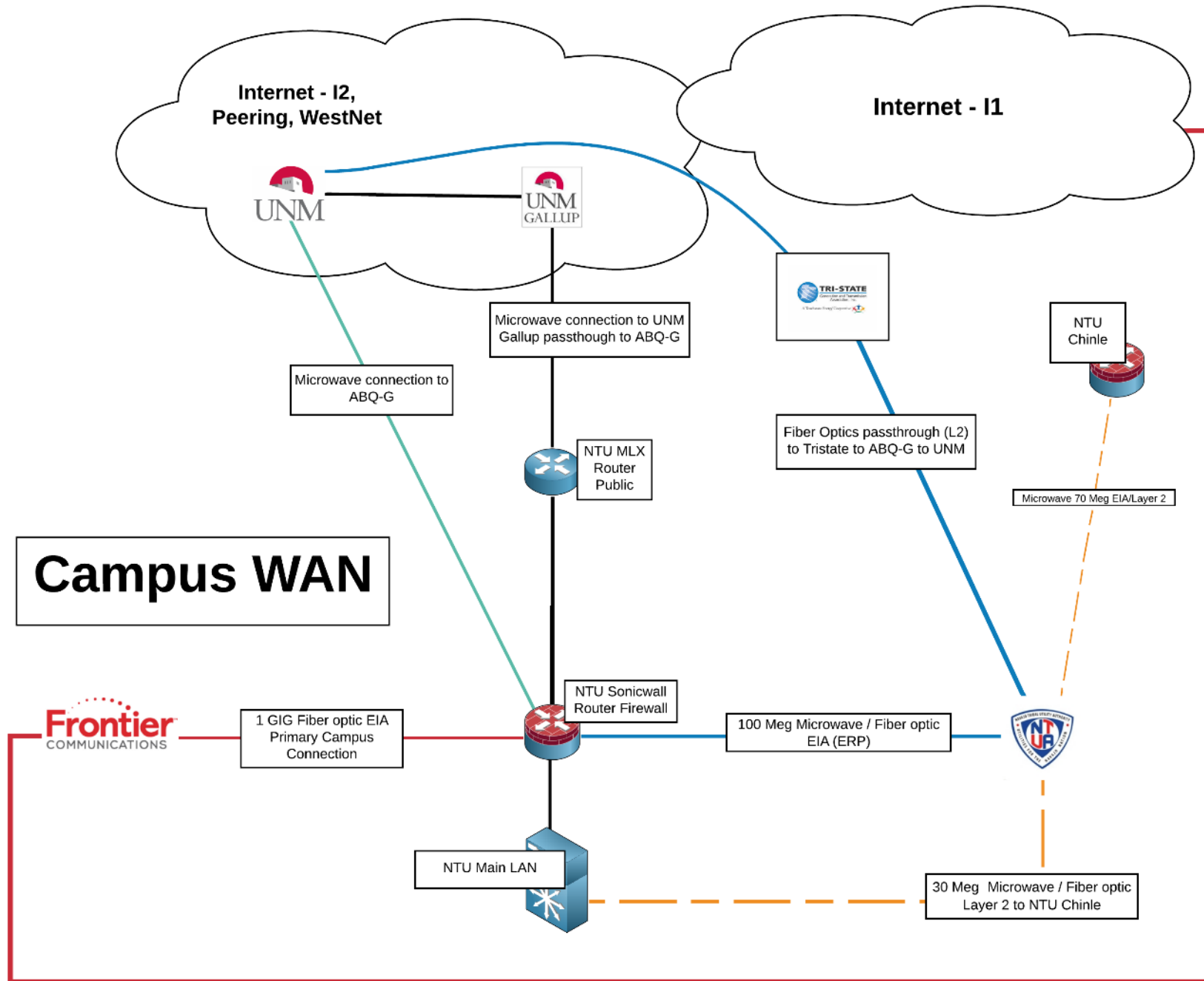
Science DMZ

A computer subnetwork that is structured to be secure, but without the performance limits that would otherwise result from passing data through a stateful firewall.
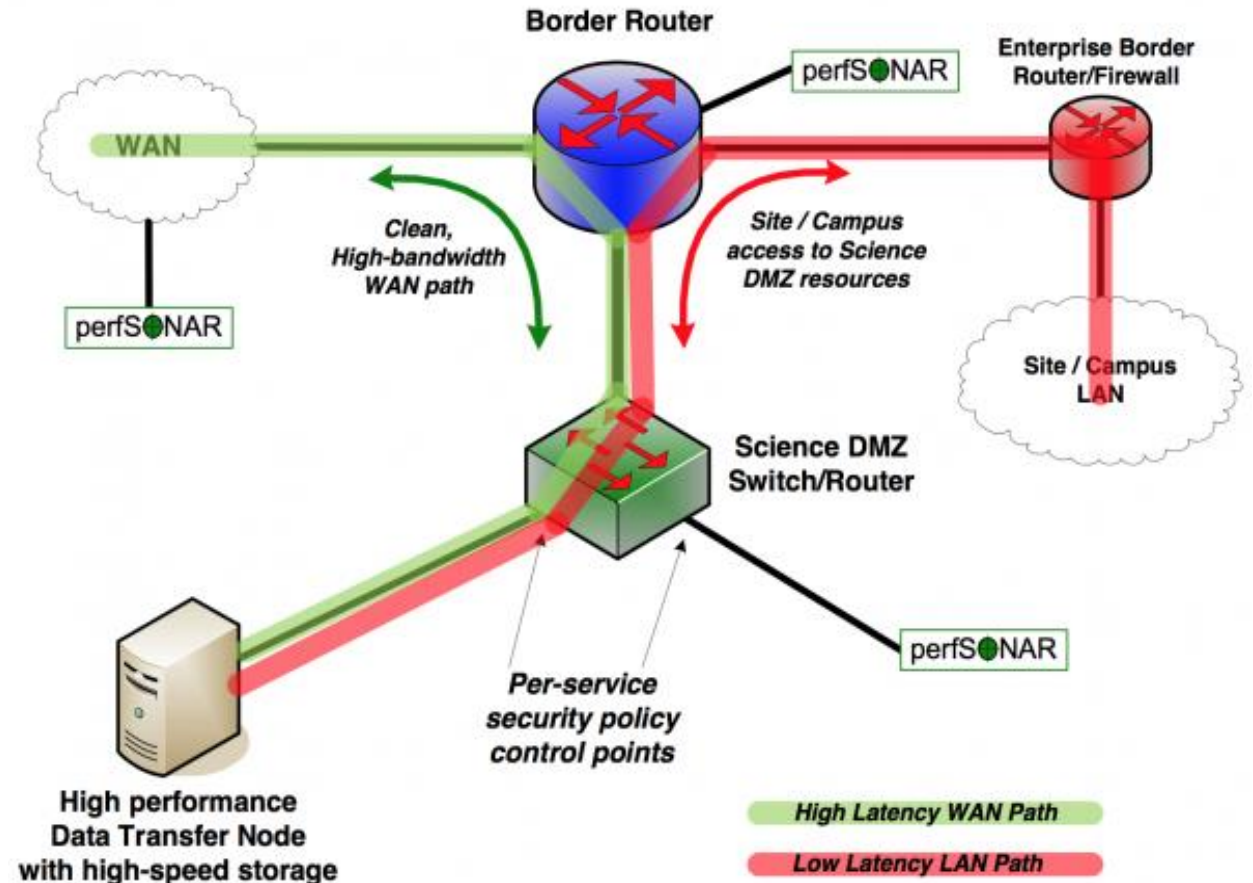
PerfSonar

A tool for end-to-end monitoring and troubleshooting of multi-domain network performance.

perfSONAR provides network engineers with the ability to test and measure network performance, as well as to archive data in order to pinpoint and solve service problems that may span multiple networks

Acknowledgment: International Networks @ Indiana University

🔖 **Other services**

Global node directory ⬈
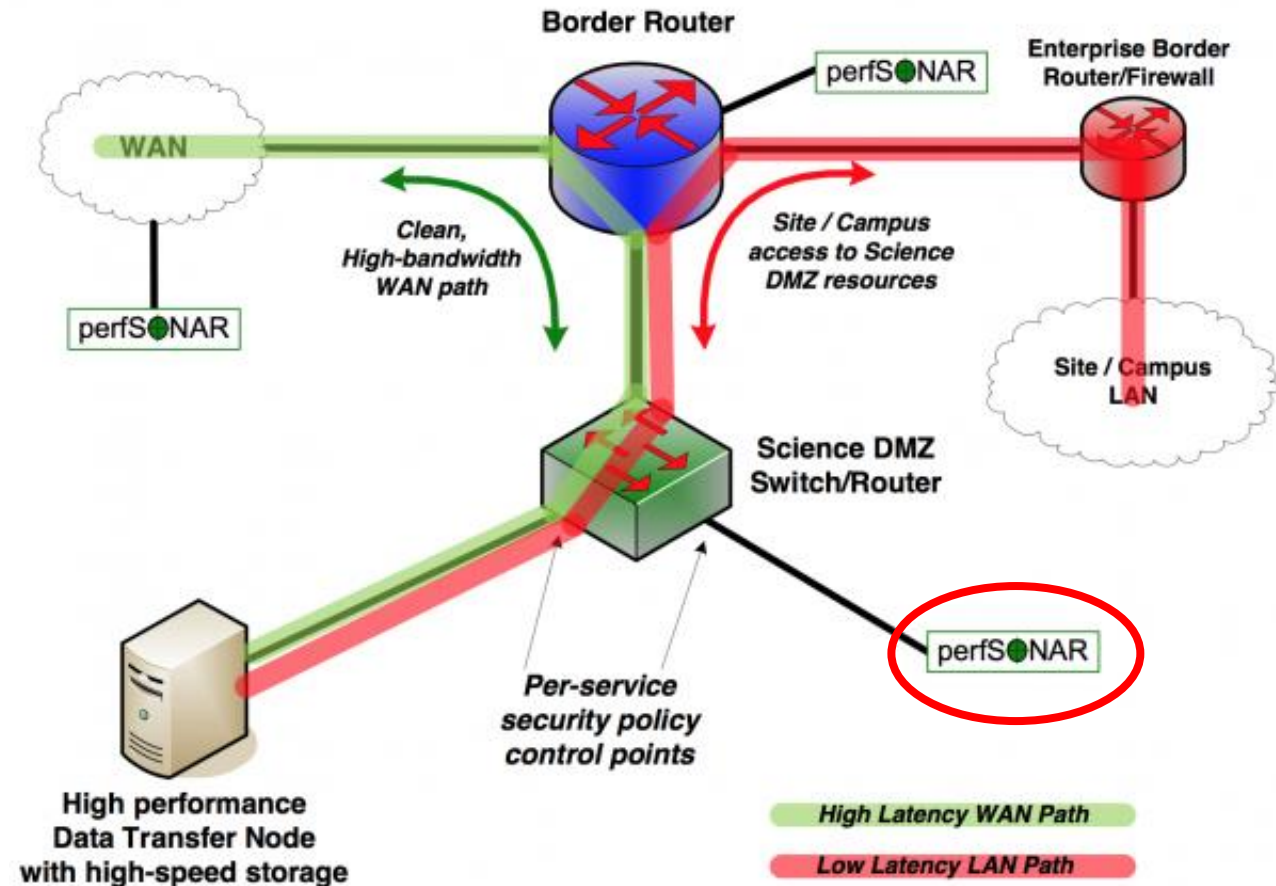
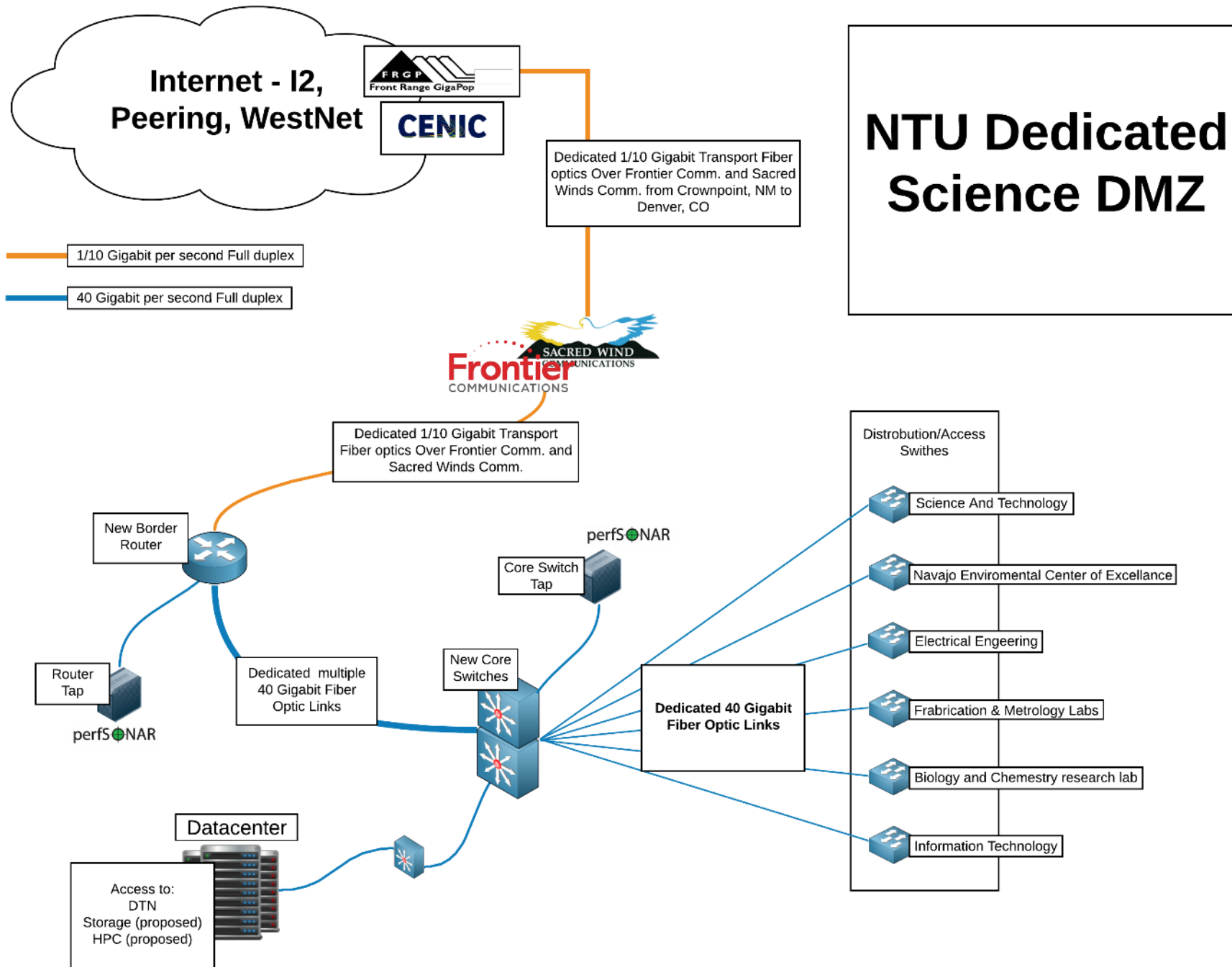|	SOURCE	DESTINATION	THROUGHPUT	LATENCY (MS)	LOSS
▲					
	50.33.113.5 Graphs | Traceroute ⬈	216-67-219-67.dsl2.kgm.az.frontiernet.net 216.67.219.67	→ 65.2 Mbps ← 92.7 Mbps	→ 9.15 ← -3.75	→ 1.859% ← 0.011%
	50.33.113.5 Graphs | Traceroute ⬈	50.33.113.4	→ 944 Mbps ← n/a	→ 1.92 ← n/a	→ 0.000% ← n/a
	50.33.113.5 Graphs | Traceroute ⬈	74.43.7.46	→ 179 Mbps ← 175 Mbps	→ 0.910 ← 2.37	→ 0.017% ← 0.009%
	50.33.113.5 Graphs | Traceroute ⬈	50.33.113.6	→ 920 Mbps ← n/a	→ -0.0389 ← n/a	→ 0 ← n/a
	50.33.113.5 Graphs | Traceroute ⬈	perfsonar.ucar.edu 128.117.132.12	→ 592 Mbps ← n/a	→ 33.6 ← n/a	→ 0.009% ← n/a
	50.33.113.5 Graphs | Traceroute ⬈	perfsonar.unm.edu 64.106.80.4	→ 472 Mbps ← 484 Mbps	→ 48.4 ← 39.4	→ 0.023% ← 0.015%
	50.33.113.5 Graphs | Traceroute ⬈	personar-serpa.nnmc.edu 40.138.144.173	→ 66.2 Mbps ← 462 Mbps	→ n/a ← n/a	→ n/a ← n/a
	50.33.113.5 Graphs | Traceroute ⬈	ps.ncar.xsede.org 128.117.212.249	→ 586 Mbps ← 643 Mbps	→ 32.3 ← 34.3	→ 0.012% ← 0.010%

Show 10 entries

Showing 1 to 8 of 8 entries   Previous   **1**   Next

Navajotech Fiber Optics Plans

Phase 1 - Crownpoint – Yatahey – Window Rock – Holbrook or Winslow – Gallup – Thoreau – Crownpoint
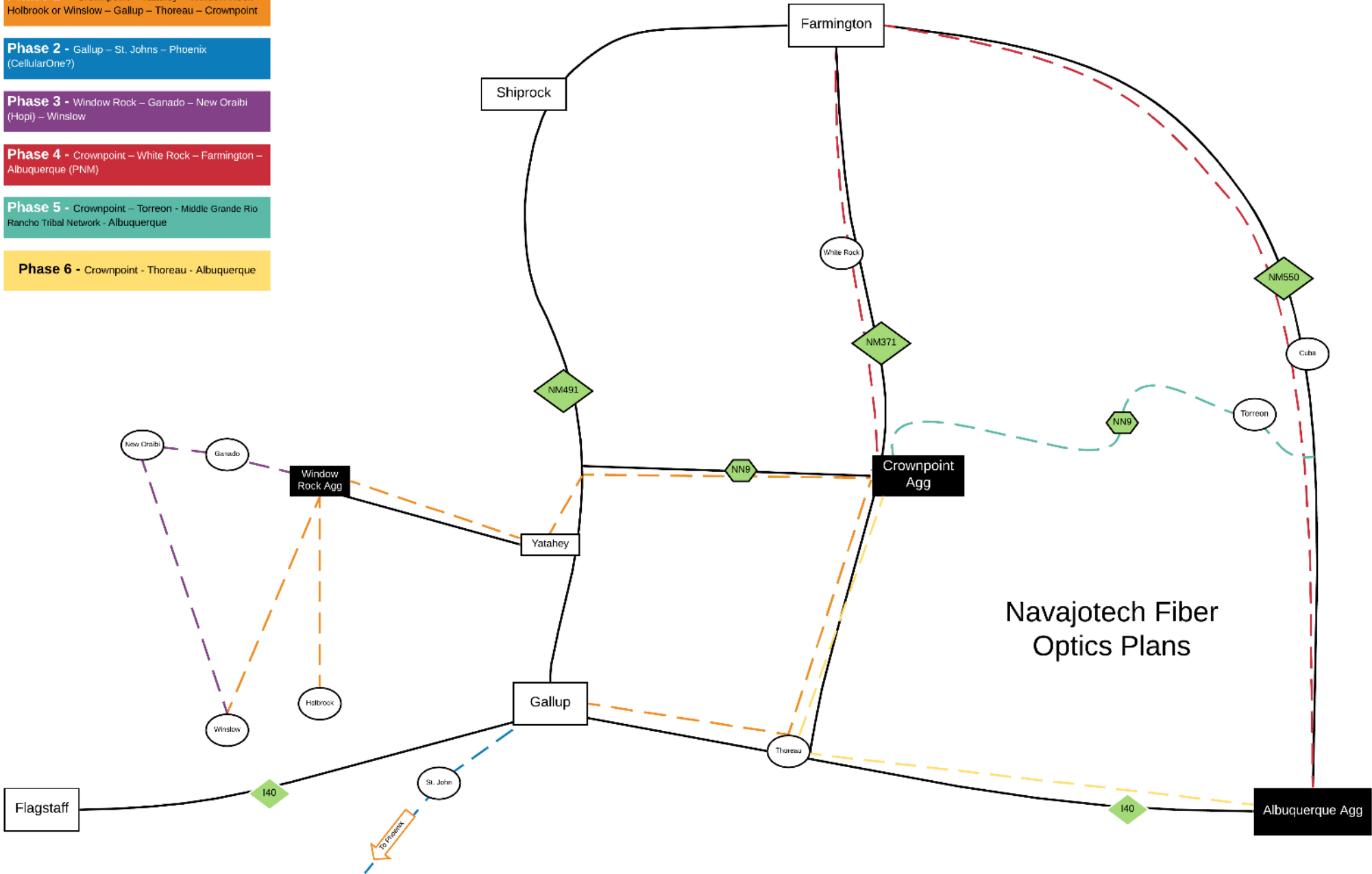
Phase 2 - Gallup – St. Johns – Phoenix (CellularOne?)

Phase 3 - Window Rock – Ganado – New Oraibi (Hopi) – Winslow

Phase 4 - Crownpoint – White Rock – Farmington – Albuquerque (PNM)

Phase 5 - Crownpoint – Torreon - Middle Grande Rio Rancho Tribal Network - Albuquerque

Phase 6 - Crownpoint - Thoreau - Albuquerque

Bandwidth (the great disparity)

1G

1YR - $4,086 Total MRC - $2400 Non-recurring charge

3YR - $2,609 Total MRC - $2400 Non-recurring charge

5YR - $2,321 Total MRC - $2400 Non-recurring charge

5G

1YR - $64,000 Total MRC - $2400 Non-recurring charge

3YR - $23,111 Total MRC - $2400 Non-recurring charge

5YR - $14,435 Total MRC - $2400 Non-recurring charge

10G

3YR - $33,400 Total MRC - $2400 Non-recurring charge

Crownpoint to Albuquerque
Transport Only

Tsalie to 1Gb EIA

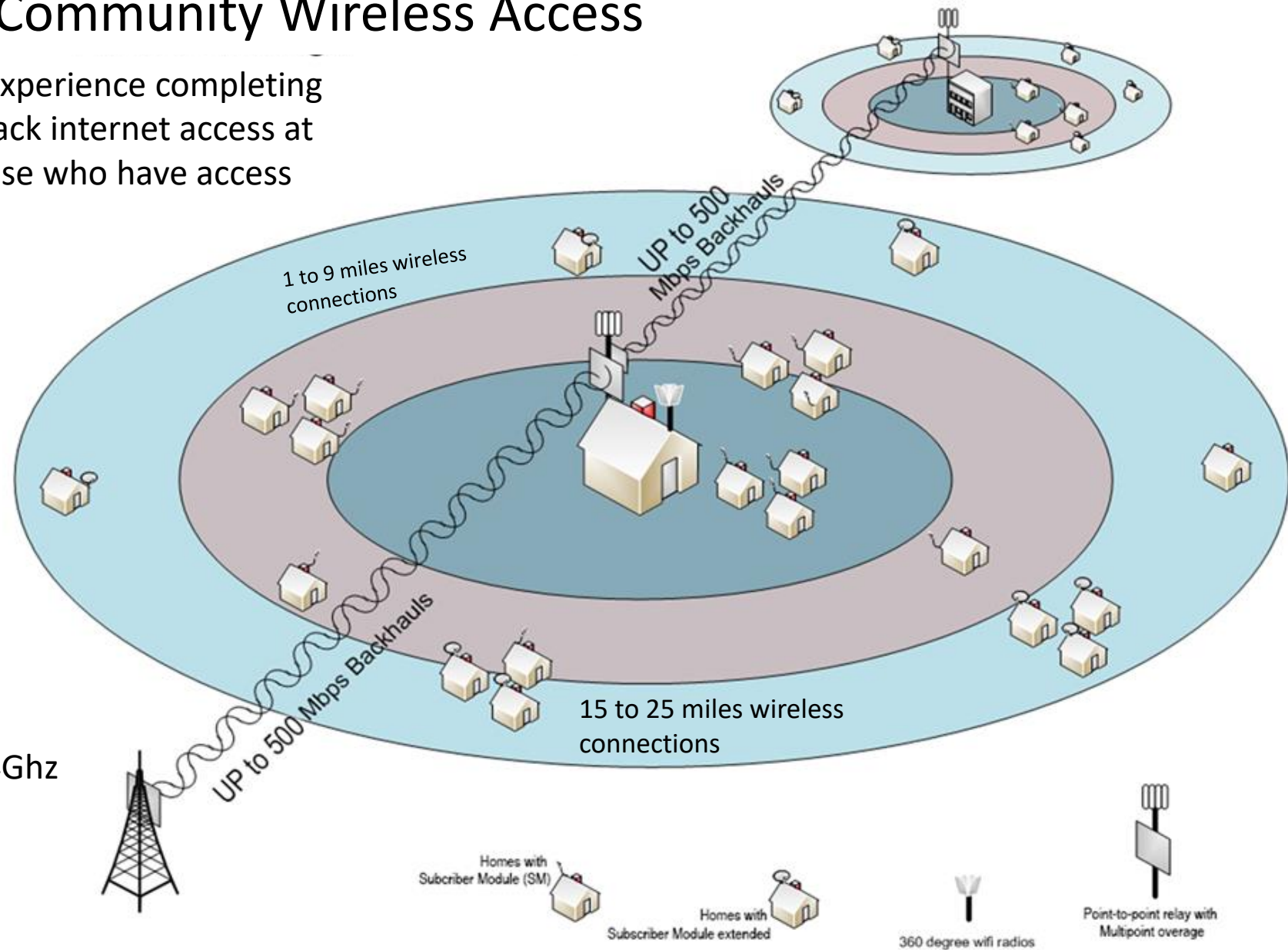| BW and DIA Rates	Rate/Mb	5% NN Tax	Total
1. Transport Cost (L2)	$30.00	$1.50	$31.50
2. Direct Internet Access (DIA)	$10.00	$0.50	$10.50
Total Monthly Reoccurring Cost (MRC)	Mb	Rate/Mb	MRC
1000 Mb DIA delivered to Tsaile Main Campus DIT office	1000	$40.00	$40,000.00
		Total	$40,000.00

NTU BondWilson to 100Mb EIA

Pricing Table

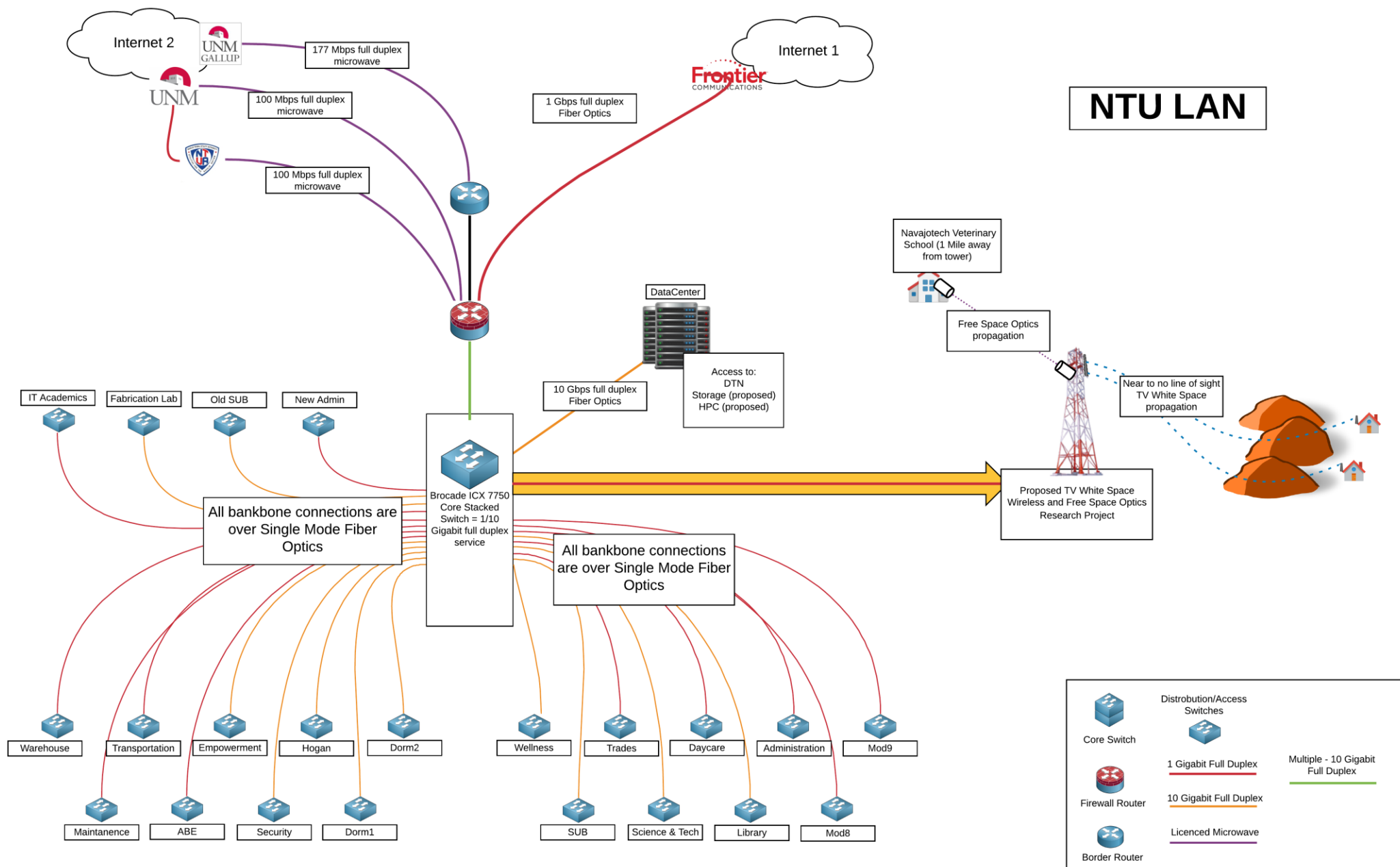| Product	Qty	Service Address	Service Details	Service Attributes	Term (Months)	MRC	NRC	Waived NRC
IQ Networking	1	583 ROAD 6100 KIRTLAND NM 87417	IQ Networking Port - Internet	Tiered 100BT 100 Mbps	36 Months	$450.00	$325.00	$325.00
Local Access	1	583 ROAD 6100 KIRTLAND NM 87417	ELA Native Single-CoS Low	CenturyLink (CLPA) GIG E 100M	36 Months	$716.00	$600.00	$600.00
					Service Sub Total:	$1,166.00	$0.00	

Homework Gap Community Wireless Access

the difficulty students experience completing
homework when they lack internet access at
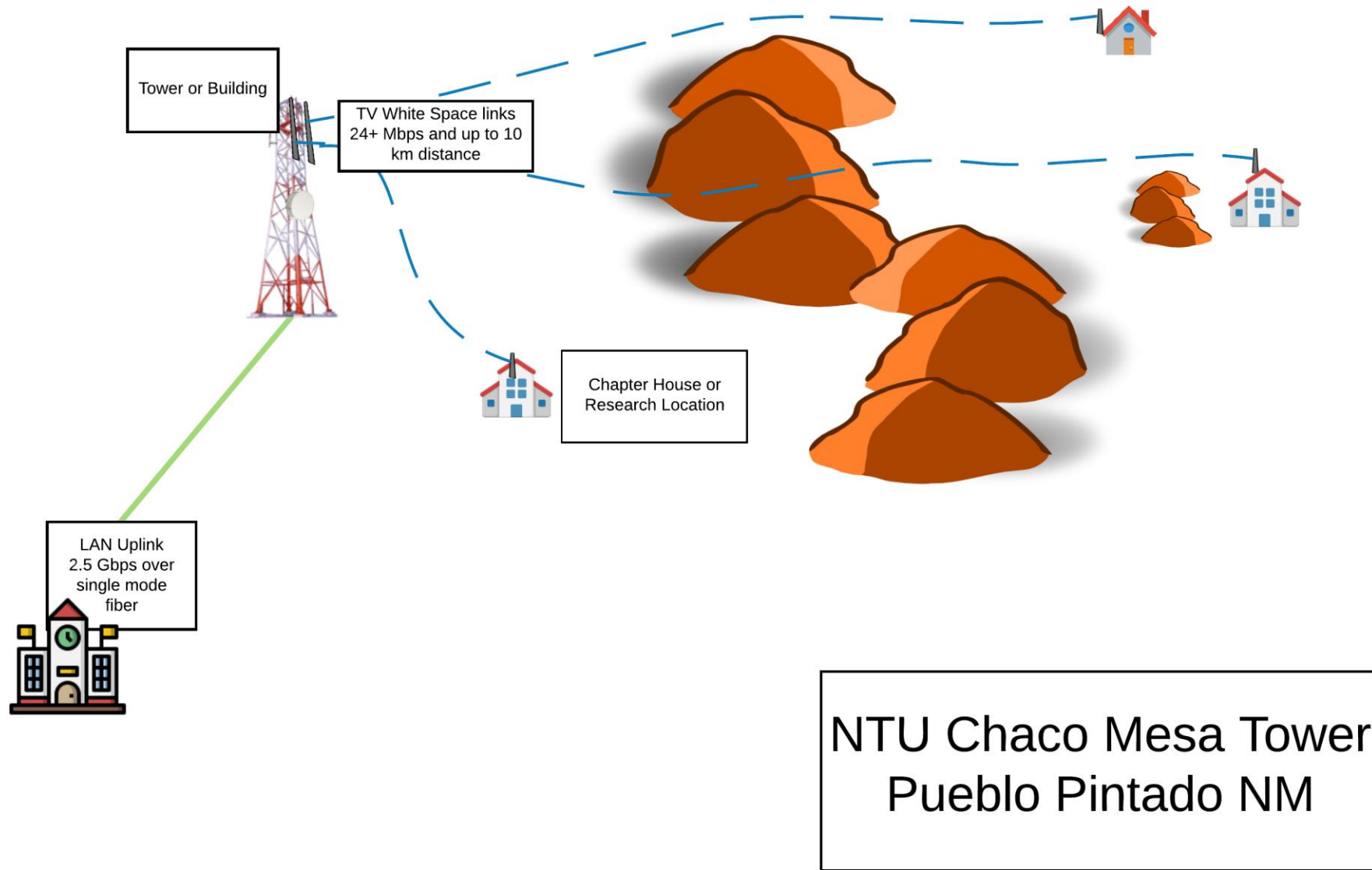home, compared to those who have access

Solutions:
- CRBS
- Whitespace
- EBS (Awaiting FCC Auction)
- 900 Mhz
- Unlicensed 5Ghz & 2.4Ghz

1 to 9 miles wireless connections

UP to 500 Mbps Backhauls

UP to 500 Mbps Backhauls

15 to 25 miles wireless connections

Homes with Subcriber Module (SM)

Homes with Subcriber Module extended

360 degree wifi radios

Point-to-point relay with Multipoint overage

NTU LAN

Tower or Building

TV White Space links 24+ Mbps and up to 10 km distance

Chapter House or Research Location

LAN Uplink 2.5 Gbps over single mode fiber

NTU Chaco Mesa Tower
Pueblo Pintado NM

Navajo Technical University

Engaging Navajo Nation to Build Better Broadband

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