Navajo Technical University: A Broadband Journey

A White Paper Presented to the Legislative Committee — Prepared by the Office of Information Technology, Navajo Technical University, Crownpoint, New Mexico

Over more than two decades, Navajo Technical University (NTU) — established in Crownpoint, New Mexico as the Crownpoint Institute of Technology — has transformed its information technology infrastructure from a modest satellite Internet connection into one of the most advanced broadband networks operated by any Tribal College or University (TCU) in the United States. This white paper chronicles that journey: the deliberate, resource-conscious decisions made at each infrastructure inflection point, the partnerships forged with state educational networks and private carriers, and the resulting capacity that now positions NTU as a regional anchor for research, education, and community connectivity on the Navajo Nation.

The history presented here is not merely a technical narrative — it is a testament to the determination of a tribal institution to close the digital divide through innovation, intergovernmental partnership, and strategic investment of public and tribal resources.

CHAPTER 1

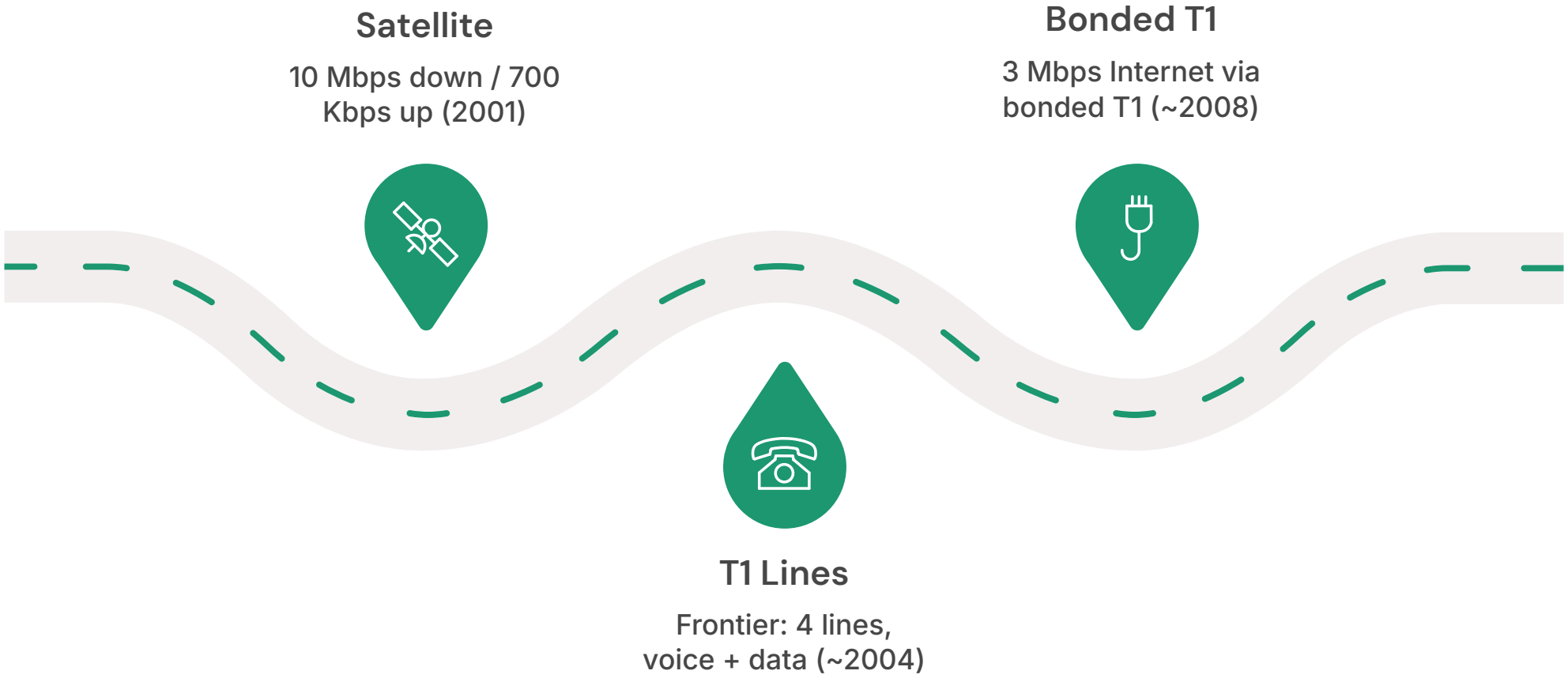
Origins and Early Connectivity (2001–2008)

2001: Satellite Internet

Operating as Crownpoint Institute of Technology, the institution established its first Internet connection via commercial satellite — delivering a **10 Mbps downlink** and a constrained **700 Kbps uplink**. This asymmetric connection reflected both the technological limitations of the era and the geographic realities of Crownpoint, situated within the sovereign boundaries of the Navajo Nation where terrestrial broadband was largely absent. While limited by today's standards, it enabled the campus to participate in the emerging digital learning environment and established the institutional appetite for expanded connectivity.

~2004–2008: T1 Lines and Terrestrial Transition

CIT transitioned to a terrestrial solution by contracting with Frontier Communications for **four T1 lines** (1.544 Mbps each). Two lines were dedicated to voice telephony and two to Internet data. The IT Office implemented **channel bonding** on the two data T1s, aggregating their capacity to produce a combined **3 Mbps** Internet connection. This modest improvement enabled the campus to begin scaling digital services. However, the high recurring cost of T1 leased lines, paired with the still-limited bandwidth ceiling, made clear that a more scalable and cost-effective solution was necessary for the institution's growing academic and administrative needs.



Each phase built institutional knowledge and demonstrated the university's commitment to connectivity — even when the available technology fell far short of what the campus ultimately needed.

CHAPTER 2

The First Microwave Build — The East Link (2009)

A pivotal chapter opened in 2009 when the **New Mexico State Legislature** provided capital outlay funding for a licensed microwave backbone linking Crownpoint to Albuquerque — formally titled **"Internet to the Hogan."** The IT Office issued an RFP for a licensed point-to-point microwave system, which introduced NTU to **Hans-Werner Braun** of UC San Diego's San Diego Supercomputer Center and the NSF-funded **High Performance Wireless Research and Education Network (HPWREN)** — a relationship that shaped NTU's wireless design philosophy. The awarded solution utilized **Harris Stratex** licensed microwave radios capable of SDH capacities up to 155 Mbps per channel.

1

Hop 1: Crownpoint → Chaco Mesa

Signal originated from an NTU-owned tower on the Crownpoint campus, directed eastward to a second NTU-constructed tower at Chaco Mesa.

2

Hop 2: Chaco Mesa → Pajarito Peak

Extended to a Sandoval County-owned tower at Pajarito Peak. NTU obtained collocation rights at no or minimal cost through cooperative intergovernmental relationships.

3

Hop 3: Pajarito Peak → Crows Flat

Signal carried to a Univision broadcast tower on Zia Pueblo land. NTU was granted collocation access at no or minimal cost through respectful dialogue with the Pueblo community.

4

Hop 4: Crows Flat → 505 Marquette, Albuquerque

Final hop delivered the signal to the Bank of the West building. A fiber jumper interconnected with the University of New Mexico's network infrastructure in the building's basement.

The University of New Mexico granted NTU a **1 Gbps fiber optic connection** at the 505 Marquette handoff. The microwave system itself operated at a fully duplex **155 Mbps** — more than 50 times the prior 3 Mbps capacity. This partnership also unlocked access to **NMREN**, **Internet2**, and **National LambdaRail**. Concurrently, NTU received an ARIN **/22 IPv4 allocation** (1,024 addresses), replaced legacy multi-mode fiber with single-mode infrastructure, and upgraded campus switches from 3Com 10 Mbps to Cisco 1 Gbps enterprise-class equipment.

CHAPTER 3

The West Link and Redundancy (2011–2016)

Around 2011, NTU was awarded a **New Mexico EPSCoR broadband grant**. Rather than expanding the Harris Stratex East Link, a cost analysis revealed that **Motorola licensed microwave equipment** could deliver equivalent performance at substantially lower per-hop cost — enabling NTU to fund a **three-hop western microwave link** within the same budget that would have purchased a single Harris Stratex solution. This decision created a second, geographically diverse broadband path, establishing **true redundancy** for NTU's external Internet connectivity for the first time.

Hop 1: Crownpoint → Deza Bluff

Westward from the NTU campus tower to Deza Bluff, collocating with **KTNN Radio** — the Voice of the Navajo Nation — reinforcing NTU's commitment to tribal collaboration.

Hop 2: Deza Bluff → Gibson Peak

Extended south to Gibson Peak above Gallup, NM, partnering with **Millennium Media** — the only commercial (non-educational, non-tribal) colocation partner in the entire infrastructure build.

Hop 3: Gibson Peak → UNM Gallup (Calvin Hall)

Final hop to the UNM Gallup campus rooftop. NTU rode the UNM fiber bundle as a **VPN tunnel** back to 505 Marquette — accessing the same Internet and research network resources as the East Link.

The West Link achieved a fully duplex **177 Mbps** over-the-air throughput. Combined with the East Link's 155 Mbps, NTU now operated **two independent licensed microwave paths** to Albuquerque — providing both raw bandwidth expansion and critical network fault tolerance. The campus had grown from a single 3 Mbps T1-bonded connection in 2008 to over **330 Mbps of redundant microwave capacity** — more than a 100-fold increase — achieved largely through grant funding and inter-institutional partnerships.

CHAPTER 4

Fiber Optic Connectivity and Network Modernization (2017–2019)

In 2017, a fortuitous convergence of relationships accelerated NTU's next infrastructure milestone. At a regional broadband meeting at Northern Arizona University in Flagstaff — organized by Dr. Gilbert Gonzales, then CIO of the University of New Mexico — NTU's technology leadership encountered the local General Manager of **Frontier Communications** at the dinner table. This informal exchange led to a formal agreement: Frontier extended **fiber optic connectivity** to the NTU campus in Crownpoint and provisioned an **Ethernet Internet Access (EIA) circuit at 1 Gbps dedicated capacity**, with a network path extending through to Dallas, Texas. For the first time, NTU possessed a high-capacity, low-latency terrestrial fiber link to a major national Internet exchange point.

Path 1 — East Microwave Link

Harris Stratex, 155 Mbps fully duplex, to UNM via 505 Marquette, Albuquerque.

Path 2 — West Microwave Link

Motorola, 177 Mbps fully duplex, to UNM via UNM Gallup campus.

Path 3 — Frontier Communications Fiber

1 Gbps EIA dedicated circuit, Crownpoint to Dallas, Texas — the first terrestrial fiber path for the campus.

This multi-path architecture delivered meaningful resilience for an institution operating in a geographically remote tribal community. As external bandwidth expanded, the campus LAN transitioned from Cisco systems to **Brocade Networks (now Ruckus Networks)** switching and wireless platforms. All campus buildings with active IT demarcation points were upgraded to network interfaces supporting **1 Gbps to 10 Gbps** connectivity, ensuring the internal campus network could keep pace with the growing external capacity.

CHAPTER 5

The 100 Gbps Fiber Build and the Research Era (2020–Present)

The COVID-19 pandemic of 2020 presented severe disruptions to higher education. For NTU — serving a predominantly rural, reservation-based student population — the challenge of transitioning to remote instruction was particularly acute. Federal **CARES Act funding** provided an unprecedented capital opportunity: rather than deploying resources solely on devices or incremental upgrades, NTU's IT Office made a strategic decision to invest in **transformational long-haul fiber optic infrastructure**.

The result was a **Layer 2 fully duplex 100 Gbps direct fiber optic link** connecting the NTU Crownpoint campus directly to the 505 Marquette Bank building in Albuquerque — provisioned over the combined fiber infrastructure of **Frontier Communications and Sacred Wind Communications**. This single-mode fiber circuit delivers 100 times the capacity of the original 1 Gbps UNM fiber port from 2009.

UNM — NMREN & Internet2

Existing UNM relationship upgraded to 100 Gbps, preserving access to NMREN, Internet2, and affiliated research networks.

Cogent Communications — 40 Gbps Internet1

NTU independently contracted with Cogent — one of the world's largest Tier 1 ISPs — for a dedicated **40 Gbps** commercial Internet connection, separate from research network paths.

Front Range GigaPoP (FRGP)

Formal partnership with FRGP — the premier R&E Network for Colorado and Wyoming — via the Western Regional Network, spanning Alaska, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Oregon, Washington, and Wyoming. An NSF CC* award led by NTU — titled *"Nilch' bee naa alkaa go ohooa doo eidii t'įį"* — focuses on connecting NTU and helping other TCUs improve external connectivity.

Sun Corridor Network via Zayo Fiber

Access to Arizona's Research and Education Network (established 2013, governed by ASU, NAU, and U of A), with three 100 Gbps points of presence in Tucson, Phoenix, and Flagstaff, and Commercial Internet Peering Service (I2PX) providing single-hop access to ~80 top content destinations.

The 100 Gbps fiber and 40 Gbps Cogent Internet connection have fundamentally altered what is possible at NTU. Researchers now have access to bandwidth capacities previously available only at major research universities. NTU stands today as a recognized research institution and — by multiple measures — **the most technologically advanced Tribal College or University in the United States.**

CHAPTER 6

Science DMZ, Nautilus, and the Research Era

What Is a Science DMZ?

The Science DMZ is a network architecture model developed by the U.S. Department of Energy's **Energy Sciences Network (ESnet)** and endorsed by the NSF — first coined in 2010 by ESnet engineer **Eli Dart**. NSF has committed over **$120 million** to support Science DMZ implementations at more than 100 universities nationwide. The architecture rests on four integrated principles: a **friction-free network path** (dedicated segment separate from the enterprise firewall); **Data Transfer Nodes (DTNs)** optimized for bulk data movement; **perfSONAR** performance measurement and monitoring; and **science-specific security policy** using IDS, access control lists, and behavioral monitoring rather than traditional stateful firewalls.

NTU is the **only Tribal College or University** in the United States to design, develop, and operate an NSF-funded Science DMZ — placing NTU in the company of major research universities and DOE national laboratory affiliates. The current deployment provides a **10 Gbps unadulterated research connection** to NTU's Digital Manufacturing Facility and Science Technology Building. The word *unadulterated* is deliberate: no firewall sits in front of this infrastructure.

The Nautilus Hypercluster

In partnership with UC San Diego's **San Diego Supercomputer Center (SDSC)** and the Ericsson Research Center, NTU is working toward the **first-ever tribal college placement of the Nautilus system** — a distributed hyperconverged computing cluster developed by the Pacific Research Platform (PRP) project at UC San Diego.

Nautilus is a multi-institution Kubernetes-orchestrated system aggregating resources from partner campuses connected at 10–100 Gbps across the United States. The PRP's Nautilus hypercluster currently encompasses over **7,000 CPU cores**, more than **500 GPUs**, and **2.5 petabytes** of distributed storage. Users access GPU-accelerated machine learning environments, TensorFlow, PyTorch, Jupyter notebooks, and large-scale data storage through a unified federated interface. NTU's participation will give faculty and students access to high-performance computing capabilities that would be cost-prohibitive for any single institution to own and operate independently.

10 Gbps

Science DMZ Speed

Unadulterated research connection — no firewall — to NTU's research facilities.

7,000+

Nautilus CPU Cores

Distributed across partner campuses in the PRP hypercluster.

500+

Nautilus GPUs

Available for machine learning, AI, and data-intensive research workloads.

2.5 PB

Distributed Storage

Petabytes of federated storage accessible through the Nautilus platform.

CHAPTER 6B–6C

Campus LAN, Wi-Fi 7, and Multi-Campus Connectivity

The expanded external bandwidth made possible by the 100 Gbps fiber link has driven a corresponding transformation in NTU's internal campus LAN. The **Academic Building** is the first building on the NTU campus connected to a **100 Gbps backbone infrastructure** — ten times the throughput of the 10 Gbps connections previously deployed — and the first deployment of **Wi-Fi 7 (IEEE 802.11be, Extremely High Throughput)** at any tribal institution on the Navajo Nation. Wi-Fi 7 advances over prior generations across four dimensions: **320 MHz channel widths** (double Wi-Fi 6); **4096-QAM modulation** (~20% higher theoretical data rates); **Multi-Link Operation (MLO)** enabling simultaneous transmission across 2.4/5/6 GHz bands; and **Preamble Puncturing** to preserve throughput in interference-affected channels. Top enterprise Wi-Fi 7 access points manage up to **10 Gbps aggregate over-the-air throughput**. Campus-wide LAN upgrades will follow a user density and concurrency model, prioritizing higher-population buildings first.

Chinle, AZ — Largest Extension Campus

Initial 1 Gbps Frontier fiber now being upgraded. Summer 2026: dual **10 Gbps connections** — one 10 Gbps Internet circuit to Dallas and one **10 Gbps direct private link to Crownpoint** — establishing the first leg of NTU's campus-wide WAN redundancy architecture.

Bond Wilson Northern Site — Comcast Bonding

Served by Comcast cable broadband. Two bonded 100 Mbps connections aggregated to **200 Mbps** — consistent with NTU's long-standing practice of maximizing available capacity within carrier constraints. Positioned for future upgrades as the Crownpoint-Chinle backbone matures.

Teec Nos Pos — From Gap to Fiber

Initially bridged by **Starlink** low-Earth orbit satellite. Subsequently, the **Navajo Tribal Utility Authority (NTUA)** — which operates a 570-mile fiber network across the Navajo Nation — provisioned NTU's Teec Nos Pos campus with a **100 Mbps fiber connection at no cost** for a two-year term, reflecting aligned missions between the tribal utility and tribal university.

CHAPTER 7

Community Broadband and Tribal Government Initiatives

Tarana Wireless: Six Navajo Chapter Communities

NTU is working with its tribal government to deploy high-performance broadband to **six Navajo chapter communities** surrounding the Crownpoint and Chinle campuses using **Tarana Wireless G1** next-generation fixed wireless access (ngFWA). Unlike conventional fixed wireless requiring clear line-of-sight, the G1 platform operates in **NLoS, nLoS, and LoS conditions simultaneously**, using teraflops of processing power to perform 5,000 link optimizations per second via beamforming, RF signal nulling, and multipath signal recombination. It leverages Asynchronous Burst Interference Cancellation (ABIC) and delivers aggregate link capacities of **800 Mbps to 1.6 Gbps per base node**. This six-community deployment is explicitly a steppingstone toward a much broader broadband expansion serving the wider Navajo Nation.

Missing and Murdered Diné Relatives (MMDR) Database with AI

NTU is leading a partnership with the Navajo Nation tribal government to develop a **Missing and Murdered Diné Relatives (MMDR) database enhanced with artificial intelligence** — recognized as a **$2 million investment** originating from the direct advocacy of affected families. The system will be hosted on NTU's tribal servers as a **sovereign repository**, featuring real-time case tracking and family alerts, a CRM system, data-sharing interfaces with federal and state agencies, open-source low-bandwidth architecture, and survey tools. **Data sovereignty** is a foundational design principle. The AI phase will deploy a working prototype on **NVIDIA Spark systems**, followed by two dedicated AI hardware cabinets for long-term trend analysis, pattern recognition, and enhanced system responsiveness.

Layer 2 BGP Transit: Community Carrier Connectivity

NTU provides **Layer 2 network transit** over its BGP connection to Albuquerque to a local carrier in the Crownpoint area — extending NTU's infrastructure beyond the campus boundary. An **affiliate discount program** offers discounted service rates to any NTU student, staff, or faculty member, generating tangible economic benefits for the Navajo Nation community.

CHAPTER 8 & CONCLUSION

Technology Stack, Future Roadmap, and Conclusion

The NTU Information Technology Office operates under a defining philosophy: **NTU is a teaching university and a research institution first.** Every technology is evaluated, tested, and often taught in a hands-on learning environment before production deployment. The current technology stack reflects this ethos: **Palo Alto Networks Next-Generation Firewalls** anchor perimeter security with ML-powered threat prevention, Zero Trust enforcement, and full TLS 1.3 decryption; **Ruckus Networks (CommScope)** ICX campus switches provide multigigabit access (2.5/5/10 GbE) with 40/100 GbE uplinks; and **Ubiquiti Enterprise switching** and **FS PicOS® switches** (running on Broadcom Tomahawk/Trident chipsets, supporting 10G to 800G, with OpenFlow SDN via Open vSwitch) serve experimental and research-adjacent environments — with AmpCon™ management reducing operational overhead by an estimated 35–40%.

⚠ The Crownpoint main campus is served by a **single carrier** — Frontier Communications. Any fiber cut or service disruption has the potential to take down the institution's entire external connectivity, including the 100 Gbps research fiber, the Cogent 40 Gbps Internet1 connection, and BGP transit services. NTU continues to advocate at every available forum for competitive carrier infrastructure investment in Crownpoint.

→ 100 Gbps → 400 Gbps Backbone Upgrade

Actively planning upgrade of core transport infrastructure to the 400G wavelength tier, consistent with optical networking standards and anticipated research data flow growth from the Science DMZ and Nautilus HPC programs.

→ Cogent Internet1: 40 Gbps → 60 Gbps

Commercial Internet circuit upgrade driven by anticipated bandwidth demands of the MMDR AI database platform and the expanded six-chapter community broadband program.

→ Chinle 10 Gbps Interconnect (Summer 2026)

Dual 10 Gbps connections establishing the first dedicated high-speed private WAN interconnect between NTU campuses — the first leg of a true multi-campus redundant network architecture.

→ Wi-Fi 7 Campus-Wide Rollout & Science DMZ Expansion

Wi-Fi 7 deployment extended to all campus buildings on a user-density priority schedule; Science DMZ 10 Gbps unadulterated research network extended to the Academic Building as the next planned phase.

> From a 10 Mbps satellite connection in 2001 to a 100 Gbps direct fiber link in 2020, NTU has multiplied its external connectivity capacity by a factor of approximately **10,000 over two decades** — demonstrating that strategic public investment, combined with institutional ingenuity, intergovernmental partnership, and respect for tribal sovereignty, can produce broadband infrastructure outcomes that serve not only a university campus but an entire tribal nation's connectivity aspirations.