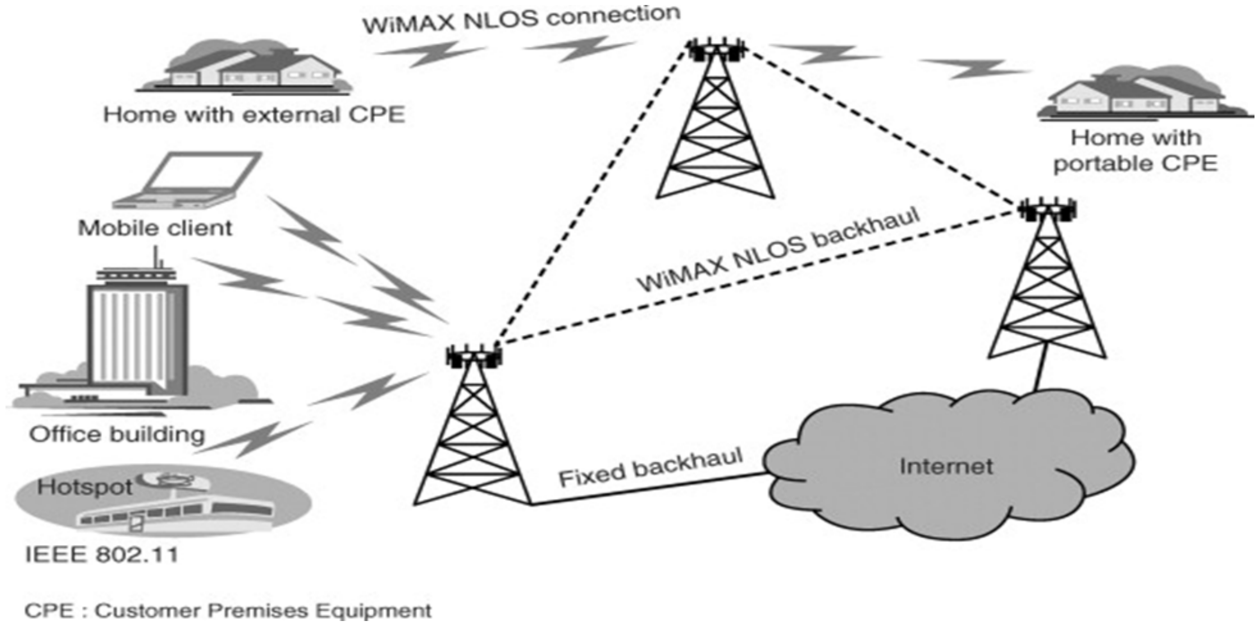

Unlicensed Fixed Wireless Still Falls Short of BEAD Requirements

Why NTIA's "5 Mbps-per-Location" Proxy Can't Rescue Unlicensed Links from the Laws of Physics

By David J. Malfara, Sr.

Executive Summary

The $42.45 billion Broadband Equity, Access, and Deployment (BEAD) program demands networks that **deliver** 100 Mbps down, 20 Mbps up, low latency, and minimal downtime to every unserved U.S. address. Fiber-to-the-premises meets those goals natively, but the National Telecommunications and Information Administration (NTIA) has opened the door to unlicensed fixed-wireless (ULFW) by accepting a paper proxy: if a design shows **5 Mbps of simultaneous capacity per location**, NTIA assumes it can burst to 100/20. That shortcut rests on a single vendor analytics report, ignores uplink and half-duplex limits, and provides no reproducible test plan.

Rural Digital Opportunity Fund (RDOF) history proves why this matters: Starlink, LTD Broadband, Starry, and Wavelength defaulted or were rejected once real-world physics—rain fade, shared spectrum, capacity ceilings—were enforced. This article traces the 5 Mbps proxy's thin provenance, dissects its engineering flaws, and proposes a standards-grade test plan grounded in ITU-R models and FCC "80/80" performance rules. We show that, over a 20-year horizon, fiber remains the fiscally conservative choice when maintenance, upgrades, and reliability penalties are counted. The piece concludes with practical recommendations for State Broadband Offices and a brief outline of how Big Bang Broadband can assist stakeholders in vetting ULFW claims.

1 | Background and Scope

When Congress passed the Infrastructure Investment and Jobs Act (IIJA) in November 2021, it earmarked **$42.45 billion** for the new Broadband Equity, Access, and Deployment (BEAD) program with a clear mandate: **bring reliable, high-speed broadband**—defined as at least 100 Mbps downstream, 20 Mbps upstream, low latency, and no more than 48 hours of outages per year—to every unserved and underserved location in the United States [1]. Those thresholds are not aspirational—they are statutory requirements that must be **delivered**, not merely **promised**. States have four years to build the networks and ten years of performance obligations to keep them operating at those levels [2].

Yet, as State Broadband Offices prepared their BEAD solicitations, they faced a perennial dilemma: deploying fiber-to-the-premises (FTTP) meets BEAD's performance mandates most robustly but comes with significant upfront costs and longer timelines in remote areas. Unlicensed fixed-wireless (ULFW) solutions, especially in millimeter-wave bands, promise rapid deployment at lower capital expense—sometimes using existing towers and CPE. The marketing hype often boasts "gigabit everywhere" and "last-mile in weeks."

The RDOF auction in 2020 offered a real-world test of those claims under the pressure of build-out milestones and performance enforcement. Several fixed-wireless bidders either defaulted on hundreds of millions in subsidies or had long-form applications rejected outright for failing to demonstrate their engineering designs could meet the promised speeds under rural conditions.

In June 2025, recognizing those precedents, the National Telecommunications and Information Administration (NTIA) issued a BEAD Restructuring Policy Notice that introduced **Appendix A**: an initial eligibility screen for ULFW proposals requiring proof of "at least **5 Mbps** of simultaneous capacity to each Broadband-Serviceable Location (BSL)" [2]. The rationale was that if each subscriber could pull 5 Mbps concurrently, a statistically multiplexed shared wireless plant should support bursts to 100/20 under typical busy-hour loads.

This article systematically examines why that shortcut is both **unsound** and **insufficient** when judged by engineering physics, peer-reviewed evidence, and real-world link-budget data. Specifically, we will demonstrate that:

1. **NTIA's proxy lacks credible engineering justification.** It rests on a single vendor's analytics report and provides no upstream metric or clear scaling guidance;
2. **No independent literature or standard supports it.** Our exhaustive Internet and standards-body search yielded zero peer-reviewed or FCC-endorsed validation of the 5 Mbps surrogate;
3. **Real-world data expose the proxy's flaws.** Sworn RDOF link-budget evidence shows how a design can satisfy the proxy on paper yet collapse under rain fade, interference, or modest concurrent demand;
4. **Without a test protocol, the risk multiplies.** NTIA offers no reproducible modeling template or statistical criteria, leaving states vulnerable to optimistic assumptions and costly failures.

We then propose actionable steps for State Broadband Offices to safeguard taxpayer funds and ensure that broadband deployments truly meet the IIJA's performance goals.

2 | RDOF's Fixed-Wireless Failures: A Policy Lesson

The FCC's Rural Digital Opportunity Fund (RDOF) auction in late 2020 was structured to deliver up to $16 billion in subsidies to companies that could bring high-speed Internet to unserved locations. The auction combined Reverse Auction bids with strict post-award obligations: applicants had to meet detailed network design requirements, build-out milestones, and, ultimately, pass performance tests under the "80/80" rule (at least 80 % of speed samples at 80 % of the promised rate).

Several headline RDOF winners illustrate why fixed-wireless warrants careful scrutiny under BEAD:

- **Starlink (SpaceX)**: Despite global Ku/Ka-band LEO spectrum, the FCC **rejected** its long-form application on August 10 2022, concluding that Starlink failed to demonstrate how it could deliver **100/20 Mbps** capacity across its rural footprint [7]. The rejection underscored that even abundant spectrum does not guarantee sustained rural performance when challenged on detailed engineering grounds.
- **LTD Broadband**: A U.S. fixed-wireless provider relying on 5 GHz and 60 GHz bands, LTD's application was rejected the same day as Starlink's for lacking credible link-budget analysis and interference mitigation plans [7]. Regulators expressed skepticism about optimistic propagation models in varied terrain.
- **Starry (Connect Everyone)**: Specializing in 37–60 GHz mmWave, Starry won $245 million in support but **defaulted** in early 2023, citing unanticipated tower-density, backhaul, and operational costs. The FCC has since proposed a **$3.8 million forfeiture** for the default [9].
- **Wavelength Internet**: Its 60/70 GHz mmWave proposal initially cleared the auction but stumbled in the long-form review. A sworn affidavit filed by an engineer detailed how beyond **360 meters**, Wavelength's design "cannot deliver gigabit speeds," and serving a cluster of ten homes would require **11 back-to-back 70 GHz links**—an "operationally impossible" requirement in rural Mohave County, AZ [8].

These RDOF outcomes were not business-plan flukes; they sprang from basic physics: line-of-sight constraints, rain-fade margins, spectrum reuse limits, and the inherent challenges of scaling shared radio networks in sparsely populated areas. When the RDOF program enforced binding milestones and robust performance tests, these optimistic fixed-wireless designs unraveled—resulting in future claw-backs, taxpayer losses, and unserved communities.

RDOF's experience teaches two critical lessons for BEAD:

1. **Speed promises require rigorous engineering backing.** An advertised "gigabit link" means little without a detailed design showing how that speed is sustained through interference, weather, and user load.

2. **Enforcement must be real.** Binding milestones, liquidated-damages provisions, and performance-test protocols must exist to ensure promised capabilities translate into delivered services.

BEAD's core mission is more ambitious than RDOF's: universal service for every unserved location. Its statutory performance requirements are non-negotiable; yet NTIA's proxy test for ULFW proposals risks undermining those goals if left uncorrected.

3 | NTIA's 5 Mbps-per-Location Proxy: A Shortcut Without Support

In the **BEAD Restructuring Policy Notice** of June 6 2025, NTIA introduced **Appendix A** to allow ULFW bids to qualify by demonstrating a network design that can deliver "at least **5 Mbps** of simultaneous capacity to each Broadband-Serviceable Location" [2]. The notice's language reads:

"To ensure that the ULFW provider will have sufficient capacity to meet the statutory speed requirement of 100 Mbps download and 20 Mbps upload, the network design for ULFW projects must demonstrate the ability to provide at least 5 Mbps (100 Mbps downstream service – to be scaled for higher speed commitments) of simultaneous capacity to each BSL in the project area."

We reject this surrogate for five reasons:

3.1 No Credible Engineering Rationale

NTIA's proxy rests on a single footnote citation to a **vendor-provided analytics snapshot**—the Preseem Q1 2024 Fixed Wireless Network Report—and the assertion that this 5 Mbps figure "reflects industry dimensioning practices" [3]. Beyond that, there is **no peer-reviewed study**, no FCC engineering white paper, and no consensus standard from any recognized body (IEEE, ITU, ETSI, etc.) endorsing 5 Mbps concurrency as proof of 100/20 Mbps performance.

The law itself—the IIJA—mandates that networks **deliver** ≥ 100 Mbps downstream and ≥ 20 Mbps upstream under typical conditions [1]. **Nothing** in the statutory language suggests a partial compliance avenue or a substitute test, especially one that omits the upstream entirely. The verb "deliver" makes clear Congress expects these speeds to be sustained whenever demanded, not merely achievable as a fleeting burst.

This unsubstantiated proxy invites sub-applicants to focus on passing a 5 Mbps-only design screen, secure BEAD awards, and then address the full performance requirements years later—often too late for effective enforcement or remediation, as RDOF defaults demonstrated.

3.2 The Cryptic, Downlink-Only Parenthetical

NTIA's text inserts a parenthetical note that only deepens confusion:

"…5 Mbps (**100 Mbps downstream service – to be scaled for higher speed commitments**) of simultaneous capacity…" [2]

This aside:

- **Mentions downstream only.** The proxy tests only the downstream capability, saying nothing about the **20 Mbps upstream** requirement. Four users each uploading 5 Mbps at once would saturate the entire upstream capacity—rendering the network non-compliant with statutory thresholds.
- **Offers no scaling guidance.** If an applicant promises 1 Gbps service or more, NTIA gives no formula, rule-of-thumb, or example showing how to proportionally increase the per-location head-room.
- **Provides no test methodology.** Appendix A fails to specify packet sizes, sample intervals, modeling parameters, or statistical pass/fail criteria—unlike FCC's detailed performance-measurement rules.

Taken together, the parenthetical reads like a half-finished thought, leaving states and applicants guessing.

3.3 Exhaustive Search Yields No Independent Support

To confirm whether any credible engineering standard endorses 5 Mbps per-location as a capacity test, we conducted a thorough Internet and literature search:

Source	Content	Supports Proxy?
NTIA, *Alternative Broadband Technology Policy Notice* [3]	Claims 5 Mbps "reflects industry practices," citing Preseem Q1 2024 report.	**No** (unsupported assertion)
Preseem, *Fixed Wireless Network Report 2024 Q1* [4]	Observes median busy-hour **download** usage around 5 Mbps/subscriber for plans < 100 Mbps.	**No** (descriptive only)
Preseem blog, "Capacity Planning for Speed Tests" [5]	Reports similar usage stats; no design recommendation or modeling guidance.	**No**
Education SuperHighway blog (Georgia BEAD IP) [6]	States "5 Mbps per location is sufficient" for challenge rebuttals—**administrative only.**	**No**
Peer-reviewed journals, IEEE/ITU standards, FCC dockets	Searches for "5 Mbps busy-hour rule," "5 Mbps concurrency planning," etc., yielded **no** results.	—

Finding: There is **no** independent, peer-reviewed, or regulatory engineering document validating NTIA's 5 Mbps proxy as a reliable surrogate for 100/20 Mbps service. The concept exists only in vendor analytics and an administrative shortcut.

3.4 Engineering Flaws the Proxy Ignores

Even giving the proxy the benefit of the doubt, its flaws are manifest when viewed through real-world physics:

- **Uplink starvation.** Four concurrent users each demanding 5 Mbps upstream would fully consume the 20 Mbps aggregate capacity required by statute, leaving zero headroom and creating immediate congestion.
- **Half-duplex TDD bottleneck.** Nearly all unlicensed fixed-wireless radios operate in Time-Division Duplex, meaning the same channel alternates between transmit and receive. The 5 Mbps "simultaneous" budget therefore covers both directions. If a sector allocates 70 % of its airtime to downlink, only 1.5 Mbps of that 5 Mbps remains for upstream traffic—an order of magnitude short of the IIJA's sustained 20 Mbps requirement. Any burst of concurrent uploads instantly erodes available downlink slots and vice-versa, exposing a fundamental capacity ceiling that the proxy overlooks.

The Downlink vs. Uplink "Bucket" Dilemma in TDD Fixed-Wireless

In unlicensed fixed-wireless, the same RF channel must handle both directions—downlink (DL) and uplink (UL)—by time-sharing. Think of the channel's total airtime as a single 100-unit "capacity bucket." Operators carve that bucket into, say, 70 units for DL and 30 units for UL because consumer traffic is usually download-heavy.

The NTIA surrogate requires each subscriber to have 5 Mbps of simultaneous capacity. NTIA's language, however, references only downstream speed, so most applicants will size the DL bucket to fit 5 Mbps × N users—without carving out a matching UL reserve.

Now imagine four users all decide to upload 5 Mbps video files at the same time:

The UL bucket needs 4 × 5 Mbps = 20 Mbps.

With a 70/30 split, the UL bucket might only hold ≈ 30 Mbps aggregate—plenty on paper, but real radios rarely hit PHY rates at peak load or in rain.

If the operator later re-tunes the split to 90/10 so that one user can burst to 100 Mbps DL, the UL bucket shrinks to 10 Mbps—half of what those same four uploads require.

Result: immediate congestion, failed speed tests, and non-compliance with the IIJA's 20 Mbps sustained upstream requirement for even a single user.

Because the NTIA proxy never defines minimum UL bucket size, packet scheduling, or split ratios, an applicant can pass the 5 Mbps screen with optimistic DL-heavy assumptions yet ship a network that chokes on ordinary upload bursts—or during firmware updates, telemedicine uplinks, and cloud backups.

In other words, without an explicit uplink metric and a test that validates both buckets under real load, the surrogate all but guarantees the 20 Mbps upstream statute will be broken in practice.

- **Weather fade.** The Wavelength affidavit's Siklu model for a 403 meter 60 GHz path passes the 5 Mbps screen in clear-sky conditions but drops below both 100 Mbps down and 20 Mbps up under a light rain event (10–15 dB attenuation) [8].
- **Demand growth.** Preseem's own data show busy-hour downstream usage trending above 5 Mbps and increasing at roughly 17 % annually [4][5]. A network dimensioned for today's averages will be grossly under-designed for tomorrow's peak demands.

These engineering realities underscore that a paper proxy divorced from uplink metrics and adverse-weather modeling is **dangerously insufficient** as the sole gatekeeper for BEAD awards.

3.5 Policy Risk in the Absence of a Test Plan

A robust grant program requires both **clear design criteria** and a **reproducible verification method**. BEAD's ULFW proxy provides neither:

- **No uniform modeling template.** Applicants may choose optimistic gain figures, zero-interference assumptions, or minimal fade margins; states lack a standard rubric to audit or compare designs.
- **No statistical test regime.** FCC's "80/80" performance testing evolved through multiple dockets, specifying server locations, packet sizes, and sample schedules. BEAD's proxy test offers **no** such guidelines for live or modeled verification.

Without a detailed test plan integrated into BEAD guidance, states risk awarding subsidies to networks that pass the paper screen but fail in the field—replicating RDOF's costly defaults, but on a far larger scale.

Why a formal test plan matters. BEAD cannot rely on ad-hoc screenshots or single-vendor dashboards; it must replicate the rigor the FCC developed through a decade of CAF and RDOF testing. A standards-grade methodology supplies a common yard-stick without forcing cookie-cutter assumptions: every applicant models local rain rates and foliage losses using the same ITU-R equations—so a tower in Seattle isn't graded against the monsoon profile of Tucson, but both must document the derivation. Packet sizes, server placement, and statistical pass lines are likewise locked down.

Without that uniform blueprint, states end up comparing oranges to grapefruits—one bid assumes clear-sky link budgets, another adds generous fade margins, and the scoring committee lacks an objective basis to decide which network will withstand the first thunderstorm.

As veteran engineers like to say, *"rookies test until they get it to work (i.e., working code); professionals test until they can't get it to fail."* The surrogate in Appendix A flouts that principle, lowering the bar from failure-proofing to mere checkbox compliance.

An example of what a proper, comprehensive test plan may resemble follows:

Component	Key Requirements / Specifications
Objectives & Scope	• Verify ≥ **100 Mbps↓ / 20 Mbps↑** under peak-hour load. • Latency ≤ **100 ms** (95th-percentile). • Availability ≤ **48 hr/yr** downtime. • Test in clear-sky, light rain **(≈ 1 mm/h)**, heavy rain **(≈ 25 mm/h)**, and leaf-on / leaf-off foliage conditions. • Collect 24-hour samples across at least **two seasons**.
Test Infrastructure	• Regional test servers with ≥ 1 Gbps backhaul. • Calibrated CPE agents supporting **RFC 6349** TCP and UDP tests. • Spectrum analyzers to log ambient noise & interference. • On-site weather stations (rain gauge, hygrometer, anemometer). • **GPS-synced clocks** for latency accuracy.
Propagation Modeling	• Rain attenuation: **ITU-R P.530 / P.838**. • Foliage loss: **ITU-R P.833** (leaf-on vs. leaf-off). • Terrain / clutter: **Longley–Rice** (Irregular Terrain Model). • Interference budgets: co-channel reuse + radar thresholds. • Margin accounting: fade, hardware, aging, maintenance.
Traffic Profiles	• Single **100/20 Mbps** TCP stream. • Four concurrent **25/5 Mbps** TCP streams to stress uplink. • Mixed UDP (VoIP @ 64 kbps; 1080p WebRTC video). • Oversubscription scenarios **1:1 → 20:1**. • Burst (10 s) and sustained (5 min) transfers. • End-to-end jitter & packet-loss capture.
Statistical Criteria	• **≥ 30 test runs** per scenario. • Pass rule: **80/80** (≥ 80 % of runs hit ≥ 80 % of target rate). • Report 95 % confidence intervals for throughput & latency. • Documented outlier exclusion policy.
Reporting & Audit	• Per-packet logs (timestamp, RSSI, SNR, throughput, latency). • Overlay performance with environmental data (rain-rate vs. Mbps). • GIS link visuals: path elevation & Fresnel clearance. • Third-party lab replicates a random **10 %** of links. • Version-controlled test-plan documents published for transparency.

4 | Physics Doesn’t Bargain: Why Fiber Remains Irreplaceable

Beyond the ULFW proxy debate, it is essential to reaffirm why **fiber-to-the-premises (FTTP)** stands as the gold standard for universal service:

1. **Virtually unlimited bandwidth.** Fiber optics can support multiple terabits per second on a single strand, with upgrades often achieved through software and optical transceiver swaps—no spectrum scarcity or tower densification needed.

2. **Weather immunity and reliability.** Glass fibers are impervious to rain, snow, foliage, and multipath interference. Their attenuation is on the order of 0.2 dB/km, orders of magnitude lower than even low-GHz wireless links.

3. **Symmetrical performance.** Fiber inherently provides the same bandwidth downstream and upstream, meeting and exceeding the IIJA’s requirement of 20 Mbps upload with ease.

4. **Low latency and jitter.** Fiber propagation delay averages ~5 microseconds per kilometer, with minimal jitter—critical for telehealth, distance learning, and interactive applications.

5. **Dedicated, non-contended service.** Unlike shared wireless cells, each fiber subscriber has a dedicated fiber strand or VLAN segment, eliminating neighbor-based contention and ensuring consistent performance.

Municipal broadband grants, CAF II, and RDOF long-form winners overwhelmingly prioritized fiber for good reason: it delivers predictable, long-term performance that aligns with universal-service objectives—even if initial costs are higher.

5 | Recommendations for State Broadband Offices

To ensure BEAD funds build networks that truly meet statutory goals, State Broadband Offices should adopt the following guardrails:

1. **Mandate full bidirectional link budgets.** Require applicants to submit detailed RF-engineering worksheets that model both downstream and upstream paths, including rain-fade, foliage attenuation, terrain profiles, antenna patterns, and interference margins.

2. **Institute an uplink concurrency floor.** Even a conservative 1 Mbps upstream concurrency requirement per BSL would expose many fixed-wireless designs as under-dimensioned for the IIJA’s 20 Mbps upload mandate.

3. **Adopt an FCC-style “80/80” performance-testing regime.** Retain at least 20 % of grant disbursements until the network passes live speed tests—80 % of samples at 80 % of the advertised rate—under real busy-hour conditions and through at least two distinct seasonal weather cycles.

4. **Score RDOF legacy.** Require any bidder with prior RDOF defaults or FCC denials to provide **specific engineering modifications** demonstrating how they addressed the link-budget deficiencies that sank their earlier proposals.

5. **Promote fiber-wireless hybrids.** Where ULFW is used, insist on fiber backhaul to every tower and, where feasible, short fiber spurs to clusters of homes. Hybrid models that marry wireless reach with fiber reliability can mitigate wireless-only risks.

These measures will tighten the eligibility gate, improve design accountability, and reduce the risk of unserved communities after construction grants are issued.

6 | Conclusion: Build to Last

NTIA's 5 Mbps-per-location proxy was a well-intentioned attempt to ease ULFW into the BEAD program, but it falls short in engineering credibility, statutory alignment, and enforceability. No peer-reviewed study, recognized standard, or FCC engineering report endorses the proxy as proof of sustained 100/20 Mbps performance. The RDOF auction's painful lessons—Starlink, LTD, Starry, and Wavelength—demonstrate how optimistic fixed-wireless models collapse under real-world conditions, waste taxpayer dollars, and leave rural Americans without the broadband they need.

States can avoid repeating those mistakes by demanding rigorous, bidirectional link-budget proofs, instituting uplink concurrency checks, adopting live performance testing, and leveraging lessons from past defaults. Ultimately, **fiber** remains the only technology built to meet BEAD's enduring statutory goals with predictability and resilience. If universal, reliable broadband is the mission, states must ensure their grant criteria reflect the unyielding laws of physics, not paper proxies that history has shown to fail.

Despite the restrictive "cost" modeling used in BEAD (which is a divergence from the Dept. of Commerce stated norm of using useful life) from a total-cost perspective, it cannot be ignored that fiber is also the fiscally conservative option. Rural fiber construction can run tens of thousands of dollars per mile, but the glass itself lasts decades, its power draw is negligible, and bandwidth upgrades require only swapping optics—no new trenches or towers.

In contrast, ULFW radios must be replaced every 5–7 years, tower leases escalate, and rain-fade troubleshooting drives operating costs. When those recurring expenses—and the economic drag of unreliable service—are amortized over twenty years, fiber's net present cost per delivered megabit is lower than ULFW in most rural scenarios. In short, investing public dollars in fiber is not a luxury; it is the cheapest way to guarantee communities a future-proof on-ramp to the Internet economy.

How Big Bang Broadband Can Help

Big Bang Broadband LLC specializes in the intersection of policy and engineering. For State Broadband Offices, local governments, or private applicants, we can:

- **Evaluate ULFW applications** for technical sufficiency, checking link budgets, rain-fade margins, and half-duplex capacity claims against BEAD's 100/20 requirements.
- **Translate policy language into engineering checkpoints,** ensuring proposals cite credible standards and performance metrics.

- **Provide lifecycle cost comparisons** that highlight the long-term financial impacts of fiber versus fixed-wireless deployments, helping decision-makers allocate limited funds prudently.

Author Profile

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