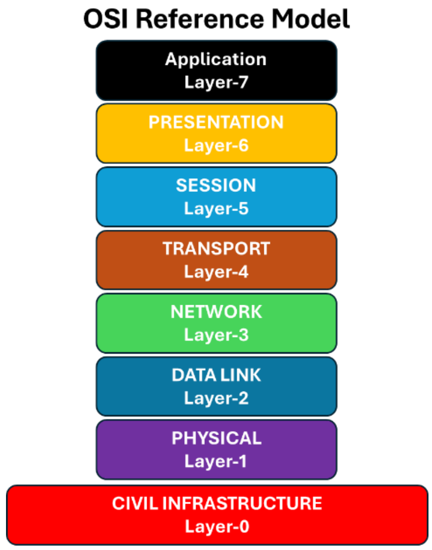
Fiber Isn't Expensive—Short-Term Thinking Is



The OSI reference model supported with Layer-0 civil infrastructure as foundational

In an exhaustive analysis, one concludes that the only sustainable broadband infrastructure is one that aligns with the Open Systems Interconnection (OSI) reference model. Further, that of all available transmission media, only fiber can support the continuous evolution of network layers without structural replacement.

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Executive Summary

Historic funding is now flowing into broadband projects—especially through the BEAD and other Infrastructure Investment and Jobs Act (IIJA) programs. Now is the time to embed Layer-0 planning into broadband builds—or risk squandering the opportunity to build it right the first time.

Short-term thinking has unduly influenced governmentally-funded broadband planning. Political election cycles, quarterly earnings pressures, and grant scoring frameworks that prioritize coverage speed and deployment velocity over architecture quality have all contributed to designing and/or building networks that may meet today's needs but often fall short tomorrow. As a result, the very communities these builds aim to sustainably serve are often reclassified as underserved within just a few years of deployment, as the benchmarks for adequate service rise with technological advances and public expectations. To no surprise, in many of these cases the perceived "high" upfront cost of fiber dominated narrowly framed planning discussions that overlooked long-term infrastructure economics. Fiber's substantial economic and operational advantages—especially in scenarios where future-proofing is critical was, thereby, obscured.

The ill effects of this analytical shortfall are further magnified because many decision-makers treated, and still treat "future-proofing" as a luxury—as if it's a nice-to-have once other boxes are checked. But for infrastructure, that mindset is exactly backward. There is a danger in allowing tactical requirements to become buzzwords—because once they do, they develop a stigma and lose their urgency. The term 'future-proofing' may sound abstract or aspirational, but its urgency is all too real when applied to Layer-0. This is the only phase of network deployment where future-proofing isn't speculative—it's structural. It literally defines where your network can or cannot go and is the layer upon which all of your network relies. Once the environmental studies are completed, the conduit is pulled, and the permitting authority has issued a certificate of completion, the opportunity to leverage the benefits of future-proofing is gone.

Marc Randolph, co-founder of Netflix, put it succinctly when asked to speculate on the general likelihood of future success in business: "Nobody knows anything."[1] This reminder captures why infrastructure must be ready for whatever comes next. The most transformative technologies comprising the evolution of the Information Superhighway often begin as unpredictable ideas which is why *future-proofing* at the infrastructure level isn't optional—it's essential.

Introduction

Optical fiber-based broadband deployment has recently come under scrutiny (again), especially when it is proposed for the most vulnerable populations—those in unserved and underserved communities. Detractors tend to focus on the initial capital expenditures associated with fiber builds when compared to ostensibly less expensive alternatives like fixed wireless, mobile cellular, or satellite-based systems such as low-Earth orbit (LEO) constellations. While this may not be their intent, the effect of such short-term focus is to deliver less for less—offering lower-cost entry options that lack the long-term value and scalability fiber provides.

Without a fiber-based infrastructure underpinning these services, such communities are denied the digital foundation needed to grow and evolve. Their connection to the broader Internet remains constrained—limited by access technologies that cannot scale with demand when used as infrastructure technologies. This debate often ignores the larger context: the *true cost* of delivering reliable, scalable, sustainable, and affordable connectivity over time. Building networks from scratch involves more than subscriber access—it involves building the area's infrastructure to support that access.

Because the discussion about long-term requirements, cost, and value is so often fragmented—or ignored altogether—fiber is rarely evaluated in its full lifecycle context. As a result, it is not recognized as the lowest-cost option it truly is when measured against the full span of ownership, upgrades, and operational sustainability—bar none. A short-term focus on installation budgets blinds decision-makers to the fact that other competing technologies incur higher total costs over time due to shorter lifespans, more frequent upgrades, and physics-based performance ceilings that accelerate obsolescence. That continuing capital cost must, typically, be recovered through subscriber rates for service that beleaguer those communities' primal goals of service affordability.

In this article, I aim to reframe the conversation away from short-term cost comparisons and toward a more strategic view of infrastructure planning. While I've previously explored the advantages of fiber in terms of performance metrics and lifecycle costs in my article "Broadband at a Crossroads"[2], here I want to focus on a critical, underappreciated aspect: fiber's unique alignment with the OSI (Open Systems Interconnection) reference model—and why that makes it the only broadband medium capable of serving as a lasting foundation for an Internet that will continue to evolve.

This is a story about multi-dimensional sustainability: technical, operational, economic, and environmental. Networks are no longer static utilities—they are dynamic ecosystems.

The OSI Model: A Blueprint for Sustainable Networks

The OSI model provides a conceptual framework for how data travels from one device to another, segmented into seven discrete layers—from the physical wiring (Layer-1) up to the applications we interact with (Layer-7). Increasingly, network architects also refer to a foundational "Layer-0": the underlying civil infrastructure—such as conduit, handholes, and utility corridors—that supports the entire physical network.

The genius of the OSI model lies in its modularity. Each layer depends on the one below it and serves the one above it—but crucially, each can evolve independently. This architectural decoupling is what allows the Internet to innovate so rapidly. We can change applications, routing protocols, or transport methods—and even their suppliers—without having to dig up streets or rewire cities. But that's only possible if the foundation is strong enough to support continual evolution.

Why Fiber? Because the OSI Stack Can't Evolve Without It

Fiber stands out as the only transmission medium that fully embraces the modular, scalable principles of the OSI model. Unlike its alternatives, fiber's nearly limitless capacity exceeds the demands of today's applications, and—more importantly—it is uniquely suited to support tomorrow's. With immense bandwidth, low latency, and nearly lossless transmission over long distances, fiber can carry any protocol, any modulation scheme, and any emerging technology that rides above Layer-1.

Upgrades from 1 Gbps to 10, 40, or even 400 Gbps are routinely accomplished by swapping electronics at the endpoints, not by replacing the fiber itself. Fiber's "set-it-and-forget-it" nature ensures that once it is properly deployed, the physical layer will never be the limiting factor in a network's evolution. That simply isn't true for wireless or satellite systems, which are often bound by spectrum constraints, physics, and structural or environmental obstacles such as weather, foliage, or surrounding development—and non-trivial hardware dependencies.

According to a 2021 feasibility study by the City of South San Francisco, "fiber is a future-proof infrastructure" that "once placed, will not need to be replaced," since upgrades typically involve only the endpoint electronics.[3]

Technologies like XR Optics, developed through the Open XR Optics Forum, further underscore fiber's evolutionary advantage. XR Optics enables dynamic, point-to-multipoint active optical transport that simplifies architecture and extends reach—all without changing the physical infrastructure. For example, XR Optics can reduce the number of transceivers required at distribution points, lower cost per bit, and improve service flexibility in rural or high-density environments. Fiber is not merely compatible with such innovation—it is foundational to it.

The Upper Layers Will Evolve – That's a Guarantee

Innovation in Layers-2 through Layer-7 is not just expected—it is inevitable. New MAC protocols, smarter routing engines, edge computing architectures, and AI-enabled applications are already reshaping how data is processed, prioritized, and delivered. These evolutions will continue, driven by demands for more interactivity, more mobility, and more machine-to-machine communication.

- At Layer-2 and Layer-3, we see ongoing work in Ethernet evolution, IP convergence with 5G (and soon, 6G), and SD-WAN flexibility.
- At Layer-4 and Layer-5, security, session control, and streaming optimization are constantly adapting.
- Layer-6 and Layer-7 are where the most dramatic changes happen—from immersive applications like augmented reality to cloud-native AI services.

Only fiber can accommodate this relentless innovation without structural overhaul; it provides the bandwidth, stability, and signal integrity that evolving protocols need. With fiber in place, the physical layer ceases to be a bottleneck—it becomes the launchpad.

A joint white paper from the Fiber Broadband Association and Vantage Point Solutions calls fiber "the most future-proof of all broadband technologies" due to its adaptability and capacity.[4]

The Real Bottleneck: Layer-0 Infrastructure

Oddly, the part of the network that changes least is the one most often overlooked. Layer-0—the civil infrastructure that makes it possible to deploy fiber—includes horizontal directional drilling, trenching, duct banks, conduit, microduct, aerial pole attachments, easements, vaults, access points, and a host of others. These components are not glamorous, but they are absolutely foundational.

If Layer-0 is poorly conceived or underbuilt, even the best fiber can't be deployed efficiently. Every upgrade or repair becomes a high-cost construction project. Conversely, if Layer-0 is planned with foresight, fiber can be installed, upgraded, and maintained with minimal disruption. A well-designed Layer-0 framework transforms every future upgrade from a costly excavation to a simple endpoint hardware swap or, at worst, the minimal cost of blowing new fiber into existing microduct.

The Addison County CUD feasibility study correctly flagged Layer-0 planning as "crucial to long-term cost containment and technological flexibility" in rural broadband initiatives.[5]

A Utilitarian Approach to Layer-0

The key to future-proofing isn't just about deploying extra fiber—it's ensuring that Layer-0 infrastructure is in place, accessible, and extensible. That means building with the understanding that more capacity could be needed, that technology will change, and that different users may someday share the same pathways.

A utilitarian Layer-0 strategy includes:

- Enacting "Dig Once" and "Build Once" policies that align broadband projects with other civil works.
- Designing open-access microduct configurations in conduit systems to support staged fiber deployments in areas where immediate builds are not yet justified but are anticipated, nonetheless.
- Installing conduits, microduct arrays and strategically located handholes to allow for non-disruptive expansion.
- Creating GIS-based shared or open-access infrastructure mapping data to prevent redundant builds and lower entry barriers.
- Standardizing vault and cabinet designs and physical interfaces so that future technology vendors can interoperate.

The U.S. federal government's historic broadband investment through the IIJA and other initiatives presents a once-in-a-generation opportunity to get Layer-0 right. As explored in my article "Missed Connections,"[6] communities must be vigilant in how funds are allocated—by prioritizing designs that support open access, scalability, and long-term sustainability over short-term connectivity checkboxes.

These considerations are timely. While the BEAD program is the most visible broadband-focused mechanism, IIJA funding also supports parallel infrastructure efforts in areas such as smart grid modernization, smart metering, water systems, and other utility frameworks—all of which involve civil works that could and should be aligned with broadband-ready Layer-0 planning. The scale and breadth of this federal investment is unlikely to be repeated. If we fail to coordinate now, the opportunity to embed Layer-0 infrastructure across this wider wave of deployment will vanish—and with it, our ability to avoid another generation of stranded or short-lived assets.

Conclusion: Build Like the Internet

The OSI model has endured for decades because it reflects a fundamental truth: systems that are modular, decoupled, and adaptable last longer and serve more people than those built for a single purpose. The Internet succeeds because it evolves layer by layer. So should our physical broadband networks.

Fiber is the only medium capable of matching the Internet's growth model. But fiber only achieves its potential when paired with smart Layer-0 infrastructure. Otherwise, we are back to digging—and spending—every time the network needs to change.

Let's stop framing fiber as expensive. Let's start framing it as the foundation we can't afford not to build. In the end, the most expensive network is the one you have to rebuild.

Short-term cost-cutting often leads to long-term waste. Future business models—whether based on smart cities, precision agriculture, telehealth, or AI-enhanced services— will depend on the flexibility and bandwidth that only well-planned fiber infrastructure can offer.

Whether you're a state broadband office, a local government, a private investor, or a new or existing service provider, the message is the same: if you want to stop rebuilding your network every decade, start with the right foundation.

How Big Bang Broadband Can Help

Big Bang Broadband LLC brings decades of combined executive, engineering, and operational expertise to help public and private sector entities develop, evaluate, and execute sustainable broadband infrastructure projects. We specialize in OSI-layer-aligned planning, feasibility studies, strategic Layer-0 design, and guiding clients through technology selection, funding strategy, permitting, and long-term operational modeling. Whether you're deploying a new fiber network or integrating it with legacy systems, Big Bang Broadband can help you build it right—from the ground up.

About the Author

David J. Malfara, Sr. is a senior executive and broadband strategist with over 45 years of experience in telecommunications engineering, operations, and business development. He has founded multiple broadband companies, served as CEO, COO, and CTO for multiple national providers, and currently leads Big Bang Broadband LLC—a consultancy focused on designing and building future-proof infrastructure. David is a Senior Member of IEEE, a member of the Open XR Optics Forum, and serves on Florida's Local Technology Planning Team for Marion County.

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