

Digital Optical Networks

Rapid, Cost-Effective Deployment and Turn-up Case Study

The Infinera Digital Optical Network[®] defines a new network architecture that offers a significant benefit: the ability to install and turn-up new services at unprecedented speed and reduced levels of cost and staff. This paper presents a real-life nationwide Infinera Digital Optical Network deployment that delivered a 90% reduction in installation cost and time, and enables the service provider to turn up new services, even across ~14,000 route-miles, in a matter of minutes. The contributing factors behind these advantages are examined - from the system's technical attributes to the role of the Infinera world-class deployment services.

Introduction

Infinera® has introduced a new paradigm in network architecture, called the Infinera Digital Optical Network, which combines the robustness, flexibility, and end-to-end service management of SONET-like digital systems with the high capacity of DWDM systems. The Digital Optical Network is a high-capacity DWDM system that cost effectively integrates sub-wavelength switching, bandwidth management, protection switching, and GMPLS-powered service intelligence at every node in the network. The system also uses Digital Wrapper technology for transparent service delivery, end-to-end performance monitoring and connection management. These are some of the reasons why many of the largest US nationwide service providers are selecting the Infinera Digital Optical Network.

The Digital Optical Network architecture also accelerates installation and service time-to-revenue with a level of service reliability and differentiation not provided by traditional DWDM equipment. Consider the case of a major US nationwide Service Provider that chose the Infinera Digital Optical Network solution for a significant build-out of its already-existing long-haul optical network. Today, the 13,800 mile build-out carries live customer traffic across 75 major metropolitan areas. By partnering with the Infinera Customer Service and Technical Support organization for Engineering, Furnishing, Installation, and Test (EFI&T) services, the build-out was deployed at a record rate of 0.73 days/site.

The deployment quality metrics for this network deployment are also notable - greater than 99.5% of the ~2600 FRUs shipped turned on successfully upon initial install, and 100% of the Digital Optical Network's spans passed Bit Error Rate (BER) test upon initial test. Moreover, with the Infinera Digital Optical Network, the Service Provider can turn up new nation-wide services in a matter of minutes. This service-delivery velocity gives the Service Provider a significant competitive edge, enabling it to retain existing customer loyalty and compete aggressively for new customer business.

This paper takes a closer look at this customer success story, and provides insight on the factors enabling these industry-leading deployment and turn-up statistics.

Simple, Fast, Easy to Deploy

A major US nationwide service provider needed to double the network capacity on its existing 18,000 mile fiber optic long haul network. The provider chose the Infinera Digital Optical Network architecture for superior service delivery speed, reliability, and ease of management. This provider also engaged the Infinera Turn-key EFI&T Service to deploy the network. All aspects of the deployment – from initial site survey through final acceptance test and delivery of the final engineering design package – were executed by Infinera EFI&T specialists.

The build-out consisted of more than 200 sites across 27 long-haul routes, spanning a total of 13,800 miles. Fully orchestrated under dedicated Infinera EFI&T Service Program Management, the entire network build-out was installed, tested and accepted in five months – at an industry leading average of 0.73 days/site.

The size of the entire installation and acceptance team was also remarkably small by industry standards for the route size. The team consisted of a total of 12 people with only 2-3 installation engineers working on any given route at a time.

As shown in Table 1, actual cost-time deployment metrics show that the Infinera Digital Optical Network delivered a 69% relative cost savings over typical traditional WDM system metrics.

A nationwide-scale Infinera Digital Optical Network can deploy at less than two-thirds of the typical cost-time for traditional WDM systems.

Deployment Metric	Demonstrated for Digital Optical Network	Industry Typical for Traditional WDM System
Number of installation engineers per site	2-3 persons	4 persons
Days required to install each site	0.73 days	1-2 days
DOA Ratio	< 0.5%	> 1.5%

69% Relative Deployment Cost-Time Reduction

Table 1: Deployment Metrics Comparison
 Traditional WDM System metrics are based upon 10Gb/s transponder-based WDM deployment of US nationwide scale.

Photonic Integration Benefits Installation and Turn-up

The ability to deploy the Infinera Digital Optical Network more quickly and cost-effectively is inherent in its unique utilization of Photonic Integrated Circuits (PICs). PICs enable the Infinera DTN™, the core building block of Infinera Digital Optical Networks, to transport, groom and manage very large capacities with reduced network equipment footprint and simplified hardware and network architecture. This significantly simplifies system installation and reduces the number of potential installation and operational-related failures.

Large-scale PIC technology integrates ten 10Gb/s DWDM channels onto a single Infinera DTN Digital Line Module (DLM), whereas a traditional DWDM system would require ten separate transponders/muxponders to provide equivalent functionality. A Band Multiplex Module (BMM) multiplexes up to eight optical channels groups from DLMs to deliver a total capacity of 400 Gb/s in one chassis, or 800 Gb/s in two chassis. Where each transponder/muxponder in a traditional DWDM system requires up to eighty modules and more than eighty related cable interconnection to multiple interleaver/multiplexing modules, the Infinera DTN can interconnect this same effective capacity using only nine modules and nine total fiber jumpers.

Figure 1 illustrates how these differences scale significantly in this case of a long-haul system; as the system capacity is increased. The relatively smaller number of chassis, fewer number of line cards required in each chassis, and fewer fiber connections enables the Infinera DTN to be installed in a fraction of the technician-hours that traditional 10Gb/s transponder-based WDM systems require.

Moreover, as all fiber management is resident within the same chassis (for up to eighty 10Gb/s channels), the Infinera DTN requires fewer inter-bay fiber connections. This saves considerable installation and trouble-shooting time spent routing and tracing fibers.

The Infinera Digital Optical Network features a simpler architecture with fewer externally integrated components, dramatically reducing the cost and time of network installation.

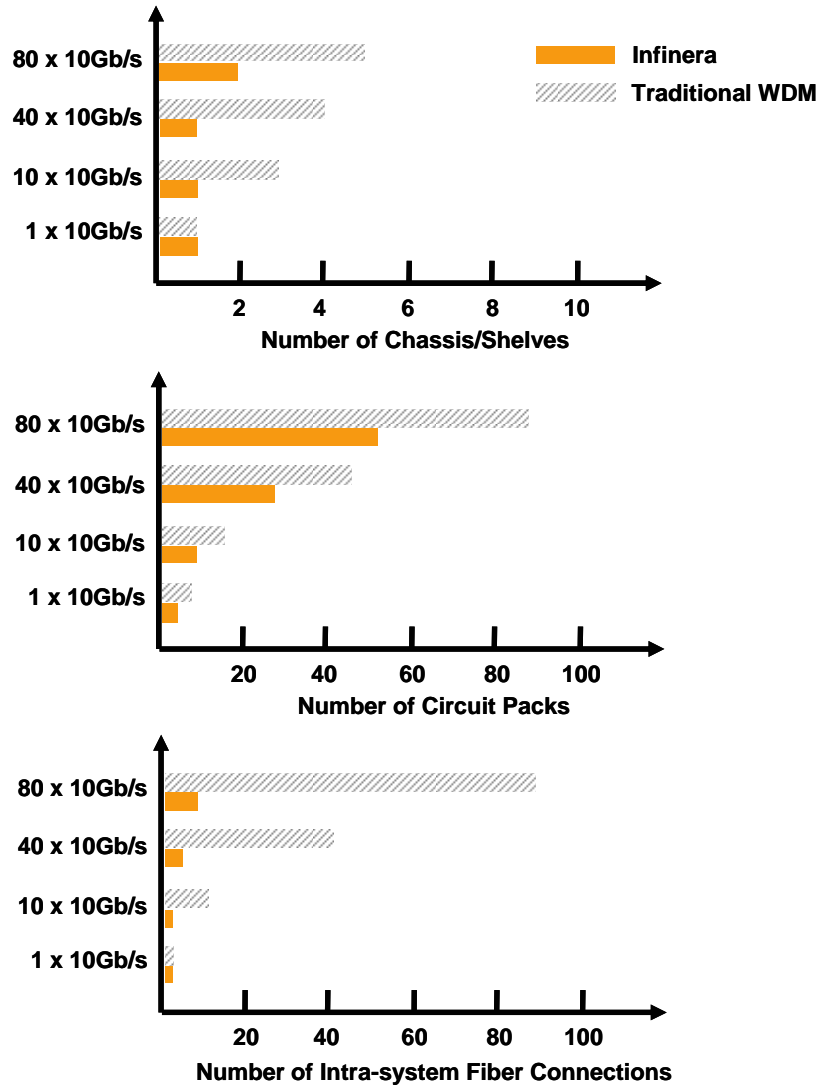


Figure 1: Number of Components and Fiber Connections Required to Turn Up N x 10Gb/s Wavelengths [Reference Node: Long-haul network, terminal configuration; Traditional WDM System utilizes half transponder / half muxponder service interface cards; Control card redundancy assumed for all.]

PIC-based systems can also improve the deployment quality metrics, such as the Defective-On-Arrival (DOA) rate and the initial pass-rate of BER testing due to significantly fewer optical components and interconnections between them. Similarly, with more than 90% of effective fiber connections made by the PIC, the Infinera Digital Optical Network installation experiences fewer failures (and resultant time-consuming troubleshooting) due to poor or dirty fiber connections.

Photonic Integration Combined with Network Intelligence

Commissioning the Infinera DTN is also simpler, compared to traditional WDM systems. The Infinera DTN uses a sophisticated GMPLS-based control plane that enables automatic topology/network discovery. Upon installation of DLMs at the endpoints of a network span, the DLMs automatically bring up 100Gb/s of service (as 10 individual channels) between the two DLMs. Built-in remote PRBS and loop back tests eliminates the need to physically roll out test equipment (BERT, OSA) and provides autonomous span testing during span acceptance.

Once the digital span is turned up and accepted between DLMs, service can be provisioned by simply adding Tributary Adapter Modules (TAMs) to both ends of a service path. Three types of TAMs support either eight 1Gb/s, four 2.5Gb/s or 10Gb/s client interfaces, and plug directly into one of the five client-slots within a DLM. In addition to the installation benefits of PIC integration, each DLM provides an integrated 2.5Gb/s cross-connect that enables sub-wavelength grooming at every DLM, including DLMs at intermediate DTN locations. This unique combination network intelligence and user automation enables end-to-end service turn-up between network end-points in a matter of minutes, rather than months.

Even a moderately sized Infinera Digital Optical Networks can deploy at significant cost savings - as much as 55% less over traditional WDM systems for initial turn-up of 10 channels, and up to 84% less for each subsequent 10 channels added.

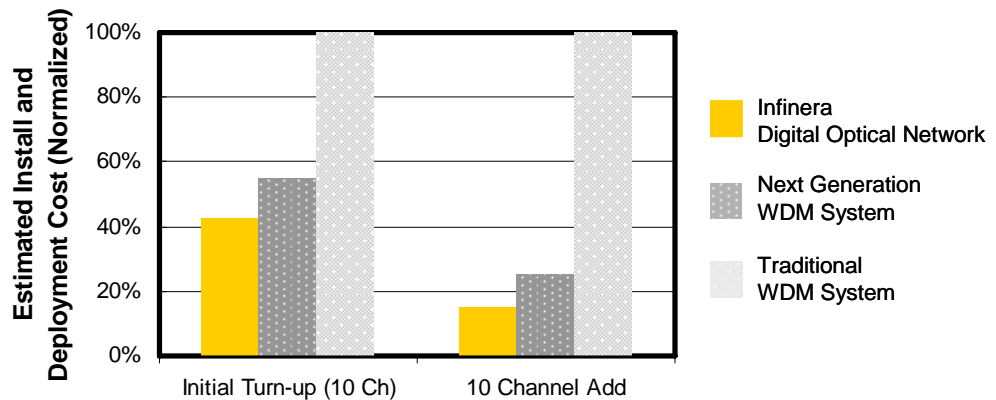


Figure 2: Estimated Deployment Cost Comparison for a 900 km DWDM Network with 10 Wavelengths. Network consists of two terminals, two add/drop nodes, and six in-line optical line amplifiers.

Overall, the installation and operational advantages of the Digital Optical Network significantly lowers deployment cost and time. The impact is significant, even for smaller deployments. For example, a simple cost-analysis using the factors discussed above estimates that, even for a modest 10 channel deployment spanning 900 route-km, the Infinera Digital Optical Network provides a deployment cost savings up to 55% relative to traditional WDM systems for initial turn-up, and up to 84% for each subsequent 10 channels added. These savings scale at a greater-than-linear rate, with increasing deployment size.

With such cost savings, carriers can lower the business case threshold required to connect customers, thereby increasing their potential revenue opportunities.

Simple, Fast, Easy to Add New Services

Once the network is initially installed, adding new services is simple, fast and easy. Unused digital spans between DTNs are already “running traffic” – by continually running BER traffic between DLMs. Addition of service into the network is achieved by simply adding TAMs to the end-points, and then point-and-clicking on the endpoints to provision new service.

Figure 3 illustrates how these few, simple steps compare to those required to turn up a single new wavelength on a traditional WDM system. The Infinera DTN provides carriers with significant simplification in the planning, engineering, and activation of new services. It eliminates multiple, cumbersome and expensive steps commonly required by Optical Add/Drop Multiplexers (OADMs), such as the manual connection of costly back-to-back transponders at WDM terminal nodes and the complex planning required to accommodate wavelength planning rules, banding constraints, and wavelength contention. In addition, the flexible add/drop architecture of the Infinera DTN simplifies operations over solutions that tie add/drop of services to a specific wavelength, as is the case with WDM terminals or OADM implementations.

Adding additional wavelengths beyond the initial ten to the Infinera DTN is equally straightforward. It requires only the installation of the new line cards, remote execution of link BER tests, and then a final end-to-end BER test.

The advantages deliver far more than simple cost savings. The ability to rapidly activate new customer circuits without complex manual provisioning operations reduces back-haul or access changes and shortens provisioning lead times. With this, Service Providers gain a significant competitive edge and faster revenue recognition.

Today, service providers using the Infinera Digital Optical Network can more successfully compete and win business because of their faster time to market, and differentiate their service offerings with the greater agility in meeting changing customer demands the Infinera DTN provides.

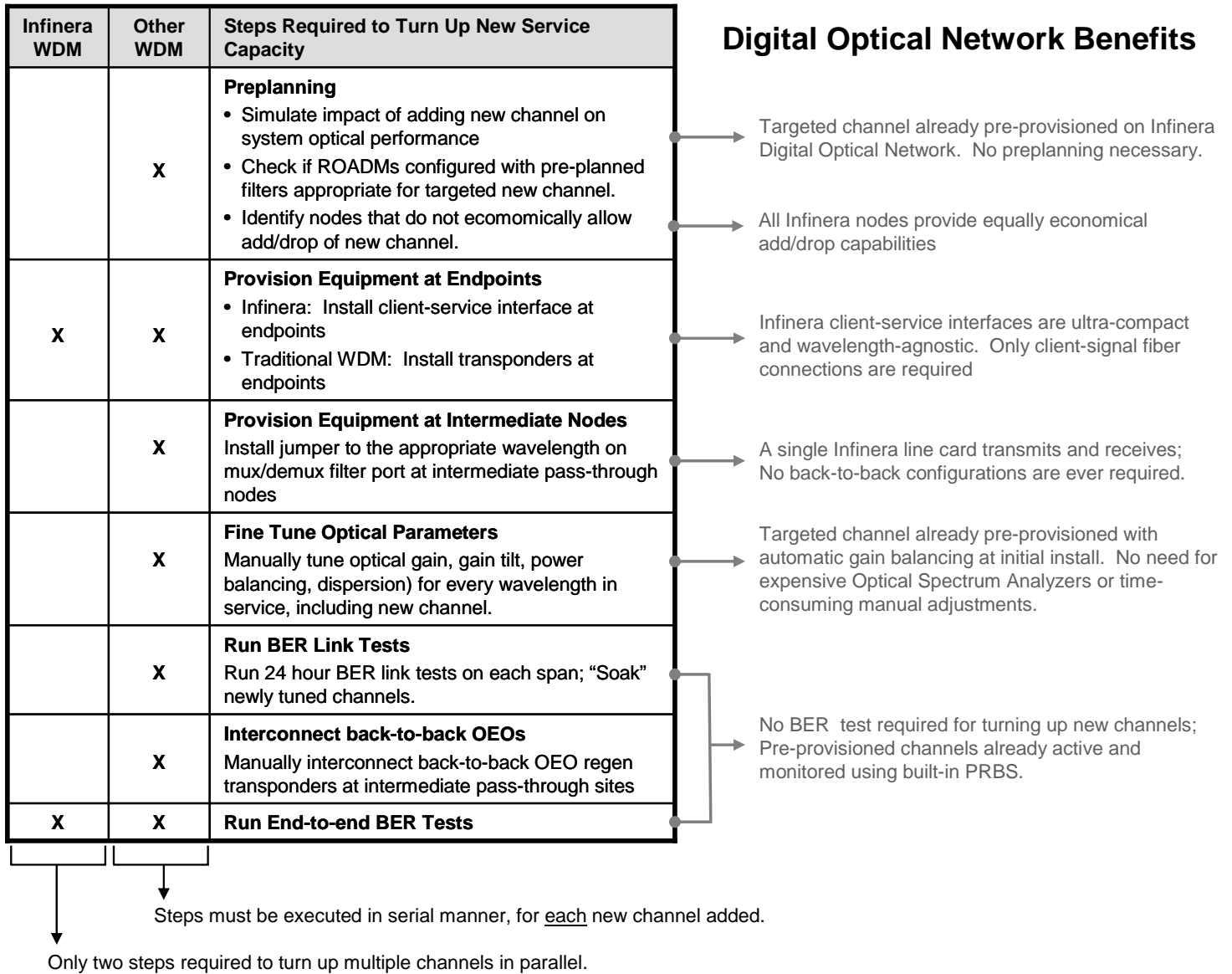


Figure 3: New Services Turn-up Comparison

The Role of Infinera Deployment Services

Although certainly significant, the Infinera DTN's technical advantages are not the only factors that enabled Infinera to install and turn up a US nationwide network in less than 5 months. After all, network simplicity is a relative concept – there is no such thing as a “trivial” network deployment. Deployments, especially ones as large as 13,800 route-miles, require complete and seamless system implementation. They require a team able to manage numerous logistics, administrative and operational issues – all without disruption to critical customer traffic.

The Infinera EFI&T Service can play a key role in realizing a faster-time-to-revenue through the Infinera Digital Optical Network, and offers significant deployment cost saving opportunities.

The Infinera Customer Service and Technical Support Team, and its comprehensive portfolio of deployment services, delivers on all these requirements. The Infinera Deployment Services focuses on providing service providers with the fastest time to revenue with the Infinera DTN by getting the Digital Optical Network up and running quickly with optimal performance from the start. Its staff of highly qualified engineers and program managers have extensive and global in-field experience that enables them to apply best practices, avoid pitfalls, and respond rapidly and competently to unforeseen issues - delivering cost-effective value and cost-saving opportunities.

Infinera deployment specialists focus on designing and implementing economical networks that deliver the highest Quality of Service and supports both current and future technology and capacity requirements. The result is a high-reliability, high-service-availability network architecture that is also simple, fast, easy, and inexpensive to modify and expand. Service providers can leverage these features to truly differentiate their own Service Level Agreements from those of their competition.

The Infinera Deployment Services includes Program Management services requisite to any network deployment, including start-to-finish project supervision, resource allocation and coordination, project planning and scheduling, issue escalation and resolution, partner and sub-contractor management, and regular milestone reviews. These services ensure the completion of network deployments on time and within budget, and give service providers a highly efficient and effective framework for communicating and implementing their requirements.

In the case of the nationwide deployment highlighted earlier in this paper, this specific Service Provider found the Infinera Program Management Services to be truly differentiated by its level of quality and commitment to their network deployment. The Program Manager took the necessary measures to ensure that every span was turned over on schedule and functioning flawlessly.

The project management was so tight that, in the single instance the service provider believed it had an issue to escalate, they found the Program Manager had already identified it and launched the necessary corrective actions. This highly proactive approach delivers a truly turn-key experience for the service provider.

The Infinera Deployment Services portfolio features a complete and flexible suite of offerings that that supports all phases of network deployment, from planning and design through final network test and sign-off. The Turn-key EFI&T Service delivers rapid, high quality deployment at minimal staffing, and enables services providers to

focus on their core business instead of the operational burdens of network deployment. Service providers may also select from a modular suite of deployment services offerings to complement their existing teams' expertise and maximize cost savings. Both options provide a vehicle for rapid revenue recognition with the Infinera DTN and the Digital Optical Network, together with the opportunity for significant cost savings in deployment operations.

Conclusion

Infinera is committed to delivering flexible, robust, and scalable network solutions to service providers that minimizes the cost of networking, reduces network operational expenses, and provides network simplification. And, because the design and deployment of today's networks are highly complex and carried out on ever-shorter implementation times with limited resources, Infinera places equal focus on providing carrier-class deployment services that also enable service providers to cost-effectively realize a faster time to revenue with their Digital Optical Network.

The Infinera DTN and Digital Optical Network provide a well-rounded and compelling set of benefits. It is the only solution of its kind that provides the capacity of WDM with the traffic management flexibility and engineering simplicity of digital transport systems, and the network cost savings of large-scale photonic integration. The Infinera DTN provides cost-effective service add/drop capabilities at any node in the WDM network, enabling carriers to more easily and quickly provide service in more markets, including secondary markets that may have previously been bypassed. And the Infinera DTN's simpler architecture significantly simplifies network installation and speeds new service turn-up, maximizing service responsiveness to new demands, changing customer connectivity, or new service requirements.

In full complement to this, Infinera provides a complete portfolio of deployment services that can be flexibly tailored to meet every service provider's needs. Designed through years of experience implementing new and expanded networks, the services focus on delivering optimal, best value implementation of the Infinera DTN and Digital Optical Networks.

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