FUJITSU

Technology Brief

Hyperscale Transport with the 1FINITY™ T600

Four cornerstones of support for data center and cloud traffic growth

Introduction

Massive traffic growth presents an equally massive challenge for data center and cloud providers, one which they can only meet by squeezing the most traffic possible through their networks. While current solutions for data center interconnect (DCI) applications have adequately served bandwidth demands until now, capacity exhaustion already looms on the horizon for many of these providers, with others sure to follow suit.

Hyperscale optical transport will require extreme but flexible fiber capacity and reach capabilities that can be scaled for various DCI applications. Fujitsu addresses these DCI needs with the 1FINITY T600 Transport blade, enabling data centers and cloud providers to equip their networks for the demands of the hyperconnected digital economy.

Four Tenets of Hyperscale Transport

The four cornerstone benefits, or tenets, of hyperscale transport are:

1. Flexibility to scale progressively while controlling cost per bit per km
2. Capacity to enable extreme optical transport use cases, further lowering overall cost
3. Automation to simplify operations and speed up adoption of network-level automation
4. Security at every level, from management to control to data plane, to protect critical data from intrusion

This document describes how these tenets are put into practice by the feature set of the 1FINITY T600 and upcoming blades in the 1FINITY Transport family.

Tenet 1: Flexibility

The T600 is suitable for multiple use cases on account of its ability to meet varied requirements for reach, capacity and power consumption. As a result, the T600 is a perfect fit for a variety of typical DCI applications. Operators can deploy just one optical transport system for short-distance, metro, long-haul, and ultra-long-haul use cases.

Functional Flexibility

For total functional flexibility, 1FINITY T600 provides the optimal balance among capacity, reach, rack space consumption, and power efficiency, giving operators full control over these key factors. As a result, the T600 can deliver optical performance optimized for specific DCI applications.

For each application, the T600 selects the most appropriate configuration set from innovative modulation schemes, constellation-shaping techniques, and enhanced and high-gain error correction algorithms. These are all offered by the NTT Electronics (NEL) digital signal processor (DSP) that has evolved over multiple generations of DSP improvements, enhancements, innovations, and field deployments. Some highlights of the T600's functional flexibility are:

- Variable capacity from 12.8 to 38.4 Tbps per C- or L-band fiber spectrum using channel spacing of 50 GHz (96 channels per fiber) or 75 GHz (64 channels per fiber)
- Wide-ranging reach distances, from 150 to 4000 km
- Variety of network (200 to 600G) and client (100 GbE, OTU4 and 400 GbE) data rates

An Optical Network that Scales to Meet Demand

- Adjustable configuration options to suit the application:
  - Span length distribution
  - Fiber route length distribution
  - Fiber type
  - Type of line systems
- Pay as you grow (PAYG) architecture based on pluggable/replaceable modules, minimizing up-front cost and maintenance overhead

Operational Flexibility

The T600's operational flexibility comes from its support of multiple management interfaces and YANG models, including some that are suited to machine-to-machine communication. Common software support across all development releases, in addition to open management that spans multiple platforms, also confer a greater degree of operational flexibility. The T600 also offers multiple options for monitoring, including the traditional CLI/SNMP interface but also streaming telemetry for automated operations. The T600 is supported by Fujitsu Virtuora Network Controller and the 1FINITY C200 Communications Integrator, allowing multiple management approaches. Operators can manage the blade directly through a variety of management interfaces; indirectly through controller software using element management functions; or via the C200, which allows logical aggregation of multiple blades as a single manageable entity.

Brownfield Applications Increase Longevity and Facilitate Evolution

Since the T600 supports 50 GHz channel spacing, operators can deploy the platform in brownfield applications and thereby take advantage of better optical performance. As the network evolves, an operator can subsequently transition the same T600 systems to 75 GHz architecture with no additional cost or overhead. The T600 supports both point-to-point and ring architecture, over both AWG+AMP and CDCG ROADM line systems, providing greater flexibility in evolving applications. With improved optical performance, existing 100G/200 Gbps applications will have greater reach and additional OSNR margins.

Easing Pressure on Total Cost of Ownership and Cost per Bit

Owing to the T600's ability to meet multiple use cases, operators only need to test/validate and deploy a single transponder for all their DCI needs, regardless of the network's optical characteristics. Inventory and spare parts management are also simplified since the number of spare parts and systems is reduced. This versatility directly results in huge savings that ease the pressure on cost per bit per km (cost/bit/km) calculations. Further cost savings are possible during integration, because now only one network platform has to be operationalized across all networks.

Tenet 2: Capacity

The T600 greatly maximizes fiber capacity by using both C- and L-Band spectrum on the line side of the network.

C-band (1530–1565 nm) is traditionally the spectrum of choice for North American WDM transport. Its popularity has been largely the result of using lower cost transceivers and other systems such as amplifiers to reduce fiber attenuation, improve performance over longer reaches, and mitigate system complexity.

Having achieved the highest possible data rates for various reach targets in C-band, operators are turning to L-band (1565–1625 nm), thus enabling the same fibers to carry almost double the capacity. This is a commonsense choice that extends the lifespan of the existing fiber plant and enables additional fiber acquisition to be delayed as much as possible. This is particularly important for applications such as long-haul where fiber costs are relatively high.

C-band owes its popularity to its low rate of attenuation. L-band comes in a close second in terms of signal attenuation, and hence is ideal for expanding capacity in applications ranging from metro to ultra-long haul. L-band uses compatible optical equipment (such as transponders, amplifiers, ROADMs and arrayed wave guides). Therefore, optical transport devices must be equipped to function in both C- and L-band.

From an operator's perspective, it all comes down to being able to achieve higher capacity with equivalent optical performance in L-band as well as in C-band, in view of L-band's relatively higher attenuation and dispersion. The Fujitsu 1FINITY T600 transponder provides equivalent OSNR characteristics at 200/300/400/500 and 600G, and delivers stable optical performance in both bands. As a result, the T600 can pack up to 76.8 Tb of traffic onto a single fiber with the same performance across all wavelengths in C- and L-bands.

The T600 doesn't just improve line-side capacity. To support growing data center traffic and further reduce cost per bit, the T600 reduces the number of client ports needed and extends capacity on the client side by providing a 100G QSFP-DD client port now, with 400G and OTU4 capabilities to follow in upcoming releases.

Improve Efficiency, Reduce Cost of Ownership

Tenet 3: Automation

Automation is becoming essential for operators as they increasingly prioritize lower total cost of ownership (TCO), in a similar way to what is already prevalent in data center packet infrastructure management. After reducing capital costs with disaggregated, purpose-built hyper-density technologies and systems, the industry's attention has turned to automation as a means of operational cost reduction. Fujitsu's Virtuora software portfolio brings much-needed operational efficiencies at every level of network management.

Embracing the Open-Source Model in Fujitsu System Software

Starting with the system software on the blade, Fujitsu embraced the open source model in the design of the latest version of Fujitsu System Software (FSS), called FSS2. FSS2 uses Linux as its base and adds a framework of common components onto that base, providing unified support for all blades in the 1FINITY family.

FSS2 system software works across the entire 1FINITY portfolio, in addition to some Original Design Manufacture (ODM) hardware and white boxes. For example, T-series blades have the same look and feel as L-series blades (common YANG models for common functions or data such as chassis, fans, and PIUs). 1FINITY blades of all series also use sets of YANG models and CLI commands that are specific to their individual functions.

As a result, FSS2 is feature-rich and has been extensively tested to support mission-critical data center needs. Most importantly, FSS2 was designed from scratch to offer modern open management interfaces and tools, which are needed to implement the level of automation customers are demanding.

To support various open initiatives, FSS2 supports YANG models from OpenConfig, OpenROADM and IETF, with proprietary Fujitsu extensions. This comprehensive set of interfaces includes familiar human-to-machine interfaces such as CLI, Web GUIs and SNMP. Additionally there are newer machine-to-machine communication enablers, such as RESTful APIs, NETCONF and gNMI, a gRPC interface protocol developed by Google.

To lay the foundation for richer automation, FSS2 can host third-party scripts or applications on the network element (NE). This capability enables execution of custom code or "agents" on the NE that perform a variety of functions. For example, agents can be used to collect and/or synthesize performance management, alarm, or event data, and trigger appropriate actions or help automate configuration processes or tasks.

Zero-Touch Provisioning (ZTP) makes configuration simple to automate and verify using a cloud-based master database. ZTP requires no or minimal human intervention and is a basis for more sophisticated forms of automation. FSS2 also supports plugins for automated device backup tools such as Oxidized and RANCID.

Automated Data Collection

System data collection can be automated using streaming telemetry as a fundamental information source for the analytics framework, to automate monitoring of overall network health and ultimately improve failure recovery capabilities.

Streaming telemetry periodically pushes selected data (such as performance statistics, alarms, operational state data, configuration data, and log content) from NEs to a monitoring system. The feature set and various controls can be configured from a data file or by using commands built into YANG models.

Streaming telemetry addresses several key automation use cases for optical networks. These include topology and traffic path visualization; resource and power monitoring; and component fault prediction.

Tenet 4: Security

As the Internet of things becomes the "Internet of everything," network security becomes a an increasingly urgent priority. Every layer, every technology, every device and every connection point carries its own security vulnerabilities. Security has paramount importance because of the mission criticality of data and the massive scale of damage that can result from breaches. The T600 is fully secure on the data, control, and management planes. Securing all three planes in optical transport networks provides a solid base for truly secure communications.

The T600 not only transports the highest per-fiber data rates in the industry, it does so securely and transparently with ultralow latency. The T600 is equipped with security on its management interfaces, applications, and physical system that enable the T600 to meet Level 2/3 requirements of the US government's Federal Information Processing Standard (FIPS) 140-2, a standard used to approve cryptographic modules deployed in highly secure applications.

Data Plane

Overall, the T600's flexible hyperscale transport capabilities enhance the security of data carried over leased dark fibers, third-party networks, leased OTN services, and switched OTN networks.

On the data plane, the T600 can be provisioned to employ industry-standard, protocol-agnostic, end-to-end Layer 1 OTN encryption using the AES256-GCM (Galois/Counter Mode) mode of authenticated encryption processing for all data traffic transported over each wavelength. This mode is best suited for symmetric-key cryptographic block ciphers, a technology used at high throughput levels due to its efficiency and performance. From the control plane perspective, the encryption key for each wavelength is exchanged using open Transport Layer Security (TLS) protocol. Layer 1 encryption offers 100% throughput with no impacts to bandwidth, since it uses OTN frame overhead bits to carry necessary encryption-related information. Encryption at the lowest layer also helps keep costs down, in part because no upgrades or changes are needed on other network layers.

Innovations that Build Value into the Network

Four Tenets of Hyperscale Transport

Flexibility

One transponder for multiple applications, reach distances and deployment models

Capacity

Support higher data rates (double the capacity) via addition of L-band capabilities

Automation

New system software provides a foundation for automation that reduces operational costs and boosts efficiency

Security

Full protection on all three planes: data, control and management, in addition to physical security

Management Plane

In line with FIPS requirements for the management plane, the T600 offers a range of secure system management interfaces (CLI and NETCONF over SSH, GUI over HTTPS, and SNMP v3). All management ports and interfaces can be disabled selectively if they are not in use. Software downloads and database backup and restore actions are performed using secure FTP, and the integrity of every file loaded into the system is validated. For enhanced security, users are authenticated based on their roles or identity. For safe return or transportation of equipment, system- and encryption-related security parameters can be completely erased by a zeroization operation before moving the equipment.

Control Plane

From configuration to software upgrades to database operations, interfaces and ports must be enabled and disabled selectively to prevent intrusion via open and unused ports or interfaces. This is essential in order to prevent unauthorized access via unused ports.

Control-plane cybersecurity also requires "sandbox-style" separation of admin and crypto (encryption) users to facilitate separation of NE management for Layer 1 encryption, and to enable operator customers to maintain dedicated control over encryption features.

Physical Security

For enhanced physical security to protect against unauthorized physical access, the T600 is designed for full opacity and does not require additional opacity shields. The system can also provide clear evidence of physical tampering.

The Bottom Line

The most prominent and vital applications of the global network and multinational cloud systems–mobile voice and data communication; big data and analytics; and large-scale video streaming–are now essential to everyday life and commerce. More value is being demanded from the network every day. The quantity, quality and speed of transmission must continue to increase in order to address these demands.

The 1FINITY T600 provides hyperscale optical transport with full flexibility, highest capacity, operational readiness and total security, supporting greenfield and brownfield DCI applications in short-reach, metro, long-haul, and ultralong-haul configurations.

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