

## GFAST™ Fractional Gigabit Ethernet System

A new member of Nebula's family of Ethernet over fiber products, the GFAST Fractional Gigabit Ethernet system lets service providers dramatically increase their Ethernet service capacity – both available bandwidth and coverage – and reduce service delivery costs at the same time.

### Conserve Energy and Space with High Density

The GFAST Fractional GigE System lets service providers upgrade existing point-to-point Ethernet configurations with a high-density point-to-multipoint design. Service providers can multiplex up to 16 customers onto a single fiber, increasing capacity of existing fiber to support more customers and higher bandwidth services. Alternatively, service providers can multiplex up to 16 customers onto a single line card in the central office to conserve shelf space and power. A high-density solution designed to meet carrier operating requirements, the GFAST Fractional GigE system supports up to 640 customers from a single Nebula EtherOptic Central Office shelf.

### Carry Business and Consumer Traffic

The GFAST Optical Line Terminal (OLT) and Optical Network Unit (ONU) are designed to GE PON standards and offer service providers a reliable, cost-effective way to build out an optical infrastructure for Ethernet/IP-based services. In addition, the GFAST GE PON system uniquely incorporates industrial strength bidirectional encryption, making it suitable for secure communications. This unique feature allows service providers to serve both business and consumer customers on the same fiber, a critical advantage in ensuring profitability.

### Define a Wide Range of Services

The GFAST system includes rich traffic shaping and Quality of Service (QoS) features to support a broad range of IP services, such as secure VLAN and Voice over IP for business customers, and video, IP TV and broadband internet access for consumers.

- Traffic marking, classification and shaping operate on eight quality of service queues per customer, supporting different service offerings on the same fiber.
- Automatic bandwidth sharing across queues (and customers) supports guaranteed service quality and guaranteed minimum bandwidth services, which can burst up to available capacity without impacting other customers' QoS.
- Two way encryption transforms PON technology into viable solution for Business services

The GFAST GE PON family uses the proven Nebula EtherOptic platform, broadly deployed today in major carrier networks for Ethernet delivery. Designed with carrier deployment and operations needs in mind, the Nebula EtherOptic platform provides

- Incremental provisioning to support profitable growth, where capital spending takes place in response to customer orders
- Addition of individual line cards to GFAST shelf without disrupting existing services
- Easy integration into existing management systems for operations and service support



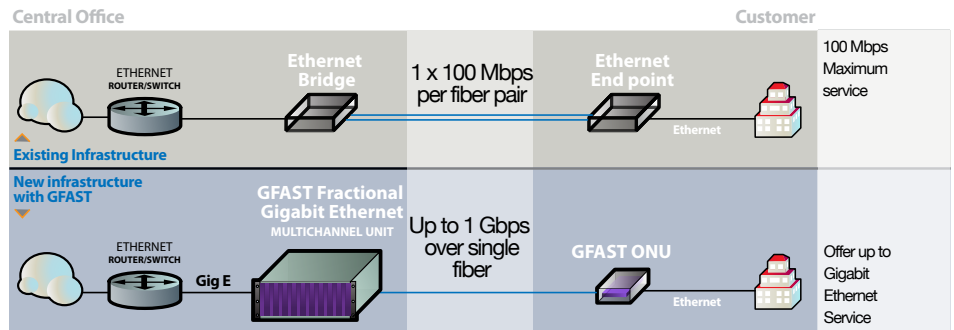
### GFAST Fractional Gigabit Highlights

- Secure Business IP services: Ethernet/VLAN services and VoIP
- Easy upgrade from legacy Ethernet services
- Significant increase in bandwidth for business customers
- Very inexpensive upgrade path for Nebula's VFAST 100 Mbps Ethernet

The GFAST Fractional Gigabit Ethernet products give service providers a cost-effective way to increase Ethernet service delivery capacity and service bandwidth. By replacing point-to-point Ethernet solutions with the GFAST point-to-multipoint system, service providers can increase bandwidth per fiber to 1 Gigabit Ethernet, and can choose to offer new, higher capacity Ethernet services, add additional customers without deploying additional fiber, or simply increase the utilization of fibers or CO space and power. In addition to increasing capacity, service providers gain significant operational benefits, as the GFAST system opens the door to remote provisioning of new services, therefore, reducing truck rolls.

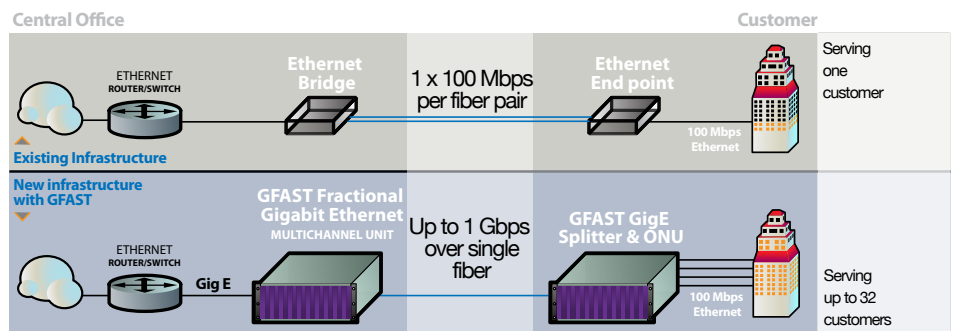
### Increasing Service Bandwidth

An existing 100 Mbps service is upgraded to support up to 1 Gigabit Ethernet using GFAST Fractional GigE solution.



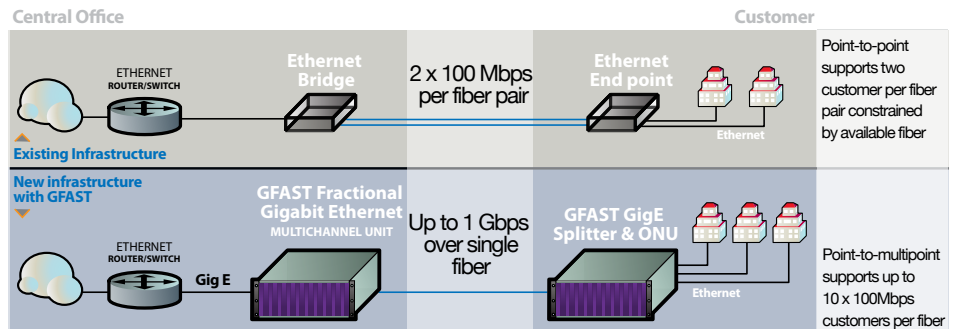
### Adding Customers

An existing solution provided 100 Mbps service to one customer over a fiber pair. With the GFAST Fractional GigE solution, the service provider can now serve up to 32 customers on one fiber, or 64 on that pair.



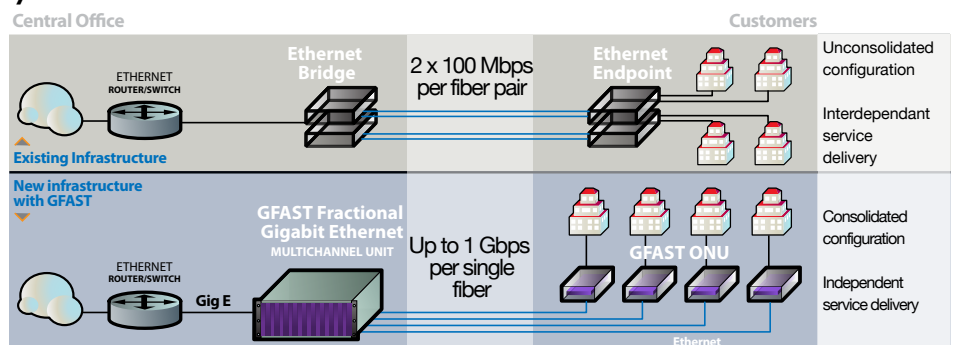
### Increasing Fiber Utilisation

An existing multiplexed 100 Mbps Ethernet bridge is replaced by a GFAST OLT at the CO and GFAST Splitter & GFAST ONUs and at the customer premise, providing additional bandwidth for existing or new customers and freeing up fiber for future use.



### Increasing Service Delivery Flexibility

Two existing multiplexed 100 Mbps Ethernet bridges are replaced by a single GFAST OLT & GFAST Splitter at the CO and low cost GFAST ONUs at each customer premise, simultaneously consolidating service management at the CO and increasing service independence for each customer.



# GFAST Fractional Gigabit Ethernet Technology

## Rich Broadband Service Offerings

The GFAST Fractional GigE system has sophisticated Quality of Service (QoS) and traffic-shaping features that give service providers the granular control necessary to offer a broad range of communication, information and entertainment services. Service providers can take advantage of the advanced bandwidth sharing features to ensure optimal bandwidth utilization and offer 'bursting' options to customers. For example, best-effort services can be policed to maximum bandwidths, while high priced services are allowed extra bandwidth when available, and voice services are guaranteed to receive the required bandwidth and immediate, low latency forwarding.

**Secure IP Services**—Recent investigation has identified that simple downstream encryption is insufficient to prevent eavesdropping and masquerading by coresident ONUs. The GFAST platform employs bidirectional encryption to ensure all communication is secure.

**Traffic Queues**—All traffic for each customer is classified and queued into a set of eight buffers (per customer) according to the QoS classification of the traffic. Priorities can be set for each queue.

**Bandwidth Assignment and Sharing**—The GFAST system assigns bandwidth based on a subscription-time variable. Bandwidth sharing can be enabled or disabled for each queue. Bandwidth is allocated with a weighted round robin (WWR) servicing algorithm that provides guaranteed minimum bandwidth to each Class of Service. When there is no congestion, minimum bandwidth is not policed and any queue can use available bandwidth.

Optimal bandwidth use is further supported by frame splitting and early discards. Early discard enables protocols such as TCP to converge to the full available bandwidth. Downstream traffic is switched to the right customer based on an internal VLAN tag in each frame. The GFAST OLT manages upstream bandwidth, allocating it in six-kilobyte windows to each GFAST ONU. The ONU can split customer frames across multiple windows, ensuring that all of the allocated bandwidth is usable. Traffic shaping is implemented in hardware for maximum throughput and minimum latency.

**QoS**—Many different QoS configurations are possible. For each QoS, the traffic is at first shaped, and then policed to the subscribed bandwidth for that QoS. Weighted round robin (WWR) queue servicing ensures that the GFAST Fractional GigE network delivers high-priority traffic immediately, without starving lower-priority traffic.

## Designed for Carrier-Grade Operations

The GFAST Fractional GigE System is designed on the Nebula EtherOptics platform which has been in use in carrier networks for more than a decade. Nebula has evolved the EtherOptic platform to meet carriers' demanding operational requirements while keeping the system highly affordable. Operations features support easy, non-intrusive deployment, upgrade and management.

**Deploy and Configure**—The GFAST OLT and ONUs are configured using a Telnet or SSH session. Commands configure the QoS features and other network modes and parameters, including the associated packet types, the bandwidth assigned, and the buffer depth before applying policing policies for each of the eight queues. The devices can be reconfigured while in operation, ensuring that changes to one customer's service do not cause downtime for others. Upgrading the unit's software can be done remotely, eliminating truck rolls, and meeting the combined goals of sustainability and reducing service support costs.

**Management**—The GFAST OLT and ONU are SNMP-managed devices. The management system in each is reached by using a VLAN number on the service provider's interface. Statistics are kept for both the Ethernet interface and individual queues. Devices can be queried for status and to download statistics.

**Reliability**—The GFAST OLT has two Ethernet interfaces, one of which can be configured to provide an automatic failover in the event that the equipment connected to the primary interface fails.

## GFAST Fractional Gigabit Ethernet System Details

### GFAST Fractional Gigabit Ethernet Units and Cards

<b>GFAST Multichannel unit</b>	A 20 slot cabinet designed for CO and customer premise environments. Fits in a 3U 19" rack. Convection cooled.  In a CO, can be configured with up to 20 GFAST OLT line cards (1 Gbps/fiber: 20 Gbps total) supporting up to 640 individual endpoints (20x32 ONUs). In a multi-tenant customer premise environment will support up to 20 endpoints (ONU's)
<b>GFAST GigE Customer Premise Unit</b>	GigE unit or line card in single-channel unit, or dual-channel unit if two links are desired

### GFAST Optical Line Terminal (OLT) and Optical Network Unit (ONU) Technical Specifications

	GFAST OLT	GFAST ONU
<b>Description</b>	Each GFAST-OLT can serve up to 32 GFAST ONUs with a total bandwidth of up to 1 Gbps	Each ONU supports a single Ethernet connection at up to 1 Gbps bandwidth
<b>Frequency</b>	1310 up/1490 down	
<b>Transmit</b>	+3 dBm	0 dBm
<b>Receive</b>	-30 dBm	-25 dBm
<b>Typical Application</b>	20 km /16 way split, 15 km /32 way split	
<b>Connections</b>	<ul style="list-style-type: none"> <li>1 SC optical connectors</li> <li>2 RJ45 twisted pair ports                             <ul style="list-style-type: none"> <li>- Customer LAN interface</li> <li>- Management</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>1 SC optical connectors</li> <li>1 RJ45 twisted pair port</li> </ul>
<b>Indicators</b>	<ul style="list-style-type: none"> <li>Power</li> <li>Carrier detect</li> <li>Secure PON Link Act</li> <li>Ready/Error</li> <li>Port1 Link/Act</li> <li>Port2 Link/Act</li> </ul>	<ul style="list-style-type: none"> <li>Power</li> <li>Carrier detect</li> <li>Secure PON Link Act</li> <li>Ready/Error</li> <li>Port1 Link/Act</li> </ul>
<b>Option Settings</b>	<ul style="list-style-type: none"> <li>WDM Emulation Mode</li> <li>FOIRL Emulation Mode</li> <li>Configuration Mode</li> </ul>	<ul style="list-style-type: none"> <li>Restore Factory Default</li> <li>Test Mode</li> </ul>
<b>VLAN</b>	Maximum 4096	
<b>Data Rates</b>	Up to 1 Gbps	
<b>Management</b>	SNMP managed device	
<b>Environmental</b>	Operating Temperatures                      -5 to 150° F (-20 to 65° C) Humidity (Relative)                              10–90% non-condensing	
<b>Dimensions</b>	1 slot (0.8 inches) wide, 3U (5 1/4 inches) high, 7.3 inches deep	

### GFAST Planar Splitters

	GFAST 1x8 Splitter	GFAST 1x16 Splitter
<b>Description</b>	Each passive GFAST 1x8 card splits a single optical path to eight equivalent paths	Each passive GFAST 1x16 card splits a single optical path to sixteen equivalent paths
<b>Operating Wavelengths</b>	1260 - 1650 nm	
<b>Connections</b>	SC (1 OLT, 8 ONU)	LC (1 OLT, 16, ONU)
<b>Insertion Loss -typical (max)</b>	9.8 (10.7) dB	13.0 (13.9) dB
<b>Uniformity - less than</b>	1.0 dB	Less than 1.4 dB
<b>Environmental</b>	Operating Temperatures                      -40 to 185° F ( -40 to 85° C)	
<b>Dimensions</b>	1 slot 1 slot (0.8 inches) wide, 3U (5 1/4 inches) high, 7.3 inches deep	