FlexE IP
A New Flexible Ethernet Client Interface Standard

FlexE IP Overview:
- Broadband Access Networks
- Metro and Core Networks
- Long-Haul and Subsea Networks
- Data Center Interconnect
- Optical Networks
- Carrier IP Networks

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Agenda

- Network Evolution
- Introduction of FlexE
- FlexE Features
- FlexE Transport Use Cases
- Open-Silicon FlexE IP
- Summary
The traditional hierarchical network with several explicit layers of devices

Currently evolving Simplified Network model; with

• A cloud services layer, which is growing rapidly and Network Function Virtualization enabling operators to provide all the data and voice services from within cloud data centers

• A transport Layer which provides MPLS, Ethernet packet services, OTN transport and switching with WDM, all via an SDN (Software Defined Network) between the two layers

Source: Infinera
Network Evolution
Mapping Packets to Intelligent OTN Transport

Router

10G/100G Ethernet

- MPLS-TP LSP to Dest A
- VLAN 1 to Dest B
- VLAN 2 to Dest B

Intelligent Transport

- ODU2e to Dest A
- PWE X (1 VLAN per PWE)
- ODUFlex to Dest B (Nx1.25G)

Source: External
FlexE Enables Simplified Services
What is FlexE?

- FlexE refers to a generic mechanism defined in OIF-FlexE-01.0 implementation agreement for supporting a variety of Ethernet MAC rates
- The FlexE group includes a range of 1 to 254 bonded 100G Ethernet PHYs
- FlexE utilizes the FlexE group framework to provide the aforementioned flexible MAC rates

How does it work?

- FlexE dissociates the Ethernet rate on the client side from the actual physical interface (also called server) by introducing a new shim through the IEEE defined MAC and PCS layers
- Uses standard 66B encoding
- Uses O code ordered sets

Where is FlexE used?

Innovations in coherent systems at various speeds like 100G, 150G, 200G, etc. optimize the cost per bit, if we could introduce similar efficiency at the Service Layer. This is where FlexE comes in, by adding in a TDM-like layer in Ethernet to use OTN style efficiency.
**FlexE Features**

**Bonding of links**
Group interfaces together to enable higher rate clients, using existing technology modules

**Better alternative to Link Aggregation (LAG), which uses hashing algorithms with a resulting efficiency of only 70-75%**

**Sub-rating**

In this example, the user desires a 300Gb/s pipe. Coherent optics needs four 75 Gb/s inputs for the highest cost efficiency. FlexE supports this by allowing four 100GE lanes to carry 75Gb/s each.

**Channelization**

FlexE allows OTN functionality in the Ethernet world

Provides a means of aggregating low-rate clients better than VLANs

**Sub-ratting**

Sub-rating is where you use only a portion of the link

**MAC** | **FlexE** | **ODUflex**
---|---|---
400G | 100G | 100G
100G | 100G | 100G
100G | 100G | 100G
100G | 100G | 100G

**Source:** OIF FlexE White Paper OIF-FD-Client-400G-1T-01.0.doc
<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>FlexE client rates</td>
<td>Can support any rate up to MAX configured bandwidth of 1.2T with a granularity of 5G. Scalable to support up to N * FlexE groups. For example, 800G could have as many as 160 clients of 5G each or just 1 client using up to 800G or less.</td>
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<tr>
<td>Channelization of input</td>
<td>Each port can have bandwidth up to 100G (minimum bandwidth 5G).</td>
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<td>User configurable rate-adapt feature</td>
<td>Feature allows for idle insertion/deletion or masking of FlexE slots as unused to support sub-rate PHYs.</td>
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<tr>
<td>Bonding single higher bandwidth MAC data</td>
<td>Can bond single higher bandwidth MAC data over multiple 100G PHYs (e.g., 200G/400G MAC).</td>
</tr>
<tr>
<td>Supports hybrid configuration</td>
<td>Supports hybrid configuration of any combination of bonding, sub-rating, and channelization.</td>
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<tr>
<td>Supports FlexE aware/FlexE Unaware/FlexE terminated mode of operation</td>
<td>Supports mode of operation for FlexE aware/FlexE Unaware/FlexE terminated.</td>
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<tr>
<td>Supports configurable de-skew FIFOs</td>
<td>Supports configurable de-skew FIFOs for both inter-lane de-skew and inter 100PHYs de-skew.</td>
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<tr>
<td>IP supports marking specific FlexE calendar slots as unavailable</td>
<td>Through config port at run time for FlexE aware networks.</td>
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<tr>
<td>Run time add/remove a FlexE client</td>
<td>Add/remove a FlexE client to a FlexE group without affecting traffic on other clients.</td>
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<tr>
<td>Resizing of FlexE client bandwidth</td>
<td>Can resize FlexE client bandwidth within a single FlexE group.</td>
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</table>
Open-Silicon Ethernet IP Subsystem
FlexE IP + PCS IP + MCMR FEC IP + Interface IP

Flow Based Client Interface

PKT I/F

HIGH LEVEL PCS & RS

FLEXE (1.2 T)

LOW LEVEL PCS

MCMR FEC & PMA

PHY

ODU Interface
66-bit Interface

Flow Based Client Interface
Summary

Open-Silicon’s FlexE IP is fully compliant to the OIF FlexE standard v1.0 and will be compliant to upcoming v2.0, supporting various client rates.

Built upon a flexible and robust architecture, Open-Silicon’s FlexE IP core is compatible with various clients supporting different rates.

The FlexE IP supports FlexE aware, FlexE unaware and FlexE terminate modes of mapping over the transport network.

Designed to be easily synthesizable into many ASIC technologies, the Open-Silicon FlexE IP is uniquely built to work with Open-Silicon's packet interface and OTN client interface or off-the-shelf MACs.

Open-Silicon provides a complete Networking IP Subsystem of FlexE IP + PCS IP + MCMR FEC IP + Interface IP + Interlaken IP for ease of integration and as one-stop solution to customers.
Thank You