A Universal **Terabit** Network Dataplane

11th of July 2017: FD.io material developed for Intel® Purley® Scalable Processor launch.
Video clip version: [https://www.youtube.com/watch?v=aLI0XLeV3V4](https://www.youtube.com/watch?v=aLI0XLeV3V4).
A Universal Terabit Network Platform
For Native Cloud Network Services

EFFICIENCY
The most efficient software data plane Packet Processing on the planet

PERFORMANCE
FD.io on x86 servers outperforms specialized packet processing HW

SOFTWARE DEFINED NETWORKING
Software programmable, extendable and flexible

CLOUD NETWORK SERVICES
Foundation for cloud native network services

LINUX FOUNDATION
Open source collaborative project in Linux Foundation

Breaking the Barrier of Software Defined Network Services
1 Terabit Services on a Single Intel® Xeon® Server!
FD.io VPP – Vector Packet Processor
Compute Optimized SW Network Platform

Packet Processing Software Platform
- High performance
- Linux user space
- Runs on compute CPUs: Intel, ARM
  - And “knows” how to run them well!

Shipping at volume in server & embedded products since 2004
FD.io VPP – The “Magic” of Vectors
Compute Optimized SW Network Platform

1. Packet processing is decomposed into a directed graph of nodes …

2. … packets move through graph nodes in vector …

3. … graph nodes are optimized to fit inside the instruction cache …

* Each graph node implements a “micro-NF”, a “micro-NetworkFunction” processing packets.

Makes use of modern Intel® Xeon® Processor micro-architectures.
Instruction cache & data cache always hot → Minimized memory latency and usage.
FD.io Benefits from Intel® Xeon® Processor Developments

Increased Processor I/O Improves Packet Forwarding Rates

FD.io Takes Full Advantage of Faster Intel® Xeon® Scalable Processors

No Code Change Required

**Breaking the Barrier of Software Defined Network Services**

1 Terabit Services on a Single Intel® Xeon® Server!
FD.io VPP & Cloud Network Services
Use Case Examples

SECURE PRIVATE CLOUD NETWORKING
Overlays for Private Cloud and Data Center Services
- vNF Scaleable L2 Switching and IPv4/IPv6 Routing
- vNF IPVPN, L2VPN, IPSec/SSL Encryption
Scale of Million FIB Entries with Service Features
- Performance at Max. of PCIe I/O of Intel® Xeon® Server

SUBSCRIBER MANAGEMENT
CG-NAT and Softwires
- vNF Carrier Grade NAT for Subscriber IPv4 Addressing Control
- vNF Softwires for Subscriber IPv4 over IPv6 Transport
Scale of Million Subscribers with Service Features
- Performance at Max. of PCIe I/O of Intel® Xeon® Server

Substantial Performance and Efficiency Gains vs. Alternatives
Fast Cloud Network Services
With Universal Terabit Network Data Plane

FD.io Fast Network Data Plane

IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

FD.io Cloud Network Service Properties:
A. Native cloud network data plane
B. Fast and Efficient
C. ~1,000 Gbps per Intel® Xeon® server

*Overlay encapsulations: VXLAN, LISP GPE
Fast Cloud Network Services
With Universal Terabit Network Data Plane

Software Defined Network – Cloud Network Services, IPVPN and Internet Security

Enterprise 1
IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

Enterprise 2
IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

Enterprise 3
IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

*mOverlay encapsulations: VXLAN, LISP GPE

FD.io Fast Network Data Plane

vNF Services

vRouter vNF

vNF Services

vNF Services

490 GE
User Side

2CPU
Network I/O 490 Gbps
Crypto I/O 100 Gbps

490 GE
Cloud DC Side

2CPU
Network I/O 490 Gbps
Crypto I/O 100 Gbps

25GE
4 Ports

100GE
9 Ports

240 GE
9 Ports

250 GE
4 Ports

25GE
x2

100GE
x2

IP Network
Private or Public

IPVPN Service Traffic Simulator
Traffic Generator

*Overlay encapsulations: VXLAN, LISP GPE
Fast Cloud Network Services
With Universal Terabit Network Data Plane

Traffic Generator – Traffic Items

473,979 Gbps
473,979 Gbps

Traffic Types
- 2 L2-3 Traffic Items
- 18 L2-3 Flow Groups

Statistics Measurements
- Latency
- Data Integrity
- Layer 1 Rate Statistics

Tx/Rx Packet Counts
- Tx: 1,073,249,151
- Rx: 1,073,239,122

490 GE
User Side

490 GE
Cloud DC Side

490 GE

IP Network
Private or Public

Traffic Generator
8 Ports on Inter-Connecting
18 Ports on Traffic Generator

LINK TYPE
- 8 10GE LAN
- 10 25GE/100GE LAN

LINK SPEED
- 8 10000 Mbps
- 8 25000 Mbps
- 2 100000 Mbps

LINK STATUS
- 18 Up
- 0 Down
- 0 Busy
- 0 Other

vRouter vNF

*Overlay encapsulations: VXLAN, LISP GPE
Fast Cloud Network Services

With Universal Terabit Network Data Plane

2CPU Network I/O 490 Gbps
Crypto I/O 100 Gbps

vNF Services

vNF Services

vNF Services

IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

IPVPN and L2VPN Overlays*, IPSec/SSL Crypto

User Side

IPv4/v6 Services

IPv4/v6 Services

IPv4/v6 Services

*Overlay encapsulations: VXLAN, LISP GPE
FD.io VPP – The “Magic” Behind the Equation

Machine with Intel® Xeon® Platinum 8168
Per processor: 24 cores 48 threads 2.7GHz
On-board LBG-NS 100G QAT Crypto

FD.io Takes Full Advantage of Faster Intel® Xeon® Scalable Processors
No Code Change Required

FD.io Data Plane Efficiency

<table>
<thead>
<tr>
<th>YESTERDAY</th>
<th>TODAY</th>
<th>Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel® Xeon® E5-2699v4</td>
<td>Intel® Xeon® Platinum 8168</td>
<td></td>
</tr>
<tr>
<td>{ + } 4 Socket forwarding rate [Gbps]</td>
<td>560 Gbps</td>
<td>948 Gbps*</td>
</tr>
<tr>
<td>{ - } Cycles / Packet</td>
<td>180</td>
<td>158</td>
</tr>
<tr>
<td>{ + } Instructions / Cycle (HW max.)</td>
<td>2.8 ( 4 )</td>
<td>3.28 ( 5 )</td>
</tr>
<tr>
<td>{ - } Instructions / Packet</td>
<td>499</td>
<td>497</td>
</tr>
</tbody>
</table>

* Measured 4 Socket forwarding rate is limited by PCIe I/O slot layout on tested compute machines; nominal forwarding rate for tested FD.io VPP configuration is 280 Gbps per Platinum Processor. Not all cores are used.

FD.io VPP – The “Magic” Behind the Equation
1 Terabit Services on a Single Intel® Xeon® Server!

Breaking the Barrier of Software Defined Network Services
A Universal Terabit Network Platform
For Native Cloud Network Services

Enjoying the following advantages:

- **Most Efficient on the Planet**
- **Superior Performance**
- **Flexible and Extensible**
- **Cloud Native**
- **Open Source**

**EFFICIENCY**
Now even more efficient with CPU core cycles/packet reduced from 180 to 158

**PERFORMANCE**
Best-in-class performance metrics, Terabit rates at Scale of multi-million FIB Entries with Service Features

**SOFTWARE DEFINED NETWORKING**
~200 programmable “micro-NFs” (graph nodes), ~20 extension “micro-NF” plugins, maximizing flexibility

**CLOUD NETWORK SERVICES**
User-space data plane with optimized SW / HW interface for high density cloud native micro-services

**LINUX FOUNDATION**
FD.io collaboration activity: 7000+ commits, 180+ contributors, 90+ organizations

Breaking the Barrier of Software Defined Network Services
1 Terabit Services on a Single Intel® Xeon® Server!