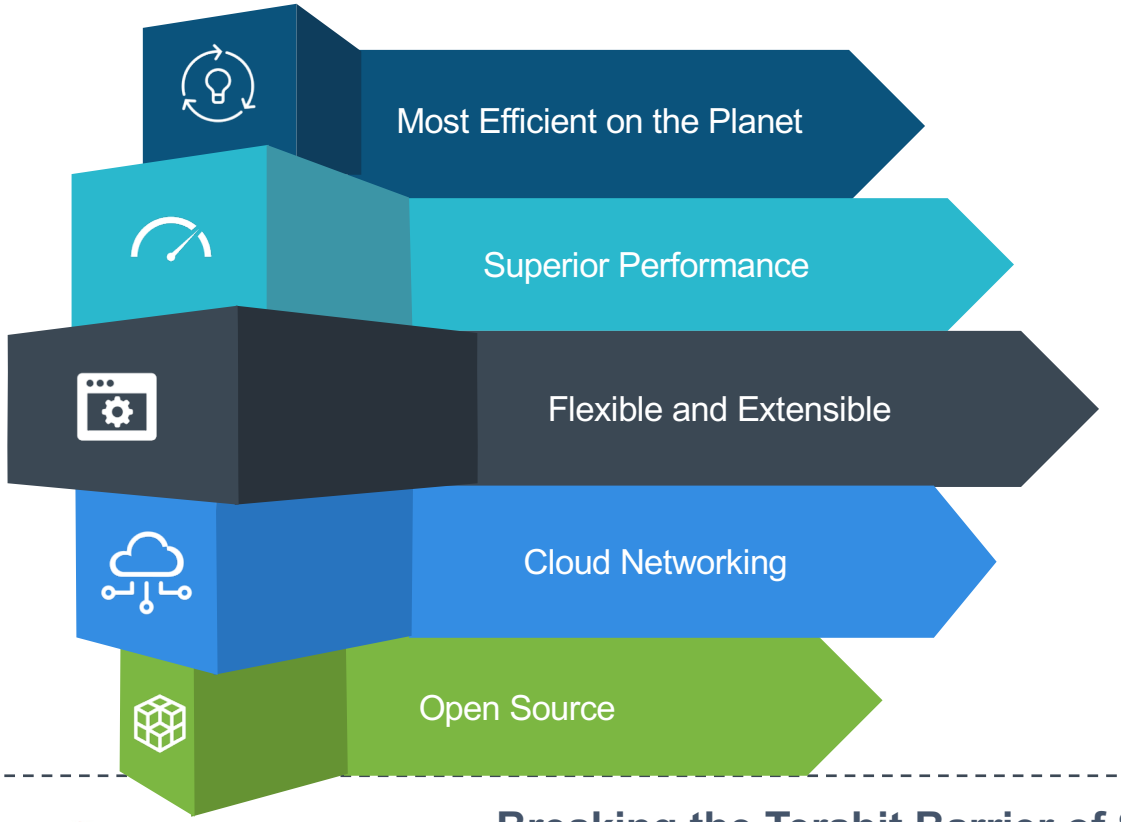
A ***Terabit*** Secure Network Data-Plane

Software for Breaking the Barriers: 1 Tb/s, 1 Bpkts/s, …

FastData.io Project

A Terabit Secure Network Data-Plane

For 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 NETWORKING
Software programmable, extendable and flexible

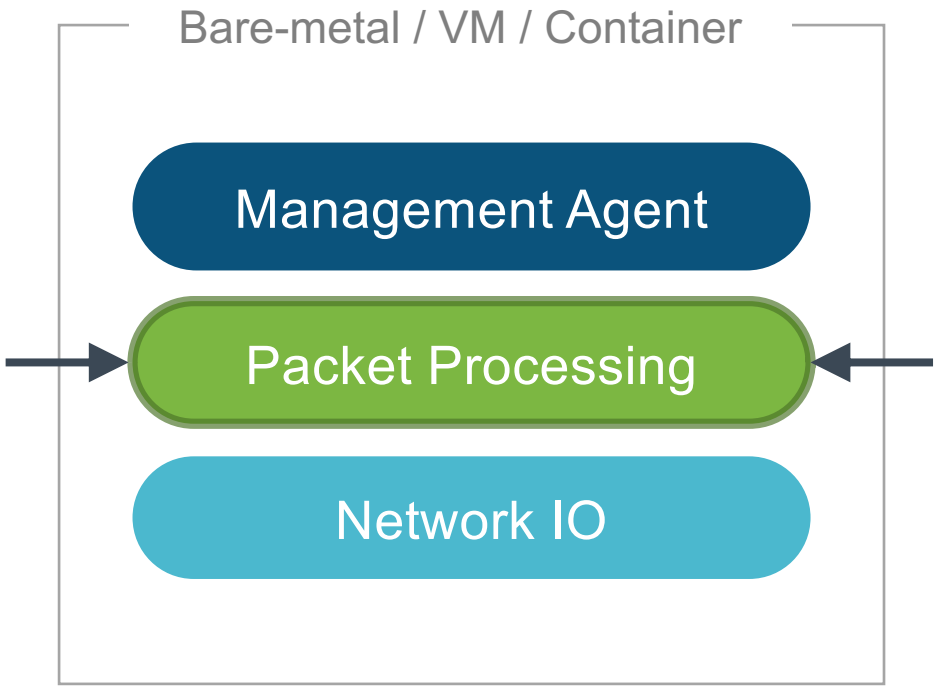
CLOUD NETWORK SERVICES
Foundation for cloud network services

LINUX FOUNDATION
Open source collaborative project in Linux Foundation

Breaking the Terabit Barrier of Secure NaaS Services on a Single 2-Socket Intel® Xeon® Server !

FD.io VPP – Vector Packet Processor

Compute Optimized SW Network Platform



Packet Processing Software Platform

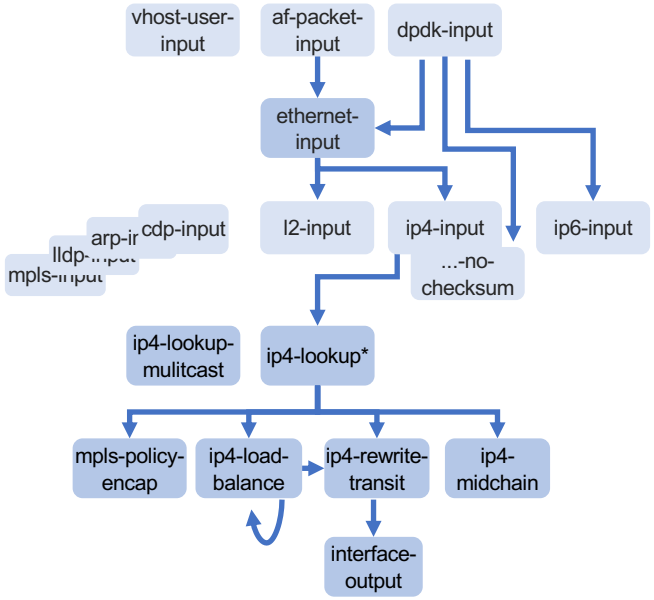
- High performance
- Linux user space
- Runs on compute CPUs: intel ARM Power
  - And “knows” how to run them well !

Shipping at volume in server & embedded products since 2004

FD.io VPP – The “Magic” of Vectors

Compute Optimized SW Network Platform

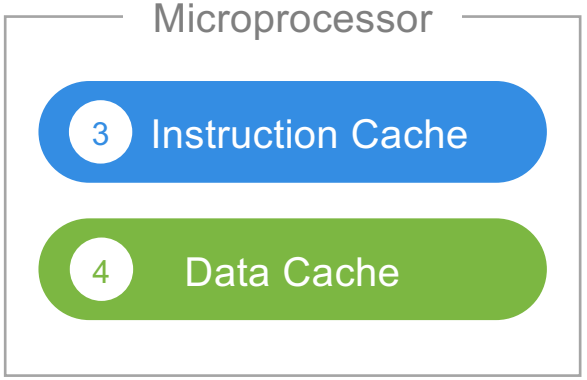
1 Packet processing is decomposed into a directed graph of nodes …



2 … packets move through graph nodes in vector …

Packet 0
Packet 1
Packet 2
Packet 3
Packet 4
Packet 5
Packet 6
Packet 7
Packet 8
Packet 9
Packet 10

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



4 … packets are pre-fetched into the data cache.

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

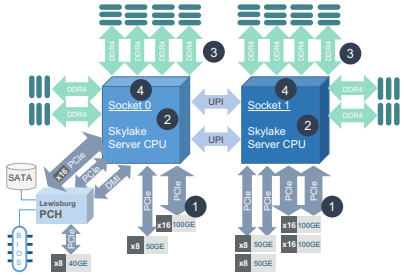
Makes use of modern Intel® Xeon® Processor micro-architectures.
Instruction cache & data cache always hot ➔ Minimized memory latency and usage.

FD.io Benefits from Intel® Xeon® Processor Developments

Increased I/O and Cipher Processing Improve Crypto Throughput

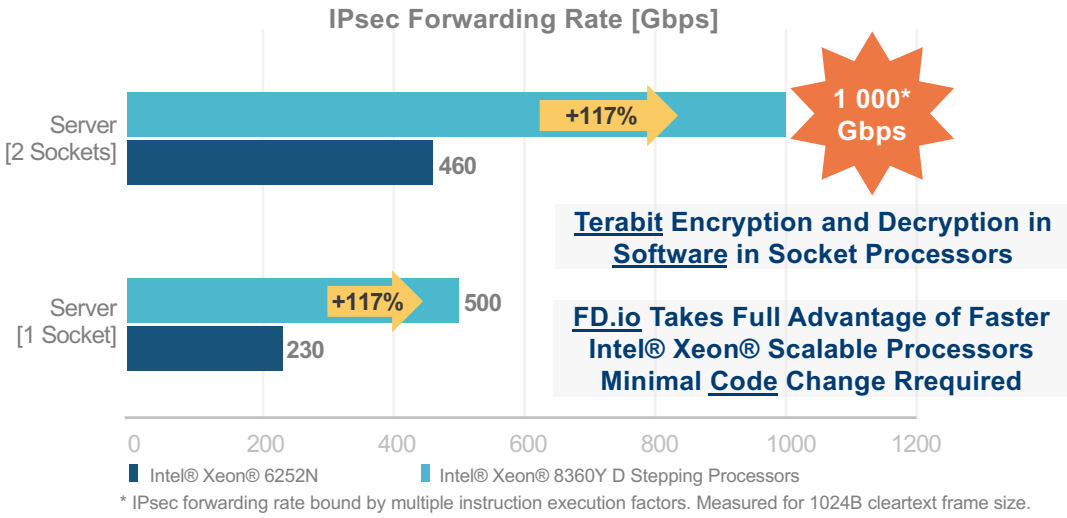
FD.io + **Intel® Xeon®** = **Terabit NaaS**

YESTERDAY



1. Network I/O PCIe Gen3: **320 Gbps**
2. Per Core Caches: L1d **32 KB**, L2 **1.0 MB**
3. Memory: **6-channels** 2666 MHz
4. Max power: **150 W** (TDP)

Intel® Xeon® 6252N
24 Cores, 2.3 GHz, 33 MB Cache

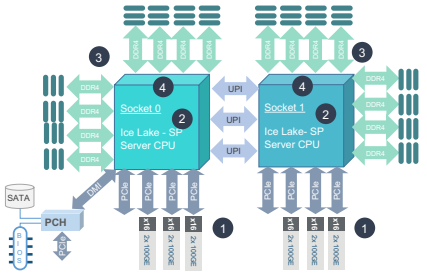


Terabit Encryption and Decryption in Software in Socket Processors

FD.io Takes Full Advantage of Faster Intel® Xeon® Scalable Processors Minimal Code Change Rrequired

* IPsec forwarding rate bound by multiple instruction execution factors. Measured for 1024B cleartext frame size.

TODAY



1. Network I/O PCIe Gen4: **600 Gbps**
2. Per Core Caches: L1d **48 KB**, L2 **1.25 MB**
3. Memory: **8-channels** 3200 MHz
4. Max power: **250 W** (TDP)

Intel® Xeon® 8360Y D Stepping
36 Cores, 2.4 GHz, 54 MB Cache

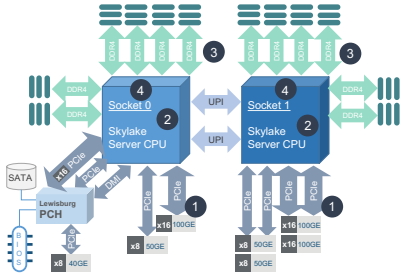
Breaking the Terabit Barrier of Secure NaaS Services on a Single 2-Socket Intel® Xeon® Server !

FD.io Benefits from Intel® Xeon® Processor Developments

Increased I/O and Processing Power Improve Packet Throughput

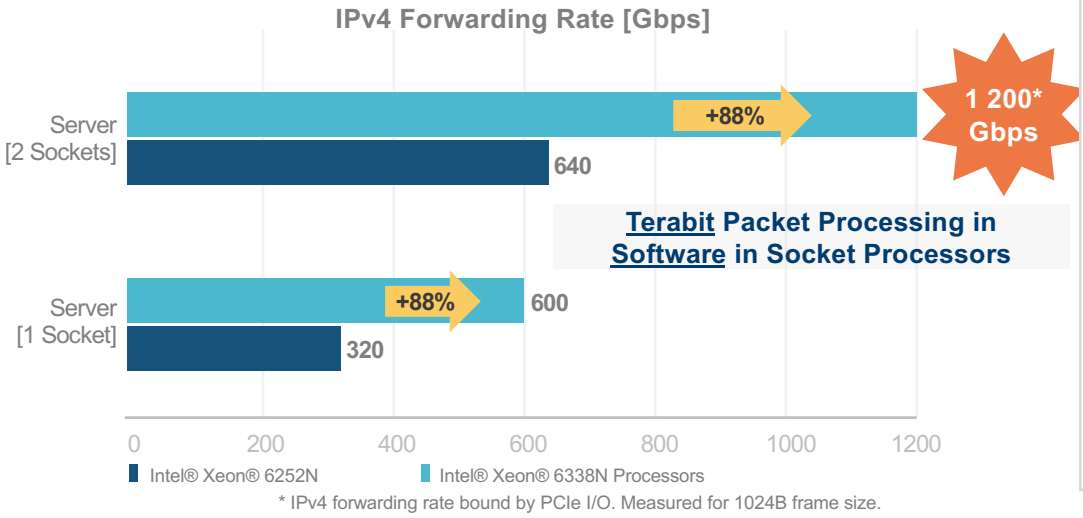
FD.io + Intel® Xeon® = Terabit NaaS

YESTERDAY



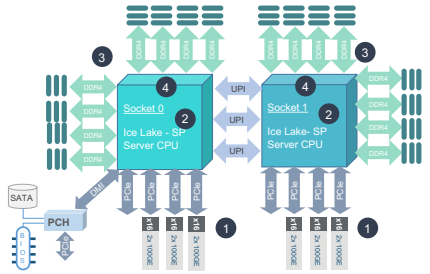
1. Network I/O PCIe Gen3: **320 Gbps**
2. Per Core Caches: L1d **32 KB**, L2 **1.0 MB**
3. Memory: **6-channels** 2666 MHz
4. Max power: **150 W** (TDP)

Intel® Xeon® 6252N
24 Cores, 2.3 GHz, 33 MB Cache



* IPv4 forwarding rate bound by PCIe I/O. Measured for 1024B frame size.

TODAY



1. Network I/O PCIe Gen4: **600 Gbps**
2. Per Core Caches: L1d **48 KB**, L2 **1.25 MB**
3. Memory: **8-channels** 3200 MHz
4. Max power: **185 W** (TDP)

Intel® Xeon® 6338N
32 Cores, 2.2 GHz, 42 MB Cache

Breaking the Terabit Barrier of Secure NaaS Services on a Single 2-Socket Intel® Xeon® Server !

.io

intel. XEON PLATINUM

FD.io VPP & Cloud Network Services

Use Case Examples

FD.io Intel® Xeon® = Terabit NaaS

SECURE NaaS CLOUD NETWORKING

Encrypted Overlays for Secure Access, Edge and Connectivity

- IPsec, TLS, QUIC, WireGuard - Fast Modern VPNs
- Horizontal Scaling with Near Linear Multi-core Speed-up
- Secure Tunnels: 40 Gbps / Core, up to 1 Tbps / 2 Sockets

Scale of Million Routes with Service Features

- Performance at Max. of PCIe I/O of Intel® Xeon® Server

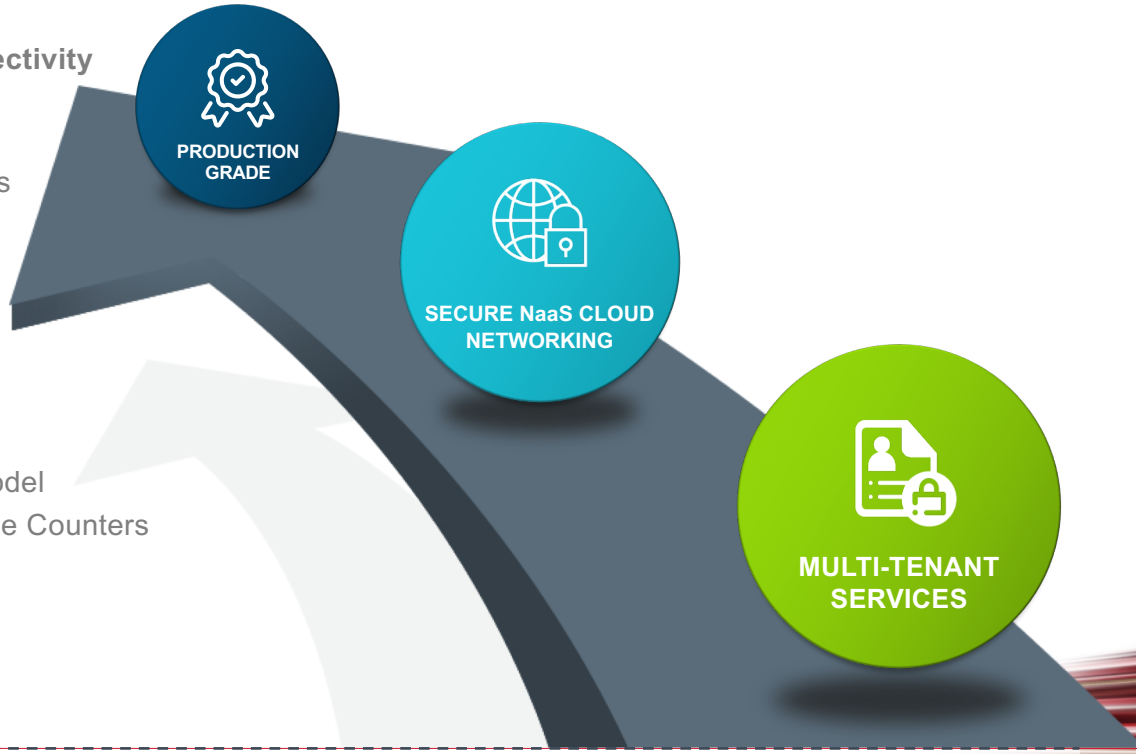
MULTI-TENANT SERVICES

Per Tenant Stateless and Stateful Packet Processing

- Rich IPv4/IPv6 Functionalities, API First Consumption Model
- Zero Cost Telemetry with Always-on Pervasive Data-plane Counters
- Service Features: ACLs, NAT, Sessions, VRFs

Multi-Tenant Scale and Elasticity

- Scale of Million Flows with Service Features



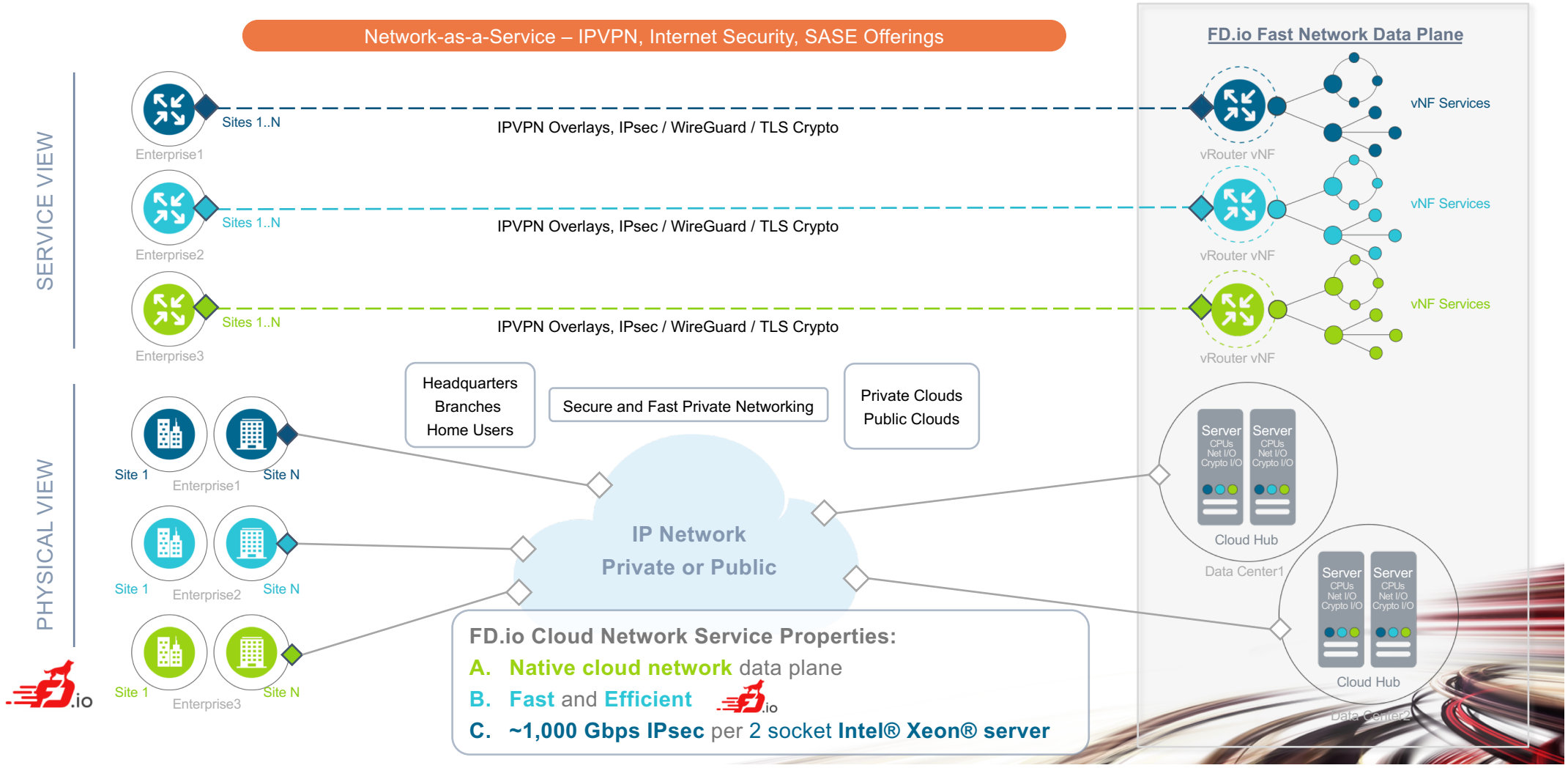
Substantial Performance and Efficiency Gains vs. Alternatives

intel. XEON PLATINUM

Fast Cloud Network Services

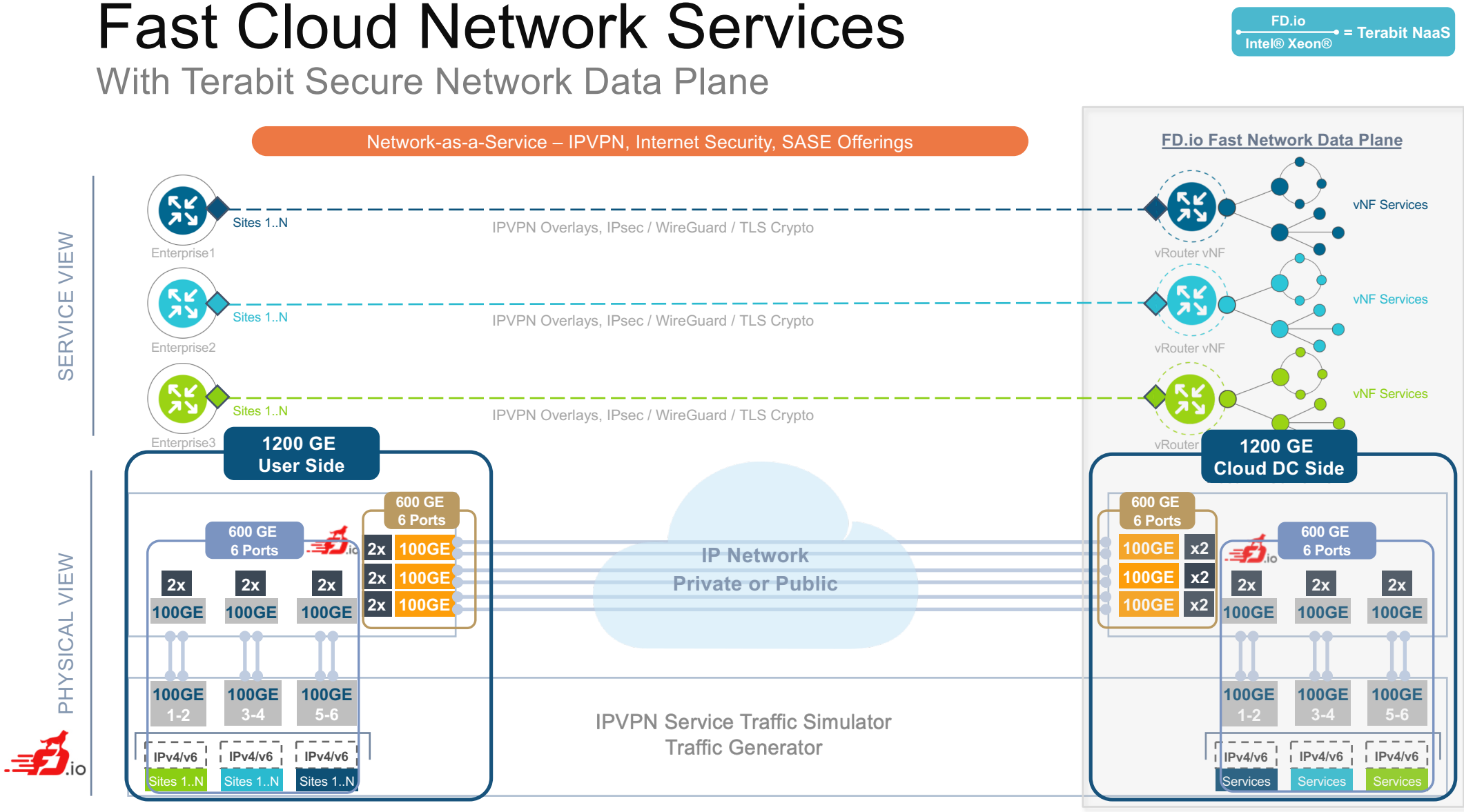
With Terabit Secure Network Data Plane

FD.io Intel® Xeon® = Terabit NaaS



Fast Cloud Network Services

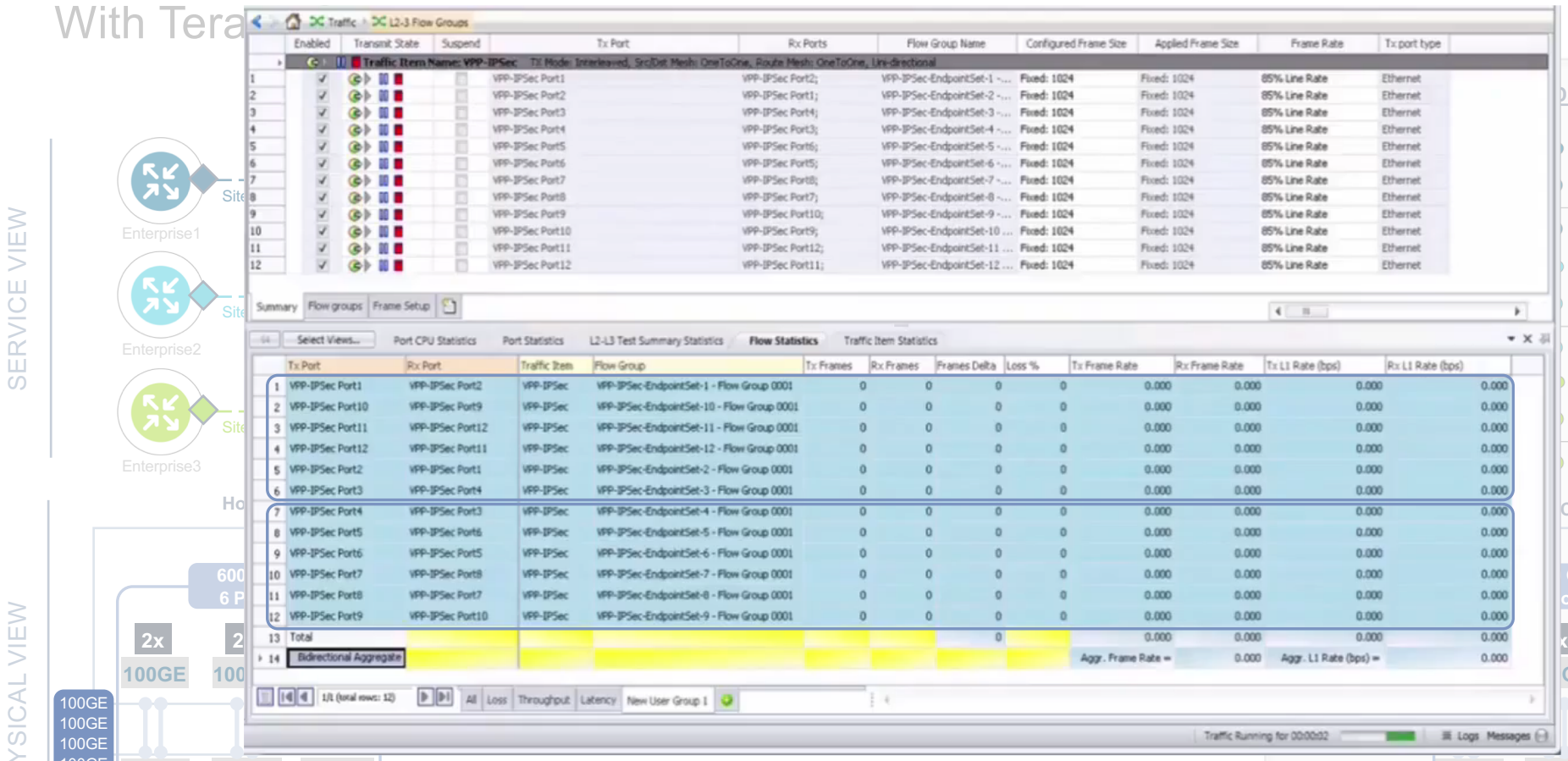
With Terabit Secure Network Data Plane



Fast Cloud Network Services - IPsec

With Tera

FD.io
Intel® Xeon®
= Terabit NaaS



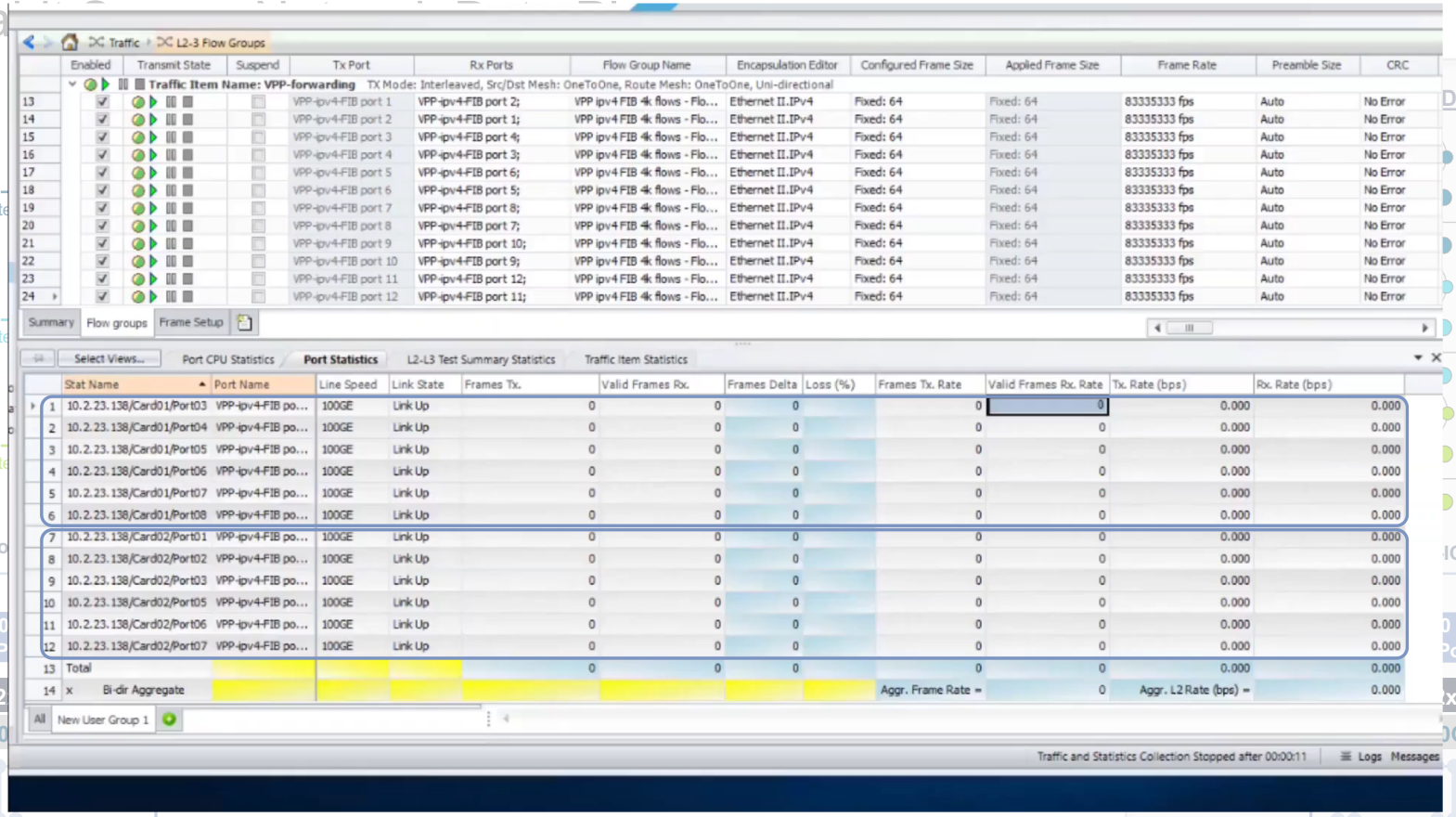
1 Terabit/s IPsec

cleartext 1024B frame size AES128GCM

Fast Cloud Network Services – IPv4

With Tera

FD.io
Intel® Xeon®
= Terabit NaaS



SERVICE VIEW

Enterprise1
Enterprise2
Enterprise3

Data Plane
vNF Services
vNF Services
vNF Services

PHYSICAL VIEW

2x 100GE
100GE 1-2
100GE 3-4
100GE 5-6
100GE
IPv4/v6 Sites 1..N
IPv4/v6 Sites 1..N
IPv4/v6 Sites 1..N

2x 100GE
100GE 1-2
100GE 3-4
100GE 5-6
100GE
IPv4/v6 Services
IPv4/v6 Services
IPv4/v6 Services

1 Billion Packets/s IPv4 Routing

64B frame size 128 000 /32 Prefixes

FD.io VPP – The “Magic” Behind the Equation

FD.io Intel® Xeon® = Terabit NaaS

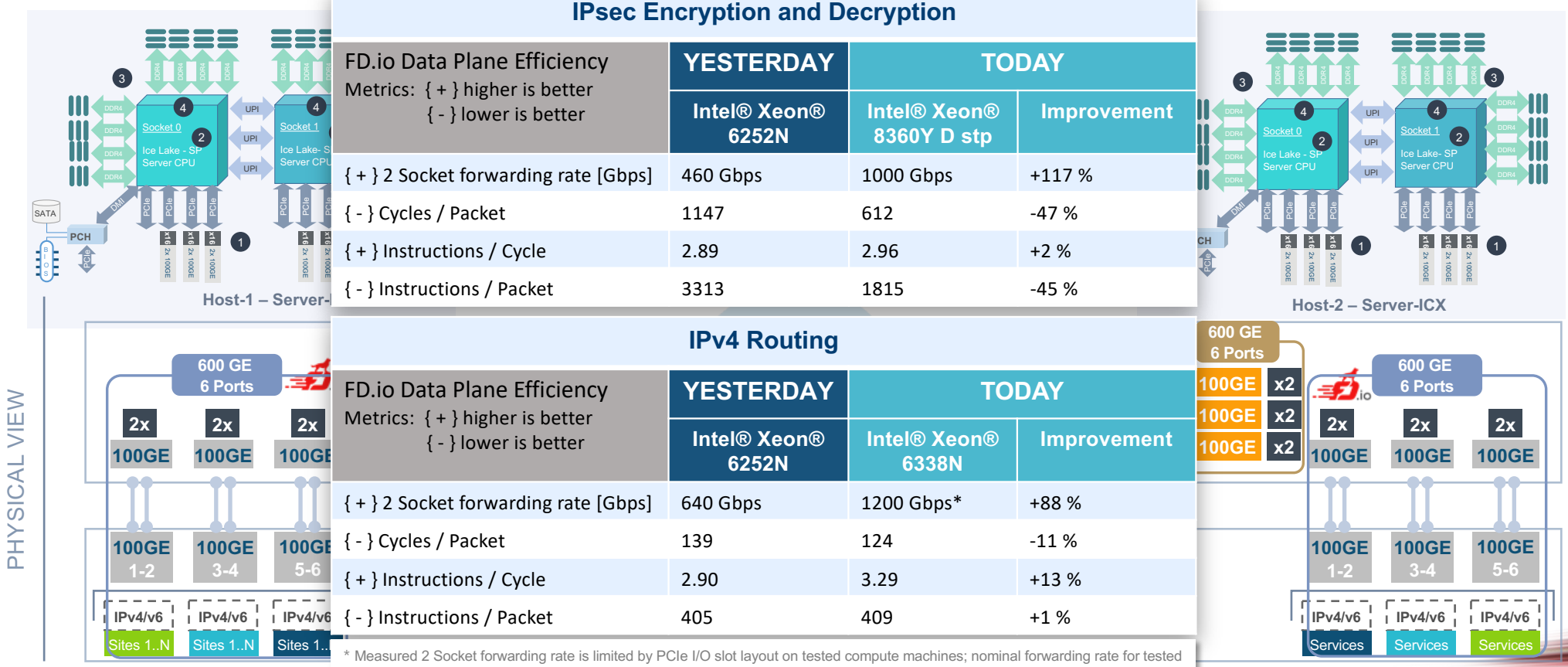
IPsec Encryption and Decryption

FD.io Data Plane Efficiency Metrics: { + } higher is better { - } lower is better	YESTERDAY	TODAY	
	Intel® Xeon® 6252N	Intel® Xeon® 8360Y D stp	Improvement
{ + } 2 Socket forwarding rate [Gbps]	460 Gbps	1000 Gbps	+117 %
{ - } Cycles / Packet	1147	612	-47 %
{ + } Instructions / Cycle	2.89	2.96	+2 %
{ - } Instructions / Packet	3313	1815	-45 %

IPv4 Routing

FD.io Data Plane Efficiency Metrics: { + } higher is better { - } lower is better	YESTERDAY	TODAY	
	Intel® Xeon® 6252N	Intel® Xeon® 6338N	Improvement
{ + } 2 Socket forwarding rate [Gbps]	640 Gbps	1200 Gbps*	+88 %
{ - } Cycles / Packet	139	124	-11 %
{ + } Instructions / Cycle	2.90	3.29	+13 %
{ - } Instructions / Packet	405	409	+1 %

* Measured 2 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 600 Gbps per Processor. Not all cores are used.

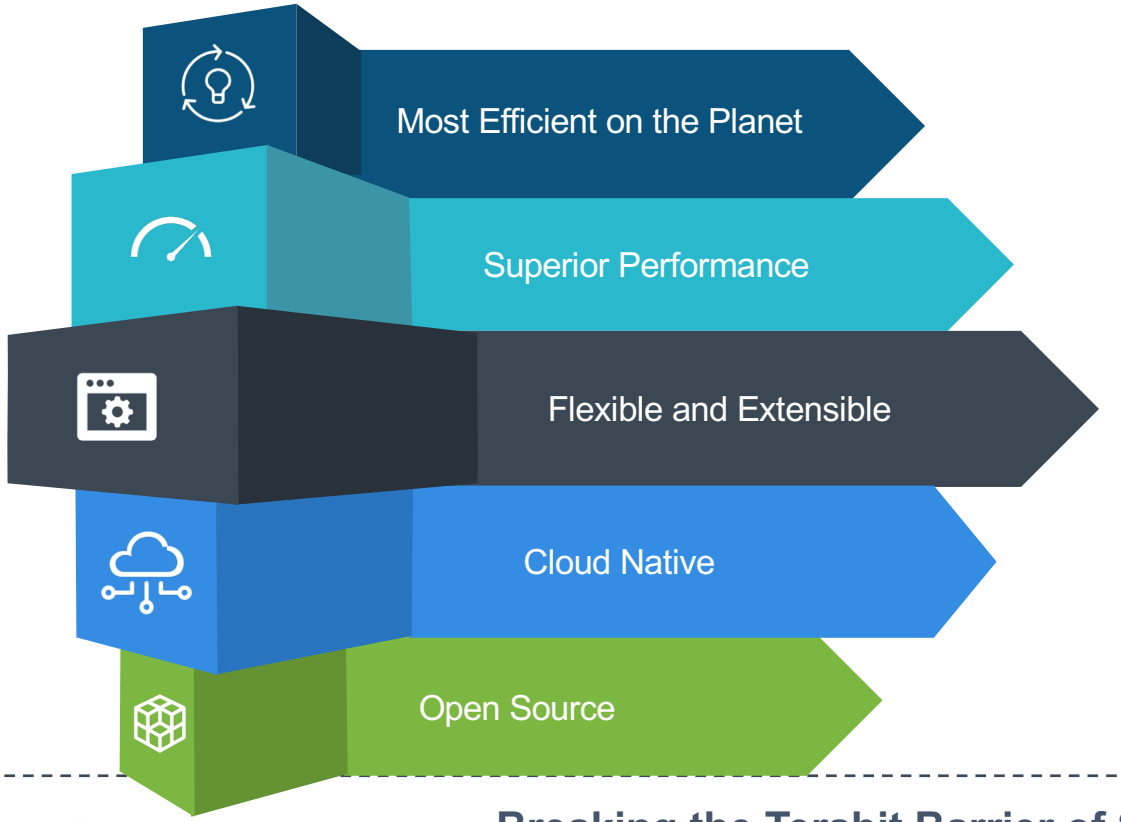


Breaking the Terabit Barrier of Secure NaaS Services on a Single 2-Socket Intel® Xeon® Server !

A Terabit Secure Network Data-Plane

For Native Cloud Network Services

FD.io
Intel® Xeon®
= Terabit NaaS



EFFICIENCY

Now even less CPU core cycles per packet: IPsec from 1147 to 612, IPv4 from 139 to 124

PERFORMANCE

Best-in-class performance metrics, Terabit rates with IPsec, Billion packets/sec with IPv4 at Scale

SOFTWARE NETWORKING

Many programmable NF graph nodes, ~20 extension 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: 21k+ commits, 500+ contributors, 120+ organizations

Breaking the Terabit Barrier of Secure NaaS Services on a Single 2-Socket Intel® Xeon® Server !

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