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Virtual Networking at Scale:
netElastic vBNG Enables Terabit Speed Broadband Networks

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Our Speakers

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About netElastic

- Help ISPs move to Disaggregated, Software-based networks
- Virtual Routing and Gateway Solutions: BNG & CGNAT
- Emphasis on market-leading performance and scalability
- Based in Santa Clara, CA / Silicon Valley
- Serving the Broadband Industry since 2015

Helping ISPs Around the World

"The **performance, scalability,** and **stability** of vBNG along with **support** from netElastic have been keys to our network success."

— *Tom Bishop, CTO, Harbour ISP*
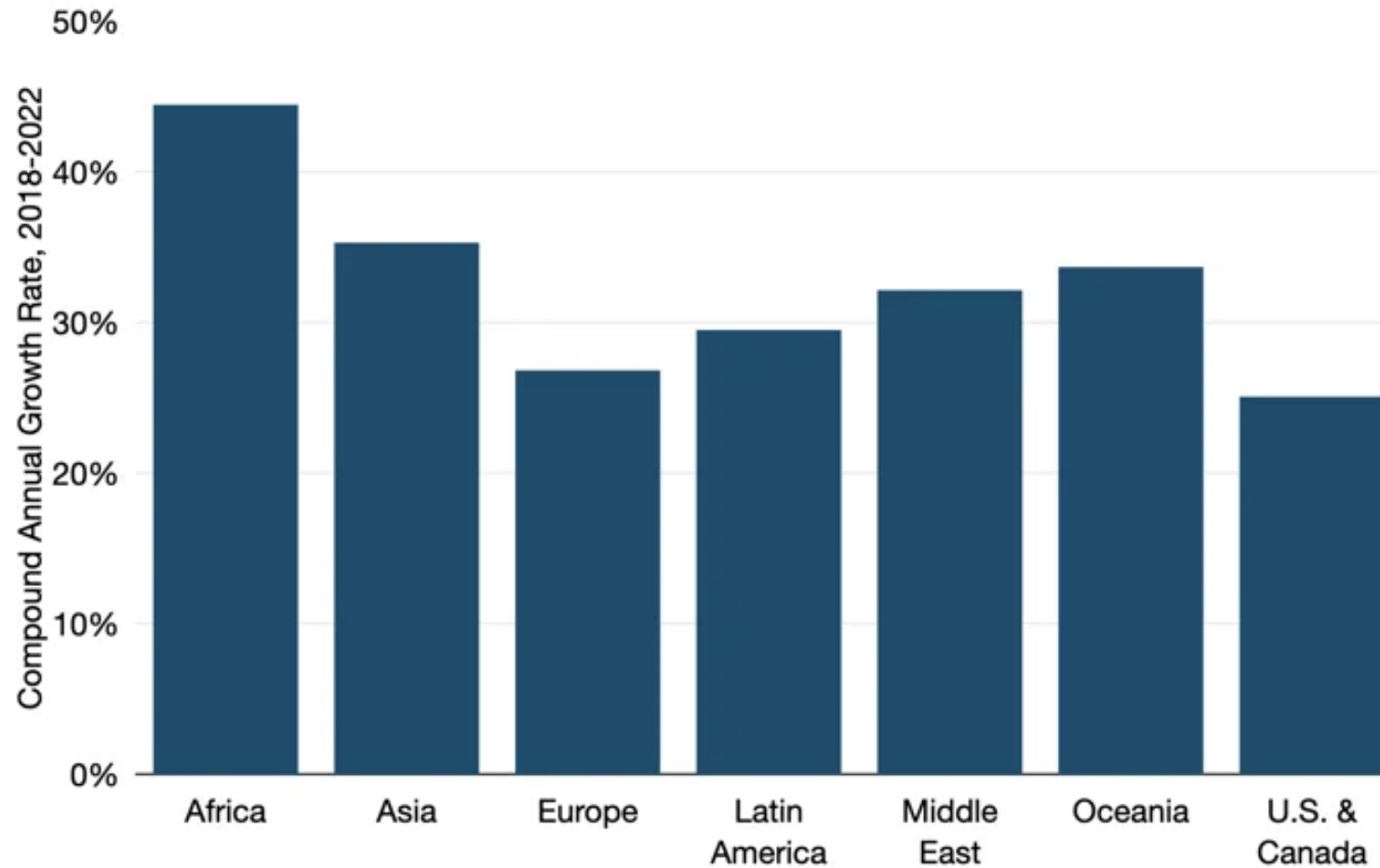
Bandwidth Growth – By the Numbers

28 Annual Global Traffic Growth %

997 Global Bandwidth in Tbps

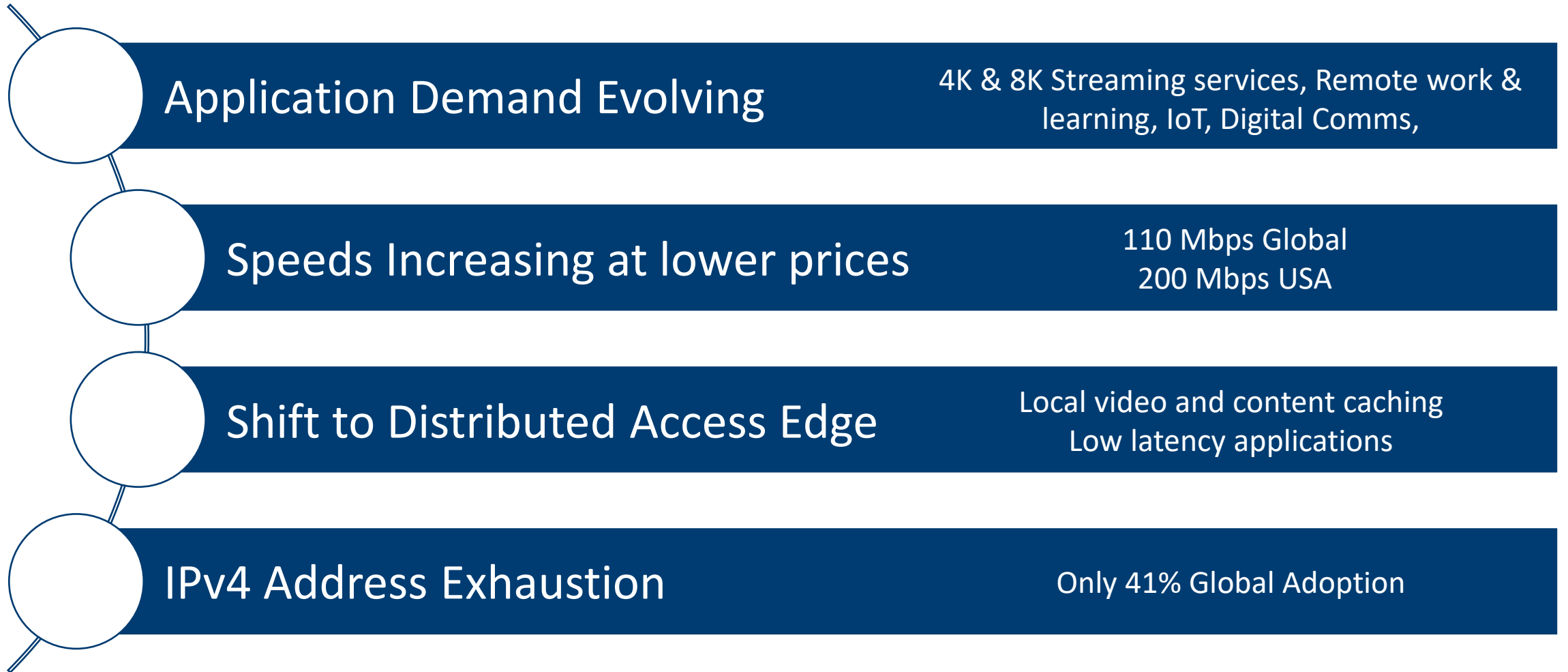**587** Average Per-Subscriber Consumption (GB per month)

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2022 Global Traffic Growth

Source: Telegeography
https://blog.telegeography.com/internet-traffic-and-capacity-remain-brisk

Service Provider Challenges

Application Demand Evolving — 4K & 8K Streaming services, Remote work & learning, IoT, Digital Comms,

Speeds Increasing at lower prices — 110 Mbps Global / 200 Mbps USA

Shift to Distributed Access Edge — Local video and content caching / Low latency applications

IPv4 Address Exhaustion — Only 41% Global Adoption

Sources: Allconnect.com; Cisco Visual Networking Index; 2023 OpenVault Broadband Industry (OVBI) report Google IPv6 Trends

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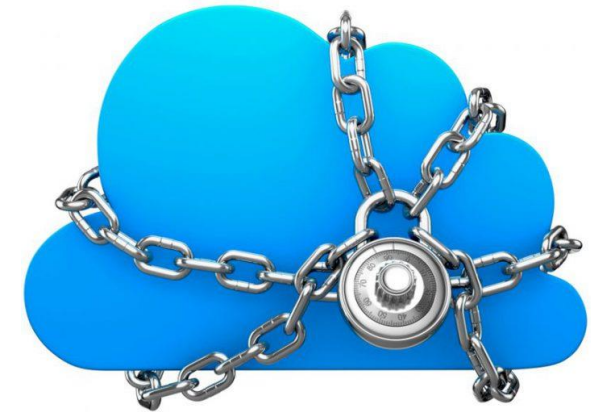
Disaggregation & Virtual Routers

- **All software virtual routers and gateways**
  - Pre-built installation tools

- **Run on Whitebox x86-based servers**
  - 4th Gen Intel® Xeon® Scalable Processors
  - Choose your own vendor
  - Bare metal or VM

- **Functionality enabled by license**
  - Full Routing Stack
  - CGNAT
  - BNG
  - Subscribers
  - 10/25/40/100G Port Capacity

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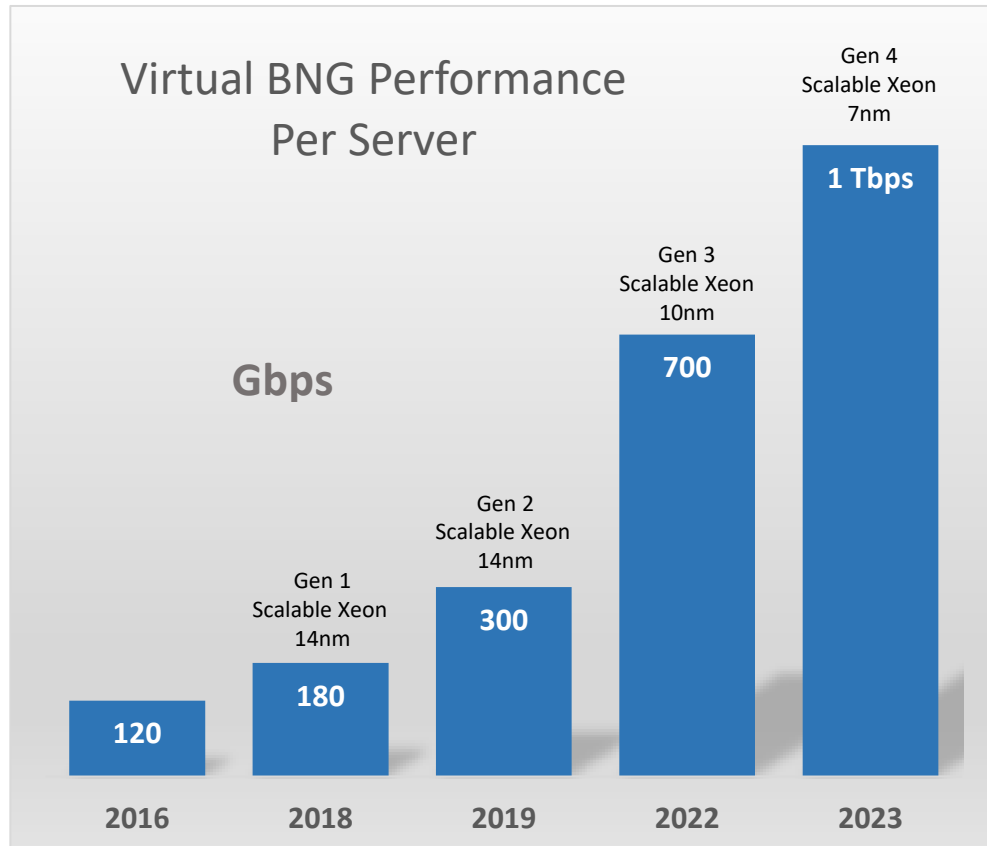
Leveraging Intel Innovations

- PCIe Gen Improvements
- 4th Gen Intel® Xeon® Scalable Processors
- DPDK Foundational libraries and Sample Applications
- Poll-Mode Drivers
- Intel Foundational NICs
  - Hardware offload
  - Dynamic Device Personalization (DDP)
  - Multi-Core Scaling

Unlocking Network Performance

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Market-Leading Performance

Virtual BNG Performance Per Server

Gen 4
Scalable Xeon
7nm

1 Tbps

Gen 3
Scalable Xeon
10nm

Gbps

700

Gen 2
Scalable Xeon
14nm

300

Gen 1
Scalable Xeon
14nm

180

120

| 2016 | 2018 | 2019 | 2022 | 2023 |

Scaling to 1 Tbps at 10 Gbps per Core
Latency in microseconds
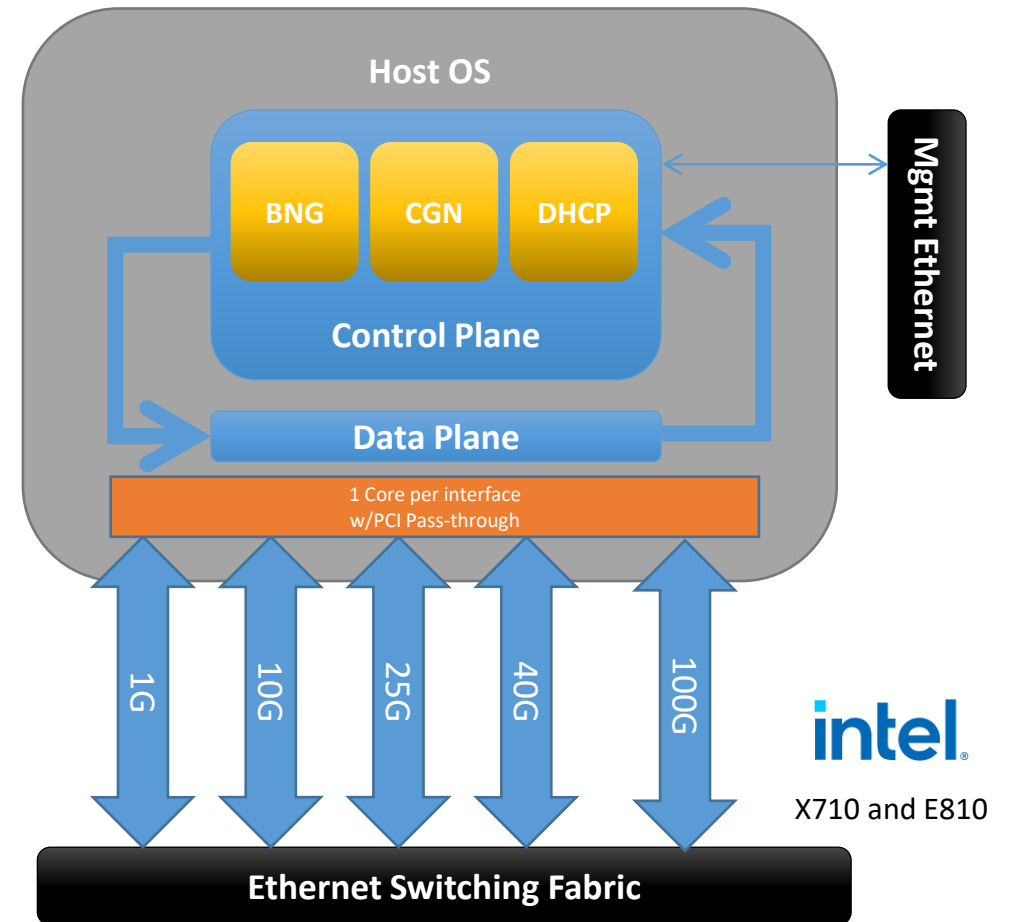
Driving Performance through innovation

- Intel® Xeon® Scalable Processors
  - Adding Cores, Cache and Memory
- Intel® Ethernet Network Adapter X710
- Intel® Ethernet Network Adapter E810
- Intel® DDP Feature
- Intel® Select Solutions for NFVI Forwarding Platform Hardware

intel.
XEON

INTEL® NETWORK BUILDERS PARTNER
A Global Ecosystem Driving the Next Wave of Digital Innovation in the Network

intel.

Source Whitepapers: https://networkbuilders.intel.com/intel-technologies/intel-select-solutions/nfvi-forwarding-platform and www.netElastic.com

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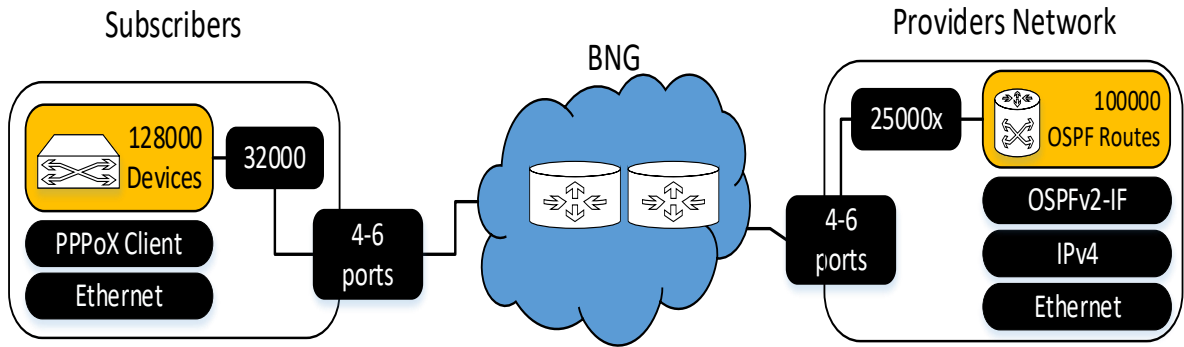
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Scalable Architecture

- Separate Data Plane and Control Plane
  - Each can be scaled independently
- Data Plane
  - Up to 1 Tbps in 2RU
  - Assign cores in Multi-core CPUs
    - 1 core per 10G of performance
    - Plus 2 cores base DP
- Control Plane
  - 2-6 cores for the CP
  - Add subscribers granularly to keep costs in line with user growth
  - Features and subscriber limits are turned on by license
- Compared to CUPS (ASIC switch-based)
  - Lower cost x86 hardware
  - Smaller fault domain with 1:1 CP/DP
  - Supports large POPs as well as small remote POPs
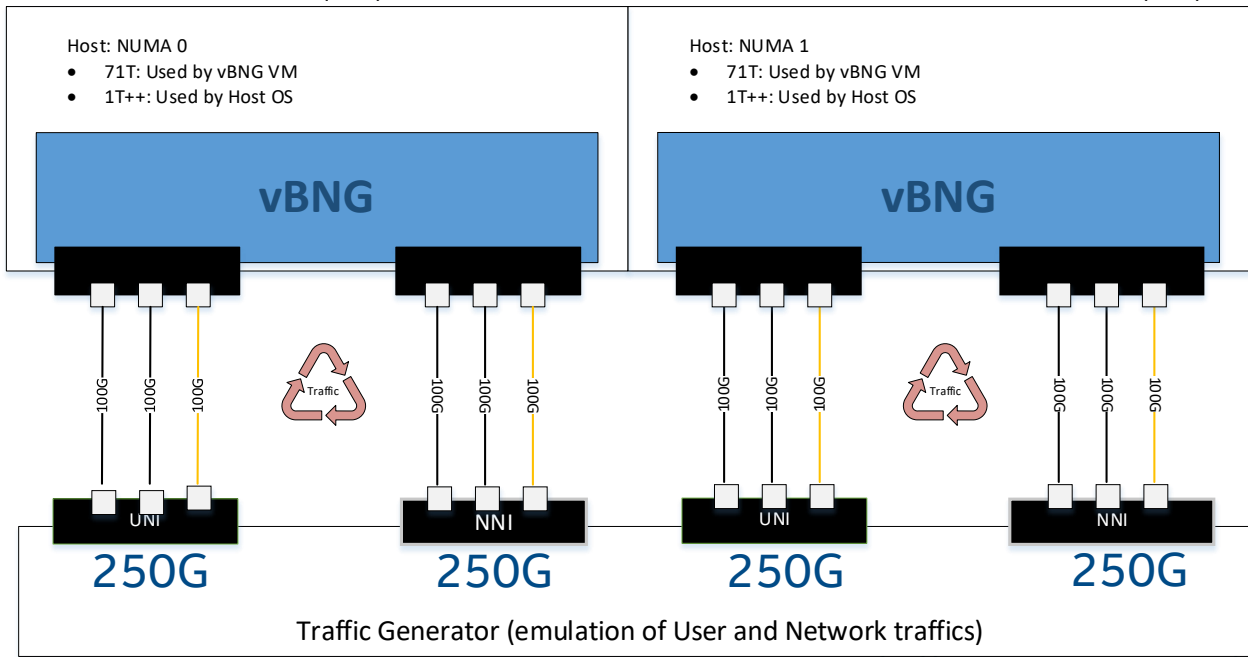 - Separate costs and hardware for CGNAT

Host OS

BNG **CGN** **DHCP**

Control Plane

Mgmt Ethernet

Data Plane

1 Core per interface
w/PCI Pass-through

1G 10G 25G 40G 100G

intel.

X710 and E810

Ethernet Switching Fabric

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Test Setup – netElastic vBNG

	Config 1 (2S 8360Y 250W)	Config 2 (2S 8470N 300W)	Config 3 (2S 8470N 300W)
Network Throughput/Socket	400Gbps	400Gbps	500Gbps
Data Plane Processing	136	136	172
Control Plane Processing & Main thread	2	2	10
Internal Thread	2	2	2
VM OS	2	2	2
host OS	2	66	22
Total Threads/Server	144	208	208
# UNI	4	4	6
# NNI	4	4	6
#ACL with QoS	No	No	No
# Subscribers	128k	128k	192k
# OSPF Routes	100k	100k	150k

Subscribers

Providers Network

BNG

128000 Devices
32000
4-6 ports
25000x
100000 OSPF Routes

PPPoX Client
Ethernet
4-6 ports
OSPFv2-IF
IPv4
Ethernet

User Network Interfaces (UNI)

Host: NUMA 0
- 71T: Used by vBNG VM
- 1T++: Used by Host OS

Network Network Interfaces (NNI)

Host: NUMA 1
- 71T: Used by vBNG VM
- 1T++: Used by Host OS

vBNG

vBNG

Traffic

Traffic

100G 100G 100G

250G

UNI

250G

NNI

250G

UNI

250G

NNI

Traffic Generator (emulation of User and Network traffics)

100G ─── 100G Active Port

100G ─── 100G Active/Passive Port

netElastic vBNG Performance on 4th Gen Intel® Xeon® Scalable Processor

netElastic Performance in Gbps (0.001% Packet Loss)

Legend: ▬ 2S 8470N 300W - L1 performance ▬ L1 Line Rate

Performance in Gbps (left axis) / Percentage Line Rate (right axis)

Packet Size	Performance (Gbps)	Line Rate
256	618	62%
384	826	83%
512	987	99%
1024	996	100%
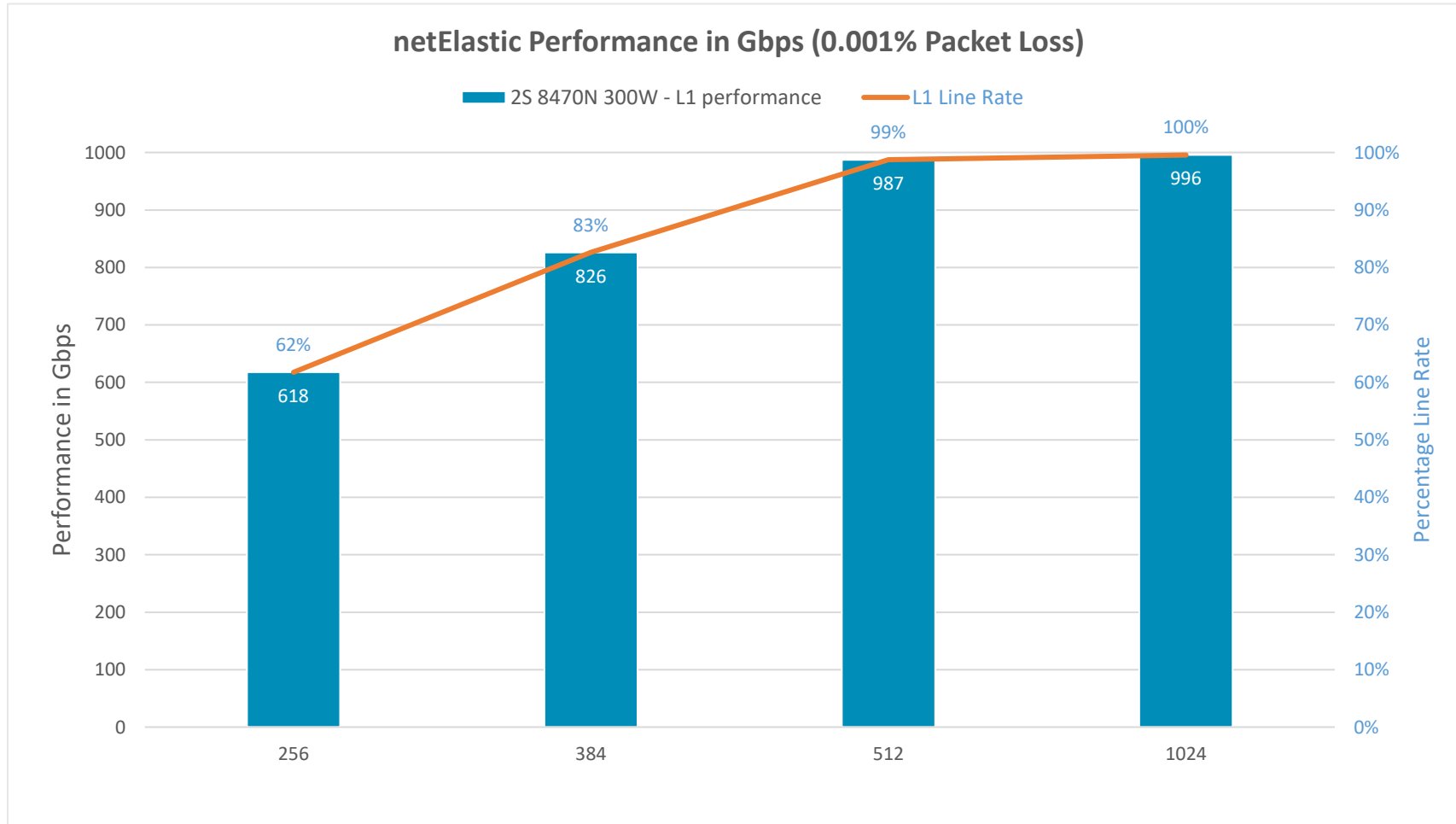
Performance density of up to 99% Line Rate of 1Tbps throughput per Server with >=512B Packet size.

2 Socket 2RU server with 4th Gen Intel® Xeon® Scalable Processor and Intel® Ethernet Network Adapter E810 with 192k subscribers with 150k OSPF routes
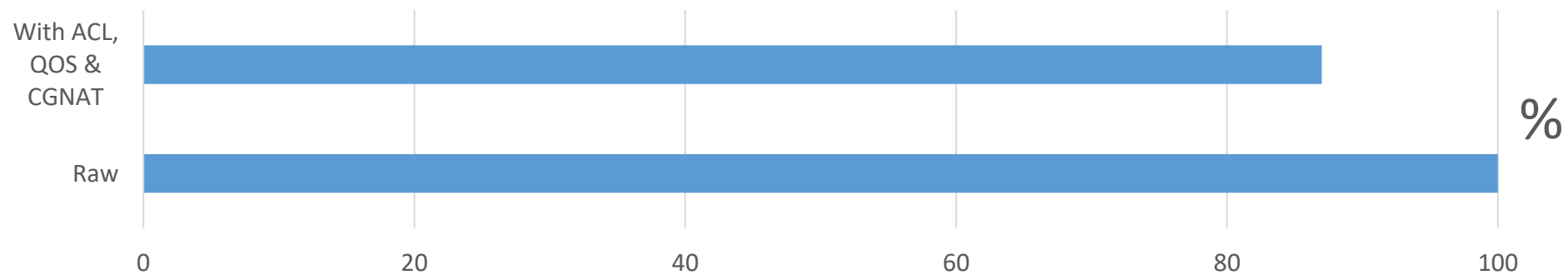
"Performance varies by use, configuration and other factors. See backup for configuration details"

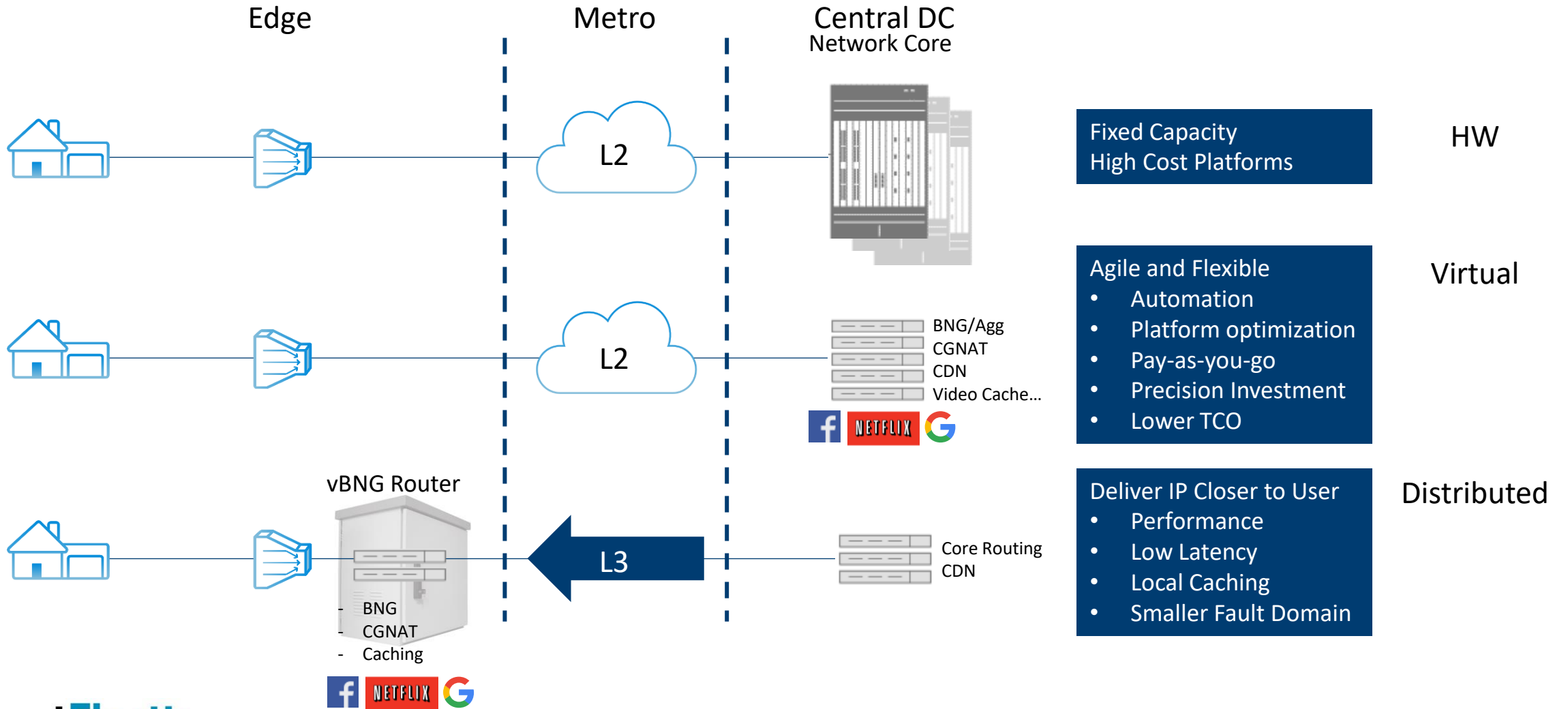intel. XEON

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Lab Test vs Real World

- Lab test shows full 1 Terabit raw performance
  - No ACL or QOS applied (possible with a few more cores)
- Results applicable for
  - Virtual BNG
  - Virtual CGNAT
  - Virtual BNG with CGNAT

The Distributed Edge

Edge	Metro	Central DC Network Core		

Fixed Capacity
High Cost Platforms

HW

Agile and Flexible
- Automation
- Platform optimization
- Pay-as-you-go
- Precision Investment
- Lower TCO

Virtual

BNG/Agg
CGNAT
CDN
Video Cache...

vBNG Router
- BNG
- CGNAT
- Caching

L3

Core Routing
CDN

Deliver IP Closer to User
- Performance
- Low Latency
- Local Caching
- Smaller Fault Domain

Distributed

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Virtualization increases Agility

Agility

- React quickly to changing network demands
- Modify capacity as needed – quickly & easily
- Add new revenue generating services
- Implement IPv4 conservation with CGNAT
- Avoid supply chain and delivery delays

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Real-World Example

- WebSprix – Ethiopia
  - First privately-owned broadband service in Ethiopia
  - Mission: Close the Digital Divide
- Challenges
  - Flexibility and Scalability
  - Performance and Stability

Outcomes
Rapid Expansion to 4 Additional Cities
1 Week – Procurement to Deployment

"netElastic has definitely contributed significantly to our success and is one of the main ingredients in our solution."

Dawin Birhanu, CEO, Websprix

Source: netElastic Case Study at https://netelastic.com/resources/

Transition to IPv6

- Still transitioning

- Globally: 41% of user traffic is IPv6
  - USA: 53%
  - UK: 43%
  - India: 67%

- BNGs need to support IPv6 transition
  - Dual Stack IPv4+IPv6
  - Integrated CGNAT
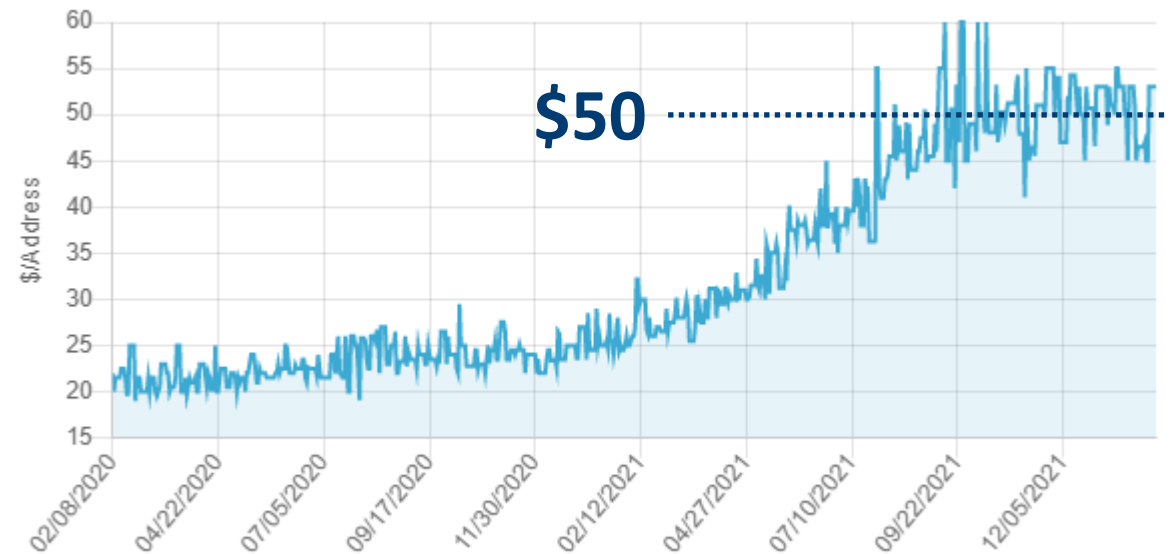
Global IPv6 Adoption – Google Users

Native: 40.82% 6to4/Teredo: 0.00% Total IPv6: 40.82% | Jul 5, 2023
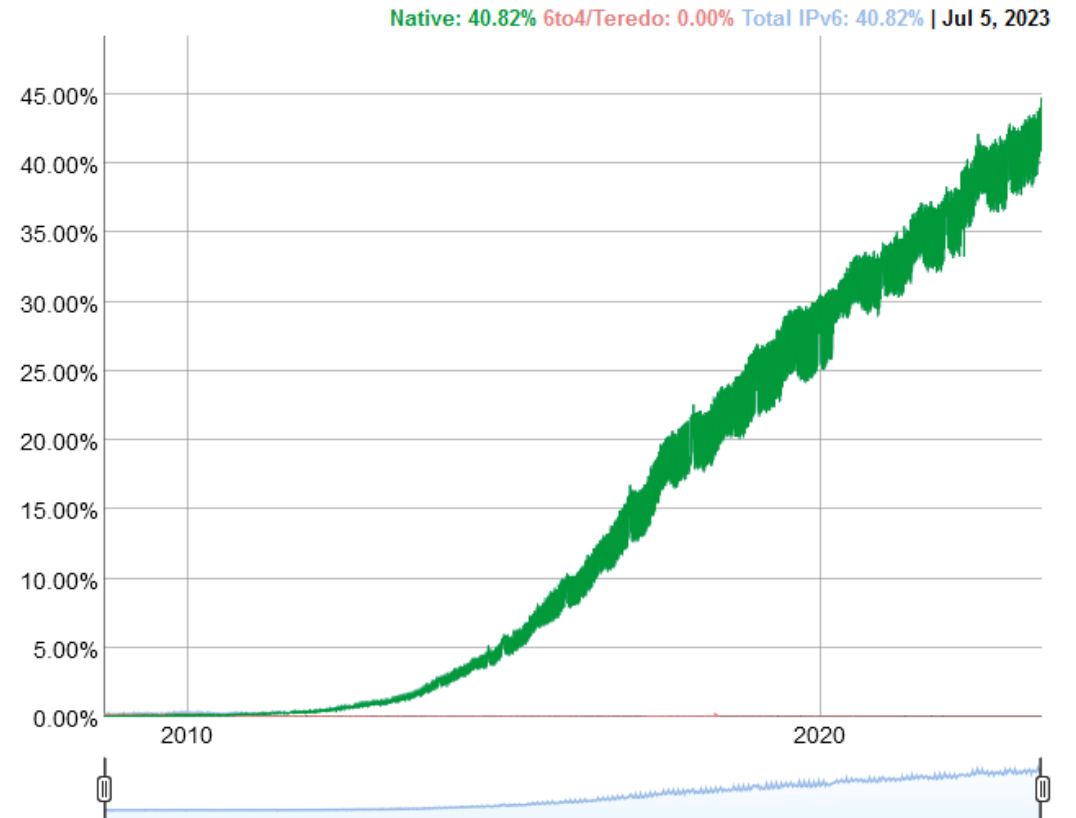
Sources: Google IPv6 Statistics 2023

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Cost of IPv4 Addresses

- Top-level IPv4 Addresses exhausted in 2019

- Secondary IPv4 market emerged
  - Sellers offering unused IPv4 for sale or lease
  - Demand driving prices up 2-3x since 2020
  - Many IP Blocks for lease/sale have tarnished history (blacklists, etc.)

- 20,000 subscribers
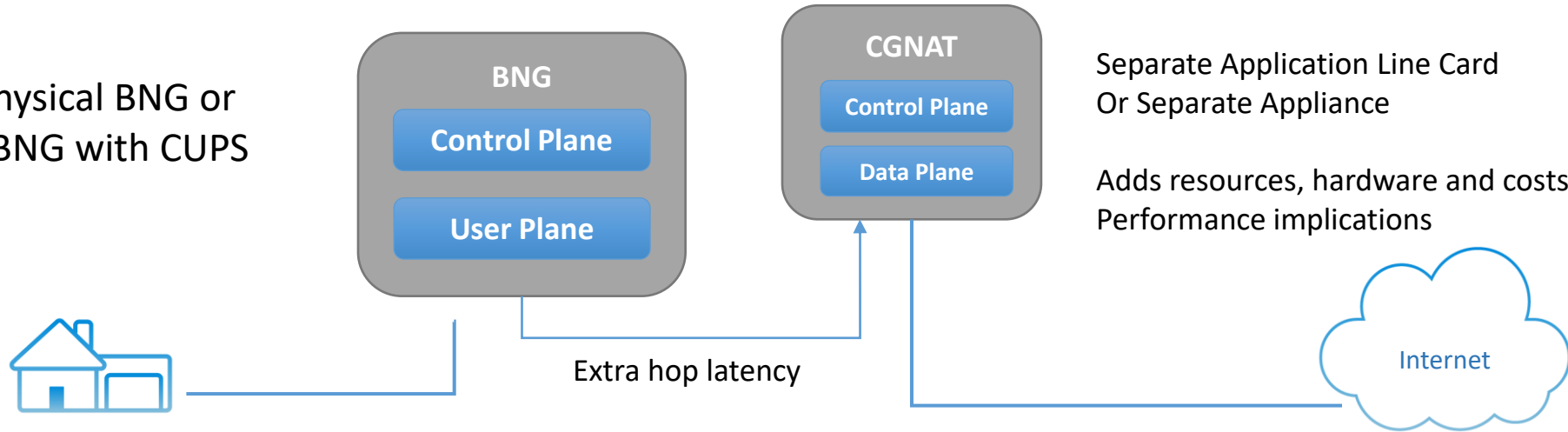 - Public IPv4 Addresses = $1 Million
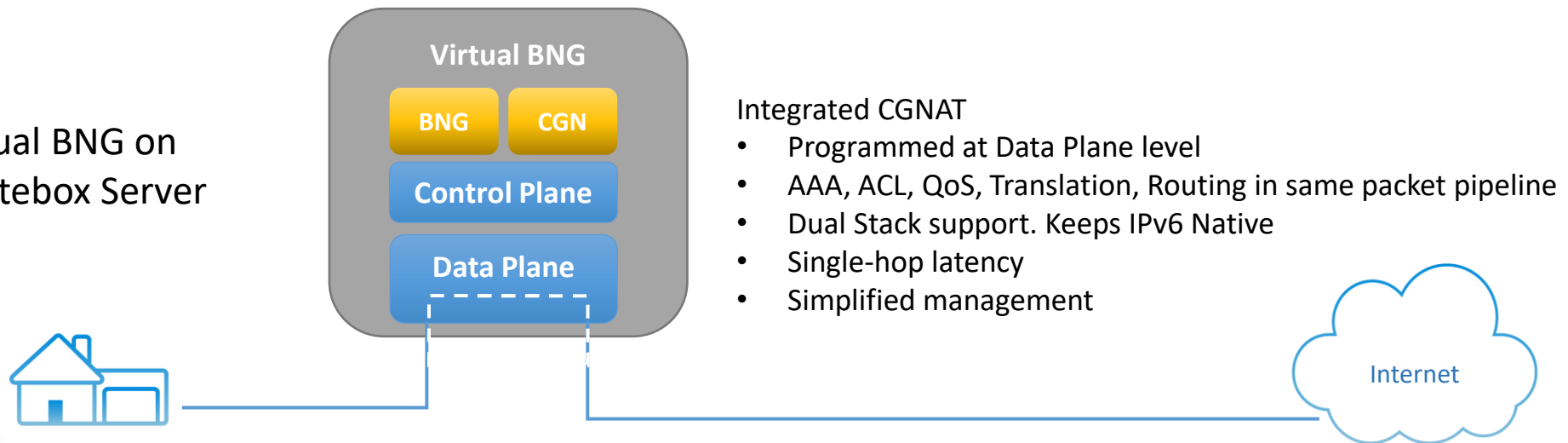 - CGNAT = Small $ Add-on to vBNG

Average Selling Price per IPv4 Address

Source: Hilco Streambank - https://auctions.ipv4.global/prior-sales

Separate vs In-line CGNAT

Physical BNG or
vBNG with CUPS

BNG
- Control Plane
- User Plane

CGNAT
- Control Plane
- Data Plane

Separate Application Line Card
Or Separate Appliance

Adds resources, hardware and costs
Performance implications

Extra hop latency

Internet

Virtual BNG on
Whitebox Server

Virtual BNG
- BNG
- CGN
- Control Plane
- Data Plane

Integrated CGNAT
- Programmed at Data Plane level
- AAA, ACL, QoS, Translation, Routing in same packet pipeline
- Dual Stack support. Keeps IPv6 Native
- Single-hop latency
- Simplified management

Internet

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Real World Example

- Praction Networks
  - Tier 2 ISP w/ 20K Subscribers
  - Major vendor Services Router for BNG
  - Appliance for CGNAT

- Challenges
  - "Scalability was really an issue with our previous routers."

Outcomes
Replaced multi-device solution with 1 vBNG
Increased performance and future scalability

"Scalability, performance, and cost effectiveness were the key criteria for us in evaluating BNGs. With netElastic vBNG, we got everything we were looking for."

- Rohit Kumar, Co-Founder and CTO at Praction

Full Case Study

Lower Costs

- Most Virtual Solutions have lower-cost licensing options
- COTS – Commercially Available Off-The-Shelf Whitebox Servers
- Vendor Neutral Hardware
- Eliminate CGNAT Appliance Costs
- Operational Savings with Software Management Tools and APIs
- Lower energy costs - power & cooling

> "netElastic's pay as you grow licensing model helps reduce our risk in entering new markets and allows us to start small and stay profitable"
> - Tom Bishop, CTO Harbour ISP
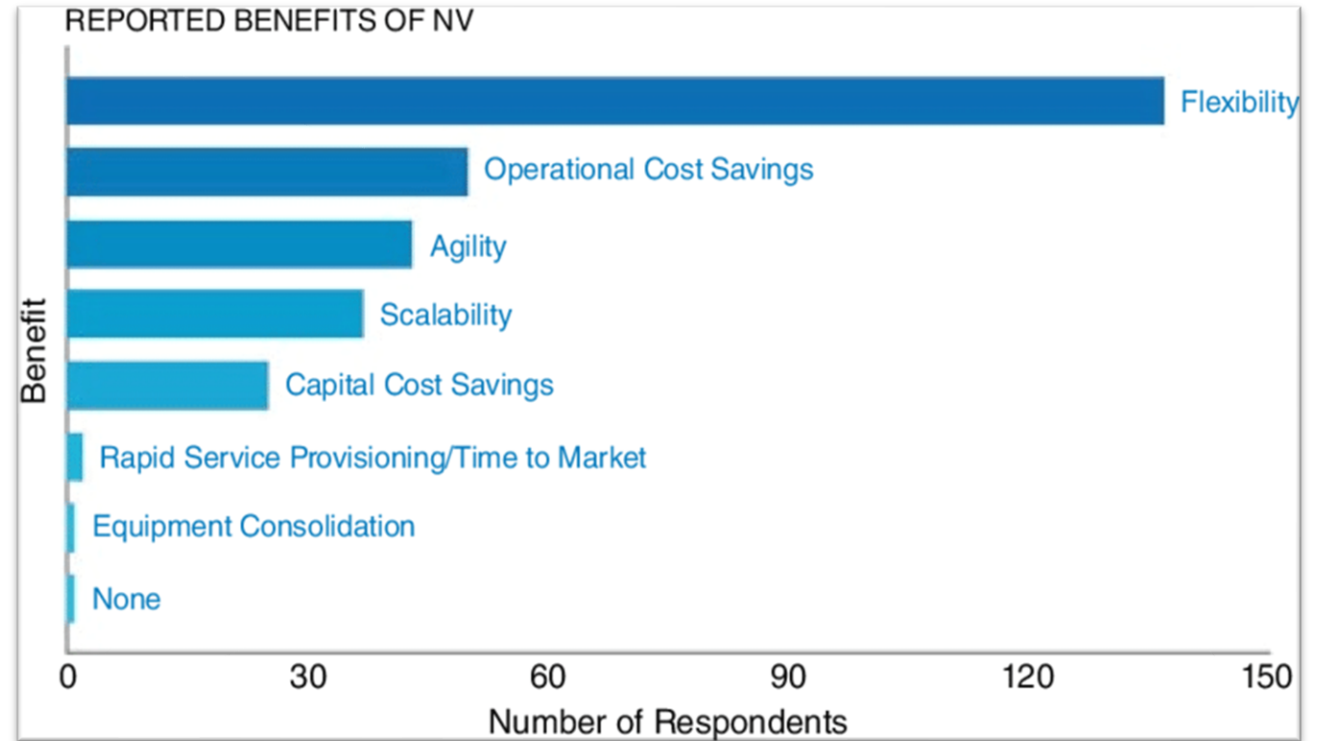
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Operational Savings with Modern Tools

- BNG Management Applications
  - Enables network and configuration management automation
  - Visibility and Troubleshooting tools
  - Role-based Access for Support Staff
- Familiar CLI
  - Eliminate retraining by leveraging existing expertise
- Supports NETCONF and YANG data models and a centralized configuration database
  - Delivers unified, programmable management capabilities
- Easier to Manage Lowers OpEx
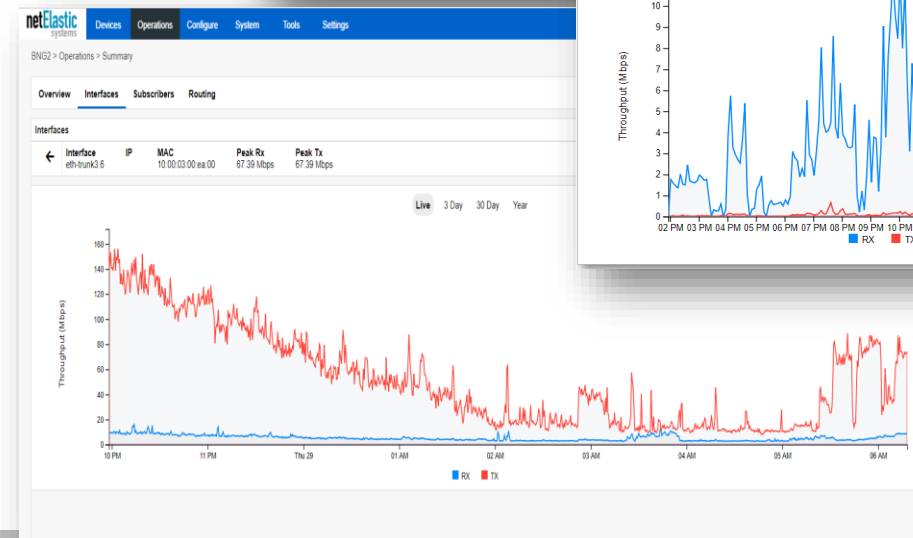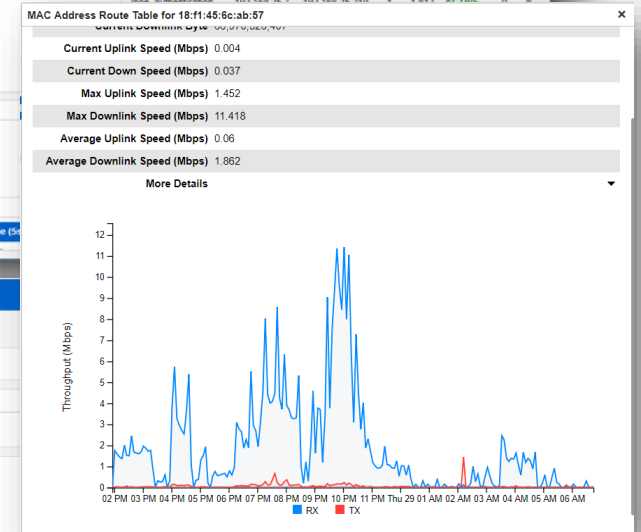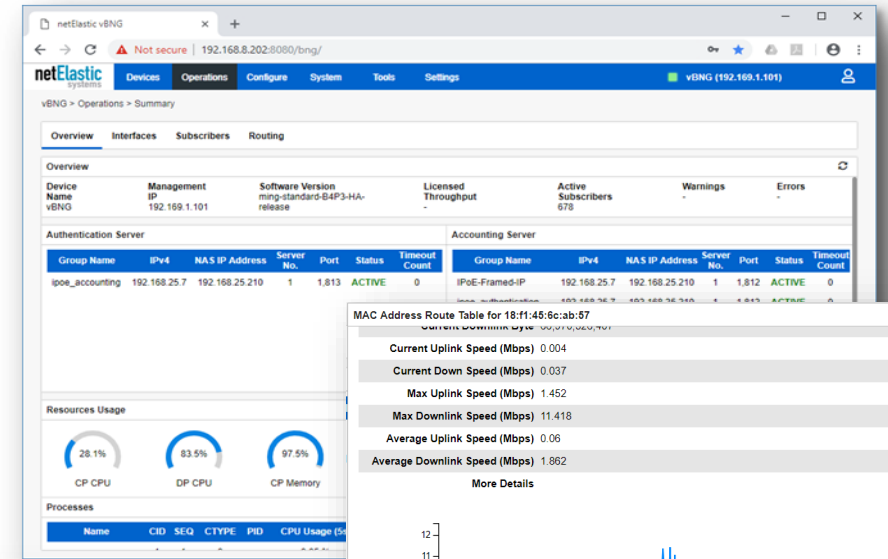
Summary

- Flexiblity
  - Faster resource provisioning
  - Add HW and SW resources as needed (Scalability)
- Agility
  - Deploy functions and services quickly
  - Rapid Time to Market
- Integrated In-Line CGNAT
- Performance
- Drives down OpEx & CapEx
  - COTS Hardware
  - Pay-As-You-Grow Licensing
  - Ease of Management

REPORTED BENEFITS OF NV

Flexibility
Operational Cost Savings
Agility
Scalability
Capital Cost Savings
Rapid Service Provisioning/Time to Market
Equipment Consolidation
None

Benefit

0   30   60   90   120   150
Number of Respondents

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For More Information

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