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ANGA COM 2025 | Axians In-Booth Theater

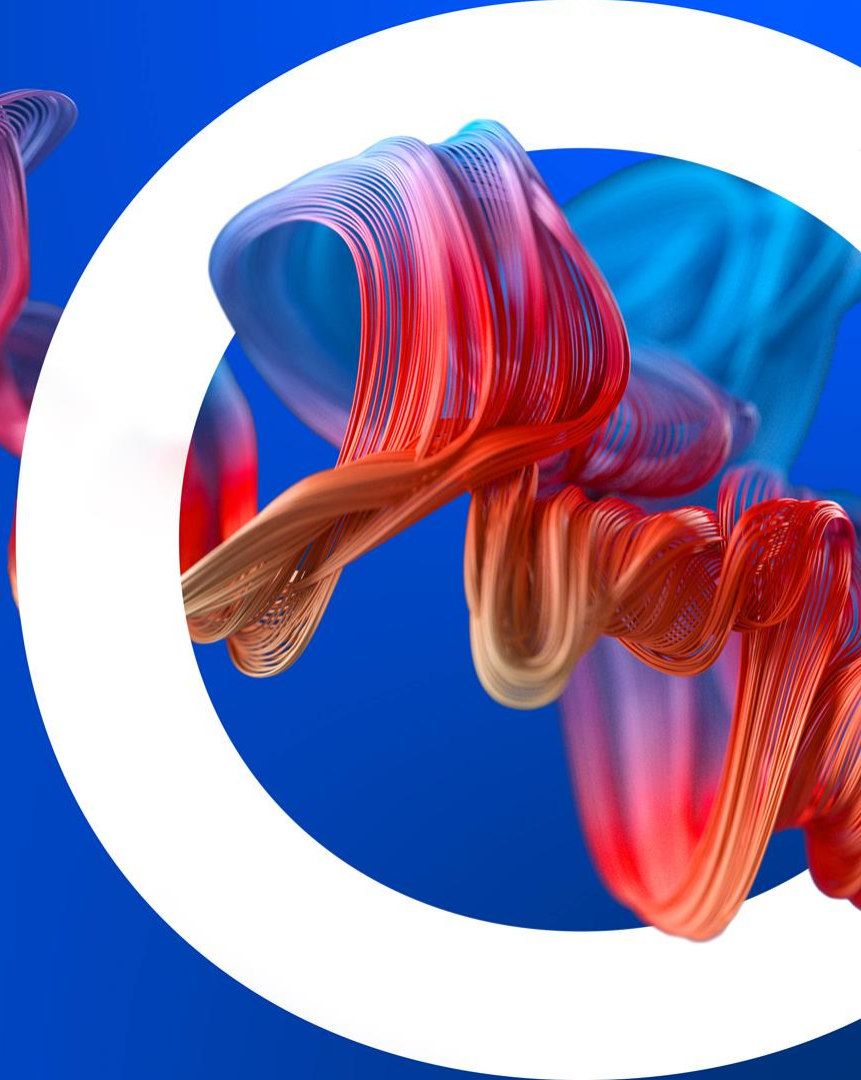
The impact of AI in Optical Networking

Christian Uremovic, Sr. Director Solutions Marketing, Nokia

AI and the impact to optical transport networking

Christian Uremovic, Sr. Director Solution Marketing

06-2025



Unprecedented Challenges in the AI Era

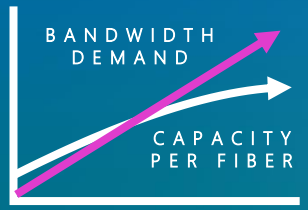
30-100%

CAGR

Statement from Meta at ECOC 2024

2X

BY 2027



AI Accelerating bandwidth growth

Significant DC Growth Driven by AI Processors Outpacing Power Availability

Exhausting fiber capacity

Traffic growth

Consumer driven

Video-based GenAI interactions

- Using mobile device
  - Educational or entertainment materials
- Using camera and video LLM
  - Car engine fixing
  - Cooking
  - Tutorials
- Using smart glasses or XR devices
  - AI assistant

AI agents interacting with drones and droids

Network driven

Digitalization

Cloud Services expansion

Artificial Intelligence

- Inside Datacenters
- Campus and long distance
- Energy exhaust in current DC

Global Internet traffic rose 17% year-over-year (YoY)

Most Popular Internet Services:

- #1 Google retained its #1 spot
- #2 Facebook
- #3 Apple

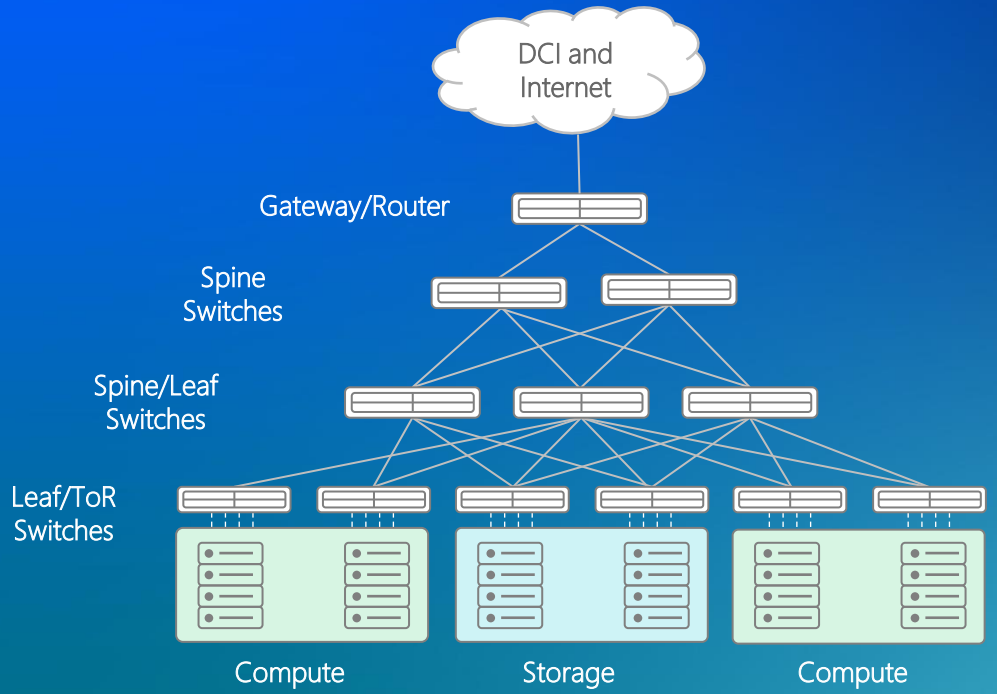
Generative AI Leaders:

- OpenAI the top generative AI service

Gaming Services in Demand:

- Roblox ranked #1
- Steam broke into the top five and Minecraft entered the top ten for the first time

Data Center Networking Architecture



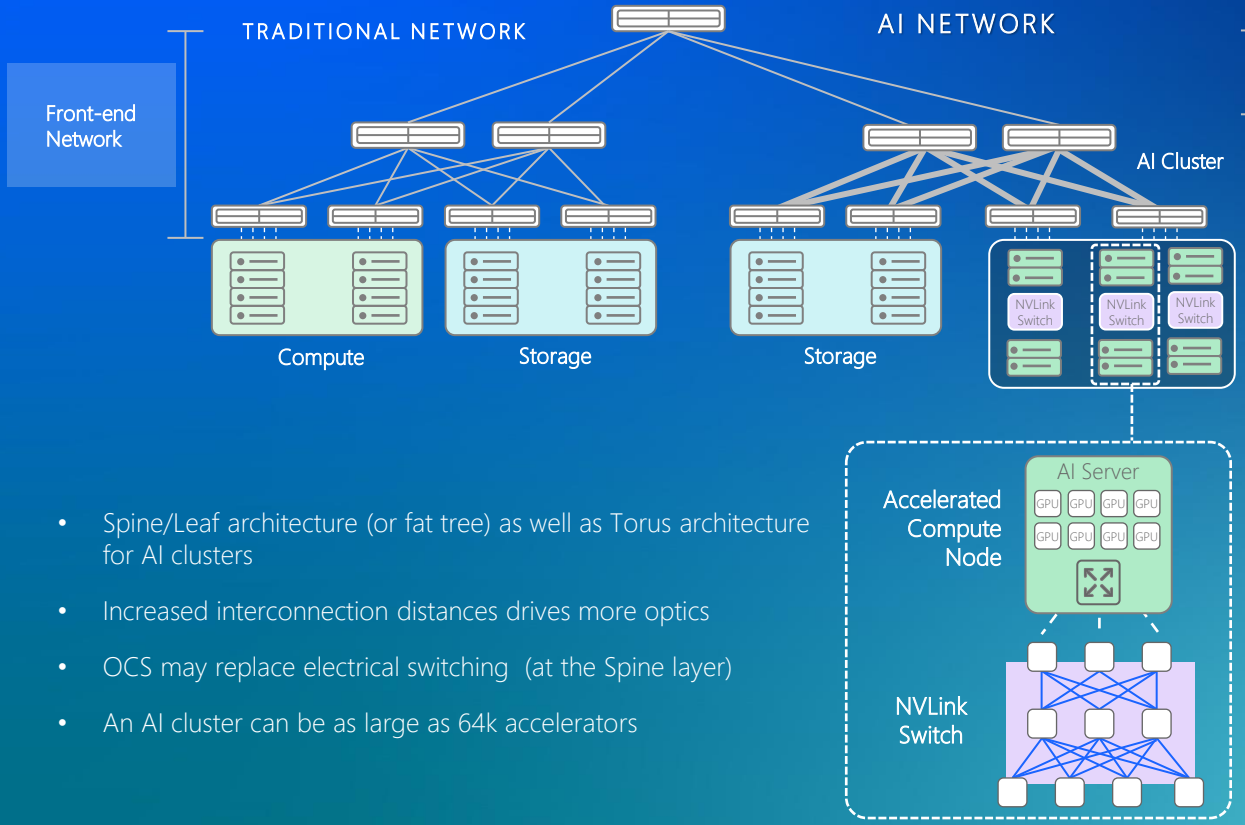
Ethernet or Infiniband

Connections up to 500m – 2km
Moving to Optical Interconnects

Connections up to 50m: Electric cables and Active Optical Cables (AOCs)

Classical Data Center Scalability Architecture

AI Clusters and Interconnectivity



- Spine/Leaf architecture (or fat tree) as well as Torus architecture for AI clusters
- Increased interconnection distances drives more optics
- OCS may replace electrical switching (at the Spine layer)
- An AI cluster can be as large as 64k accelerators

Front-end Network

Back-end Network "Scale Out"

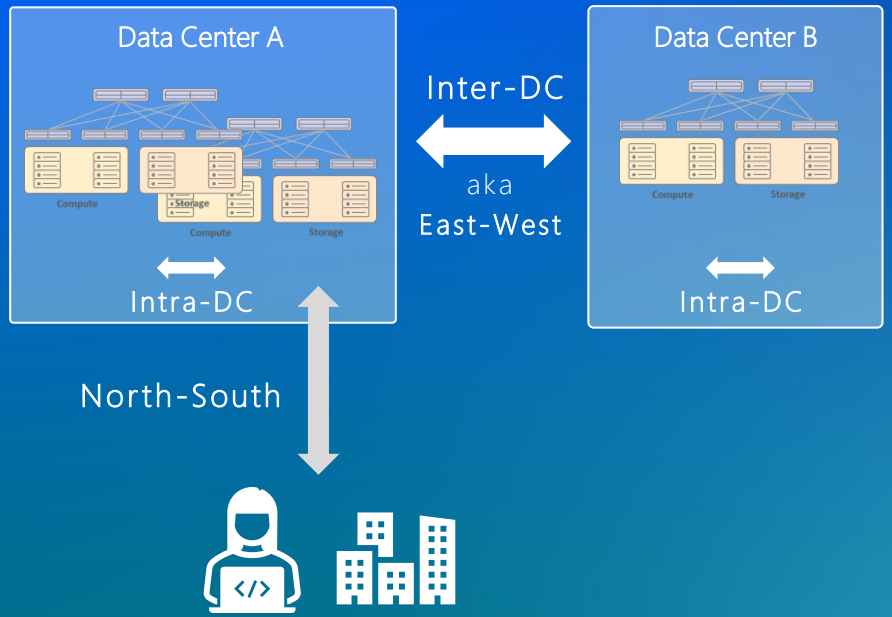
AI Backbone – Spine/Leaf
- Infiniband (IB)
- Ethernet and future Ultra Ethernet Consortium (UEC)

Back-end GPU Fabric "Scale Up"

GPU to GPU and Memory interconnection
- Typically includes a single/few racks
- Onboard interconnect – PCIe and Compute Express Link (CXL)
- Nvidia: NVLINK
- Intel: Ultra Path Interconnect (UPI)
- AMD: Infinity Fabric

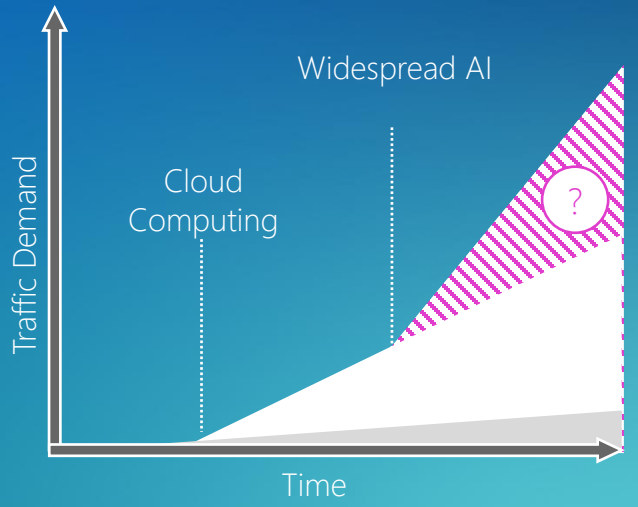
Traffic Flow Between Data Centers

Classic Cloud Computing

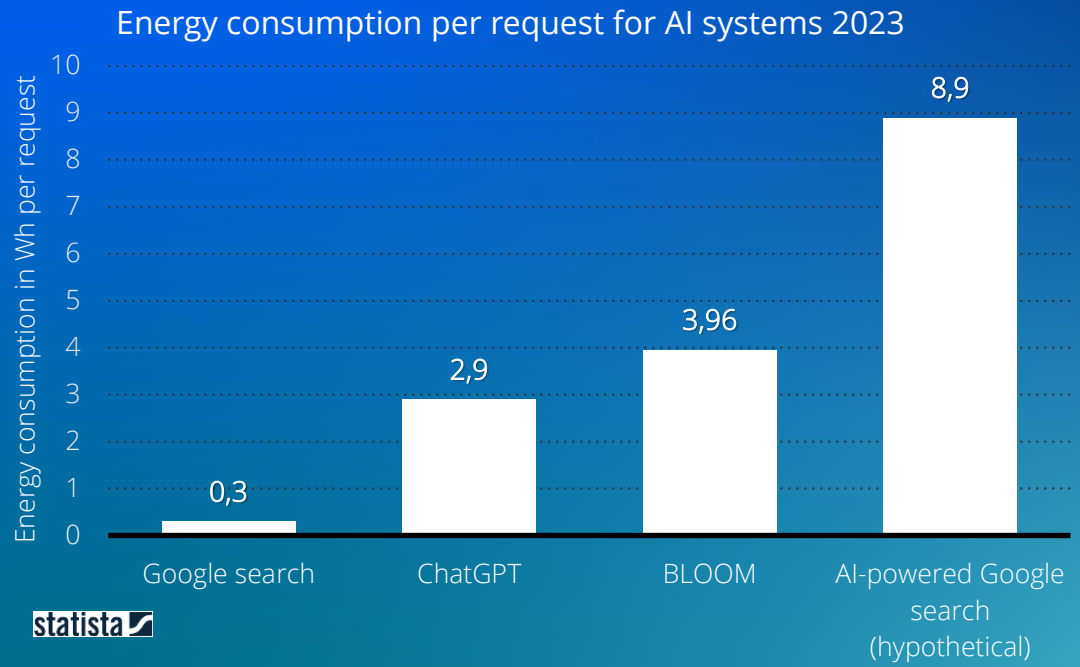


Why does E-W backbone traffic grow?

- More cloud data
- Database synchronization
- Load balancing
- Resilience



Estimated energy consumption per request for selected AI-powered systems as of 2023 (in Watt-hours)



Note(s): Worldwide; 2023
Further information regarding this statistic can be found on page 8.
Source(s): ScienceDirect; Expert(s); Various sources; ID 1536926

If we use ChatGPT instead of Google search, we would need 10x more power

1GW Data Center

Kairos Power Google

Google invests in SMR reactors

New nuclear clean energy agreement with Kairos Power

Oct 14, 2024 · 3 min read

To accelerate the clean energy transition across the U.S., we're signing the world's first corporate agreement to purchase nuclear energy from multiple small modular reactors (SMR) to be developed by Kairos Power.

Michael Terrell, Senior Director, Energy and Climate · Share

Since pioneering the first corporate purchase agreements for renewable electricity over a decade ago, Google has played a pivotal role in accelerating clean energy solutions, including the next generation of advanced clean technologies. Today, we're building on these efforts by signing the world's first corporate agreement to purchase nuclear energy from multiple small modular reactors (SMRs) to be developed by Kairos Power. The initial phase of work is intended to bring Kairos Power's first SMR online quickly and safely by 2030, followed by additional reactor deployments through 2035.

1 GW HELION Microsoft

MICROSOFT SIGNED UP TO BE FIRST CUSTOMER FOR HELION

HELION TRYING TO MAKE THE WORLD'S FIRST NUCLEAR FUSION POWER PLANT

2028 IS THE STATED TIMEFRAME

835 MW Microsoft

TWO DECADE AGREEMENT TO RESTART THREE MILE ISLAND UNIT 1 REACTOR

COLLABORATE WITH ENERGY PROVIDERS TO DEVELOP CARBON-FREE ENERGY SOURCES


JVC

The Six Stages of AI

1

Rule based Systems AI

Pre-defined rules set by humans

2

Context Awareness

Comprehend and recall the context to shape response - e.g. Chat bots, Alexa, Netflix, Amazon…

3

Domain specific Expertise

Power by large set of data & algorithms

e.g. Medicine, Finance, … more than human capacity

4

Reasoning Machines

Mimic human thinking and reasoning

Tackling uncharted problems - Could achieve self awareness

5

Artificial Superintelligence

ASI… Captivating and envisioning

AI exceeding human intelligence - Risks: ethical implications

6

Singularity and Transcendence

Beyond human intelligence and beyond what we can explain.
Learning and adopting exponentially

Incomprehensible intelligence

Companies using AI comprehensively

Storage
Using AI for planning routes and to predict volumes to plan and use resources more efficiently

Sustainability
Using AI to reduce energy consumption in their Data centers reducing CO2 and costs.

Sourcing
Using AI for demand forecast and to plan their stock more efficiently and to reduce shipping time for delivery

Pricing
Using AI to dynamically design pricing in real time based on demand and other variables

Customer relations
Using AI (Einstein) to analyze CRM data for recommending sales and marketing strategies

Autonomous driving
Is pioneering the development of autonomous vehicles, leveraging vast amounts of data to train its neural networks and refine its algorithms continually.

Erik Schmidt, the former CEO of Google, said in a recent interview

"If you're not using AI in every aspect of your business, you're not going to make it.".

AI for Networking – Domain Specific Expertise (Telecom)

VIRTUAL OPERATIONAL ASSISTANT

NETWORK HEALTH AND ANALYTICS

PREDICTIVE MAINTENANCE

TROUBLESHOOTING

MULTI-VENDOR NETWORK PLANNING AND CAPACITY OPTIMIZATION

NETWORK TAMPERING DETECTION

Unprecedented Challenges in the AI Era

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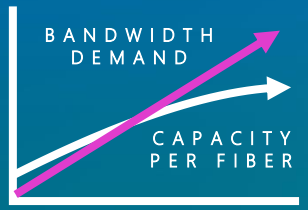


AI Accelerating bandwidth growth

Significant DC Growth Driven by AI Processors Outpacing Power Availability

Exhausting fiber capacity

→ Optical innovations to drive down cost & power per bit while increasing capacity

→ More Fibers

→ More capacity per fiber

→ More Optical Line systems

→ New fiber types

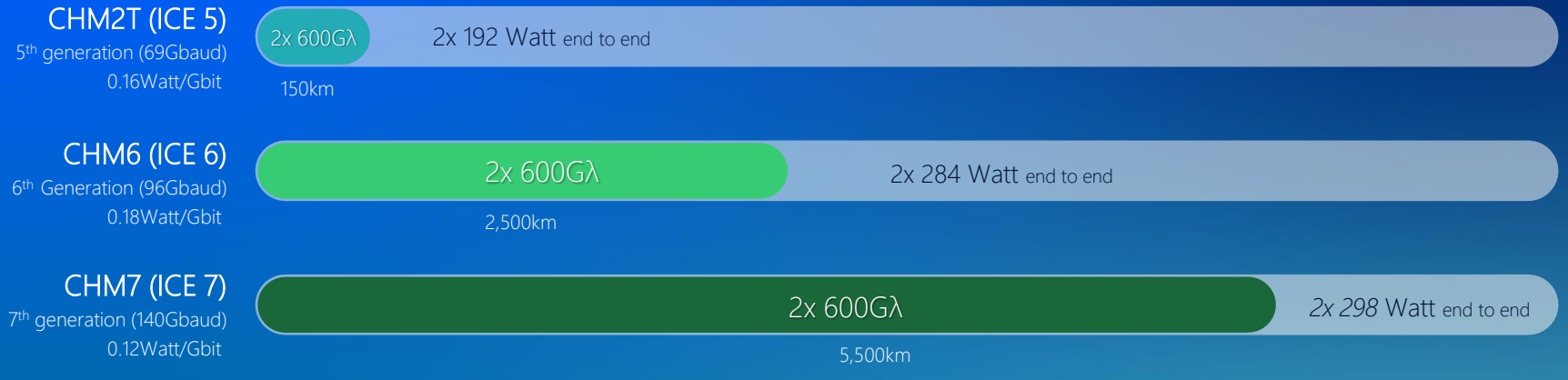
Impact of AI to optical transport networking

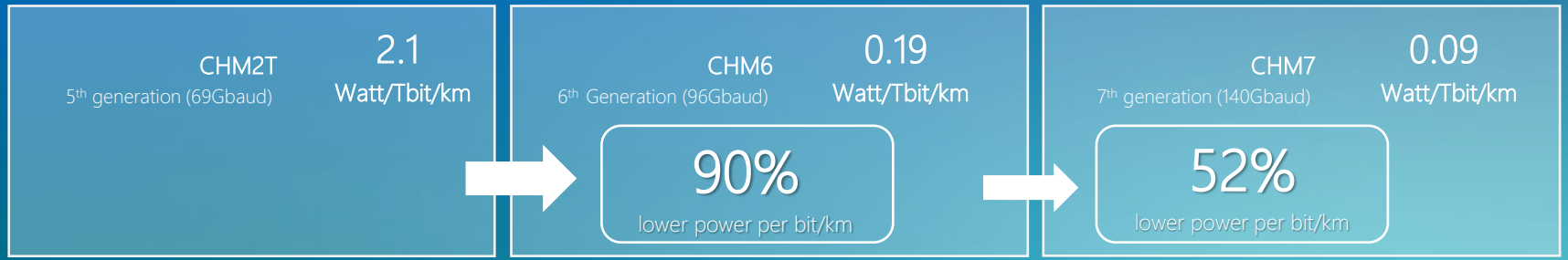
EXPANDED SPECTRUM ON THE FIBER	EMBEDDED AND PLUGGABLE ENGINES	SIMPLIFIED OPERATIONS FOR OPEN	SECURE MULTI-LAYER TRANSMISSION
MORE CAPACITY OVER FIBERS AND MULTI-RAIL	CONTINUOUS POWER, SPACE AND COST REDUCTIONS	MANAGEABILITY, CONSISTENCY, AUTOMATION	KEY GENERATION, DISTRUTION AND ENCRYPTION

OPTIMIZING FOR POWER, SPACE AND ECONOMICS

Optical innovations to drive down cost & power per bit while increasing capacity

MODULE CAPACITY @ 600Gλ vs. TECHN. GENERATION vs. REACH vs. POWER CONSUMPTION





POWER CONSUMPTION SAVINGS

Hyperscale DCI

Optimized for operational efficiency and power consumption

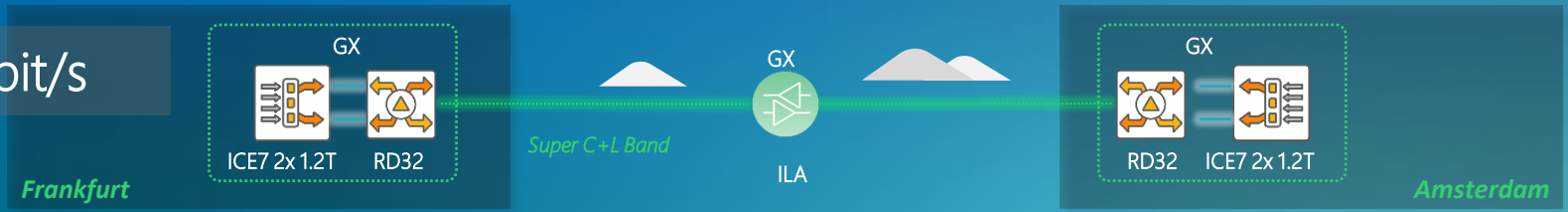
51.2 Tbit/s

~0.1 Watt/Gbit

Multi-haul Terrestrial

Optimized for max fiber capacity (Super C+L)

104.4 Tbit/s



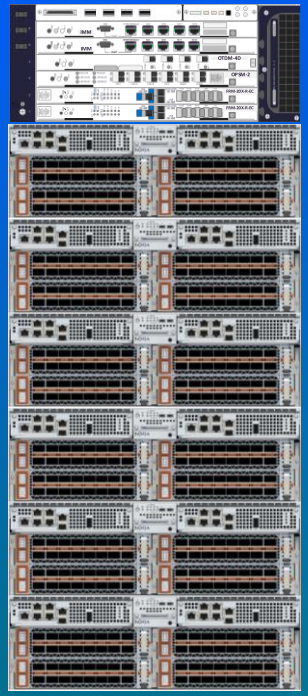
~0.15 Watt/Gbit

Footprint comparison at full C-band fiber

Embedded
22RU total

0.2 Watt/Gbit

4RU
3RU
3RU
3RU
3RU
3RU
3RU

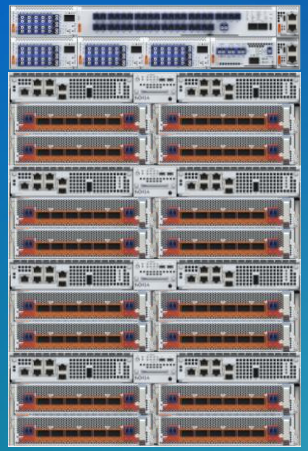


4.8THz and 800G @ **100GHz**
= 48Ch = 38.4Tbit
= 24x CHM6S

~50%

Embedded
0.14 Watt/Gbit
14RU total

2RU
3RU
3RU
3RU
3RU



4.8THz and 1.2T @ **150GHz**
= 32Ch = 38.4Tbit
= 16x CHM7S

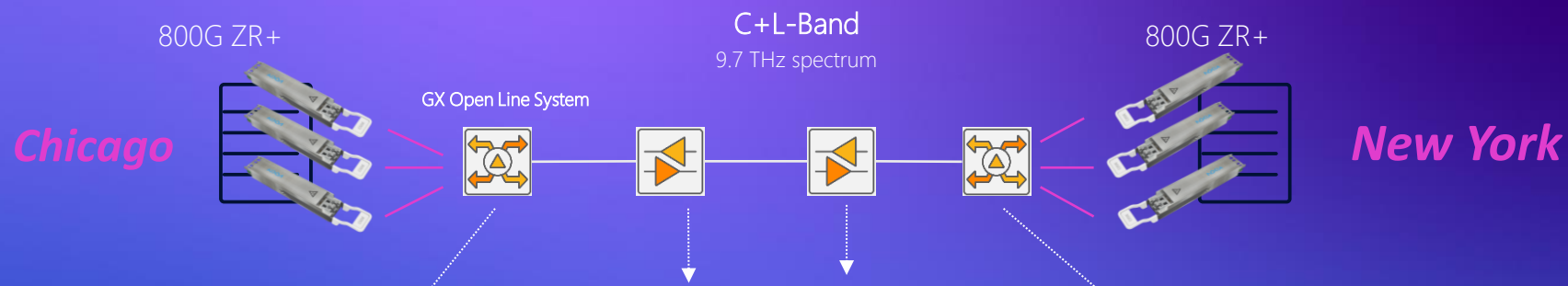
>50%

Pluggable
0.1 Watt/Gbit
6RU total

2RU
2RU
2RU

4.8THz and 800G @ **150GHz**
= 32Ch = 25.6Tbit
= 8x CHMS8

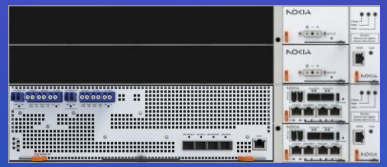
Industry's most operationally efficient hyperscale Open Line System



GX G32E – 600mm front to back airflow

RD66 ROADM-on-a-blade
Integrated C+L Band WSS
Integrated C & L Band EDFA Pre Amp
Integrated C & L Band EDFA Booster Amp
Integrated C & L Band ASE
Integrated OTDR
Integrated OCM

GX G34c – 300mm front to side airflow



D2ILA Dual degree ILA blade
Integrated C+L Band EDFA Pre Amp
Integrated C & L Band DGE
Integrated OTDR
Integrated OCM

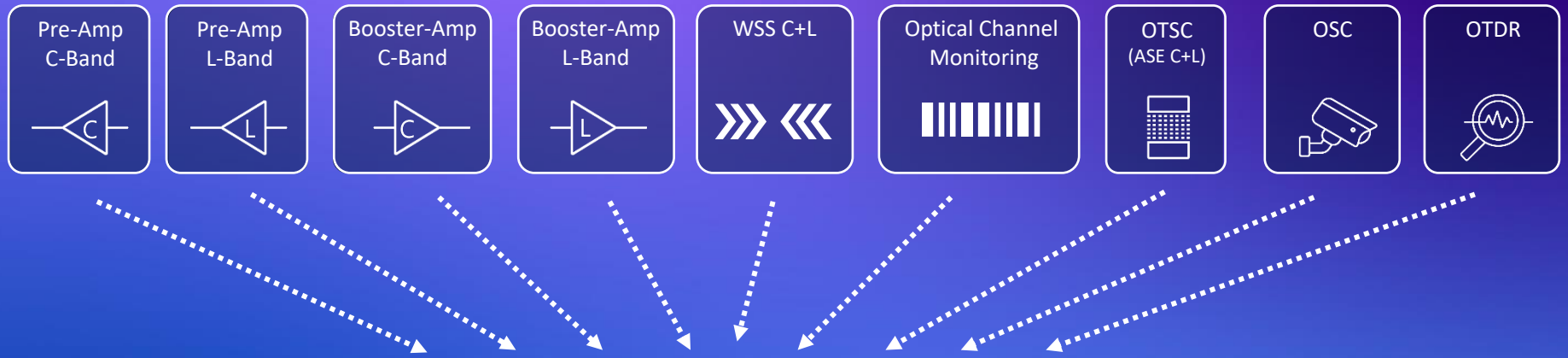
GX G32E – 600mm front to back airflow

RD66 ROADM-on-a-blade
Integrated C+L Band WSS
Integrated C & L Band EDFA Pre Amp
Integrated C & L Band EDFA Booster Amp
Integrated C & L Band ASE
Integrated OTDR
Integrated OCM

51.2 Tbit/s
Over single fiber pair

800G coherent pluggables in 150GHz over 9.7THz spectrum = 64 x 800Gbit/s = 51.2 Tbit/s

Industry's most operationally efficient hyperscale ROADM

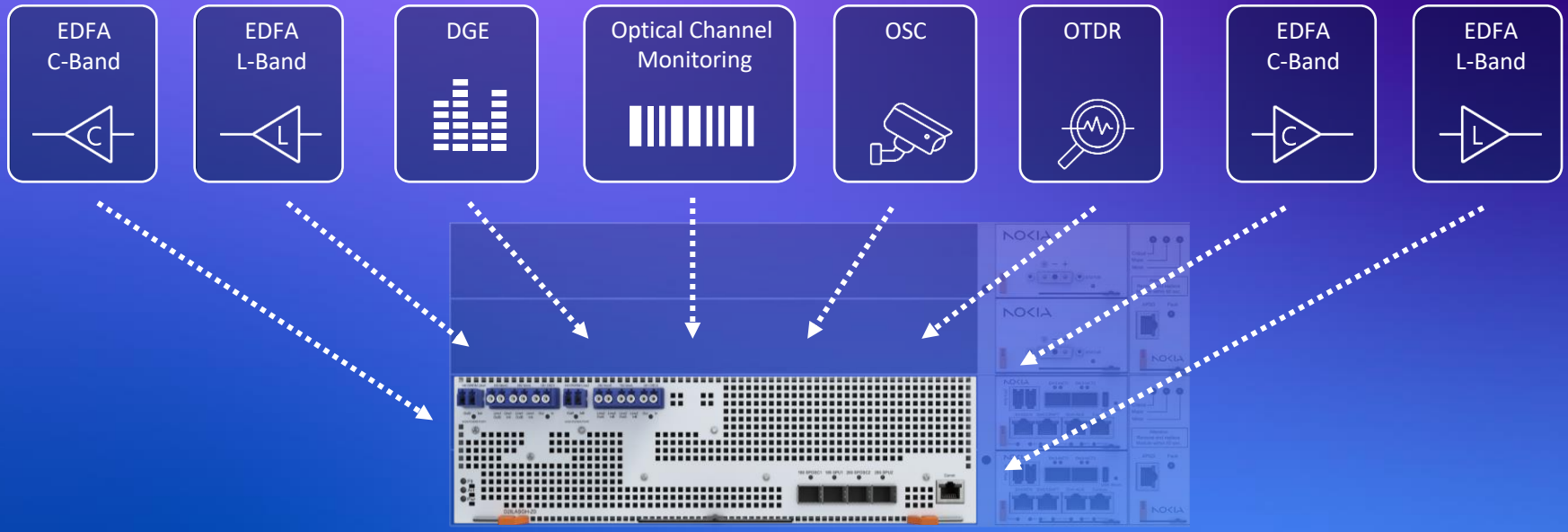


Any coherent wavelength
Any coherent generation
Pluggable and embedded
AD input range:
-18.5dBm/12.5GHz to
-5dBm/12.5GHz

66 duplex LC connectors for add/drop ports
1 duplex LC connector for 'DWDM' port
6 duplex LC connectors for 'Monitor' ports
SFP-DD cage for Optical Supervisory Channel SFP
1 QSFP-DD for universal usage 'DDU'

RD66
66-degree ROADM

Industry’s most operationally efficient ILA



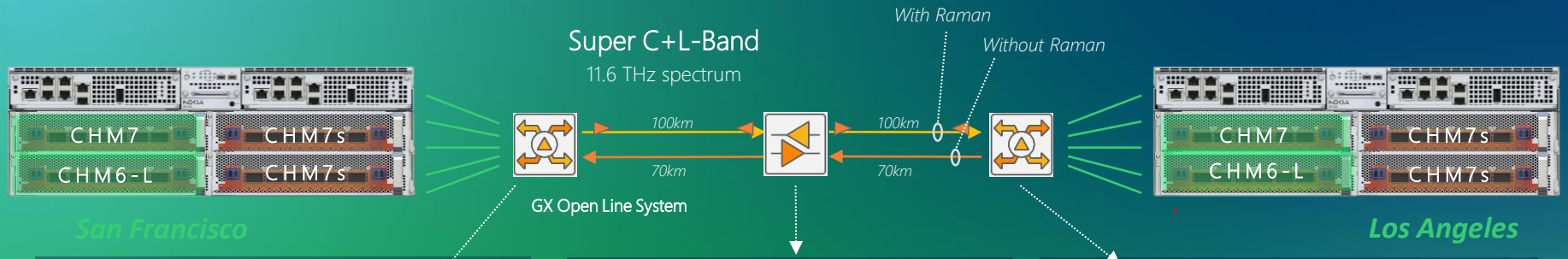
D2ILA

Dual EDFA C+L band module

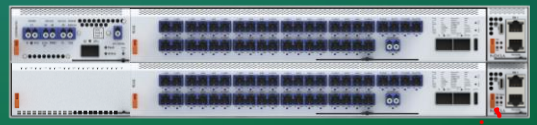
1 module for both degrees

C+L Band Raman optionally available

>100Tbit transmission in Super C+L band network



GX G32 – 600mm front to back airflow



RD32 ROADM-on-a-blade Super C-Band
Integrated Super C Band twin WSS
Integrated Super C Band EDFA Pre Amp
Integrated Super C Band EDFA Booster Amp
Integrated OCM

RD32 ROADM-on-a-blade Super L-Band
Integrated Super L Band twin WSS
Integrated Super L Band EDFA Pre Amp
Integrated Super L Band EDFA Booster Amp
Integrated OCM

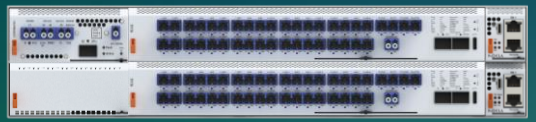
Raman Amplification Super C+L
Integrated Super C+L

GX G34 – 300mm front to side airflow

BiDi EDFA Dual degree
Integrated Super C Band EDFA Pre Amp
Integrated OCM

RAMAN Super C+L
Integrated Super C+ L Band Raman Amp

GX G32 – 600mm front to back airflow

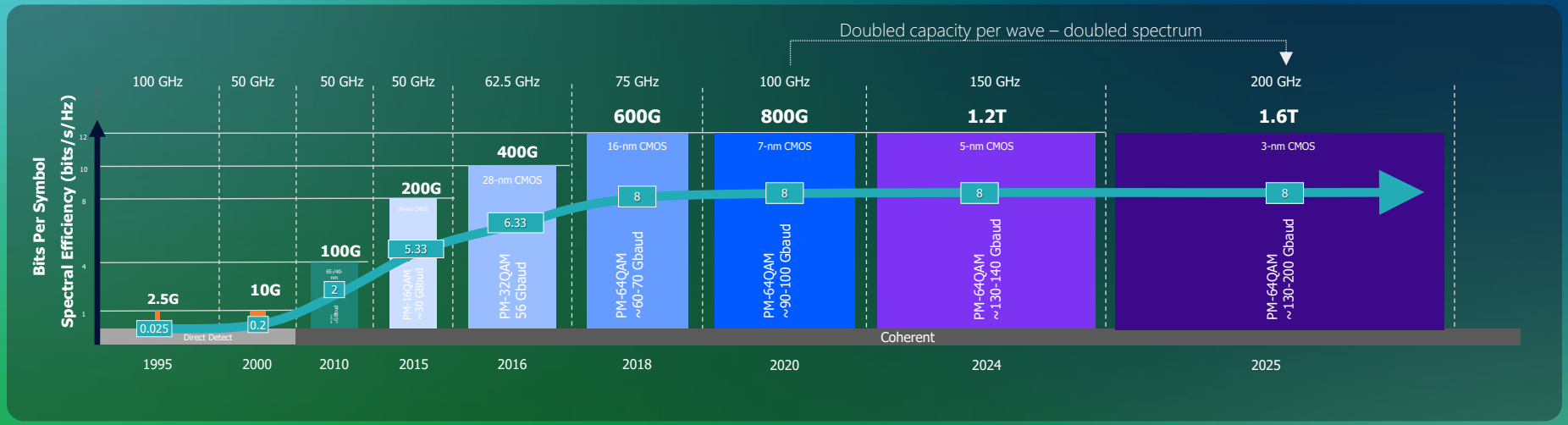


RD32 ROADM-on-a-blade Super C-Band
Integrated Super C Band twin WSS
Integrated Super C Band EDFA Pre Amp
Integrated Super C Band EDFA Booster Amp
Integrated OCM

RD32 ROADM-on-a-blade Super L-Band
Integrated Super L Band twin WSS
Integrated Super L Band EDFA Pre Amp
Integrated Super L Band EDFA Booster Amp
Integrated OCM

Raman Amplification Super C+L
Integrated Super C+L

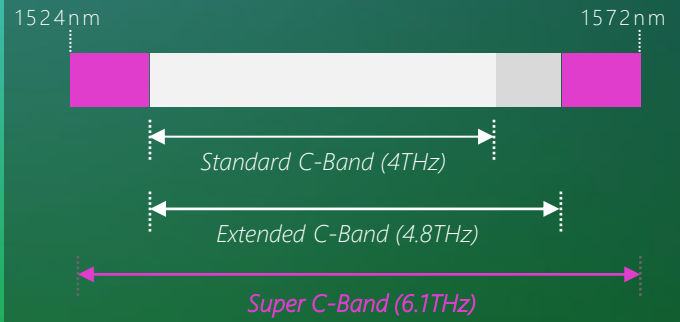
Future Capacity Gains from Optical Engines is diminishing



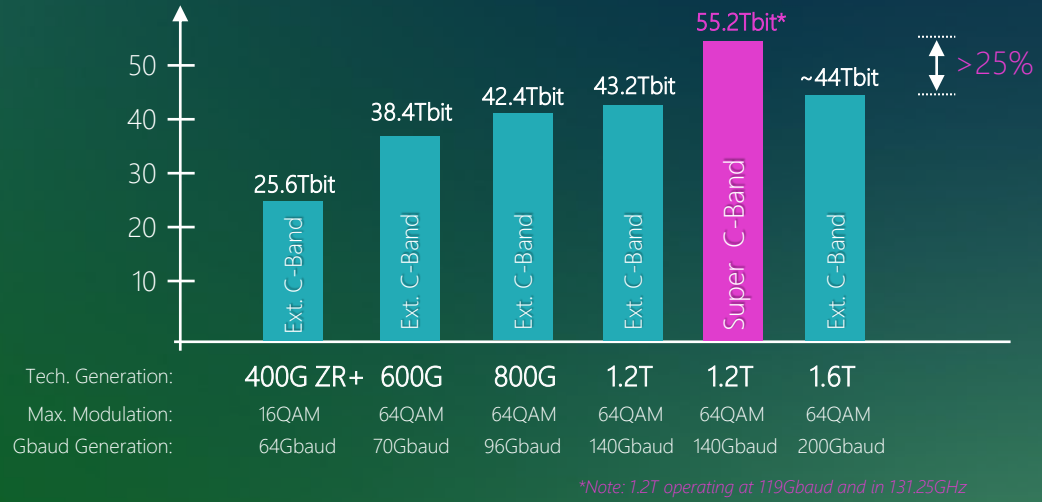
- Max Bits per Symbol has been 12 (PM-64QAM) for since 600G Generation
  - Shannon's law means that going 13 bits per symbol (PM- 128QAM) would halve the distance (100~200km ->50~100km) while greatly increasing power and complexity
- State of the-art optical engines are now 1-2dB from the Shannon limit
  - Max theoretical spectral efficiency gain is 30%~40%, next gen engines (5nm/3nm) targeting 10%~20%
  - Future spectral efficiency gains (2nm and beyond) likely to be increasingly incremental

The Power of Super C

Fiber Spectrum (C-Band)



Max. Theoretical Fiber Capacity



*Note: 1.2T operating at 119Gbaud and in 131.25GHz

Spectrum utilization extension without any performance loss

Higher Baud-rate doesn't improve spectral efficiency
Super C-Band Transponder provide **>25% more capacity**

Industry’s first multi-vendor interoperable multi-haul pluggable

Leading Optical Performance

Multi-vendor Interoperability

- OpenROADM 6.0 for Open Probabilistic Constellation Shaping + FEC
- OIF 800ZR (Implementation Agreement 1.0)
- OIF 400ZR (Implementation Agreement 3.0)
- OpenZR+ Rev 3.0.
- CMIS and C-CMIS compliant

Fully Programmable

- Modulation, launch power and many other parameters for an easy deployment over existing infrastructure

Integrated System Level Features

- Streaming telemetry
- Remote troubleshooting and diagnostic tools
- Remote loopbacks
- MACSec encryption


NOKIA

Copyright and confidentiality

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Vielen Dank für Ihren Besuch!

Wie hat Ihnen der Vortrag gefallen?

Titel: The impact of AI in Optical Networking Referent: Christian Ure movic, Nokia

Jetzt abstimmen