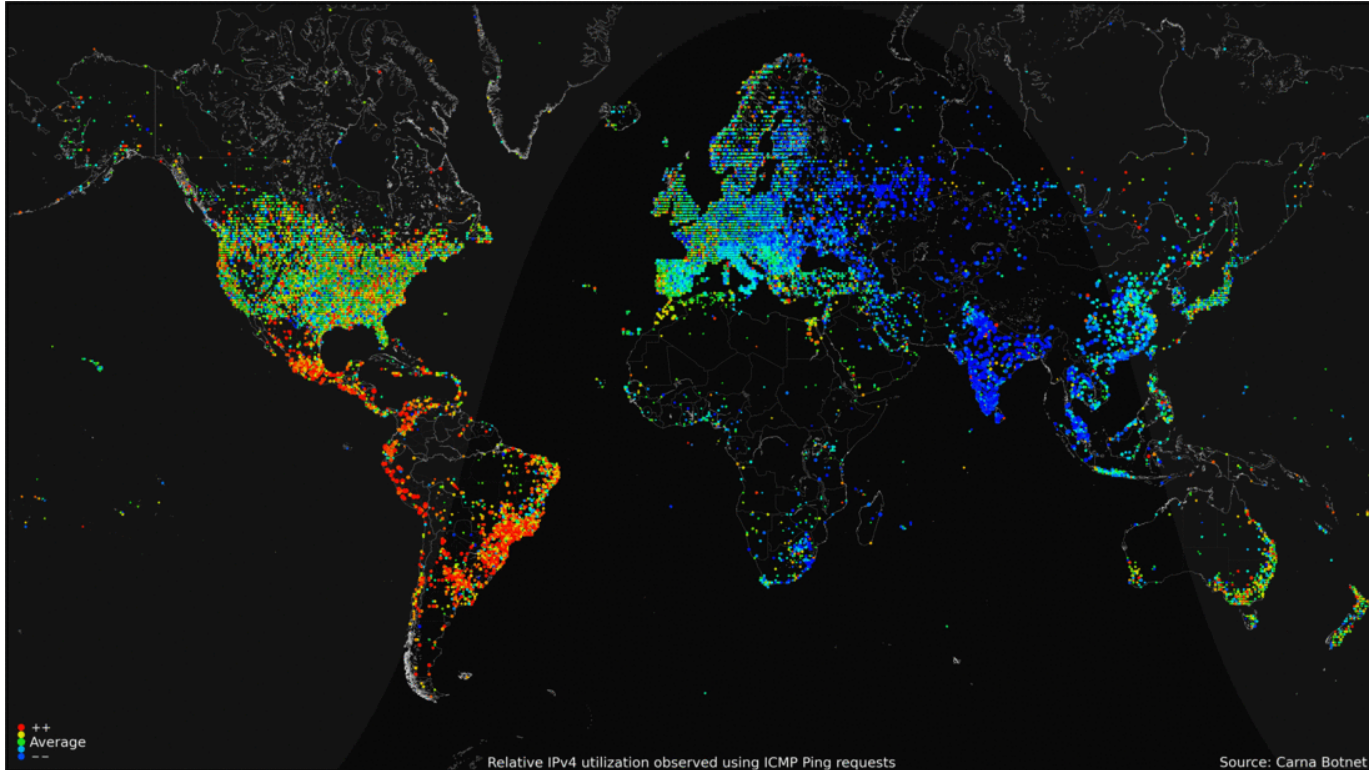


Optical networks: From past challenges to future opportunities

NETWORLD EUROPE & CCSA
FUTURE OPTICAL NETWORKS WORKSHOP



Optical networks connect the world

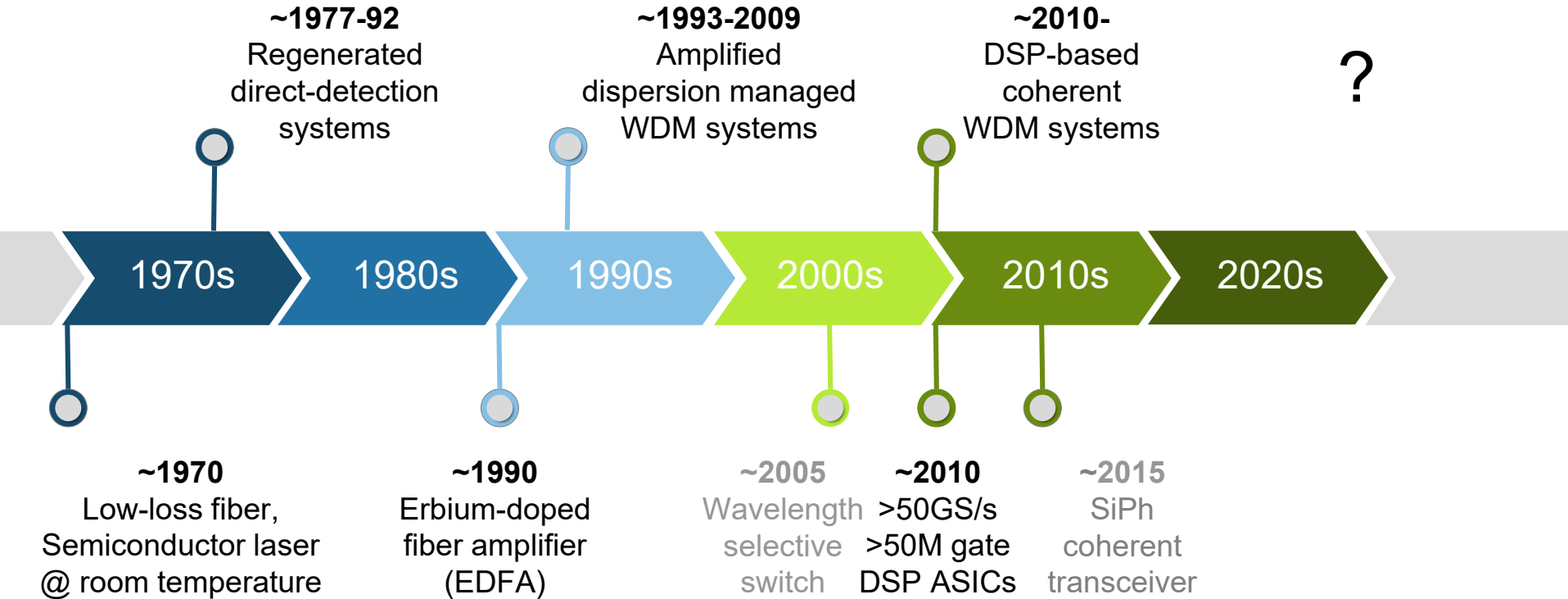


“2012 Internet Census” - 1.3B IPv4 addresses – 24h

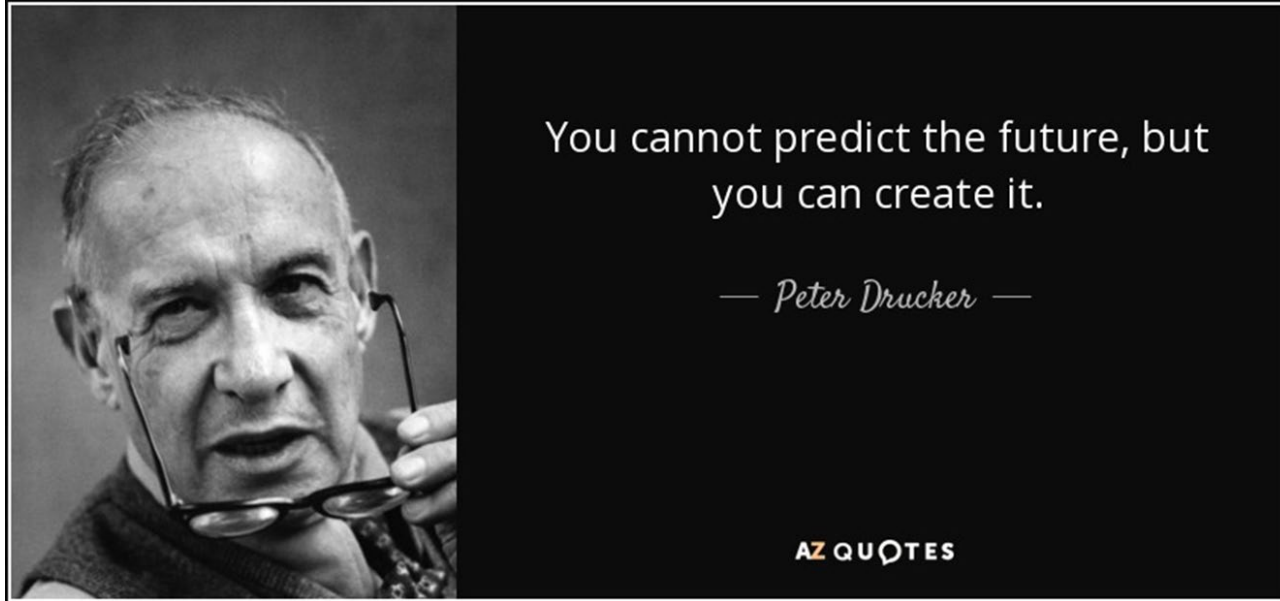
https://en.wikipedia.org/wiki/Carna_botnet

WHAT IS NEXT?

We achieved 50+ years of lightspeed connections



Predictions are difficult, especially about the future



The capacity crunch continues

Traffic growth

25% CAGR:

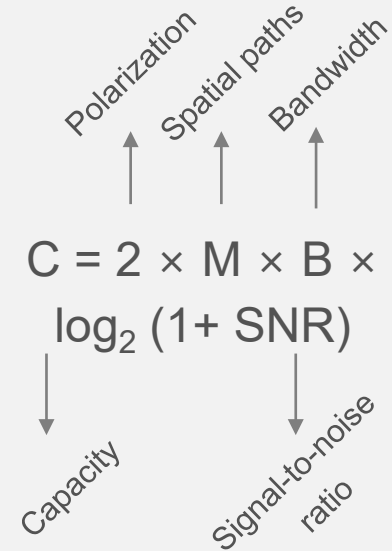
~10x growth in 10 years

50% CAGR:

~60x growth in 10 years

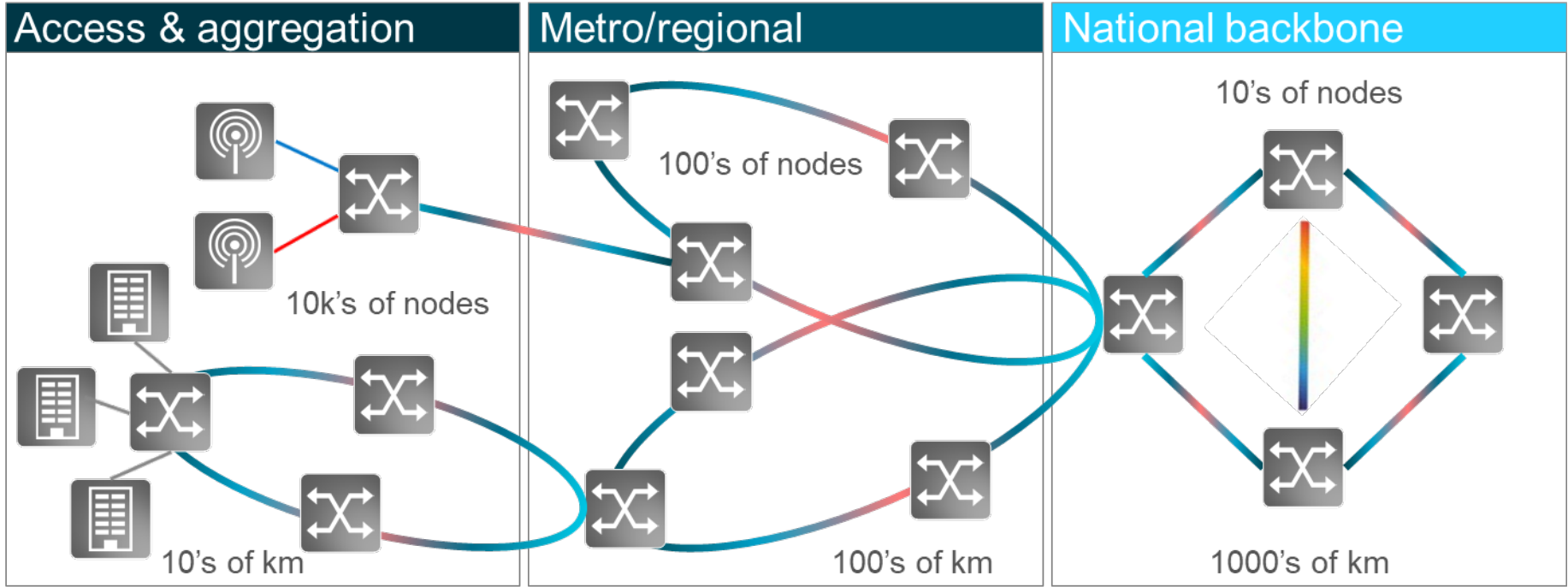


[Claude Shannon](#) by [Konrad Jacobs](#),
CC BY-SA 2.0 de



WILL MAINTAIN A MULTI-DOMAIN NETWORK WITH SWITCHING AT DOMAIN BOUNDARIES

A hierarchical network architecture prevails

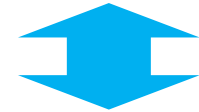


LATENCY AND TIMING BEHAVIOR BECOME CRITICAL PARAMETERS FOR CERTAIN SERVICES

Deliver capacity in the core & connectivity in the access

	KPI	2020	2025	2030
Core	Port speed ¹ (Tb/s)	0.4	1.6 ⁸	6.4
	Fiber spectrum ² (THz)	5	15	50
	Line capacity ³ (Tb/s)	25	~200	~1500
	Node capacity ⁴ (Pb/s)	0.15	1.2	9
Access & Aggregation	Uplink speed ⁵ (Gb/s)	100	400	1600
	PON speed ⁶ (Gb/s)	10	50	>200
	Data rate ⁷ (consumer, Gb/s)	0.1	~1	>5
	Data rate ⁷ (business, Gb/s)	1	10	50

High capacity
Long routes
Controlled environment



Many endpoints
Short routes
Harsh environment

¹ Extrapolation of Ethernet roadmap

² 25% CAGR, in line with conservative traffic predictions

³ 50% CAGR, in line with ICP predictions

Assumes exploitation of frequency and space domain

⁴ Based on degree 4 node with 50% local add/drop.

⁵ One generation behind core port speed

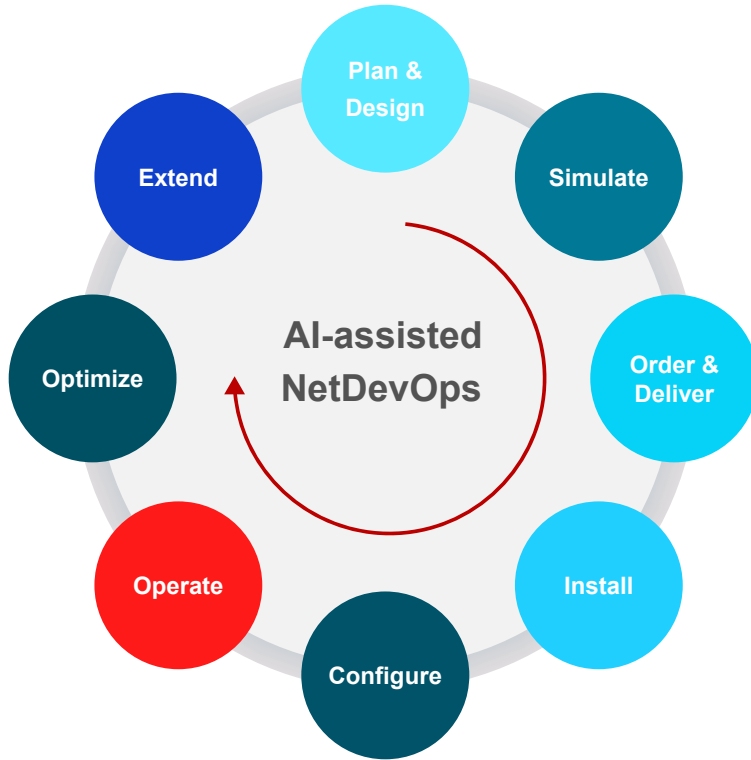
⁶ Extrapolation of PON roadmap

⁷ 50% CAGR based on Nielsen's law

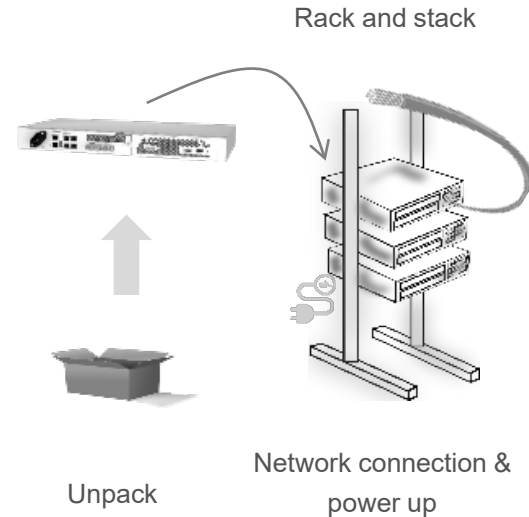
⁸ IEEE decided to develop 800G and 1.6T in parallel

NETWORK LIFECYCLE MANAGEMENT & SECURE ZERO-TOUCH PROVISIONING IS NEEDED

Increasing network complexity calls for more automation

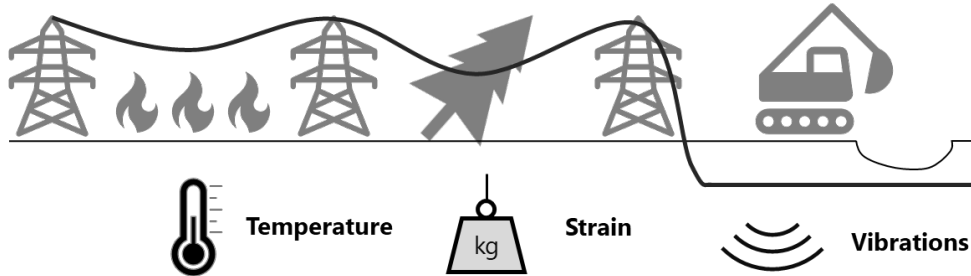


Secure zero-touch provisioning (ZTP)



PROTECT COMMUNICATION INFRASTRUCTURE AGAINST FAILURES, ATTACKS AND NATURAL DISASTERS

Network resilience gets challenged



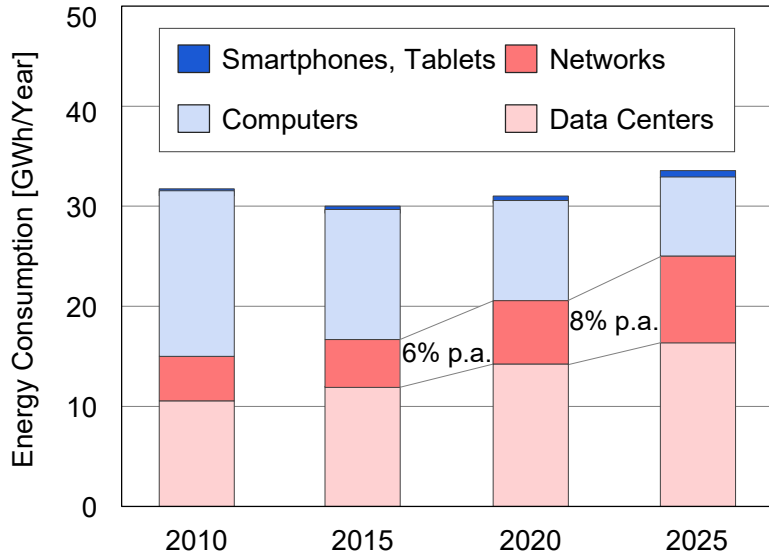
Optical JC&S*:
Phase-sensitive OTDR for
infrastructure monitoring

*Joint communication & sensing

NEED TO BEAT THE EXPONENTIAL GROWTH WITH NEW APPROACHES AND A HOLISTIC VIEW

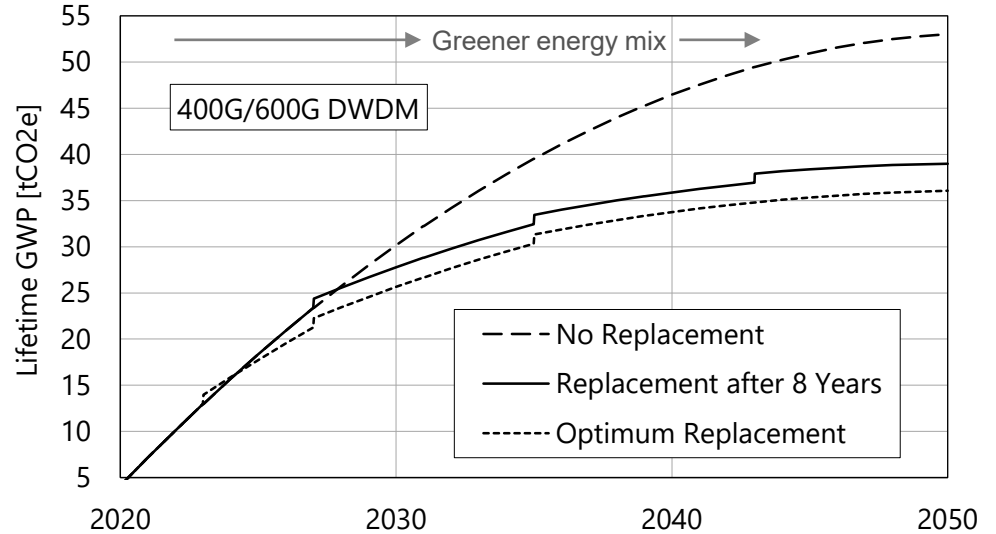
Sustainability & energy efficiency are critical

ICT energy consumption (Germany)



[Hintemann et al., Electronic Goes Green 2016+, Berlin, September 2016]

Lifecycle assessment of an optical transponder



[K. Grobe, OFC 2022]

GWP: Global warming potential

Thank you

joerg-peter.elbers@adtran.com

