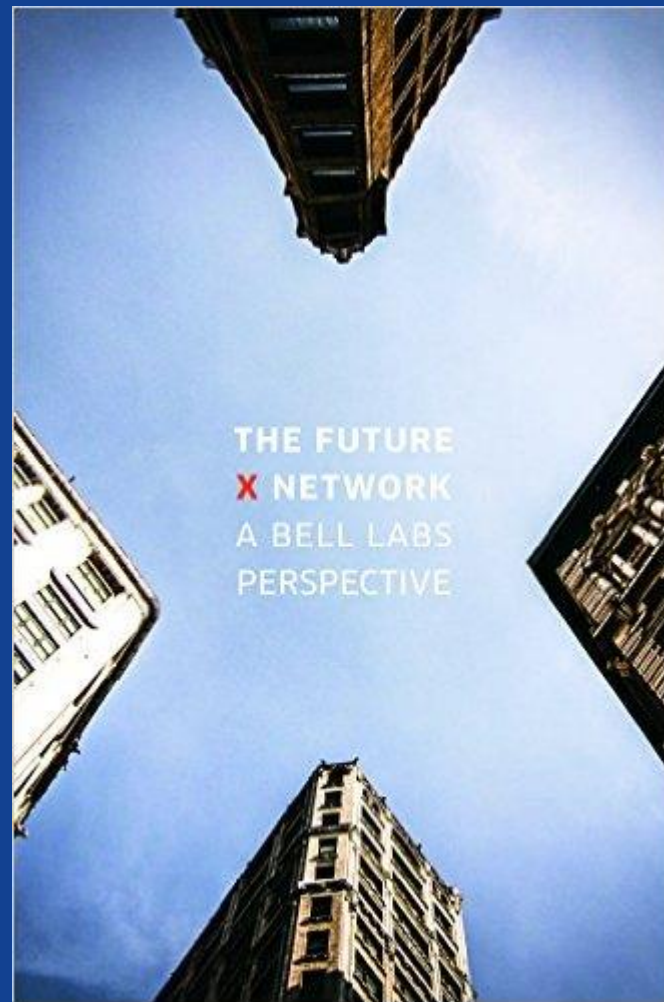
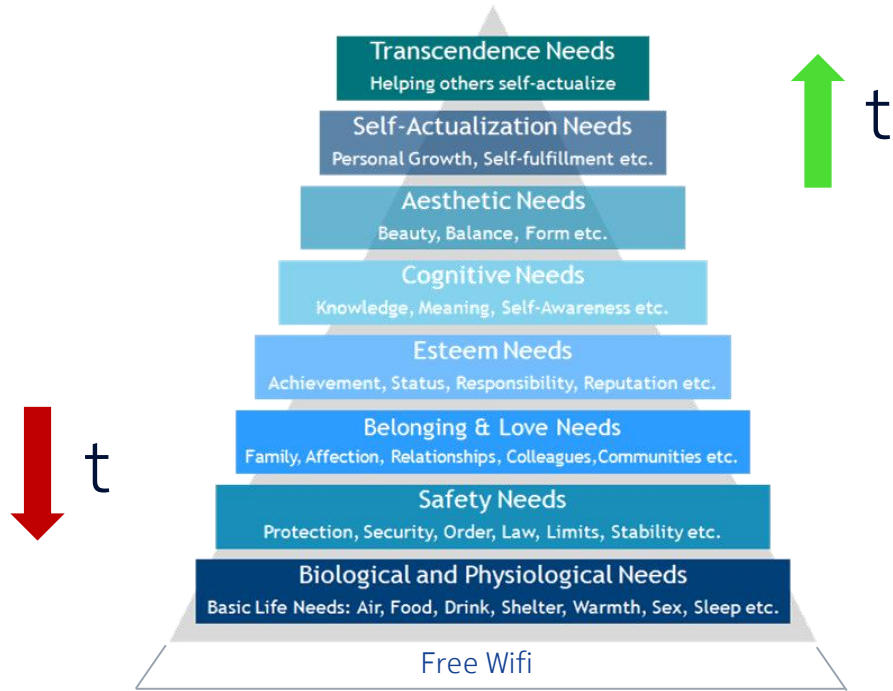


Creating new Opportunities with the FutureX Network

Theodore(Tod) Sizer
Nokia Bell Labs



Human value: Time



Thinking time....

$$\uparrow s^{-1} \rightarrow t \downarrow$$



X 100



X 500



X 1000



X 5000



X ??

We have continuously created tools to augment our physical abilities...and save time

Thinking time....

↑ D → t ↓ ↑

Google



amazon

X 10 - X 1000 ?

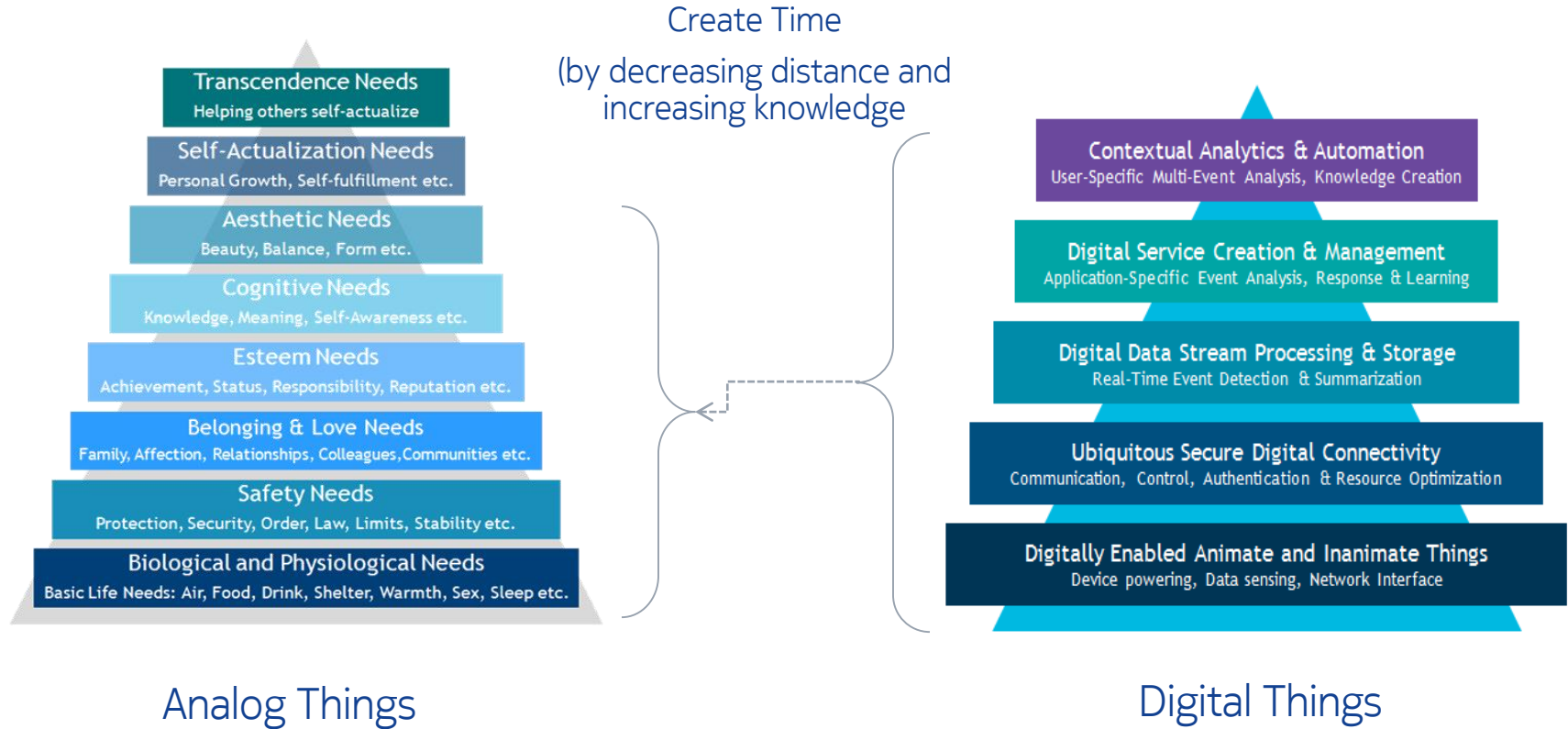
We have created tools to increase discovery to save time (and waste time?)

Thinking time....



Need to interface digital & physical realms...to decrease distance and waste, and create time

The Future of All Things and the Creation of Time



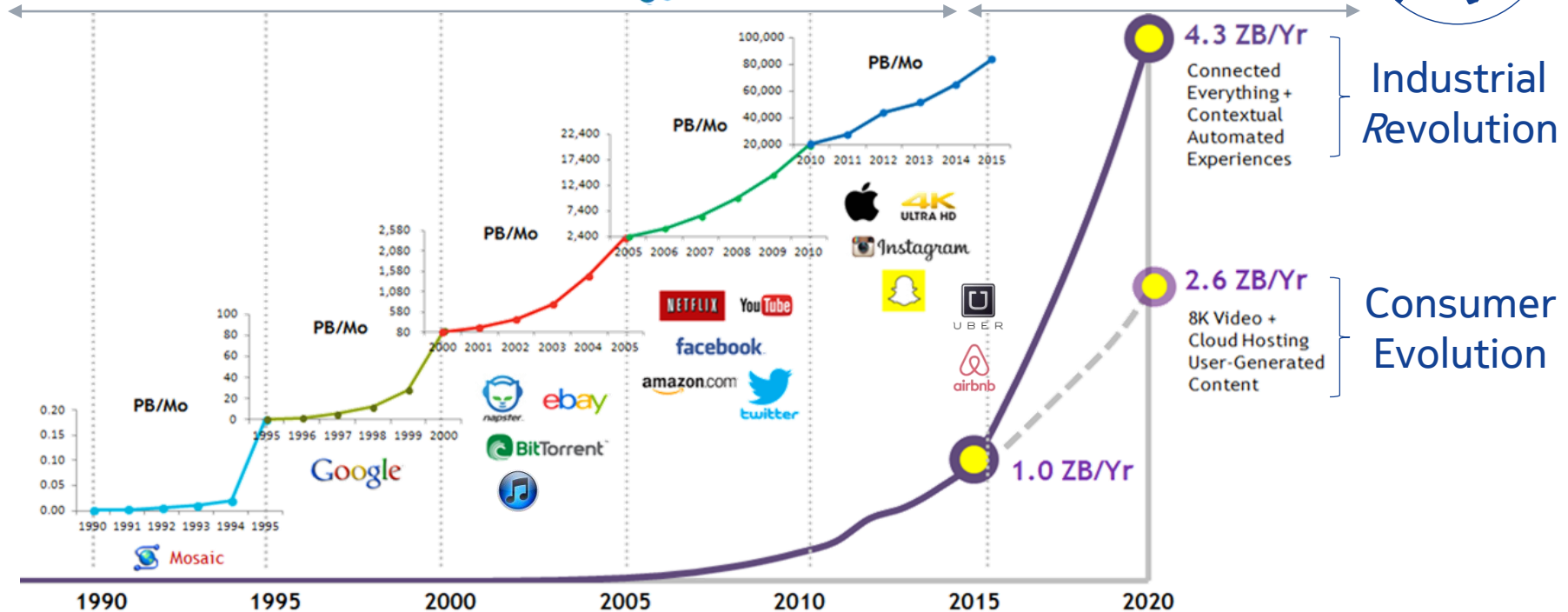
Creating Time
is the
5G Killer App

The new digital era

Digitization, delivery & sharing of:



Digitization, distribution & optimization of:



The coming revolution

Technological Revolution (def):

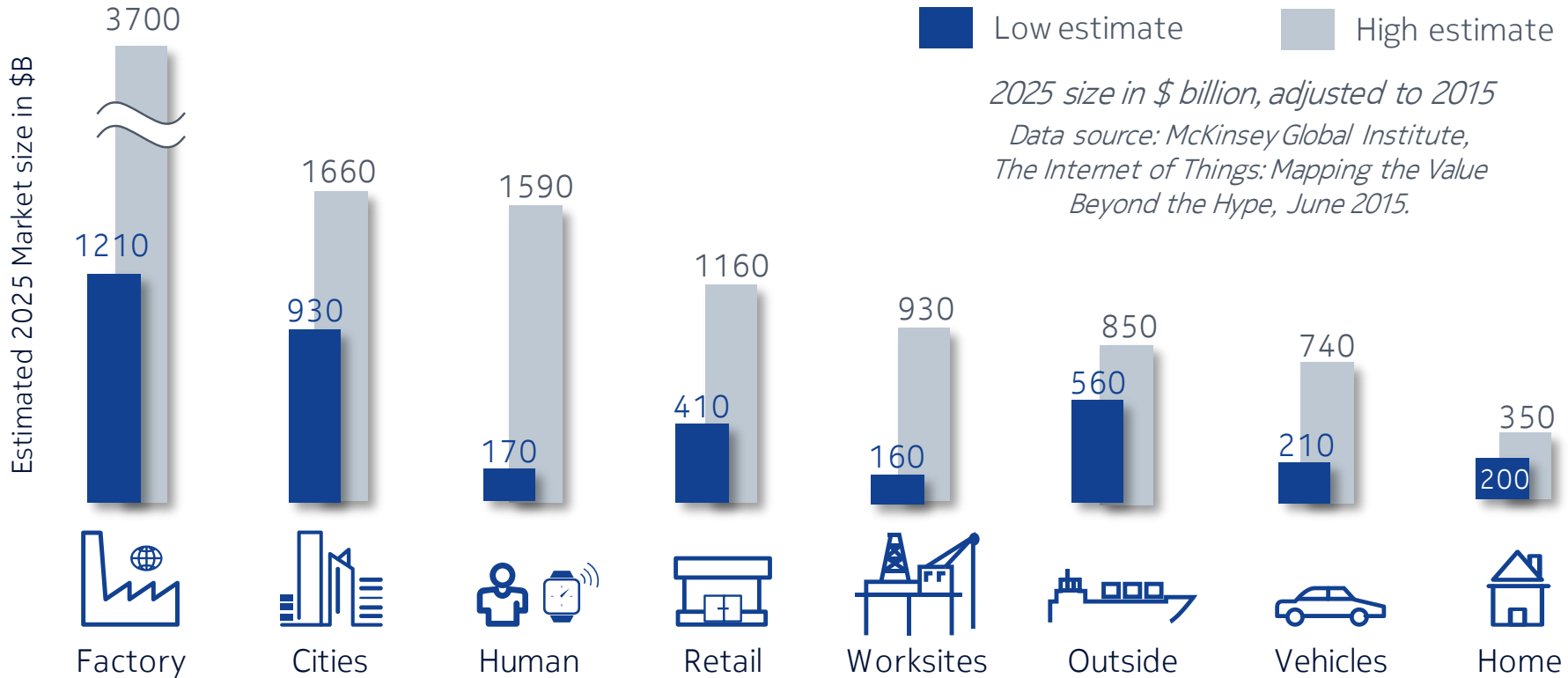
Interconnection of new systems and technologies + capacity to profoundly transform economies & society

Tech. Revolution	Enabling Technology	Connectivity
Financial (1600 – 1740)	Stocks & Bonds	Banking & Stock Market Infrastructure
1 st Industrial (1780 – 1840)	Steam Engine & Iron Production	Rail and Shipping Networks
2 nd Industrial (1880 – 1920)	Steel & Chemicals	Extended Transportation Networks Electricity & Telecom Networks
Scientific-Technical (1940 – 1970)	Analog & Digital Signal processing	Digital Communications Networks
Information (1985 – 2015)	The Web, Cloud computing & Mobile devices	Internet & Broadband Access
Automation of Everything (2015 –)	Digital interfaces & Data analysis	Future X Network




We are here

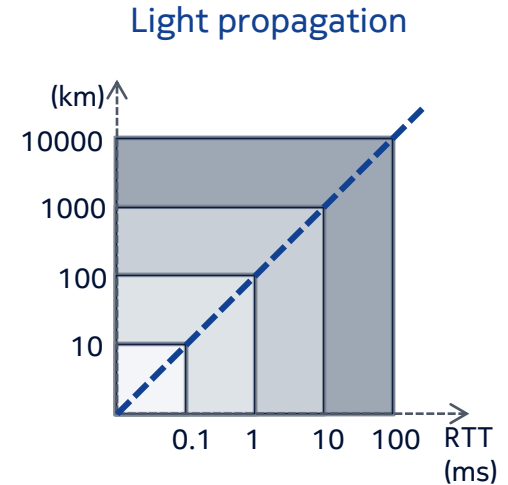
Future of automated systems, platforms, infrastructure

An estimated \$3.8T-\$11T market in 2025



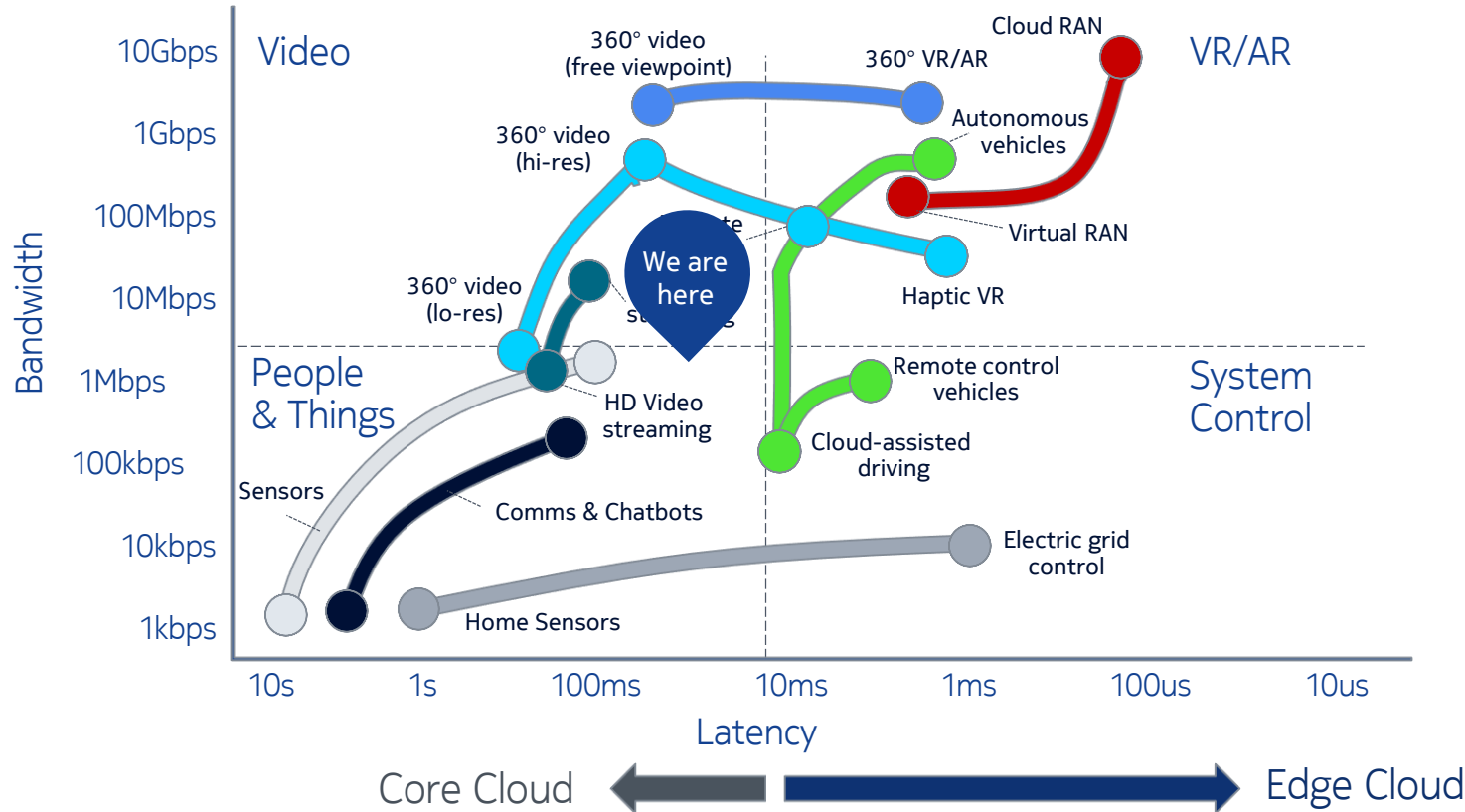
Latency matters ... reducing time to save time

	Speed	Distance Traveled		
	3 m/s	1 ms	10 ms	100 ms
	150 km/h	3 mm	3 cm	30 cm
	100 km/h	4.2 cm	42 cm	4.2 m
	100 km/h	2.8 cm	28 cm	2.8 m

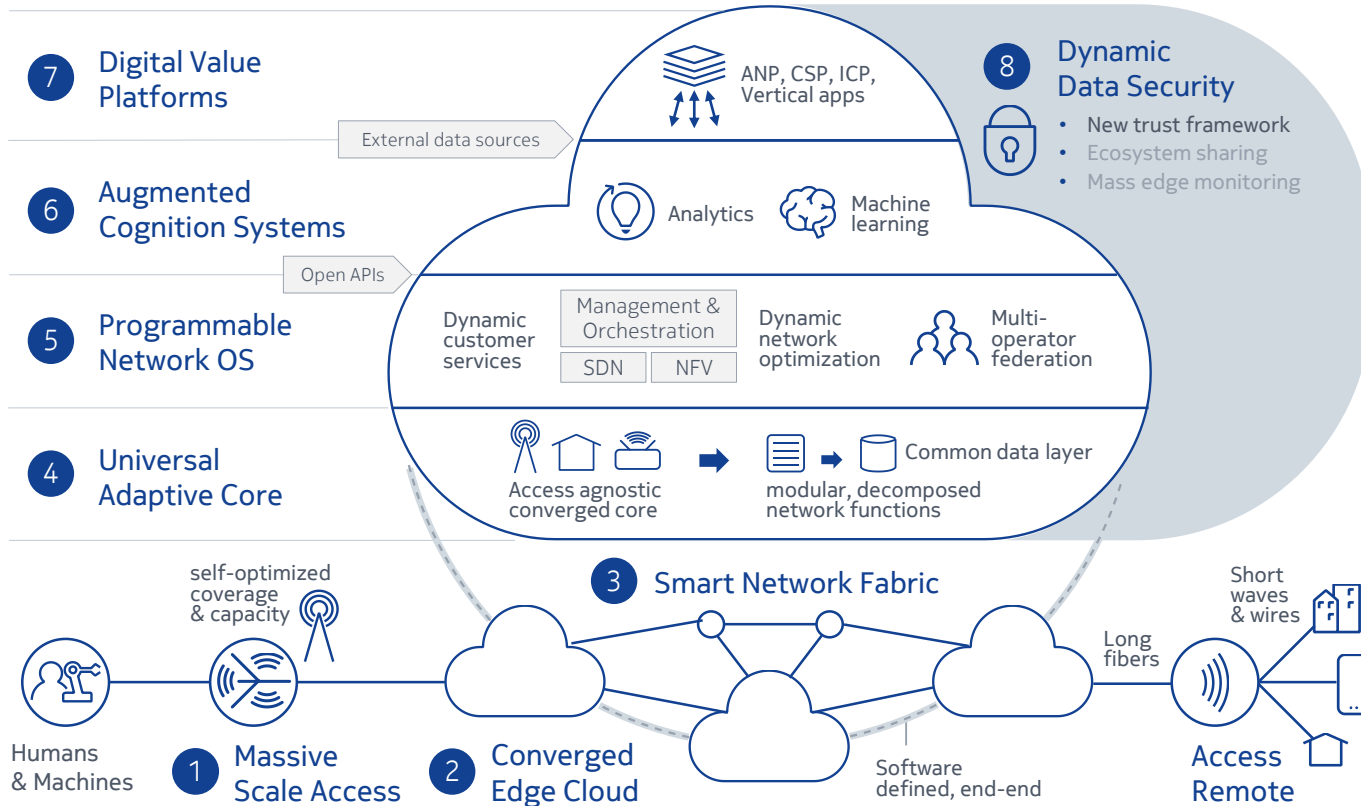


Fundamental truth: Low Latency requirement demands Distributed Cloud Architecture

Latency & bandwidth matter ... for new digital experiences that save time

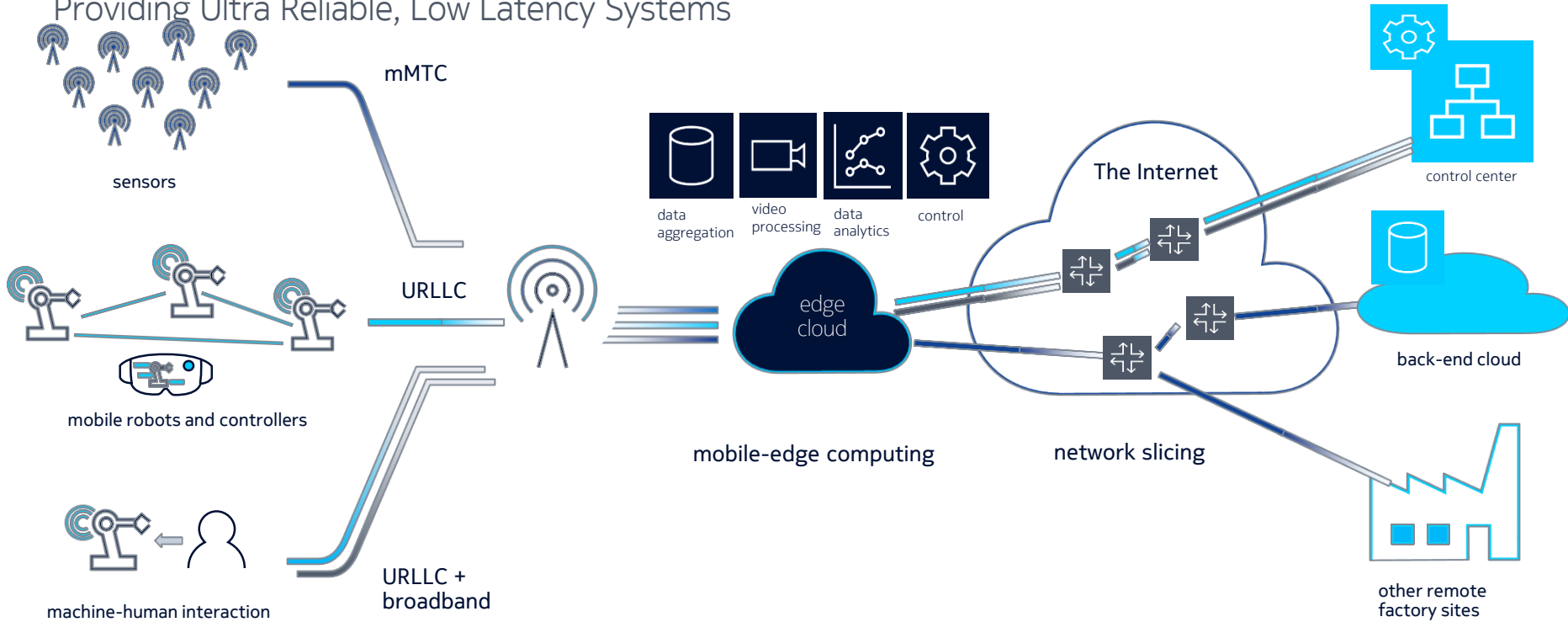


The New Architecture for New Value



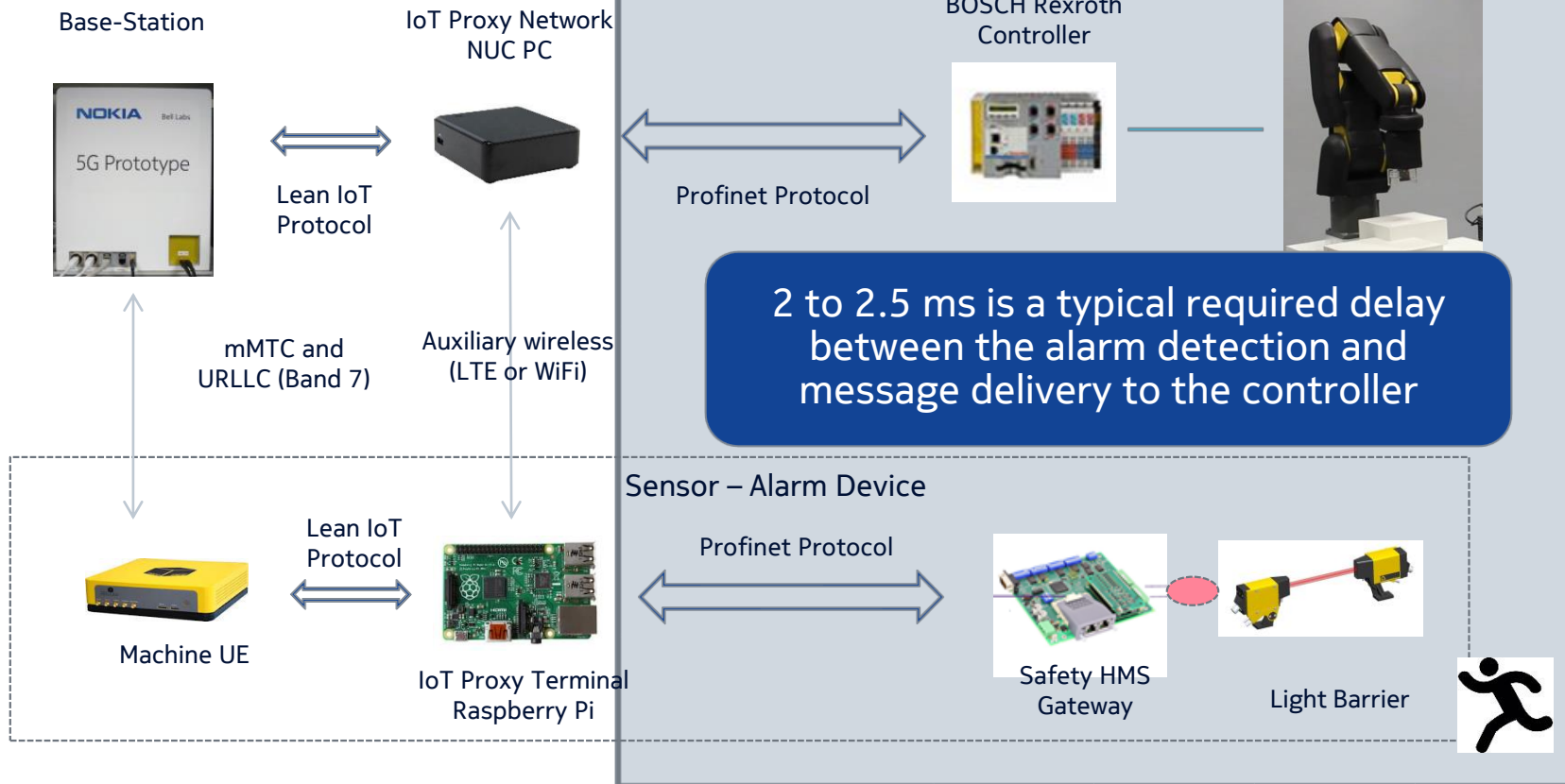
Future Communication Network for Industrial Applications

Providing Ultra Reliable, Low Latency Systems

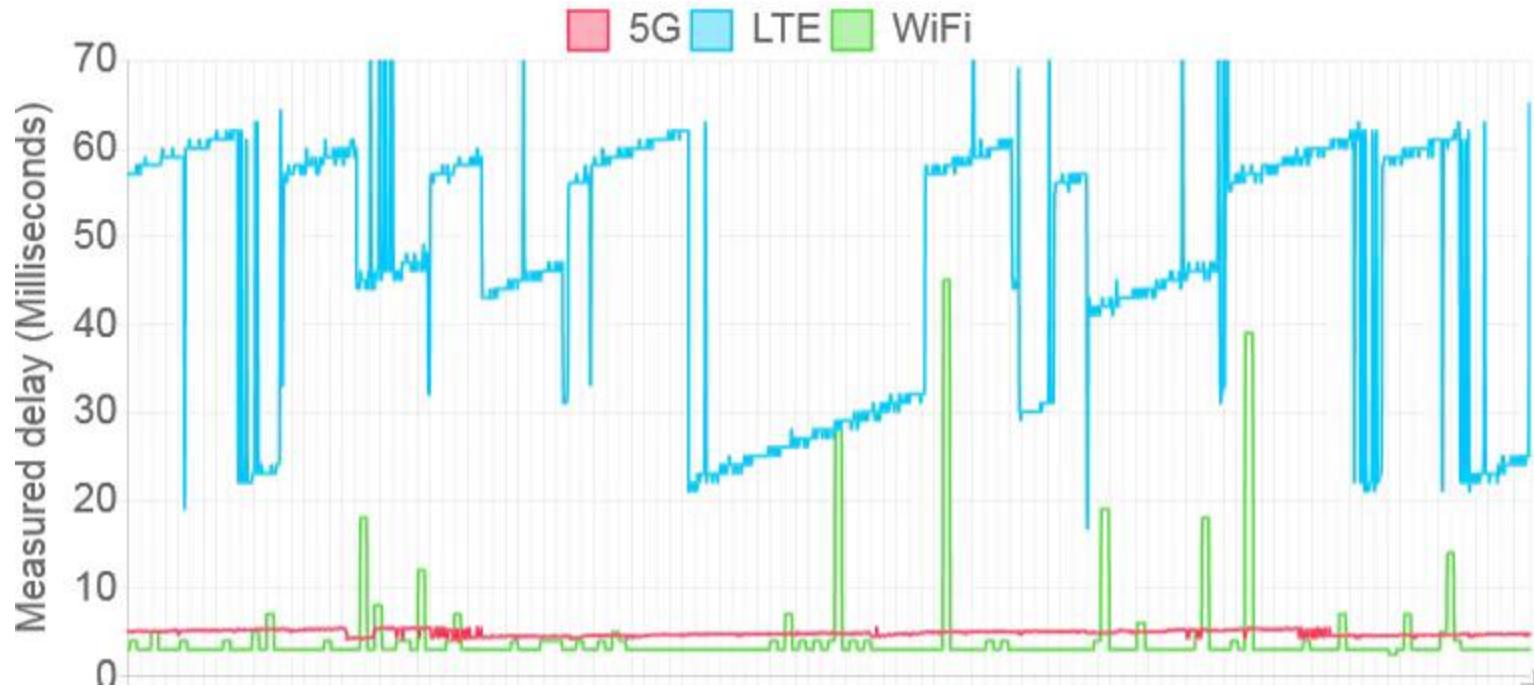


New Capabilities create new solutions for machine to machine communication.

Factory Test Platform



Round Trip Time Measurements



5G offers superior low latency connection with high reliability

Ultra Reliable Low Latency Control and flexible Networks



Industrial Robotics



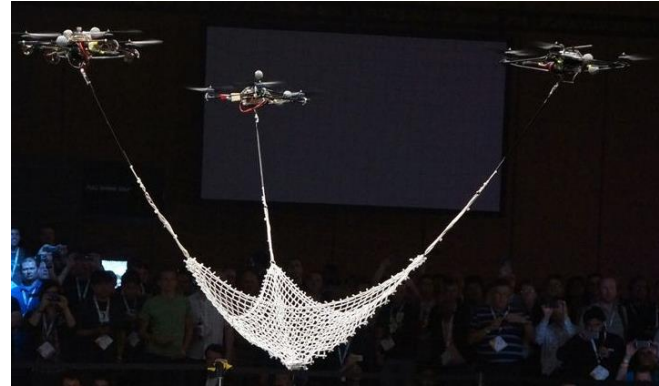
Cooperative Collision Avoidance



3D Printing - Construction



Drone Installation of Nokia LTE FCell



Cooperative Drone Control

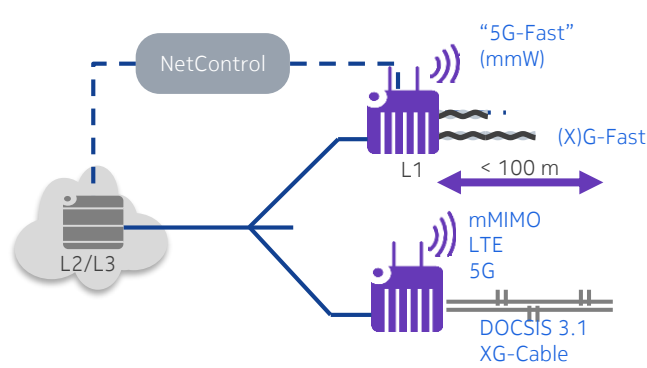


Teleoperation

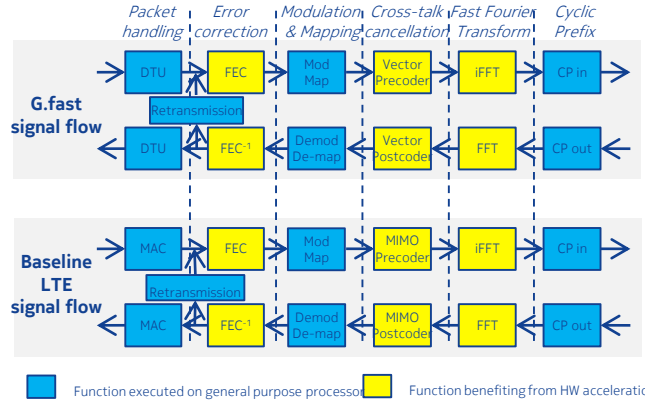
Converged Access

What: Universal remote node fully programmable for converged 5G mobile and fixed access exploiting deep fiber access.

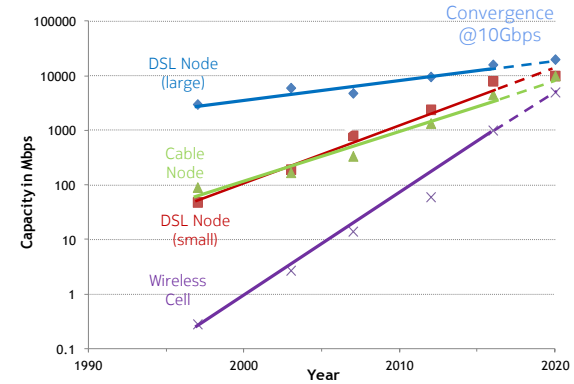
Benefit: Common access node, common site usage, Multi-Access speed increase.



Similar architecture



Similar signal format

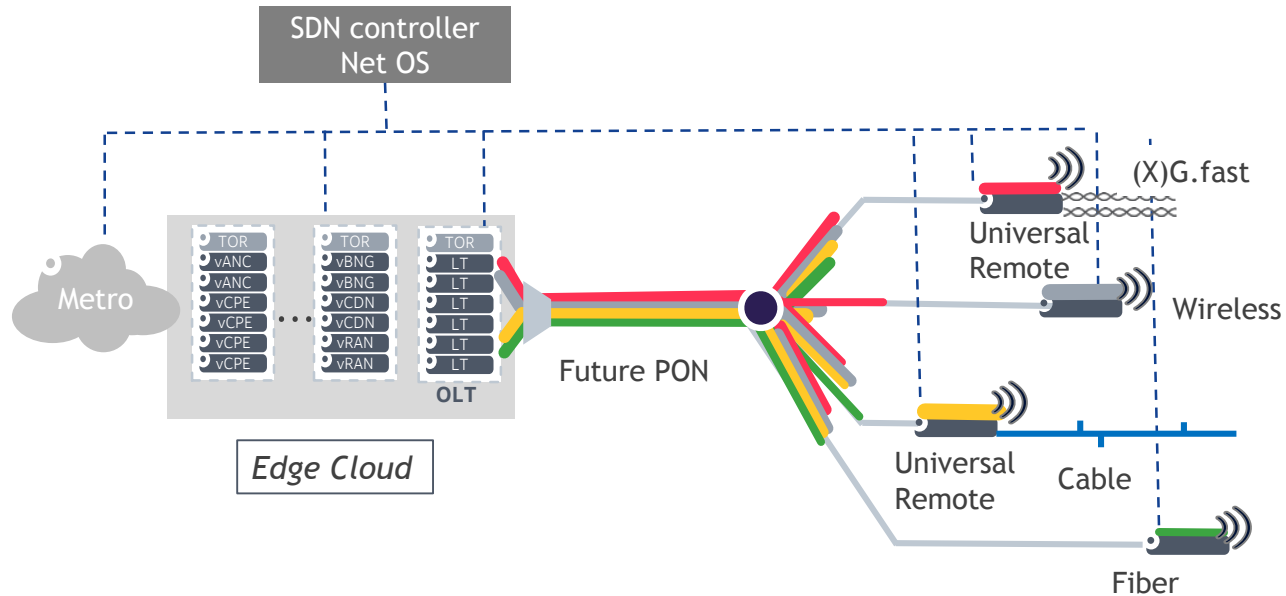


Similar throughput

Leverage commonalities to realize truly converged universal remote

Future Broadband Access Architecture

Universal Remote Access Node



Imagine a converged network at fiber-like access speeds and fully programmable

Is 5G the last “G”? Should this be our ambition?

Move to Software/Cloud based Solutions



Capabilities of SDR and SDN are now largely sufficient

Software flexibility can allow continuous network adaptation and improvement

Software support for new applications.

Myriad new and diverse devices will dominate



Smartphones and variants will continue.

Ubiquitous connection of machines with new requirements.

5G standard must build Phy layer flexibility into the standard.

Human Needs for Communication are evolving faster than every 10 years



5G initiatives in Korea and the US are moving faster than standardization.

Usage is exploding.

Dependence is Growing.

New uses proliferating.

Software systems together with rapid service introduction will force market acceleration

NOKIA