NOKIA

Internet of Things brought to life

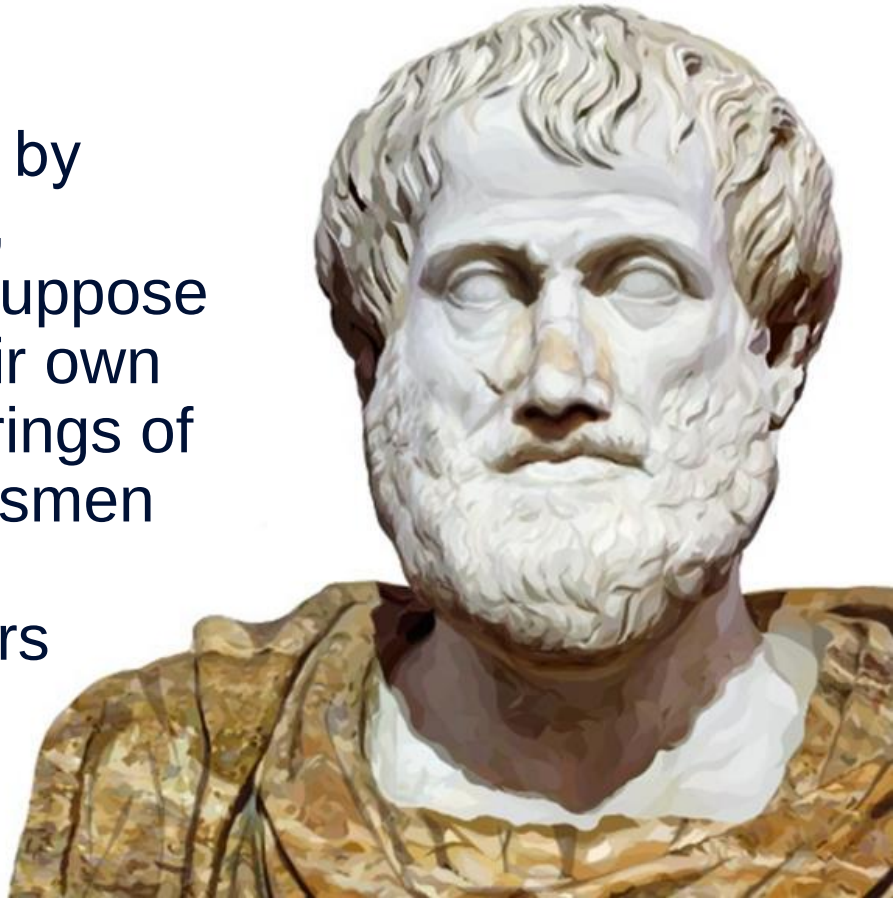
HTE Conference presentation

- Zoltán Schönleber
- October 2016

Humanity's long standing dream…

"Suppose every instrument could by command or anticipation of need, execute its function on its own; suppose that spindles[1] could weave of their own accord and plectras[2] strike the strings of zithers[3] by themselves; then craftsmen would have
no need of hand-work and masters have no need of slaves."

Aristotle (384 - 322 BC)



[1] a tool used in hand-spinning to twist and wind thread from a mass of wool.
[2] thin flat pieces of material to pluck the strings of a musical instrument.
[3] a musical instrument consisting of a flat wooden sound box with numerous strings stretched across it, placed horizontally and played with the fingers and a plectrum.

While the past has been about connecting people, the future is about connecting things in a programmable world

- Improving people's lives through automation, enhanced connectivity and intelligence
- Helping industries to become more efficient, agile and real-time

The programmable world provides an opportunity to improve people's lives

Of fatalities in car accidents are due to human error and slow reaction[1]

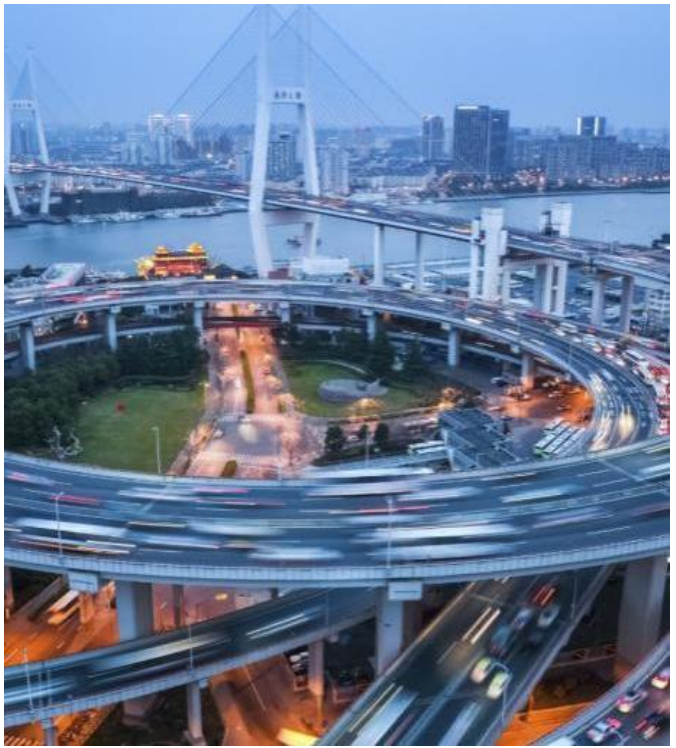
90%

Water lost each year in the US because of aging and leaky pipes, broken mains and faulty meters[2]

2.1T gallons

Fatalities each year worldwide by not following doctor's prescriptions[3]

1 mio



Mobile glucose monitoring tools can cut diabetes management costs by[4]

50%

Estimated energy waste in US buildings due to inefficient and outdated HVAC systems[5]

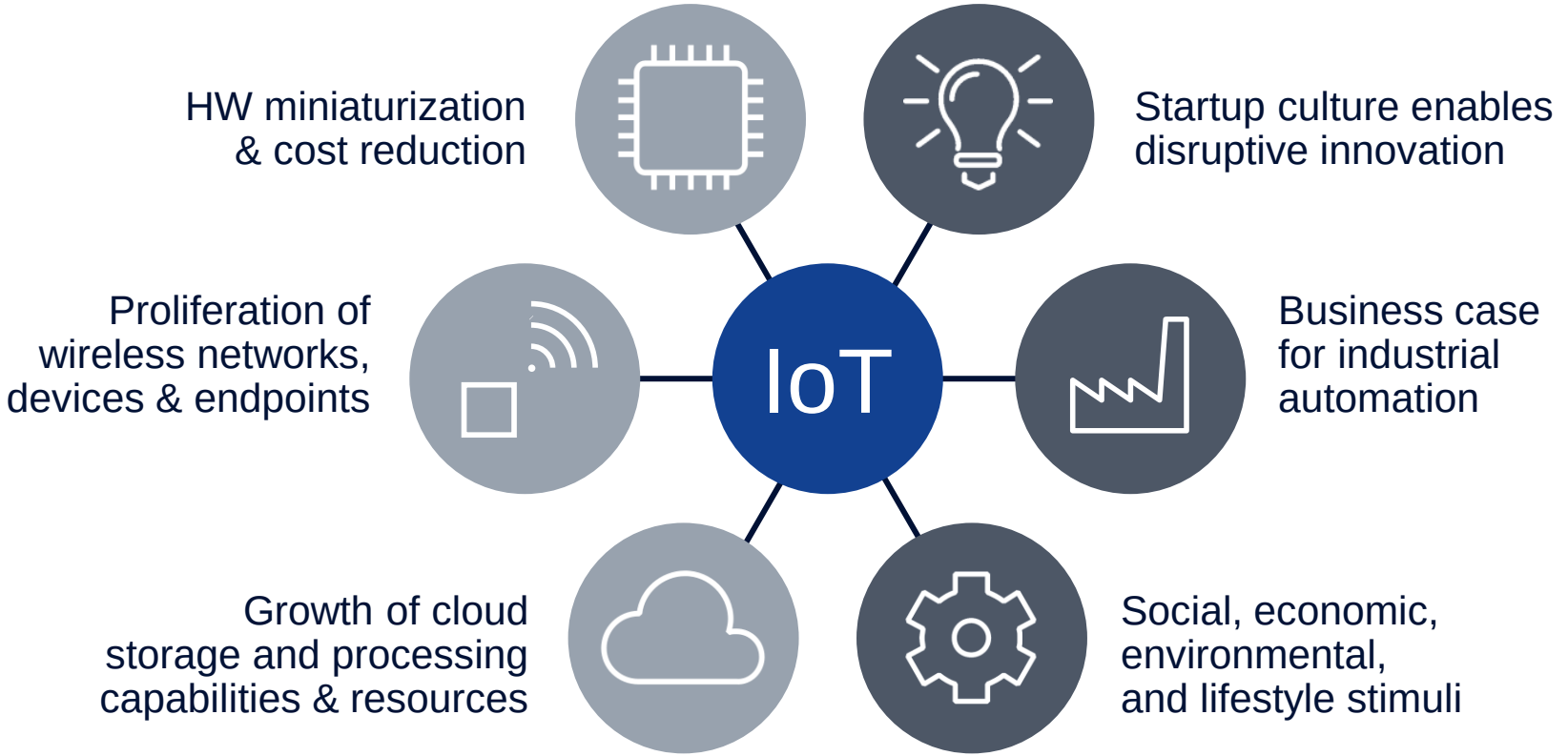
50%

Possible yearly economic impact of IoT applications in cities in 2025[6]

$1.6 trio

[1] International Organisation for Road Accident Prevention; [2] NPR; [3] Huffington Post; [4] fiercehealthcare; [5] American Physical Society ; [6] McKinsey

Why now?



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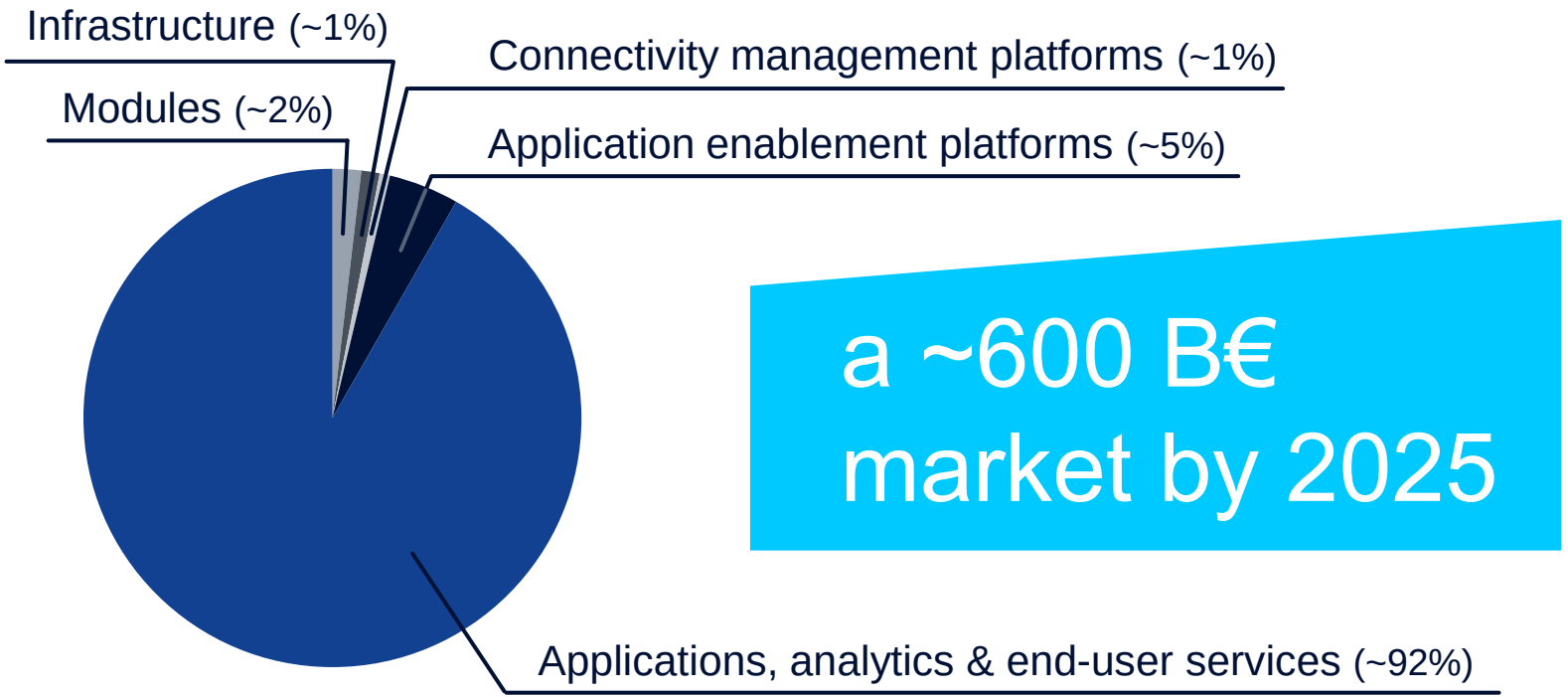
The IoT provides an unprecedented opportunity for hardware, software and services players in telecoms, IT and electronics



Source: Machina Research and Nokia Strategy, 2016

… but also ‘traditional’ Service Providers will have to become more agile, and gain expertise in vertical markets

“The operator (and vendor) community is preparing several technologies to enable IoT for cellular networks. Of course, technology by itself is no panacea, and operators will require expertise in vertical markets to become trusted enablers rather than pure access providers.

Our advice to telcos is to be selective in terms of vertical engagements, since effort and investment are necessary to become an enabler. In areas where they choose not to invest and are content to merely provide the connectivity layer, operators can partner with specialist systems integrators or use application providers as a channel.”

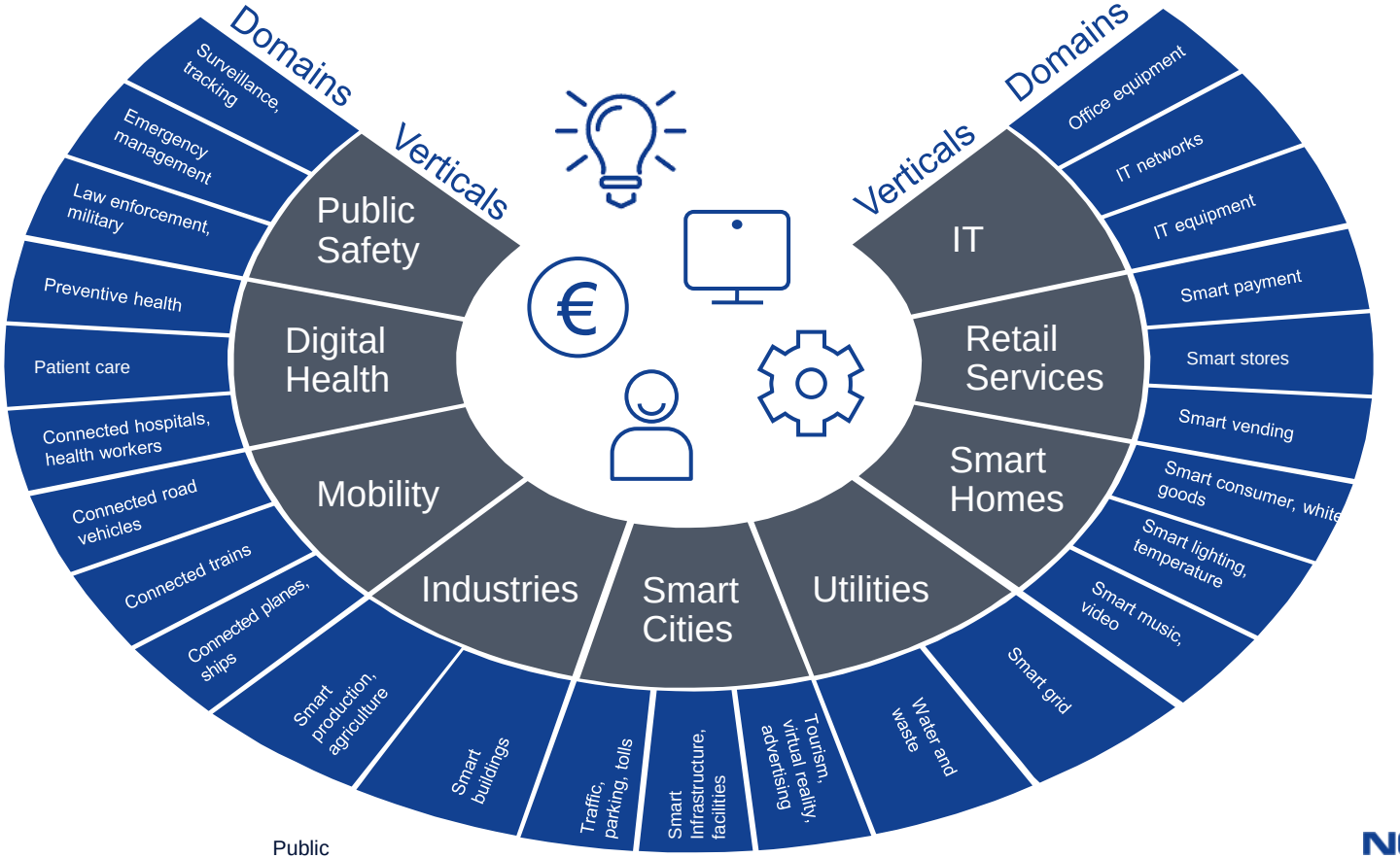
“How will telecoms networks enable IoT?” - OVUM, March 2016

Quantifying the service delivery value chain

	Connectivity	Device	Application	Service provision	System Integration
Description	Offer the network for transmission of data from IoT devices	Offer the end-user module, with an embedded M2M chipset	Provide the actual applications that manage the data collected by the device	Manage the distribution, supply chain, fulfilment, billing and support	Provide system integration services; Design/develop systems
Approximate share of value	5-30%	5-20%	30-60%	20-30%	<20%
Approximate EBIT margin	~10%	<5%	0-30%	0-10%	~ 0%

Source: Analysys Mason, 2015

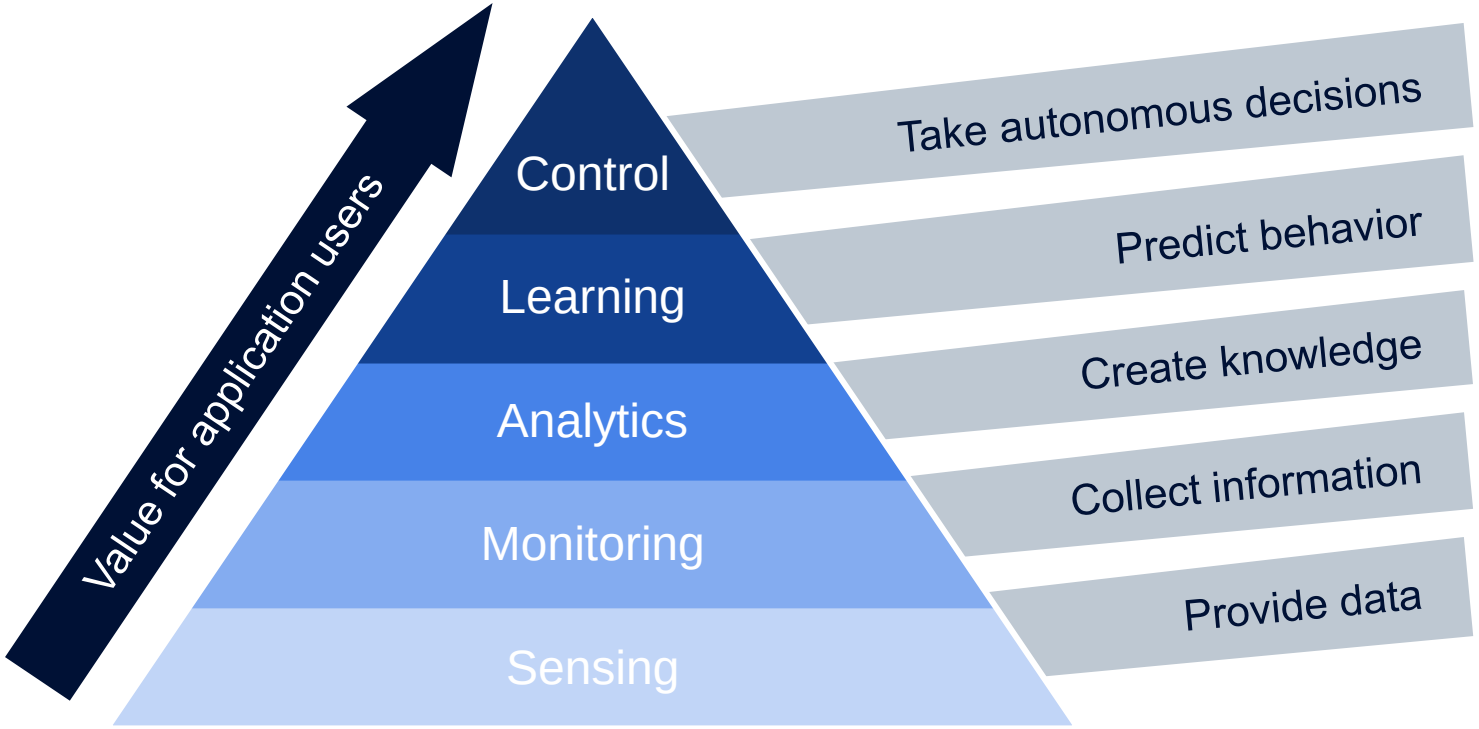
The IoT has a transformational impact on (almost) all sectors



Because the IoT is fundamentally changing products, business models, operational processes, and customer/user interaction

Product innovation	• Customer focused • Smarter products, always connected
Business models	• Disruptive models, players and ecosystems • '*Servitization*' of devices, applications and data
Process automation	• '*Mechatronics*', '*devops*' and *'DDDM'* • Data-driven control and decision making
Customer interaction	• Self-measurement and self-management • Data driven marketing and customer interaction

Big data is the ‘new oil’, driving IoT innovation, business value and customer experience



The network can make or break the IoT

Within the next 5 years, more than 90% of all IoT data will be hosted on service provider cloud platforms.

90%

Within 3 years, 50% of IT networks will transition from having excess capacity to handle the additional IoT devices to being constrained.

50%

By 2018, 40% of IoT-created data will be stored, processed, analyzed, and acted upon close to, or at the edge, of the network.

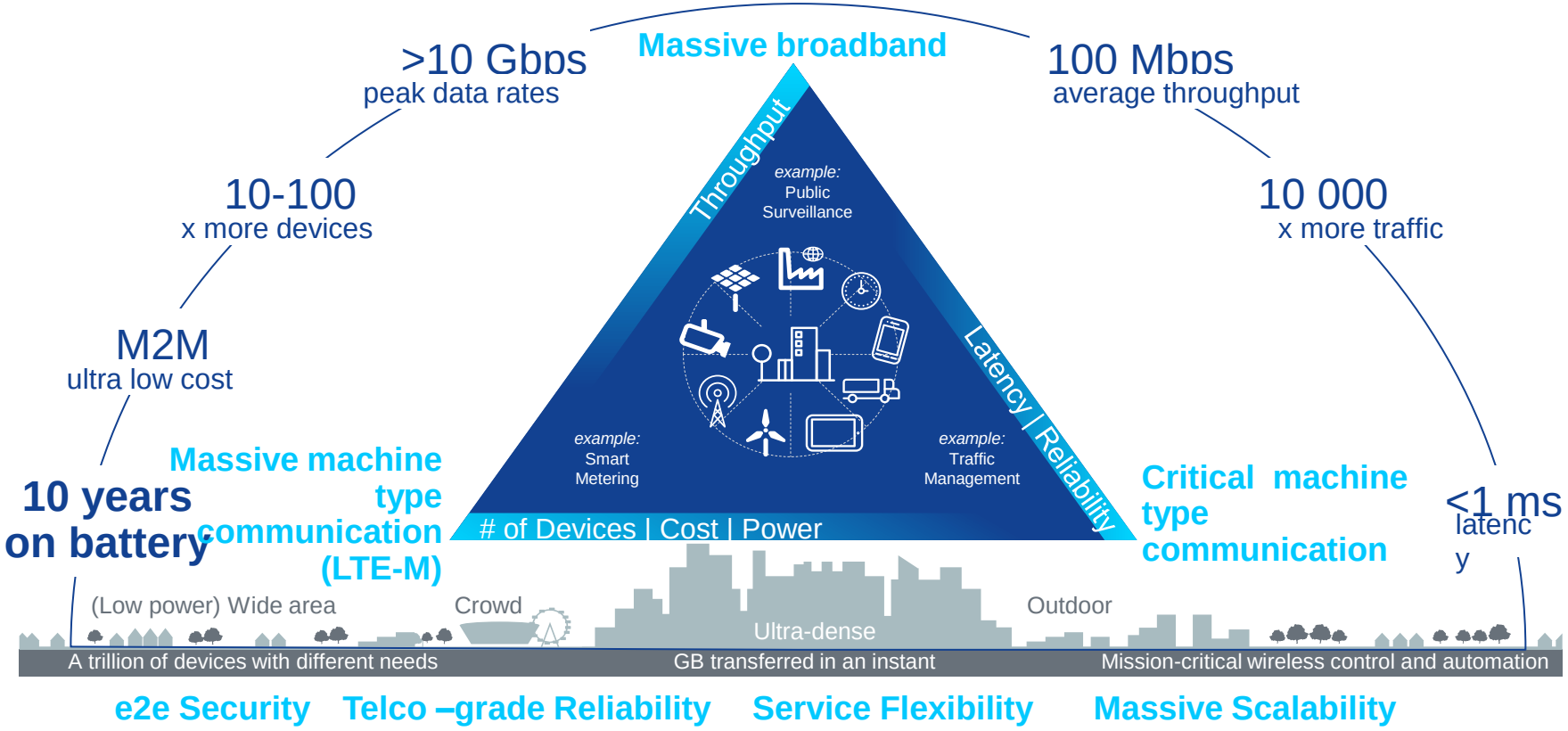
40%

Within 2 years, 90% of all IT networks will have an IoT-based security breach.

90%

Source: IDC, December 2014

IoT is a major driver for the evolution towards 5G



Why Nokia in IoT?

1. As a global market leader in mobile and fixed connectivity, we are supporting our customers in the evolution towards new business models and services, and positioning 5G as the future network for all BB and IoT services.

2. Cloud, software, security, applications, and services are key enablers for the IoT.
This is a unique opportunity for Nokia to further innovate our business, and expand our footprint in these emerging domains.

3. Connected devices, big data analytics and network transformation are at the heart of digitalizing industries.
As such, the IoT is a key driver for Nokia's customer differentiation strategy and our GEPS business.

4. Nokia is reimagining a world where technology is enriching people's lives.
IoT networks, platforms and applications are instrumental to realizing our vision of a programmable world.

Nokia is investing in the IoT, 5G and security

Nokia showcases 5G-powered IoT at Brooklyn 5G Summit

Nokia buys Withings for $191 mio

engadget

Nokia raises USD 350 mio investment fund for IoT companies

telecompaper

Nokia acquires security software vendor Nakina Systems

ZDNet

Nokia joins the Z-Wave Alliance, integrates Z-Wave IoT standard into smart home offerings

FierceWirelessTech

Nokia’s 3-layered IoT value proposition

Improve people’s lives and business results with the Internet of Things …

- Human
- Trusted
- Open
- Insightful
- Impactful

… and optimize and design networks for the Internet of Things

- Scalable
- Flexible
- Cloudified
- Efficient
- Secure

Applications

Platform

Infrastructure

Driving the human and business value for selected verticals

Automotive

- V2X
- Service Fleet
- Trace & Track

Utilities

- Smart Meter
- Service fleet
- Leakage

Public safety

- Situational awareness
- Mission control
- Smart vehicle

Cities

- Traffic and parking
- Bus shelter
- UAV mgmt

Health

- Preventative
- Remote care
- Rural care

Home

- Security
- Energy
- Automation

V2X: Vehicle to anything UAV: Un-manned aerial vehicles

To fully capitalize the Internet of Things opportunity, five main challenges have to be addressed

Robust connectivity: availability, coverage, latency.

1

Standardization: Standard connectivity for billions of things

2

Interoperability and open interfaces: Enabling platforms to talk with each other

3

Privacy and security: Prevent malware injection and data misuse

4

Domain knowledge:
Deep, vertical-specific insights

5

Our IoT portfolio from a helicopter view

Applications

IoT Community ecosystem (ng Connect)
Applications for selected use cases

Platform

IMPACT platform
- Application enablement (AEP)
- Device management (CDP)
- Connectivity management (CMP)
- Data collection & analytics

Infrastructure

Cellular radio: NB-IoT, eMTC, EC-GSM
Unlicensed spectrum: LoRa, Wi-Fi, BTLE
Optimized IoT core, leveraging SDN/NFV
Mobile Edge Computing, Backhaul & FTTx

CPE and devices

Home hub (ONT) with partner devices
Withings digital health products

Security

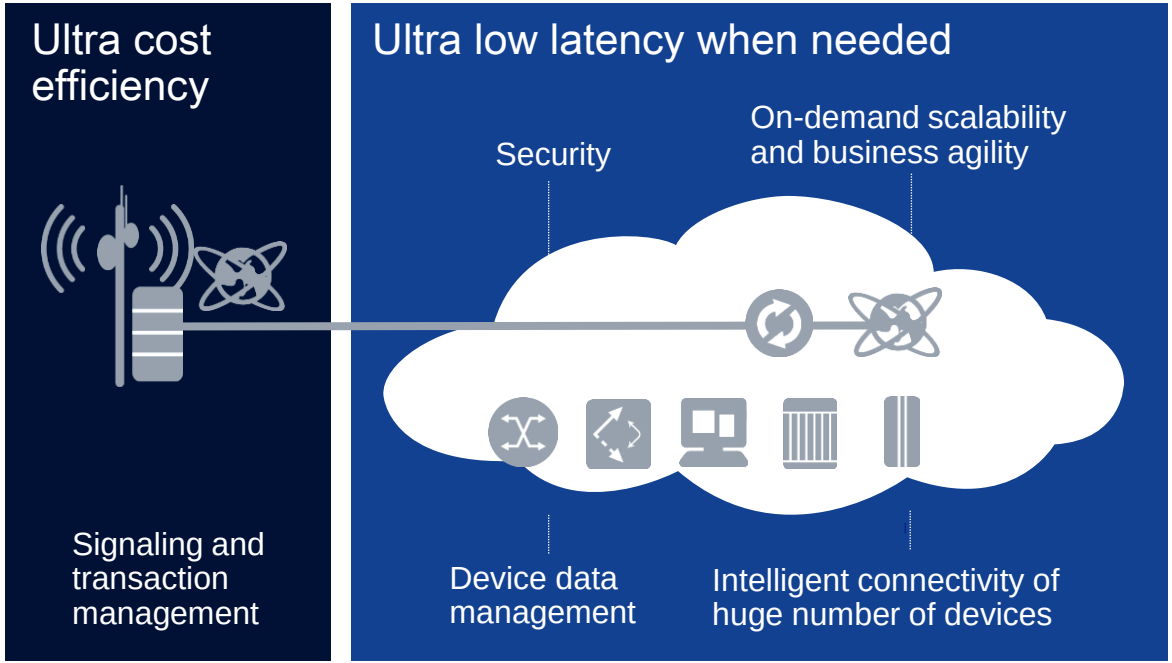
Services

Optimizing connectivity for the IoT

LPWA access technology
- Licensed
- Unlicensed
- Short range

Core
- Dedicated packet core
- Signaling traffic reduction
- Multitenancy

Services
- IoT life-cycle turnkey services
- Radio optimization for IoT
- Core optimization for IoT



IoT low power wide area access technology landscape

	Short-range	SIGFOX	LoRa	eMTC Rel. 13	NB-IoT Rel. 13	EC-GSM-IoT Rel. 13
Range* MCL**	10cm to 200m	<12km 160 dB	<15km 155 dB	<100km 156 dB	<35km 164 dB	<35km 164 dB
Spectrum	Unlicensed	Unlicensed	Unlicensed < 1GHz	Licensed LTE bands in-band	Licensed LTE in-band guard-band stand-alone	Licensed GSM bands
Bandwidth	2.4 GHz	900MHz 100Hz	900MHz <500kHz	1.08 MHz (1.4 MHz carrier bw)	180 kHz (200 kHz carrier bw)	200 kHz
Max Data rate***	<100s Mbps	<100 bps	<50 kbps (DL/UL)	<1 Mbps (DL/UL)	<170 kbps (DL) <250 kbps (UL)	<140 kbps (DL/UL)
	Nokia ONT		Nokia partner	Nokia RAN		

* Depending on spectrum being deployed ** Maximum Coupling Loss *** Instantaneous peak rate

Optimized mobile core for IoT

Dedicated core network

Overlay core to serve and fulfill requirements of IoT devices

Signaling reduction/ overload control

Prevention of overload situations cause by signaling storms

Resource optimization

Optimizing resource usage both in IoT devices and in network

Subscription optimization

Optimizations for subscriber data storage and retrieval

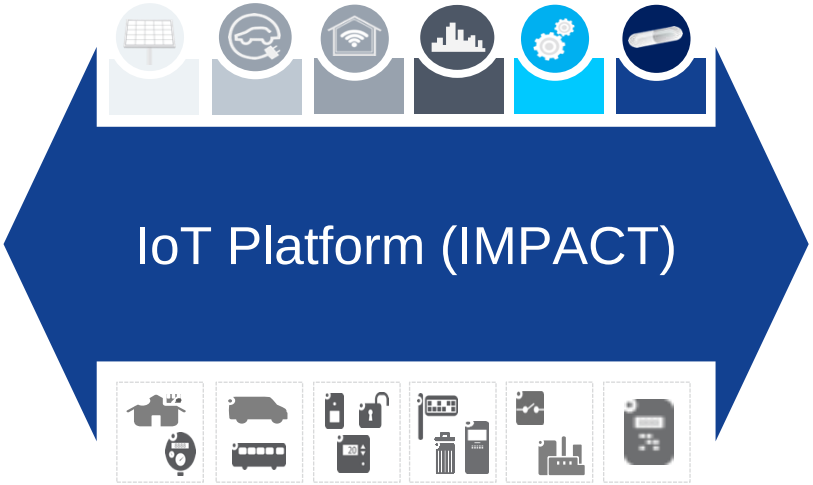
Small data transmission

Transmission of small data from/to IoT devices

Monitoring

Reporting connectivity status of IoT devices to IoT applications

A horizontal platform approach to enable mass adoption



Vertical Point Solutions are expensive
- High Cost for integration
- Duplication of effort
- Underutilized resources
- No Economies of Scale

Horizontal approach drives down cost
- Adopt Best Practices
- Streamline Operations & Reduce Costs
- Mix and Match devices and Applications

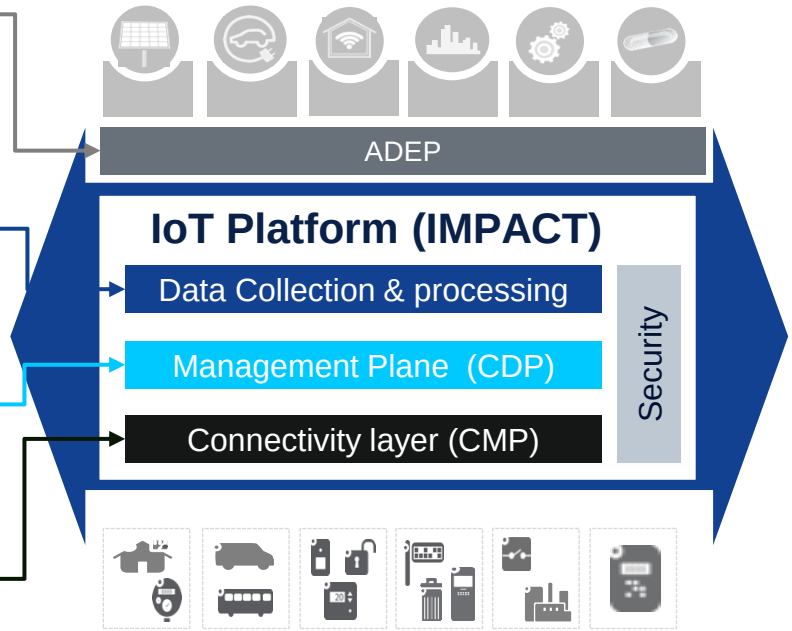
Nokia’s IMPACT platform connects operator & enterprise networks

Host Application Providers
on an Application Development & Execution Platform with corresponding analytics (cloud and distributed via Mobile Edge Computing)

Monetize Applications
data & event collection, storage, analytics, location, applications, management

Manage Devices
device discovery, OTA upgrades, Configuration

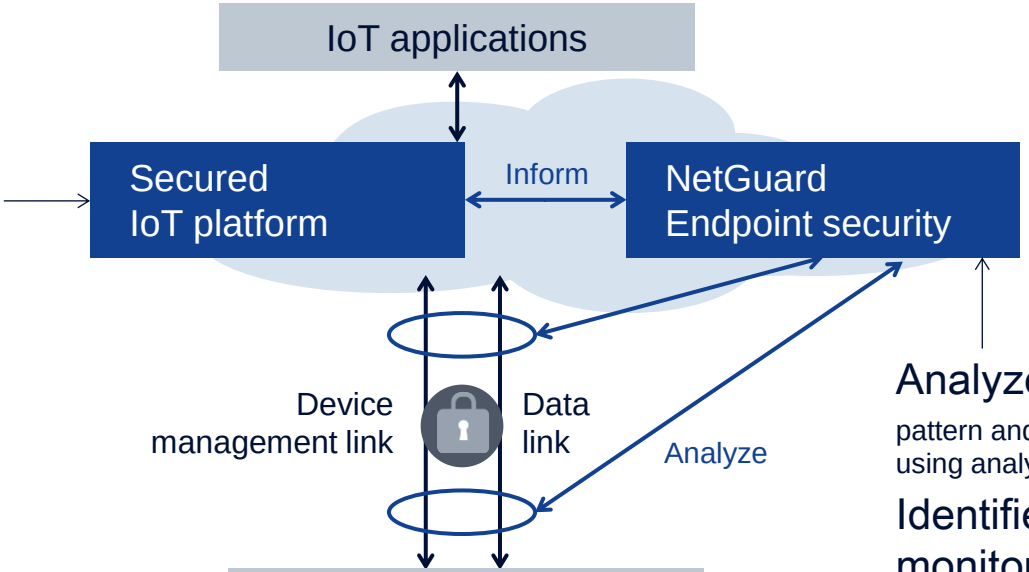
Manage Services
SIM subscription, provisioning, rate plans, charging ,eSIM, enterprise mgmt



Security for the IoT – keeping the endpoint secure

Manage endpoints to establish trust

Using industry best practices (2-way authentication; signed software delivery from trusted source to ensure authenticity; certificates; keys; encryption)



Analyze traffic

pattern and detect anomalies using analytics

Identifies and monitors

access to IoT elements

Endpoint profiling

Alert and mitigate any deviation

Connected devices

Services: The driving force behind IoT transformation

Customize applications

Optimize connectivity

IoT core as a service

Operate for high performance and extreme reliability

Secure by design

Analyze for insights

Driving IoT transformation

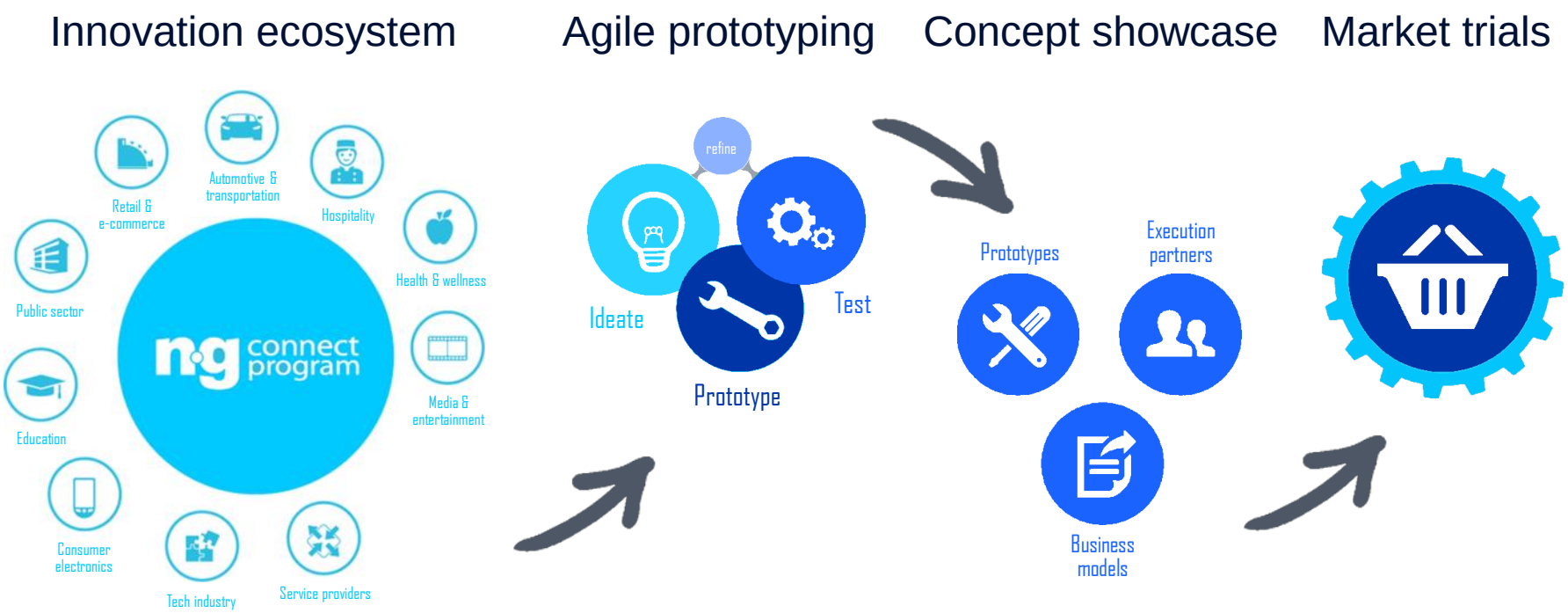
Business and technical consulting

Prime integration for end-to-end value creation

Network optimization expertise

Multivendor approach

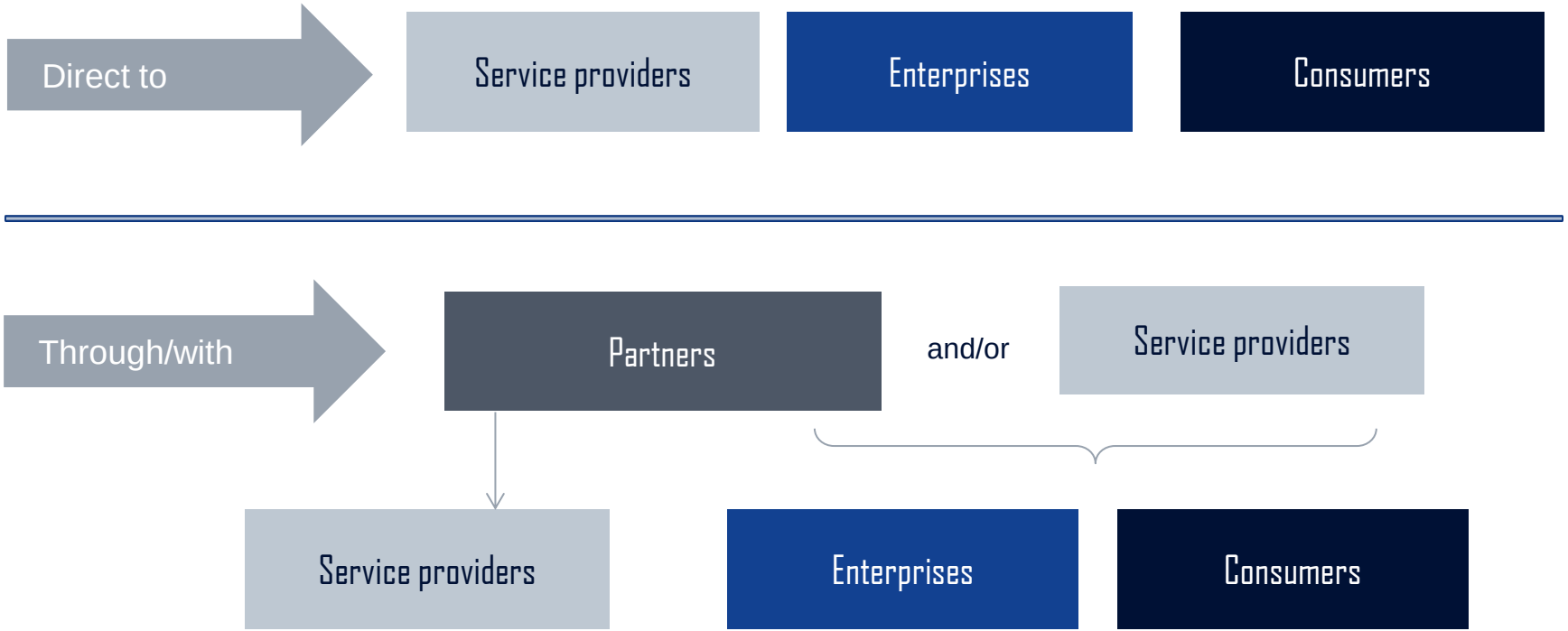
Unleashing the potential of the IoT through technical and market validation with a partner ecosystem



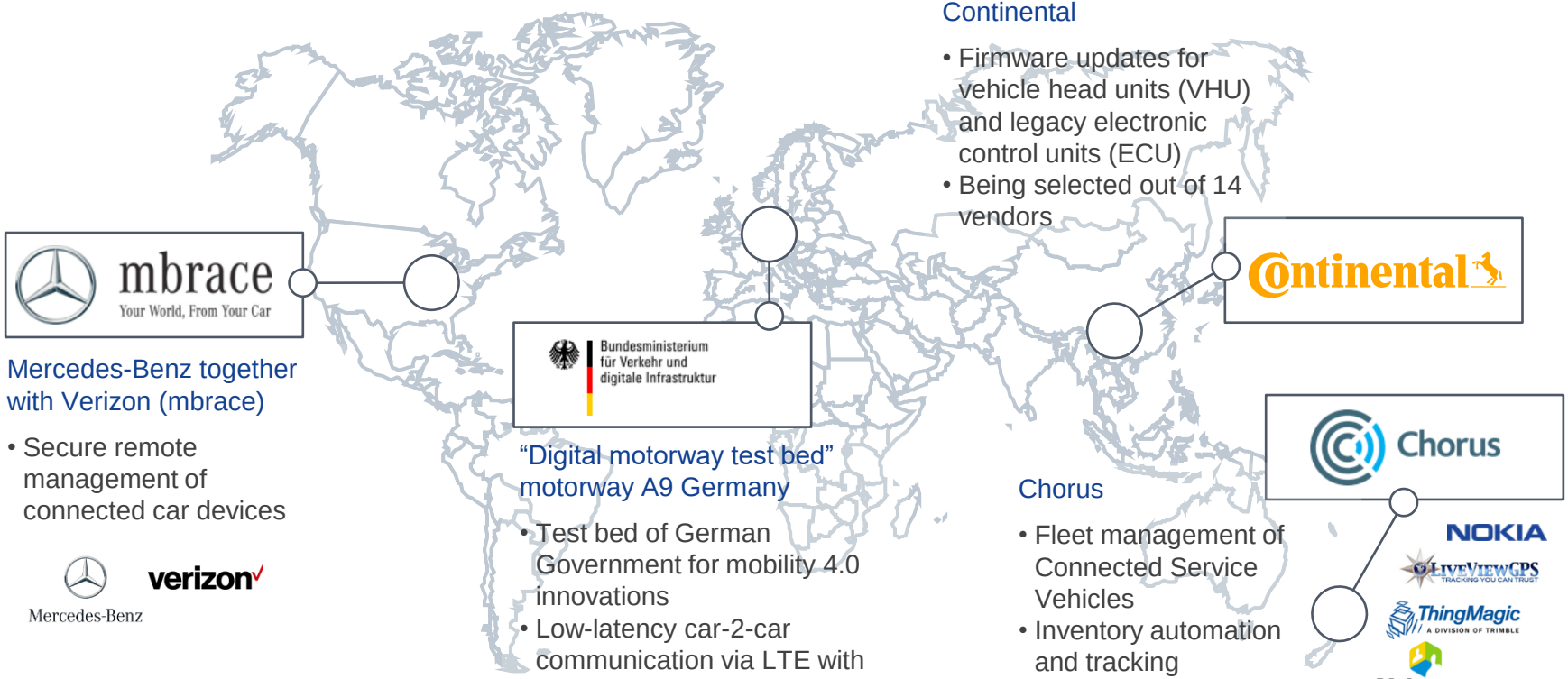
Our IoT Community spans a wide range of industries and markets, and includes innovators in all domains*

* 250+ ng Connect members; 60+ IoT Community since launch at MWC16

We’re approaching the market with a diversification strategy



Some of our IoT references



Mercedes-Benz together with Verizon (mbrace)

- Secure remote management of connected car devices

mbrace Your World, From Your Car

Mercedes-Benz verizon

"Digital motorway test bed" motorway A9 Germany

- Test bed of German Government for mobility 4.0 innovations
- Low-latency car-2-car communication via LTE with mobile edge computing

Bundesministerium für Verkehr und digitale Infrastruktur

NOKIA T-Systems Fraunhofer Continental

Continental

- Firmware updates for vehicle head units (VHU) and legacy electronic control units (ECU)
- Being selected out of 14 vendors

Continental

Chorus

- Fleet management of Connected Service Vehicles
- Inventory automation and tracking

Chorus

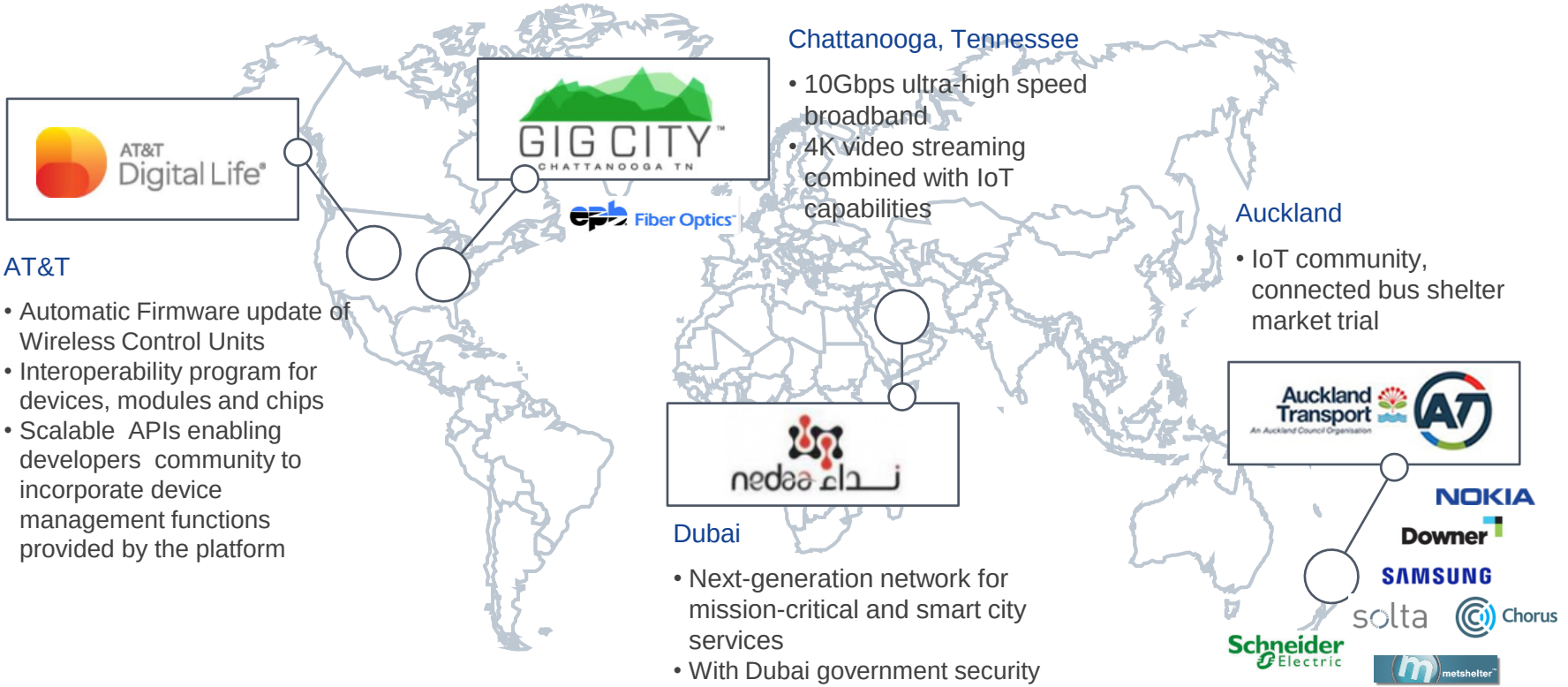
NOKIA

LiveViewGPS Tracking You Can Trust

ThingMagic A Division of Trimble

Vidyo

Some of our IoT references (cont'd)



AT&T

- Automatic Firmware update of Wireless Control Units
- Interoperability program for devices, modules and chips
- Scalable APIs enabling developers community to incorporate device management functions provided by the platform

Chattanooga, Tennessee

- 10Gbps ultra-high speed broadband
- 4K video streaming combined with IoT capabilities

Dubai

- Next-generation network for mission-critical and smart city services
- With Dubai government security networks operator Nedaa

Auckland

- IoT community, connected bus shelter market trial

Summary: Nokia key differentiators in IoT

Connectivity

we support all major access technologies (licensed, unlicensed, fixed), and have optimized the packet core for IoT services

Platform

our IMPACT platform offers a horizontal, secure application-independent platform to quickly bring services to market

Security

a comprehensive end-to-end approach to security, and a broad expertise in designing and deploying mission critical networks

Services

our expertise to design, integrate and customize IoT solutions to meet the needs of different verticals

Market leadership

in LTE infrastructure with >30% market share, and device management with 1.5B managed devices worldwide

Go to market

we drive the human and business value for SPs and verticals, with focus on automotive, utilities, public safety, smart cities, home and healthcare

Use cases

are instrumental for understanding business models, value chains, go to market, partnerships, data sharing, etc.

Ecosystem

our IoT Community brings innovative companies together to collaborate on solutions and market trials