New Testing Paradigm for 5G – IoT Ecosystem

ITU-T QSDG Workshop

Brazil, 27th-29th November
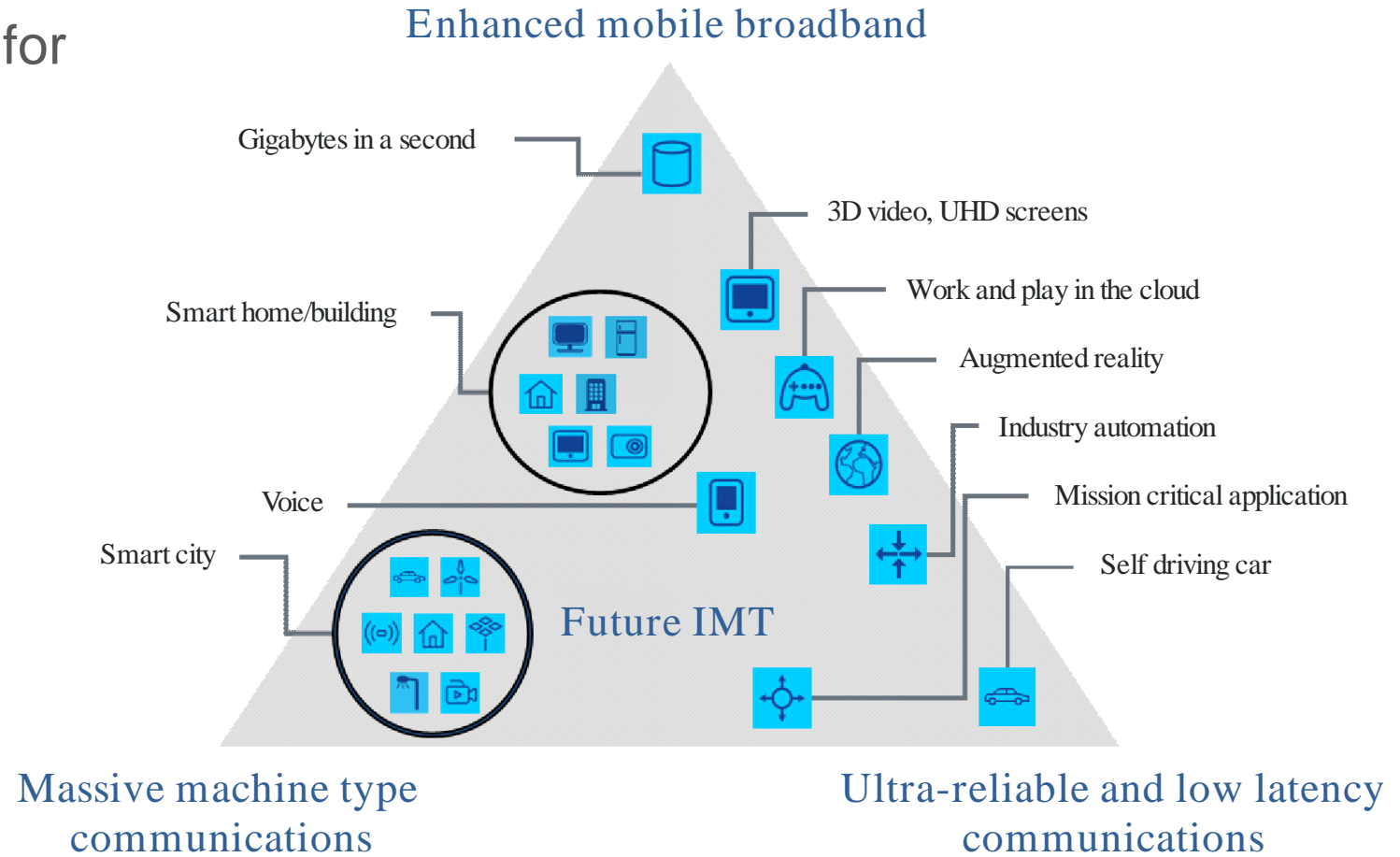
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Agenda

- 5G – IoT ecosystem at a glance

- Requirements and strategy for 5G quality testing

- A testing approach for IoT QoS/QoE
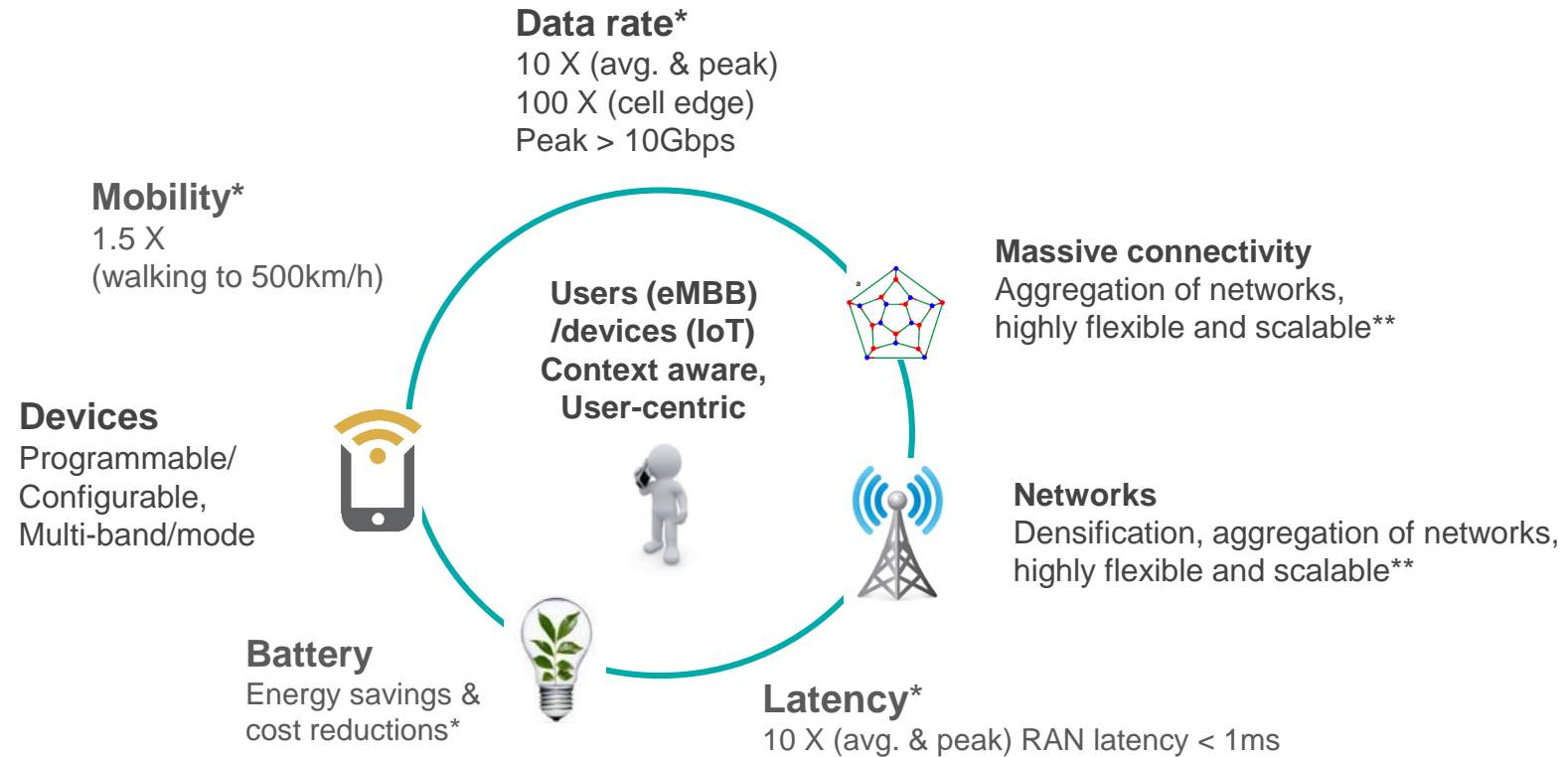
- Take aways

5G – IoT Ecosystem at a Glance

5G - IoT ecosystem at a glance: Use Cases

Usage scenarios of IMT for 2020 and beyond

Enhanced mobile broadband

Gigabytes in a second

3D video, UHD screens

Work and play in the cloud

Smart home/building

Augmented reality

Industry automation

Voice

Mission critical application

Smart city

Self driving car

Future IMT

Massive machine type communications

Ultra-reliable and low latency communications

M.2083-02

5G - IoT ecosystem at a glance: Requirements

Data rate*
10 X (avg. & peak)
100 X (cell edge)
Peak > 10Gbps

Mobility*
1.5 X
(walking to 500km/h)

Massive connectivity
Aggregation of networks,
highly flexible and scalable**

Users (eMBB) /devices (IoT) Context aware, User-centric

Devices
Programmable/
Configurable,
Multi-band/mode

Networks
Densification, aggregation of networks,
highly flexible and scalable**

Battery
Energy savings &
cost reductions*

Latency*
10 X (avg. & peak) RAN latency < 1ms

*Vs. 3GPP Rel.12; ** no single solution to satisfy all these extreme requirements at the same time

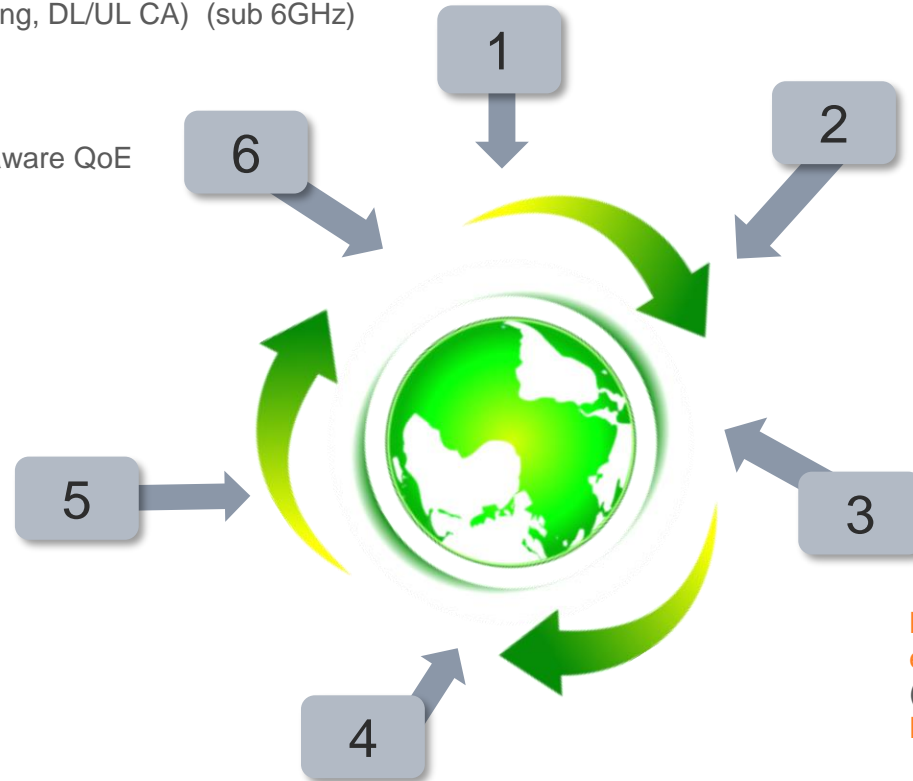# 5G - IoT ecosystem relies on its legacy to 4G

5G New RAN (NR) above 6HGz and mmW
(new air interface including some LTE-Pro concepts e.g. Cell Range Expansion, control /user plane split, Coordinated Multipoint CoMP, reduced L2 signaling)

5G capabilities (latency and throughput) with LTE-Pro RAN technology features (e.g. massive MIMO, beamforming, higher order coding, DL/UL CA) (sub 6GHz)

1

5G – IoT context aware QoE

6

2

5G New Core (NC) – Rel 2018+

5G Standalone (NR, NC)

5G Non Standalone
(5G NR, LTE core) with multiconnectivity

5G capabilities (latency and throughput) with Licensed and Unlicensed spectrum
(LTE-U/eLAA; LTE-WiFi interoperability, dual connectivity)

Legacy and 5G Network Slicing
per 5G type of use case and/or vertical:
eMBB, Massive connectivity IoT
(legacy: LoRa NB-IoT, LTE-M based,
EC-GSM), Mission critical IoT
(legacy: connected cars, V2X communications)

5

3

Legacy and 5G Virtualization; SDN/NFV requiring Mobile edge computing and distributed cloudification
(used in networks as well as testing tools)
D2D communications

4

Legacy and 5G
Big Data Analytics; Automation, Machine Learning and Artificial Intelligence
(used in networks as well as testing tools)

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Requirements and Strategy for 5G Quality Testing

Requirements and strategy for 5G quality testing
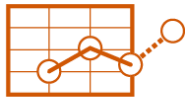
Quality test uses case to cope with

Test conditions and use cases | **Architecture changes** | **QoE context awareness concept**

Enhanced Mobile Broadband

Area Traffic Capacity

Over the Air Latency

Connection Density

High Mobility

Current Architecture
- Cell Centric

Future Architecture
- Device Centric
- Smarter Devices

5G Context Aware QoE
- User
- Device
- Application
- Network

User Context
User's perception and preferences (quality, location, activity)

Device context
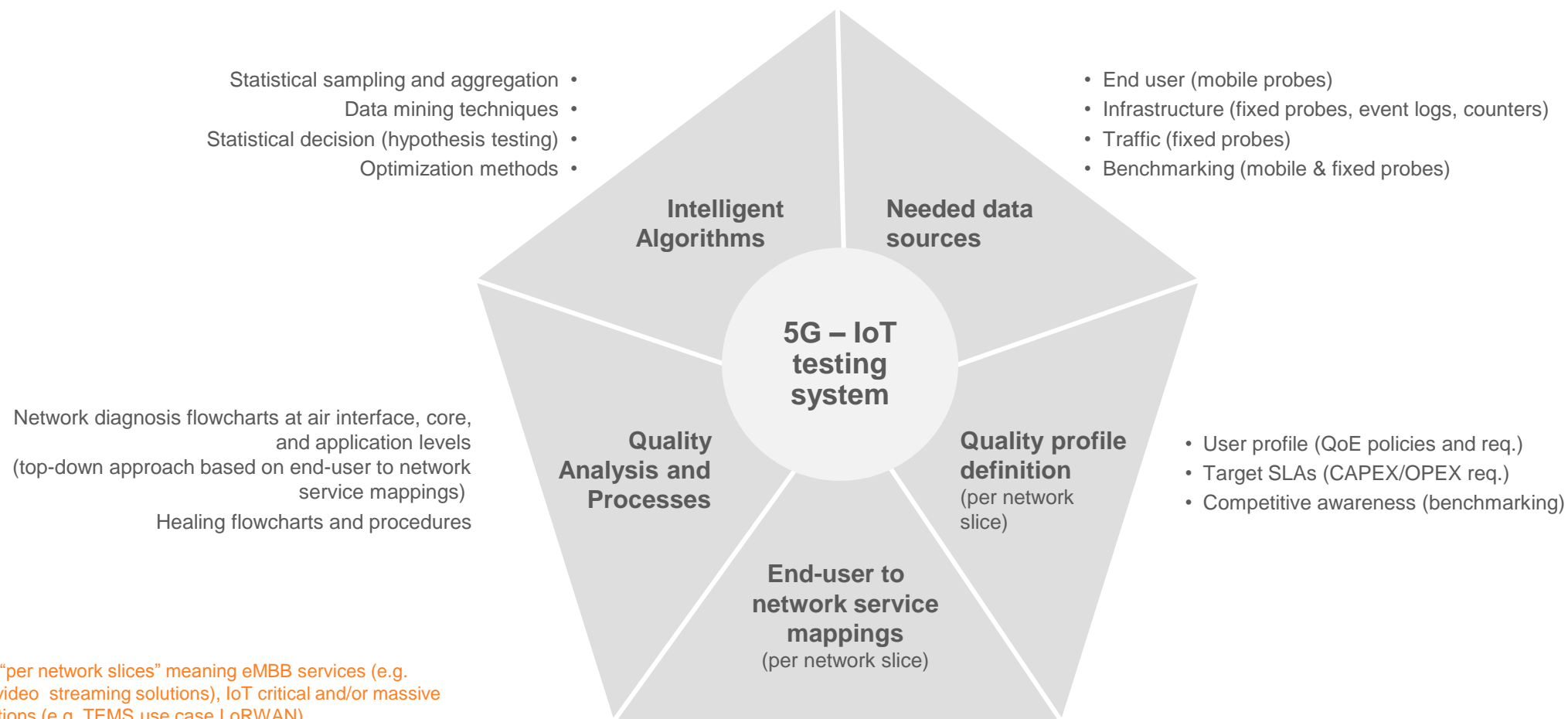CPU load, battery state, device characteristics

Application context
QoE metrics, video specific parameters (on demand vs. real time), bit rate, resolution

Network context
Load/congestion, air link/backhaul quality, timely available BWD, alternative network/spectrum availability

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Orchestrating network performance

5G-IoT quality defined by service centric / network sliced quality testing – required pieces

Statistical sampling and aggregation •
Data mining techniques •
Statistical decision (hypothesis testing) •
Optimization methods •

• End user (mobile probes)
• Infrastructure (fixed probes, event logs, counters)
• Traffic (fixed probes)
• Benchmarking (mobile & fixed probes)

Intelligent Algorithms

Needed data sources

5G – IoT testing system

Network diagnosis flowcharts at air interface, core, and application levels
(top-down approach based on end-user to network service mappings)
Healing flowcharts and procedures

Quality Analysis and Processes

Quality profile definition
(per network slice)

• User profile (QoE policies and req.)
• Target SLAs (CAPEX/OPEX req.)
• Competitive awareness (benchmarking)

End-user to network service mappings
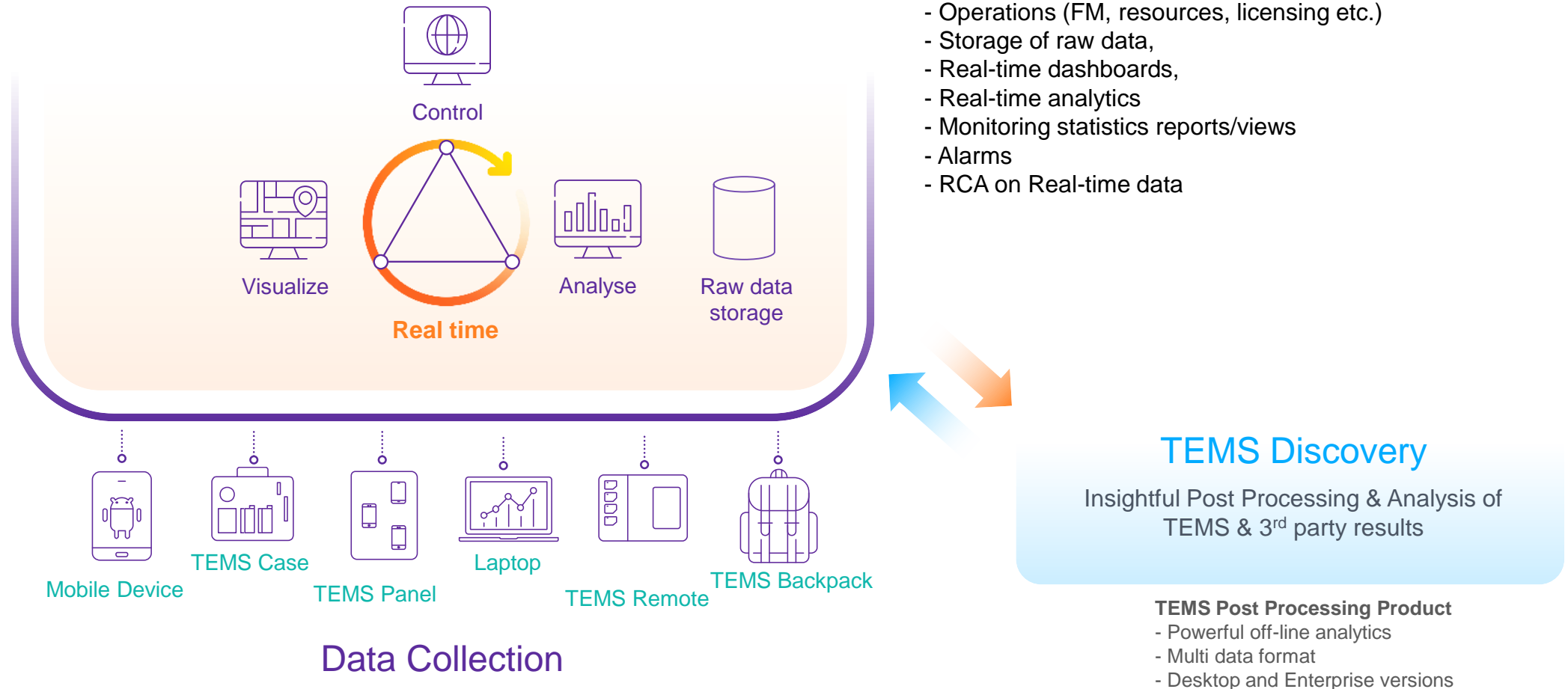(per network slice)

NOTE: "per network slices" meaning eMBB services (e.g. TEMS video streaming solutions), IoT critical and/or massive applications (e.g. TEMS use case LoRWAN)

• KPI to QoS (network), to respective QoE (end-user), per service
• KPI, QoS, and QoE profiles per time and space scale

TEMS 5G testing approach – performance orchestration platform

Aligned with draft recommendation E.FINAD "Framework for Intelligent Network Analytics and Diagnostics", TD 307 (TEMS contributors)

- Operations (FM, resources, licensing etc.)
- Storage of raw data,
- Real-time dashboards,
- Real-time analytics
- Monitoring statistics reports/views
- Alarms
- RCA on Real-time data

Control

Visualize

Real time

Analyse

Raw data storage

Mobile Device   **TEMS Case**   **TEMS Panel**   **Laptop**   **TEMS Remote**   **TEMS Backpack**

Data Collection

TEMS Discovery

Insightful Post Processing & Analysis of TEMS & 3rd party results

TEMS Post Processing Product
- Powerful off-line analytics
- Multi data format
- Desktop and Enterprise versions

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A View on IoT QoS/QoE

Connected devices forecast

Ericsson Mobility Report
June 2016

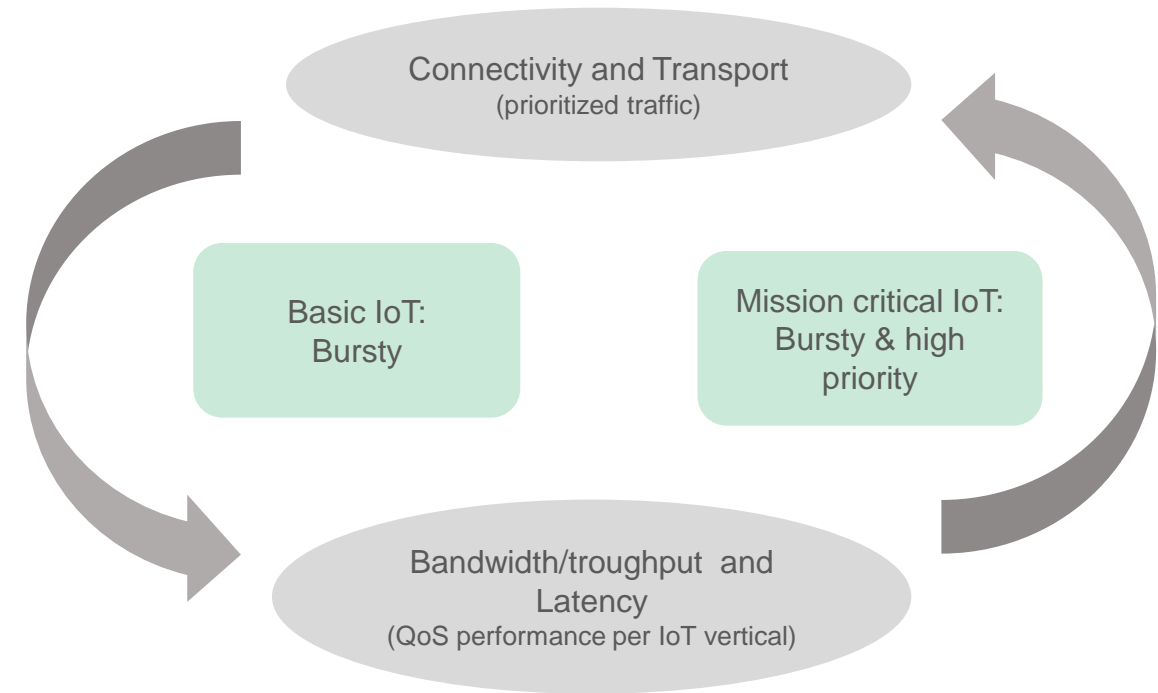|	2015	2021	CAGR 2015-2021
Cellular IoT	0.4	1.5	27%
Non-cellular IoT	4.2	14.2	22%
PC/Laptop/Tablet	1.7	1.8	1%
Mobile Phones	7.1	8.6	3%
Fixed Phones	1.3	1.4	0%
	15 billion	**28 billion**	

IoT at a glance

A range of technologies for a range of applications within mission critical and massive communications context

Use Cases	Surveillance	Connected cars, connected homes	Smart meters, agriculture, transportation, environment, helth care, industry
Requirements & Contraints	THROUGHPUT	LATENCY	COST	BATTERY
Technology	Lte Cat-1	Lte Cat-M	LoRa	Lte NB-IoT	sigfox

An IoT quality testing strategy

- **STEP 1**. IoT verticals: trace based coverage, connectivity and availability monitoring and user directed troubleshooting

- **STEP 2**. IoT verticals (SLAs and QoE centric) use case solutions for automated root cause analysis

  - Performance (throughput, latency within QoS aware scheduler's context), availability and consistency

  - RAN resources and performance stress (cellular IoT)

Connectivity and Transport
(prioritized traffic)

Basic IoT:
Bursty

Mission critical IoT:
Bursty & high
priority

Bandwidth/troughput and
Latency
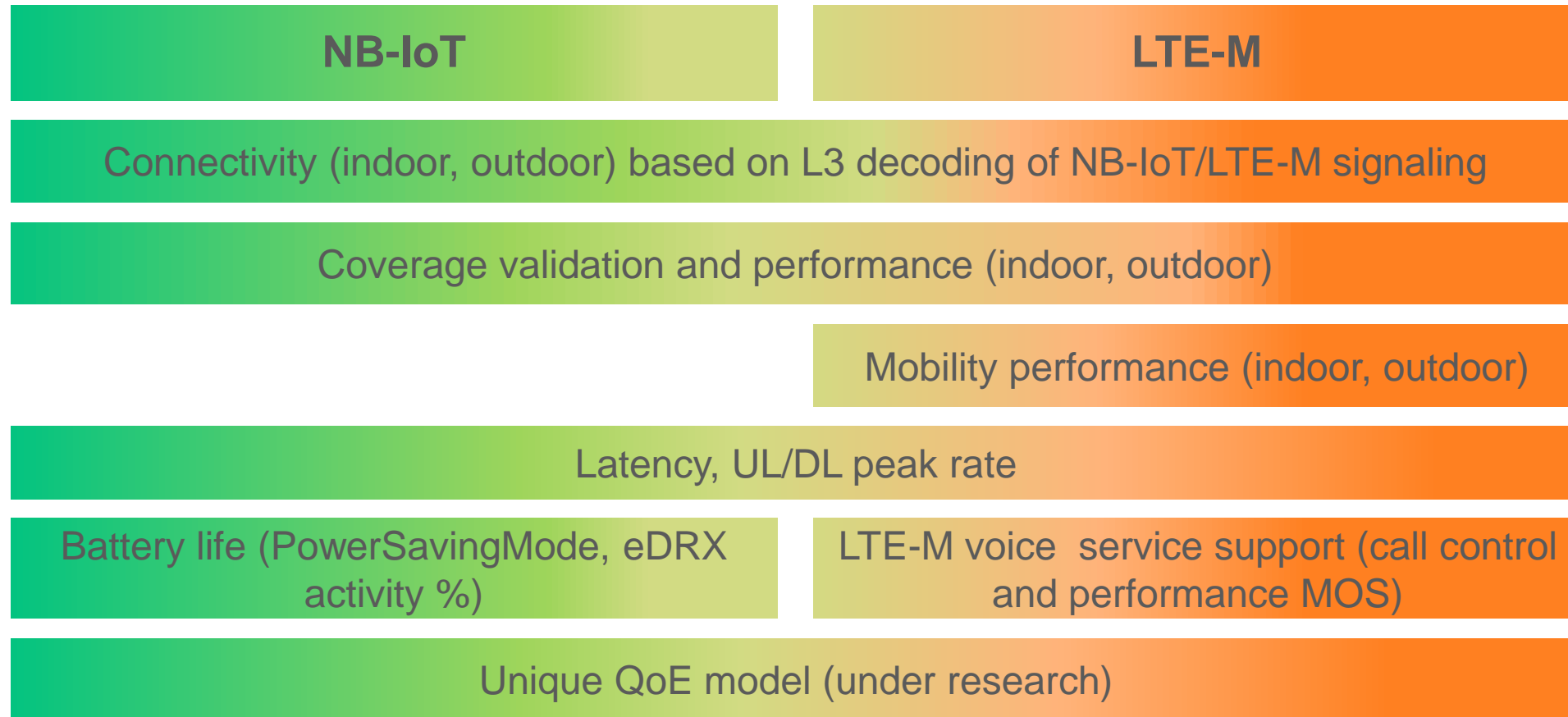(QoS performance per IoT vertical)

IoT testing questions and InfoVista/TEMS preliminary answers

- Is the (NB/LTE-M)-IoT cell configured as planned?

- Does the network perform as expected?

  - What is the coverage?

    - Enough to receive NPSS and NSSS and use received signal power and quality…

    - …or to test a traffic transfer and measure BLER…

    - …or is something else required?

  - Are all procedures executed as expected?

    - Perform tests (containing the different procedures) and verify signaling

  - Performance in regards to throughput and latency?

    - Run the services and verify the results

- Is legacy LTE performance affected ?

IoT QoS/QoE testing

NB-IoT	LTE-M
Connectivity (indoor, outdoor) based on L3 decoding of NB-IoT/LTE-M signaling	
Coverage validation and performance (indoor, outdoor)	
	Mobility performance (indoor, outdoor)
Latency, UL/DL peak rate	
Battery life (PowerSavingMode, eDRX activity %)	LTE-M voice service support (call control and performance MOS)
Unique QoE model (under research)	

Take Away

Take away

1 5G – IoT ecosystem's use cases variety, technologies complexity and interdependencies require testing paradigms which regard not only the technology (r)evolution but also radical shift in testing procedures and methodologies

2 Automation, analytics, user/device centric and context aware become crucial for the 5G –IoT ecosystem quality

3 TEMS proves once again thoughtful leadership with foreseen 5G preliminary test use cases and novel modeling of QoE IoT testing

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Thank you!

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