COSMOTE
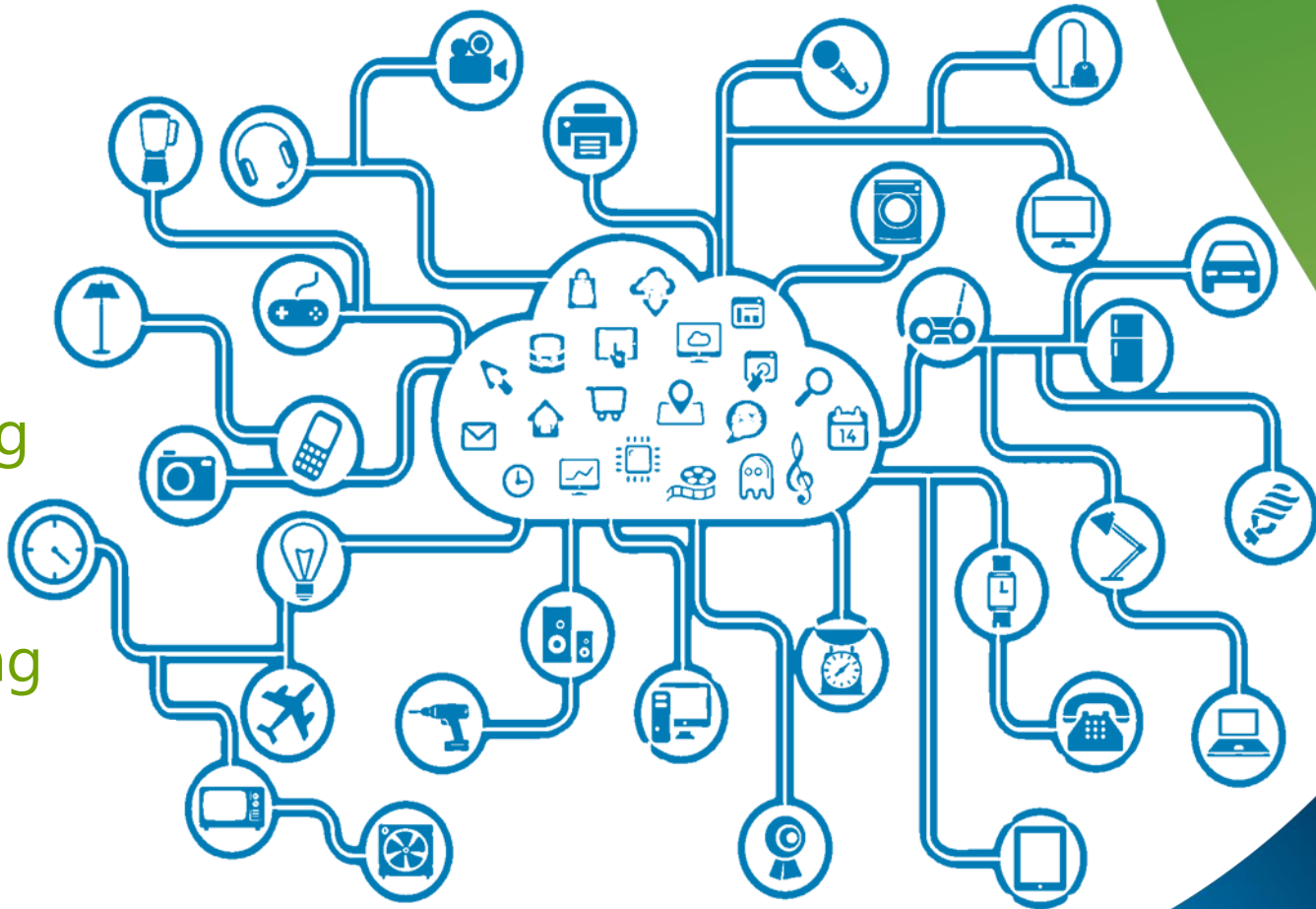our world is you

5G & IoT

Accelerating Digital & Transforming Life

Kyros Rizoulis,
OTE Group, Senior Manager, Corporate Networks DevOps, Fixed & Mobile

OTE
GROUP OF COMPANIES

5G & IoT - Accelerating Digital & Transforming Life

Agenda

OTE Group: Indisputable Leader in Greek Market

COSMOTE Network Mobile Broadband Facts

Global Mobile Broadband Facts

5G Evolution

5G Basic Requirements

5G Air Interface

5G Layers

Cellular IoT market outlook

IoT re-shaping effect on society
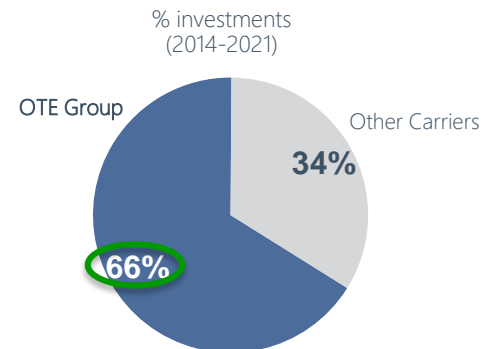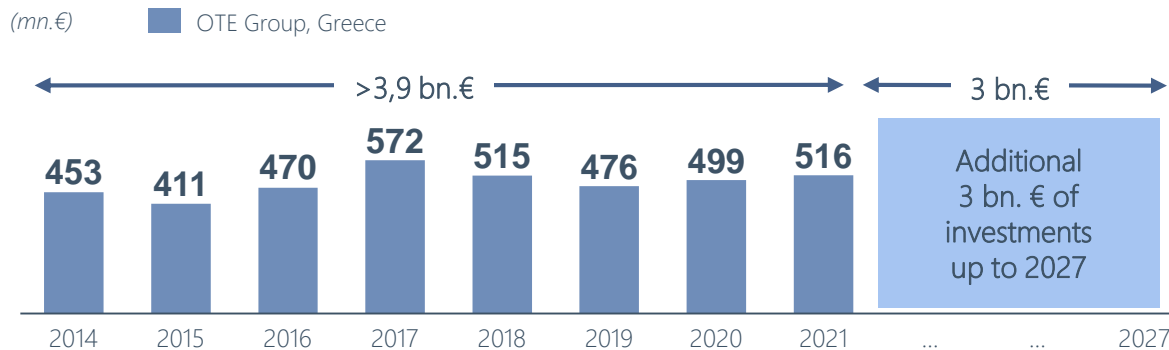
Cellular IoT technologies

IoT hot apps

Conclusions

OTE Group: Indisputable Leader in Greek Market – By far the largest Investor

> 60% of total sector investments in years 2014 - 2022

No 1	No 1	No 1	No 1	No 1	
Fixed	**| Broadband**	**|Mobile**	**|TV**	**| ICT Solutions**	**|Digital Services**

Financial Results 2021	REVENUES	EBITDA (adj. AL)	CAPEX (adj. AL, before spectrum cost)	oFCF (adj. AL)
	3.078 εκ.€	1.265 εκ.€	€516 εκ.€	821 εκ.€

The largest investor in telecoms

>60% of sector investments

(mn.€) ■ OTE Group, Greece

>3,9 bn.€   3 bn.€

2014	2015	2016	2017	2018	2019	2020	2021	...	...	2027
453	411	470	572	515	476	499	516			

Additional 3 bn. € of investments up to 2027

% investments (2014-2021)

OTE Group — 66%

Other Carriers — 34%

A considerable part of the revenues is re-invested in new technologies

COSMOTE 5G 2021 to 2022

97% ATHENS AREA → 100%

90% THESSALONIKI AREA → 100%

60% OF POPULATION BY END OF 2021 → 80%
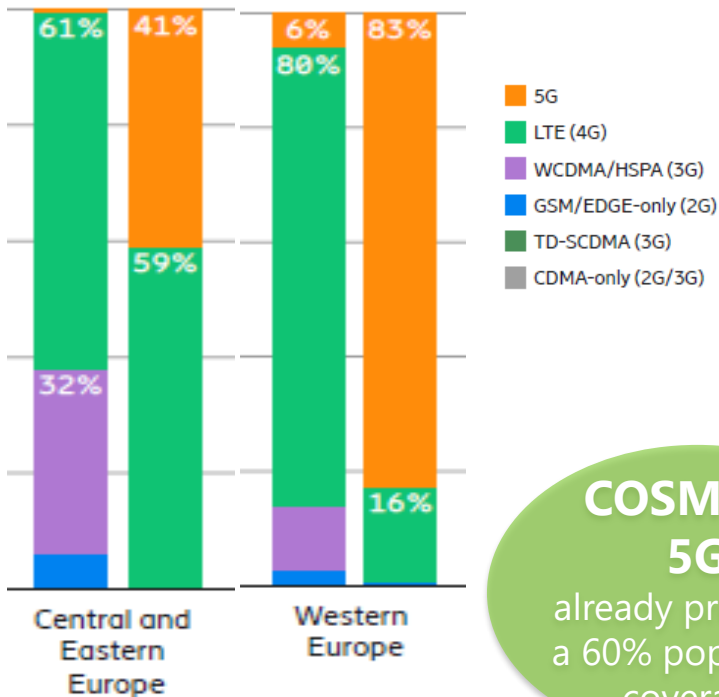
7th

NT in Europe from DL throughput point of view

>1Gbps

SPEEDS IN SPECIFIC AREAS

COSMOTE Network Mobile Broadband Facts

Ready for 2027 MBB Challenge

5G (orange)
LTE (4G) (green)
WCDMA/HSPA (3G) (purple)
GSM/EDGE-only (2G) (blue)
TD-SCDMA (3G) (dark green)
CDMA-only (2G/3G) (grey)

Central and Eastern Europe: 61% / 32% / 41% / 59%
Western Europe: 6% / 80% / 83% / 16%

source: ERICSSON mobility report - November 2021

best in test

For adding something on top in Greece and reaching an overall score of 905 dots in mobile network benchmarking survey we proudly award this certificate to

Cosmote Greece

Score 905 out of 1000 in Total
Score 299 out of 320 in Voice Services
Score 429 out of 480 in Data Services
Score 177 out of 200 in Crowdsourced Quality

Hakan Ekmen
Chief Executive Officer Telecommunication

Bëst 04 IN 21 Test.

umlaut

OOKLA
GREECE'S FASTEST MOBILE NETWORK
2020

Greece's Fastest Mobile Network

Cosmote

IS HEREBY NAMED THE 2020 AWARD WINNER FOR FASTEST CARRIER BY OOKLA IN RECOGNITION OF PROVIDING THE FASTEST SPEEDS FOR THE Q3-Q4 AWARD PERIOD.

Given on
January 1st, 2021

AWARDED BY

Doug Suttles
CEO

COSMOTE 5G
already providing a 60% population coverage

Umlaut Best in Test for 7 consecutive years

OOKLA Best MBB Network for 5 consecutive years

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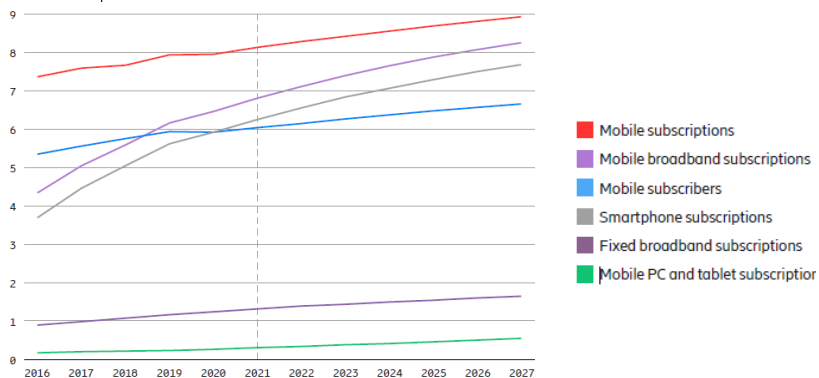
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Global Mobile Broadband Facts

Subscribers and Technology Outlook

By **2027** there will be globally:

- **8.9 billion** mobile subscriptions,
- **8.2 billion** MBB subscriptions
- **7.7 billion** smartphone subscriptions

Fast-growing 5G adoption

5G share @ 50% in subscriptions footprint after 5 years

Subscriptions/ lines, subscribers (bl)

Mobile subscriptions by technology (billion)

Legend (left chart):
- Mobile subscriptions
- Mobile broadband subscriptions
- Mobile subscribers
- Smartphone subscriptions
- Fixed broadband subscriptions
- Mobile PC and tablet subscription

5G subscriptions are forecast to reach 4.4 billion in 2027.

4.4bn

Legend (right chart):
- 5G
- LTE (4G)
- WCDMA/HSPA (3G)
- GSM/EDGE-only (2G)
- TD-SCDMA (3G)
- CDMA-only (2G/3G)

source: ERICSSON mobility report - November 2021

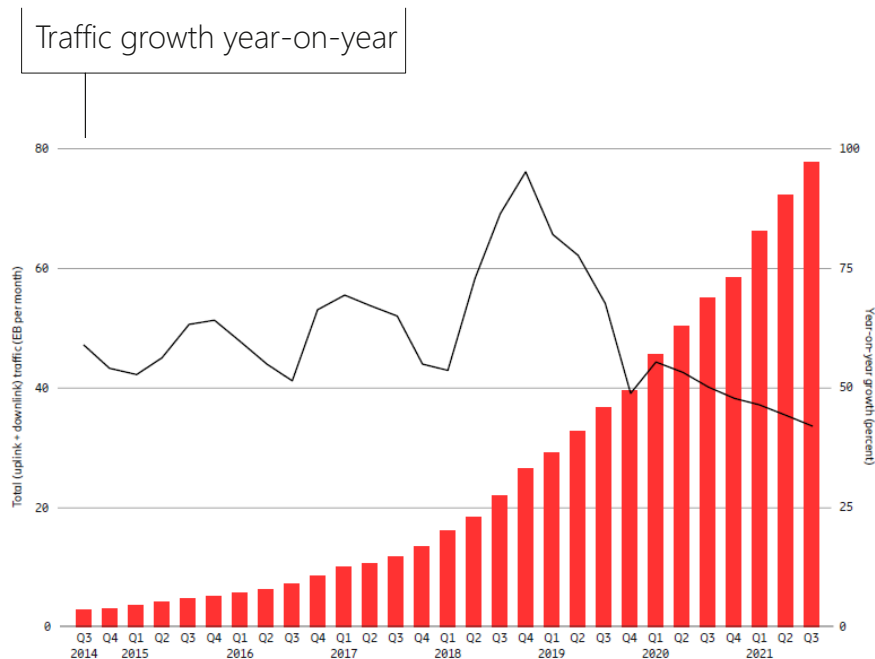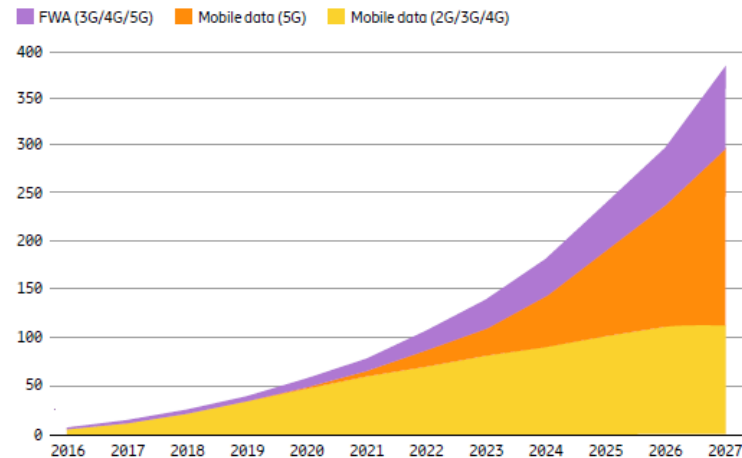5G & IoT - Accelerating Digital & Transforming Life

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Global Mobile Broadband Facts

Mobile Traffic Outlook & Data Rates Evolution

42% YoY mobile data traffic growth from Q3'20 to Q3'21

Traffic growth year-on-year

source: ERICSSON mobility report - November 2021

FWA (3G/4G/5G) — Mobile data (5G) — Mobile data (2G/3G/4G)

11.4 GB per device: av. monthly global data usage today

62% of mobile data coming from 5G in 2027

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5G Evolution
or revolution?

5G — Business Enabler

4G — High performance mobile broadband

3G — Multimedia and basic mobile broadband

2G — Digital communication and mobility
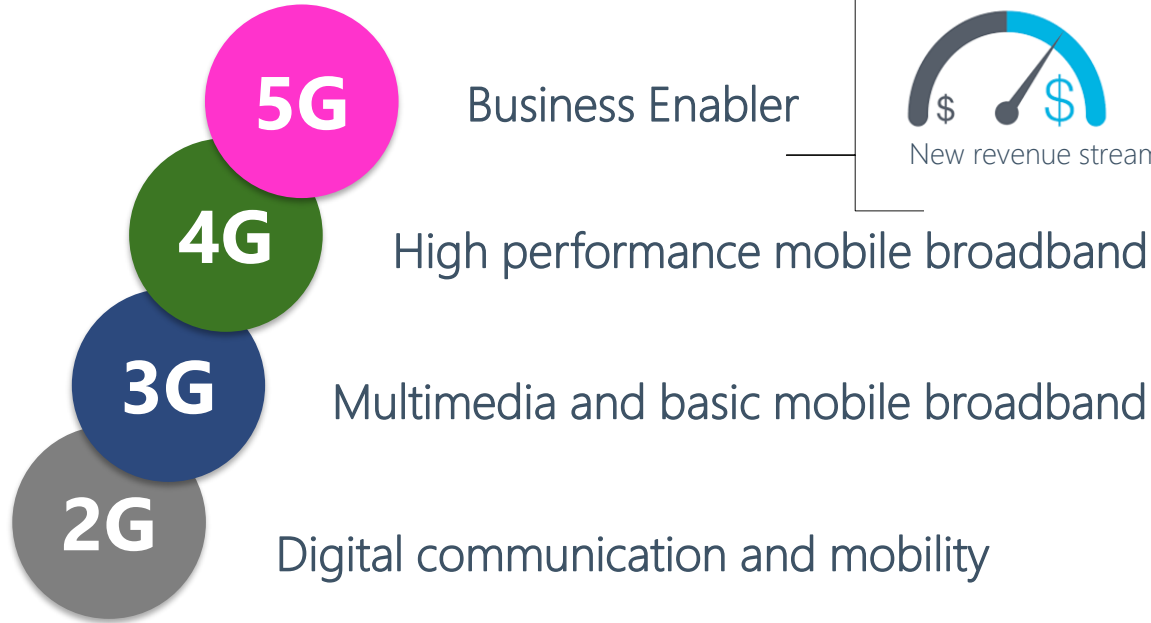
Virtual networks & Gigabit networked society

New business models

New revenue streams

Capacity & Reliability

Security

Energy efficiency

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5G Basic Requirements
evolving by revolving

(new) requirements:

- 1-10Gbps connections to end points
- 1 millisecond end-to-end round trip delay
- 1000x bandwidth per unit area
- 10-100x number of connected devices
- ~99.99% availability
- ~100% coverage
- 90% reduction in network energy usage
- ~10 years battery life for low power M2M devices

5G

The hyper-connected vision:

5G, mobile operators would create a blend of pre-existing technologies covering 2G, 3G, 4G, Wi-fi to allow higher coverage and availability, with greater connectivity enabling Machine-to-Machine (M2M) services and the Internet of Things (IoT). This vision include a new radio technology to enable low power, low throughput field devices with long duty cycles of ten years or more.
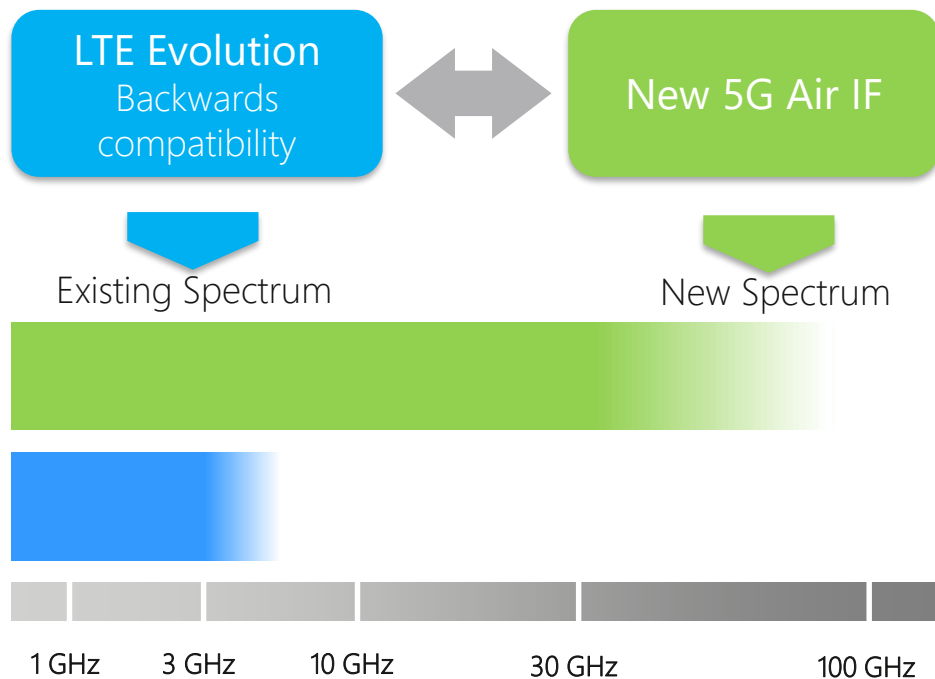
Next Generation Technology vision:

This is more of the traditional 'generation-defining' view, with specific targets for data rates and latency being identified, such that new radio interfaces can be assessed against such criteria. This in turn makes for a clear demarcation between a technology that meets the criteria for 5G, and another which does not.

source: NGMN

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5G Air Interface
Massive channels, massive MIMO

LTE Evolution
Backwards compatibility

New 5G Air IF

Existing Spectrum   New Spectrum

1 GHz   3 GHz   10 GHz   30 GHz   100 GHz

- Evolution of existing technology adding new RAN technology

- LTE+ and New Air Interface combined allows rapid switching based on radio conditions

- New Air Interface initially applied at new spectrum (up to millimeter waves) with super channels, massive MIMO & beam forming

- Gradual migration of New Air Interface into existing spectrum

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Cellular IoT market outlook

5.5 billion cellular IoT @ 2027

Cellular IoT 2021-2027 CAGR of 19%

Broadband IoT and Critical IoT (4G/5G)   **Massive IoT (NB-IoT/Cat-M)**   **Legacy (2G/3G)**
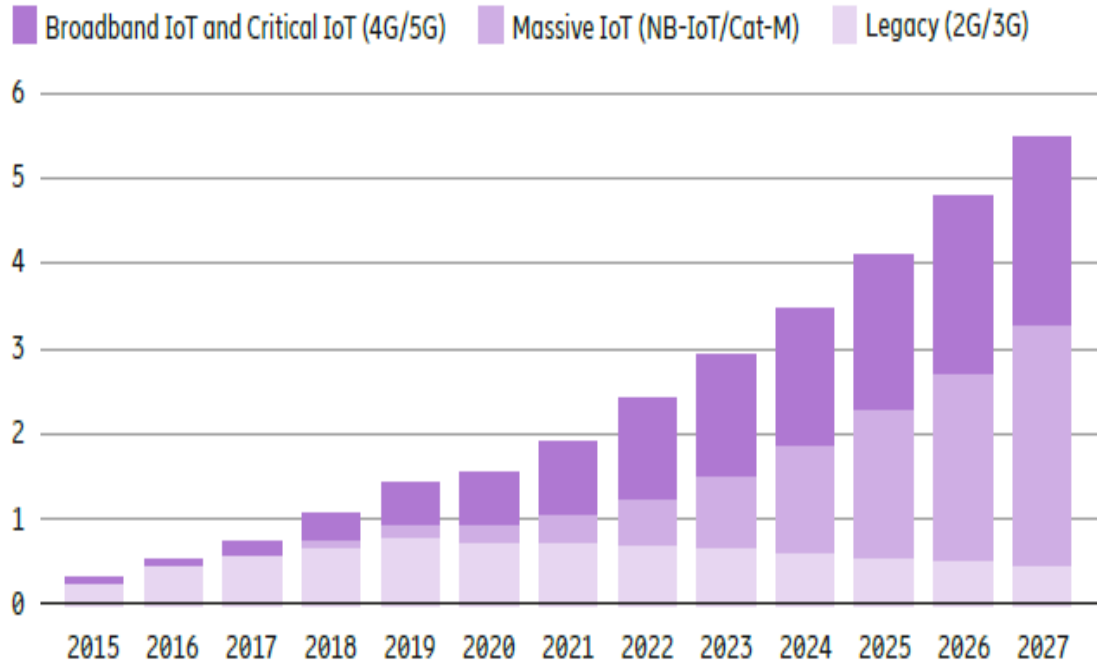
source: ERICSSON mobility report - November 2021

Cosmote within the first twenty networks commercially deployed in 2017

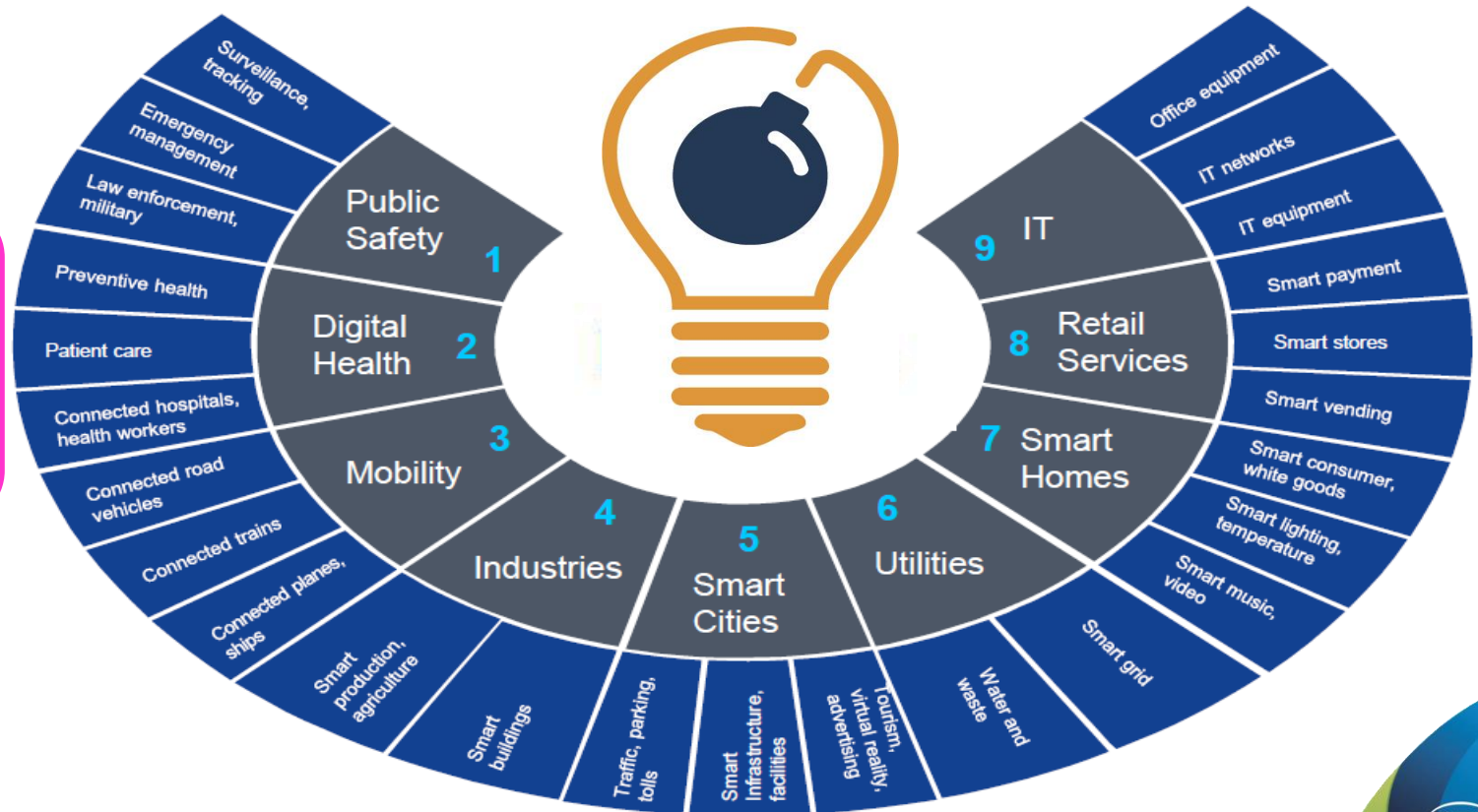**NB-IoT & Cat-M will make up 51% of cellular IoT connections in 2027**

5G & IoT - Accelerating Digital & Transforming Life

IoT re-shaping effect on society

Transformational impact in all industries, value chains & entire business configurations

IoT transforms the way we:
- Work
- Commute
- Interact
- Entertain

1 Public Safety
- Surveillance, tracking
- Emergency management
- Law enforcement, military

2 Digital Health
- Preventive health
- Patient care
- Connected hospitals, health workers

3 Mobility
- Connected road vehicles
- Connected trains
- Connected planes, ships

4 Industries
- Smart production, agriculture
- Smart buildings

5 Smart Cities
- Traffic, parking, tolls
- Smart infrastructure, facilities
- Tourism, virtual reality, advertising

6 Utilities
- Water and waste
- Smart grid

7 Smart Homes
- Smart music, video
- Smart lighting, temperature
- Smart consumer, white goods

8 Retail Services
- Smart vending
- Smart stores
- Smart payment

9 IT
- IT equipment
- IT networks
- Office equipment

source: Nokia

Cellular IoT Technologies

LTE is already sufficient - 5G advantage is on critical side

NB-IoT
- **Very** low complex & cost UE
- **Very** high device volumes
- **Very** small data packages
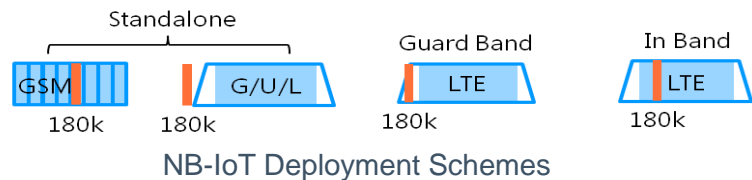- **Very tough static radio conditions**

- Extreme Battery Efficiency
- High Coverage
- Long Cell Range (120km NB-IoT 100km Cat-M)
- IoT Positioning

CAT-M
- **Low** complex & cost UE
- **High** device volumes
- **Low** size data packages
- **Mobility**
- **Voice Support**

NB-IoT Deployment Schemes

Standalone — GSM 180k | G/U/L 180k
Guard Band — LTE 180k
In Band — LTE 180k

Mass market IoT already took off over LTE with R13 SW/HW ✓

Critical IoT coming over 5G NR

	NB-IoT	CAT-M1	LTE
Uplink Peak Throughput/ UE	~105 kbps [1]	~1,119 Mbps [2]	Inherited from LTE (UE category dependent)
Downlink Peak Throuhput/ UE	~80 kbps [1]	~533 kbps [2]	Inherited from LTE (UE category dependent)
Bearer	FDD (1 Anchor PRB)	FDD (Single Narrowband)	FDD & TDD
Cell Range	Up to 120 km	Up to 100 km	Up to 100 km
Coverage extensions	CE Level 0,1,2	Coverage Enhancement Mode A	
Battery Life	Up to 10 Years	Up to 10 years	Use case dependent
Energy Efficiency	Power Saving Mode, extended DRX	Power Saving Mode, extended DRX	Power Saving Mode, extended DRX
Mobility	Idle Mode Mobility	Connected & Idle Mode mobility	Connected & Idle Mode mobility
Voice	Not supported	VoLTE	VoLTE
Positioning	CID	OTDOA (3GPP R9), ECID	ECID, OTDOA, A-GPS
Baseband Unit support	Baseband 52/66 – Full	Baseband 52/66 – Full	Baseband 52/66 – Full
Capacity (#cells, #users etc.)	See latest "Ericsson RAN Compute Capacity Roadmap"		

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IoT hot apps

smart city - smart environment – smart industry – smart agriculture – smart business

Air Pollution
Control of CO_2 emissions of factories, pollution emitted by cars and toxic gases generated in farms.

Forest Fire Detection
Monitoring of combustion gases and preemptive fire conditions to define alert zones.

Wine Quality Enhancing
Monitoring soil moisture and trunk diameter in vineyards to control the amount of sugar in grapes and grapevine health.

Offspring Care
Control of growing conditions of the offspring in animal farms to ensure its survival and health.

Sportsmen Care
Vital signs monitoring in high performance centers and fields.

Structural Health
Monitoring of vibrations and material conditions in buildings, bridges and historical monuments.

Quality of Shipment Conditions
Monitoring of vibrations, strokes, container openings or cold chain maintenance for insurance purposes.

Smartphones Detection
Detect iPhone and Android devices and in general any device which works with Wifi or Bluetooth interfaces.

Perimeter Access Control
Access control to restricted areas and detection of people in non-authorized areas.

Radiation Levels
Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.

Electromagnetic Levels
Measurement of the energy radiated by cell stations and WiFi routers.

Traffic Congestion
Monitoring of vehicles and pedestrian affluence to optimize driving and walking routes.

Water Quality
Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.

Golf Courses
Selective irrigation in dry zones to reduce the water resources required in the green.

Waste Management
Detection of rubbish levels in containers to optimize the trash collection routes.

Smart Parking
Monitoring of parking spaces availability in the city.

Smart Roads
Warning messages and diversions according to climate conditions and unexpected events like accidents or traffic jams.

Smart Lighting
Intelligent and weather adaptive lighting in street lights.

Intelligent Shopping
Getting advices in the point of sale according to customer habits, preferences, presence of allergic components for them or expiring dates.

Noise Urban Maps
Sound monitoring in bar areas and centric zones in real time.

Water Leakages
Detection of liquid presence outside tanks and pressure variations along pipes.

Vehicle Auto-diagnosis
Information collection from CanBus to send real time alarms to emergencies or provide advice to drivers.

Item Location
Search of individual items in big surfaces like warehouses or harbours.

source: Libelium
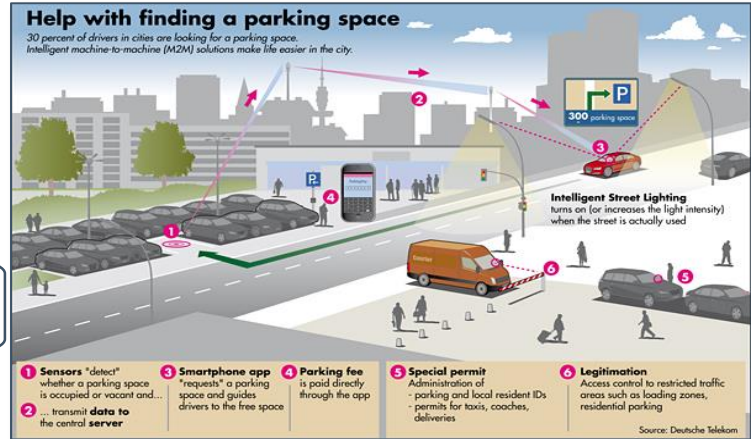
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IoT hot apps - Public

Typical applications & use cases
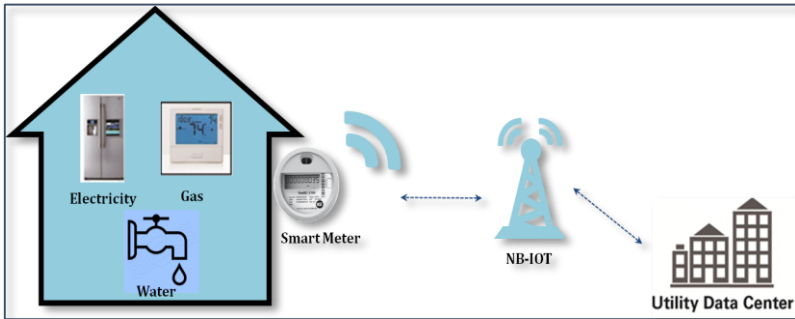
Smart metering
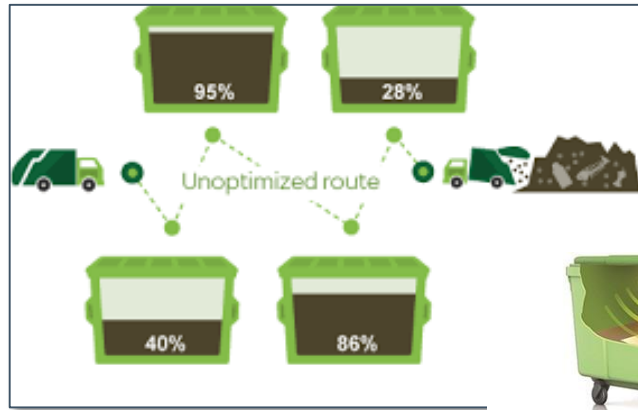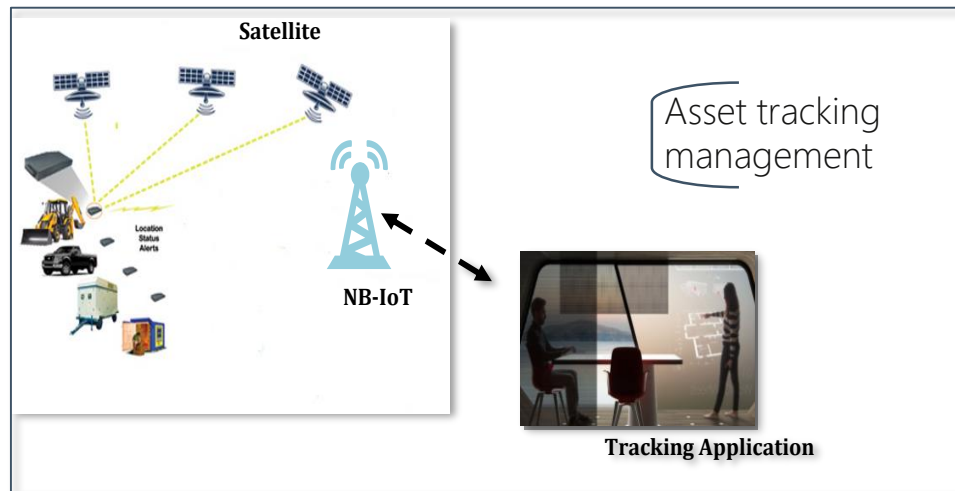
Smart waste management

Smart parking

source: Huawei, DT

IoT hot apps - Industry

Typical applications & use cases

Logistics tracking

Satellite

NB-IoT

Asset tracking management

Tracking Application

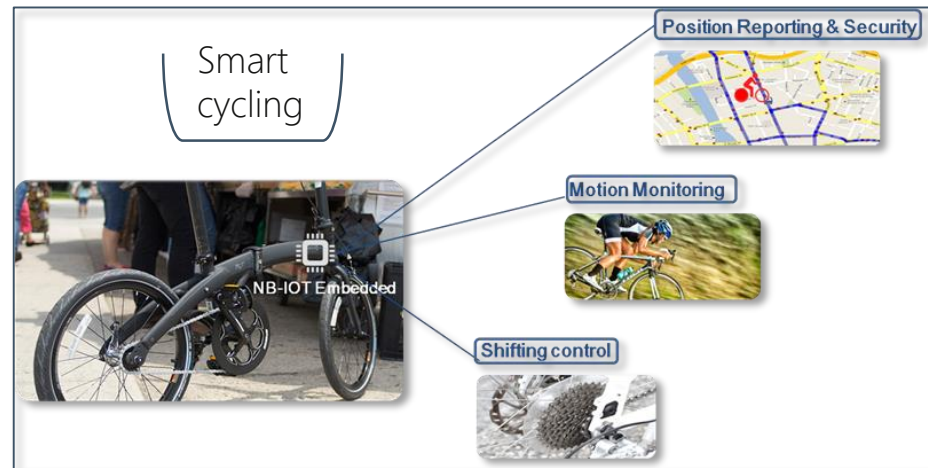Smart agriculture

source: Huawei

IoT hot apps - Personal

Typical applications & use cases

Wearables

Smart cycling

Kids monitoring

source: Huawei

Conclusions

Key messages

- Having started out as a mobile evolution, 5G is actually a revolutionary enabler, because it:

    - enables a litany of new functionalities for people, societies, businesses & industries

    - facilitates the deployment of huge numbers of devices, new applications and the internet of things

    - eventually employs new network structures & architectures as centralized functions, virtual networks, real-time processing, etc.

- IoT is already here with NB-IoT and Cat-M1 supporting most current app needs. 5G will support critical ones.

- While 5G is further evolving, 4G is also making the necessary convergence steps, allowing for smooth inter-operation of the two ecosystems ➔ 1 Gbps already available with LTE advanced technology.

The new era is already here !

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Thank You!