GRUPPO TELECOM ITALIA

5G: work in progress in TIM

Bologna, July 4th 2017

Enrico Maria Bagnasco
Director of Innovation Area

TIM

Agenda

Intro of TIM

5G the next revolution

Key Techs

TIM approach

The software and NFV challenge

Circular innovation

Since January 2016 Telecom Italia and TIM are a Single Brand

Italian leader for ICT, Fixed and Mobile Telecommunication , Internet, Digital Content, Business Solutions and R&D

TIM Il futuro firmato Telecom Italia

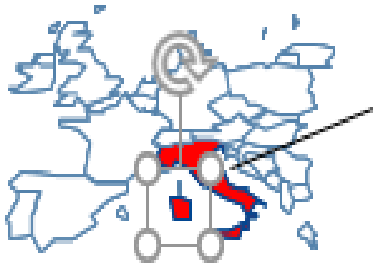
Employees	Customers	Revenue 2016	Investments
66.000	**100** Millions	**19 MDI€**	**11 B€** in Italy 2017-2019
56.000 in Italy		15MDI€ in	

INWIT — Tower company

SPARKLE — Backbone and International Services

Olivetti — ICT and IOT Services

Italia

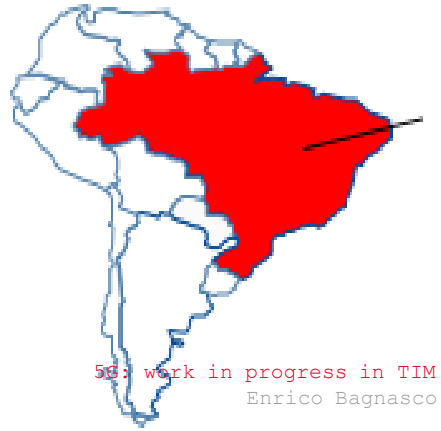


Brasile

TIM / TIM BRASIL 2015

Evoluir é fazer diferente

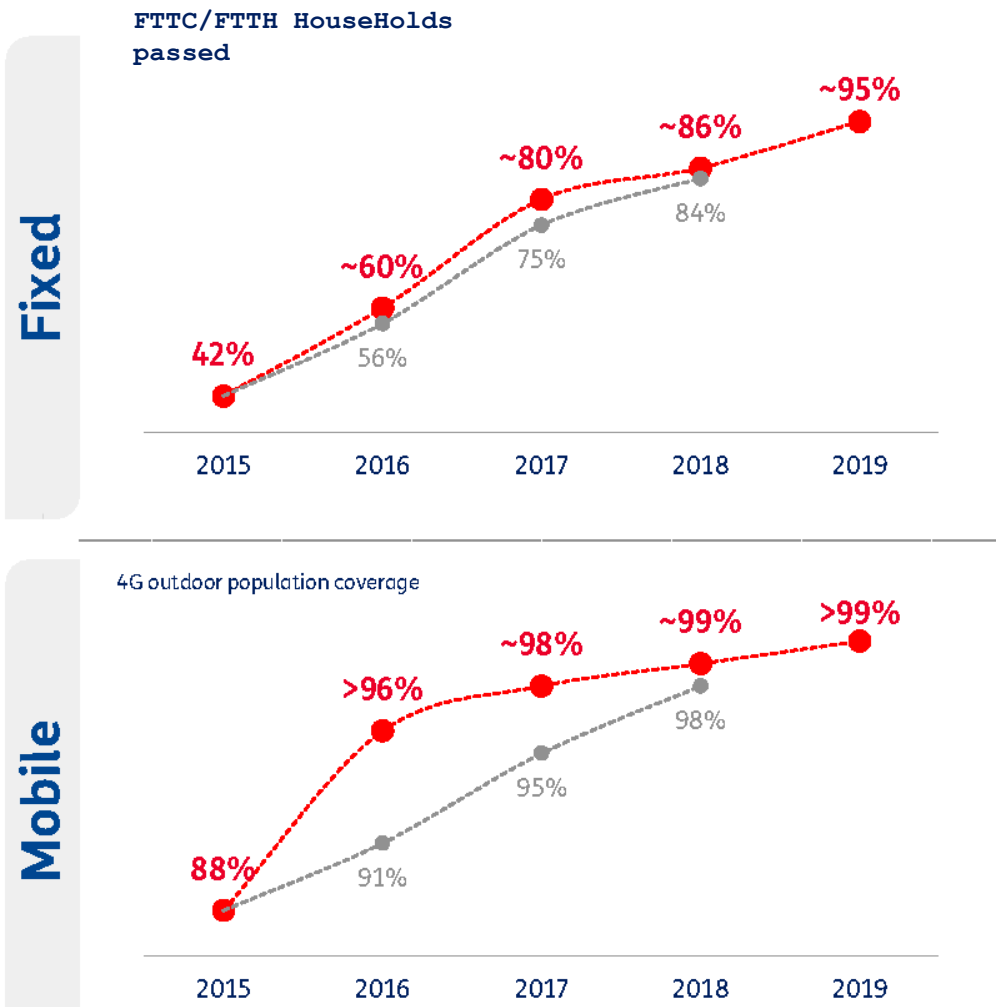
66,2 MILIONI DI LINEE MOBILI	**1°** OPERATORE MOBILE IN BRASILE PER COPERTURA 4G	**59%** DELLA POPOLAZIONE URBANA RAGGIUNTA	**411** CITTÀ COPERTE CON 4G	FINO A **14** MILIARDI DI REAIS DI INVESTIMENTI NEL 2016-18



TIM Transforming Company – Biggest Network in Italy with the Best Quality

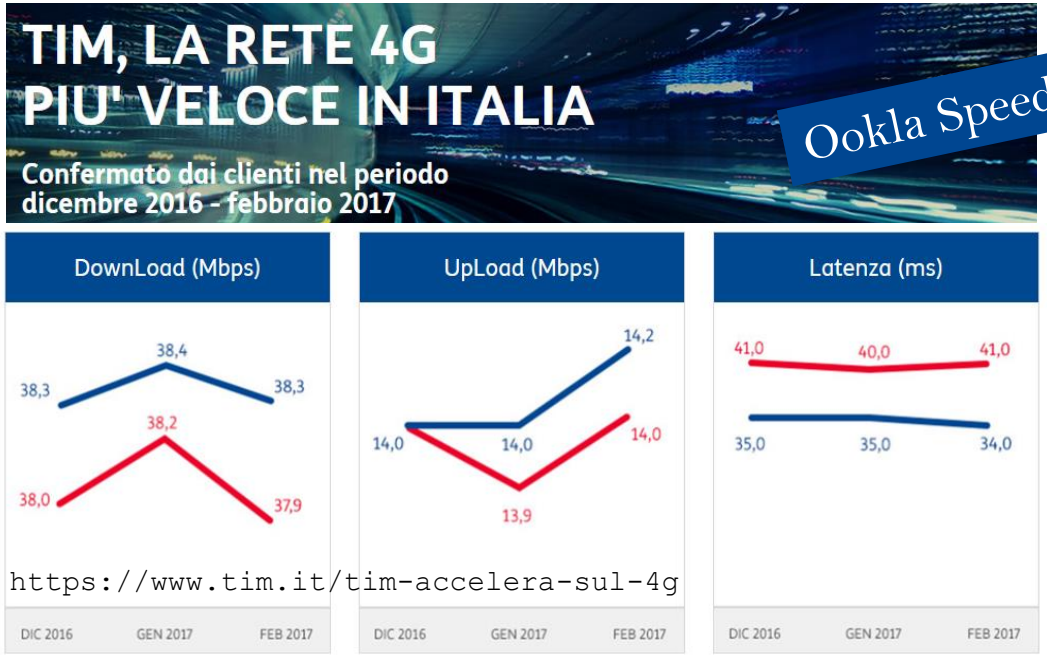
Fixed and Mobile UltraBroadBand Plan: end 2016 and accelerated 2017-2019 plan

11 billion € investment in Italy in 2017-2019



TIM 2017-2019 «Plan for Italy»

- 99% Coverage UBB Mobile 4G
- 95% Coverage Fiber
- Best Network Quality by third party



https://www.tim.it/tim-accelera-sul-4g

TIM

First competitor

Looking forward to 5G

Coverage 4G 6849 Italian Cities - Coverage 4GPlus 660 Italian Cities *(February 2017)*

4GPlus 255 Mbit/s
November

2014

4.5G 500 Mbit/s (Sanremo)
February

2017

2016

November
4GPlus 300 Mbit/s

2017

To 1 Gbit/s

5G the next revolution

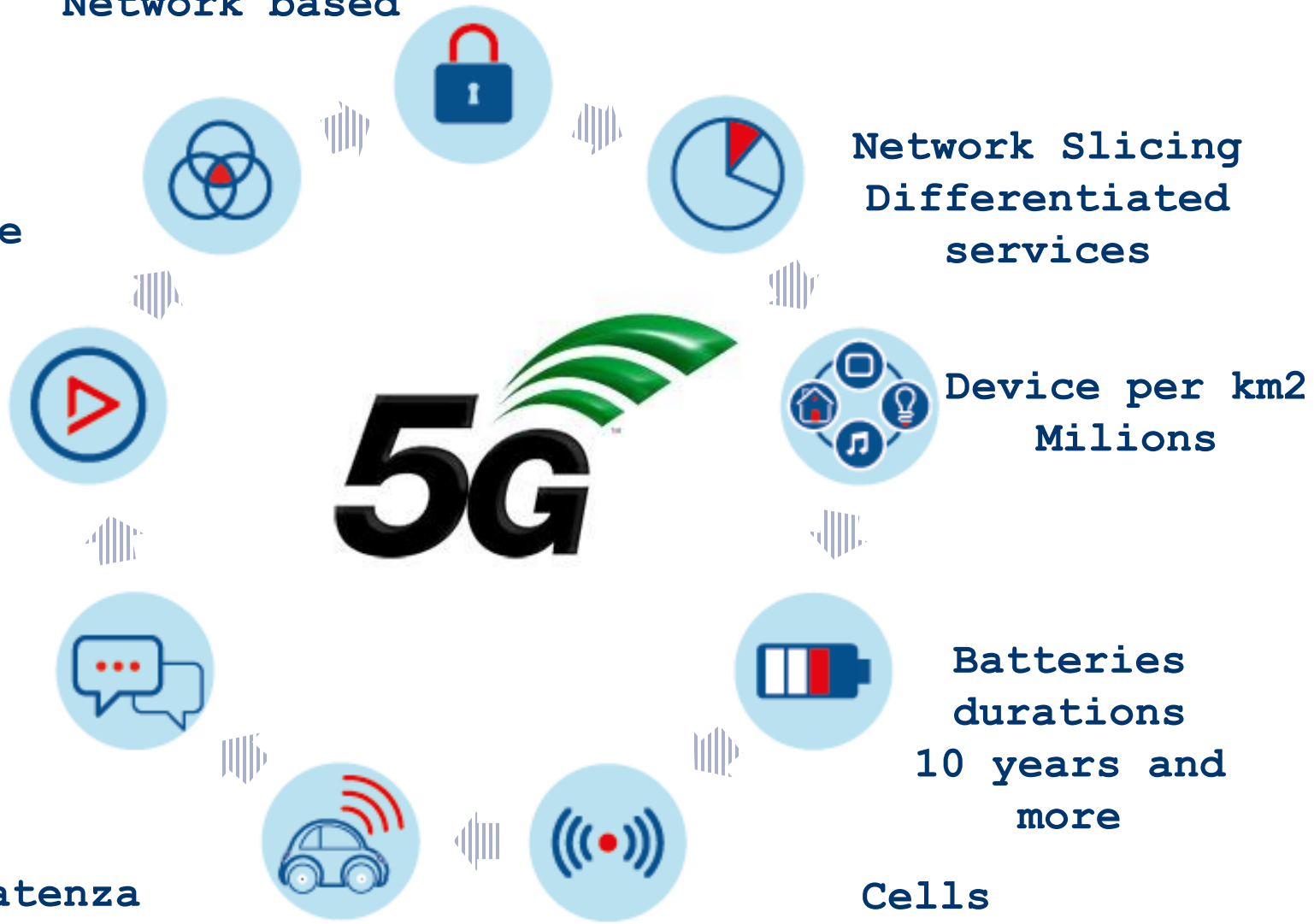
5G … the next step

High Quality and Security Network based

Frequencies 100's MHz, New Radio, mmWave

Network Slicing Differentiated services

Multimedia and Speed 10x LTE UHD, 8K, Immersive Video, Cloud Computing



Device per km2 Milions

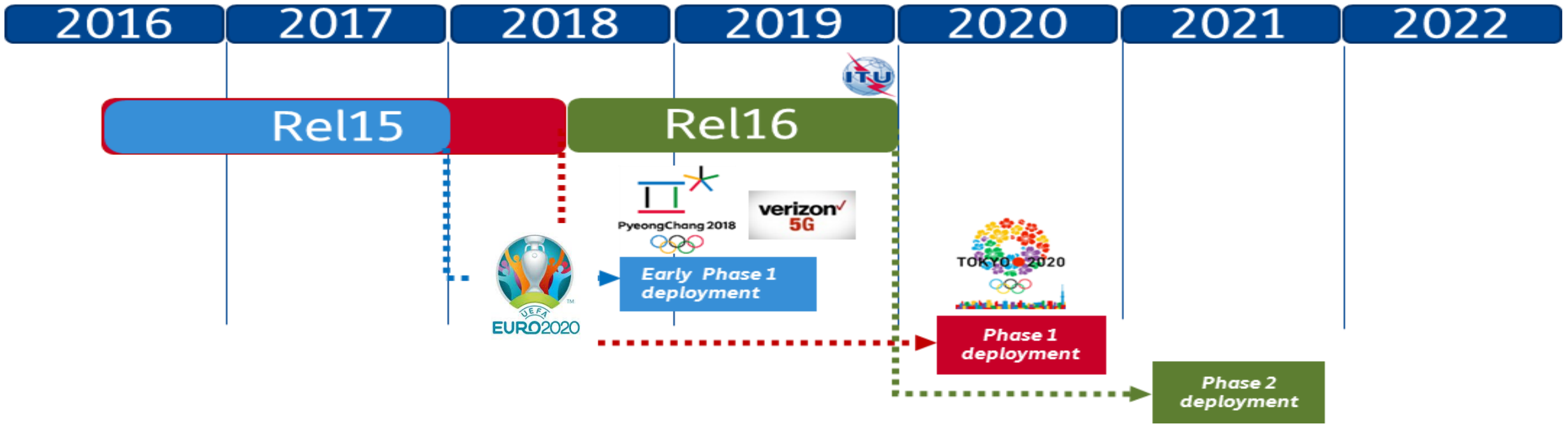
Relay Devices Always maximum coverage

Batteries durations 10 years and more

Latenza 1/10 LTE, few ms

Cells 1000's Small Cells

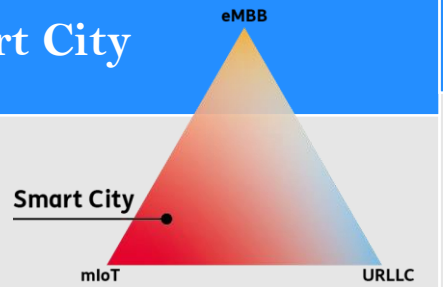
But … When?


2016
2017
2018
2019
2020
2021
2022
Rel15
Rel16
PyeongChang 2018
verizon 5G
EURO2020
Early Phase 1 deployment
TOKYO 2020
Phase 1 deployment
Phase 2 deployment

Developing services covering the complete spectrum of 5G use cases…

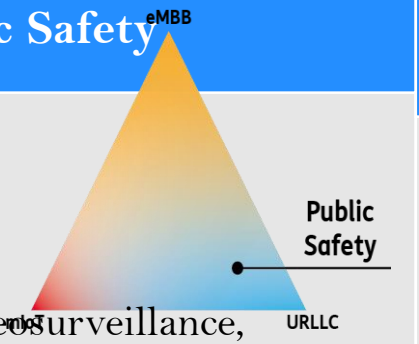
5G FOR ITALY
Industry 4.0
Transports
New Services Cases

Smart City



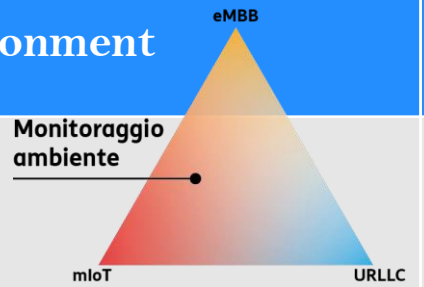
- City Control Room,
- Parking, Lighting

Public Safety



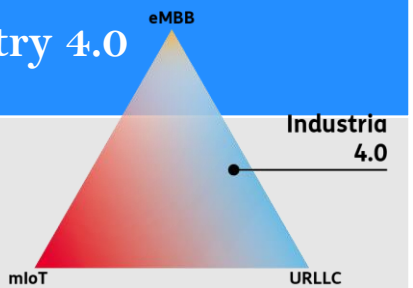
- Videosurveillance,
- Drones,
- ….

Environment



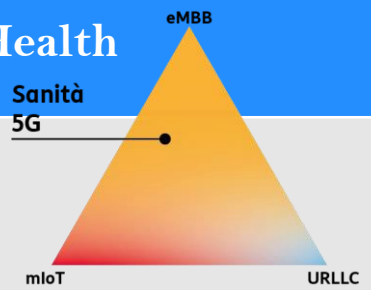
- Environment monitoring
- Smart infrastructure and building monitoring

Industry 4.0



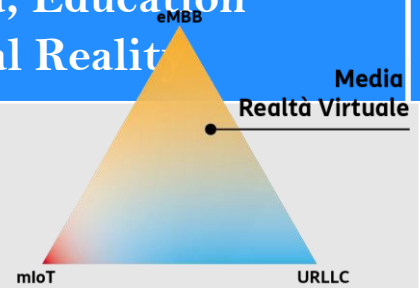
- Asset Tracking
- Service Robotics
- Smart Energy
- ….

5G EHealth



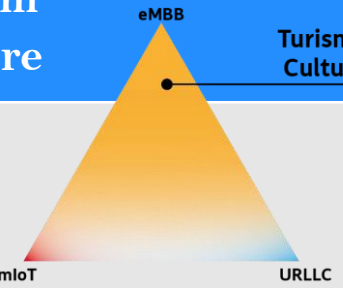
- Wearable
- Remote monitoring,
- Teleconsulting ..

Media, Education Virtual Realit



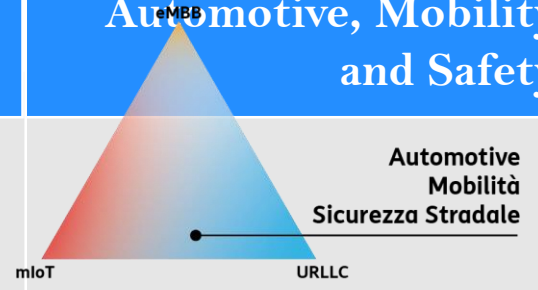
- «New» Entertainment
- Virtual Shop
- Remote Education
- ….

Turism Culture



- UBB video,
- remote visits
- …

Automotive, Mobility and Safety



- V2X for safety
- Assisted Driving

eMBB mIoT URLLC

«FutureNet» and 5G

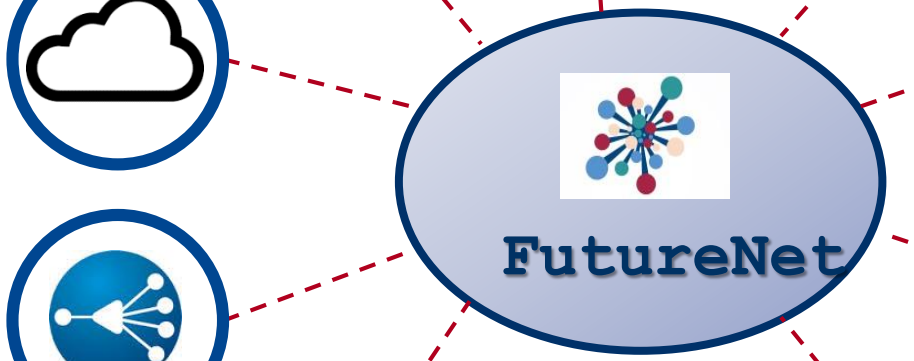
CORD
Central Office is becoing a Data Center white box (switching, optical interfaces, server and memories)

Open Source
Also Network Functions are «open»

1 Gbps in ogni stanza WiGig e Multi-AP to provide ultrabroadband in the whole home

Dynamic Cloud
Dynamic alllocation of VNF on a policy basis (traffic, services)

virtualCPE
Becoming part of the cloud



NGPON2 e oltre
Channel capacity ≥ 25Gb/s, bonding + channels

Double level of IP and Optics
Integration into one level

xPON for backhauling e fronthauling
Collaboration of wired e wireless networks

ODN evolution
For reliability and reconfigurability (Optical Switch) for dual homing

performance management of IP and Video
Both for customers' and infrastructure services (MEC and OpenCaching solutions)

Key Network Technologies in 5G

5G: new frequencies requires new tools

mmWave lab, new (Active) Antenna Systems to keep the pace…

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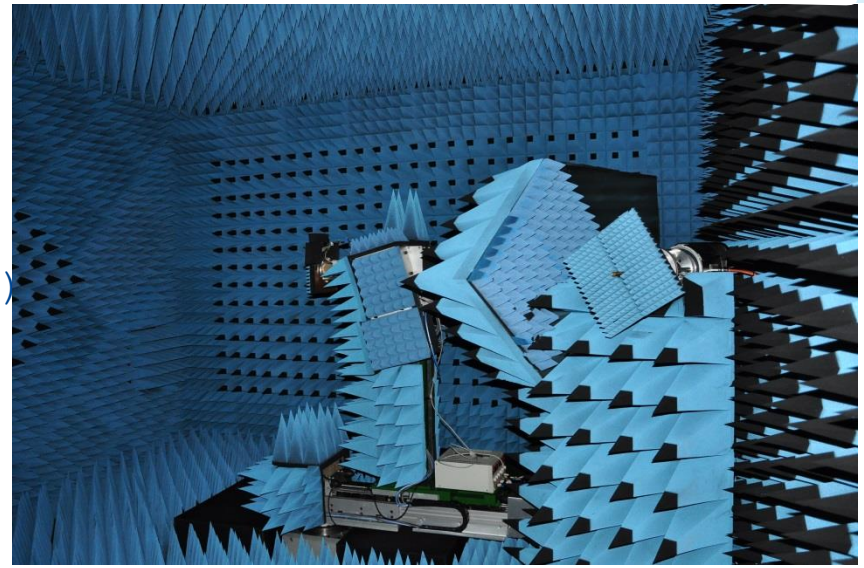
Open Labs
Memorandum of Understanding
Tech Provider, University, PA



- **New frequency ranges**
  - Sub-6GHz
  - Above 6 GHz: from cm to mm Waves (up to 170 GHz)
- **BeamForming and new MIMO solutions**
  - Digital ("per-user") and mixed Analogue-Digital
  - Multi User, Full-Dimension / 3D, Massive MIMO
- **New antenna test ranges in TIM to validate new (Active) Antenna Systems**
  - Sub-6GHz: a **new** Compact Antenna Test Range / Spherical Near-Field test range is under construction
    (scheduled to be ready by 2018Q1)
  - Above 6 GHz: the operating frequency range of the mmW lab (currently working up to 110 GHz) will be extended **up to 170 GHz by 2017Q4**

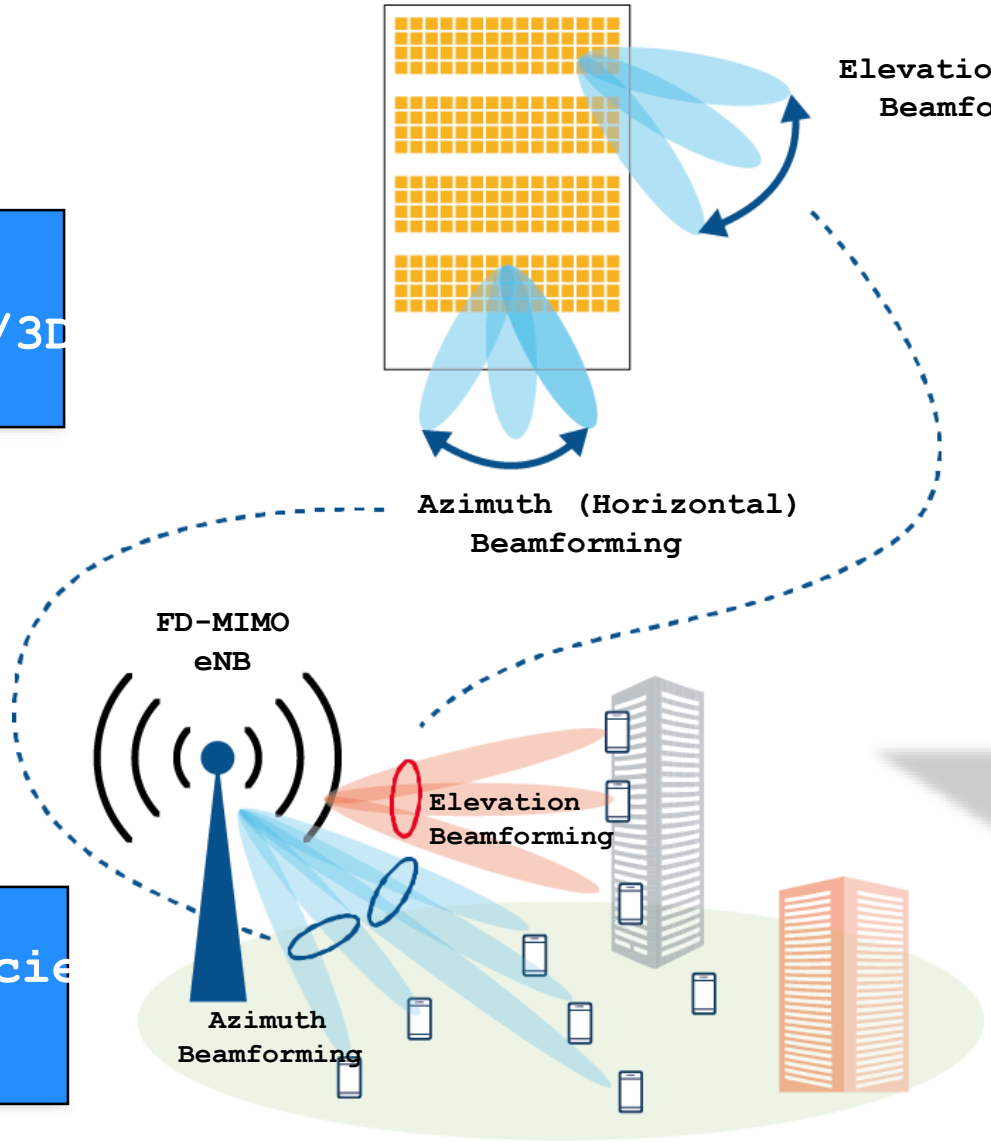
5G: Active Antennas

Beamforming

- Multi User
- Full Dimensional/3D
- Massive MIMO

mmWaves

- High radio frequencie
- Large bandwidth

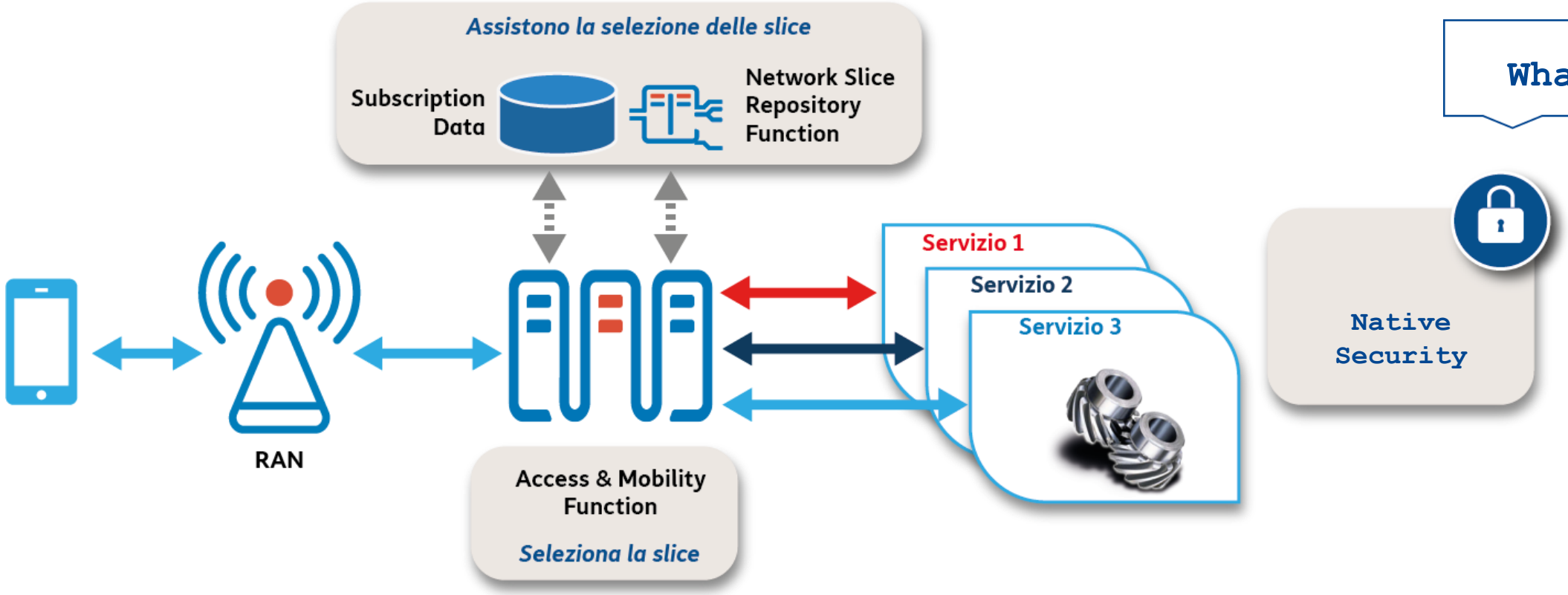


What

Smart Antenna Systems

- Array of hundreds of ele
and active systems:
- Incresing of:
  - Capacity
  - Spectral efficiency

5G: Network Slicing



Slice as aggregation of network resources

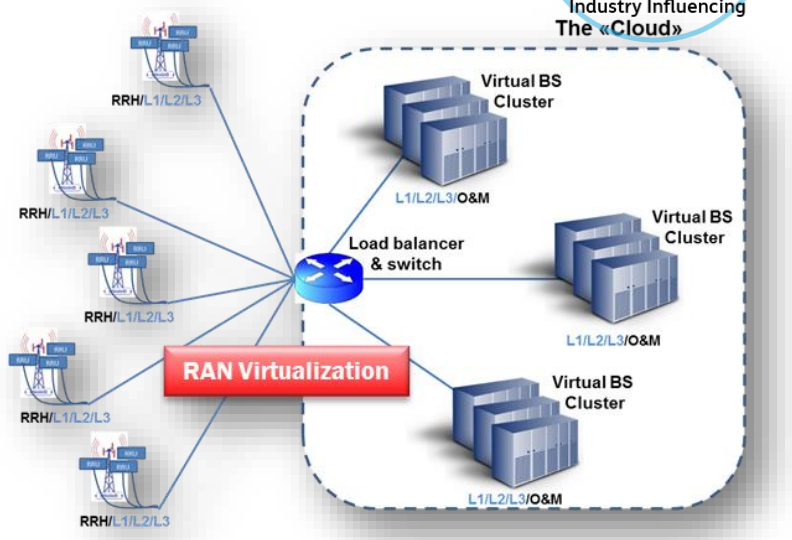
Dynamic selection of slide per each traffic component

Orchestration of multiple slices

Some Technological Efforts towards 5G

- **Virtual RAN:**

  TIM, in collaboration with Altiostar, successfully tested the vRAN architecture, both at the innovation lab in Turin, and on field in Saluzzo: a virtual server has been installed in Turin, more than 60 km away from the Saluzzo antennas. The capability of coordinating radio base station even at considerable distances was demonstrated, without affecting performance, thanks to the efficient transmission techniques based on Ethernet fronthauling(1).



- **Telecom Infra Project**

  At the and of 2016 TIM joined Facebook TIP initiative(2) aiming to reimagine the traditional approach to building and deploying telecom network infrastructure. Among the different groups, TIM is participating to the recently started vRAN Fronhaul project that will focus on virtualization of the RAN for non-ideal backhaul (3).

(1) http://www.telecomitalia.com/tit/en/archivio/media/note-stampa/market/2016/TIM-Altiostar-VRAN.html

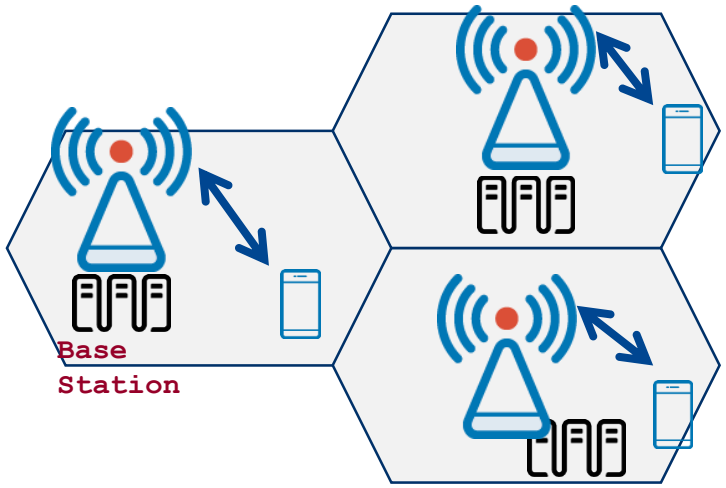
(2) https://telecominfraproject.com/

(3) http://www.lightreading.com/mobile/fronthaul-c-ran/facebooks-tip-seizes-vran-initiative-from-3gpp/d/d-id/733683

5G: Cloud/Virtual RAN

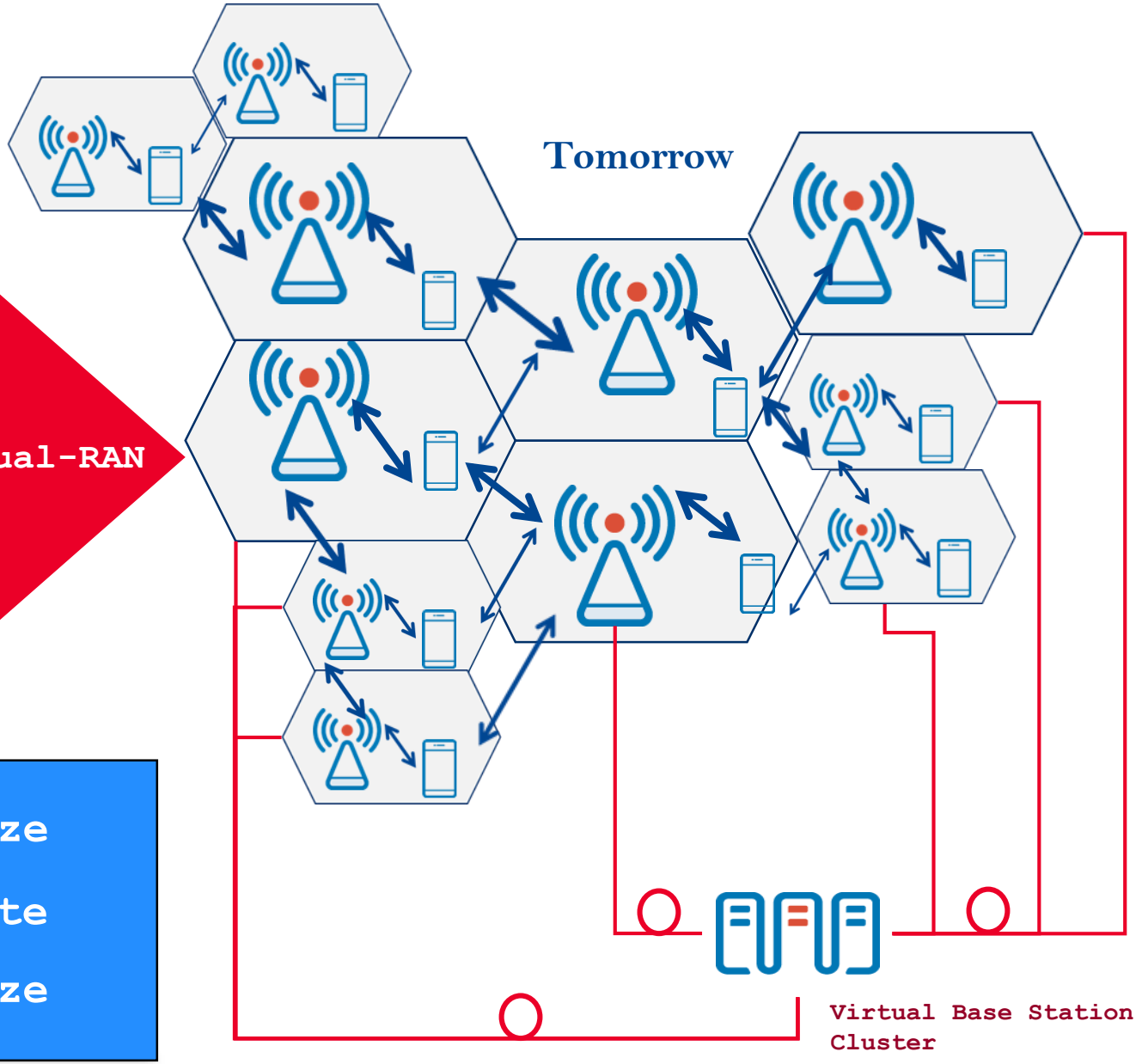
What

Today



Cloud/Virtual-RAN

Tomorrow



Centralize

Coordinate

Virtualize

The Virtualization and Softwarization efforts and tools

The Plan 2017 – 2019: the platforms

Decommissioning Integrato

Tim ha comunicato ad AGCOM l'elenco di oltre 6.000 centrali da dismettere

Il Sole 24 ORE

TIM ACCELERA LA MIGRAZIONE VERSO LA FIBRA

TIM ha comunicato ufficialmente all'AGCom l'intenzione di accelerare il processo di **ammodernamento della propria rete fissa**, pubblicando **l'elenco delle centrali che verranno dismesse nei prossimi anni**, nel pieno rispetto della normativa vigente. In effetti, la delibera dell'AGCom (ex Delibera 623/15/CONS) prevede che il **mercato sia informato con tre anni di anticipo** nel caso di **centrali non aperte all'unbundling** e con **cinque anni di anticipo** nel caso di **centrali aperte all'unbundling**.

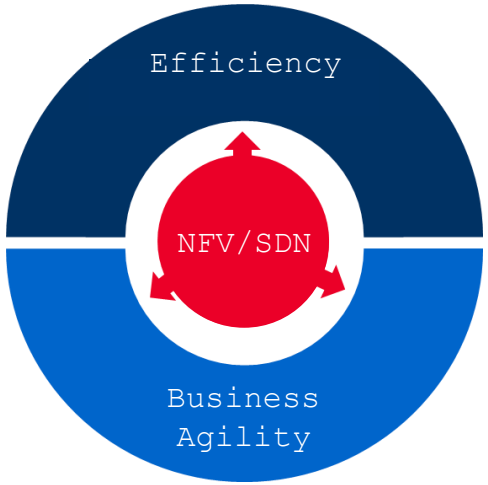
Si tratta di un passaggio fondamentale per la definitiva realizzazione della rete di accesso in fibra di nuova generazione integralmente basata sulle tecnologie Full IP, che verrà **completata in più fasi entro il 2024**. In questo modo, verranno progressivamente migrati i servizi di accesso offerti sulla rete in rame a quelli offerti sulla rete in fibra garantendo a tutti i cittadini e imprese l'accesso ai servizi innovativi di nuova generazione.

Il progetto riguarda **oltre 6000 centrali** su un totale attualmente pari a circa 10.500 e comporterà un significativo innalzamento dell'affidabilità della rete. La semplificazione dei processi di assurance e delivery ed il miglioramento della qualità intrinseca nei servizi di nuova generazione porterà indubbi benefici ai cittadini mentre la riduzione delle aree da infrastrutturare porterà benefici anche agli altri operatori che comprano servizi in modalità wholesale da TIM.

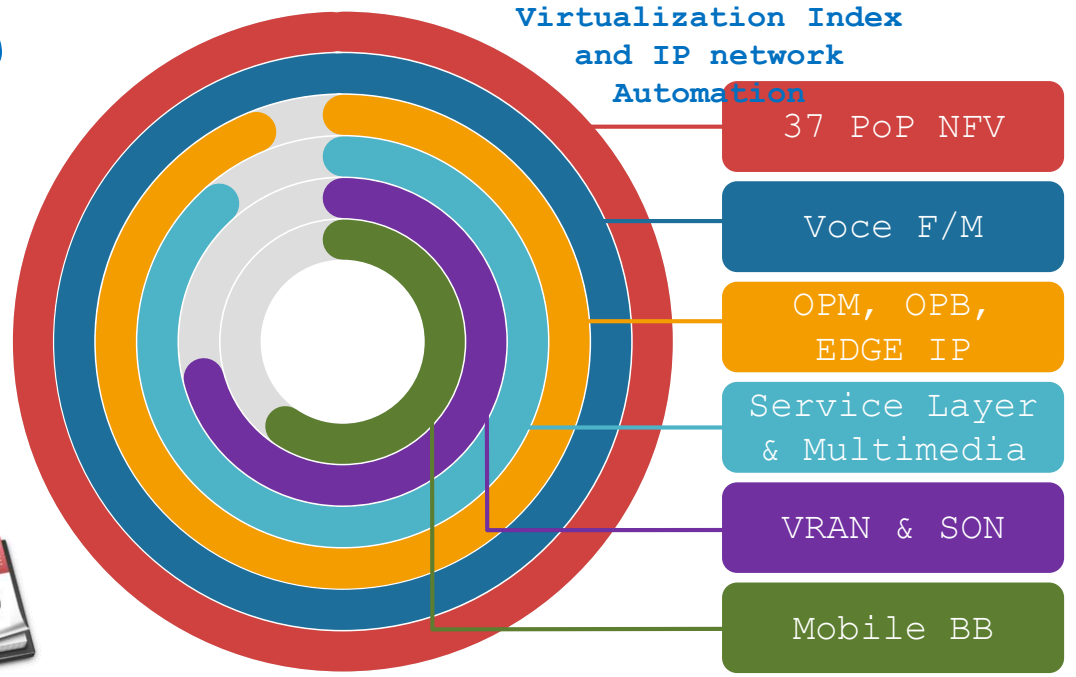
The Plan 2017 – 2019: the platforms

Network Transformation

New Operation Model and Technologies for imrpving efficiency and business agility

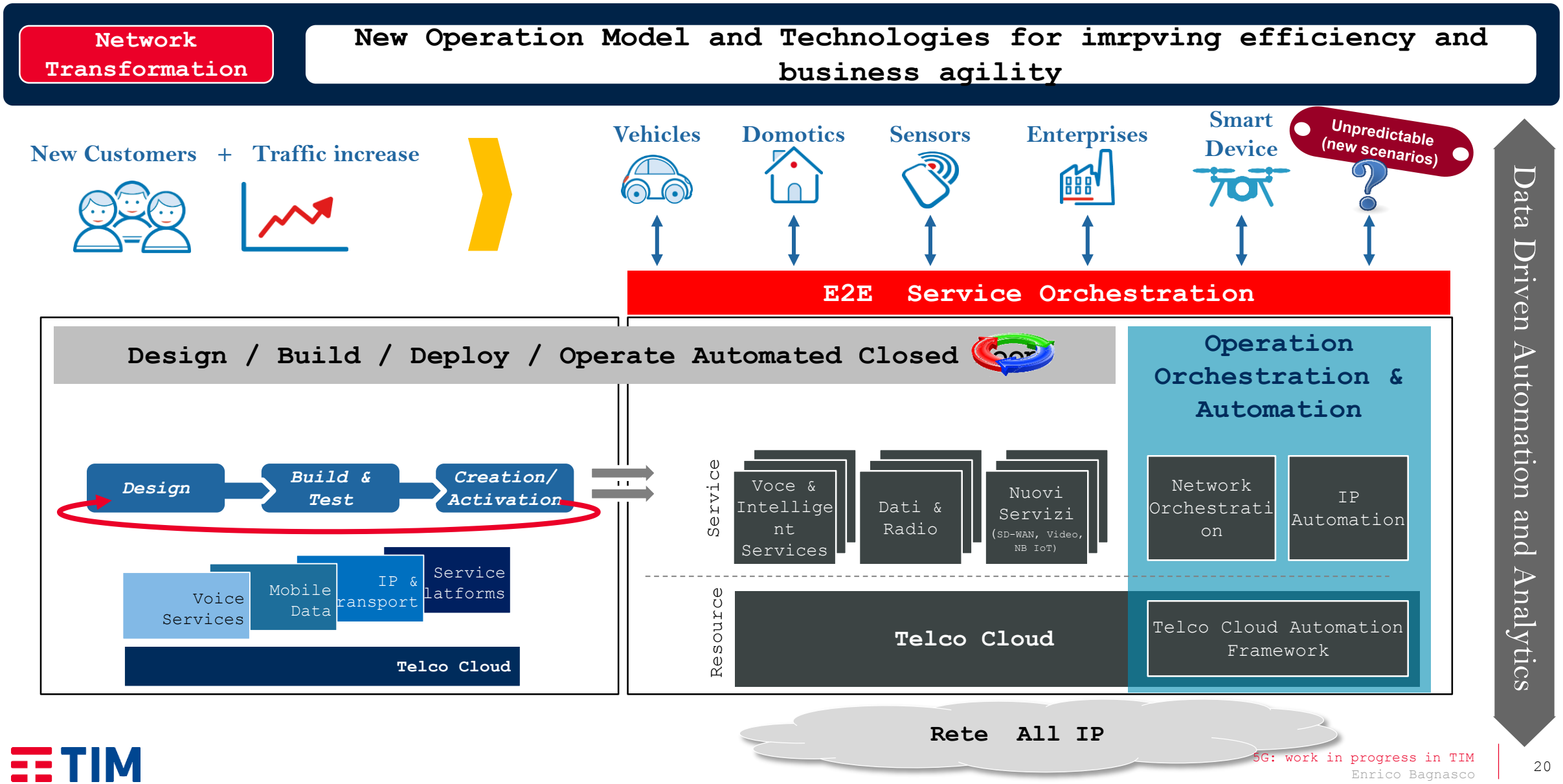


2019



- **Network Transformation to support "On Demand" services: improving efficinecy and business agility**
- **Extending the program of network Virtualization and Automation**
- **Technology Transformation (NFV, SDN, SON) and Operations Model (DevOps, Network Academy)**

The Plan 2017 – 2019: the platforms



Working with Partners

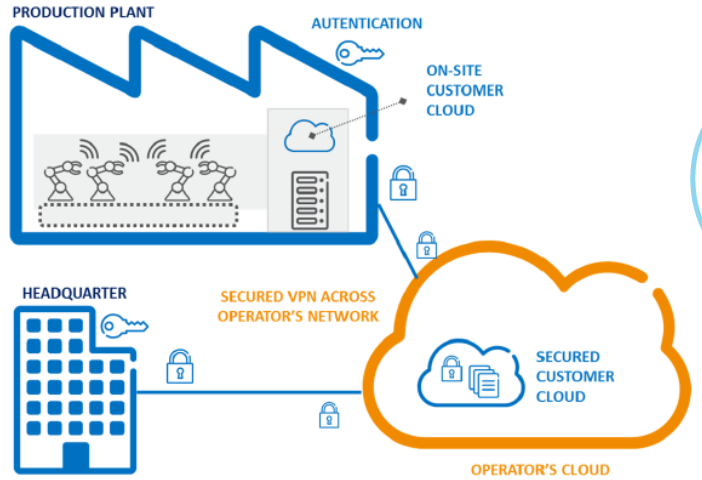
TIM towards 5G: an approach leveraging Ecosystems and «Circular Innovation»

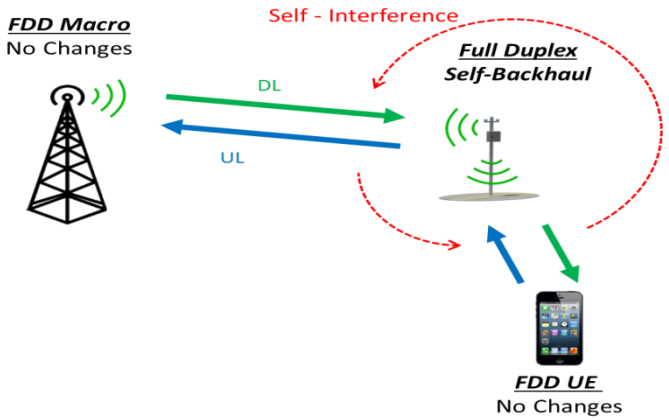
We will briefly go through this areas of action ….

Some TIM Technological Efforts towards 5G

- **5G for Italy**

TIM and Ericsson launched the initiative "5G for Italy" in 2016 for the establishment of an ecosystem of experimental industrial partners, confirming the commitment of the two companies to innovating technologies and networks in support of the socio-economic growth of the country(1).





- **"Full Duplex relay"**

TIM carried out in 2016 in Turin the world's first test of "Full Duplex Relay", which can double the capacity of the LTE network in view of 5G(2).

(1) https://www.ericsson.com/it/it/press-releases/3/2016/TIM-and-Ericsson-launch-the-program-5G-for-Italy

(2) http://www.telecomitalia.com/tit/en/archivio/media/comunicati-stampa/telecom-italia/mercato/consumer/2016/TIM-Turin-

TIM and Turin, first Italian 5G city

TIM ACTION PLAN
Turin 1st European 5G City PoC & Field Trials

- MoU with City of Turin, in line with the 5G Action Plan from the EC, signed March '17
- Turin first 5G Italian network enabling the delivery of innovative

2017
More than 100 *smart cells* (low power, innovative antennas) in

2018
5G trial launch in the city area

2020
Full 5G city coverage and evolution of

Smart City Trials:

- Internet of Things,
- Public Safety solutions,
- public transport management and associated information services,
- Virtual Reality solutions for turism, and new services toward Industry 4.0.

«The main challenge is leaveraging this technology to enable growth opportunities for the territory in terms of economic development, new skills creation, and collaborations with other bodies such as Universities, research centers, and companies»

TIM Campus 5G @ Polito

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Tech Provider, University, PA

5G CAMPUS

TIM

POLITECNICO DI TORINO

Campus 5G

Campus coverage 4.5G and progressivly 5G

5G Radio Lab

5G Core Lab (5G core network , SDN, NFV, slicing, …)

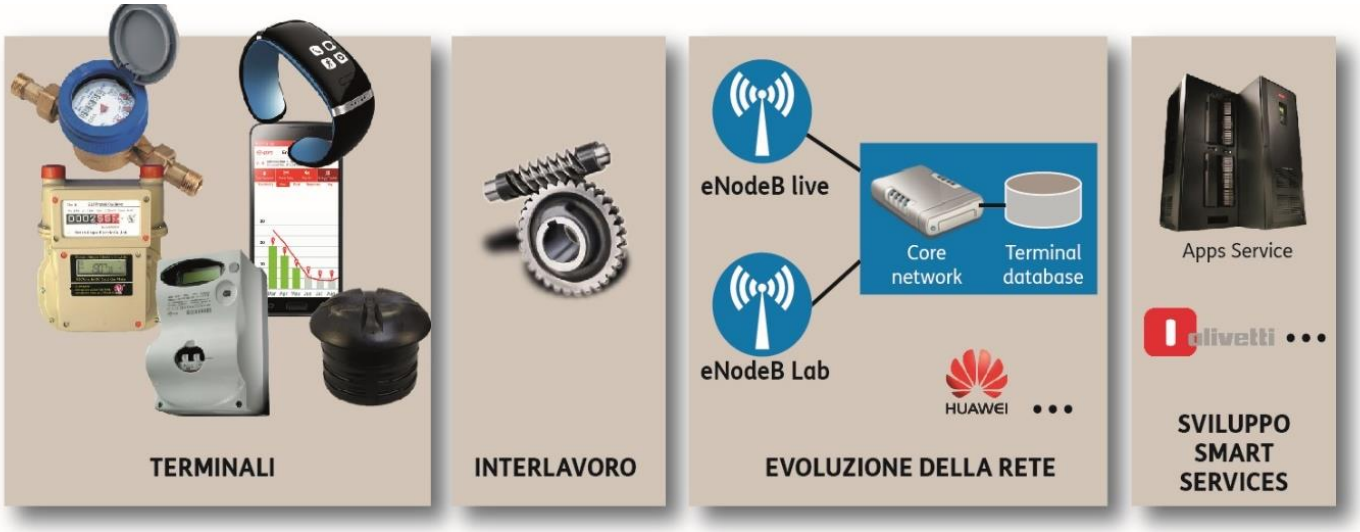
5G Platform: Open Platform for service development and testing

5G Living Labs
Inclusion and aggregation of students and researchers energies

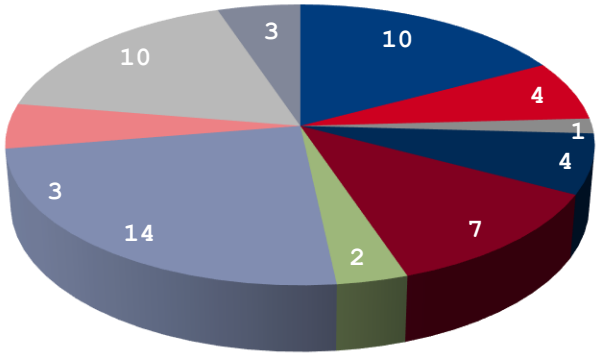
Pre 5G Techs: Open Lab for IoT in Torino

10s of visits and meeting with suppliers and customers

About one out of three becomes a collaboration

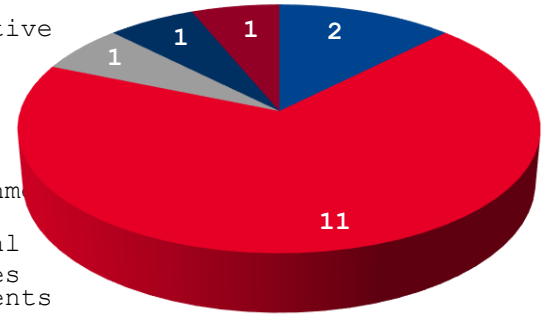


Vendor per segment



Energy Efficiency
Telco
Automotive
R&D
ICT
Environm
Vertical Services
Components
Metering

Customer per segment



Banking
Utilities
Municipalities
Insurance

Key points:

- **wireless data tecnologi s**
  - Tradizional 2G
  - **Current Nb-IoT**
  - Next 5G
- **Real network for pre-commercial test and validation**
- **Platform open and secure for** for data management
- Integrated lab for application **co-development with Partner,** testing in **controlled environment,** with a complete **end to end testing chain**
- **Specialized skills for education and certification; relationship with the internazional contest** (GSMA, 3GPP)

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Thank You