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# Cooperative Intelligent Transportation Systems and the EMERGE project

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**Universita' degli Studi dell'Aquila – Dept. DISIM**

**& Radiolabs Consortium**

**18 and 19 April 2018 Second Thematic Workshop in L'Aquila**

# Towards advanced transportation systems

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## *Smart, green and integrated transport in H2020*

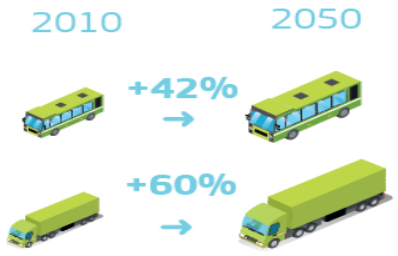

The Mobility sector employs more than 11 million people, accounting for 5% of total employment.

Almost **50%** of freight transport

Road transport accounts for almost half of the total freight transport activity

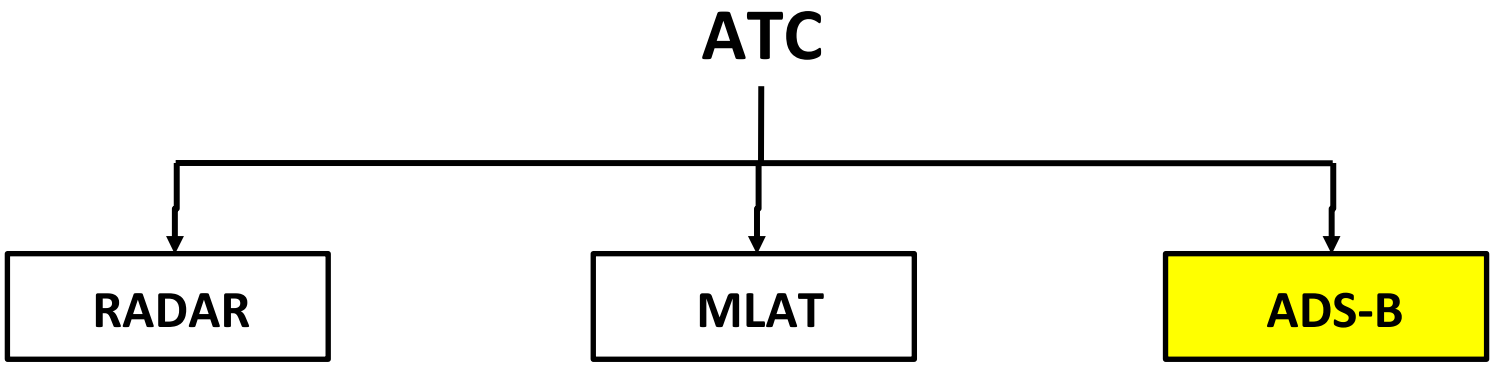
**13%** of household expenditure

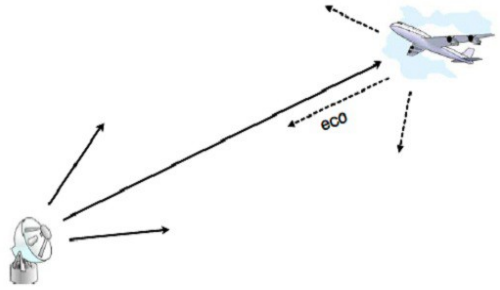
Transport accounts for 13% of the total household expenditure

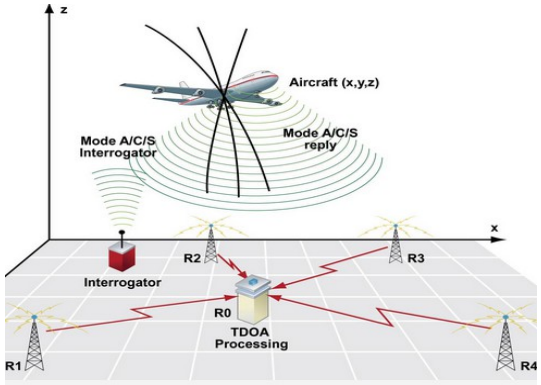



From 2010 to 2050, it is estimated that passenger transport will grow by about 42 per cent. Freight transport is expected to grow by 60 per cent

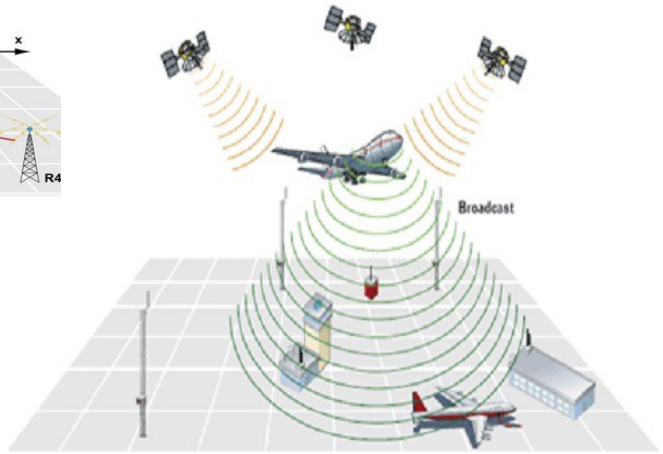
# Air traffic management



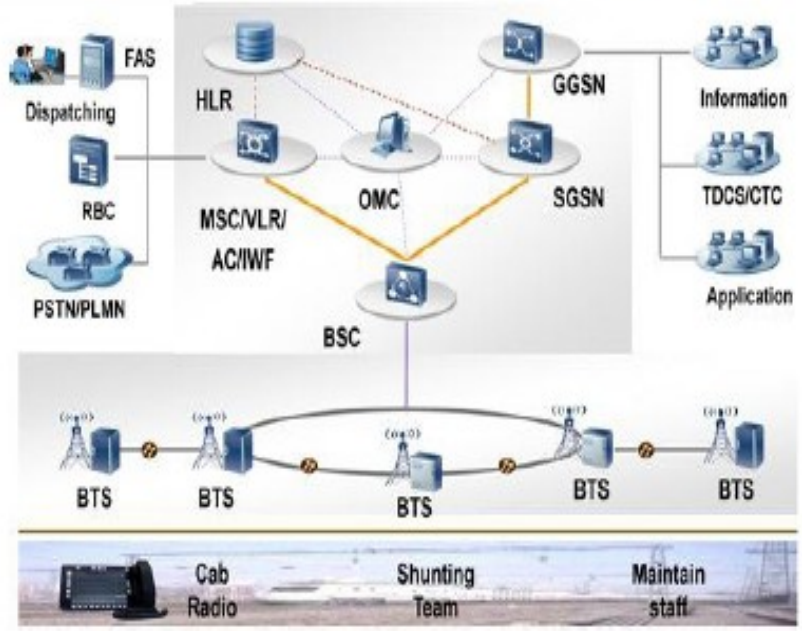







# Rail traffic management

In Europe GSM-R is the TLC standard for Train-to-Wayside wireless communication for railway . A sub-system of European Rail Traffic Management System (ERTMS)




## GSM-R critical issues:

- Very expensive (CAPEX) dedicated solution
- No spectrum availability to increase capacity
- Near the obsolescence
- Strongly supported by the TLC industries lobby

# A project on IoT in freight trains at Radiolabs

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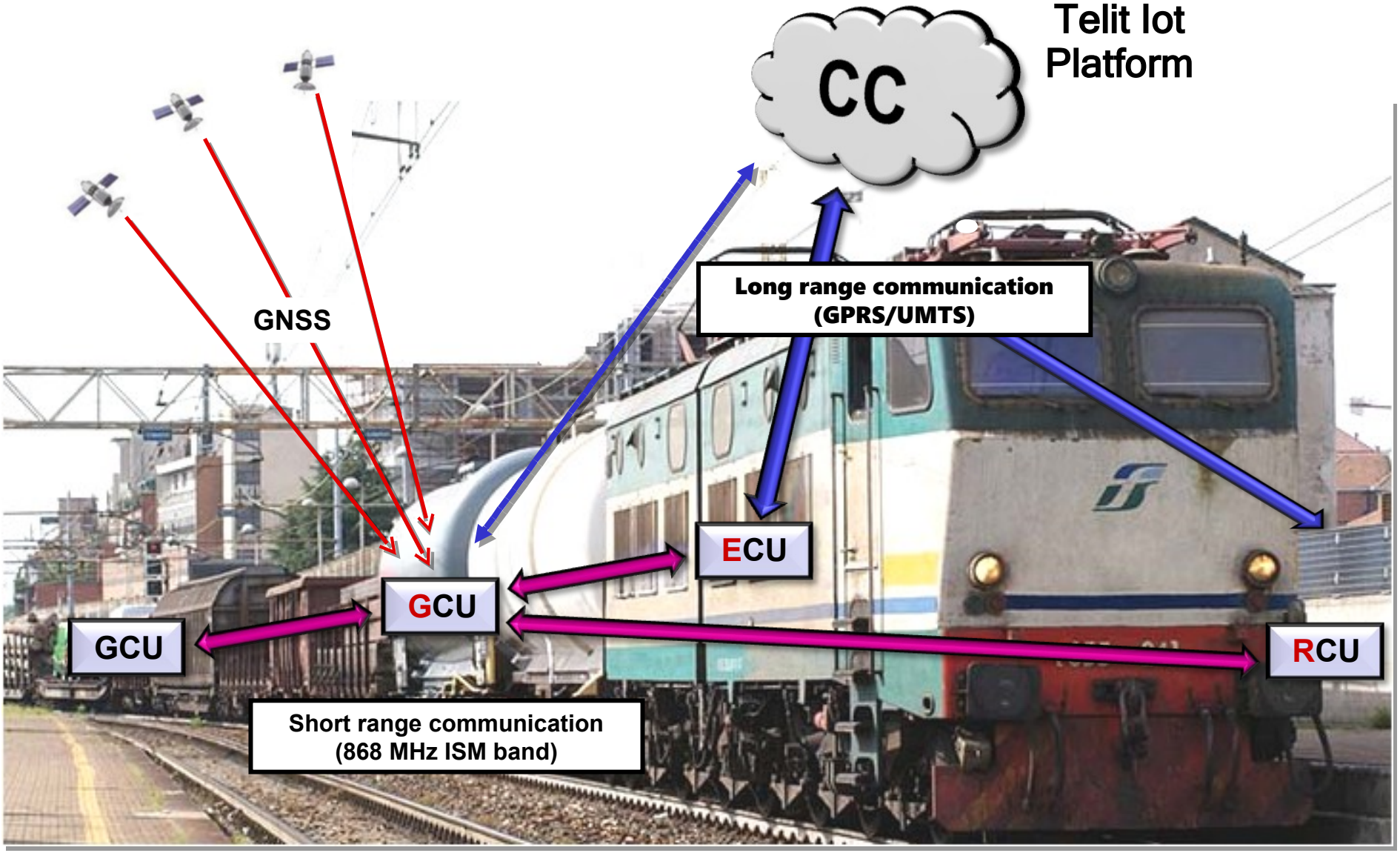

# Rail traffic management

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## Shift2Rail requirements for next generation communications in the railway domain

- Overcoming the current limitations of GSM-R
- Bearer independence and transparency to applications
- Backward compatibility to ensure coexistence and smooth migration
- Multi-Access Support & Resilience to Radio Technology Evolution
- Enabling new operating models such as “Network-as-a-Service“
- Support of easier applications' development for railways

# Road traffic management

Key transformations and new services in the automotive industry (see e.g. 5G Automotive vision)

- Automated driving
- Road safety and traffic efficiency
- Digitalization of transport and logistics
- Intelligent navigation
- Information society on the road

# Levels of automation by SAE (US Society of Automotive Engineers)

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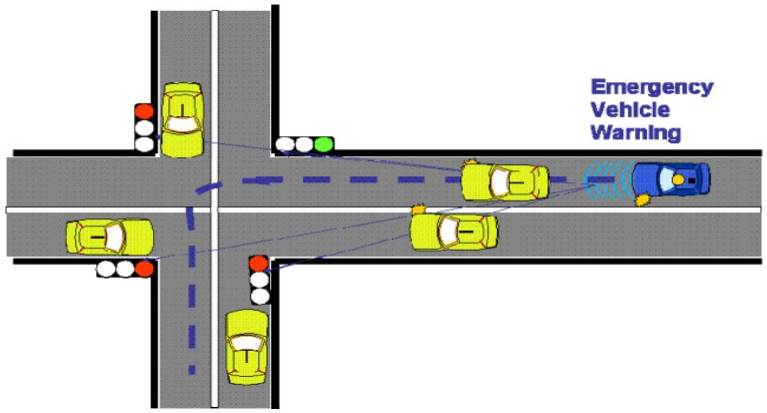
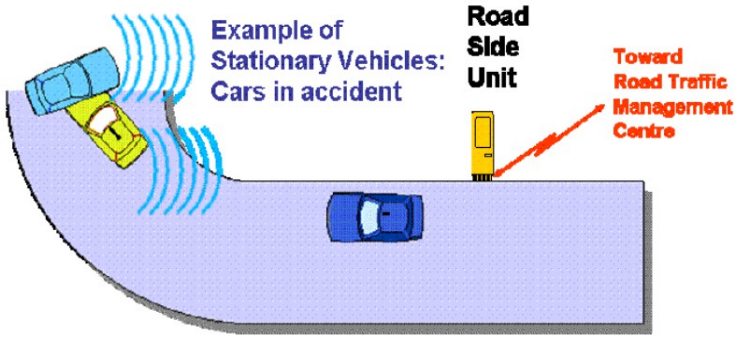
| SAE level | Name | Narrative Definition | Execution of Steering and Acceleration/ Deceleration | *Monitoring* of Driving Environment | Fallback Performance of *Dynamic Driving Task* | System Capability *(Driving Modes)* |
|---|---|---|---|---|---|---|
| ***Human driver* monitors the driving environment** | | | | | | |
| 0 | **No Automation** | the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems | Human driver | Human driver | Human driver | n/a |
| 1 | **Driver Assistance** | the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task* | Human driver and system | Human driver | Human driver | Some driving modes |
| 2 | **Partial Automation** | the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task* | **System** | Human driver | Human driver | Some driving modes |
| ***Automated driving system* ("system") monitors the driving environment** | | | | | | |
| 3 | **Conditional Automation** | the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene* | System | **System** | Human driver | Some driving modes |
| 4 | **High Automation** | the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene* | System | System | **System** | Some driving modes |
| 5 | **Full Automation** | the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver* | System | System | System | **All driving modes** |

# Examples of cooperative road safety

E-call + emergency vehicle warning




Stationary vehicle warning



# Pervasive connectivity on the road

*Integration of several layers of networking infrastructures: wired and wireless, public and private, intra-vehicle and inter-vehicle networks, backbone networks . . .*

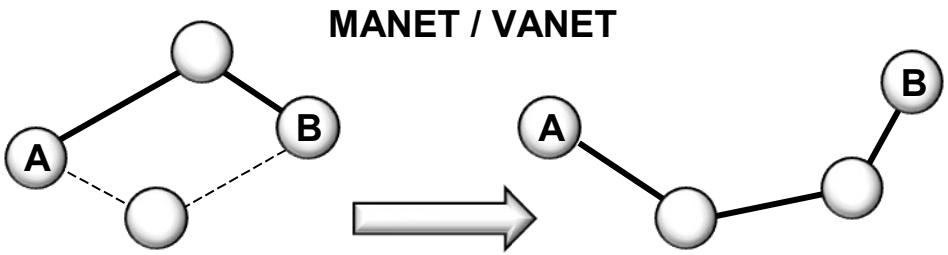
**Mobile ad-hoc inter-vehicle networks and vehicle-to-roadside**

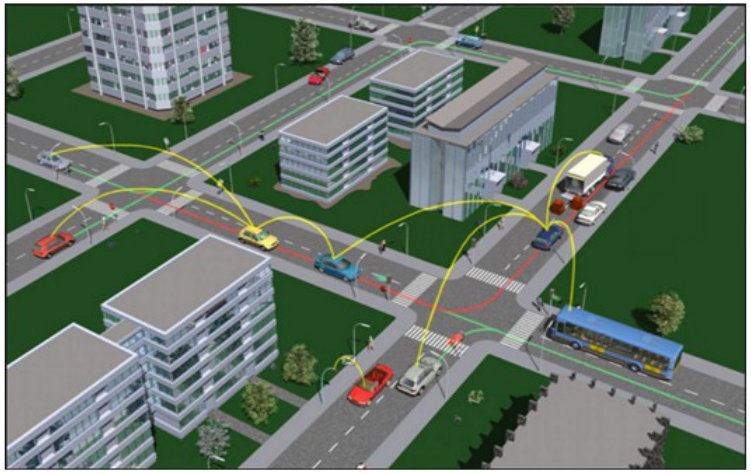
**Mobile Ad-hoc NETwork**
**Vehicular Ad-hoc NETwork (802.11 p)**

A **local dynamic wireless infrastructures** for information exchange

The information set can be quite rich and is intended to disseminate both vehicle-related and/or environmental data, that can be rapidly exploited for reacting e.g. to alerting conditions or simply adapting driver's behavior to local traffic conditions in order to preserve energy efficiency.

Need for bandwidth and energy efficient, reliable and cooperative communication paradigms.



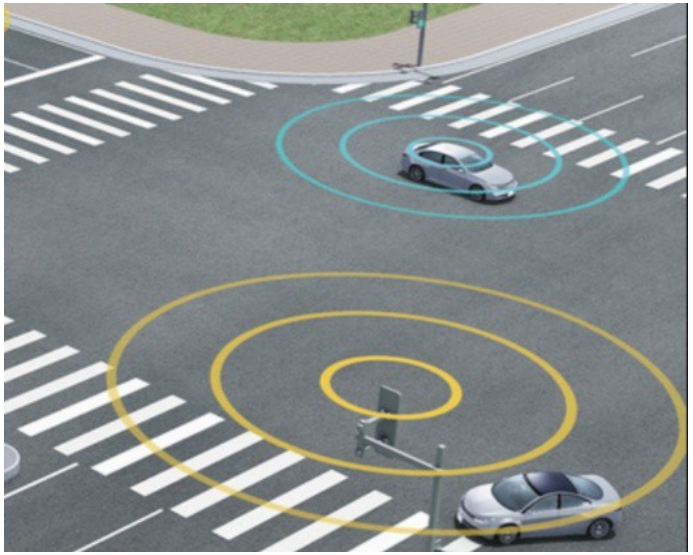



# Pervasive connectivity on the road

*Integration of several layers of networking infrastructures: wired and wireless, public and private, intra-vehicle and inter-vehicle networks, backbone networks . . .*

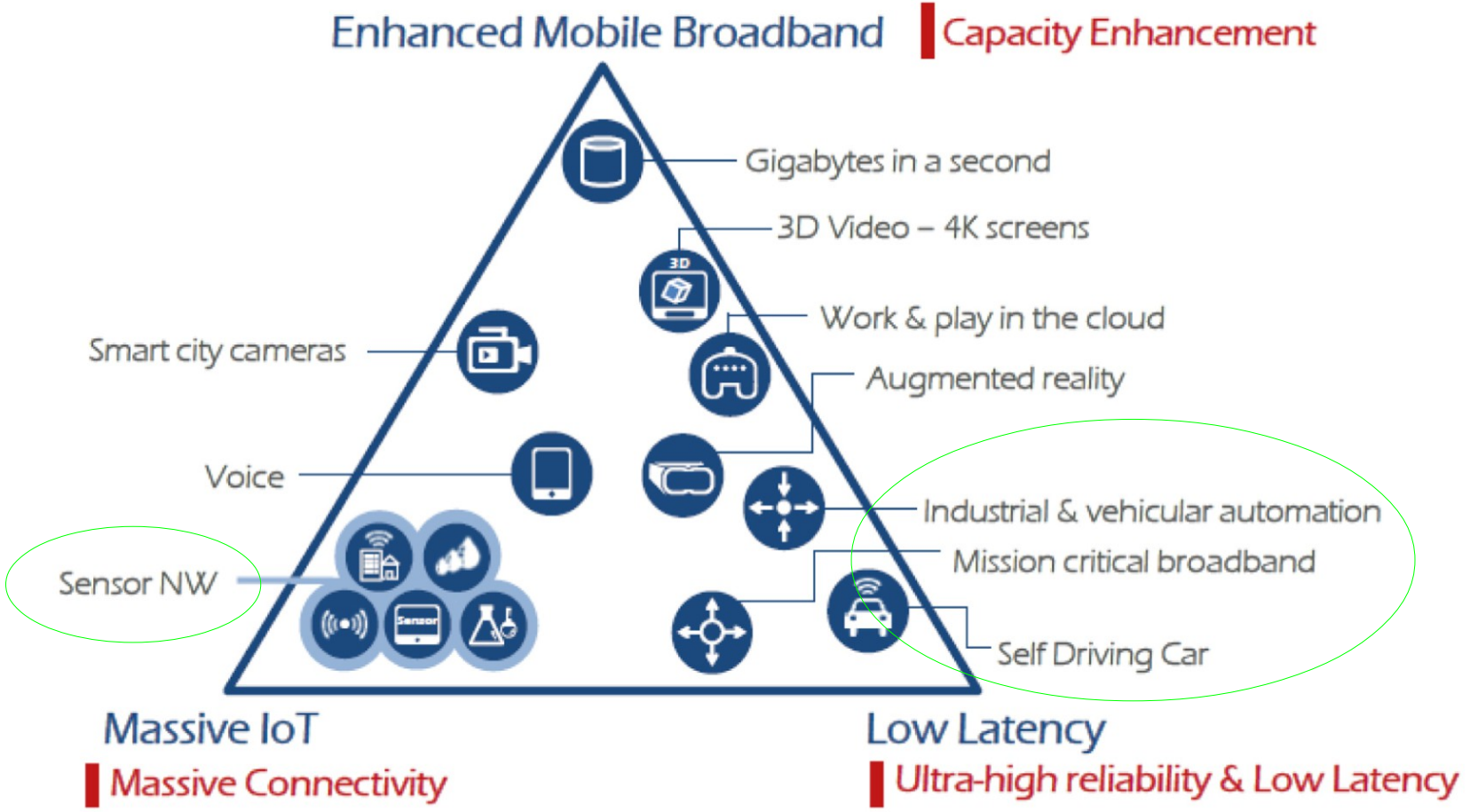
## Short range intra-vehicle and vehicle-to-roadside networks

Sensing tier of the entire system infrastructure.



• Need for efficient encoding of information along with communication protocols that are able to meet both energy efficiency requirements and reliability constraints.

# The “connected vehicle” in the 5G framework




(Source: ETRI graphic, from ITU-R IMT 2020 requirements)

# Aerospace, ICT and Automotive in Abruzzo Region


Main industrial assets in ICT and aerospace

**Leonardo**: avionics, cybersecurity and professional communications

**Thales Alenia Space**: design and integration of sub-systems for space segments

**Telespazio**: Fucino space center with Galileo Control Center

**Reiss Romoli**: professional education and consultance

**ELITAL**: PMI developing satellite antennas and aerospace products

Industrial assets in microelectronics and silicon

**Micron**: design center for solid state storage devices

**Lfoundry**: foundry services

A new arrival: **ZTE innovation** center in L'Aquila

Other relevant industrial domains in the region: automotive (**FIAT-DUCATO** line of production), chemical-pharmaceutical

Further relevant institutions:

**Gran Sasso national INFN labs**

**GSSI (Gran Sasso Science Institute)**

# Universita' dell'Aquila at-a-glance

Students: **>19.000**

Academic staff: **≈540**

Administrative and Technical Staff: **≈480**

Budget **> 90 Million euro**

30 Bachelor Degrees

31 Master degrees (7 of those are **international programs**)

5 Master degrees with single cycle (5 years programs)

8 PhD programs

**7 Departments**

- Biotechnological and Applied Clinical Sciences - DISCAB
- Civil, Construction-Architectural and Environmental Engineering - DICEAA
- Human Studies - DSU
- Industrial and Information Engineering and Economics - DIIIE
- Information Engineering, Computer Science and Mathematics - DISIM
- Life, Health and Environmental Sciences - MESVA
- Physical and Chemical Sciences - DSFC

# Universita' dell'Aquila: doctoral school in ICT

## Five technology tracks

New generation computing on architectures (cloud computing, web 2.0) and contents
Distributed and networked embedded control
Communications and networking
Advanced Software engineering
Complex electronic and photonic devices

## Main application domains

Smart city and smart environment
Automotive and sustainable mobility
Intelligent manufacturing and logistics
Aeronautical, avionics and space systems

… in a fully international program launched in cooperation with the ICT domain

About 10 new students per year enrolled with a mix of institutional and private fellowships.

# Universita' dell'Aquila and the local eco-system

The University and several companies have been actively involved by the Regional Government to define the **local Smart Specialization strategy as recommended by the EU.**

**ICT and aerospace** has been retained as one of the five strategic industrial sectors to be considered for the regional economic and social development, and for conveying investments from structural EU funding

Moving from a long lasting experience of cooperation with local companies, the University has been proactive in **promoting formal association of companies and institution in the ICT and aerospace domain.**

**Under full auspicies of the Regional Government, the formal agreement for instituting the ICT and aerospace domain has been signed on Sept. 8th 2017. More than 30 companies have already signed, while others are about to join.**

**The University and local institutions have successfully promoted L'Aquila as one of the 5 cities selected by MiSE for 5G trials in Italy**

# Universita' dell'Aquila and the 5G-based smart city

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IL PIANO ZTE
**Lo sviluppo delle reti 5G**
Il progetto Zte consiste in un centro di ricerca e innovazione, all'Aquila, per lo sviluppo delle reti 5G e il miglioramento della user experience dei clienti attraverso tecnologie digitali. L'azienda, considerata leader in ambito Ict, impiega circa 30mila dipendenti in 160 Paesi. Nel 2016 Zte ha attivato una partnership con Wind Tre per il consolidamento e la modernizzazione delle attuali reti mobili.

IL PIANO EMERGE
**Il trasporto intelligente**
Emerge punta a realizzare un avanzamento scientifico e tecnologico nel campo Its (Intelligent transport systems) attraverso una partnership tra l'Università dell'Aquila e altre realtà del mondo produttivo e della ricerca come RadioLabs, il laboratorio associato dell'ateneo aquilano e il polo di innovazione automotive Iam. Una sinergia che si avvarrà del supporto di altre iniziative che prevedono la partecipazione di Fca.

IL PIANO DARKSIDE
**Rivelatori di luce al silicio**
Le quattro tecnologie abilitanti che concorrono a rendere possibile DarkSide hanno un potenziale di impatto enorme. I rivelatori di luce al silicio permettono la realizzazione di nuove macchine di screening anti-tumorali e sono al cuore della tecnologia LiDAR, che sta rivoluzionando il comparto automotive. Ad Assergi nascerà un centro di ricerca e assemblaggio di fotosensori al silicio.

IL PIANO S4L
**La banda ultra larga**
Un raggruppamento di società italiane del settore a guida Thales Alenia Space Italia ha elaborato la proposta de sistema S4I (soluzioni satellitari per la smart specialization in Italia). L'obiettivo è complementare le reti terrestri, esistenti e future, per servizi istituzionali che necessitano di banda ultra larga. S4I è una infrastruttura di telecomunicazione in grado di soddisfare le richieste di connettività a banda ultra larga.

# Ecco i progetti per il futuro dell'Aquila

## Ricerca, sviluppo e tecnologie digitali ricevono l'ok dal vice ministro Bellanova: «Ricadute su tutta la filiera industriale»

di Monica Pelliccione
L'AQUILA

La Zte, leader nell'Information and communication technology, è pronta a sbarcare all'Aquila con un centro di ricerca e innovazione che si occuperà dello sviluppo delle reti 5G e del miglioramento della user experience dei clienti, attraverso le nuove tecnologie digitali. E' una delle quattro iniziative presentate nell'ambito del forum "Ricerca e sviluppo: i progetti industriali per il futuro dell'Aquila", alla presenza del vice ministro dello Sviluppo economico, **Teresa Bellanova**.

Il centro di ricerca Zte è frutto della rete di rapporti costruita dal presidente del *Centro s.p.a.*, **Alberto Leonardis**, con la società cinese guidata da mister **Hu-Kun** e le istituzioni locali. «Stiamo ponendo le basi», hanno dichiarato **Gianpaolo Porchiazzo**, Legal istitutional manager e **Mirella Zhu**, director Zte Italy, «per concretizzare un'implementazione della ricerca sulle tecnologie avanzate nel campo delle telecomunicazioni, in sinergia con l'Università dell'Aquila».

Il progetto Darkside prevede la nascita, ad Assergi, di un laboratorio per la ricerca e l'assemblaggio di fotosensori al silicio. C'è poi il progetto Emerge che, grazie alla partnership con l'Università dell'Aquila e con Fca, punta a realizzare un avanzamento scientifico e tecnologico nel campo dell'Intelligent Transport Systems. Infine, S4I Space Economy con un progetto che coinvolge Thales Alenia Space e Telespazio.

«C'è perfetta sintonia tra lo sforzo che è stato fatto in questo territorio e le linee di politica industriale che il governo ha messo in campo negli ultimi tre anni», ha detto il vice ministro dello Sviluppo economico, **Teresa Bellanova**, «questa città è già proiettata in una dimensione internazionale per quanto riguarda innovazione e ricerca. I quattro progetti hanno un valore profondo perché hanno ricadute su tutta la filiera industriale. C'è la speranza di dare a questo territorio, e al nostro Paese, una fuoriuscita dalla crisi che è dentro una visione che dice che si può remunerare il capitale investito e si possono generare opportunità di lavoro qualificato». Presenti all'incontro il vice presidente della Regione, **Giovanni Lolli**, la rettrice dell'ateneo, **Paola Inverardi** e il sindaco, **Massimo Cialente**.

**Monica Pelliccione**


La presentazione dei progetti a Palazzo Silone (foto Raniero Pizzi)


Da destra Lolli, il vice ministro Bellanova, la rettrice Inverardi e Cialente

Aula Magna del Dipartimento di Scienze Umane
Viale Nizza, 14

Mercoledì 19 Aprile 2017
Ore 10:30

# 5G@AQ

L'avvio della sperimentazione della tecnologia 5G nella città dell'Aquila

## Connected Vehicles & 5G

Enrico Pisino
FCA-CRF – Vehicle Research & Innovation

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RadioLabs

*standing for*

**"Consorzio Università Industria – Laboratori di Radiocomunicazioni"**

*Research Consortium*

*(home page: http://www.radiolabs.it)*

UNIVERSITA' degli STUDI di ROMA TOR VERGATA

ROMA TRE UNIVERSITÀ DEGLI STUDI

Università degli Studi de l'Aquila

AnsaldoSTS

Hitachi Systems CBT S.p.A.

*Consortium founded in 2001*

*An Associated Research Lab is in L'Aquila*

# The rail-road innovation loop for autonomous mobility

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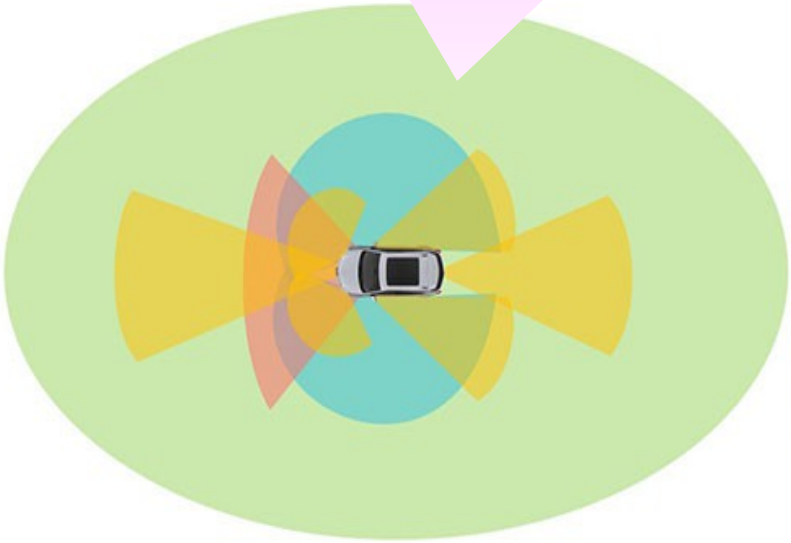
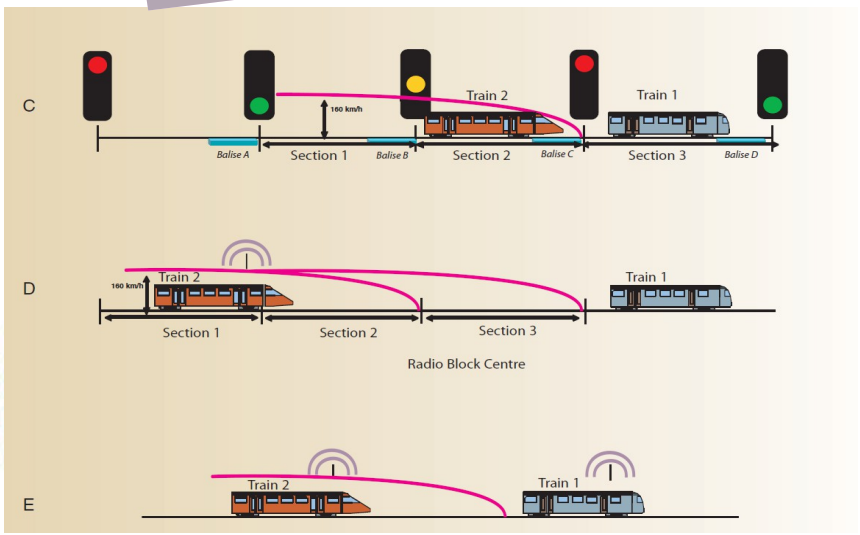
**Highly accurate, secure and trustable localization**
**(Radiolabs & Ansaldo-STS)**

**Automated (centralized) management of high speed trains through positioning and GSM-R connections**






**Advanced wireless technologies (5G) and pervasive sensing through smart infrastructures**

**From centralized control to autonomous mobility on railways**

# EMERGE at-a-glance

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- EMERGE – linked to a strategic Italian initiative - aims to develop & validate the enabling technologies for the **Connected Car**:
  - *Geo-localization*
  - *Pervasive Connectivity*
  - *Cybersecurity*
- Main partners: FCA-CRF, Radiolabs, University of l'Aquila
- Unique features:
  - Test Bed in urban environment with a 5G network
  - 5 vehicles with SAE L3 automated driving systems
  - Sinergy with Rail automation stake-holders (RFI-Ansaldo STS)
- Open to international collaboration

# EMERGE: (more than) three interconnected projects

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## Connected vehicle

**FCA-CRF**

**Applications for vehicles**

- *Safety margin*
- *Dynamic navigation*

**Dual use for daily operations and emergencies**

**Framework program for innovation FCA - MiSE**

## EMERGE Navigation

**RadioLabs**

**with Elital, Leonardo, Telespazio, UnivAQ**

**Technological platforms and applications**

- *Geo-localization*
- *Connectivity*
- *Cyber-security*
- *Cloud and edge computing*
- *Navigation*

**Prototyping on light commercial vehicles (DUCATO)**

**Industrial research project Agreement for innovation**

**MiSE & Regione Abruzzo**

## EMERGE Centre of Excellence

**UnivAQ**

**Advanced research on connected vehicles**

- *Research*
- *Higher education*
- *Development of labs*
- *City-wide test bed:*
  - → *GALILEO*
  - → *5G*

**Networking with international research centres (GSA, ESA, ASI, ...)**

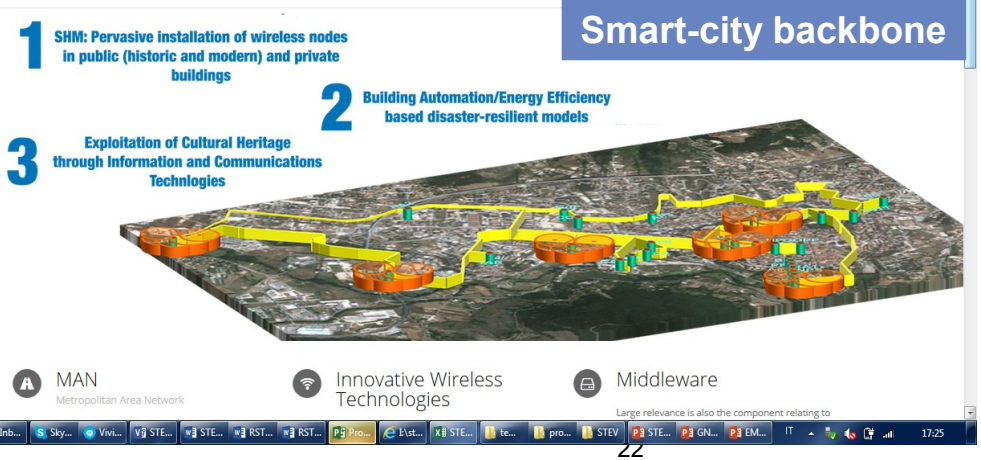
**CIPE**
**Special funding for research and innovation in L'Aquila**

# EMERGE: living test bed opportunity

- ***Hub for the deployment of the EMERGE initiative co-ordinated by FCA***
- ***Pre commercial trials with 5G (EC 5G Action Plan)***
- ***A smart city with a pervasive broadband infrastructure and test facilities***
- ***Collaboration with international research Centers and Space Agencies***



Smart-city backbone




5G network deployed by WIND-TRE selected
after a competitive tender by Ministry of Develeopment
(University of l'Aquila and CRF partners of the Consortium )

# EMERGE: R&D, exploitation and impact

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**Innovation**

High accuracy – high integrity, GALILEO-based geo-localization platform
Advanced Vehicle Autonomous Integrity Monitoring
Cybersecurity platform
V2I platforms on heterogeneous networks including 5G & Satcom
Low-profile electronically steered vehicular antennas
Edge-Computing and Cloud-based services
Collaborative navigation in urban environment

**Exploitation and impact**

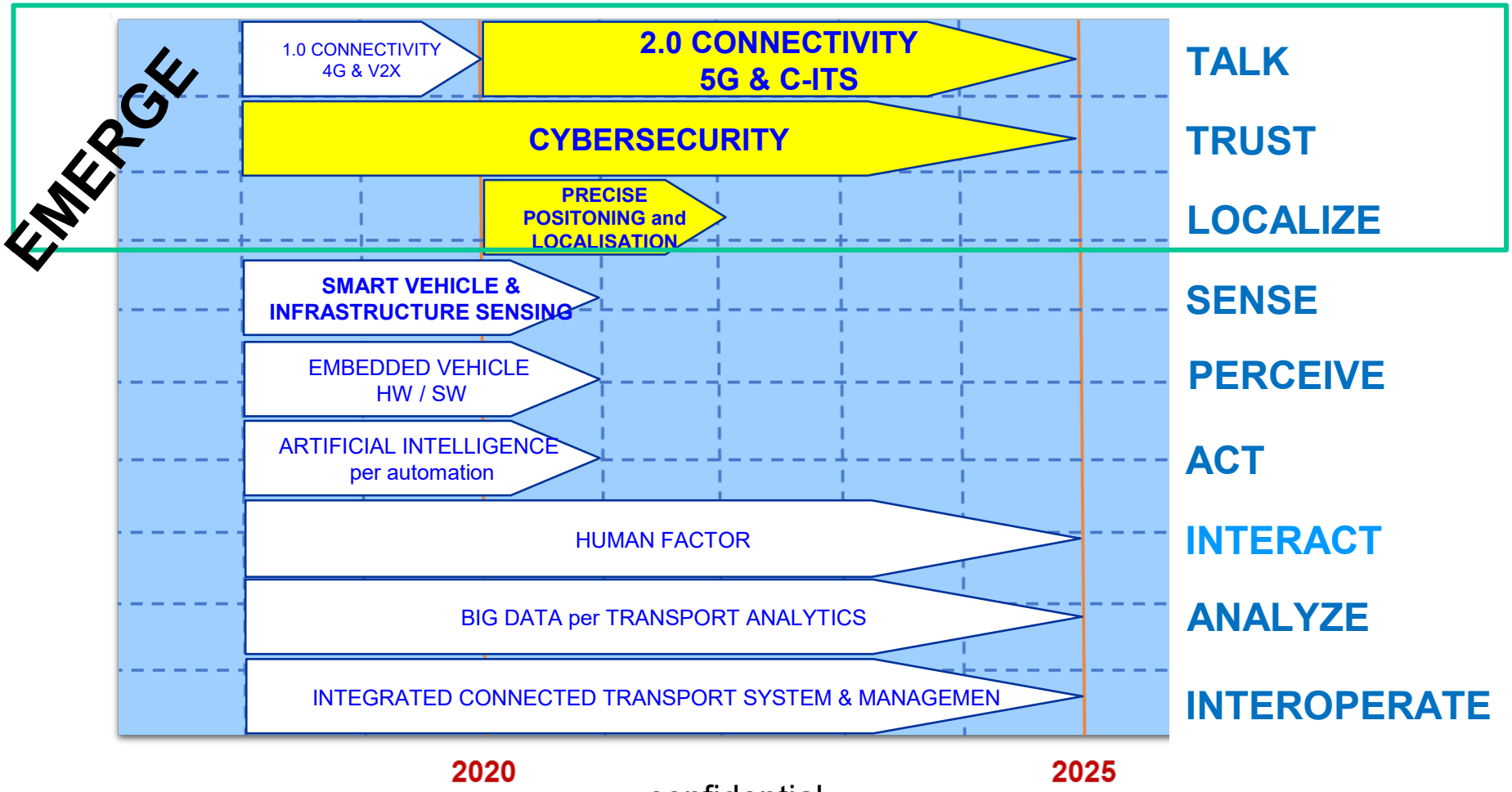
Enrolment and education of students in the ITS domain at both master and doctoral level → improved attractiveness for UnivAQ
Promotion of tight industrial cooperation within the local ICT\aerospace domain in a global network → new qualified job positions
Further qualification with job opportunities of the local automotive district
Job opportunities in research and innovation in the academy, related research centres and spin-offs, large industry.

# Research agenda of Cluster Nazionale Trasporti



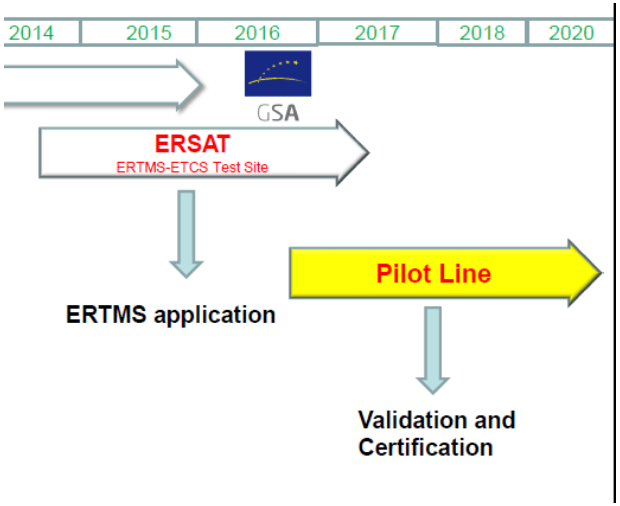
Road | Rail | Waterborne

## ROADMAP automated & connected vehicles (1-2 March 2017)



# Long-term synergy between automotive and rail


## ERSAT EAV Test Bed



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# Thank you!

Questions