INSTITUT Mines-Télécom

FONDATION TELECOM

INSTITUT CARNOT Télécom & Société numérique

Panorama des activités de l'IMT en Com Num: Enjeux et Perspectives

Sébastien Houcke

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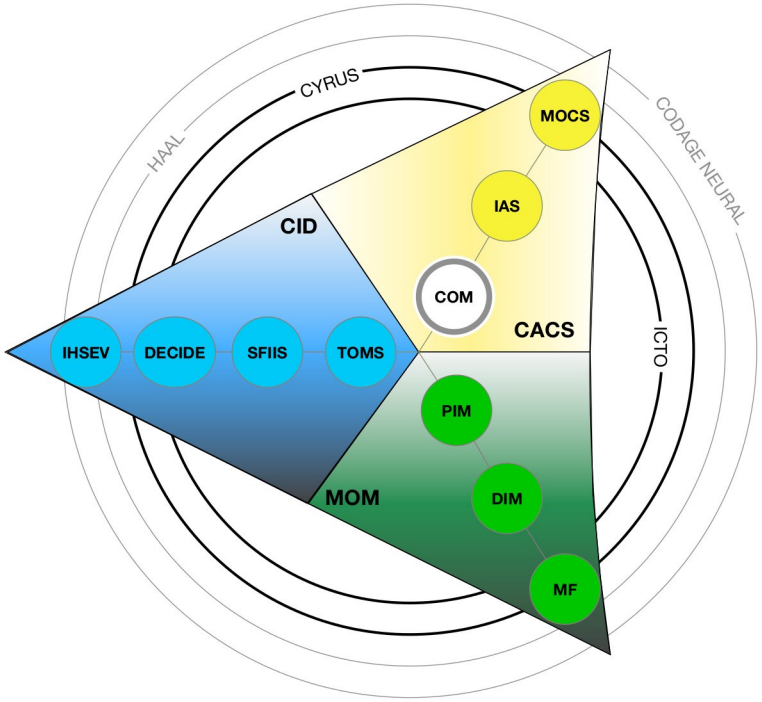
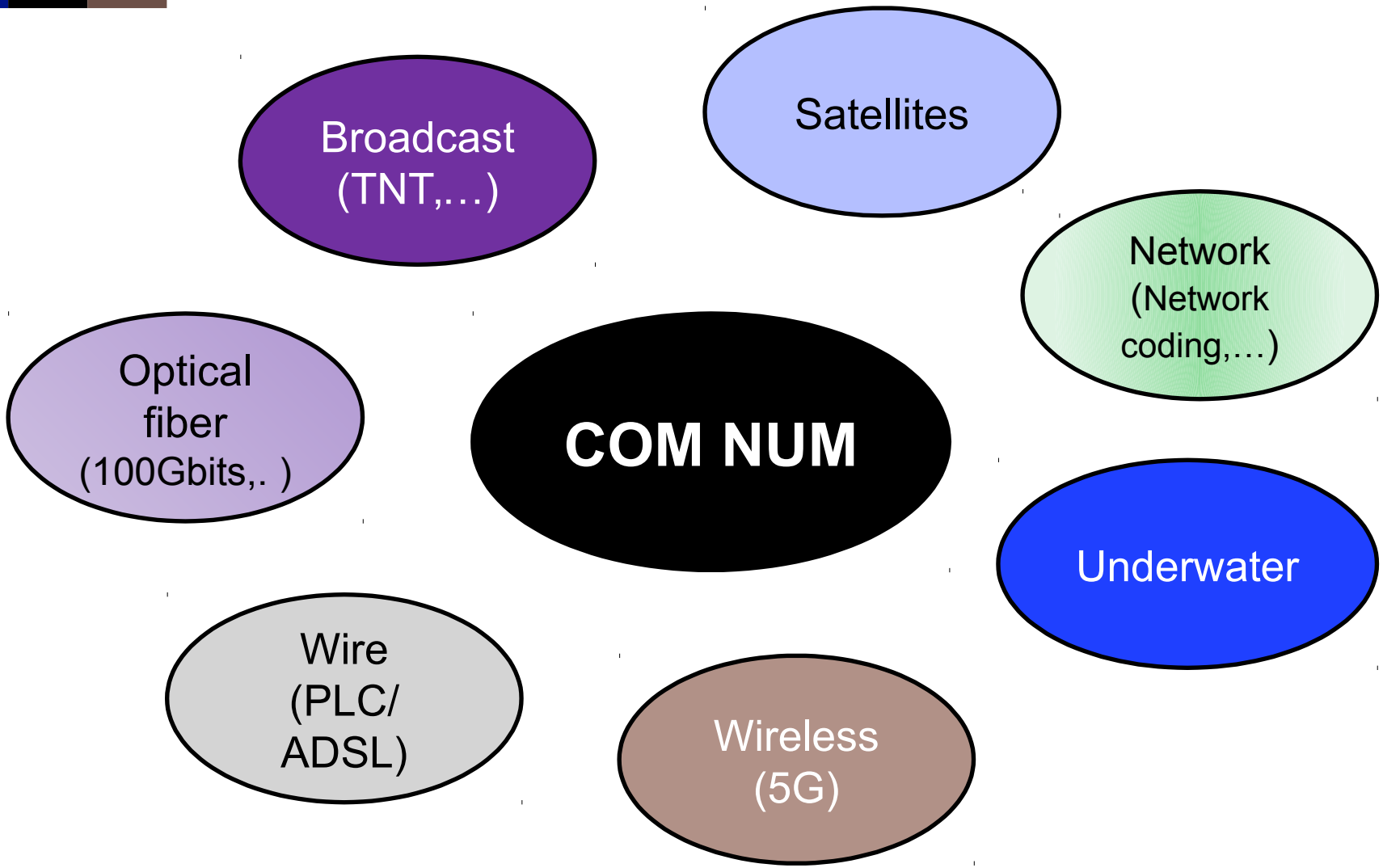
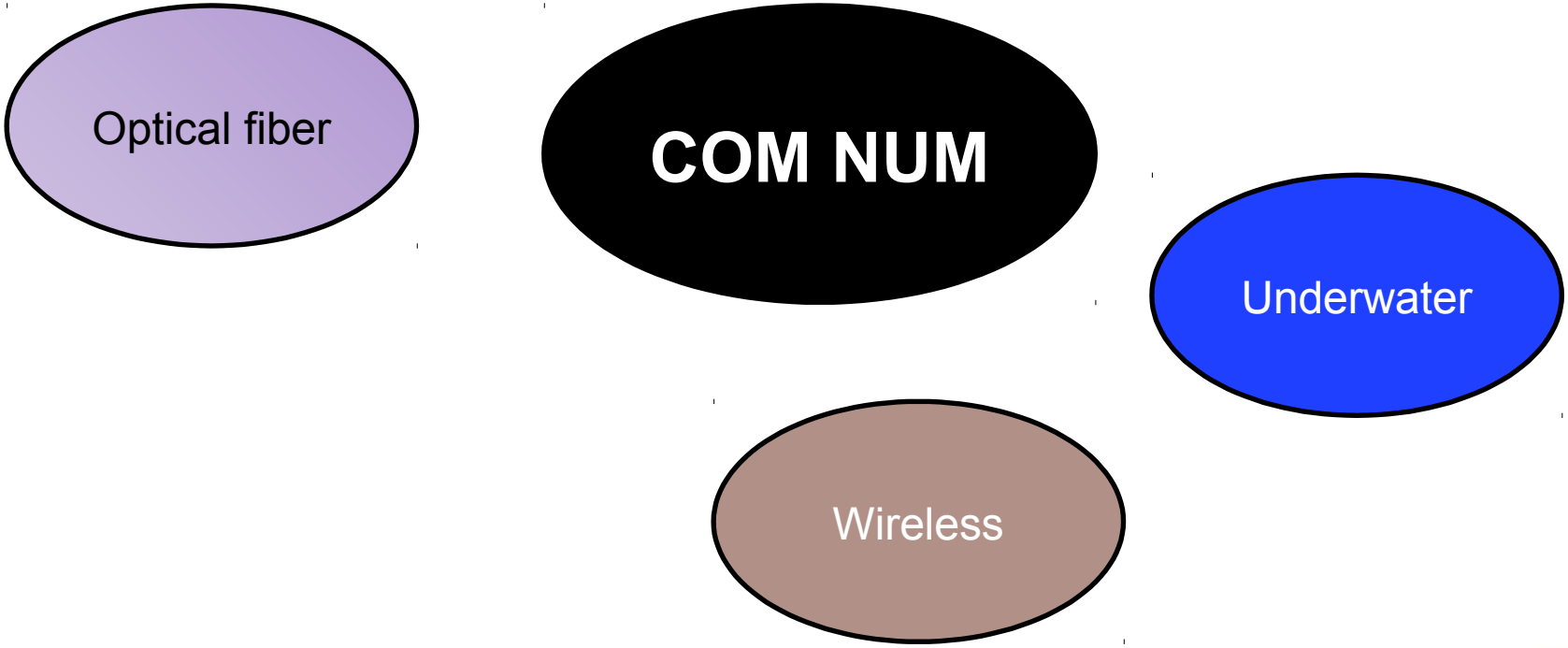
Télécom Bretagne / Lab-STICC



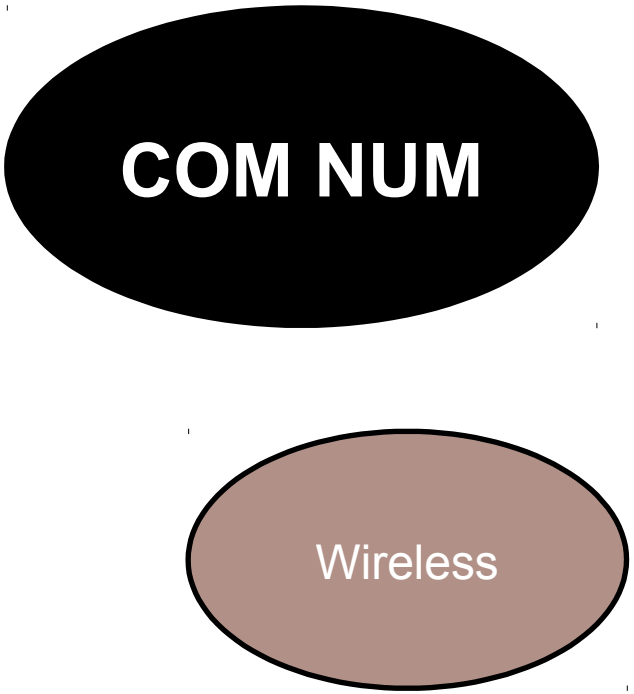
« Communiquer et décider, des capteurs à la connaissance »


Broadcast
(TNT,…)
Satellites
Network
(Network
coding,…)
Optical
fiber
(100Gbits,.)
COM NUM
Underwater
Wire
(PLC/
ADSL)
Wireless
(5G)


Optical fiber
COM NUM
Underwater
Wireless

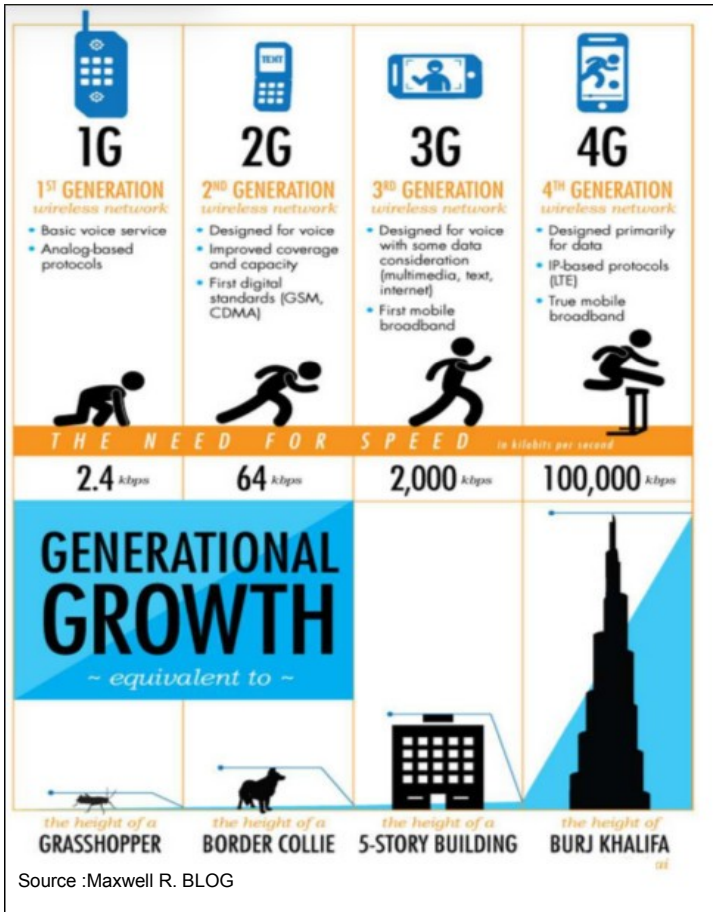
La 5G

Projets phares : METIS/FANTASTIC 5G
Coopération massive (sujet en rupture)

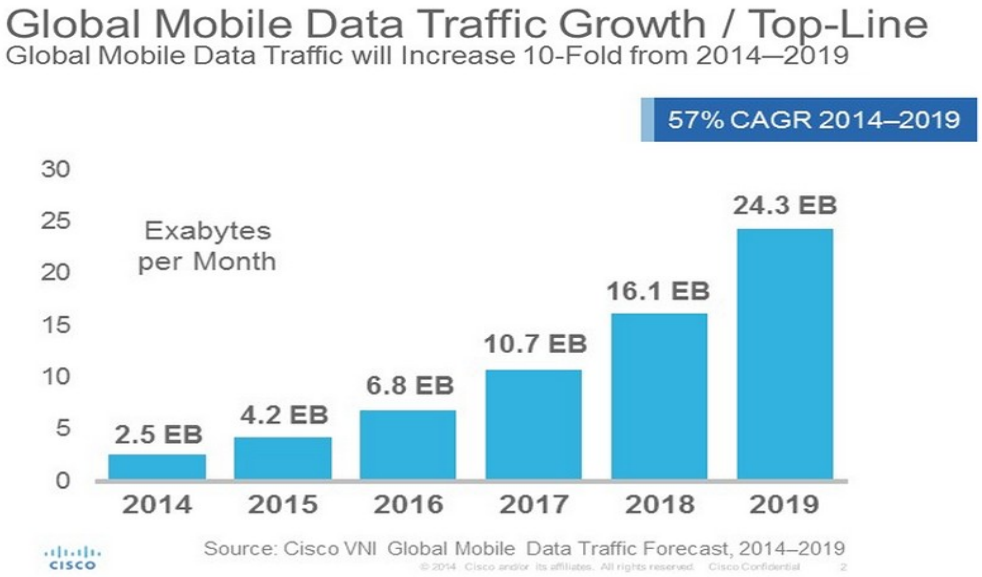


5G Context

Mobile Data traffic increase : x2 every year or two years according to different sources : x1000 in around 15 years …



Source :Maxwell R. BLOG



Greater traffic data asymmetry: Ratio of downlink to uplink traffic will rise as the proportion of video traffic in the mobile network grows.

5G design challenges

The Need for Immersive Experience

GSM 12kbps voice
3G 1Mbps HTTP
4G 10MBps Web Browsing
5G 1Gbps Multi-View UHD

The Need for Fibre-Like User Experience

GSM 20kbps
3G 24Mbps
4G 300Mbps
5G 10Gbps

The Need for Zero Latency Experience

GSM 150ms
3G 50ms
4G 10ms
5G 1ms

The Need for 0-Switching Time Experience

GSM Seconds
3G 500ms
4G 200ms
5G 10ms

The Need for Always-On Experience

5 Billions People
100 Billions of Things
3 Billions of Apps

Source Fig.:D. Soldani, « On the Advanced 5G Network Infrastructure for the Future Internet », ICC 2013, Budapest, June 2013

5G

High Performances

Densify
Use more spectrum
Increase spectral efficiency
Model systems and evaluate performance

Efficient Resource allocation

Manage interference
Manage spectrum
Save energy
Manage traffic and Mobility

Massive connectivity

Support MTC
Support Intelligent Transportation Systems
Support Public Safety applications

QoE and Security

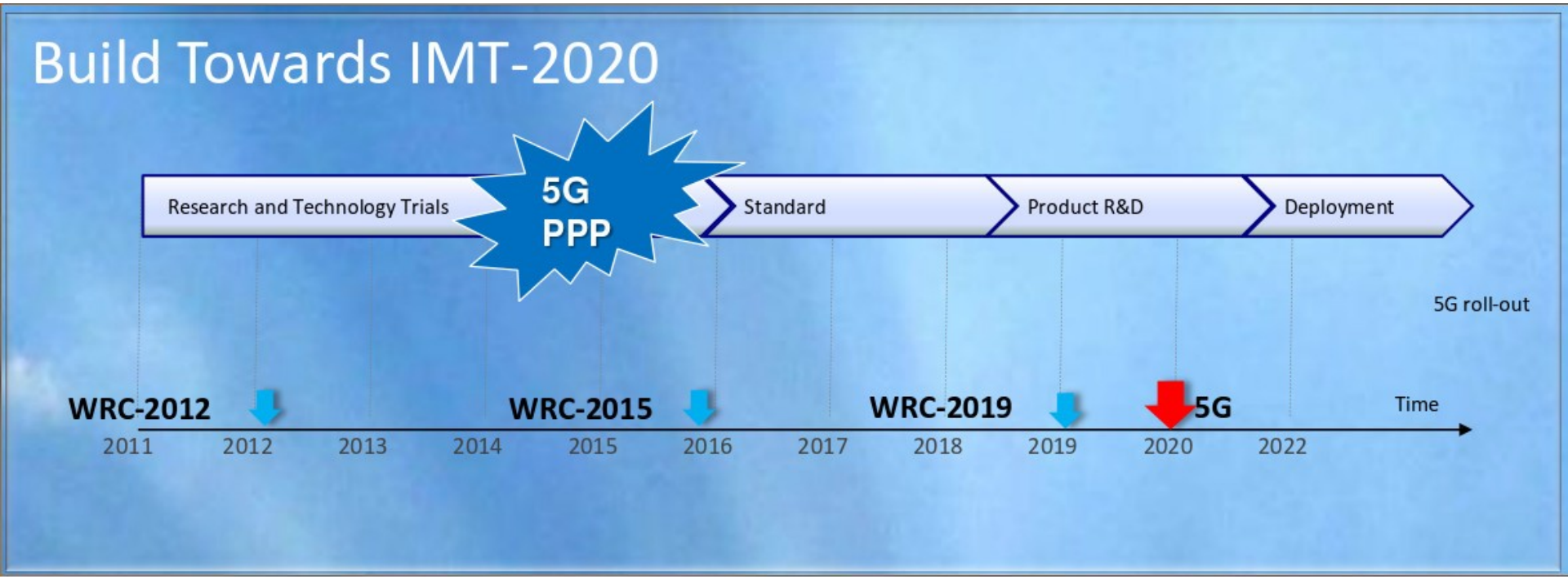
Improve video QoE
Ensure efficient content diffusion
Ensure securtity and privacy

Flexible and Low Cost Network Management

Virtualized and cloud based networks
Decentralized self-organized networks
Fixed-mobile convergence
Infrastructure sharing

Source: M. Coupechoux

5G Timeline


Build Towards IMT-2020
Research and Technology Trials
5G PPP
Standard
Product R&D
Deployment
5G roll-out
WRC-2012
WRC-2015
WRC-2019
5G
Time
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2022

METIS et FANTASTIC 5G

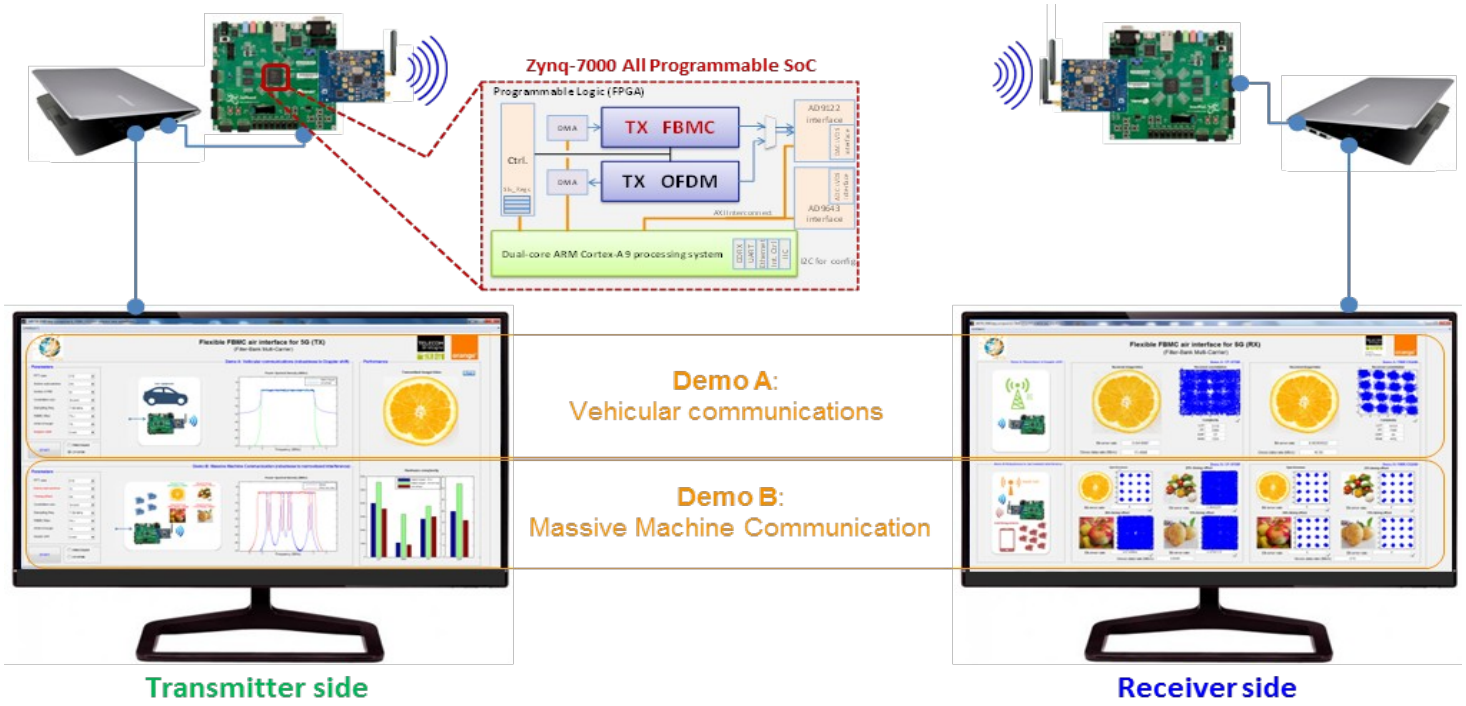
METIS (FP7) : Mobile and wireless communication Enablers for the Twenty-twenty Information Theory

Resource and power allocation for NOMA schemes

Coding solutions

METIS et FANTASTIC 5G

- Proof-of-Concept: flexible FBMC (filter bank multicarrier) air interface for 5G
- Novel low-complexity hardware architecture is proposed for FBMC/OQAM at transmitter side



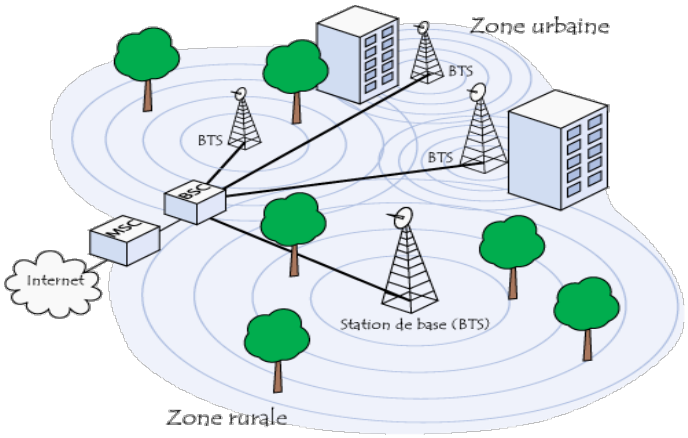
IMT Activities on 5G

Densification

HetNets: impacts on capacity, coverage,
energy efficiency, impact of mobility.
Multi-RAT: joint radio resource management schemes
Relays: relay placement optimization,
relay power optimization, relay selection,
D2D: online matching of D2D users

Improve Spectral Efficiency

MIMO: MU, Massive, Network MIMO
Network Information theory: for the cognitive interference channel.
Decentralized optimization.
Lattice codes: interference reduction, network coding



IMT Activities on 5G

Interference and Spectrum Management

Interference coordonation and load balancing. User association schemes with service differentiation
Opportunistic spectrum access: joint power and sensing strategies for underlay cognitive radio. Collaborative sensing.
Inter-operators spectrum sharing rules, algorithm design for Licensed Shared Access, Carrier Aggregation

Energy Saving

Energy optimization of **mobile devices**.Modeling of device energy consumption
Base station switch off mechanisms: Transmit power reduction impact on capacity and coverage

IMT Activities on 5G

And many other topics:

Machine-Type-Communications (Architectures, access,…)

Traffic and Mobility Management (User location prediction, delay tolerant users,…)

Intelligent Transportation Systems

Quality of Experience (adaptive video streaming algo.,…)

Security and Privacy (PHY Layer security, …)

Software Defined Networks

Cloud Architectures

RF Design

ERC – PERFUME (D. Gesbert)

High PERformance FUture MobilE internet

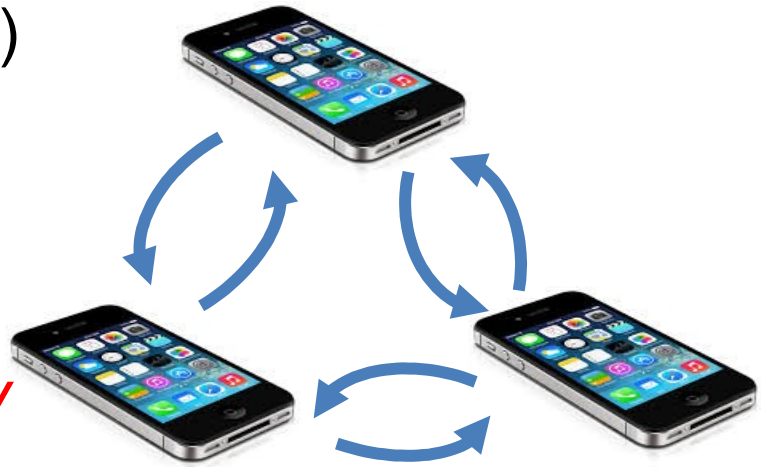
- 5 year project, starting Oct 1st 2015.
- 8 recruitments, 2.4M euros budget.
- *"Coordination with a twist"*

The PERFUME twist

- Coordination methods targeting devices
- Devices are smarter…yet underutilized
  - More computing power (GHz chips)
  - More memory (hundreds of GBs)
  - More aware (measurements, D2D com)

- Can we utilize the *collective intelligence* among devices?

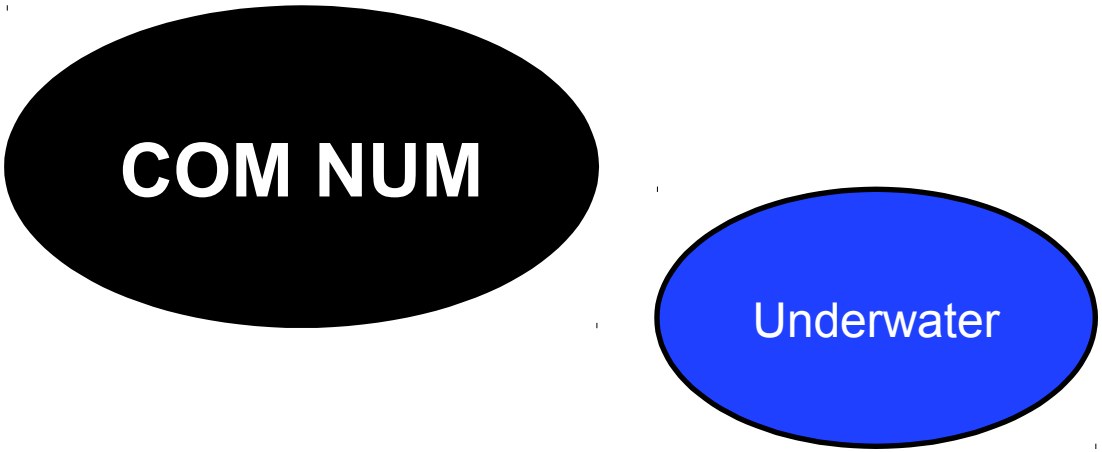
=> Rooted in *Team Decision Theory*



The PERFUME twist

- Content caching
- Cognitive spectrum sharing
- Coordinated MIMO, power control, scheduling
- Coordinated access protocols (MTC..)
- Coordinated positioning (drones)
- Challenge: *Robust coordination under limited information sharing*

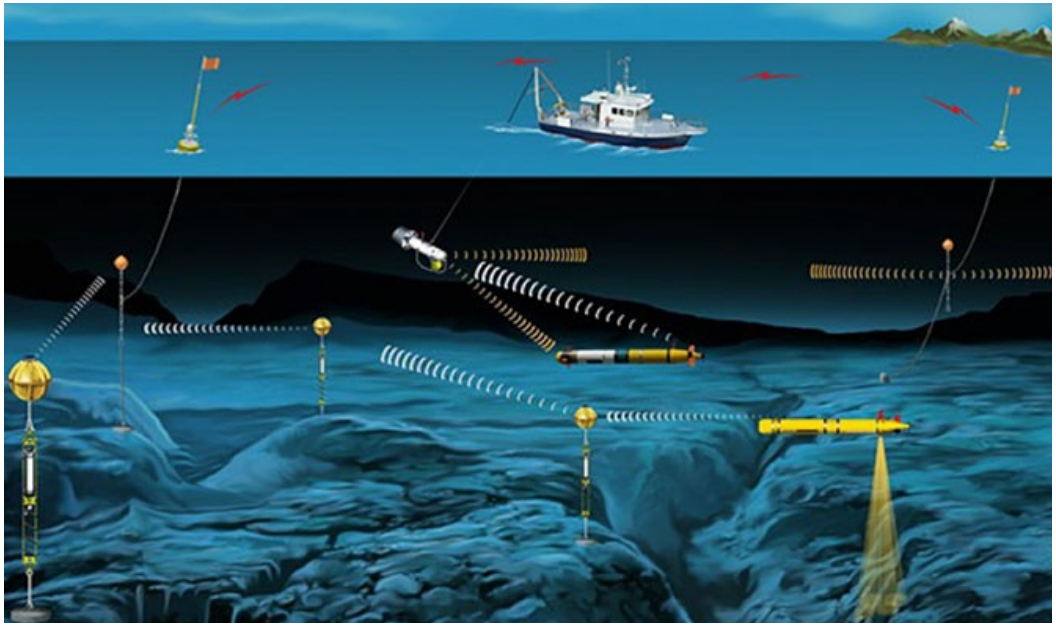
Réseau Sous marin intelligent



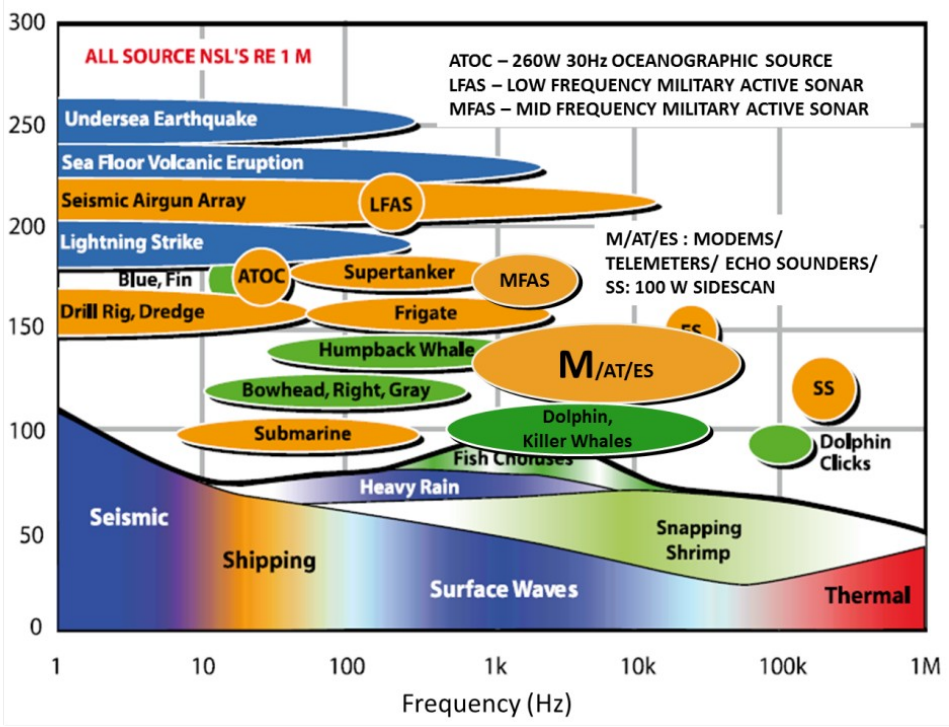
Communications Acoustiques

Context
WirelessTransmission underwater
Exploration, security and ocean supervision (drones)

Tools
MIMO Tech.
Chanel estimation
Underwater networking
Plate-forme



Réseau de Modems Acoustiques Intelligents



Sensing

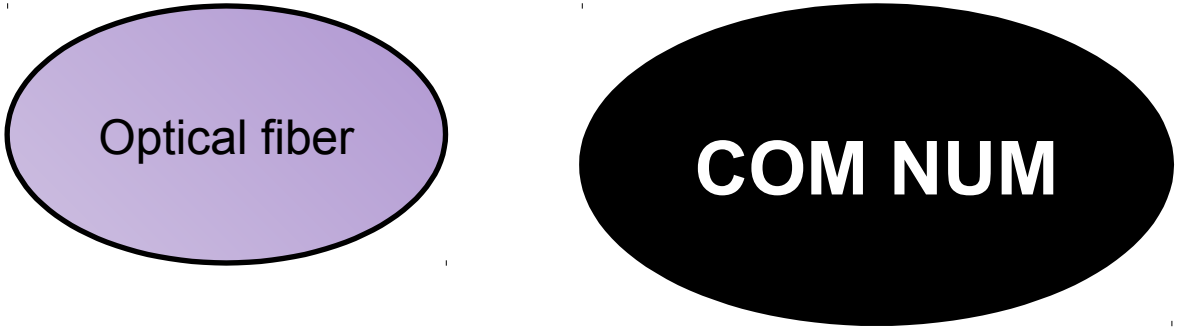
Transmission parameters adaptation

Localisation (fixe / mobile)

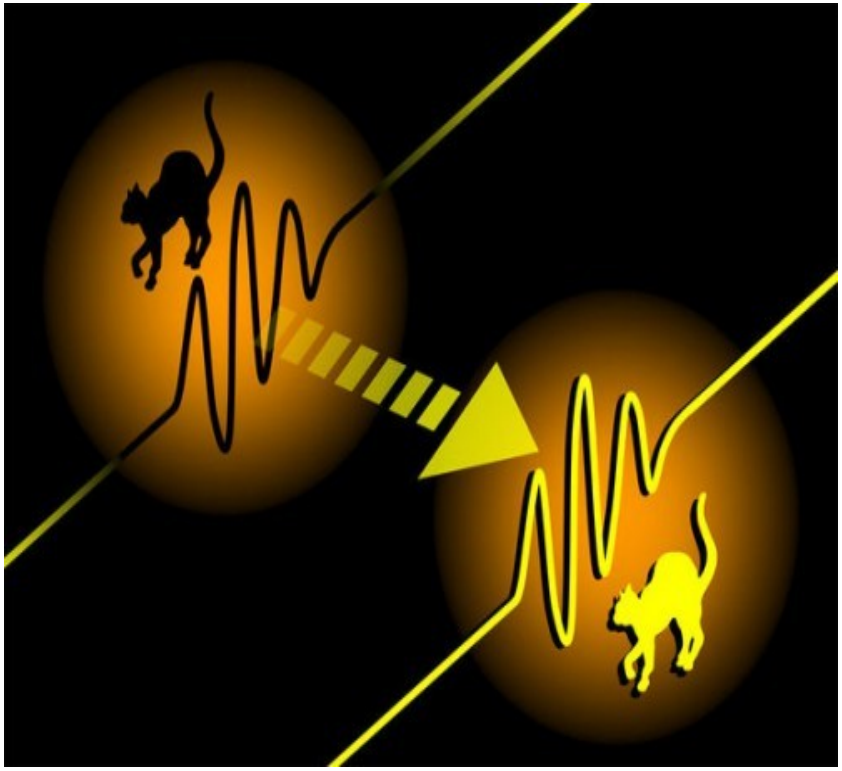
Plate forme Portability (hardware/ software)

Chanel Estimation and stochastic replay

Les communications quantiques



Communications Quantiques



Basé sur le principe de l'intrication :

« phénomène dans lequel l'état quantique de deux objets doit être décrit globalement, sans pouvoir séparer un objet de l'autre, bien qu'ils puissent être spatialement séparés. »

Communications Quantiques

La distribution des clés en cryptographie

Le calcul quantique

Le codage correcteur d'erreurs

Les outils fondamentaux

Autre Sujet en forte rupture

ERC – NEUCODE (C. Berrou)

Crossroad of neuroscience, computational intelligence and information theory

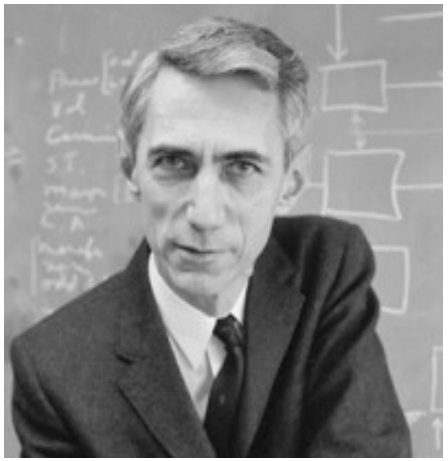
Way information is represented, stored, recalled and processed in the cerebral cortex

Contributions :

- intelligence artificielle
- neurosciences cognitives

ERC – NEUCODE (C. Berrou)

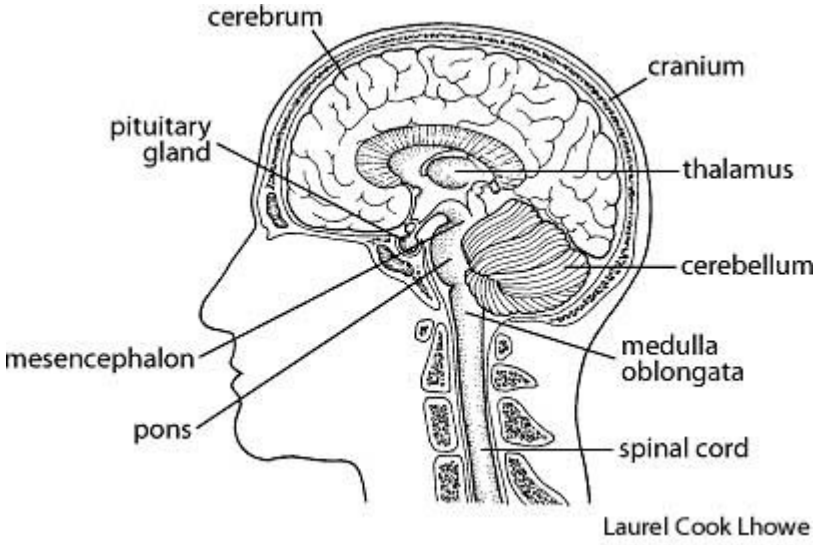
Modèle de Shannon appliqué au cerveau



Monde physique exubérant → On enlève la redondance inutile → Codage de source → On ajoute de la redondance subtile → Codage de canal → Monde mental, parcimonieux et robuste

analogique

numérique



CLAUDE BERROU
VINCENT GRIPON

PETITE MATHÉMATIQUE DU CERVEAU

UNE THÉORIE DE L'INFORMATION MENTALE

Odile Jacob
sciences

Remerciements

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