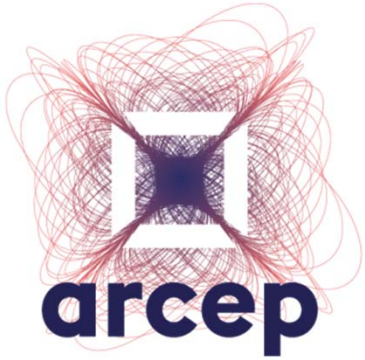

5G : Issues and Challenges

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Spectrum 5.0 : Policy Choices for 5G Deployment

Madrid, 14 september 2018

Why do we need 5G ?

- Some historical background
  - 1st mobile phone call in 1973
  - 1981 1G
  - 1992 2G
  - 2001 3G
  - 2009 4G
  - 2020 5G
- Tech leap frog :
  - 2G success in Europe (3.8 billion users in 2015, 700 operators, 219 countries)
  - Less successful for 3G 4G
- Addressing growing data and application demands
  - Data = magnify x10 in the last 5 years
  - Potentially inconsistent applications and congestion issues
  - Households customers asking for enhanced QoS
    - High speed, mobility...
  - Specific needs of "vertical" industries
    - health, energy, automobile, local communities, media, agriculture...)

The drivers of 5G

- 5G : a global technical system more than a simple new generation of technology
  - Ability to address specifically and appropriately to different needs
    - massive connectivity of very numerous connected things
    - out and indoor ultra broadband reliable & low latency applications
    - critical and low latency for massive machine type communications

- 5G : incremental and progressive
  - Progressive transition from 4 to 5 G : 4 – 4.5 – 4.9 G
    - 4G and 5G will coexist for a long time:
    - The terminals will be multimode;
    - 4G and 5G carriers can (and will) be aggregated; 4G carriers will be in fine encapsulated in 5G carriers.
  - The first deployments, before 2020, cannot be considered as part of the "real" 5G, but rather as evolutions of the 4G network. In parallel, experiments (on a larger or smaller scale) on 5G breakthrough technologies will multiply.
  - No spontaneous disruption of market structures (oligopoly, vertical integration)
  - 4G continuous roll out and technological evolution with numerous pre-5G experiments
    - Bouygues Telecom, in partnership with Huawei, was able to achieve a maximum bandwidth of 1 Gbps thanks to the simultaneous use of 4 carrier aggregation (800 MHz, 1800 MHz, 2100 MHz, 2600 MHz) and more efficient modulation (256 QAM);
    - The SFR-Numericable group has performed tests with Huawei in 3.5 GHz band with new antenna configurations (MIMO 8x8);
    - Orange launched a massive MIMO experiment (16x16) with Nokia and, in partnership with Ericsson, Orange was able to reach a maximum speed of 10 Gbps.

Main various uses of 5G… potentially incompatible

- mMTC - Massive Machine Type Communications
  - uses related to the Internet of Things : extensive coverage, contained energy consumption and relatively low data rates.

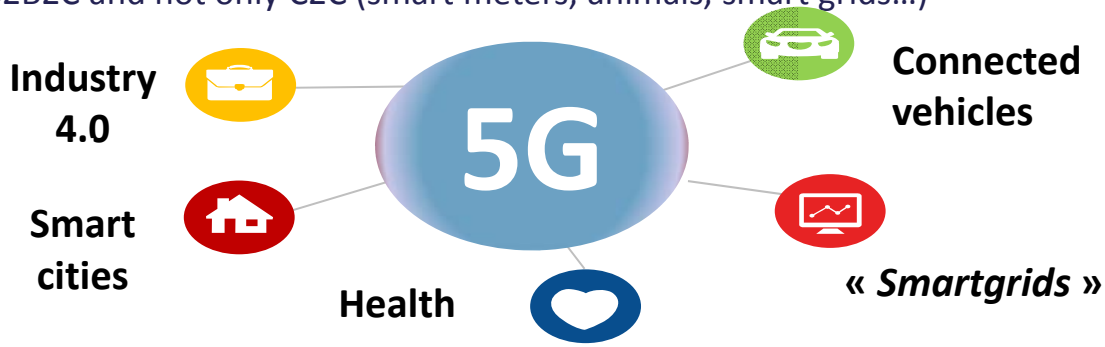
- eMBB - Enhanced Mobile Broadband
  - ever faster connection, to view videos in ultra high definition (8K) or to use virtual or augmented reality applications. This family represents the evolution of most services offered by 4G networks.

- uRLLC - Ultra-reliable and Low Latency Communications
  - high reactivity and a very strong message transmission guarantee

- Calling for network slicing and new performances
  - Each family (mMTC, eMBB & uRLLC) is characterized by its own uses and an appropriate performance envelope.
    - The indicators cannot all be satisfied simultaneously
  - 5G networks configured in "slices", adapting dynamically to demand, depending on usage.
  - Adaptation (network slicing) implemented thanks to
    - the "softwarisation" and "virtualization" of a large number of network components,
    - using as many generic and reconfigurable components as possible, rather than specific components dedicated to very specific tasks

No spontaneous disruption… yet new business models for 5G: a critical cornerstone

- Radical change in electronic communication services design
  - Multimode devices
  - Carrier aggregation
  - Virtualization & Network / service separation
  - specific and adapted answers to different needs
- Internet oriented visions AND service oriented
  - Two visions corresponding in fact to two successive phases of deployment
  - The vertical application areas of the 5G and 5G single techno designed from the needs of vertical
- Weights of vertical sectors and entry of specialized suppliers and platforms
  - B2B2C and not only C2C (smart meters, animals, smart grids…)



- Who should invest and what monetization /premium price to back investments ?

The corresponding specific challenges of 5G

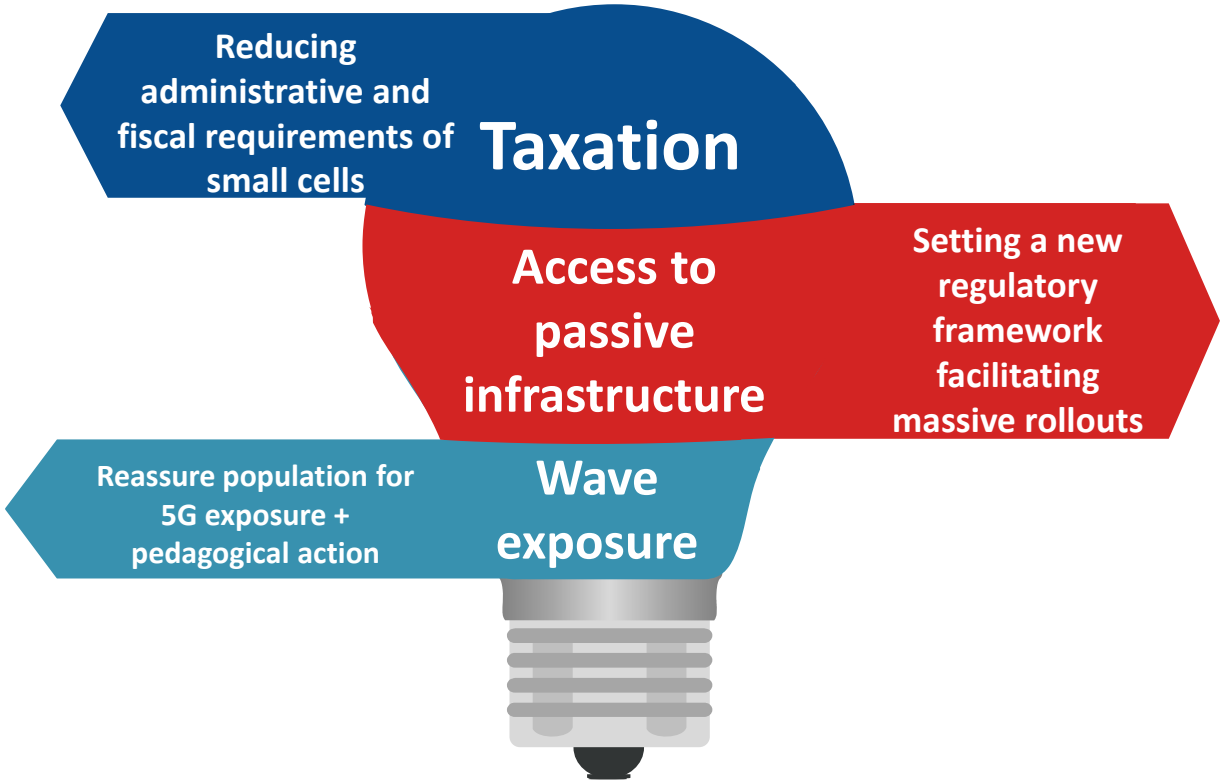
Conditions for the markets take off

Technical challenges

- Availability of high performance services
  - A new ATAWAD perspective
  - Sustainable Solutions
- Interoperability and standards
  - Interoperability at data, object, application or infrastructure level
- Massification of connectivity
  - millions of objects
  - Mobile Infrastructure + fiber backhaul

Example : smaller and smaller cells

- The 5G is presented as the generation that will make massive use of small cells.
  - Adapted to millimeter spectrum
  - network performance and quality in areas supportint high demand (public transport, shopping centres, etc.)
  - more generally in an urban context.
- The deployment of small cells : a priority issue for mobile operators and calling for public action



Economic challenges

- Financing infrastructure investments
  - Avoiding the winner takes all and first mover advantage
  - Who will pay? Operator / transport operators / civil engineering or road infrastructure ?
- Value sharing
  - Data monetization
  - Customer control
- A form of paradox
  - Commoditization risk
    - « Neutral small cell as a service" ?
    - Wholesale operators ?
  - Emergence of intermediaries, platforms, consortia to capture value
    - Who will capture value: manufacturers, telcos, OTT, service providers
    - Competition between different ecosystems
- Pricing models to be designed
  - applied to micro communications

Arcep regulatory challenges : to facilitate rather than regulate

- Supporting experiments and pilot sites
  - Arcep regularly allocates experimental frequencies
    - 5G experimentation in 3.5 band
  - An experimental legal framework now in place
  - Setting of a spectrum allocation window / desk
    - allows an actor to offer innovative services on a commercial basis by being exempted by Arcep from certain obligations (subject to a turnover and a maximum number of users and for a maximum period of two years).
    - Both technical and marketing test
  - (Calling) Support for vertical sectors

- 9 pilots sites
  - Le Havre, Lille, Lyon, Nantes, Saint-Étienne…
  - To provide technical and faisability answers
  - In order to adapt award procedure accordingly

Spectrum issues

- Spectrum management/ harmonization
  - Availability of frequencies and technological neutrality
  - A spectrum review ; introduction of new bands and multi carrier aggregation
    - 3,5 (3.4-3.8) : core of the 5G, the 1st deployed in Europe / up to 400 Mhz blocs / for telco or specialized service providers ?
      - Currently Internal Affairs/ THD radio
    - 2,6 : Professional Mobile Radio (currently Defence)
    - 700 : Golden frequency
    - 1.4 (L band) : Supplemental down link + Pb of radio relays and Defence use
    - 26 Ghz : Pioneer band, millimeter, Width + 3Ghz . But problem with radio links and observation satellites
    - Free bands
      - around 900 MHz for IoT
      - around 5.9 GHz, for connected vehicles (ITS or Intelligent Transport Systems) and connected trains (CBTC train autopilot system, already used for example on line 1 of the Paris metro) which are very large objects.
    - Satellite connections for specific needs
  - Frequency refurbishment
  - Coverage requirements, due to millimeter frequencies

- the impacts of the multiplication and transformation of numerous small cells
  - Regulation, mutualization, investments and roll out...
  - Street furniture access
  - Sharing of physical infrastructure among multiple providers
    - Need to change network sharing guidelines?
    - Sharing everywhere or in town ,
    - Roaming and coverage
  - The backhaul
    - How much does it cost and who pays
- Timeframe
  - 2018 : year of the pilots
  - 2019-2020 : allotments of frequencies
  - Frequency release and refurbishment
  - Allocating (together)
  - which recipients : operators or vertical industries?

Other regulatory challenges

- Data-based regulation and control
  - Coverage
  - Variability of QoS (latency, energy, flow, symmetry)
- Net neutrality (network/service link, traffic differentiation)
  - "network slicing", used in future 5G deployments, a priori to comply with BEREC recommendations.
  - The subject of net neutrality applied to future 5G networks is still very open:
    - new analyses to be carried out, in parallel with the 5G definition.
- Specific scopes of intervention
  - Infrastructure economics v. Data economics
  - Privacy
  - Social acceptance of waves
    - Anses, same framework for wave exposure

Conclusion

An international hurdles race competition ?

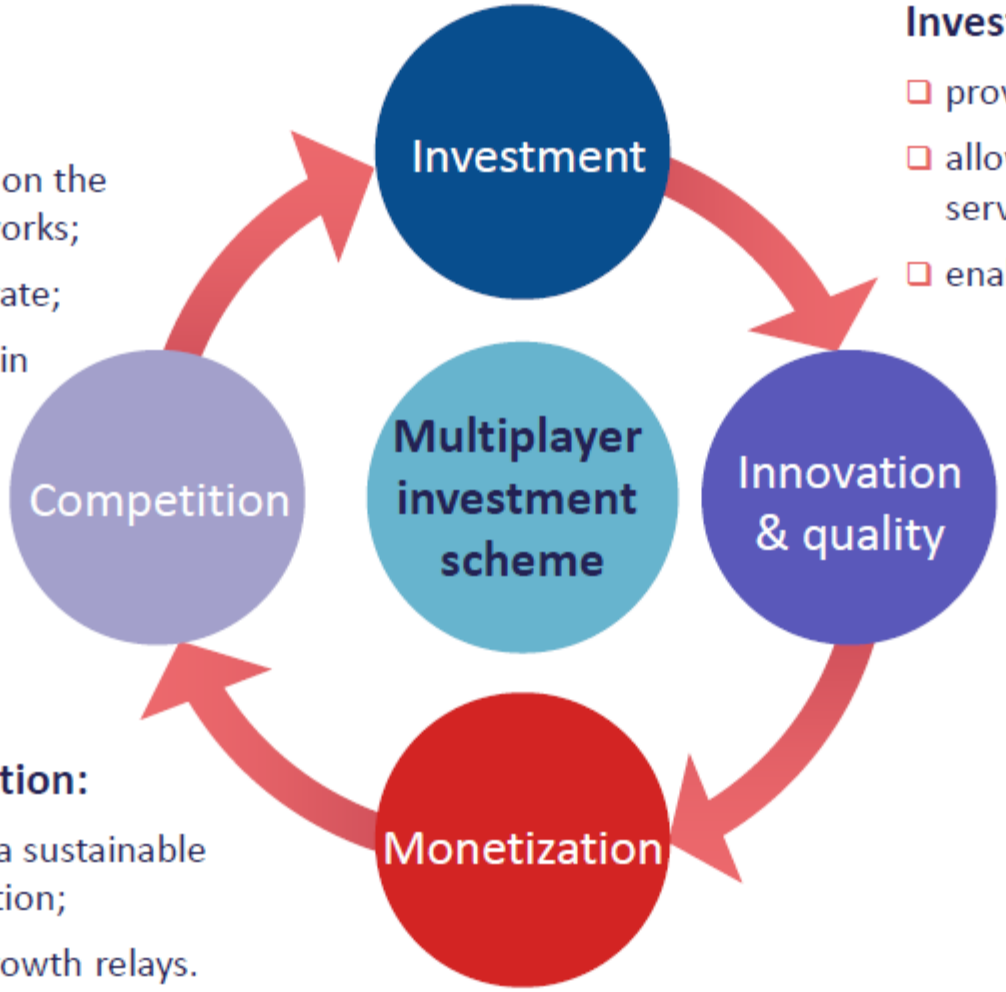
The ultimate goal : a sustainable multiplayers scheme

Investment:

- provides coverage and services;
- allows for bandwidth consuming services;
- enables innovation.

Competition:

- pressures operators on the quality of their networks;
- incentivizes to innovate;
- leads to investment in the networks.



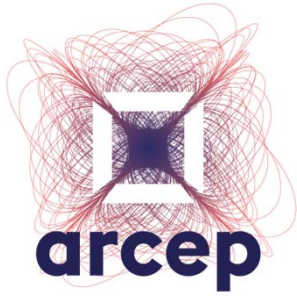
Innovation and quality:

- improve user experience;
- allow for monetization.

Monetization:

- enables a sustainable competition;
- brings growth relays.

Thank you for your attention



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