Policy Webinar on

Spectrum issues affecting EU/US ICT development collaboration

Wednesday, March 28th, 2018

15:00-16:30 (UTC)

The event is free of charge

Registration is required at:

www.picasso-project.eu

ICT Policy, Research and Innovation for a Smart Society

PICASSO has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 687874.

Spectrum issues affecting EU/US ICT development collaboration
Webinar Objectives

- With the webinar on **" Spectrum issue affecting EU/US ICT development collaboration"**, PICASSO will bring forward policy recommendations designed to improve EU/US ICT-orientated collaborations - specifically in the technological domains associated with 5G networks, Big Data, and IoT/CPS.

- The focus is on connectivity and the interactions among EU and US spectrum policy, technology development and research that challenge existing spectrum management rules (esp. on licensing and access) and create a need for research to establish the possibilities and the impossibilities that determine the balance among different spectrum access control policies.

- The participatory webinar will discuss the briefing paper that will be forwarded to registered participants latest one week before the webinar. The draft outline document is available at: http://www.picasso-project.eu/projectevents/picasso-webinar-on-spectrum-issues-affecting-euus-ict-development-collaboration/

Spectrum issues affecting EU/US ICT development collaboration

Agenda – Wednesday, March 28, 2018 – 15:00 - 16:30 (UTC)

- **PICASSO Welcome and purpose of the call**
  Maarten Botterman, PICASSO Policy Expert Group Chairman
- **Introduction to EU-US Spectrum policy issues relating to ICT development**
  Jonathan Cave, GNKS Consult and University of Warwick

Participatory discussion: current status and expected development in EU and US

- **Three domains focus - 5G, Big Data, IoT/CPS**
  PICASSO 5G Networks Expert Group – Yaning Zou
  PICASSO Big Data Expert Group – [Jonathan Cave, deputising]
- *PICASSO IoT/CPS Expert Group – Christian Sonntag*

Introduction and Participatory discussion: Focus per domain on spectrum issues and its affections to EU-US collaboration

- **Preliminary conclusions (Briefing Document validation)**

Project in brief

> **Coordination and Support Action**, funded by the European Commission/DG CONNECT

> **Duration:** January 1, 2016 - June 30, 2018

> **Target groups:** industry, government and civil society actors involved with ICT research and innovation development and policy

> **Target regions:** European Union, United States of America

> **Key Message:** ICT research and innovation (R&I) collaboration between the EU and the US can help it to reflect socioeconomic and technological realities and to improve the contributions of ICT development and policy to enhancing economic growth and reconciling industrial needs with societal objectives.

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PICASSO priorities at the heart of EU policy orientations

"On its Strategy to create a Digital Single Market and digitise European industry, the European Commission focuses on accelerate standard setting and related enabling technologies, such as 5G, cloud computing, internet of things, data technologies and cybersecurity."

Andrus Ansip , Vice-President EC for Digital Single Market
Günther Oettinger, Commissioner for Digital Economy and Society

PICASSO focusses on synergies between ICT *policies* and ICT *technologies* to:

> reinforce EU-US collaboration in pre-competitive ICT R&I in key enabling technologies with the greatest promise in meeting societal challenges: **5G Networks, Big Data and Internet of Things (focus on Cyber Physical Systems)**

> support EU-US ICT policy dialogue by creating a forum for discussion and contributing to policy debate regarding **privacy, security, internet governance, interoperability and ethics**.

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Expert Groups

Synergies between policy and technology groups

3 Technology Groups
Strategic ICT Technology areas linked to Societal Challenges

5G Networks | **Big Data** | **IoT/CPS**

1 Horizontal Group
On ICT Policy linked to key ICT technology areas

Policy issues:
Privacy and data protection | Security | Standards and Interoperability | Ethics …

+25 Experts in total across all groups

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Spectrum and its impact on EU-US ICT collaboration: fundamental approaches and developments

Scoping the issue

Maarten Botterman
Chairman of PICASSO ICT Policy Expert Group

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Hypothesis for this webinar:

Research collaboration should mainly focus on common challenges;

1. Identify ways to find solutions that robustly work around the world ;
2. Support joint research that exploits these technologies to resolve common problems;

The possibilities and implications of agility in spectrum allocation and management constitute perhaps the most promising research area.

SPECTRUM ISSUES HAVE FUNDAMENTALLY CHANGED

Introduction to EU-US Spectrum policy issues relating to ICT development

Dr. Jonathan Cave

ICT Policy, Research and Innovation for a Smart Society

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Introduction

- PICASSO technological domains rely on connectivity.
  - Radio is important - users require ubiquitous connectivity
  - Much ‘fixed-line’ connectivity comes wirelessly
    - ★ Lower fixed capital investments
    - ★ Easier and cheaper to maintain, extend and update.
  - PICASSO-relevant developments
    - ★ 5G, Big Data, Internet of Things/CPS
    - ★ Derived areas such as Machine to Machine (M2M) communications, Broadcasting, Cloud Computing, Internet access and Smart Cities

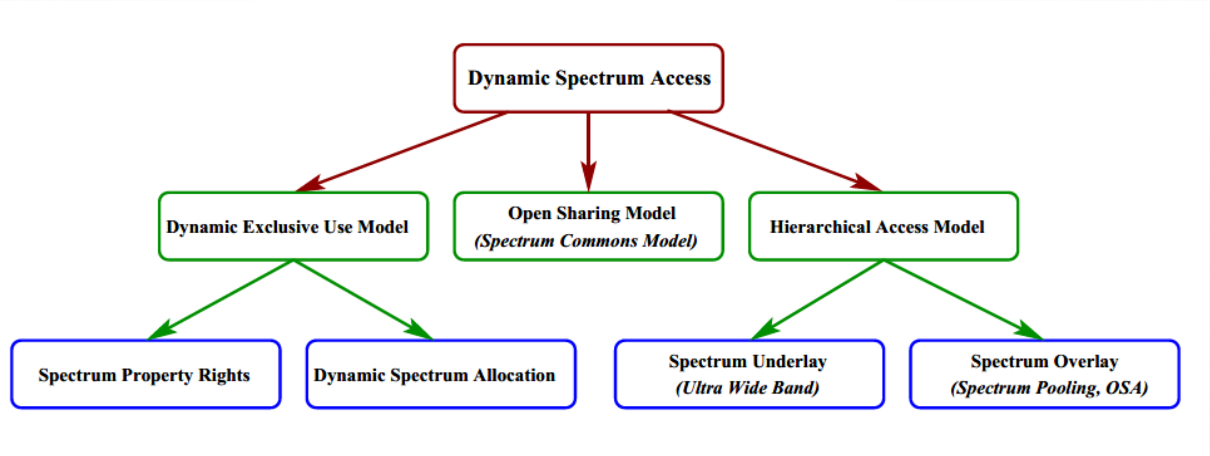
  all need connectivity based on innovative wireless communications
- Increased demand met by
  - Higher frequencies
  - More efficient use of existing bands (e.g. dynamic spectrum access)
  - Provides impression of virtually infinite bandwidth

Outline

- The spectrum policy framework
- Preliminary issues
  - adapt spectrum allocation and management to cope with technological development
  - anticipate and coordinate changes to research programs and outputs arising from spectrum policy
  - ensure, through policy and other means, the availability of suitable spectral resources for scientific purposes
- [domain-specific perspectives]
- Conclusions and outlook for policy

Allocation mechanisms

- Traditional mix of long-term exclusive rights and unlicensed bands
  - 1 user, all uses (place, power, protocol,…)
  - Any user, restricted uses
- ‘tweaks’ to boost innovation, availability, quality
  - Spectrum resale (new licence forms, interference protocols)
  - Use-it-or-lose-it, easement, white space disclosure rules
- DSA approaches:



Challenges to existing spectrum policies

- There are 4 broad 'styles' of spectrum policy:
  - *Prohibition*
    - Bans access/use of specific spectral resources by designated users, uses or technologies
    - Default: allow access/use under common framework conditions
  - *Permission*
    - Allows access/use by designated users, uses or technologies
    - Default: do not permit such access
  - *Trade*
    - System of tradeable spectrum access/use rights
  - *Negotiation*
    - Bargains or contracts between
      - those who create, administer or own spectral resources and
      - those who might need access to them or usage rights.
- These may need to be rebalanced or reconfigured

Altering spectrum policies

- Immediate impacts
  - Enable (or inhibit) identification and implementation of *efficient* use of spectral resources
  - Improve or impair service production and distribution over existing spectrum
- Dynamic effects
  - Incentives for the development and deployment of new technologies, services and business models
  - Induced changes in market structure and economic outcomes
  - Affects any value chain with a wireless link

Research into wireless technologies and services

- Price of access determines technology development and deployment
- Changes associated with technological domains
  - User demands
    - Different requirements for e.g. continuity, quality, privacy, security
    - Vary among e.g. mobile users, Autonomous Vehicles, IoT devices, smart systems.
  - Uses
    - Different access and management technologies
    - Varying time-patterns and location, (fixed or varying) frequency and bandwidth needs
    - Exclusive, negotiated or pre-emptive access
  - Property rights and (re)assignment mechanisms
    - Contending needs of users and uses, business models, QoS, organisational structures
    - Variations: licensed, unlicensed, over/underlay spectrum; requirements to monitor and offer unused spectrum within a licensed block; and white space issues.
  - Physical infrastructure
    - Legacy dedicated infrastructures and links to wireline/fibre networks
    - Issues include e.g. femtocell planning, permissions, ownership and operation; train/road/subway/plane provision; and creating, operating and maintaining networks of 4G/5G repeaters.

Example: dual-use spectrum

- 2.6 GHz bands are meant to be available on a neutral basis
  - Suitable for symmetric (LTE) and unpaired (WiMax) technologies
  - Not obvious how much and which bands each should have
  - Intra-technology interference requires 'guard bands'
- Potential bidders were different
  - LTE bidders typically MNOs (more innovation, more agile)
  - WiMax bidders typically telcos and ISPs (richer, more mature)
- 3-stage auction mechanism
  - Allocation to technologies
  - Allocation to bidders
  - Location and pricing
- Complications
  - Adjacent legacy licenses
  - Option on resale (cornering the market)
  - Knock-on effects on participation and investment

Spectrum for research collaboration

- Coordinated scientific spectrum policy can facilitate research cooperation and development of interoperable and globally-compatible technologies
- Issues:
  - Spectrum availability for non-commercial, non-government uses
  - Integration of scientific, other spectrum management policies
  - Mobilisation of policies to extend reach and utility of shared scientific infrastructures (e.g. European Open Science Cloud)

Conclusions (in from the extremes)

- Spectrum *management* modalities will shift from static, long-term licenses to dynamic and less-controlled regimes, within broad limits on interference
- Spectrum *allocation* will be less restricted to specific uses or band 'owners'
- Spectrum *use* will become far more agile; today's long-term exclusive licences will be replaced by short-term, local, transferrable and 'recombinant' alternatives
- The *intersection of spectrum policy and regulation* will no longer belong to telecommunications regulators, but will increasingly involve
    - other regulators (competition, privacy, financial, health)
    - industry and civil society stakeholders

  This will enable it to
    - Reflect the increasing diversity of use, user and technology viewpoints
    - Shed a more balanced light on impacts of spectrum choices and
    - Employ new governance forms
- Spectrum policy will be part of a more integrated set of digital policies.

Spectrum in 5G networks

Dr. Yaning Zou
Manager of PICASSO 5G Expert Group

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Spectrum Vs 5G Use Cases

	eMBB	mMTC	uRLLC
Bandwidth	High, up to 2 GHz	Low	Moderate
Data rate	High, up to 20Gbps	Low	Various
Coverage	Up to 200m (Small cell)	Up to 30 km	50-500 m
Perspective Spectrums	**High-Band >6GHz**	**Low-Band <1 GHz**	**Mid-Band 1-6 GHz**

- Significant potential for the coexistence of 5G and other wireless services in higher frequency bands above 24 GHz

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5G Spectrum Management Models

- Licensed spectrum
  - Exclusive use $$
- Unlicensed spectrum
  - Wifi, bluetooth, Zigbee, LTE-U, Multefire…
  - L+UL spectrum: Licensed assisted access (LAA)
- Shared spectrum
  - Dynamic spectrum access (DSA)
  - US: Citizens broadband radio service (CBRS)
  - EU: Licensed shared access (LSA) or Collective use of spectrum (CUS)

- Technology neutral spectrum licences are essential!

Spectrum Harmonisation

- Motivations
  - Global roaming
  - Low cost device due to scale-economics
  - Avoidance of interference issue with neighboring countries
  - Value creation of spectrum licensing
- Alignment: governments and regulators
  - National-Regional-International levels
- WRC-19 -highly important!
  - Decisions on new mobile spectrum, especially in high bands
  - EU priorities: 24.25-27.5 GHz (adjacent to the US 28 GHz), 40.5-43.5 GHz (adjacent to the US 39 GHz band) and the 66-71 GHz band (seen in the frame of 57-71 GHz for licence-exempt use).

Potential Areas for EU-US R&I collaborations (1)

- Perspective spectrum access methods for 5G
  - What and how?
  - Relevance to vertical sectors
- Scope for licensed vs rule-based spectrum use-controls
  - Many possibilities…
- Enablers for innovative agile spectrum access and management
  - Technical: major technical components, research challenges & opportunities
  - Policy: how to link those technical aspects to spectrum policy for enabling effective 5G deployments with
    - ★ Different services and verticals
    - ★ Different actors – MNOs, new entrants and vertical industries

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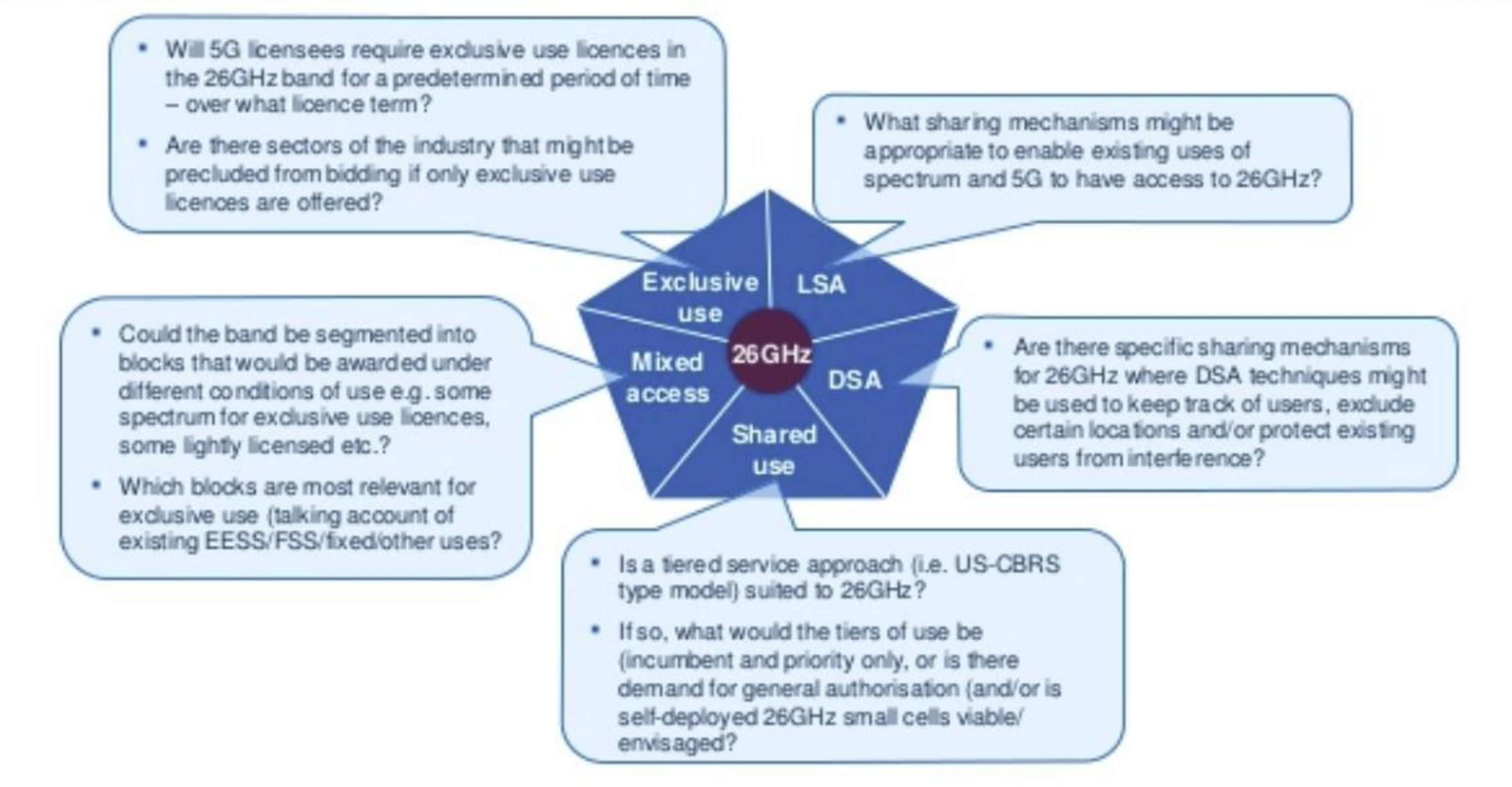
Potential Areas for EU-US R&I collaborations (2)

- Co-existence/sharing study
  - E.g., with fixed links and satellite services
- Analysis and policy for spectrum use conditions and pricing
  - License durations
  - National or sub-national level?
  - Whether the conditions should mandate levels of coverage, sharing mechanisms, etc.
- New possibilities for serving different use cases
  - Converged fixed + mobile services at high bands
  - Verticals will seek localised licences or local shared access
  - Neutral host small cell providers will serve a wide range of localised uses
  - Dual use spectrum for access + backhaul

Example: Access Models @26 GHz



Spectrum and Big Data

Dr. Jonathan Cave

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Big Data

- Two distinct perspectives (applying to Big Data + AGI)
  - Spectrum as an infrastructure to support Big Data applications
  - Application of Big Data to spectrum management
- Spectrum support for Big Data
  - Communications demands will grow in size and complexity with the range, distribution and criticality of Big Data-enabled services
  - Issues:
    - ★ Scaling;
    - ★ Handling the 3+ Vs;
    - ★ Data latency spectrum; and
    - ★ Mobile data access restrictions (privacy and security)

Big data spectrum management

- Resembles contributions of data analytics in other network contexts (e.g. Smart Grids or Smart Networks), including fine-grained approaches of active supply and demand management
- Range
  - (Existing) data visualisation, technical calculations and control monitoring systems and devices
  - Flexible, adaptive and ‘open’ forms of sensing and control, e.g. use of Machine Learning to detect new patterns in unstructured data and to conduct interventions and experiments to manage systems where management and users respond to each other
- Assists at all levels
  - Static allocation mechanisms
  - Human operational decisions
  - Automated management and DSA

Outlook

- Technologies become invisible and need seamless connectivity
- Spread of ambient intelligence will create demand for adaptive and flexible ‘environments’
- Artificial Intelligence (AGI/ML) will interact on the Internet with data, connected systems and other intelligences
- AGI/ML will allow us to manage complexity
  - Spectrum itself
  - Connectivity and QoS for ‘predict and provide’
  - Active demand management
- The AV example (how long is 1.4 seconds?)
  - Interactions of devices, data centres and humans

Spectrum Issues relating to IoT-enabled CPS

Based on a draft policy paper on spectrum by Jonathan Cave

Christian Sonntag

Manager of PICASSO IoT/CPS Expert Group

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Convergence of IoT and CPS: IoT-enabled CPS

- **Focus of current research and development in IoT**
  - Low-cost sensors / computing, connectivity, middleware → **enormous amounts of data can be collected**
- **How to make use of the data is often not clear**
  - What benefits can be gained from the data
  - **Challenge: From sensing to actuation, closing the loop**

→ **IoT is an enabling technology for CPS**

- **Cyber-physical systems are often embedded in large systems consisting of many coupled components with partial autonomy**
  → Cyber-physical Systems of Systems (CPSoS) **See also www.cpsos.eu**
  - E.g. power grids, oil and gas pipelines, commercial buildings, transportation systems, production sites, and other complex, critical infrastructures

Relevance of Spectrum to IoT-enabled CPS

- **Many billions of devices will be connected to the IoT**
  - In particular: Enormous increases in M2M communication
  - Connection of a vast variety of physical components with increasing levels of autonomy
    - Including sensors and actuators
- For practical reasons, often **wireless/spectral connections** are the only feasible approach
  - E.g. due to remoteness, large cost for retrofitting of existing infrastructures, mobility of system components, etc.

→ **Efficient spectrum management will be a crucial prerequisite for future IoT-enabled CPS**

Some Challenges

- **Identification / satisfaction of the range of requirements and device-specific needs for IoT/CPS traffic**
  - Communication ubiquity
  - Communication reliability and QoS
  - Communication prioritization and criticality
- **Identification / satisfaction of use-case-specific needs**
  - E.g. in Smart Cities, smart production, smart farming, etc.
- **Ownership issues that arise from many interacting parties**
  - In particular regarding the electromagnetic spectrum

Discussion

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