Sector Coupling through the lens of 5 G networks

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24/25 June 2020

9th Conference on the Regulation of Infrastructures

Data value chains from the perspective of 5G based big data virtual networks

5G is multipurpose driven for a large and open set of IoT applications with heterogeneous ICT requirements entailing heterogeneous Quality of Service (QoS) requirements of bandwidth capacities, heterogeneous sensor networks, heterogeneous (big) data processing capacities and heterogeneous security requirements.

To fulfill the requirements of IoT applications (networked vehicle applications, shared mobility service, microgrid etc.) it is important that the virtual network providers have the entrepreneurial decision competences to design the big data value chains according to the requirements of the IoT applications.

Spectrum allocation for future 5G based virtual networks

Within 5G networks there is an increasing trend from special purpose frequency allocation towards application blind unbundled flexible allocation. Whereas historically radio frequency were strongly coupled to specific types of service (e.g. broadband, radio senders, voice communications) the transition towards all-IP based Next Generation Networks (NGN) increases the trend towards unbundled flexible provision of frequencies.

Taking the allocation of the radio spectrum committees as given, one can nevertheless consider the degrees of freedom of the actors involved regarding reallocation. The focus is on sharing solutions: from separated sub bands with different priorities for parties involved towards market driven sharing based on opportunity costs of utilization of spectrum. Technological progress regarding spectrum usage is changing opportunity costs for spectrum allocation mechanisms creating innovative forms of sharing (dynamic spectrum sharing, spectrum pooling). Role of innovational complementarities should not be neglected. Innovations of the complementary dimensions should be taken into account e. g. big data and complementary investments into physical network infrastructures with particular focus on path-dependency.

Data driven sector coupling in smart sustainable cities (1)

Smart sustainable cities are not only considered as data hubs collecting large volumes of data offering large scope for data driven innovations, they are also providing within a nutshell a large variety of sector coupling opportunities due to the variety of smart network infrastructure and services involved.

Different forms of sector coupling within smart sustainable cities may be differentiated building innovative sustainable value chains:

- Sector coupling between different sectors: Synergies of urban system integration can be exploited in transport, energy, waste systems coupling biogas produced in recycle wastewater plants with feeding the busses and taxes.
- Sector coupling shaping new intermodal markets: From intramodal transportation markets towards mobility as a service markets and shared mobility projects.
- Coupling generation with consumption within microgrids operator platforms.
- Coupling renewable energy with electric vehicle mobility.

Data driven sector coupling in smart sustainable cities (2)

- Examples for cross-functional applications of ZigBee IP sensor networks within smart sustainable cities are infrastructure maintenance, garbage management and street parking.
- Electronic devices endowed with smart metering facilities enable real-time digital collection of consumption data of network services within urban infrastructures with remote accessibility of consumption data of electricity, heat, gas and water consumption enabling not only meter reading, but also billing, leak detection and peak load pricing.
- “Mobility as a Service” platforms can evolve for intermodal physical transportation services enabling seamless app-based mobility as a service combining the advantages of sector coupling with different complementary rail and road-based transportation.
- ICT and digitalization of urban flows is gaining importance increasing the opportunity to monitor and manage urban infrastructure in real-time. Smart sustainable cities also may benefit from cross-sector data sharing enabled by ZigBee IP sensor networks and smart metering. Examples can be drawn from electricity, water and waste systems, transport with real time peak load demand and supply.

Digital twins versus virtual networks

- Digital twins entail virtual replicas of urban infrastructure with real-time information feeds from sensors and other data sources. 5 G driven artificial intelligence (AI), augmented and virtual reality (AR/VR) technologies made it possible to create virtual replicas of objects, processes or places from the physical world consisting of a software representation of the real assets.
- Cities having deployed digital twins are Newcastle, Rotterdam, Boston, New York, Singapore, Stockholm, Helsinki, and Jaipur. The new capital city of Amaravati, India, uses digital twins when designing a greenfield smart city. A strongly growing number of digital twins is expected within the next decade.
- Although data value chains are pivotal in developing IoT applications in smart sustainable cities, the entrepreneurial governance problems within IoT requires physical and complementary virtual networks both together enabling the adaptive, real time and location differentiated network configurations.
- Although digital twin technologies may become very supportive within city planning and city operation activities, virtual replicas cannot replace the entrepreneurial governance problem solutions to organize the market driven activities of the different actors involved such as platform operators, virtual network providers or all-IP broadband capacity providers.