Quality of Service and MObility driven cognitive radio Systems

QoSMOS is about opportunist spectrum access, with managed QoS and mobility. Value chain development, spectrum portfolio management, integration with core networks, flexible terminals and demonstration are the main ingredients. The use of TV White Spaces is an early opportunity to exploit the outcome of the project. The consortium for this 3-year IP includes service providers, manufacturers, systems integrators, a test equipment manufacturer and the best research institutions and universities. NEC Japan has joined the consortium without funding, the first time they have been engaged in an EC project.

Main Objectives

The top-level objective of the project is to provide a platform for efficient radio access to future networks. Under this objective are two scientific and technical (S & T) objectives and two non S & T objectives. The two S & T objectives are cognitive wireless access provision and network support provision. The two non S & T objectives are use case development and preparation of regulatory policies.

The drivers for the project are a general dissatisfaction of customer experience with mobile broadband, coupled with a shift in spectrum regulation. At present there are two ways that a user may obtain mobile broadband services, one is using a mobile network operator (MNO) who employs licensed spectrum and the other is to use a fixed network operator with unlicensed spectrum on a WiFi service. In the first case, the customer experience is determined by the QoS policies and cell planning of the MNO and is better outdoors. In the second case, the customer experience is largely determined by the density of WiFi access points in the locality and the experience is better indoors. Initiatives by both types of operator have emerged to improve the coverage from different directions – the MNOs are introducing femtocells to improve indoor coverage and the fixed operators are increasing outdoor coverage through the use of hotspots and systems like FON.

The shift in spectrum regulation, by the national spectrum agencies, is to move away from the binary choice of licensed or unlicensed, by including a third option which is secondary use of spectrum. This is where network operators can use, for free, spectrum that is licensed to users such as broadcasters, if it can be proven that such use does not cause interference to the licensed (or primary) users. QoSMOS plays into this space – by providing a framework to allow secondary use of spectrum to provide indoor and outdoor broadband mobile communications – and opening up an alternative to either schemes currently used by MNOs or fixed operators. An early opportunity is the use of TV White Spaces in the UHF bands.

QoSMOS is driven largely by industry, to provide a long term solution to ever-increasing data demand
and the ever-decreasing willingness for users to pay for it. The framework will encourage new service providers to enter the marketplace, allow networks to grow as they are needed and will have the flexibility to allow custom application development. Coverage will be provided by a large number of small and flexible base-stations in the same way as MNOs are talking about for LTE. The beneficiaries of QoSMOS are several: the end user, who will have a better experience; the network operator who will have access to large amounts of radio spectrum for free; the entrepreneurial service provider and application developer who will have a flexible and efficient delivery platform and the vendors who will have new markets.

Doing this work on a European scale offers several advantages. First, the companies involved form a critical mass of effort and bring several use-cases to the project so that the benefits are felt widely. Second, the regulatory conditions in the various countries are different but with common traits – such as the requirement to avoid harmful interference – and the framework being developed by QoSMOS allows fine-tuning for the different regulatory regimes.

The achievements expected are a framework and development of key technologies as outlined above. Standards support is being set up from the beginning, with an ETSI RRS work item and early contributions planned to IEEE 802.21 and 802.22. This is being done to ensure standards acceptance and development from the beginning. Proof of concept of the key technologies and guidelines for deployment will be provided in the final year of the project, enabling products to reach the market roughly one year after the project end.

**Technical Approach**

The approach starts with use-cases that are generated by the industrial members of the consortium. The initial use-cases are the connected home, rural broadband connection, coverage of the street, smart metering, cellular extension and public safety. Workpackage 1 is developing these use-cases and continues to work them through the value chain analysis as the project progresses. Workpackage 2 takes the use-cases and provides designs and specifications for the system architecture. Radio environment sensing and mapping, one of the key technical challenges, takes place in Workpackage 3. Workpackage 4 will perform research to arrive at best designs for terminals; software defined, highly flexible, low complexity, low power consumption and low cost. Workpackages 5 and 6 form a two-step cognitive process for managing the spectrum (see concept diagram). First, Workpackage 6 will develop a management method for spectrum portfolio management, probably done centrally. From this portfolio, techniques to be developed in Workpackage 5 will allocate radio resources to individual links, probably done in a distributed fashion. This two-step process is considered key to gaining high efficiency in spectrum management. Workpackage 7 is concerned with building test-beds and simulations to prove the key technologies. Workpackage 8 is about exploiting and disseminating results and it is here that the standards work is performed, as well as the interactions with the EAB. Finally, Workpackage 9 is management of the project.

**Key Issues**

The key issues that the project will tackle are:

- sensing, database and other methods of avoiding interference from secondary users to primary or other secondary users,
- developing metrics for spectrum occupancy for decision making and micro-trading,
- development of QoS and mobility management in cognitive radio and integration with core networks
- researching best methods for cognitive radio terminal designs,
- spectrum portfolio management

**Expected Impact**

The impact will be the availability of a viable alternative mobile broadband delivery platform which is low-cost, has QoS management and can support mobility. Downstreaming of the results will be via the External Advisory Board (EAB) that consists of European regulators, broadcasters and other bodies, via ETSI, and via any new bodies that will be set up, such as a European cognitive co-ordination body similar to CogNeA in the USA. Through the EAB, European regulators will be prepared for the commercialisation of opportunistic use of spectrum. The project will provide the necessary framework and critical technical building blocks to enable actors in the value chain, from vendors to applications providers, to differentiate themselves and bring CR systems to market.