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*Contribution to Working Group 4-Intersystem coexistence and
cooperation*

*Control Channels for the Cooperation of Cognitive Management
Systems in Opportunistic and Composite Wireless Networks*

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Opportunistic Networks (ONs) are assumed to be temporary, localized extensions of the infrastructure network that are created under certain circumstances. According to that vision, ONs are coordinated by the radio access network (RAN) operator which governs the overall system behaviour (e.g. ON related policies), provides the necessary resources (e.g. dedicated spectrum bands) and supports users in decision making (e.g. additional knowledge and context information). ONs comprise both nodes of the infrastructure and infrastructure-less devices. For the management and control of operator-governed ONs the introduction of Cognitive Management Systems (CMSs), localized on the terminal and infrastructure side, is proposed. The cooperation of CMS entities will require existence of well-defined control channels. In order to enable the necessary signalling between the CMS entities, Control Channels for the Cooperation of the Cognitive Management Systems (C⁴MS) are proposed.

Specifically, CMSs comprise self-management and learning capabilities and can determine their behavior in an autonomous manner, reactively or proactively. A CMS makes and enforces decisions on the creation of an ON by taking into account the context of operation (environment requirements and characteristics), goals and policies, profiles (of applications, devices and users), as well as by exploiting knowledge obtained based on the past experience.

The accuracy of obtained knowledge on the context of the environment can be increased through the deployment of a cooperation mechanism between CMSs. C⁴MS enable such exchange of information and the coordination between CMSs. These control channels can be based on the exploitation and evolution of three concepts: the Cognitive Pilot Channel (CPC), cognitive control radio (CCR) and cognitive control channel (CCC). The CPC is defined as a channel (logical or physical) which conveys the elements of necessary information facilitating the operations of Cognitive Radio Systems and can be seen as an enabler for providing information from the network to the terminals, e.g., frequency bands, available RATs, and spectrum usage policies. The CCR can be seen as a channel for the peer-to-peer exchange of cognition related information

between nodes (e.g., between terminals) belonging to the same network. The CCC is a logical channel and was proposed as an alternative solution to CCR to address the scenarios in which cognition related information needs to be distributed without the CCR connectivity. Similarly to CCR, CCC targets the exchange of cognitive information which is relevant to other secondary nodes in the area. C4MS will integrate the above mentioned concepts and enable the provision of context information, policies, parameters etc. either between heterogeneous network nodes (terminals or infrastructure nodes) or between terminals and infrastructure. In addition, C4MS will enable the management of Opportunistic Networks and the infrastructure guidance. It will integrate different existing mechanisms for the information delivery and introduce new procedures, and related protocols to enable new features related to Opportunistic Network management.

Various options for implementation of C⁴MS are possible. These options may include RAT/System independent, RAT/System dependent approaches. The RAT/System independent based approaches would be quite generic but could lead to limitations for time critical applications. The RAT/System dependent based approaches, on the other hands, are expected to represent a low-latency solution while they need to be tailored to a specific system. C4MS may be also build on a combination of RAT/System dependent and independent approaches. A hybrid implementation could potentially guarantee the most suitable solution for the delivery of infrastructure governed guidance/assistance information towards the Opportunistic Networks and for providing means for the management of Opportunistic Networks.

The information to be exchanged through the control channels could be divided to the following sets:

- Policy information (e.g. including spectrum assignment policy, maximum number of users etc.)
- Context information (e.g. node-wise context, link-wise context, application-wise context etc.)
- Capabilities information (e.g. if a terminal supports ON, supported frequency bands, supported display resolution etc.)
- Profile information (e.g. supported applications- the set of applications/services that are included in the contract of the user etc.)
- Knowledge (e.g. spectrum-related data, estimated channel availability etc.)

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