

Opportunistic Networks and Cognitive Management Systems for Efficient Application Provision in the Future Internet

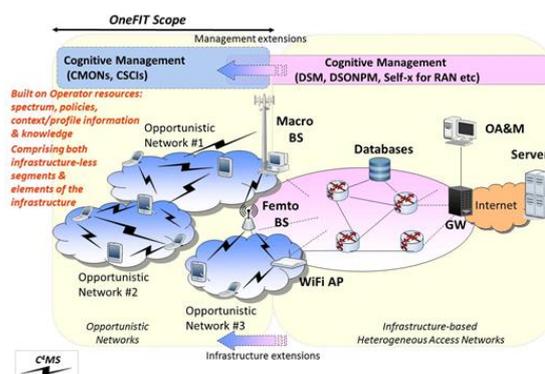
Opportunistic networks and cognitive management systems for efficient application provision in the Future InTernet (OneFIT) aims at improving efficiency of future internet applications by *developing* and *validating* the vision of opportunistic networks that are coordinated with the infrastructure and managed by advanced cognitive systems.

Opportunistic Networks (ONs) are temporary, localised network constructs that are created under certain circumstances. In the OneFIT vision, ONs are always governed by the Radio Access Network (RAN) operators, so they can be considered as coordinated extensions of the infrastructure network. ONs comprise both nodes of the infrastructure small cells and devices connected in infrastructure-less mode.

Opportunistic Networks lead to better services for the user and create market opportunities for manufacturers, operators and service providers. Evidence of this is the relevant discussions in 3GPP.

OneFIT accomplishments

- **Cost efficient handling** of various congestion/outage situations including unexpected or not-frequently occurring events,
- **Lower transmission power levels, energy consumption, traffic load,**
- **Increased utilization of resources,**
- **Value creation** through the support of more scenarios.



All this has been realised through the establishment of a **functional and system architecture**, a so called **Control Channels for the Cooperation of the Cognitive Management Systems (C4MS) specifications and performance evaluation**, the development of **algorithms** and a **prototype for the experiments** and validation of the OneFIT solution, contributions to **standards** and finally through **dissemination**, regulation, exploitation and training activities.

The resulting OneFIT **Functional Architecture** for the management and control of Reconfigurable Radio Systems (RRS), as well as for the management and control of infrastructure governed ONs, is comprised of the following main building blocks; the Cognitive management System for the Coordination of the infrastructure (**CSCI**) and the Cognitive Management system for the Opportunistic Network (**CMON**). The CSCI performs the coordination with the infrastructure, the ON suitability determination and detects the situations where an ON may be useful. CMON is responsible for coordinating with other nodes in the ON, as well as for the execution of ON establishment/ creation, the maintenance and decision on termination/ termination execution of the ON.

C4MS allows the exchange of a variety of information between nodes residing on the terminal side, as well as on the infrastructure side. More specifically, it stores information on profiles, context, decisions, knowledge and policies. In each area there is information on communication, computing, storage resources and on ON specific aspects. There are two main implementation options of the C4MS concept, the 3GPP, including Diameter, and the IEEE standards. These options are

further described in ETSI TR 102 684 "Feasibility Study on Control Channels for Cognitive Radio Systems", in which OneFIT partners' contributions were significant.

Algorithmic solutions for enabling opportunistic networks have been developed, and their performance has been evaluated, according to proper KPIs (Key Performance Indicators). Performance assessment also included aspects related to the practicality of the solutions proposed. Algorithms have been developed for addressing situations characterized by different **scenarios** (coverage extension, capacity extension, infrastructure supported opportunistic ad-hoc networking, traffic aggregation in the radio access, resource aggregation in the backhaul network), **technical challenges** (node discovery, node selection, route selection, spectrum identification, spectrum selection) and **management stages** (ON suitability determination, ON creation, ON maintenance, ON termination).

OneFIT Benefits

The **benefits** that derived from the **OneFIT solution** comprise **performance**, as well as **energy consumption reduction** both for the **operator** and the **end-user**. More specifically, in the area of **identification and selection of spectrum opportunities**, several solutions have been developed, among which a fittingness factor-based selection. Through this solution the link dissatisfaction probability is estimated (i.e. the probability of observing a bit rate below the Cognitive Radio application requirement). As a consequence, the resulting knowledge based scheme leads to considerably better spectrum selection decisions; for instance the reduction in the dissatisfaction probability ranges from 65% for medium traffic load to 15% for high traffic load.

In the area of **nodes and routes selection**, specific solutions have been developed, so as to address the issue of resolving congestion. Indicatively, regarding the communication quality of congested infrastructure, the OneFIT approach has caused the delay of successfully delivered messages to drop approximately by 15-35% and at the same time the load of the congested infrastructures to decrease by 15-40%. As far as energy aspects are concerned, the energy consumption of the problematic infrastructures has been reduced by 15-25%, while the transmission power of terminals that switched to ON has been reduced by 27% approximately (depending on distance and traffic load), due to switching to short range interface. This was realised at the expense of increasing energy consumption by an average of 19% in intermediate nodes, which is due to the increased traffic that needs to be handled by these nodes.

OneFIT has an extensive portfolio of standardization achievements in ETSI (TR 102 684), 3GPP (TR 22.803 – uptake in D2D communication in proximity services), ITU and other regulation bodies (national, regional, global activities).

OneFIT Consortium

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