European Commission

Dense Cooperative Wireless Cloud Network (DIWINE)

At a glance: DIWINE

Dense Cooperative Wireless Cloud Network

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SEVENTH FRAMEWORK PROGRAMME

The project will solve the problem of wireless communications in densely interfering ad hoc networks, by using paradigm of virtual relay based self-contained wireless cloud with simple and uniform interface to terminals.

Main objectives

DIWINE considers wireless communication in a dense relay/node scenario where wireless network coding (WNC) messages are flooded via dense massively air-interacting nodes in the self-contained cloud while the physical layer air-interface between the terminals (sources/destinations) and the cloud is simple and uniform. A complex infrastructure cloud creates an equivalent air-interface to the terminal, which is as simple as possible. Source and destination air-interfaces are completely blind to the cloud network structure. The cloud has its own self-contained organising and processing capability. This concept facilitates energy-efficient, high-throughput and low-latency network communication performed directly at the physical layer, which is capable of operating in complicated, dense, randomly defined network topologies and domains.

Wireless network coding messages are flooded via dense massively air-interacting nodes in the self-contained cloud.

Applications

The applications of the DIWINE paradigm are generic, being relevant to complex systems ranging from intelligent transport systems to healthcare and even machine-to-machine communication in wireless networks. In order to exhibit practical, highly focused and high impact results, DIWINE concentrates on two core application cases:

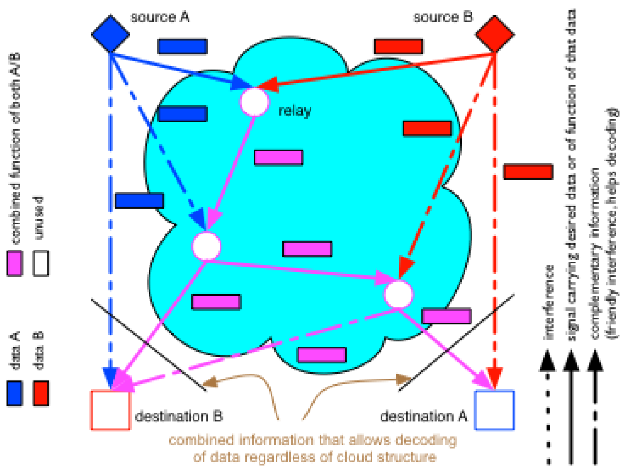
1. smart metering networks;
2. critical industrial control and monitoring applications.

To this end, DIWINE algorithms and theoretical technology will be integrated into two industrial proof-of-concept demonstration platforms targeting the aforementioned applications. Both of these applications require low-latency, dense networking solutions and are sure to be integral to future European policy and society as evidenced by recent European Commission initiatives, for example EUROPE 2020.

Technical and research challenges

- Design of WNC and processing. The cloud uses WNC which performs directly at the PHY all medium access tasks traditionally performed by routing and MAC, with potential large performance gains. In this way the functionality traditionally provided by cross-layer design is now implemented only on the PHY.
- WNC coding and processing for massively parallel signal interactions. The cloud contains a large node density with a large number of interacting wireless nodes creating mutual interference between every pair of nodes.
- Distributed intelligence of the PHY cloud – design of WNC codes and processing for imperfect knowledge of signal and topology of interfering wireless nodes. Terminals do not use signalling or a priori knowledge of network structure. Cloud nodes have only imperfect knowledge of signals, complementary side information and network topology.
- Throughput/robustness/delay/memory/energy trade-off in delay-tolerant, information storage ad hoc networks.
- Trade-off between cloud self-organisation (by signalling) vs. diversity directly at PHY/WNC level, e.g. by properly forming hierarchical decision maps at relays to provide multiple paths for the information.
- Distributed cloud PHY/WNC signal processing.
- Joint optimisation of energy and throughput. Energy consumption has two aspects: energy consumption (i) of terminals when communicating with the cloud, and (ii) within the cloud.
- Design of simple and transparent terminal interfaces to the cloud.

Key issues



Expected impact

- The "flexible spectrum usage" objective is achieved by an efficient dense smart cooperating wireless cloud fully utilising the whole capacity potential of spectrum sharing directly on the physical layer without need for orthogonal "slicing" of the spectrum resources, or medium access and routing protocol overhead.
- The "novel radio network topology" aspect is the central focus of the DIWINE project. It is presented by the cloud paradigm.
- The "energy efficiency" is an inherent ingredient (along with spectrum efficiency) of DIWINE. It is achieved by the dynamic cooperation of the cloud nodes taking into account the energy metric. Additional energy-saving follows from the improved efficiency in application areas where dense deployment increases the reliability and efficiency.
- The "high capacity backhaul and autonomy" is again one of the main contributions of DIWINE. The transparent and self-adjusting cloud structure creates a seamless wireless back-bone functionality with autonomous self-organisation.
- The "low power node design and proof-of-concept" is part of the reference demonstrator application case.
- The "optimised EMF radiation" comes as inherent side-effect of the node energy efficiency optimisations.
- The "novel signal processing methods" form an essential ingredient of the DIWINE solution where the network efficiency constrains the development of novel paradigms in distributed processing algorithms.
- The "user driven research" is demonstrated in DIWINE by aiming all research parts of the project to a clearly defined main demonstration application (smart meter/control networks) case with strong impact on industry and user experience. A disruptive impact is expected when the concept of cloud extends to make use of the users' smartphones to complement infrastructure networks (GSM/UMTS/HSPA or WiMAX/LTE) for point-to-point communication between geographically neighboured users.
- The "seamless transparent end-to-end connectivity" is achieved by DIWINE's novel cloud based wireless solution.