Cross-network cooperation paradigms supporting co-located heterogeneous wireless networks

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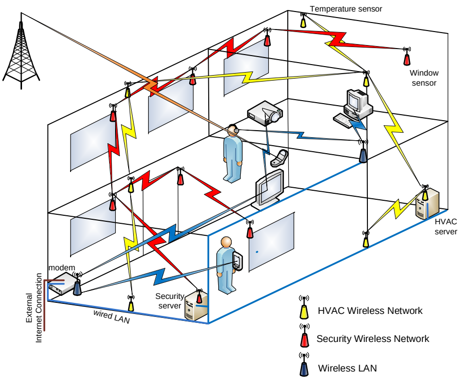
I. Introduction

Wireless services and wireless devices have become an important part of our daily life. However, as the number of wireless devices increases, so does the density of **co-located devices** in home, office, industrial and public environments. This increasing density in combination with the emergence of more and more advanced wireless services, will demand a huge capacity from future wireless networks. In addition, a lot of these networks are sharing the same frequency band (e.g. WLAN, Bluetooth, ZigBee, …), which means that increasing the capacity is not just a matter of adding more wireless infrastructure[1][2]. The coordination between co-located wireless infrastructure and devices, generally operated by different providers, network administrators or individual users, will hence become more and more important[3].

Within this PhD, we introduce the novel **concept of 'Symbiotic Networks'**. These are independent, co-located homogeneous & heterogeneous, wired & wireless networks that cooperate across all layers and across network boundaries through advanced sharing mechanisms. Symbiotic networks take the notion of cooperation to a new level, paving the way towards true cross-network optimization and the disappearance of network boundaries. Symbiotic networks will ultimately result in a more efficient use of the scarce spectrum, better scalability, additional dependability, a more efficient energy consumption, lower radio emissions and better QoS guarantees, as well as enable new advanced cross-network services.



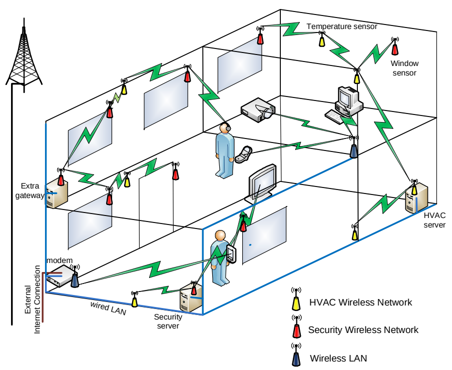


Figure 1 Left: Current state of the art home network. No inter-network cooperation is available, creating spectrum scarsity. Right: Symbiotic networking. Notice that the average link distance drops dramatically, allowing a better use of the available spectrum.

II. STRATEGY

To develop Symbiotic Networking solutions, the **DiNS strategy** is proposed. This is a phased approach consisting of 3 consecutive phases:

1) ***D****istributed Network Discovery phase*, which enables a wireless network to detect other wireless networks in its vicinity and to disseminate the network parameters of individual networks to other co-located networks.

2) ***I****ncentive based* ***N****etwork Binding phase*, which enables communication between independent networks. This covers a negotiation process for adapting radio, network and protocol configurations as well as incentive-driven network mechanisms for cross-network communication.

3) ***S****ervice enabling phase*, which allows for the discovery of services, authentication, authorization and reasoning. This phase enables resource efficient execution of services, through intelligent migration and incentive-based sharing mechanisms.

III. OBJECTIVE

The **main research objective** of this PhD project is to design, develop and validate distributed dependable & incentive-driven networking solutions to support advanced cross-layer/cross-node/cross-network cooperation between co-located, but otherwise independent networks. With 'independent networks' is meant that in view of applications and services, these networks have no common goals and are most probably deployed by different providers.

This PhD primarily focuses on the first two phases and will in particular address the **potential of cognitive radio (CR)** for symbiotic networking. Although CR is not necessarily a prerequisite for Symbiotic Networking, it will obviously facilitate the network discovery and network binding process and lead to more advanced global optimization strategies (not only from a local or terminal centric point of view, but from a global multi-terminal and multi-network system point of view).

IV. SYSTEM ARCHITECTURE

For the **system architecture,** we use a modular approach[4], while safeguarding backward compatibility with traditional layered protocol stacks. In a modular approach, functionality in a node is divided in modules that interact with each other through a shared data base, in contrast to layered architectures, where each layer is designed and operated independently. Symbiotic Network functions will be as much as possible introduced as an additional module that interacts with existing protocol standards, rather than modifying well-established protocol stacks. However, for networks where there is no common standard yet (e.g. sensor networks), more advanced architectural paradigms will be explored.

V. REFERENCES

[1] S. Young Shun, H. Seong Park, W. Hyun Kwon: Mutual interference analysis of IEEE 802.15.4 and IEE 802.11B, Elsevier, science direct – computer networks, 2007

[2] F. Vanheel, I. Moerman: Study on Distance of Interference Sources on Wireless Sensor Networks, 38th European Microwave Conference 2008

[3] L. Tytgat, B. Jooris, P. De Mil, E. De Poorter, I. Moerman, P. Demeester: Multichannel protocol for interference avoidance in wireless sensor networks, in Proceedings of the 2nd Ghent University and KEIO University Global COE Joint workshop, sept. 2008

[4] E. De Poorter, I. Moerman, P. Demeester: An information driver sensornet architecture, in Proceedings of the 3rd International Conference on Sensor technologies and Applications, Athens, Greece, June 2009