Resource Assignment for Cooperation of Independent PANs

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1. Introduction

With the availability of devices equipped with low power ZigBee [1] transmitters, standardized by the ZigBee Alliance, e.g. sensors or cell phones, user can build an own Personal Area Network (PAN). We consider near future applications that involve communication and cooperation of independent PANs. Coexistence of many PANs leads to radio resource conflicts, so that the applications of the user cannot work. In this paper, we propose an resource assignment algorithm for coexistence and cooperation of those independent PANs and their applications.

2. Problem Statement

We consider a scenario, where many users with independent PANs exist in radio vicinity. Their PANs run applications and consist of devices with ZigBee transceivers, mainly body attached sensors, multi-media devices and cell phones. A cell phone, as the most capable device, acts as the coordinating device (called ZigBee coordinator) and forms a PAN. Communication between independent PANs is not covered by the ZigBee standard [1], since Inter-PAN communication is not available. The standard defines 16 radio channels in the 2.4 GHz band. In the scenario, more PANs than radio channels may coexist in radio vicinity, when many users meet in public spaces for example. This leads to problem conditions for the radio resources, like high interferences, blocked channels and performance degradation, so that the user cannot run applications. Therefore, we need a new strategy to avoid those problems.

3. Proposal of Algorithm

To solve the stated problems, we propose a new algorithm, that uses key-features of the algorithm in [2], which presents a decentralized scheme to assign different time slots to coexisting PANs. The new algorithm assigns radio resources to independent and coexisting PANs based on their cooperation needs.

In our scenario, when the devices are started, the coordinating device forms the PAN. It chooses an unoccupied channel, via *Energy Detection* and *Active Channel Scans*, or requests resources from PANs on occupied channels via beacon messages and the adapted strategy of [2]. In Figure 1 – Step 1, PAN A and PAN B are formed, by using channel 1 and 2, they coexist with least possible interference. When applications want to cooperate, all involved devices must use the same channel to communicate.

Inter-PAN communication is realized by learning required parameters via *Active Channel Scans* and *Beacon Requests* and then modifying necessary parameters (e.g. PAN-ID) when sending packets to other PANs. In Step 2, PAN A and PAN B want to cooperate, they exchange *Cooperation Request* and *Cooperation Reply* with data like network management information, number of devices inside the PAN, interference measures (energy level of radio channels) and a *Candidate List* of channels for cooperation. With those information, both PAN coordinators decide about a cooperation channel, in the figure channel 1. They assign each other different global time slots

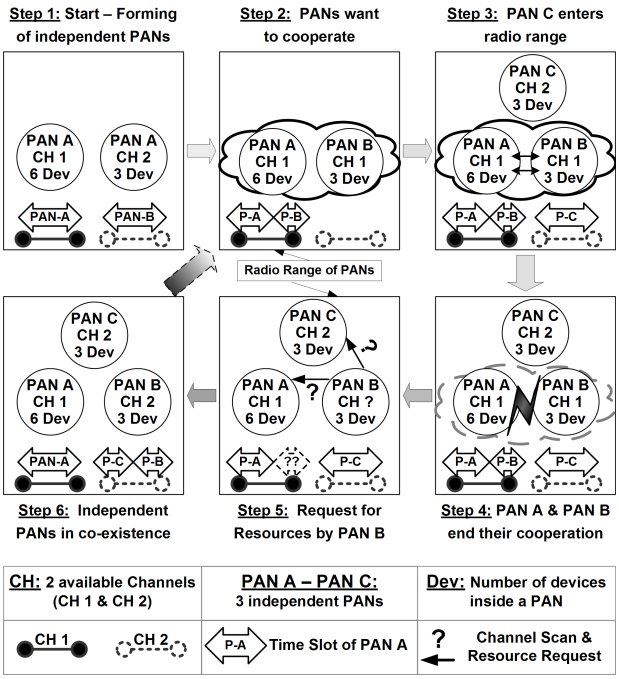

Figure 1 Example of Algorithm Operation Flow

based on application needs, e.g. bandwidth, traffic requirements, and number of devices in each PAN (adaptation of [2]).

During their cooperation period (Step 3), PAN C enters radio range. He uses the unoccupied channel 2. When PAN A and B decide to end their cooperation (Step 4), they try to restore their original time slot and channel usage (PAN A on channel 1, PAN B on channel 2). PAN B detects, that channel 2 is now occupied, he performs interference detection and requests resources from PAN C while staying temporary in the time slot on channel 1 (Step 5). If he gets more resources from PAN C on channel 2, he decides to switch and leave channel 1. Since PAN A has more devices and therefore needs a bigger global time slot (Step 6), PAN B will get a bigger global time slot on channel 2 from PAN C. All PANs return to their normal coexisting states afterwards, awaiting further cooperation request from their applications.

4. Conclusion

We proposed a new resource assignment algorithm for coexistence and cooperation of independent PANs. Future work will involve the inclusion of different parameter-adaptable cooperation schemes and further evaluations of the solution.

References

[1] ZigBee Specification, ZigBee Alliance, Dec. 2006.

[2] N. Thepvilojanapong et al. Resource allocation for coexisting ZigBee-based personal area networks, in *Proceedings of the 7th International Conference on Networking (ICN'08)*, April 2008.