Proposition de recherche doctorale

**Wireless Body-to-Body Networks: Optimization Models and Algorithms**

**Mots clés :**
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- Domaine scientifique principal: Divers

**Résumé du projet de recherche (Langue 1)**

Becoming mature enough to be successfully used for improving the Quality of Life, Wireless Sensor Network technologies are considered as one of the key research areas in computer science and healthcare application industries. More particularly, Wireless Body Area Networks (WBANs) play an important role in enabling ubiquitous communications, creating a huge potential market. WBANs consist of a set of wearable or implanted communicating sensors that consistently monitor the patient’s vital signs, such as electrocardiogram, pulse and blood pressure, or important environmental parameters like temperature and humidity. These sensors, communicating through wireless links, can transmit data from the body to an external aggregator device, from where data can be forwarded to other networks, such as wireless sensor networks, WiFi access points, cellular networks, etc. The Body (wearable) Sensors have to be small, light-weight, ultra-low-power and nonintrusive; therefore, they are expected to be extremely resource constrained with respect to wireless data transmission, processing, storage, and battery energy supply. While sensors in general are energy constrained, body sensors are more so. The co-existence of multiple WBANs, the communication and the interactions between such networks extend the classical concept of WBAN and present a new paradigm, which is referred to as Wireless Body-to-Body Network (WBBN). WBBN is more dynamic and potentially large scale, where each WBAN member can join and/or leave the WBBN network, seamlessly, and without the need for any centralized infrastructure, providing thus Anywhere and Anytime network connectivity. In comparison to WBANs, WBBNs introduce several new design constraints and research challenges. Therefore, to meet the main challenges of WBBNs, in this thesis the PhD student will propose paradigm-shifting mechanisms, developing a cross-layer (PHY, MAC and Networking layers) optimization framework to provide seamless, anywhere and anytime network connectivity for mobile WBANs. More specifically, the PhD student will first investigate existing solutions and studies that have been already conducted in this area in order to identify and propose novel and more efficient methods. For example, to design new, energy-aware mechanisms for WBANs/WBBNs, there are a number of challenges one must overcome, including how to make tough balances between efficiency and practicality. Stringent resource constraints on devices within a WBAN, especially the sensor nodes, basically require the new mechanisms to be as lightweight as possible. In this thesis, the proposed framework will consider the following research issues, only to cite a few: 1) Since each WBBN consists of several mobile WBANs, the connectivity between all WBANs (if needed) should be maintained even when a WBAN member leaves the network; at the same time, the connectivity with the “in-WBBN” aggregator device should be guaranteed for reliable data delivery, while being efficient in terms of energy consumption. 2) WBANs can be connected to an external (“off-WBBN”) aggregator device, from where data can be forwarded to other networks, WiFi access points, cellular networks, etc. 3) Since WBAN is mobile and can move from one WBBN to another, the roaming of a WBAN between different WBBNs, but also between a WBBN and another network (WiFi access points, cellular networks...) should be investigated. Then, the PhD student will use mathematical tools (i.e., Mixed Integer Linear Programming and Game Theory) as well as simulation tool and a real testbed to develop new, energy-efficient, reliable, secure and lightweight models, protocols and architectures for WBBNs. At last, but not at least, the PhD student will evaluate the performance of the proposed models, protocols and architectures through extensive numerical simulations and real case studies. Work program: The PhD student will have to realize the following main tasks: 1. Investigation of existing methods and studies that have been already conducted in the literature. 2. Development of an optimization framework for wireless body-to-body networks: development of new, energy-aware and realistic mechanisms for WBBNs using mathematical and simulation tools. 3. Performance evaluation of the proposed framework in realistic WBBN scenarios. 4. Validation of the proposed approaches through real experiments, considering real case studies, where multiple WBANs can communicate and interact. Challenges: Design a specific WBBNs simulation environment providing an accurate and realistic PHY and mobility modeling to ease the design and the performance evaluation of high level communication protocols for WBBNs. Such simulation environment will be set up and used by the PhD student to implement and validate the proposed approaches. Possible International Cooperations: We have already contacts with a number of researchers working in prestigious research laboratories (namely, the ANTLab at Politecnico di Milano and Broadband Wireless Networking Laboratory at the Georgia Institute of Technology), which are leaders in this domain and who will be very glad to invite the PhD student to spend a fruitful scientific research period in their laboratories. This thesis will enforce further the cooperation between Sup'Com Tunis and the LIPADE Laboratory of Paris Descartes University.