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BEng Thesis

Towards an implementation of the IEEE 802.15.4 time critical MAC extensions over a real-time OS

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Abstract

Growing at a fast pace, the adoption of embedded computing systems, capableof monitoring and controlling the physical environment around them, is spreadingacross different environments, from our houses to the industrial setting. Thislatest trend, induced by recent advancements in the information and communicationfields, craves for the new Wireless Sensor Network (WSN) concept, whichaims to enable an infrastructure that interconnects the set of widespread 1cintelligent 1ddevices, capable of wireless communications, constituting a network ofsensor nodes.On an Industrial context, the new Cyber-Physical Systems (CPS), promptedby the Industry 4.0 revolution, aim to correlate the present automated systemsto the new information technologies, such as cloud and cognitive computing,to compose a group of collaborative computing systems that enact the 1csmartfactory 1d. This new targeted model however, relies on certain time assurances andother QoS (Quality of Service) properties such as scalability, energy efficiencyand robustness, which WSN technologies intent to grant. Although a tenderparadigm, propositions such as the IEEE std. 802.15.4 protocol ambition toenable the WSN infrastructure and satisfy the QoS requirements.The IEEE std. 802.15.4 protocol provides several MAC (Medium Accesscontrol) behaviours to frame the communications stack, each aiming to meetthe set of requirements of distinct applications. For deterministic latency, highreliability and scalability QoS requirements, IEEE 802.15.4 standard provides theDSME(Deterministic Synchronous Multichannel Extension) MAC behaviour.Parallel to the phenomenon of the WSN technologies, real-time operatingsystems (RTOS) are emerging among the IoT(Internet of Things) community tohelp tackle QoS specifications for determinism and time-critical constraints.The use of a real-time OS in conjunction with a time reliable protocol suchas DSME is the key to enable a truly deterministic and time critical WSN.However, besides these settings, QoS at the computing platform must beguaranteed as well if these network infrastructures are to become a reality. Computationsmust be performed in a predictable way, as to support the QoS demandsin terms of latency these networks present. Hence, in this Thesis we propose torely on the FreeRTOS for a real-time operating system and a well known WSNplatform, such as the TelosB to implement the DSME time critical MAC behaviour.To achieve this defined goal, this Thesis presents a port of FreeRTOS tothe TelosB platform, wich includes an IEEE 802.15.4 compliant radio, as well as apreliminary study of the future implementation strategy of the network protocol.Hereby, this Thesis concludes with a successful implementation of the RTOS,FreeRTOS, for the TelosB platform, along with the necessary groundwork andtime requirements support for the DSME extension. Additionally the Thesisprovides a suggested model for the protocol stack to fit the FreeRTOS task system.