Abstract

The Internet of Things (IoT) refers to the idea of internetworking physical devices, vehicles, buildings, and any other item embedded with the appropriate electronics, software, sensors, actuators, and network connectivity to allows them to interchange data and to provide highly effective new services. In this thesis we focus on the communications issues of the IoT in relation to mobility and we provide different solutions to alleviate the impact of these potential problems and to guarantee the information delivery in mobile scenarios.

Our reference context is a Smart City where various mobile devices collaboratively participate, periodically sending information from their sensors. We assume that these services are located in platforms based in cloud infrastructures where the information is protected through the use of virtualisation ensuring their security and privacy.

This thesis is structured into seven chapters. We first detail our objectives and identify the current problems we intend to address. Next, we provide a thorough review of the state of the art of all the areas involved in our work, highlighting how we improved the existing solutions with our research. The overall approach of the solutions we propose in this thesis use prototypes that encompasses and integrates different technologies and standards in a small infrastructure, using real devices in real scenarios with two of the most commonly used networks around the world: WiFi and 802.15.4 to efficiently solve the problems we originally identified.

We focussed on protocols based on a producer/consumer paradigm, namely Advanced Message Queuing Protocol (AMQP) and particularly Message Queue Telemetric Transport (MQTT). We observed the behaviour of these protocols using in lab experiments and in external environments, using a mesh wireless network as the backbone network. Various issues raised by mobility were taken into consideration, and thus, we repeated the tests with different messages sizes and different inter-message periodicity, in order to model different possible applications. We also present a model for dimensioning the number of sources for mobile

nodes and calculating the number of buffers required in the mobile node as a function of the number of sources and the size of the messages.

We included a mechanism for avoiding data loss based on intermediate buffering adapted to the MQTT protocol that, in conjunction with the use of an alternative to the Network Manager in certain contexts, improves the connection establishment for wireless mobile clients. We also performed a detailed study of the jitter behaviour of a mobile node when transmitting messages with this proposal while moving through a real outdoor scenario.

To emulate simple IoT networks we used the Cooja simulator to study and determine the effects on the probability of delivering messages when both publishers and subscribers were added to different scenarios. Finally we present an approach that combines the MQTT protocol with Delay Tolerant Network (DTN) which we specifically designed for constrained environments and guarantees that important information will never be lost.

The advantage of our proposed solutions is that they make an IoT system more resilient to changes in the point of attachment of the mobile devices in a IoT network without requiring IoT application & service developers to explicitly consider this issue. Moreover, our solutions do not require additional support from the network through protocols such as MobileIP or Locator Identifier Separation Protocol (LISP). We close the thesis by providing some conclusions, and identifying future lines of work which we unable to address here.