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# A Study on the Design and Implementation of a Ubiquitous Network Simulation Environment

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## Abstract

Nowadays, various kinds of ubiquitous networks, such as sensor networks, home networks and so on, are actively researched and being utilized as part of our daily life. These networks are different from computer networks in some aspects; for example, they tend to consist of numerous nodes, and are likely to exchange with each other information obtained from the surrounding environments. In the software development phase for those systems, sometimes the software has to be written without the hardware platform on which the software is executed; this is in contrast to computer networks consisting of general-purpose components. In such a case, the duration of software development can drastically be reduced by testing the software independently from the hardware using a simulation environment that can simulate the entire system, including the functionality of yet unimplemented hardware and the surrounding environments. In order to simulate ubiquitous networks accurately enough for such purpose, a testbed must support handling properties that are different from those of computer networks; therefore additional functionalities are required in this case compared to typical computer network simulators.

In the first part of this thesis, I will discuss the specific properties of ubiquitous network systems, and the required functionalities for the environment in which ubiquitous network systems are simulated. Based on these properties and requirements, a ubiquitous network simulation environment RUNE (Real-time Ubiquitous Network Emulation Environment) is proposed. RUNE is aimed to be useful in any stage of the development of ubiquitous network systems, from the initial development phase to the operation phase.

RUNE utilizes StarBED, a PC-cluster based testbed, for performing large-scale ubiquitous network simulation including many components, such as nodes, network media, and the surrounding environments, in multiple abstraction levels.

In the following part of the thesis, some ubiquitous network system simulations done with RUNE are described. After showing how those simulations were implemented, and presenting the knowledge obtained from the simulation, we discuss how RUNE must be improved in order to meet more advanced requirements for ubiquitous network simulation.

**Key Words:** Ubiquitous Networks, Sensor Networks, Home Networks, Real-time, Distributed Testbed, Supporting Software