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Simulator for radio resources management functions in CDMA systems

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ABSTRACT

Mobile network technologies have been experiencing great progress. Simulations and analysis of these systems are challenging tasks. Different network simulation and modelling tools have already been developed. However, these simulation and modelling tools are commercial, they are focused on the physical layer simulations or they are simply unavailable. Hence, the own simulation program was created in Matlab. This paper gives a brief review of several simulation tools and presents its own simulation program. This program enables simulation of radio resources management functions for Code Division Multiple Access (CDMA) systems. Finally, simulation results obtained by using the proposed simulator are also presented.

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1. Introduction

The 2G (2nd generation) systems, like GSM (Global System for Mobile communications), are slowly replaced by latter systems. The 3G (3rd generation) systems, IMT-2000 (International Mobile Telecommunications in the year 2000), are already installed and used at present. It seemed that novel systems like LTE (Long Term Evolution) will replace these systems in a short time. However, there are some circumstances that cause the 3G systems (and their upgrades) to survive for a while. An example is HSDPA (High-Speed Downlink Packet Access) which is an innovation of UMTS (Universal Mobile Telecommunication System) and which increases the data rate up to several Mb/s. A number of mobile devices (that support this technology) are already spread between users. Mobile devices for LTE are not so available (at present). This is an example why the operators still support and extend UMTS networks. UMTS is used below as a representative of CDMA systems.

The 3G systems have been standardized by 3GPP (3rd Generation Partnership Project) releases. However, these standards do not define everything in detail. There are radio resources management (RRM) functions in UMTS. They are responsible for supplying optimum coverage, ensuring efficient use of physical resources, and providing the maximum planned capacity. These functions are not standardized in detail, so their evolution and optimization is still in progress. Simulation tools are used for design, simulation and optimization of these functions. A number of different network simulation and modelling tools have already been developed. These tools are mostly focused on the physical layer simulations. They have been developed in order to simulate power levels, interference levels, network coverage, or handover occasions eventually. Matlab or NPSW can be used as examples, Section 2. Detailed survey of several tools for network simulation can be found in [1]. This book is focused on tools, modelling principles and state of the art models for discrete-event based network simulations, the standard method applied today in academia and industry for performance evaluation of new network designs and architectures. Complex simulation of RRM functions is not a common feature of the simulation tools. Hence, the own simulation program was created in Matlab. The rest of the paper is organised as follows. Section 2 describes some known simulation tools.

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Section 3 presents radio resources management functions. Section 4 describes the proposed simulation program and it presents some basic simulations. Simulation results (obtained by using the proposed simulation program) of admission control algorithm are presented in Section 5. Finally, Section 6 provides conclusions.

2. Simulation tools

A number of simulation programs and tools have already been developed. A complex review of network tools can be found for instance in [2]. In this paper, there are only few examples of simulation programs that could be used for simulations of wireless systems:

- *Matlab*. It is a high-level language and interactive environment that enables performing of computationally intensive tasks and simulations. The main advantages are the wide support background and simple producing and debugging of the scripts.
- *Simulink*. It is an environment (based on Matlab) for simulations of dynamic and embedded systems. It provides an interactive graphical environment and a set of block libraries that enable to design, simulate, implement, and test a variety of systems.
- *Network simulator* 2. It is a discrete event simulator targeted at networking research. This tool is able to simulate LAN (Local Area Network), WLAN (Wireless Local Area Network), UMTS and E-UMTS (Enhanced UMTS), see [3] or [4].
- *Network simulator* 3. It is a discrete event network simulator. The NS-3 is not backward compatible with NS-2. This tool is able to simulate LAN and WLAN. Special attention (for WLAN networks) is focused on WiFi (IEEE 802.11) and Wimax (IEEE 802.16) systems, see [5].
- *OPNET modeler*. It is an industry solution for modelling and simulation of communications networks, devices, and protocols. It is object-oriented modelling approach. Users can analyze simulated networks to compare the impact of different technology designs on end-to-end behaviour. Modeler incorporates a broad suite of protocols and technologies, and includes a development environment to enable modelling of all network types and technologies, such as LAN, WLAN and WAN (Wide Area Network).
- *NPSW* (*a Matlab implementation of a static radio network planning tool for WCDMA*). It is a static simulator for WCDMA systems, which was created in Matlab. It enables setting of several parameters (parameters for Node B: antenna high, elevation, transmitted power, etc.), and it calculates a number of data (path losses, service Node Bs, interference levels, etc.).

There are also some other simulation tools, some examples follow. Dynamic simulation program can be found in [6]. Static simulation program is presented in [7]. This paper also compares the proposed simulation tool (the results) with [6].

Some of the above mentioned programs are determined for commercial use (OPNET for example, see Table 1), they are simply unavailable ([4], [6]) or they are focused mainly on the physical layer simulations (Matlab, NPSW). Simulation of RRM functions is a problematic task. OPNET is the most suitable tool for this purpose but it is a commercial program. There are other simulation tools that were designed directly for the RRM simulations ([4] or [6], for example). However, these programs and their documentations (designed by individual researchers) are not available online (they are unavailable at all). To summarize, the simulation programs are commercial, they are focused on the physical layer simulations or they are simply unavailable. Hence, the own simulation program was created in Matlab. This simulation program enables simulation and evaluation of several RRM functions. The program is introduced in Section 4.

Table 1 shows a brief summary of several simulation tools. Several tools are commercial or unavailable, so more detailed comparison is not possible.

Table 1
Brief summary of several simulation tools.

Tool	Usage	Target network	Outputs
Matlab	Commercial	–	Simulation of physical layer
Simulink	Commercial	–	Simulation of physical layer
NS-2/3	Research	LAN (WLAN)	Simulation of TCP, routing and multicast protocols
OPNET	Commercial	LAN, WAN, WLAN	Simulation of wide networks, several protocols, delay, utilization, etc.
NPSW	Research	CDMA	Simulation of physical layer (path losses, power levels, interference levels, etc.) for CDMA systems
Ares [7]	Research	CDMA	Simulation of power control, admission control, packet scheduling, load control, handover control, etc.
E-UMTS simulator [4] (based on NS-2)	Research	CDMA	Simulation of admission control, handover control, power control, packet scheduling and congestion control
Dynamic CDMA simulator [6]	Research	CDMA	Simulation of admission control, handover control, active set management, etc.
Own CDMA simulator	Research	CDMA	Simulation of admission control, handover control, congestion control, power control, interference level control

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