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Secured Reconfigurable Software Defined Radio using OTA software download

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----------ABSTRACT----------
Dynamic Reconfiguration of lower layers of the protocol stacks used in communication terminals is a key for the development of future multimode software radio. Together with the use of software downloading, future terminals will become a platform to support the deployment of yet unspecified services and applications. Today software radio is viewed more as a technology to enable the reconfiguration terminals at all stages of design, and production. This paper proposes the concepts of software radio reconfiguration by software downloading on 3G and possible future 4G standards. The work is to discuss the Software Defined Radio (SDR) main challenges including the over the air software downloads, installation, execution and automatic reconfiguration.

Keywords - **Mobile Communication, Over the air, Reconfigurable terminal, Software Download, Software defined radio.**

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1. INTRODUCTION

The remarkable advances of practical software defined radios that use programmable digital devices and radio architectures will enable people with different kinds of equipment running on different frequencies to communicate with one another by proper reconfigurations of their communication devices. Once reconfigurable equipment is deployed in the field, systems tuning, functional changes and standards migration can be accommodated purely in software. A fundamental change in approach is required and a growing awareness of the attractiveness of reconfigurable DSP, flexible architectures or SDR systems [1] is also required**.** This approach is termed reconfigurable SDR, because of the hardware can be configured for a particular application [2]. Software radio systems are potentially the next main improvement in mobile and wireless communications. Mobile communication providers have led to the planning of a universal connection that adapts itself to different requirements. The software radio terminals must be auto reconfigurable in order to match the different telecommunication standards**.**

The mode switching and software downloading is very important to SDR. A new idea about the software reconfiguration with over the air download [3**,4**] was proposed. Huge man-power is needed for time-consuming work to upgrade or bug-fix the enormous number of cellular base stations. SDR base stations can be remotely bug-fixed quickly by downloading new software via the network [5]. The reconfiguration can enhance or update software on all communication layers [6]. An SDR reconfigurable device is able to combine a software programmable processor and reconfigurable hardware components that can be reused for different applications. Software downloading is the delivery of reconfiguration data or new executable codes to an SDR device to modify its behavior or performance.

In the following section, describes the reconfigurable mobile terminal and the OTA downloading performance between server and mobile terminal is discussed in section 3. The avoidance of security issues are presented in section 4. The last section concludes the secured reconfiguration.

2. RECONFIGURATION METHOD USING SOFTWARE DOWNLOADS

Software download is a key enabler for ubiquitous Reconfigurable User Terminals. The process of software download involves the introduction of new functionality into the terminal, with the aim of modifying its configuration or content. Software download may consist of software patches, software upgrades, software licenses and keys, install scripts, validation test cases and device configuration files. There are different categories of software that can be downloaded in a device, for example:

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application and service provision software. [7] Figure.1 shows the generic flow of software download.

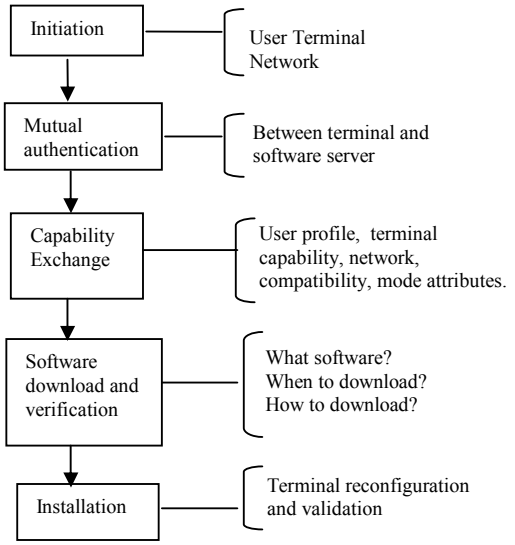

Figure.1 A generic software download flowchart

For a successful communication with different systems, the radio has to communicate and decode the signals of devices using software download. Different methods for software download concepts can be conceived. (i) Smart card loading (SIM), (ii) ROM/EPROM based reconfiguration (different radio configurations are stored inside the software radio), (iii) service terminal (offline reconfiguration by connecting physically to a service terminal), (iv) air interface download and etc. Reconfigurable radio terminals can be altered with respect to frequency range, modulation or maximum power by a change in software, safety could be compromised for human beings.

The increasing power and reducing cost of digital signal processing will allow the use of reconfigurable baseband processing in mobile handsets which will in turn permit the use of flexible air interfaces. The software download in the mobile terminal must be as fast as possible and easy to perform [8]. The air interface download is the most flexible one, but needs a dedicated channel for the download. This implies standardized hardware solutions of resident compilers. The implementation of a JAVA virtual machine is the most promising technology in this field [9]. The SDR forum developed an Application Program Interface (API) to support on-the-fly reconfiguration of the mobile terminal.

3. OVER-THE-AIR BASED SOFTWARE DOWNLOAD PROGRAM

Software downloading can be accomplished by OTA via the radio interference. For wireless multihop network, it is more preferable and effective to accomplish software and firmware updating via a certain OTA technology then just recall from users to bring their devices to facility. The SDR technology may be the next break trough in future 4G mobile communications.

The SDR software download activity between a server node and a client node comprises pre/ during/ post download processes. These processes are defined by the SDR forum. The pre download process includes initiation of the download, mutual authentication between SDR devices, download setup and so on. The during download process takes charge of physical transfer of the software from the server node to the client node, verification of the integrity of the download software, retransmission requests and so on. After the during download process is finished, the post download process starts. The installation of the software, SDR node reconfiguration and so on is accomplished in the post download process.

When the mobile wants to update, it request the RM (Reconfiguration Manager) by sending signal Request to Download (RTD). The RM first sends the signal Clear to Download (CLD) and then shows a list of available LSW to the MT. After selecting the SW, the MT request the LSW and authentication is processed to make security. In during phase, after a successful software download, the MT notifies the RM of the software download completion. Since this notification does not have much impact of the following reconfiguration phase, the signaling messages is depicted in dotted line as well as the acknowledgement message from the RM. The MT verifies the SW after completion of the software download and performs the reconfiguration. Finally the MT notifies the RM of the success of the reconfiguration. (Post downloads). Figure 2 shows the OTA sequences

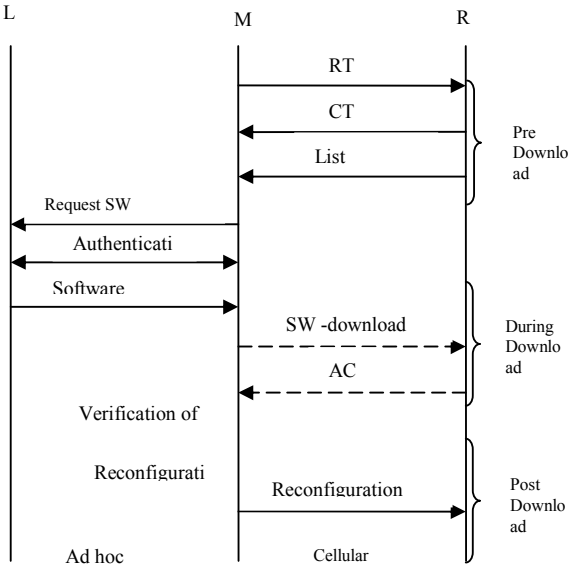

Fig.2 OTA download Sequence

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After the OTA download had finished successfully, the prototype was automatically reconfigured by the system control program. The proliferation of successful OTA download companies (eg, Bitfone, Innopath, Redbend software) demonstrates the huge potential of this emerging field [10]. OTA software download is an enabling technology that leverages on the flexibility of radio hardware. With dynamic OTA download, mobile devices can connect to any type of wireless network, download the required radio software and reconfigure on demand [11].

4. IMPROVING THE PERFORMANCE OF SOFTWARE DOWNLOADS

Reconfiguration through software download over the air (OTA) is the most concerned issue to many researchers since its attractive concept of dynamic reconfiguration of SDR terminal. The whole reconfiguration terminal process only can happen when the mobile terminal (MT) is reachable by the network, i.e. there is connection between the MT and the Reconfiguration Manager (RM). When the network load is very high or if the connection between the MT and the RM is not good, the software download process cannot be carried out successfully. For this, an local software update server was introducedwhich has shown in Figure3.

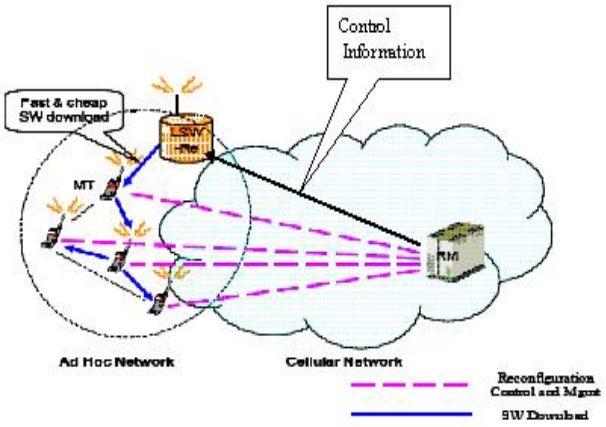

Figure: 3 Decentralized Software Download Architecture

4.1 Use a Local software update server

In a large network, one server may not be sufficient to handle all kinds of software upgrades. The local software update server- Local Software Repository (LSW) using ad hoc network connectivity for software download via high bandwidth, short range radio access technologies, like WLAN, Bluetooth [12]. A Reconfiguration Manager located in the cellular network takes the role of reconfiguration control and management. Centralized and decentralized architectures are two conventional software download architectures. For wireless ad hoc networks and sensor networks, a decentralized node to node approach for software download or software upgrade may be preferred, because a node can obtain the software from its neighbors when the software is broadcast in the network. The decentralized software download architecture is shown in Figure 3. The RM sends control information (size of data and the route information of the particular mobile) to LSW.

4.2 Use delta compression download

Once the software code has been downloaded, it must be detected and validated by the mobile device, after which the hardware parameters are modified, ideally without user intervention. The delta compression algorithms are more efficient in reducing correlation between adjacent files. It takes advantage of the statistical correlations between two different configuration files so that common sequences between the two different configuration files so that common sequences between the two files can be encoded using a copy reference. Typically, this results in much smaller configuration files to be transmitted, thereby saving considerable bandwidth and improving latency.

4.3 Security for software downloads

Security consideration must be taken into account within the software control for some sensitive software, which may cause severe problem to the mobile terminal. Secure software downloading [13] is a critical security issue in the SDR functioning. For secure downloading, it includes four different cryptographic techniques and employment of tamper resistant hardware. The cryptographic techniques by Kocher [14] employed in 1998 are: (a) a secret key encryption technique; (b) a public key encryption technique; (c) a technique for cryptographic hashing and (d) a technique for digital signature. SDR uses the end to end encryption method in which data is encrypted at the source or very close to it and decrypted at the wireless terminal.

A well known and widely used security mechanism to protect software download is signed content. The software provider attaches a digital signature to the module that is verified by the receiving device. The digital signature ensures integrity and authentication of origin. The receiving device validates the signature of a received software module ensuring that it has not been tampered with and it checks whether it originates from a trusted provider. Correct root keys of authorized software providers have to be available [15]. The channel bandwidth may vary according to the transmission standard parameters, such as bit rate and modulation scheme. The software download depends strongly on the selected physical link for transmission; the channel conditions and the system load [16,17].

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4.4 Use Customized QoS

Quality of Service is designed for the purpose of performance assurance and service differentiation. The networks should be able to offer different QoS according to the user requirements. For example, a television station is broadcasting some important news. For users with wired networks connections, they would like to receive both the video and audio streams with high quality. For users with their mobile device, only Low quality video clips or only audio with text can be received in real time. Also the available wireless capability may change during the connection because of the mobility. In mobile and wireless environments, not only the capacity of the connection changes frequently, which make the performance assurance difficult, but also the handoff latency greatly affects the QoS. A lot of approaches are deployed to decrease the handover latency. Using Software radio, the most suitable handover strategy can be chosen to fulfill the individual QoS requirement of the application.

The software downloading time is evaluated according to the following procedure: the software downloading time is obtained as the time necessary to download the files corresponding to the module that has to be reconfigured waited with a scaling factor. This factor models the traffic in the network within the cell to which the terminal belongs. Note that the obtained results for the downloading time can be seen as an upper bound of the software downloading time estimates obtained when the statically distribution to model of the traffic are used**.** Efficient download strategies to minimize impact on system capacity for regular traffic must be derived [18]. It is very important that user terminal do not get disconnected during the reconfiguration procedure.

4.5Calculations of software download time.

The software download time T_D refers to the channel data rate R of valid data and the code download quantity D. that is, T_D is a function of the bandwidth W of the software download channel, the spectral efficiency of various modulations. Assigned the spectral efficiency of the GMSK modulation is 1.35b/s/Hz, the bandwidth W of the software download channel is 200kHz and the code download quantity D are estimated as follows, the time T_D for node A,B and C respectively is shown in Table1,

Table 1: W=200 kHz, 1.35b/s/HZ

Type	Node	D	T_D
Small	A	64bytes	1.3ms
Medium	B	5kB	15s
Large	C	5MB	148s

The most important requirements for software download traffic are error free reception and an acceptable latency**.**

5. CONCLUSION

4G terminals can be expected to be future proof and multi-mode multi-service and multi- standard, because of downloadable software reconfigurability and operate on new communications standards, using lower layer reconfiguration technology implemented with software radio technology. By this work, need not to change the device, just upgrade the required firmware by software downloading for future technology and for future updating.

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