

REMOTE CONFIGURATION OF A COMMERCIAL WIRELESS TERMINAL - PREPARATION OF A JAVA SPECIFICATION REQUEST

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ABSTRACT

Efforts are underway within the Software Defined Radio (SDR) Forum to develop an Application Program Interface (API) to support on-the-fly reconfiguration of commercial SDRs. Functions required for the reconfiguration of a mobile terminal include two basic steps: transport of software modules and parameters to a mobile terminal and the actual reconfiguration of the mobile terminal with the downloaded modules. The goal of the efforts within the SDR Forum Terminal and Network Architecture (T&NA) Working Group is to complement existing download protocols with a reconfiguration API to help standardize the way in which mobile terminals will be reconfigured. Although the initial work is being done in a technology-independent manner, the initial target for standardization is the Java Community Process (JCP).

This presentation will include a discussion of use cases that have been developed as part of this analysis, identification of different reconfiguration-related functions within an SDR, and the overall structure of the resulting configuration and management function of a commercial mobile SDR.

1. INTRODUCTION

Pertinent information on the work done over the last year within the SDR Forum Terminal & Network Architecture Work Group (T&NA WG) is presented here. The T&NA WG is focused on a commercial architecture for Software Defined Radios (SDRs). This includes scenarios and technologies that have been evaluated and compiled defining a consistent architecture for wireless terminals. This document provides the needed steps for the preparation of a Java Specification Request (JSR) for wireless terminal reconfiguration.

This document is outlined in four sections.

They are:

1. An overview of the approach defined within the T&NA WG on the completion of the analysis to support the definition of the JSR.
2. Results of a use case analysis focused on wireless terminal configuration.
3. Requirements for the configuration architecture.
4. The planning for ongoing work.

1.1 Defining JSR

A key requirement for the rollout of SDR is a consensus attained of the methodology for remote configuration of wireless terminals. Progress continues in work by the Software Defined Radio Forum to define key requirements and an architecture for remote configuration of a mobile terminal.

Within this forum, the Terminal and Network Architecture Working Group (T&NA) focuses on the preparation of an implementation independent set of requirements. These requirements serve as a baseline for the preparation of a JSR for gaining standardization of the configuration architecture within the Java Community Process (JCP).

1.2 Configuration Management Function

For the mobile terminal, multiple layers of application program interfaces (APIs) are involved as illustrated in Figure 1. These are:

- **High-level:** Provides an interface mechanism to the terminals configuration management function.

- **Low-level:** Provides an interface between the terminal configuration management function and the radio protocol stacks.
- **Radio engine:** Provides the interface between the radio protocol stack and other software and radio engine hardware.

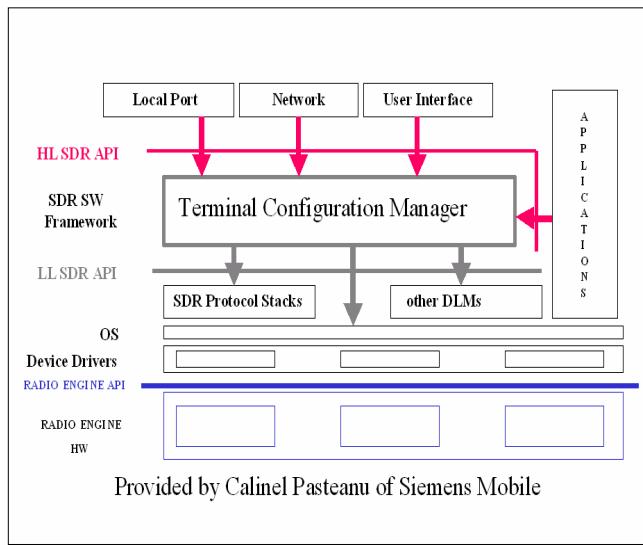


Figure 1: Overview of Configuration Management Function

The focus of this effort is defining the requirements and architecture of the high-level API. The expected definition of the high-level configuration management function will enable use of SDRs within the commercial sector, and definition of other layers APIs will logically follow.

1.3 Wireless Terminal Configuration

This effort (defining a JSR) prepares the basis for a JSR submission within a one-year period. Four basic goals in this process are to:

- Leverage previous work done with the SDR forum and other openly published efforts regarding wireless terminal configuration.
- Involve parties from various aspects of the wireless communications sector (i.e., manufacturers, research and development

groups, network operators, and service providers).

- Provide a flexible architecture and anticipate the full range of requirements for future terminal configuration.
- Coordinate with other complementary efforts within the SDR Forum. (for example: general API development efforts and efforts related to remote download of radio software).

2. ANALYSIS APPROACH

There are three key steps defining the analysis work. The result is the development of a baseline definition that is suitable in supporting a JSR request for definition of a Java profile that supports wireless terminal remote configuration.

- **Use-Case Analysis:** Focuses on definition of scenarios that drive the overall architecture configurable wireless terminals.
- **Requirements definition effort:** Focuses on distilling from the use-case analysis key requirements of a configuration management function within a wireless terminal.
- **Architecture definition task:** Focuses on the definition of salient architecture features that result from the requirement analysis.

The resulting architecture is technology independent as it can be implemented in any language and/or hardware architecture.

3. USE-CASE ANALYSIS

The use-case analysis involved the review of a number of documents. Initially all aspects of configuration and download were reviewed. It was found that functions need to be separated into two categories: 1) Those focused on download and 2) those involved in the actual configuration of a terminal.

The reconfiguration functionality that resulted from the use-case analysis is illustrated in Figure 2.

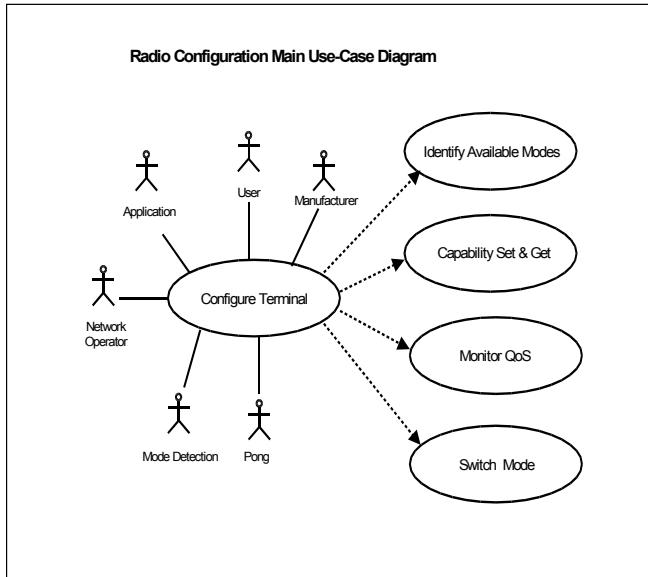


Figure 2: Main Use-Case Analysis

3.1 Configure Terminal Scenario

Four major capabilities are included in the configure terminal scenario

1. Identification of available modes of operation.
2. The ability to conduct *capability set* and *capability get* actions with the SDR terminal. This effectively includes requesting the terminal of capabilities and setting new ones.
3. Monitor Quality of Service (QoS): Assists the terminal in determining whether a mode reconfiguration is to be required or appropriate.
4. Switch Mode of the terminal. This involves the reconfiguration of the terminal from one air interface operational mode to another.

3.2 Downloading and Configuration

Changing the operating mode of a SDR terminal involves downloading the appropriate software and parameters.

The configuration steps for installing the software and parameters and initiating the new radio functionality entail five (main) steps. The first two are:

- Transport of air interface modules and parameters to a terminal

- Storage of modules and parameters on the terminal

These first two are download related. They are addressed by standards and profiles that are currently being developed in general support of the download of application and radio functionality software.

The last three are:

- Activation of specific functionality using the new modules and parameters
- Deactivation of specific functionality provided by previously loaded modules and parameters
- Removal of air interface modules from the device and resetting of the parameters

The last three are related to the actual configuration functions of a terminal.

The configuration functions were extracted to formulate a set of requirements and an architecture that is required for wireless terminal mode switching. Although a larger number of references and discussions played roles in the initial case analysis six of these primary references are noted. See References 1-6 for additional details.

Sixteen different scenarios are defined as part of our Use-Case Analysis. See References 7 and 8 for details of this work. These scenarios are relatively broad, including both download and configuration functions.

3.3 Identification of Interfaces

Figure 3 provides an overview of the original API definition with actors positioned in appropriate places, in order to identify interfaces that may be used in mobile terminal reconfiguration.

Key factors were identified and serve to define the grouping of these scenarios. They are:

- Initiator of the terminal configuration request (user, application, and network).
- Differentiations between immediate mode-switches after a module download and delayed mode switches.
- Differentiation of various interfaces that are used, (e.g., local ports and remote wireless interfaces) impacted by the configuration process.

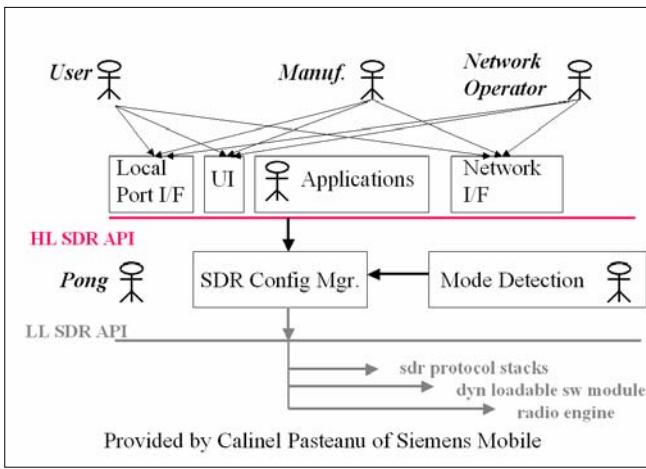


Figure 3: Overview of API and Actor Relationships

For all these scenarios defined, three steps summarize the configuration scenario for a terminal. They are:

- Actors initiate (request) a configuration change.
- The terminal completes configuration.
- Test new mode of operation is conducted and reported.

3.4 Actors

Several actors (entities that can initiate a configuration change) are defined:

- User
- Network Operator
- Application
- Mode detection function: the mode detection function resides internal to the mobile terminal above the lower level API and can initiate configuration change requests locally.
- Pong: the pong actor resides within the terminal that provides an ability to initiate configuration when the terminal itself detects an error. This error requires a full configuration to recover.

Initiation of a mode change does not convey that an actor can direct a mode change in an autonomous manner. Any request or initiation of a mode change has to involve interaction with other

appropriate entities (e.g., network, before a mode switch occurs.)

Three actors (user, manufacturer, and network operator) are external to the mobile terminal. These actors interact with the terminal configuration management function through four (basic) interfaces. They are:

1. Local port (e.g., serial, Bluetooth) that does not require configuration of an air interface standard to use.
2. User interface
3. Network interface: requires configuration of an air interface to use.
4. Application: the application does not reside on the terminal as a radio module. It acts for the other external entities to enable configuration change requests.

4. REQUIREMENTS DEFINITION

The four basic requirements that resulted from our analysis include:

- The configuration manager must be able to access various components of an SDR in a modular manner.
- The configuration manager function must have access to an I/F that provides for a mechanism for querying a mobile terminal for the identity and status of installed modules or entire radio personality.
- The configuration manager function is able to trigger the activation and deactivation of an installed module or set of modules.

These requirements lead to definition of particular requirements for the configuration management function and its interfaces. First, the software, next the binary images, and lastly the parameter required for operation of a mobile terminal must be segmented into meaningful groups that allows access of different functions within the terminal. Eight possible components are:

- **Management and control unit (MCU):** Provides the capability to manage and control the flow of digital data to configure the terminal (e.g. Bootstrapping, software

- downloading, and lifecycle management).
- **Antenna (A):** May need to be reconfigured to be utilized for different standards and specific users.
 - **Radio transmit/receive unit (RF):** Responsible for analog transceiver functionality in the mobile terminal.
 - **Digital signal processor array (DSPA):** Responsible for digital transceiver and modem functionality in the mobile terminal.
 - **Digital protocol unit (DPU):** Responsible for the higher layers of the protocol stack within the mobile terminal.
 - **Information and security unit (ISU):** Responsible for all information and security related aspects of the mobile terminal.
 - **Input output unit (IOU):** Provides interfaces to various media drivers (speaker, display, and microphone) and other local ports (serial port).
 - **Optional components (OC):** A generic Optional Components (OC) module is provided to allow for generic evolution of this architecture without requirement for revision of these components. OC's can be added with any functionality associated with them. Separation of the radio terminal into different components allows for partitioning of radio functionality into separate units.

All units are triggered and managed by the Configuration Manager; therefore applications do not have to be concerned about each unit. This enables portability and a minimum of I/Fs to be known by applications.

4.1 Capabilities

Capabilities must be put in place on the terminal for enabling the querying of component modules, the installation and removal of components, and the activation of component modules. The three commands to do this are to be used at the system (mobile terminal) or component level.

1. **Identify:** the process of querying an SDR for the identification and status of an installed module,
2. **Configure:** The process of installing and

removing a module.

3. **Initiate:** The process of activating an install module.

Any of these commands can be used to configure the terminal or convey information on the configuration between the terminal and an external actor. Additionally, the configuration management function of the radio can utilize any of these three commands to configure, initiate, or query a specific component of the radio.

These two commands have a response. The configuration and initiate commands have only two outcomes: success or failure.

Upon the installation of a module into a specific component of the radio or the initiation previously installed one of the two reports will be made to identify success or failure pertaining to the particular step being done.

The Identification command requires a response via the Configuration Manager about the SDR capabilities of the terminal. There is no requirement in this configuration management function that any particular type of language, hardware, or operating system be used in the configuration or operation of a radio. It is expected that prior to download a manufacturer will have validated accepted configurations of the software and parameter with a particular handset. The focus is to allow for controlled remote configuration of a terminal not necessarily requiring portability of all software and parameters downloaded to a terminal. Every module will have a particular personality (e.g. type of air interface supported) and will also be identified as valid for a particular handset or set of handsets. This is *not* a drawback for this approach as it is expected that this type of validation of modules with specific hardware will be required for use of SDRs to avoid interface to a network from manufacturing terminals.

5. NEXT STEPS

The T&NA WG is focused on completion of the following two tasks:

- Architecture definition: this will be concluded

- at the tie of the publication of this paper.
- Preparation of a JSR: this will be filed through the Java Community Process, *see* <http://jcp.org>

6. ACKNOWLEDGMENTS

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