# An SDL Implementation Framework for Third Generation Mobile Communications System

Juha Sipilä and Vesa Luukkala

Nokia Research Center, Mobile Networks Laboratory,
P.O. Box 407 FIN-00045 NOKIA GROUP
{juha.p.sipila,vesa.luukkala}@nokia.com

**Abstract.** This paper presents an SDL implementation framework for the third generation mobile communication system protocols. The framework includes specific stylistic notations of SDL and extensive usage of ASN.1. Furthermore the framework requires that all protocols should define certain packages and combine certain functionalities into one process. This framework has allowed creation of a prototype implementation of third generation mobile system protocol stacks. This prototype implementation contains nearly all protocols from mobile station, radio access network and some protocols from the core network side. This implementation has and will be used in multiple prototype and validation system implementations within Nokia.

## 1 Introduction

The enormous growth in usage of mobile communications systems worldwide has created a need for new, better and more efficient services and thus higher bit rates. In addition to these quantities the future system should also be, unlike the current systems, globally standardized.

The current mobile communication systems are called second generation systems and their successors will logically be called third generation mobile communications systems. The most widely used second-generation system at the moment is GSM (Global system for Mobile Communications).

The most famous member of the third generation standard family is Universal Mobile Telecommunication System (UMTS). The work for UMTS standardization was completed in early 2000, however corrections are still being made. The standardization work was done by 3GPP (Third Generation Partnership Program). 3GPP consists of multiple national standardization bodies and representatives of the telecommunication industry from Europe, Japan and the USA.

The large size, concurrency and real-time nature of mobile communication systems present a set of difficulties when generating a good specification. Some of the problems are such that it is not possible to track them on paper, thus early implementations from the specification are required.

These early implementations set special requirements for the implementation language. The language should provide the possibility to do the implementation

R. Reed and J. Reed (Eds.): SDL 2001, LNCS 2078, pp. 288–299, 2001.
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quickly, support distribution and concurrency, provide good tracing facilities and make possible to use formal methods for the most complicated parts of the system. On the other hand it is not absolutely necessary to have product level performance and memory consumption at this phase.

Desirable properties for a development environment in this context would be a notion of concurrency with proper support for simulation and tracing and well-defined semantics for the language used. With these requirements SDL [2] is a very good choice. SDL has been designed for telecommunication use and it hides all the irrelevant features of lower level programming languages (like pointers). Tool support for SDL is good as functional level debugging, tracing and simulation possibilities with the tools are excellent. SDL is a formal language which makes possible the use of verification and validation methods for selected parts of the system. SDL has also been used for a long time in telecommunication industry and it has been found out to be suitable even for product level implementation.

One problem with SDL is the presentation of data types. SDL as a language does not include the concept of PDU (Protocol Data Unit) and does not allow converting internal data representation to some transfer syntax. These problems can be solved by defining all the data types of the system with ASN.1 (Abstract Syntax Notation One) language. ASN.1 provides the ability to define a universal transfer syntax and thus makes it possible to distribute the different components of the system across diverse computer architectures.

Languages as such, even if they are good ones, are not the answer in themselves. Tools and frameworks are required to limit the degrees of freedom and make it possible for the implementor to focus on the essentials.

Telelogic SDT (Specification and Description Tool ) [5] has been used for a long time in the telecommunication industry and it has stabilized its position as a mature SDL development environment. Due to its earlier use at Nokia Research Center (NRC) it was an obvious choice for an SDL tool within this project. SDT has support for ASN.1 language, but unfortunately it was found to be too limited for our needs and a special tool called ASN4SDT was developed to integrate NRC's ASN.1 tool set with the SDT tool.

From the beginning it was clear that the 3GPP specifications will be evolving and they would be in a state of constant change. This was one of the major cornerstones on which the system design was based.

To assure that the complete system stays modular and extendable it was essential to develop our own protocol implementation framework. Based on previous experiences, exact naming conventions for all the used SDL concepts and a basic process structure for protocols were defined. This process structure consists of certain packages and processes which must be defined for all protocols.

Section 2 gives a brief introduction to the context of this work, the UMTS radio network, Sect. 3 presents the high level architecture of the system and Sect. 4 presents the used framework. Section 5 gives an example of the principles outlined in Sect. 4 and finally Sect. 6 presents the conclusions.