Real Time and Estelle: A Comparison of Approaches

Stefan Fischer
University of Mannheim, Praktische Informatik IV
D-68131 Mannheim
Email: stefis@pi4.informatik.uni-mannheim.de

1 Introduction

The notion of real time becomes more and more important in protocols and distributed systems. Especially in modern telecommunication systems like multimedia, Quality of Service (QoS) plays an increasingly important role. Quantitative QoS parameters like throughput, delay, jitter or frame rates are defined with respect to real time. Thus, if formal methods are to be used for the specification of such systems and QoS is to be taken into account, a notion of real time has to be available in the respective language.

In this paper, we first show that standard Estelle's approach to model time is too weak for real-time purposes. As a consequence, the language has to be enhanced. As a basis for further investigations, we present a short overview on how real time can be represented in the basic formal model of state sequences. This is necessary, since such state sequences also form the underlying model of Estelle specifications. In the main part, we then introduce into a number of approaches that all attempt a real-time enhancement of Estelle. A comparative discussion should give hints what the advantages and disadvantages of each approach are and serve as a base of discussion on the question whether these approaches are worth being followed.

Since this is only am extended abstract, the following sections do only describe what will be found in the final version and be presented during the workshop. Technical details are left out.

2 Formal representation of time

In this section, as a motivation, we will first show that Estelle's delay clause — the only language construct with a relation to time — is not very useful to describe real-time characteristics of a system.

The underlying model of Estelle specifications are state sequences, since every Estelle specification describes a set of such state sequences (called computations in Estelle). We will shortly describe how the general model of state sequences can be enhanced by a notion of time. The resulting model is called *timed state sequences*. It will be shown that timed state sequences can be used without big difficulties to replace the state sequence model of Estelle.

3 Enhancing Estelle by real-time constructs

In order for an Estelle specification to produce timed state sequences instead of simple state sequences and to offer the possibility of real-time specifications, noy only the model, but also the syntax and semantics of the language have to be enhanced. That means that some sort of real-time construct(s) has to be introduced.

This sections presents some of the approaches reported in the literature to solve this problem. The approaches discussed are:

1. Introduction of time parameters for transitions [2]
2. Modification of the semnatics of the delay clause [1]
3. Time-Estelle [5]
4. Real-Time Estelle [4, 3].

The last one is described in more detail since it has been developed by the author.

4 Comparison of the methods

Finally, the presented methods are compared with respect to their usefulness in different phases of the system development cycle (design, specification, simulation, implementation). Strengths and weaknesses are pointed out.

The results are intended to serve as a basis for discussion at the workshop on possible extensions of standard Estelle with respect to real time.

References

[1] S. C. Chamberlain. *Estelle Enhancements for Formally Specifying Distributed Systems.* PhD thesis, University of Delaware, USA, 1992.

[2] P. Dembiński and S. Budkowski. Simulating Estelle specifications with time parameters. In H. Rudin and C. H. West, editors, *Protocol Specification, Testing and Verfication VII*, pages 265–279. Elsevier Science Publishers B.V. (North–Holland), Amsterdam, 1987.

[3] S. Fischer. Real-Time Estelle. Technical Report TR-96-003, University of Mannheim, 1996.

[4] S. Fischer and S. Leue. Formal methods for broadband and multimedia systems. *Computer Networks and ISDN Systems*, Apr. 1998. To appear.

[5] T. Tsang and R. Lai. Time Estelle: An Extended Estelle Capable of Expressing Multimedia QoS Parameters. In *IEEE Int. Conf. on Multimedia Computing and Systems (ICMCS'97), Ottawa, Canada.* IEEE Computer Society Press, 1997. To appear.