Modeling, Simulation, and Emulation of QoS Oriented Transport Mechanisms

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ABSTRACT

The design and development process of communication protocols and real-time systems and particularly transport protocol mechanisms requires adequate methodology and efficient instrumental support. In this paper, an extensible and QoS-oriented development framework integrating design and simulation with UML (Unified Modeling Language), and implementation and evaluation with emulation is introduced. An early use of the proposed framework is illustrated with the design and development of simple transport mechanism.

Categories and Subject Descriptors

C.2.2 [**Network Protocols**]: [Transport mechanisms]

General Terms

Languages, Verification

Keywords

QoS, UML, design, simulation, emulation, transport protocol.

1. INTRODUCTION

Transport services, based on the composition of various mechanisms, are a mean to improve the end-to-end quality of service offered to applications. Many ad-hoc mechanisms have been proposed to adapt the underlying network service to the various application needs in term of reliability, order and time. The process of design, modelling, implementation, testing and evaluation of such communication mechanisms and their composition is however often achieved manually without a proper methodology and tools. Then, this process remains a heavy task that can be alleviated by the way of ad-hoc environment.

This paper proposes an extensible QoS-oriented development platform integrating design and experimentation frameworks provided for both high level specifications with UML (Unified Modeling Language) anddevelopment level implementation. An early use of the proposed platform is illustrated with the design and development of simple transport mechanism.

CoNEXT'05, October 24–27, 2005, Toulouse, France.
ACM 1-59593-035-3/05/0010.

2. PLATFORM

The complexity involved in designing and developing communication protocols and real-time systems is mainly represented by the participation of different actors in different phases sharing a partial vision of the solutions. During the initial phase dedicated to the analysis, the modellers try to represent and describe the current state of the studied system thus creating a model of the reality aimed at detecting and understanding the problem to be solved. From this phase, the designers use this model to start proposing and designing solutions to the problem. These solutions are generally specified using high level languages in a high abstraction level context. These solutions allow a first evaluation of the proposed mechanism. This simulation phase allows to test several scenarii based on simulating QoS network conditions. This conception phase lead to the implementation of the solution ant its integration into the target system. Test and performance evaluation of the resulted software must be achieved.

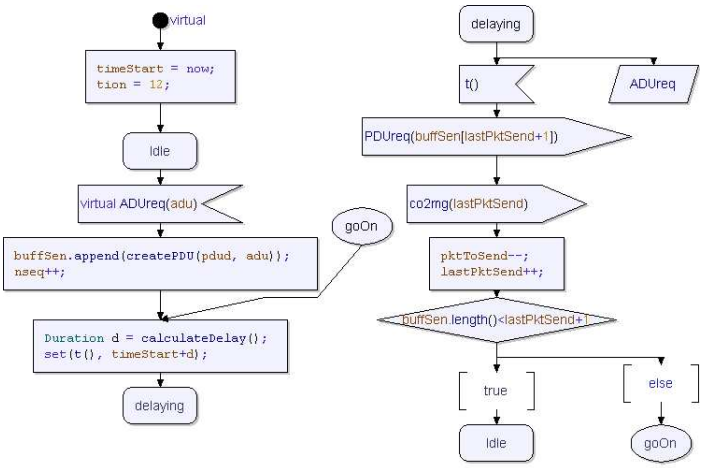
In order to design and develop new transport mechanisms that aim at improving the QoS, the Unified Development Process (UDP) is a classical methodology used for the development of complex system. This methodology is particularly based on UML that is widely used into the development of telecommunication standards and protocols.

The proposed platform integrates design and development methodology and tools intended to specify, model, simulate, implement, test and deploy real-time applications and advanced communication services[1]. The UDP methodology is integrated and used for both the specification and the development of the system studied and the solutions proposed[1]. Various components compose the platform including multimedia applications and communication subsystem and are available in both high level solution specifications and implementations. Then, various types of applications such as audio/video streaming using different sort of codec are proposed in both context. In the same way, a communication environment is proposed in both context (either UML and Implementation) to produce specific target communication behaviour in term of quality of service, allowing reproducing artificially network impairments aiming at testing particularities of the experimented protocol.

3. QOS-ORIENTED RATE CONTROL

The proposed platform is used for the development of a rate control mechanism in the context multimedia applications over quality of service network. The rate control mechanism is based on a simple version of TFRC [2]. This mechanism is to be integrated into the Enhanced Transport Protocol (ETP)[2], a QoS oriented end to end service.
The rate control has been modeled using the various UML schemas.The next figure show statechart diagram providinng a way to represent the mechanism behaviour (see 1). The

Figure 1: Rate Control



UML model can then be evaluated into the simulation environment provided into the Telelogic TAU 2.4 tool, by the way of the experiment framework. The mechanisms are evaluated using the provided applications and using several types of network conditions. From these preliminary studies, the mechanisms have been extended to better support the applications QoS requirements. This extension consists for the rate control mechanism to take into account both the application data unit's semantic (e.g., type of images) and the underlying networking conditions to process the ADU (delay, dropping, etc.) linked to the actual state of the type of ADU and the network.
An implementation of the mechanisms has been realized and integrated into ETP. The implementation is tested using an emulation system aiming at controlling in real-time the communication dynamic of IP packets to produce a particular network conditions. The mechanism has been tested using a real video streaming application using MPEG-TS codec. We have compared the results to UDP or TCP.

4. CONCLUSION

In this paper a preliminary version of a platform intended to design and develop communication protocols and real-time systems has been introduced. The benefits of using the platform have been illustrated while designing and developing a transport protocol mechanism for multimedia application. Anomalies in functional and non-functional properties of the specification can be detected and corrected early during the design phase. The platform then allows efficiently testing and evaluating the implementation of the developed mechanism.

5. REFERENCES

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