

Service-oriented Architecture as an Enabler for the Convergence of the Internet with Cellular Systems

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I. MOTIVATION

The fraction of users accessing the Internet through cellular networks is increasing and expected to surpass that using wired access in near future. The convergence of the Internet with cellular systems – such as the 3G and 4G systems standardized by 3GPP – is inevitable. 3GPP is a standardization development organization created by telecommunication associations whose specifications govern nearly 4 billion cellular network subscribers.

At the same time, the Internet is increasing in complexity in the sense that it is expected to support an increased number of applications. While initially Web browsing and Email were the dominant applications, the future Internet is expected to host all flavours of multimedia communications in an efficient manner. The service-oriented approach is a paradigm in software engineering suitable to tackle complex systems.

The subject of this work is to unite these two aspects and address the question, whether and how the 3GPP system can employ the service-oriented architecture paradigm to meet requirements of tomorrow's multimedia communications.

II. REVIEW OF SERVICE-ORIENTED NETWORKING ARCHITECTURES

The service-oriented approach is a well known paradigm in software engineering. The basic concept is that tasks are achieved by the composition of elementary services.

There have been several efforts to apply this principle to network architecture, such the Protocol Heap approach from Braden et al. [4], the SILO approach from Dutta et al. [6] and the future Internet architecture from Müller and Reuther [8]. All three follow the so-called clean-slate approach proposing a new architecture for the Internet. While in the Protocol Heap and SILO approaches the focus is on the header of the actual data packet, the latter approach puts the focus on the workflow.

III. REVIEW OF 3GPP SYSTEM ARCHITECTURE

As mentioned above, cellular networks need to be given a prominent role when thinking about the future Internet.

With the advent of 4G the 3GPP mobile network has been specified as an All-IP network. The 4G access network architecture is specified in 3GPP TS 36.300 [1] and the 4G core network architecture is specified in 3GPP TS 23.401 [2] (3GPP access) and 3GPP TS 23.402 [3] (non 3GPP access). These specify the stage 2, i.e., the functionalities of the entities

and the procedures which achieve the desired tasks. Standardization in 3GPP follows a three stage process where in stage 1 the requirements, in stage 2 the architecture and in stage 3 the protocols are specified. Considering the procedures is important as they determine the time needed to execute tasks such as connection establishment.

IV. MODULAR PROCEDURES

When applying the Service-oriented architecture paradigm to the 3GPP procedures which deal with mobility, QoS and security, an open question is how the protocol stack is created. This can be done employing modular procedures. There is a set of elementary procedures and they can be grouped to procedures which achieve the desired task. I.e., the focus is not on the protocol stack, but on the procedure. This allows for a smooth evolution from the 3GPP system architecture of today's specifications. Each elementary procedure fulfills a task, and for each task there may be multiple elementary procedures to choose from. An example is the initial attach procedure, which may consist of the elementary procedures "Diameter authentication" and "IPv4 address allocation". In this case the tasks are authentication, for which the choices may be Diameter [5] or RADIUS [9], and IP address allocation, for which the choices may be IPv4 or IPv6. There are two main challenges when designing procedures out of such elementary procedures. The dependencies need to be treated appropriately. In many cases the choice of an elementary procedure for one task influences another task. E.g., a certain QoS protocol may not be compatible with all mobility protocols. Secondly, a low connection setup delay needs to be ensured. As a matter of fact, the motivation to couple different tasks together in common procedures is to reduce the delay. A further point that needs to be considered is how the elementary procedures are selected. The end of end-to-end has been proclaimed [7], but one should not forget that there are strong reasons to keep the intelligence in the terminal. The terminal knows what the user wants to do, what its capabilities are and what the context (e.g., battery level) is. Therefore, the terminal is suited best to initiate the connection establishment.

V. CONCLUSION

Employing the service-oriented architecture paradigm is a promising approach to enable convergence of the Internet and cellular systems. The concept of modular procedures seems a good compromise between allowing the flexibility promised by

the service-oriented approach and compatibility with legacy 3GPP systems.

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