Dominikus Herzberg: **Modeling Telecommunication Systems: From Standards to System Architectures**

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Kurzfassung:

The architecture of a technical system reflects significant design decisions about the system's organization and typically documents a description of key system elements (be they hardware or software), their composition, functioning, and interrelation. The process of creating a description of an architecture is called architecture modeling. In the telecommunication domain, the architecture level has always played an important role in the design and evolution of communication systems and networks.

However, the way how telecommunication engineers describe their architectures is surprisingly rudimentary: They use natural languages and conceptual drawings, as a look into "old" as well as recent standards unveils. Even in the transition phase from standards to the early design phases of system development, system designers do not go much beyond that level of informality. Therefore, as practice shows, in telecommunications, architecture modeling but not the understanding of architecture as such lacks (i) a suitable, consistent and formal modeling language, which is adapted to the needs of systems designers, and (ii) a methodology to support the modeling process. This work addresses these deficiencies.

In this thesis, a systematic approach is presented for modeling architectures of virtually any telecommunication system. This includes a methodology, a modeling language, and a prototype implementation of the language. A major contribution of this work is the statement that such an approach can be based upon as few as three basic cornerstones for a networked system: the types of communication and the design principles of distribution and layering. The investigation distills fundamental insights for the design and construction of modern communication systems.

The outcome can be summarized as follows: The aspect of control leads to the distinction of three elementary types of communication (control-oriented, data-oriented, and protocol-oriented communication) and provides the rational for greybox architecture descriptions. The aspect of distribution can be manifested by the notion of a complex connector, which is the key concept to model connection-oriented, connectionless, and even space-based communication networks including quality of service. Layering in telecommunication systems is different from the ordinary understanding of the term. Layers in a distributed communication system follow a generic form of refinement, namely communication refinement. Communication refinement constitutes a true abstraction hierarchy, which can be interpreted from two perspectives: from a node-centric and from a network-centric viewpoint. The viewpoint chosen has an important impact on the systems understanding.

The foundation of this work is mathematical, its application is practical. The mathematics help giving precise definitions on the notions of distribution and layering; the resulting implications shape the methodology and the language. The language developed is based on ROOM (Real-Time Object-Oriented Modeling), an object-oriented but also component-based language. Key language features of ROOM will be integrated in the forthcoming 2.0 release of the Unified Modeling Language, UML. The extensions proposed to ROOM led to a careful redesign of the language and a prototype implementation. The accompanying methodology is organized in method blocks, each block being a self-contained methodological unit encompassing heuristics and architectural solution patterns.

The thesis statement is supported by a real-life case study on the SIGTRAN (SIGnaling TRANsport) architecture. In the case study, first the understanding of architecture models as imposed by standards is presented. At the end of this work, it is shown that systematic architecture modeling is relatively easy and comes at little costs — the gains in terms of clarity, preciseness and expressiveness are remarkable.