Modular Link Layer Functions of a Generic Protocol Stack for Future Wireless Systems

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Overview

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• Generic Protocol Stack in the Context of Multi-Mode Capable Wireless Networks
• Modular Approach
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• Conclusion and Outlook
Introduction and Motivation
Overview - Introduction - Generic Stack - Modular Approach - Realization - Outlook

• Idea: Protocols share a lot of communalities, that can be exploited in an efficient reconfigurable wireless system

→ Generic Protocol Stack

• Advantages: runtime reconfigurability, maintainability, code/resource sharing and accelerated protocol development through reusability

• Generic part is crucial: Tradeoff - general usability vs. implementation effort

• Two approaches for realization, depending on the abstraction level of identified similarities:
  – Parameterizable modules including fundamental protocol functions
  – Inheritance of generic part(s) [1]

• Integration to a system-specific protocol/layer (step 3)
  – merging of generic and specific parts (modular composition or inheritance)
• Development of standard-specific supplements (step 2)
  – features and functions unique to the respective system technology
  – representation of the individual behavior of a system
• Identification of similarities (step 1)
  – layer by layer analysis
  – extraction of common features
• Protocol Reconfigurability (step 4)
  – Combined with reconfiguration management and functions: a flexible as well as efficient realization of a reconfigurable protocol stack

Generic Protocol Stack

Overview – Introduction – Generic Stack
– Modular Approach - Realization - Outlook

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Enabling Transition between Multiple Modes

... with the help of a **Modes Convergence Protocol**.

- Separation into specific/generic part in each layer
- Management of (parallel existing) protocol stack/layer
- Administration of user data (seamless mode transition)
- Cross layer optimization (preservation of protocol status info)
- Support of network-initiated reconfiguration
Modern communication protocols cannot be forced into classical layered architecture of ISO/OSI RM.

Though belonging to Data Link Layer, common fundamental protocol functions can be found in multiple layers (2-4):

- Error handling - Forward Error Correction or Automatic Repeated reQuest protocols [2]
- Flow control
- Segmentation, concatenation and padding of PDUs*
- Multiplexing and De-Multiplexing
- Dynamic Scheduling
- Ciphering
- Header Compression

Modular Approach

- Common protocol functions as parameterizable modules and system-specific modules form a complete protocol layer
- Communication inside: generic service primitives and generic PDUs

**Functional Module**: Realizes fundamental functionality as black box

**Manager**: Composition, rearrangement, parameterization and data query of modules; Administration of internal communication

**Interface**: Translation of generic service primitives to specific ones

**Service Access Point**: Is needed, if a classical layer is demanded for fitting into ordinary stack

→ Simulation and performance evaluation on several levels: (sub-)layer as well as complete protocol stack
Parameterization implies:

- Specification of a value
- Switching on/off of a behavior or functionality
- Extension of the modules’ interface

Segmentation module as example:

- Use of concatenation
- Targeted PDU size after handling
- Use of Padding, i.e. filling up of a PDU to reach a certain size
- Transmitter/Receiver Role
- Buffer size for SDUs concatenated in a single PDU
- Behavior in case of an error, i.e. interworking with ARQ module
Exemplary Protocol Layers


TCP/UDP/IP

UMTS RLC

802.11 MAC

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SDU is separated into PDUs to fit to transport channel

Here: Segmentation aspects of UMTS RLC in Unacknowledged Mode

- Protocol overhead vs. optimized channel utilization
- The segmentation module reflects the known behavior → it can be legitimately used in an multi-mode capable protocol stack
Conclusion and Outlook

The identified similarities are decisive for success → tradeoff of genericity

- Generic protocol stack takes up well-proven and known fundamental protocol functions
- Existing (as shown) and future protocols (4G) can be composed out of adequately parameterized modules
- Library of common functions results in a construction kit for accelerated protocol development
- Efficient protocol reconfigurability through parameterization is enabled on the basis of functional modules

The introduced approach is a first step to an efficient multi-mode capable wireless system
Thank you for your attention!

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