Potential new case studies for behavioural types: Switching software systems

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Summary

- Introduction
- Switching software
- System requirements
- Related work on formalisms
- Concrete protocol examples
- Cases study: system description
- Call flows
- Problems: previous experiences
- Switching software perspective

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What is switching software?

Switching software in telecommunication network

Picture taken from:
http://commons.wikimedia.org/wiki/File:WAC_telephone_operators_operate_the_Victory_switchboard_during_the_Potsdam_Conference_in_their_headquarters_in..._-_NARA_-_199007.jpg

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Switching software

- Telecommunication exchanges are developed more then 50 years
- Main concepts are space division and time division
- Numerous formal approaches were developed
- Still we face with number of failures

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System requirements
System has to provide:

- Parallel execution of multiple different requirements, for number of users
  - e.g. Systems implementing MSC logic has to cope with more than milion requests in parallel,
  - provide number of different ‘standard’ protocol interactions
- high availability for its users
  - If certain malfunction happen the peers has to be timely informed, and all related resources properly released, avoid congestion situations
- properly dimensioned – aviod load
- response by the required time
  - Real time system, a system with a real-time constraints
- Interoperable with other vendors equipment
- Inside logic has to provide external protocol compliance

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System requirements
System has to provide:

- Easy to maintain
  - system structured into number of logical functions
  - Well defined and separated logical functions
  - Easy to trace system dynamics
  - Easy transformed from object code back to original code

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Switching software systems: Programming languages examples

- PLEX: used in Ericsson AXE telephone exchange
  - Concept of program segments: data encapsulated by set of procedures (modules) that could access data, other modules can not
  - Software is living ***modular*** system and basic requirements are flexibility, manageability, ease of modification, ease of handling, etc.
- CHILL: Used in 1240 ITT telephone exchange
  - Has to support more than 100 000 telephone calls **simultaneously**, fully distributed control
  - Concept of 'finite message machines'
    - Predefined set of input messages and each produces a finite set of replies
    - No FMM has direct access to memory of another FMM – all communication through messaging
    - FMM may reside on the same or different machines – message handler implements routing functionality among the machines for each messages
- Erlang
  - **Reliable** system but in presence of errors

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Switching software systems 1:

Application of formal methods to the verification of communication protocols

- the most commonly used methods for ensuring the correctness of a system are simulation and testing
- exhaustive for any reasonably complex system is imposible
- Errors can sometimes occur only for specific execution sequences which are difficult if not impossible to reproduce or debug, making an exhaustive analysis necessary
- Knowledge that the design logic of a system is correct help us to avoid critical system faults
- the errors during implementation are less likely to be fundamentall logical errors that are very difficult to understand and solve

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Switching software systems 2:

ITU-T Standardisation, Z series

- Unified Model ling Languague UML diagrams, Message Sequence Chart MSC
- Specification and Description Language SDL (ITU-T)
- for the description of communication protocols including concurrent and real-time aspects
- System is represented as set of blocks and processes,
- Processes interact asynchronously via signals that are placed into and consumed from queues.
- The communication structure is given by signal routes that connect individual system components.
- Used as automatic verification techniques like model checking
- high-level languages and formalisms particularly made for real-time and communication systems, CHILL

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Concrete protocol examples

- Signalling network and protocols in celular telecomunication network

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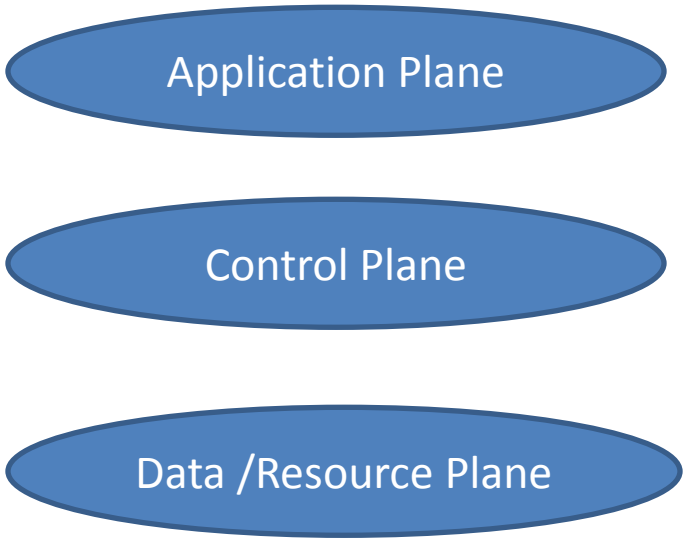
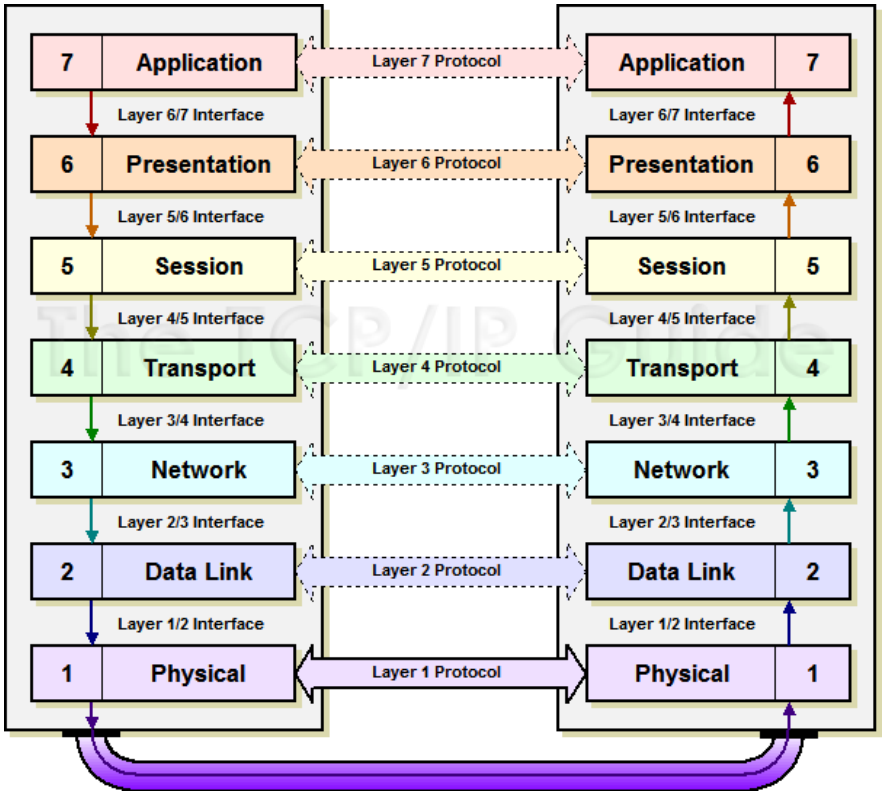
Network communication architecture

- Networks are defined and modeled at different abstraction levels



Network architecture



Open Systems Interconnection Model

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Case study

- Signalling network in mobile communication network
- We can consider as high priority data traffic network
- Developed according 3GPP standardisation body regulations

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Evolution of telecommunication network

- 3rd Generation Partnership Project
  - Standards for cellular telecommunications network technologies
  - http://www.3gpp.org/

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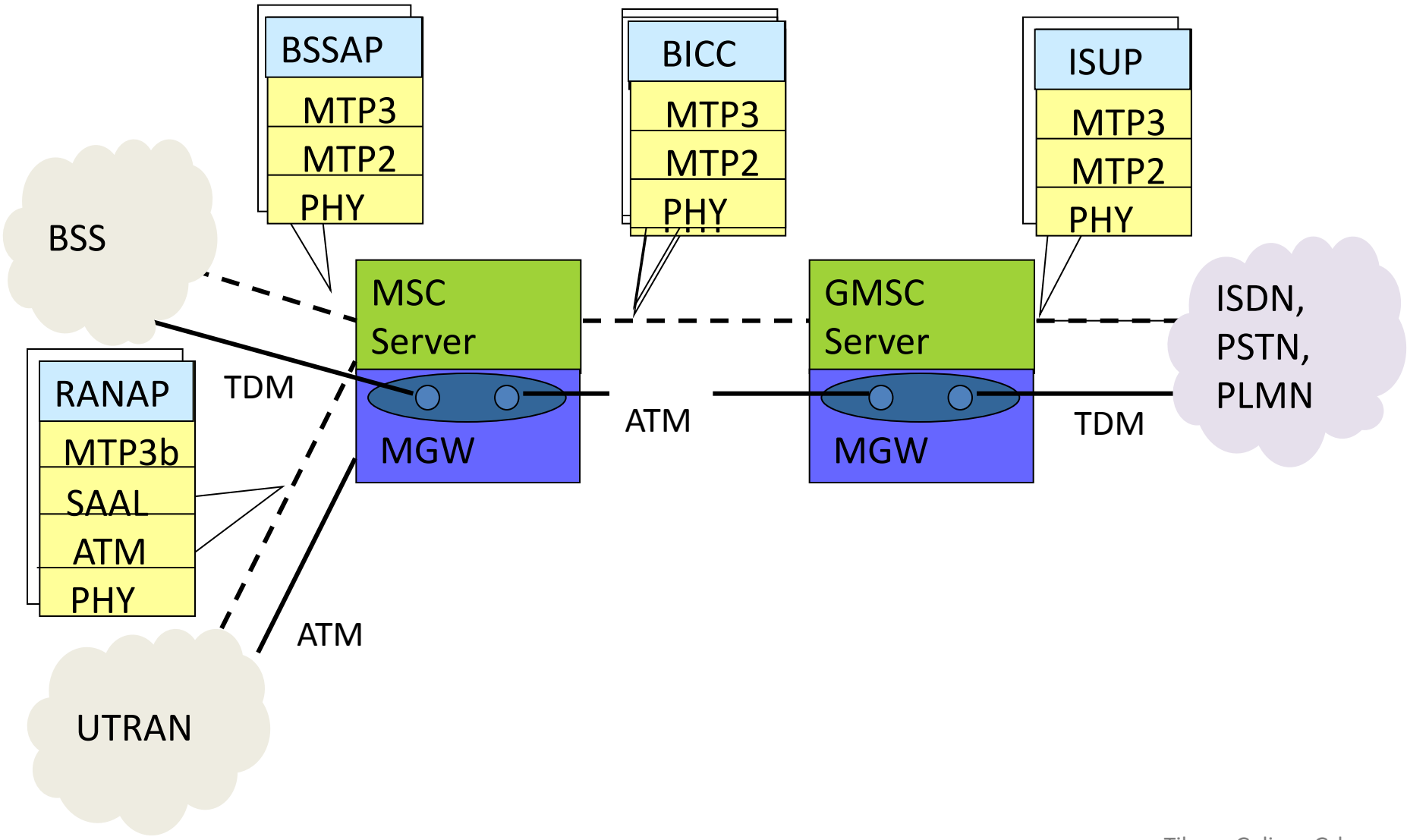
Signalling netowrk evolution

Phase 1: Introduction of ATM transport and new BICC protocol



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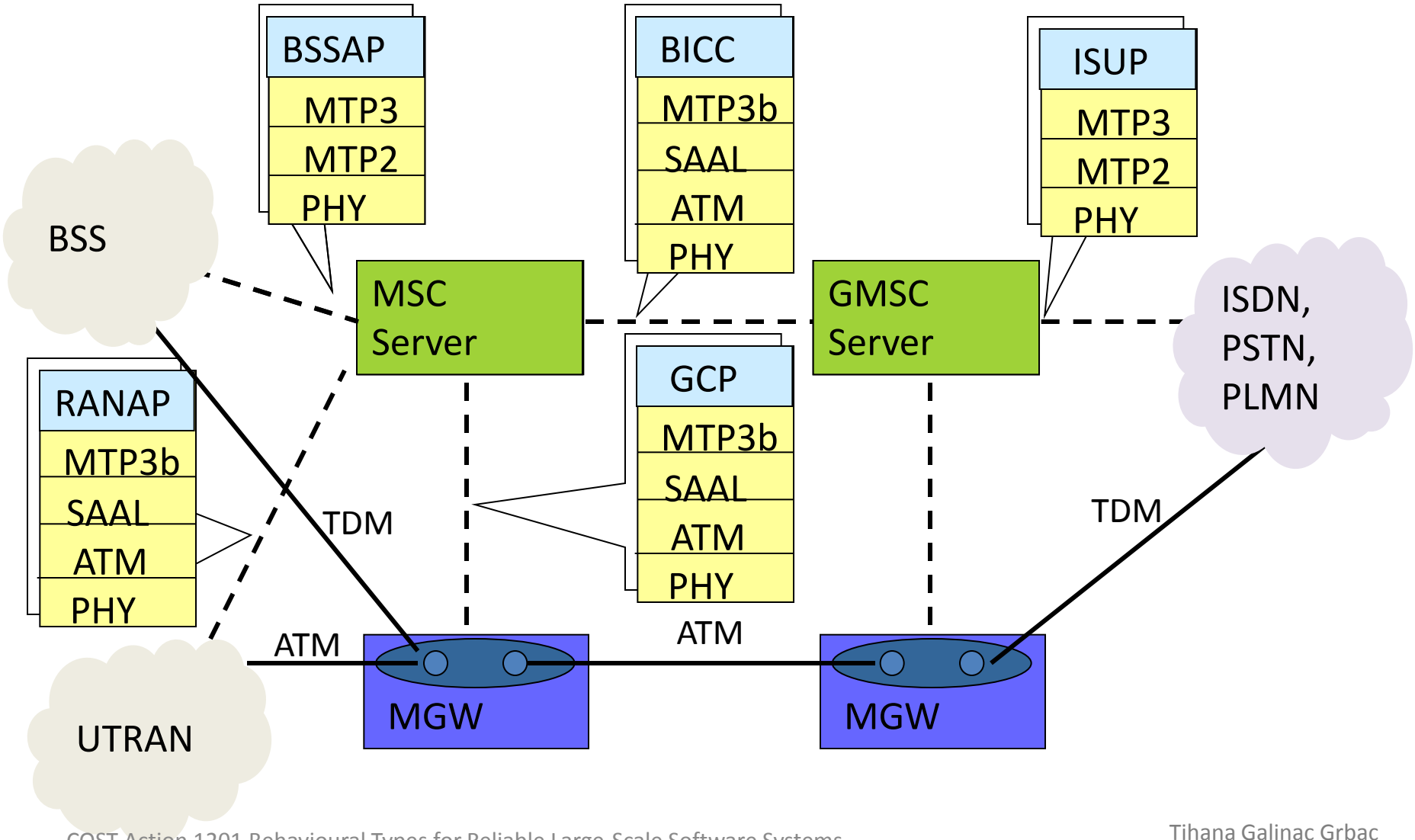
Signalling netowrk evolution

Phase 2: Sppliting of network architecture- new GCP protocol



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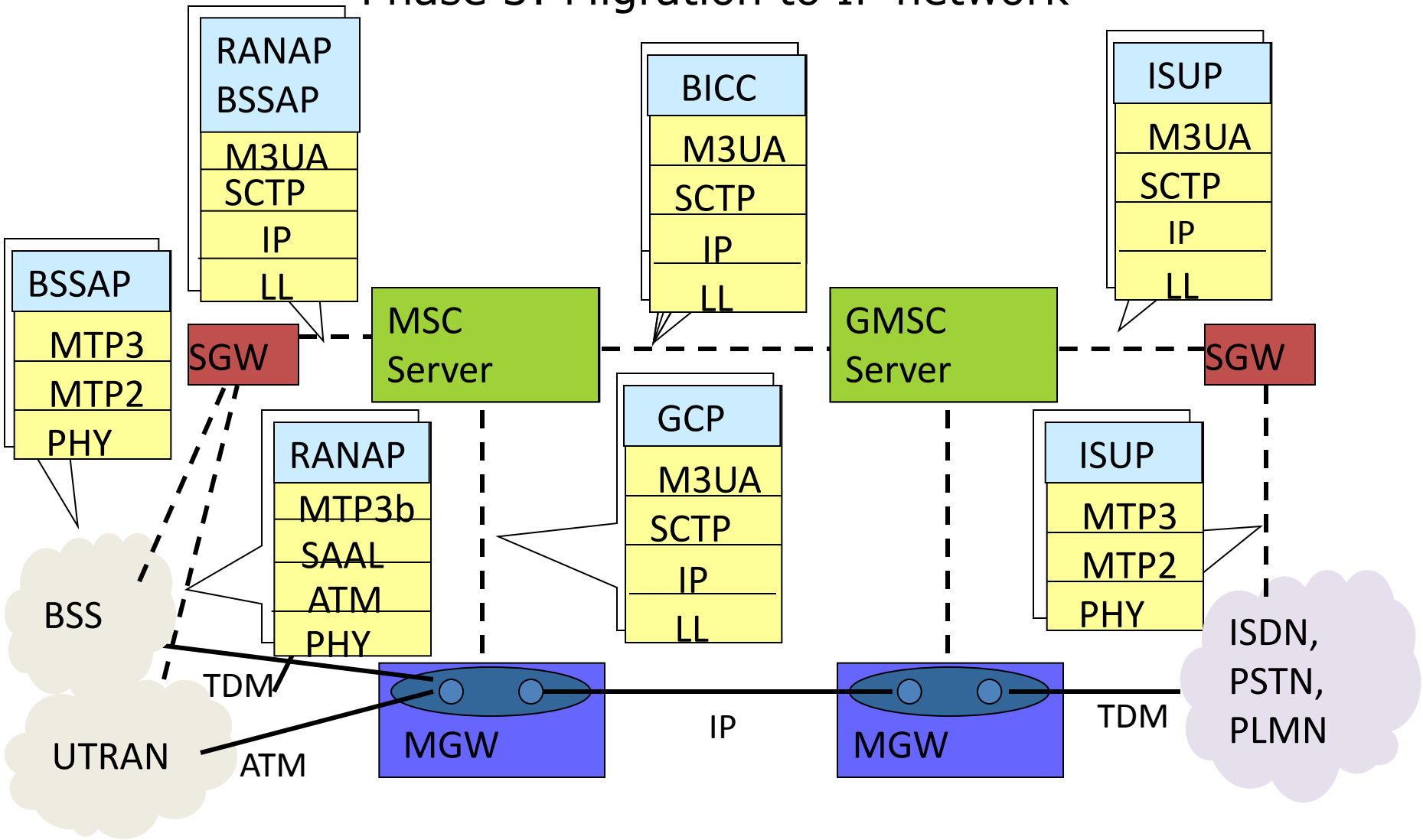
Signalling netowrk evolution

Phase 3: Migration to IP network



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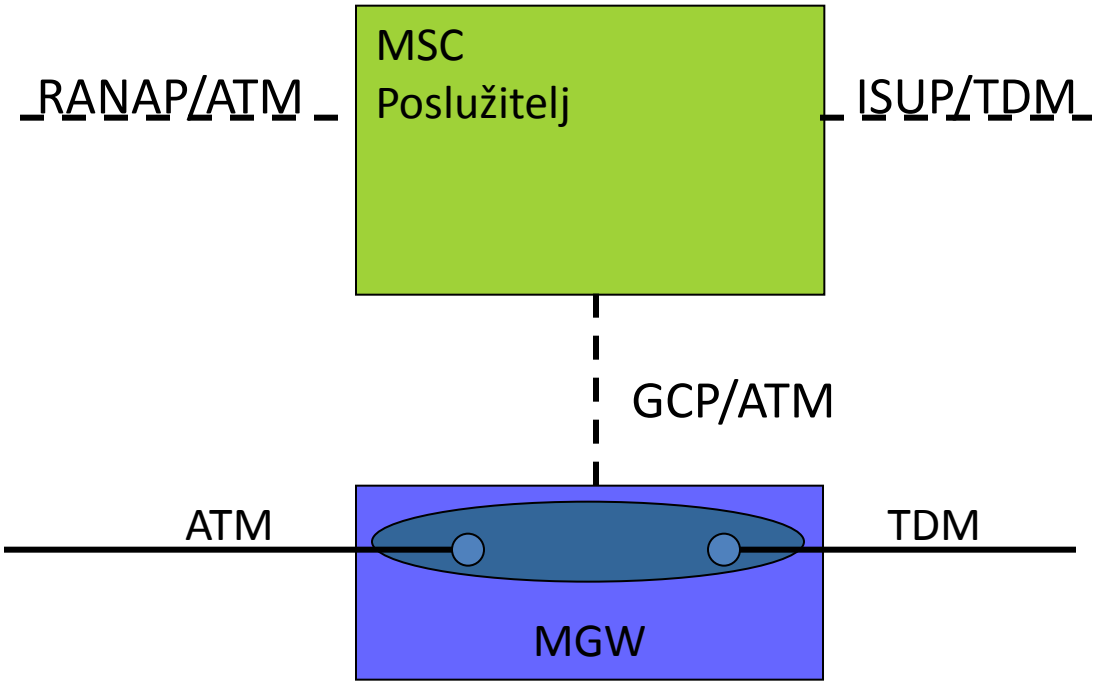
Protocol example

- Interaction between horizontal and vertical protocol



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System

- AXE based MSC node
- PLEX signals
- several million lines of code
- Divided into more then 1000 modules
- More then 1 million of simultaneous requests
- Priority levels
- Resources
- Real time with time constraints

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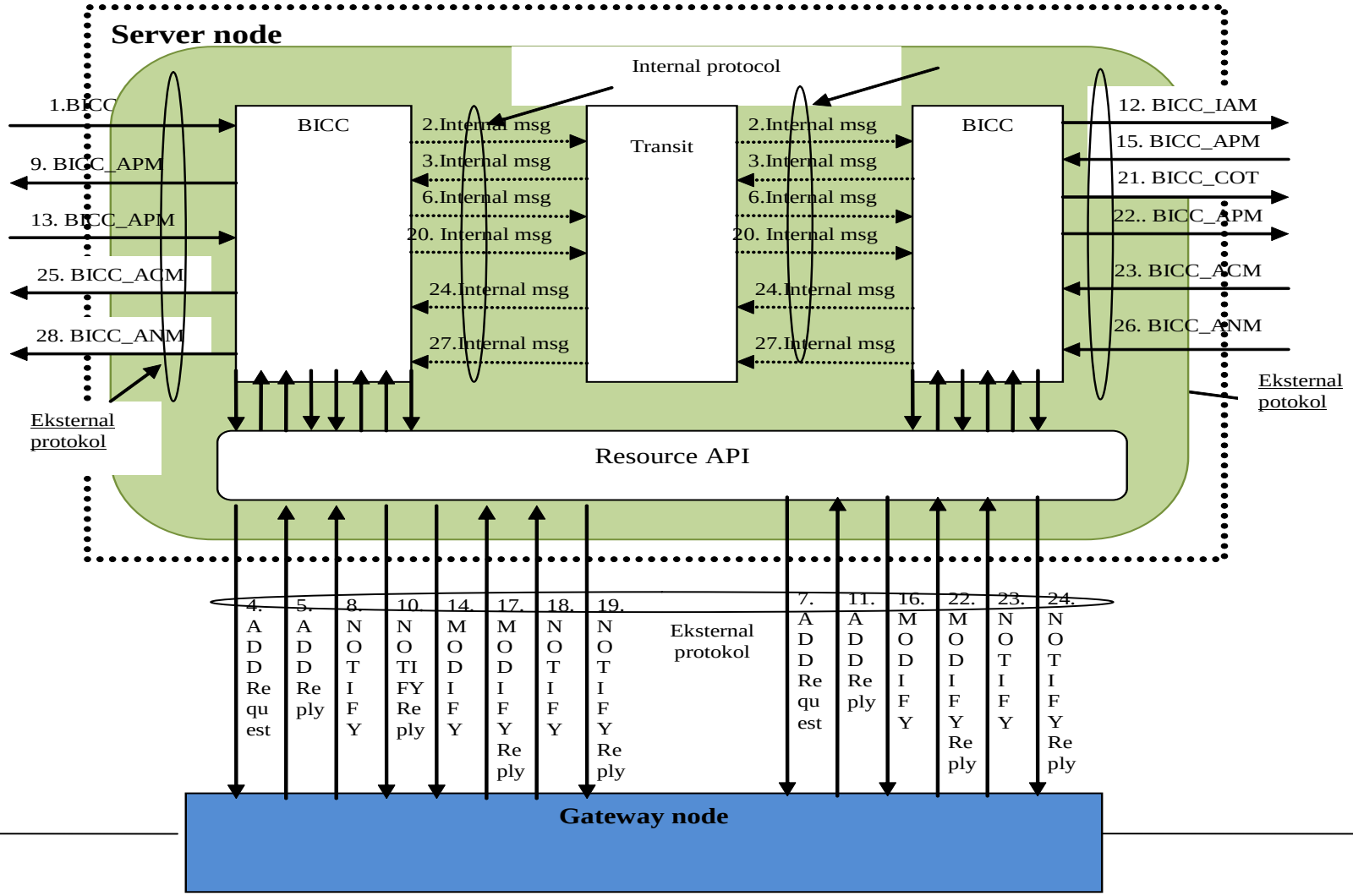
Call set up



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Call flows

- Example: Session Initiation Protocol
- http://www.cisco.com/c/en/us/td/docs/voice_ip_comm/sip/proxies/2-2/administration/guide/ver2_2/eflows.pdf

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Problems (1)

- Several levels of abstractions
- How to define right structure - and secure type safety between internal and extenal intefaces
- The most critical issues in the maintainance – from the aspect ‘How hard is to locate the fault’
- Interactions between system functions and network functions

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Problems (2)

- Protocol interactions
  - E.g. Node recovery, congestion control, etc.
  - System internal optimisations aiming to increase the system performances (e.g. Dual seizure – shortcut in internal communication)
- Partially executed system procedures may affect inconsistencies
- Order of release procedure is important (Control process)
- System configuration change that may take longer time because of lower priority
- Shared resources and correct release procedures, relinking of blocks, traffic interference
- Message multiplication, congestion and time constraints
- Timers in the system and their interaction (are some timers long enough)
- Priorities of error cases

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Switching software perspective

- Connectivity software, implemented in software switch
- include call agents, call servers and media gateway controllers
- Becomes to be increasingly important
  - Internet of Things – anything can communicate with anything and anybody
  - M2M interaction
  - Software Defined Network – software can reconfigure itself at runtime
  - Open Source community - Everybody could contribute to distributed application development
- Consequences of failure are higher then ever
- Problems of dynamic restructuring of system design becomes the most important mechanism

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