Network Modelling and PSTN-NGN Migration

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Review

1 Introduction

2 New Network Model

3 Procedure for Designing a Network

4 Interworking between Networks

5 PSTN-NGN Migration
1 Introduction

Changes in Telecommunication Networks
- NGN (Next Generation Networks), Voice/All over IP, UMTS Release 5, Fixed/mobile Convergence
- Network integration: e.g. PSTN, ISDN, GSM
- More complex networks

Reduction of complexity
- By using a structured network model
- OSI Reference Model with 7 Layers, ISDN- and generic protocol reference model
- But: Restricted to certain Layers or Strata
- But: Important network functions such as „Services“, „Mobility“, „Security“, „Quality of Service“ are spread over different Layers and Planes → not modelable

→ New network model required!

2 New Network Model

Characteristics
- For modelling arbitrary Telecommunication Networks
- 1) Graphical Model
- 2) Calculation Model for variant calculation
- Strata: Layer(s)
- Planes
- Functional columns
- Network Management
- Concrete network characteristics such as number of subscribers, traffic dimensions

→ Overcoming the restrictions of OSI Reference Model

→ Solving the problem of modelling overall network functions such as Security and Mobility
New Network Model with Strata and Functional Columns

3 Procedure for Designing a Network –
Step 1: Definition of Requirements

– Step-by-Step modelling

Step 1: Definition of requirements for
– Basic network functions
– Services
– Security
– Mobility
– Quality of Service
– Network Management
– Network Characteristics

→ „Natural“ approach
Step 3: Allocating Network Functions to Network Nodes

Type of Network, e.g. SIP/IP-based:
→ SIP User Agent
→ SIP Registrar Server
→ SIP Proxy Server
→ SIP Application Server
→ Conference Server
→ IP Router
→ Firewall
→ Bandwidth Broker

- One individual column-based network model for each type of network element
- Each network element model = Subset of total network model
- Overlap of all network element models = total network model

Step 4: Complete Functions in one or more Nodes if necessary

- Additional functions are automatically adopted from nodes into total network model

Step 5: Export Network Characteristics from Graphical Model into Calculation Model

- Automated readout of numeric network characteristics (e.g. number of subscribers, traffic dimensions, costs) from up to four graphical network models

Step 6: Use Calculation Model

- Add further numeric characteristics to imported characteristics if necessary
- Network calculations, network optimisations, migration scenarios
- Arbitrary number of single scenarios for time sequence simulation

Step 7: Export Results from Calculation Model into Graphical Model
### Procedure for Designing a Network - Overview

1. **Network to be modelled**
2. **Network Requirements**
   - Deriving Functions for the Network
   - Allocating Functions to Network Nodes
3. **Graphical Model**
4. **Export Network Characteristics**
5. **Calculation Model**
   - Network Calculations
   - Migration Scenarios
   - Network Optimisation
7. **Results from Calculation Model**

### 4 Network Interworking

- In future: pure IP networks such as SIP/IP fixed networks, UMTS Release 7
- While still converging: heterogeneous networks, both circuit and packet switched, different protocol stacks

→ Interworking, gateways for connecting (2) networks

- Steps 1 and 2: Graphical Model for each of the 2 networks
- Step 8: Merging both Graphical Models → Relationship of network functions, Interworking Function (e.g. ISUP-SIP)
- Step 9: Allocating Interworking Functions to network nodes (e.g. Media Gateway Controller)

- Full Model Realisation with EXCEL and VBA (Visual Basic for Applications)
Interworking of two different Networks

X-Y Interworking Function

Network X, e.g. PSTN Network

Network Y, e.g. SIP/IP Network

IWF

5 PSTN-NGN Migration

Network 1
PSTN

AGW

Network 2
SIP/IP

TGW

RGW

PSTN Phone

IP Phone

SIP: Session Initiation Protocol
PSTN: Public Switched Telephone Network

TGW: Trunking Gateway
AGW: Access Gateway
RGW: Residential Gateway
PSTN-/SIP/IP Migration

User Traffic
- 0.119 Erl per PSTN subscriber
- 0.4 Erl per SIP/IP subscriber

Trunking Gateway (TGW)
- Traffic: 7,200 Erl (240 E1 à 30 Erl)
- Cost: 720 CU (Cost Unit)

Access Gateway (AGW)
- Traffic: 2,380 Erl (20,000 PSTN subscriber à 0.119 Erl)
- Cost: 12,500 CU

Residential Gateway (RGW)
- Traffic: 0.119 Erl
- Cost: 1.2 CU

IP-Phone
- Traffic: 0.4 Erl
- Cost: 1 CU

Subscriber Development in case of linear Migration

Subscriber Development

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53 Mio PSTN Subscriber
53 Mio SIP/IP Subscriber
Number of Gateways required

![Graph showing the number of gateways required over time.](image)

Migration Costs

![Graph showing migration costs over time.](image)
Interconnection of four different Networks

PSTN-SIP/IP- and GSM-IMS-Migration → All-IP Network

- 0,119 Erl average traffic per bearer channel (fixed subscriber)
- max. 50000 bearer channels per local exchange

- 0,4 Erl average traffic per SIP/IP subscriber
- max. 1 Million subscriber per CS (Call Server = SIP/IP-Softswitch)

- 0,025 Erl average traffic per GSM subscriber
- max. 150000 mobile subscriber per MSC (Mobile Switching Center)

- 0,4 Erl average traffic per IMS subscriber
- max. 1 million subscriber per S-CSCF (Serving-Call Session Control Function)

- max. 19354 Erl per IP/PSTN- or IMS/GSM-Media Gateway
- GSM/IP- and PSTN/IP-Gateways exchangeable

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Subscriber Development in case of simultaneous linear Migration of 4 Networks

Subscriber Development

Number of Switching Node required

Number of LEs, CSs, MSCs and CSCFs required in case of 4 Networks Migration
Number of Media Gateways in case of simultaneous linear Migration of 4 Networks

Subscriber Development in case of sequential linear Migration of 4 Networks: 1. PSTN, 2. GSM
Number of Media Gateways required in case of sequential linear Migration of 4 Networks: 1. PSTN, 2. GSM

- Redundant PSTN-SIP/IP-Gateways can be reused for GSM-SIP/IP and GSM-IMS

Subscribers Development in case of sequential linear Migration of 4 Networks: 1. GSM, 2. PSTN

- Rapid SIP/IP Migration
- Reduced PSTN-SIP/IP-Gateways can be reused for GSM-SIP/IP and GSM-IMS

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Number of Media Gateways required in case of sequential linear Migration of 4 Networks: 1. GSM, 2. PSTN

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- Many GSM subscribers
- 0.4 Erl per IMS user

Summary

- Use of the new network model recommendable
- Proceed according to the steps 1 to 9
- Migration of circuit to packet switched network
  - very strong reduction of the number of switching systems
- Minimization of redundant media gateways by clever migration
- Possibility of minimization of PSTN-SIP/IP migration costs by clever model use
- Choose the most suitable Gateway type in each case
- Migration costs can be related to providers (TGW, AGW, RGW) or users (IP-Phone, RGW)