Planning and design requirements for NGN

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Network Planning Requirements
Content

• Role of Network Planning
  • Requirements
  • Domains and methodology

• Network design issues in NGN

• Strategic Planning and Technology mapping
Network Planning Requirements
Mission of network Planning

“Decision making on the network deployment to Optimize Business and Quality based on quantitative evaluation”

• Considering geo-marketing scenarios and traffic demand
• Overall vision on the network layers
• Deciding network topology, interconnection and routing
• Optimizing balance between performance/SLA and cost (CAPEX + OPEX)
• Considering regulatory constraints
• Anticipating business evaluation and feasibility

Network Planning Requirements
Key requirements in competition (I)

• Strategy Oriented Needs
  – What selection of customer classes and associated services?
  – When to decide migration to new technologies and what speed?
  – Which level of convergence versus specialization?
  – What resources to built and what to lease?
  – Which are the most convenient partnerships with other operators and suppliers?
Network Planning Requirements
Key requirements in competition (II)

- Business Oriented Needs
  - Which services have to be introduced through time?
  - What is the best service bundling per customer type?
  - How to maximize revenues?
  - How to reduce capital expenditure?
  - How to reduce operational expenditure?
  - How to price services and bundles?
  - How to optimize network profitability?

Network Planning Requirements
Key requirements in competition (III)

- Network Oriented Needs
  - How to forecast new services and traffic demands?
  - How many nodes to install?
  - What is best location for systems and related communication media?
  - What is the best network architecture and routing?
  - How to plan capacity evolution and solutions migration at access, local and transit segments?
  - How to ensure QoS across multiple domains?
  - How to ensure protection level and survivability?
  - How to ensure and manage SLA?
Network Planning Requirements
Key requirements in competition (IV)

• Operation Support Needs
  – How to evaluate alternatives for direct vs outsourced operation?
  – How to organize the operation processes?
  – Which level of integration is needed to operate multimedia services?
  – Which IT applications ensure an efficient support to operation?
  – How to plan labor force training on the new operational activities?

Network Planning Requirements
Network Modeling for planning

• High complexity of the whole Network requires a modeling and splitting in subnetworks to facilitate analysis, design and planning.
  • By Layers in a vertical dimension following the client-server relation (one layer is supported in the layer below and provides resources for the layer up). Physical, Transmission, Switching, etc.
  • By Segments or splitting of the end to end communication into sub-areas as customer premises, access, core national, core international
  • By Technologies or underlying technique as SDH, WDM, ATM, IP, IMS, GSM, 3G, WiMax, etc....
Network Planning Requirements
Network Layer Modeling for planning

Service and Control level
- Network Planning Requirements
- Network Layer Modeling for planning

Functional level
- Transport/SDH/WDM
- Infrastructure and Cable level
- NGN network

Technological alternatives at core
- Origin Scenario
  - Dark Fiber
  - Managed Fiber
  - Bandwidth
- Target Scenario
  - Circuit based
  - Managed ATM/FR/IP
  - ATM VPN, IP VPN

Network Planning Requirements
Technological alternatives at core

Origin Scenario
- Circuit based
  - Multiservice ATM/FR/IP
  - ATM VPN, IP VPN
- Target Scenario
  - Packet based
  - Ethernet ptp
  - Internet Gbit access
  - LAN to LAN connection

Transport/SDH/WDM
- Infrastructure and Cable level
- NGN network

April-May, 2007
Network Planning Requirements
Planning activities

- Assignment and Routing
- Demand forecasting
- Configuration and Location
- Inputs generation
- Optimization
- Dimensioning and QoS
- Assignment and Routing
- Configuration and Location
- Results analysis
- Demand forecasting
- Costing and business
- Inputs generation

Network Planning Domains

- Business Planning
- Fixed Access Planning
- Fixed Switching and routing planning
- Signaling and control planning
- Access radio planning
- IT, OSS, NM and Applications planning
- Core radio planning
- Transmission planning

April-May, 2007
Network Planning Requirements
Planning: Main supporting pillars

NETWORK PLANNING METHODOLOGY

- Market and demand forecasting
- Teletraffic Methodology
- Economical Engineering
- Operational Research and optimization
- Architecture and Technology Know-How

Network Planning Requirements Scope:
Main supporting pillars

NETWORK PLANNING METHODOLOGY

- Statistical flow modeling for arrival rates and holding times
- Capacity models based on stochastic processes: Analytical and Simulation
- Dimensioning based on efficiency, performance and QoS
- Good foundation on the multiple contributions from the International Teletraffic community (ITC)
Network Planning NGN and IMS

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- Strategic Planning and Technology mapping

Network Planning Requirements

Modeling issues for NGN and 3G

- New models needed to represent multiservice flows
- New dimensioning methods for resources handling multimedia services with QoS
- New measurement procedures for aggregated multiservice traffics
- New multicriteria dimensioning for 3G and xG combining coverage by frequency, service speed and data traffic capacity
- Which procedures to ensure interoperability and end-to-end performance across multiple domains?
- Which units to define dimensioning and costing units for interconnection?
Network Planning Requirements
QoS and Performance Issues

- Quality of Service (QoS) domains to be modeled, defined and/or extended for NGN and 3G. Measured in waiting time and/or loss probabilities

- Domains for QoS evaluation:
  - Service accessibility: capability to access a service
  - Connection establishment: Capability to get connection
  - Information transfer: Quality of information delivery
  - Reliability: Failure probability
  - Availability: Probability of system being active
  - Survivability: Capability to provide service in abnormal conditions
  - Security: Information and systems protection level
  - Qualitative: Intelligibility, audibility, visualization ... of information content as derived from user perception (MOS)

Network Planning Requirements
Traffic flows for QoS based dimensioning

- **T1) QoS constant stream**: bandwidth transmission at a constant speed with a specified delivery and jitter (ie: video distribution)

- **T2) QoS variable stream**: bandwidth transmission at a variable speed derived from a user information and coding algorithm which requires guaranteed quality and specified jitter (ie: VoIP, Video streaming, audio streaming, etc.)

- **T3) QoS elastic**: bandwidth transmission at a variable speed without jitter restrictions and asynchronous delivery (ie: browsing, file transfer, mail, UMS, etc.)
Perceived Quality of Service as a function of the number of crossed domains for the G.711 + PLC coding with $pp = .01$ and gold/silver SLA (19th International Teletraffic Congress, September 2005, Beijing)

High importance of the number of crossed domains and quality per domain on the end-to-end performance.

Network Planning Requirements

How to define dimensioning and costing units for interconnection?

- Requirements for service flow units to be used:
  - Should be quantifiable with defined engineering rules
  - Useful for interrelation between demand/dimensioning/costing for a given QoS and SLA
  - Reflecting service provisioning and market value across multiple networks
  - Applicable to multiservice/multimedia flows
Network Planning Requirements
Traffic units for aggregated flows

Proposal of NGN units in multiservice networks/interfaces for demand/dimensioning/costing:

– Equivalent Sustained Bit Rate (ESBR) or aggregated equivalent rates for same QoS category flows efficiently carried in a common reference busy period (ie. 5 minutes)

– Computed as weighted average for the services at QoS category (i) and customer classes (j) at each network element:

\[ \sum_i \sum_j \text{ESBR}_{ij} \]

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Network Planning Requirements
Solution Mapping

Solution mapping is more important today as the number of technologies and network options increase

- Large variety of geo-scenarios within the country
  - Geography
  - User profiles
  - Density
  - Economy

- Alternatives modeled with all key parameters that characterize scenario, services, demands and solutions
- Best solutions selected based on techno-economical evaluation and resulting best Cost of Ownership

Projects/Geo-scenarios

- Compliance
  - Services
  - Capacities
  - Availability
  - Operational constraints

- Techno-economical Evaluation
  - Architecture
  - Density
  - Capital expenditure
  - NPV of full costs
  - Entry costs

- Qualifiers
  - Flexibility
  - Speed to service
  - Evolution
  - Experience

Input criteria

Results

Actions

Recommendations
Network Planning Requirements
Solution Mapping: Cost Modeling

**Capital Costs**
- Electronic equipment
- Cables/towers
- Civil works
- Licenses, permits
- Installation
- Replacement
- Customer premises equipment

**Operating Costs**
- Rights of way
- Space rental
- Operations and maintenance
- Power
- Management and salaries
- Cost of inventory
- Marketing campaigns
- Overheads

**Full Costs** = Capital Costs + Operating Costs

Network Planning Requirements
Solution Mapping: Example of Geo Scenarios

- L1: Distance between suburban
- L2: Suburban - metropolitan distance
- L3: Suburban - village distance
- L4: Distance between villages
- L5: Distance between rural

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Network Planning Requirements
Solution Mapping:
Technological alternatives at access (Fixed)

Access Technologies
- Wireline
  - Narrowband (up to 144 Kbps)
- Wireless
- Point to Multipoint
  - Satellite Bidirectional
- Multiservice DLC (FTTC)
- xDSL
- PLC
- SDH/SONET Add Drop Mux
- Ethernet
- CATV/MFC
- MMDS/WiP/Wimax
- LMDS
- Satellite Bidirectional
- DBS/DBT

Wireline
- Broadband
  - xDSL
- PLC
- SDH/SONET Add Drop Mux
- Ethernet
- CATV/MFC
- MMDS/WiP/Wimax
- LMDS
- Satellite Bidirectional
- DBS/DBT

Wireless
- Direct: POTS/ISDN
- RSU: POTS/ISDN
- Point to Multipoint
- Satellite Bidirectional
- Multiservice DLC (FTTC)
- xDSL
- PLC
- SDH/SONET Add Drop Mux
- Ethernet
- CATV/MFC
- MMDS/WiP/Wimax
- LMDS
- Satellite Bidirectional
- DBS/DBT

Network Planning Requirements
Solution Mapping:
Investment sensitivity to density in WL Access

High density areas

- Metrop. total
- Metrop. infrastructure
- Sub. total
- Sub. infrastructure

Density (subscribers per KM²)

Monetary units

Network Planning Requirements
Solution Mapping:
Technological alternatives at access (Fixed)
Network Planning Requirements
Example of mapping recommendation

- High clustering
- Low clustering

8000
1000
200
20
0.5

Cust./Km²

Services & Traffic

POTS/Fax
POTS/ISDN/Data
POTS/Data nx64
POTS/data/Video
Multimedia BB

Satellite

Satellite

Network Planning Requirements
Benefits of mapping and planning activities

- Saving factors of 20 to 200 % by adequate solution/technology mapping in the access segment
- Additional gains between 20 to 40 % by topology/routing optimization
- Anticipation of 2 to 3 years in the positive IRR
- Assure fulfillment of SLA and QoS
- Positioning of the operator in the top competition levels
Network Planning Requirements
Summary of Key Requirements

- **Multiservice flows** impose a set of requirements on models and tools for NGN and 3G.

- **Interoperability and interconnection** require special effort to players and planners to ensure end-to-end performance.

- High number of new technologies and capabilities reinforce the need of **solution mapping** for each country scenario.

- Complexity of converged networks require the use of **high quality support tools**.