

Cost models for Next Generation Networks with Quality of Service parameters

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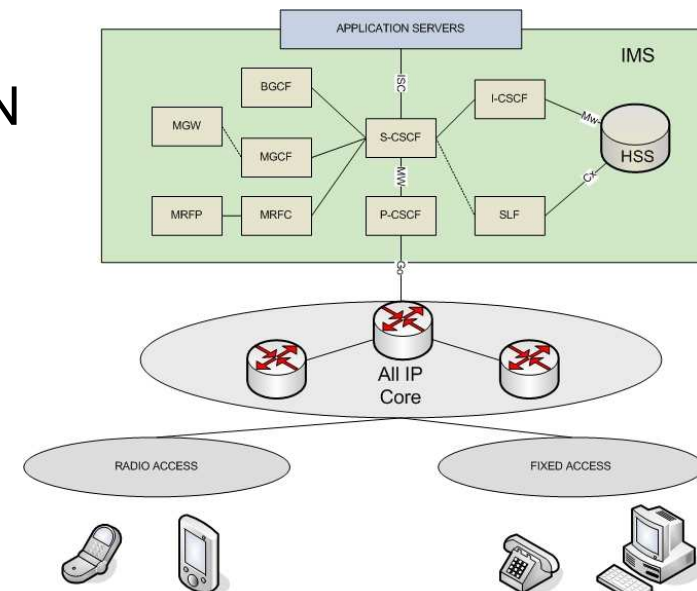
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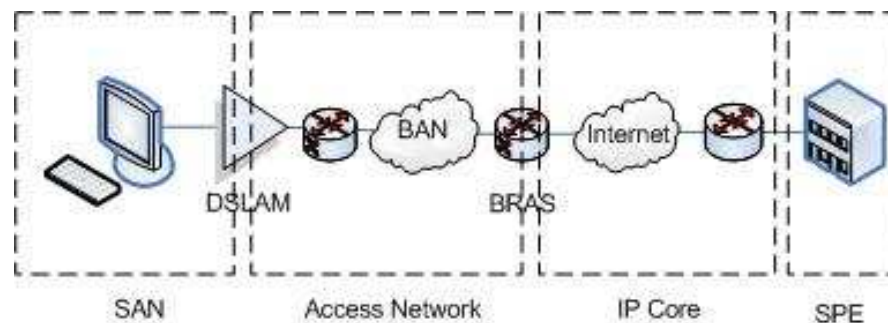
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- Introduction
- Cost Models for Next Generation Networks
- Application
- Conclusion and future work

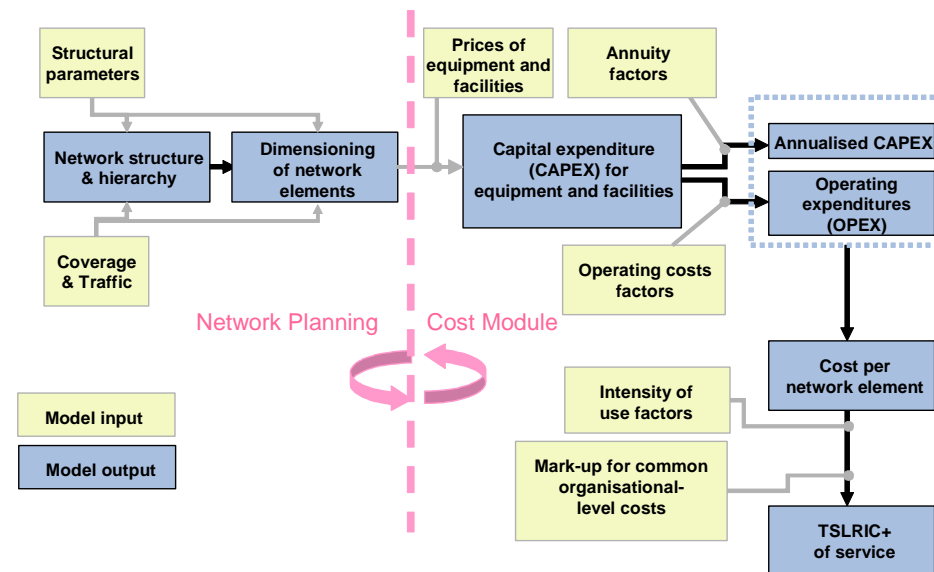
- The current objective of network development is Integration and Convergence which considers multiples aspects mainly:
 - Services integration
 - Network evolution
 - From dedicated networks to only one common platform
 - Separation of the control- and the transport layer
 - Different types of access networks depending on the geographical situation and mobility of a user
 - Fixed mobile convergence
- Network operator will implement a NGN under IMS with
 - IMS-TISPN or
 - IMS-3GPP



- The changes in the service- and networks require- techno-economic studies for corresponding service costing and pricing, e.g. the determination of an equilibrated service tariff scheme
- The main parameter for such studies are an correct estimation of the network cost based on the service parameters as:
 - Bandwidth requirement
 - Quality of Service requirement
 - The statistical behavior of the corresponding traffic
 - The applied traffic engineering methods
 - The resulting dimensioning in each network segment (access, aggregation, core)



- This contribution studies the network dimensioning with respect to cost- and pricing using a corresponding model (e.g. FL-LRIC model)
- Its results provide the input for the so called Total Element based long run incremental cost model (TELRIC)
- Modelling goal: Maximize the number of users which can be aggregated in a network element (e.g. DLSAM) under a given bandwidth



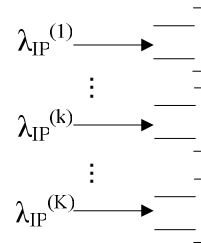
For dimensioning purpose in NGN we propose a TELRIC model which considers the following aspects:

- Different service classes (e.g. real time, streaming, guaranteed data, best effort)
- Different user types (e. g. residential, business each with standard or premium)
- Source traffic characteristics at layer 2 or 3 considering the first two moments of the inter-arrival time and the packet length
- Aggregated multi-source traffic per service classes under a user-type service-class matrix
- G/G/1 queuing model as smallest network element
- QoS by the End-to End mean delay and its distribution over the different network element
- Dimensioning under the aggregated multi-source traffic characteristics

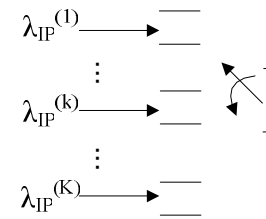
Offered user class	Residential standard	Residential High speed	Business Standard	Business Premium
Dominant service	www, P2P	P2P, VoIP, streaming	VoIP, transaction, FTP	VPN/VLAN service

- For calculating the total bandwidth (V_t) required we consider three traffic engineering methods as:

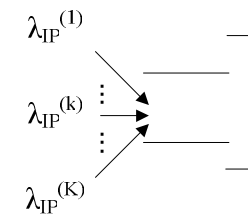
- Separated virtual tunnel for each service class:
 V_t s (traffic segregation)



Virtual tunnels



Priority queuing



Over-engineering

- Priority queuing: V_{tp}

- Common capacities for the traffic of all services:
 V_{to} (over-engineering)

- We used the model for calculating the maximal number of users which can be aggregated into a network element with a given bandwidth
- We construct a service/ traffic scenario using results from different studies in the literature

Services class	Service parameter	Stand. Res.	Prem. Res.	Stand. Bus.	Prem. Bus.
Real time	KB/s	8.00	8.00	8.00	8.00
	C(Ta)	1.50	1.50	1.50	1.50
	L (Bytes)	384.00	384.00	384.00	384.00
	C(L)	0.00	0.00	0.00	0.00
	τ req [ms]	1.00	1.00	1.00	1.00

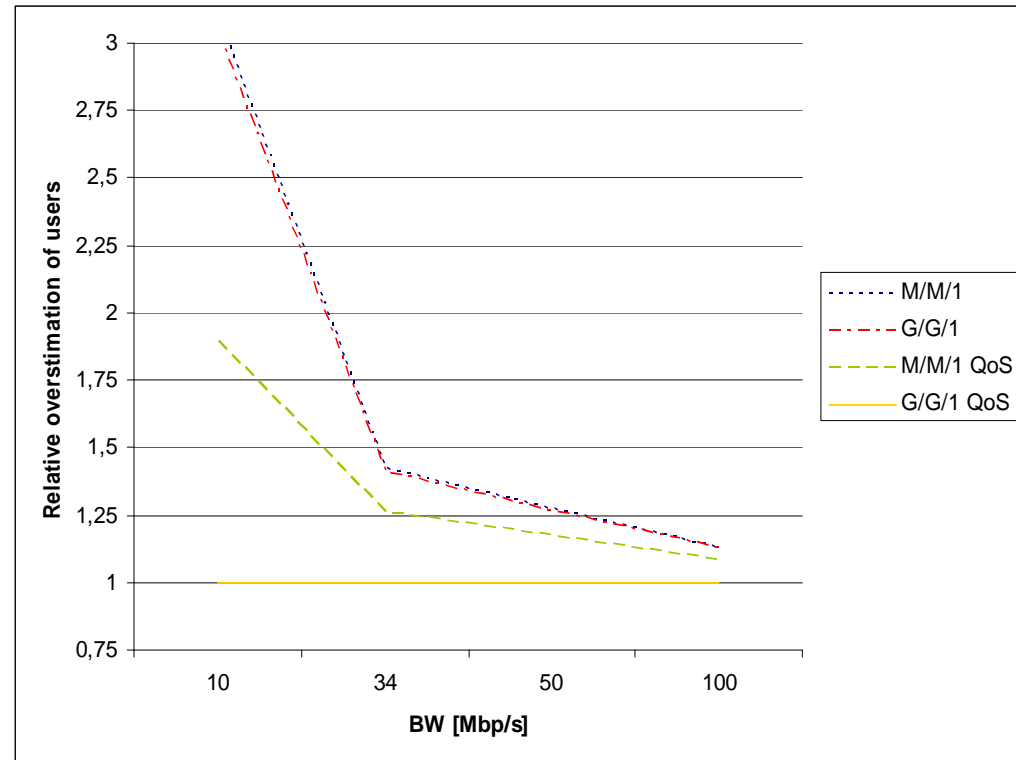
	Residential standard	Residential premium	Business standard	Business premium
% users	50	20	20	10
Concurrency factor $a_c^{(1)}$	0.3	0.5	0.9	1
Degree of use in the HLP: Real time	0.2	0.2	0.3	0.2
Degree of use in the HLP: Streaming	0.05	0.1	0.025	0.04
Degree of use in the HLP: Guaranteed data	0	0.1	0.675	0.76
Degree of use in the HLP: Best effort	0.75	0.6	0	0
				8

- **For a typical DSLAM connection of 100 Mbit/s results:**

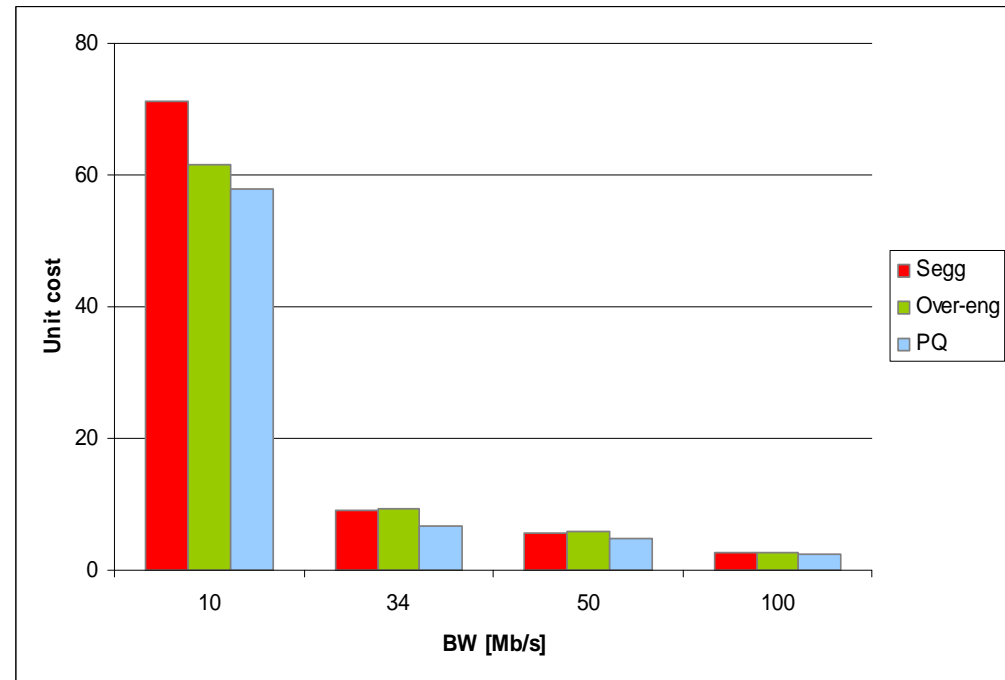
- Similar number of users for traffic separation and over-engineering
- Nearly 12% more user under priority queuing and a strong degree of capacity use
- For lower BW values the difference is more significant

Band-width [Mb/s]	Segregation	Over-Eng.	Priority Queuing
10	39	45	48
34	341	335	455
50	559	550	678
100	1253	1240	1379

- We studied the over-estimation of the number of aggregated user in case where either the QoS parameter, the traffic characteristics or both not considered
- For small BW values results a strong over-estimation of the number of user which can be aggregated and hence the traditional M/M/1 model should not be applied
- For high BW values resulting from the Metro and long distance core the QoS parameter and traffic statistic loose influence and hence the application of an M/M/1 model might provide a practicable approximation for a cost estimation



- We calculated the cost contribution of the network element under a concave cost function with a fixed charge value
- It will be mainly New Entrance Operators which require at least initially smaller bandwidth values provided by an dominant network operator which might result an economical advance for the dominant operator
- It results that a corresponding TELRIC model has to consider
 - the long term traffic development produced by all users aggregated in the network elements
 - A price differentiation depending on the user classes and the traffic engineering mechanism



Unit cost for standard residential user

Concavity factor of the cost function	0.5
Cost per bandwidth unit (1 Mbps)	100
Fixed cost	5000

- NGN cost studies under the TELRIC model has to consider for each service mainly in the access- and aggregation network part:
 - the required average BW
 - The QoS parameter at least the average delay corresponding to the network element
 - The statistic of the traffic mainly by its first two movement and the applied traffic engineering method
- The study confirms the assumption that SMPO due to its aggregation of a high user number has a dominant position and that the access point for ISPs with smaller market penetration might be situated at a high level of the network contracting from the SMPO “Bitstream Access Service with QoS differentiation.
- For higher network elements with bandwidths in the range of 1Gbps the use degree is nearly independent of the traffic engineering method and the QoS value and hence the traditional dimensioning under a M/M/1 model might be applied for TELRIC studies

- **Future work should consider:**
 - Influence of traffic and QoS parameters to real cost for different network elements
 - Comparison of the dimensioning results with simulation studies under real life traffic pattern
 - Considering additional parameters from the SLA and its influence to the cost as:
 - Service availability under normal and exceptional situation
 - QoS values over daily and not high load periods

Thank you for your attention