



Engineering of QoS

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1.0 THE HOLY GRAIL OF MODERN COMMUNICATION - ENGINEERING OF QUALITY OF SERVICE.

Given the limiting nature of the communication channel in a communication system, the end user applications (such as browsers, FTP clients, media clients) experience certain effects of the communication channel. These effects, such as delay, throughput, error rates, variation in delay etc. constitute the elements that make up for the user experience or "service".

The teletraffic engineering world was a relatively simpler world in the voice telephony era and very effective techniques of measuring and engineering service quality are in place. In this section we shall consider only the packet data networks and use the term "network" to mean "packet data network".

1.1 The goals of QoS engineering

The key components of engineering "service quality" in any type of communication system are:

1. Service quality
2. Communication network model
3. Source Traffic Model
4. Network Traffic model

The aim of QoS engineering is to define the service quality parameters in a given network, arrive at suitable traffic models that reflect the source traffic as closely as possible and model the communication link behaviour.

ITU-T defines the teletraffic engineering as the iterative process of:

- Demand Classification
- Grade of Service definition
- Dimensioning and control
- Performance Measurement
-

Quality of service engineering encompasses of multiple related fields, each one useful in one of the phases of the teletraffic engineering. An end to end Quality of service in a heterogeneous network is an interesting field of study, albeit, a wide one.

1.2 QoS Layered model

The end to end QoS, which an end application experiences is a result of multiple interacting entities and most QoS frameworks such as Network Calculus, Generalized Processor Sharing, and Discrete Generalized Processing Sharing use simplifying assumptions about the network characteristics to arrive at an analytically feasible model.

A heterogeneous packet data network comprises of multiple traffic sources, with a wide variety of traffic source processes, a network that manages traffic at bearer, network as well as at the transport layers, if not at application layers as well!

1.3 A critique of Queuing model

The network model of multiple traffic sources with a queuing model is amenable to analysis for dimensioning and traffic control, but misses the "integrated" view of the service quality. For example, the delay, jitter, throughput guarantees at the bearer level do not translate to efficient link saturation when multiple elastic, inelastic tcp streams use the same bearer. The network layer guarantees e.g. those of managed QoS techniques such as Diffserv do not translate directly to parameters at the transport or application.

The QoS model based on queuing network model with regulators is fundamentally a simplistic view for the following reasons:

- The network model of processors and queues is flat one dimensional view, which essentially misses the hierarchical nature of networks.

- QoS engineering based on one flat network of processors, queues, bottlenecks does not factor in built in adaptation of network nodes communicating over multiple bottlenecks.
- The queuing network does not model the adaptability of the transport layers to artificially changing view of the BW or delay as “advertised” by the link layer. For example there are cross layer optimizations of the TCP that are link layer “aware” and adapt the flow (by changing the rate at which they send out TCP segments or by advertising smaller congestion window).

1.4 A hierarchical model

We propose a hierarchical model defined as follows:

A network, for the purpose of QoS Engineering is $N = \{T\{N\{L\}\}\}$, where T represents the transport network, N represents the network layer and L represents the link layer.

A transport network $T = T\{TNM * K\}$ where TN is the transport connection between Transport Nodes with the characteristics matrix as $TN_{ij} = \{\text{Bandwidth, Delay}\}$,

A Network network is collection of routes $N = \{R1 \dots RN\}$ spanning through a matrix of nodes $N = N\{NNM * K\}$, where NN_{ij} is the route between network nodes i and j.

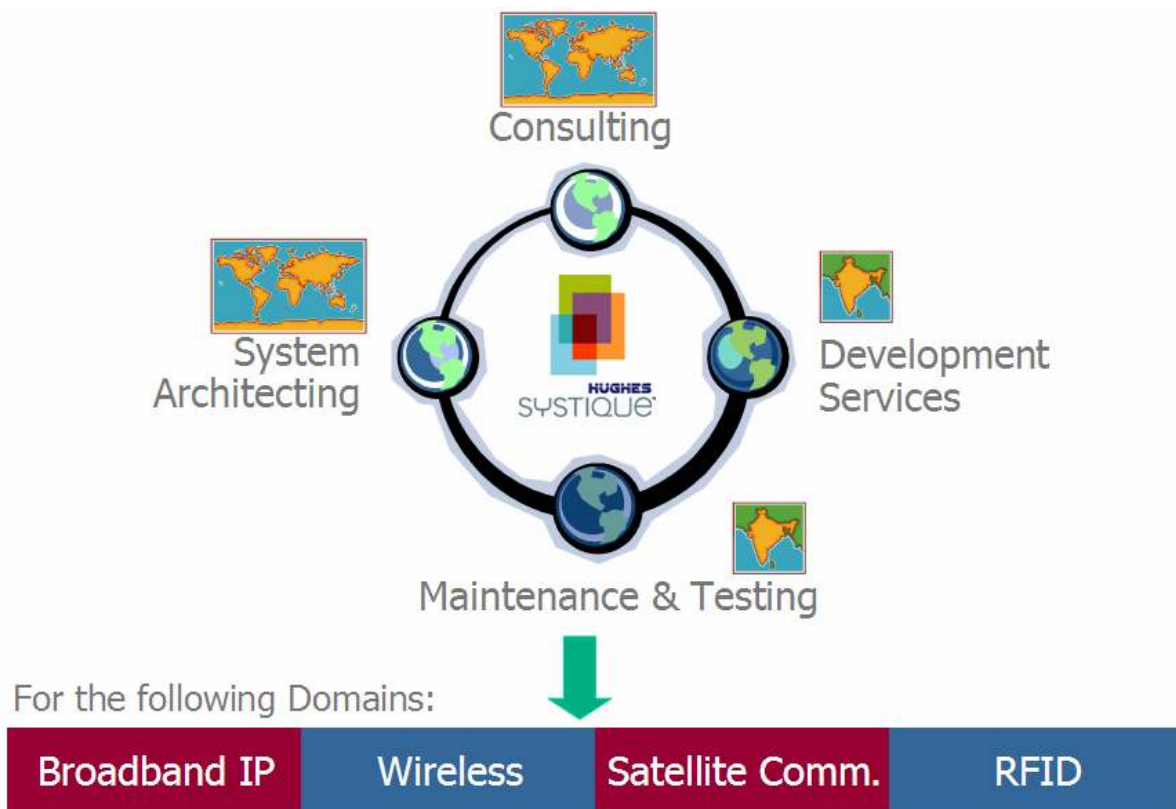
A Link network is a pair of nodes connected through a single link, such a link network is represented by $L = \{N1, L, N2\}$, where $N1/2 = \{\text{Regulator and Queue}\}$ and $L = \{\text{Channel characteristics}\}$.

Taking a Linear optimization view of a data comm network: given the above model of a network, the task of QoS Engineering is to maximize the Objective function that defines the user service, constrained by the Service Layer Agreement and the Network resources.

APPENDIX A ABOUT HUGHES SYSTIQUE CORPORATION

HUGHES Systique Corporation, part of the HUGHES group of companies, is a leading communications Consulting and Software company. We provide Consulting, Systems Architecture, and Software Engineering services to complement our client's in-house capabilities. Our "Best Shore" model coupled with an experienced management and technical team is capable of delivering a total solution to our clients, from development to deployment of complex systems, thus reducing time, risk and cost

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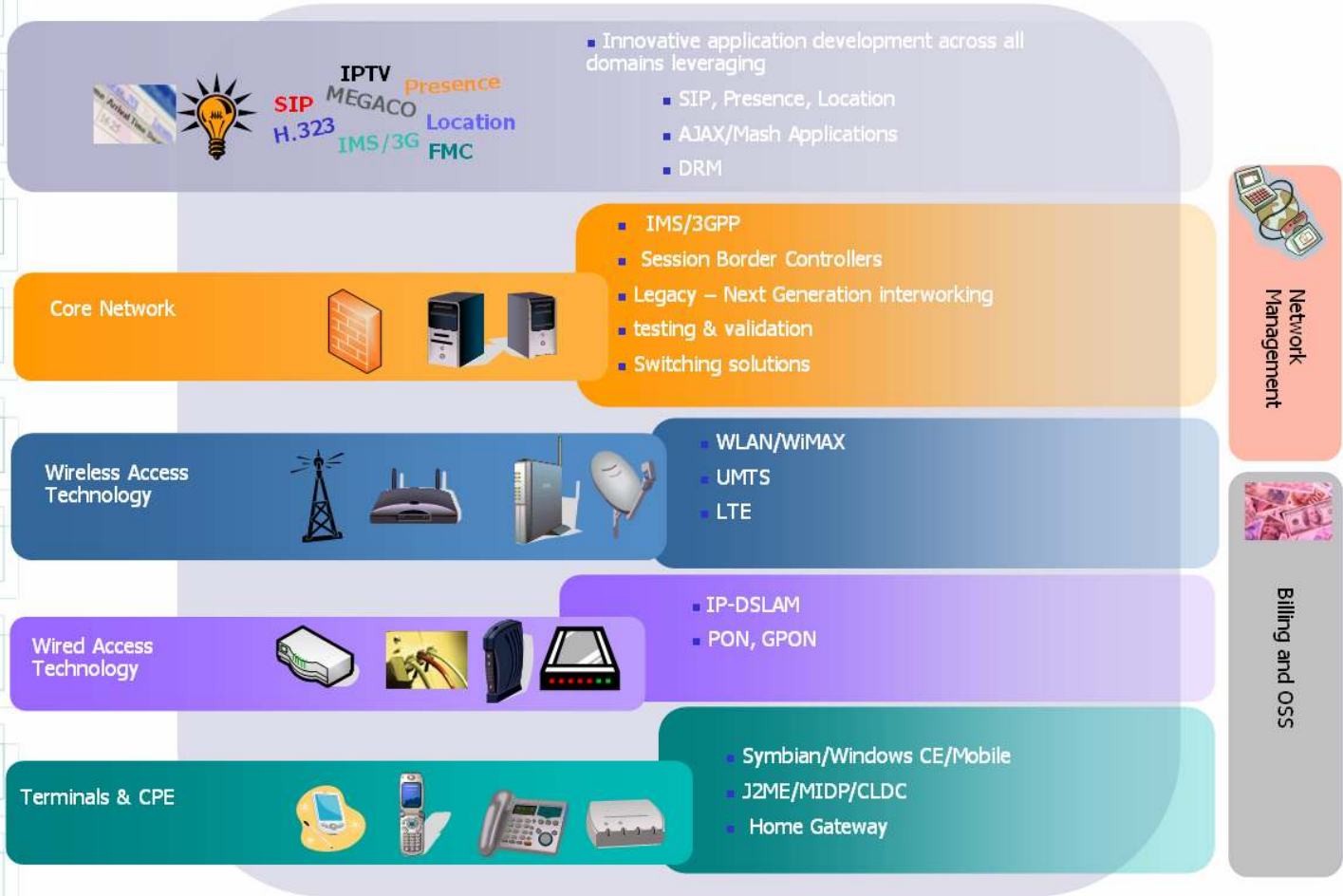
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