

An Architectural Framework for Providing QoS in IP Differentiated Services Networks

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Presentation Outline

- ❑ Introduction and Objectives
- ❑ Service Level Specifications (SLSs)
 - Contents and Semantics
- ❑ Functional Architecture
- ❑ SLS Management
- ❑ Traffic Engineering
- ❑ Policy Management
- ❑ Summary



- ❑ The Internet evolves towards the global multi-service network of the future
 - Support for end-to-end (e2e) QoS guarantees
- ❑ Need for scalable QoS solutions
- ❑ Differentiated Services (DiffServ)
 - Classify, mark and police at the edges
 - Limited per-hop behaviours (PHBs)
 - Scheduling disciplines, buffer management
 - Per-aggregate state information
- ❑ Traffic Engineering
 - Control the manner traffic is treated
 - User and network-oriented objectives

Objectives

- ❑ Current proposals focus on control and data plane mechanisms. Management plane?
 - Bandwidth Broker (BB)
- ❑ Specify the **contents and semantics** of SLs
 - Reflect the elemental QoS-based services
- ❑ Develop an architecture for enabling **negotiation, monitoring and enforcement** of SLs between customer/ISP and ISP/ISP
- ❑ Develop a model of co-operating components, algorithms and protocols offering a **BB solution** for fulfilling the contracted SLs, while continuously optimizing use of network resources



- **IP Flow** - stream of IP packets sharing at least one common characteristic (*WHAT*)
 - Source, Destination, Application, DSCP info
- **Scope** - the geographical limits over which the SLS is to be enforced (*WHERE*)
 - Support for pipe, hose and funnel models
- **Traffic Envelope** - set of (conformance) parameters describing *HOW* the packet stream should look like to get performance guarantees
- **Traffic Conformance testing** - set of actions for identifying in- and out-of-profile packets



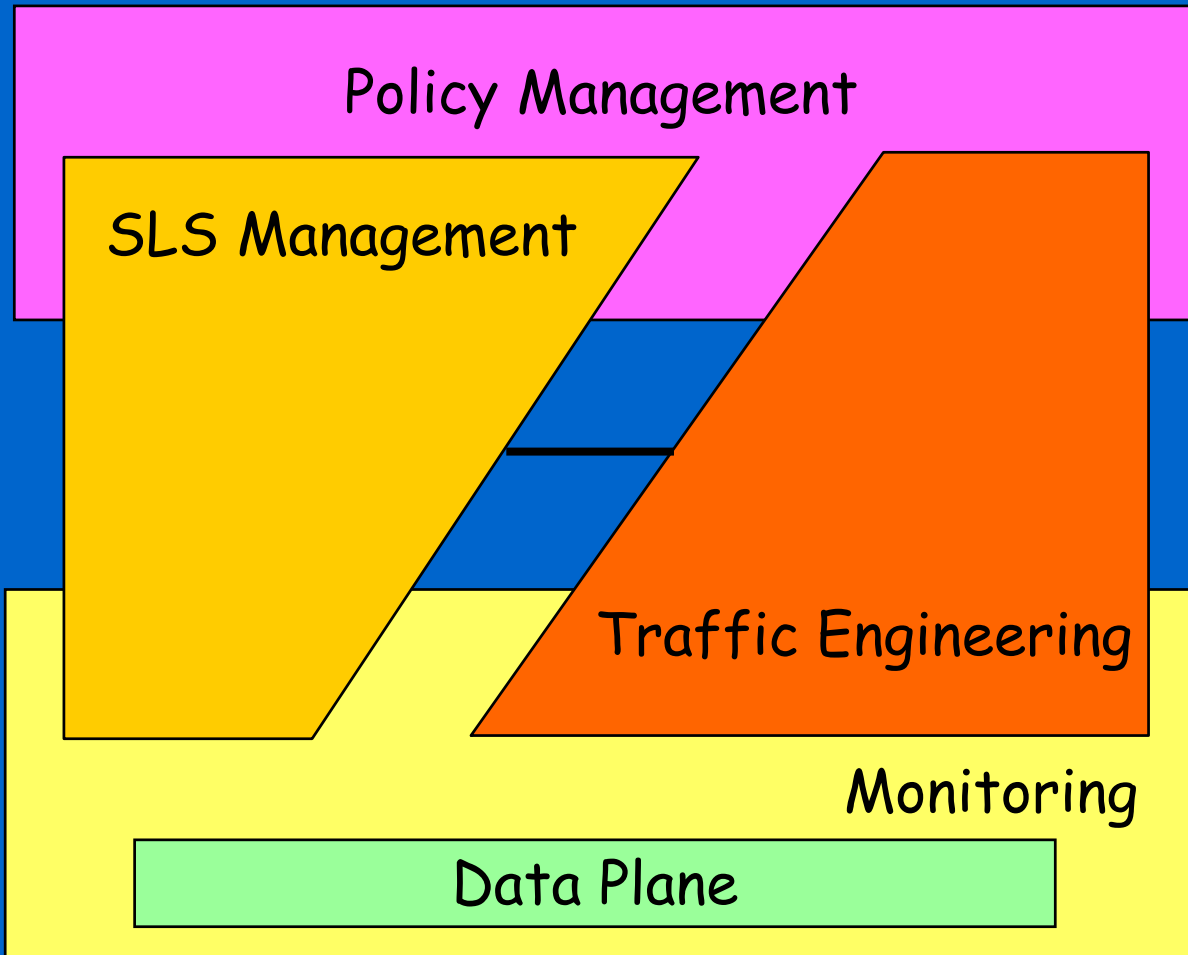
SLS Contents and Semantics (cont'd)

- **Excess Treatment** - how the out-of-profile traffic is treated
 - drop, shape, remark
- **Performance guarantees** - describe the transport guarantees the network offers to the customer
 - throughput, loss, delay, jitter
- **Service Schedule** - indicates *WHEN* the SLS is active
 - Start and end time
- **Reliability** - indicates the level of SLS assurance
 - mean downtime per year, maximum time to repair

Defining IP Transport Services

- The proposed SLSs constitute the elemental blocks for defining services
 - Unidirectional
 - Not necessary to quantify all the parameters
 - Also quantification using relative values (e.g. for defining Olympic services)
- Providers can choose to offer only certain predefined SLSs
 - By using limited pre-defined (ranges of) values
- More complex services can be defined, e.g.
 - Bi-directional Virtual leased lines (2 pipe SLSs)
 - Virtual Private Networks (combination of multiple hose and funnel SLSs)

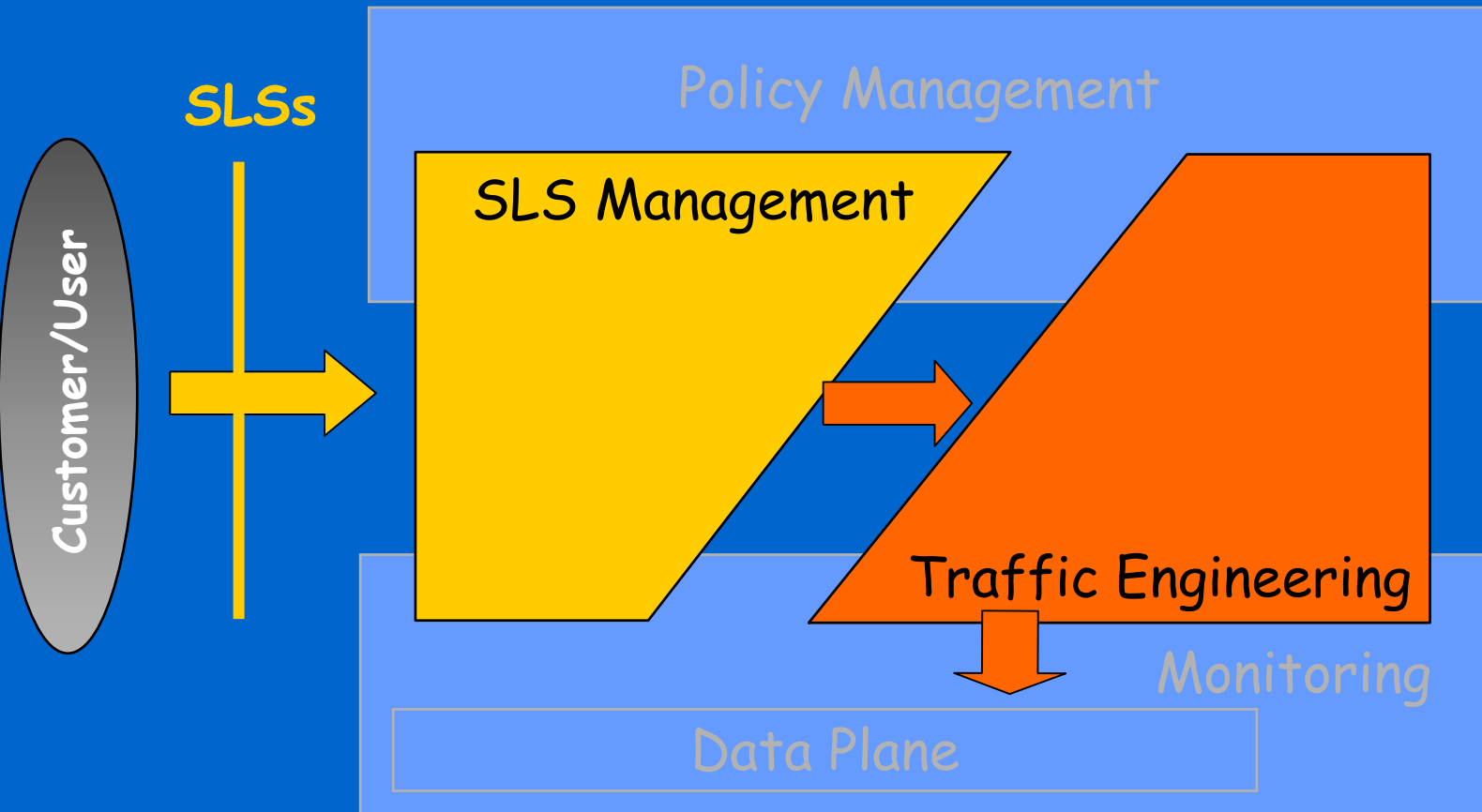
Functional Architecture for Supporting QoS



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Functional Architecture: Fulfilling the SLSs

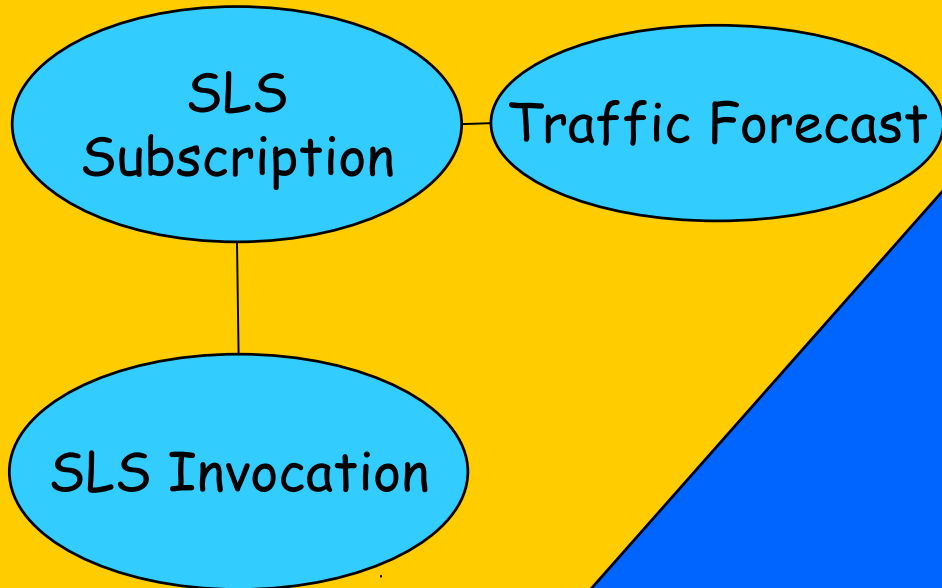


Service description and negotiation through SLSs (per-)Customer awareness

Service provisioning through Traffic Engineering (per-)Class awareness

SLS Management

SLS Management

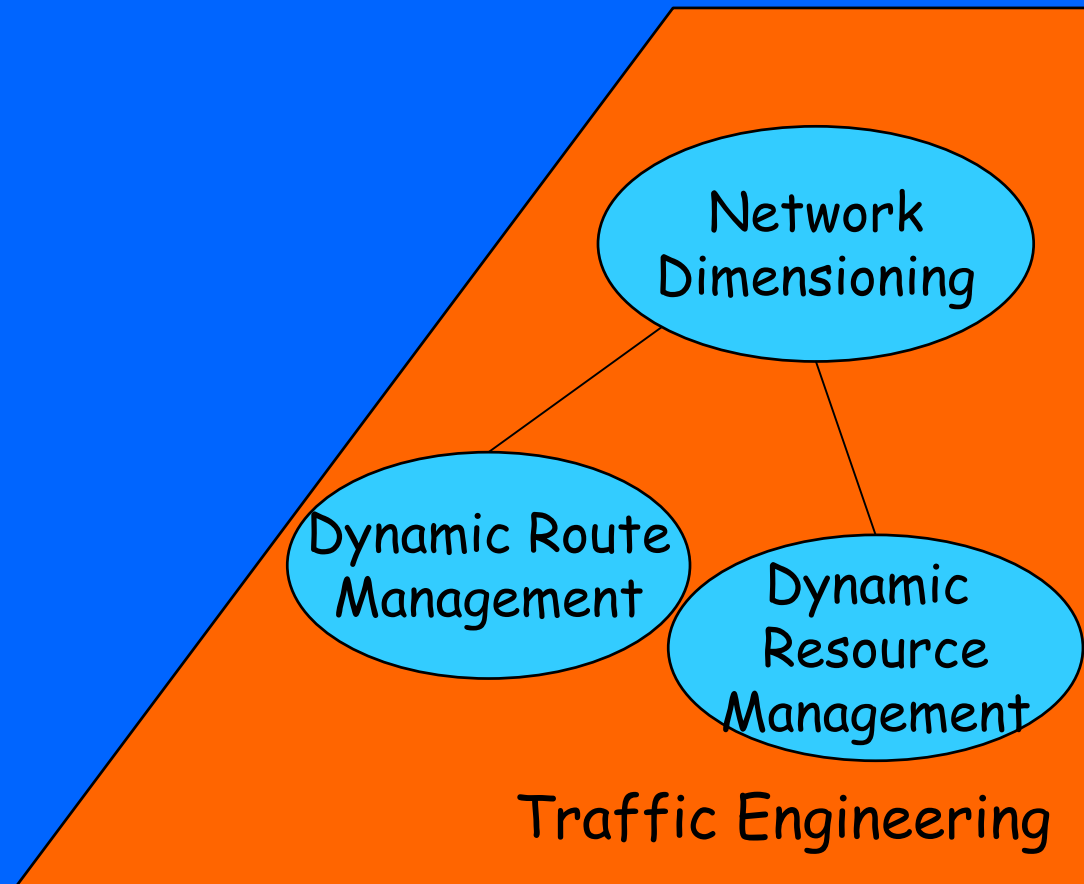


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SLS Management (cont'd)

- **SLS Subscription** between Customer-Provider
 - Customer registration and long-term policy-based admission control
 - Negotiating the right to later invoke SLSs
 - Allows the provider to *provision* the network
- **SLS Invocation** between User-Provider
 - Dynamic (per-flow) admission control based on:
 - the subscribed/provisioned SLSs
 - traffic measurements
- **Traffic Forecast** provides the estimated traffic matrix
 - Based on subscribed SLSs, measurements and (over-subscription/business) policies
 - Ties the customer- and resource-oriented parts



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- **Two Traffic Engineering approaches:**
 - **Explicit routed path based**
 - Multi-Protocol Label Switching (MPLS)
 - **Node-by-node based**
 - Open Shortest Path First (OSPF)

- **Operation timescales**
 - **Long-term (days)**
 - Network Dimensioning
 - **Short-term (minutes)**
 - Dynamic Route and Resource Management

□ Network Dimensioning

- Input: network topology, traffic forecast, policies
- Objective: optimisation problem
 - Maintain low link cost while satisfying QoS objectives
- Output in the form of configuration directives:
 - Explicitly routed paths (MPLS-based)
 - Values for the link cost metrics (IP-based)
 - Per-queue range of requirements

□ Dynamic Route Management (DR+M)

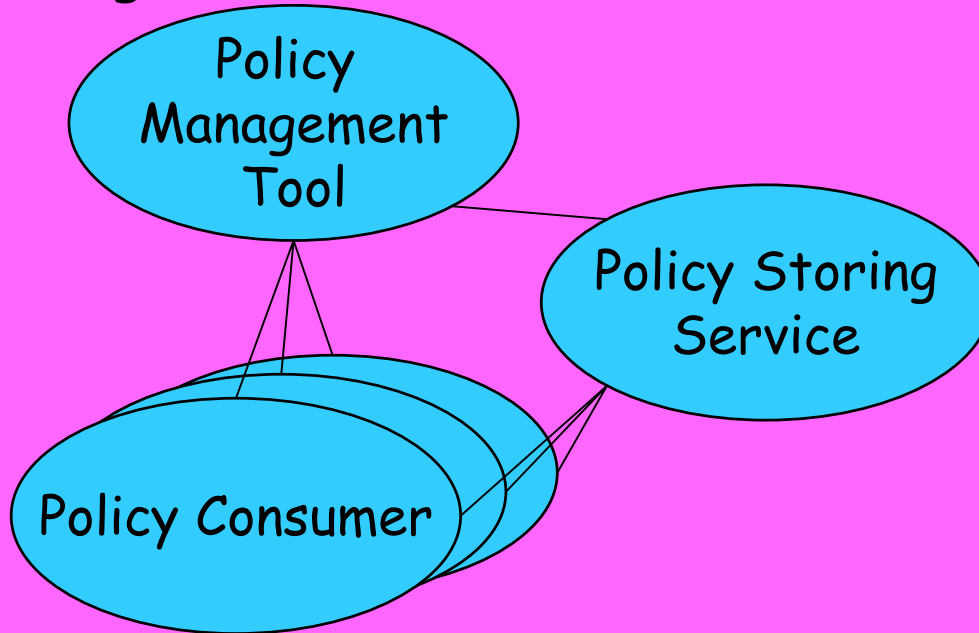
- Multi-path load distribution

□ Dynamic Resource Management (DRsM)

- Configures PHBs
- Performs dynamic link partitioning

Policy Management

Policy Management



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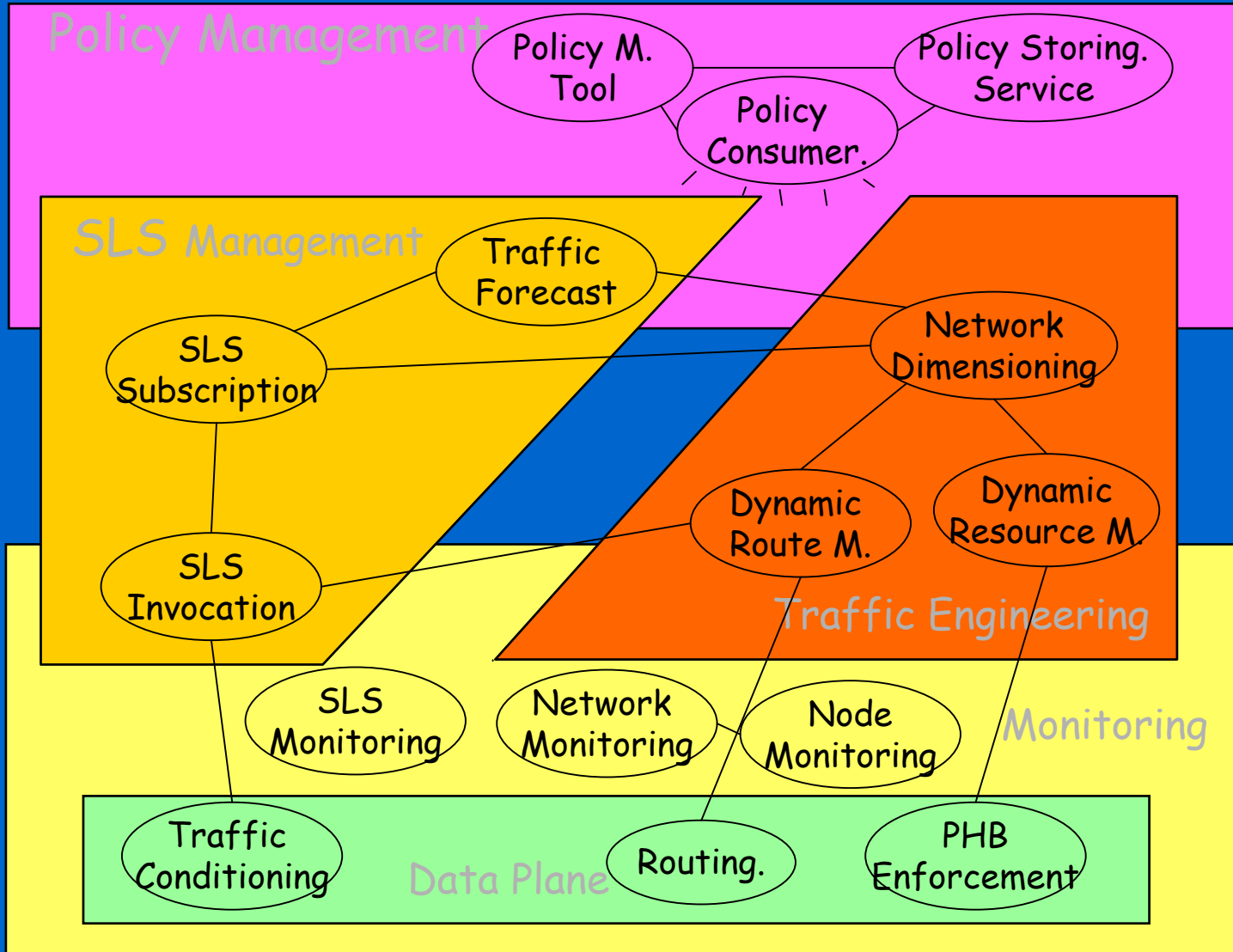
□ Policy Consumer

- Policy interpretation and enforcement
- Many instances, collocated with:
 - SLS Subscription, SLS Invocation, Traffic Forecast, Network Dimensioning, DRtM, DRsM

□ Policy refinement and hierarchical decomposition

- High-level policies refined to reflect the hierarchical management architecture
- Targets: managed objects of the associated component or one level below
- The administrator defines of classes of policies and refinement logic/rules
- Automated decomposition of instances of policy classes

Functional Architecture: Detailed View



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- ❑ Definition of an architecture for DiffServ-based IP QoS
- ❑ Proposed SLS content and semantics
 - IETF drafts
- ❑ Policy-driven SLS Management and Traffic Engineering
- ❑ Detailed design of algorithms and protocols
- ❑ System currently being realised
- ❑ Validation both through simulation and testbed experimentation
- ❑ **Work done in the European project TEQUILA**

TEQUILA: Traffic Engineering for Quality of service in the Internet at Large scale

Partners:

Alcatel, France Telecom, Algonet, Global Crossing,
University of Surrey, University College London,
University of Ghent, National Technical University
of Athens

For more information visit:

<http://www.ist-tequila.org>

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	Virtual Leased Line Service	Bandwidth Pipe for Data Services	Minimum Rate Guaranteed Service	Qualitative Olympic Services		The Funnel Service
Comments	Example of a uni-directional VLL, with quantitative guarantees	Service with only strict throughput guarantee. TC and ET are not defined but the operator might define one to use for protection.	It could be used for a bulk of ftp traffic, or adaptive video with min throughput requirements	They are meant to qualitatively differentiate between applications such as:		It is primarily a protection service; it restricts the amount of traffic entering a customer's network
				on-line web-browsing	e-mail traffic	
Scope	(1 1)	(1 1)	(1 1)	(1 1) or (1 N)		(N 1) or (all 1)
Flow Descriptor	EF, S-DIP-A	S-DIP-A	AF1x	MBI		AF1x
Traffic Descriptor	(b, r) e.g r=1	NA	(b, r)	(b, r), r indicates a minimum committed Olympic rate		(b, r)
Excess Treatment	Dropping	NA	Remarking	Remarking		Dropping
Performance Parameters	D=20 (t=5, q=10e-3), L=0 (i.e. R=r)	R=1	R=r	D=low L=low (gold/green)	D=med L=low (silver/green)	NA
Service Schedule	MBI, e.g daily 9:00-17:00	MBI	MBI	MBI	MBI	MBI
Reliability	MBI, e.g MDT=2 days	MBI	MBI	MBI	MBI	MBI

