algorithm. The label is used as an index to a forwarding table[12] where the next hop and a new label can be found. The old label is replaced with the new one and the packet is forwarded. The label is removed as the packet leaves the MPLS domain [64].

MPLS labels can be used to provide forwarding along an explicit route, and to identify packets to receive certain QoS. An efficient tunneling mechanism is also provided. These features make MPLS useful for traffic engineering [122, 51].

A disadvantage of MPLS is that it should be extensively deployed, i.e. the MPLS domain of the network should be relatively big. Otherwise MPLS offers no benefit.

Traffic Engineering and Constraint-based Routing

Dynamic routing protocols such as RIP[13], OSPF[14], and IS-IS[15] can cause uneven traffic distribution. "*Traffic Engineering* is the process of arranging how traffic flows through the network so that congestion caused by uneven network utilization can be avoided" [122].

Constraint-based Routing can be used to make the traffic engineering process automatic. It enables computing routes that are subject to multiple constraints such as resource availability, QoS requirements, and other policies [122].

Constraint-based Routing increases the size of routing tables, and may introduce instability as routing tables change frequently [122]. Thus it should be considered whether it offers any benefit or just consumes more resources.

Difficulties in development of a new service model

The nature of the Internet is decentralized and heterogenous. This causes several problems that need to be solved before new technologies can be deployed:

- Inter-domain QoS guarantees, CoS classifications, and the involved interaction between Internet Service Providers (ISPs) may represent problems due to different policies and diverse architectures of underlying networks.

[12] Forwarding table is constructed as the result of label distribution [122].

[13] Routing Information Protocol, see [45, ch. 4].

[14] Open Shortest Path First, see [45, ch. 5].

[15] Intra-Domain Intermediate System to Intermediate System Routing, see [45, ch. 6].

- Usage of new services should be charged, otherwise they offer no benefit[16]. Charging for network usage in the Internet with a large number of ISPs might be difficult.
- Some proposed technologies demand ubiquitous deployment in order offer any benefit. However, big changes to the best-effort architecture currently in use are difficult, perhaps impossible to deploy.

Some of these problems and other aspects related to development of new service model are addressed in [96] and it's references 4, 8, 30, and 37.

5.3 Performance management

Performance management is used to evaluate the behavior of managed objects and the efficiency of communications activities. It is collecting statistical data, analyzing it, and where appropriate, predicting trends of communications between open systems [58].

A network performance management system must be able to provide reports on the efficiency of the system and its current and previous performance. Reports on a daily, monthly and annual basis are needed.

Performance management is also controlling traffic in the network. It consumes resources, and thus a separate control station is usually needed to collect and analyze traffic statistics. However, controlling traffic is a reliable and cost-effective method to find out problems before they exist. Traffic controlling can be limited to the most important parts of the network [9].

Performance management is related also to configuration management. It is easier for the operator to plan modifications of the network when the usage of the network is known.

Performance analysis

Network performance analysis becomes important when the network increases in size and complexity. Analyzers are used for traffic monitoring, protocol analysis and statistics collection and interpretation of performance-related data. Analyzers are

[16] Charging would ensure only the most performance-sensitive applications would request higher service.