MPsLS: A Novel Switching Scheme Improving Per-flow QoS for Time-sensitive Applications

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Abstract

In this paper, the author proposes a new data forwarding scheme, named Multi-Protocol synchronous Label Switching (MPsLS), suits for the integrated data network. MPsLS is a novel data forwarding scheme for the core areas of the integrated data network. It provides an interface between layer-3, the network layer, and layer-2, the data link layer. It successfully integrates layer-2 synchronous frame transfer, similar to DTM, with asynchronous packet transfer based on label switching.

In the MPsLS network, data are transferred in cyclic mode with a constant period ($\tau = 125\mu s$) called a frame. A frame consists of a number of slots with the same size (512 bits). A few slots in the header part of a frame are used as control slots, which dedicate to communicate with neighboring nodes and exchange the network control information for routing and setting up connections.

The remaining slots in a frame are data slots, which carry the application data and temporary control message. A slot carries only a segment of a layer-3 packet. Two-bits tag is introduced on the header of each data slot to distinguish the types of the slots.

MPsLS has two types of channels with different characteristics on data transfer, named appointed channels and filler channels.

Appointed channels of MPsLS provides connection-oriented service. Time-sensitive traffic is transferred synchronously on specified appointed channel. Since the number and the positions of the appointed channel slots are fixed, time-sensitive application flow can be identified by checking the positions in the frame and referring the corresponding channel table.

While non time-sensitive traffic is forwarded pseudo-asynchronously by filler channels which shares slots in the frame. The number and the positions of the filler channel slots are variable, thus, an additional 32 bits switching label like MPLS following tag bits is introduced to a filler slot in order to identify non time-sensitive flows.

The appointed channel has two possible connection modes, exact synchronous connections and less strict synchronous connections. Although less strict synchronous connections lead to a little longer delay than exact synchronous connections, but the delay values of the time-sensitive applications can be controlled within a given offset range of the slots positions according to QoS requirement.

Since the number and positions of each appointed channel slot are reserved to per-flow, and the traffic belonging to distinct time-sensitive applications is isolated each other. Besides, the appointed channels are dynamically set up at the beginning of a session and are kept all the time during the session. Therefore, it naturally provides per-flow QoS guarantees for the time-sensitive application.

On the other hand, the introduction of tag bits and additional switching label to filler slots makes the filler channel possible to use not only free slots which are not reserved for time-sensitive applications, but also to use temporary idle slots which are reserved for time-sensitive applications. When the slots are temporarily idle, the slots in that positions can transfer non time-sensitive traffic, though the appointed channels for time-sensitive traffic have priority to non time-sensitive traffic. Therefore, non time-sensitive traffic is transferred at best-effort model on filler channels. The use of the idle slots has not influence upon the performance of the time-sensitive applications, while the utilization of network resources is improved remarkably.

Therefore, MPsLS successfully combines the advantages of synchronous transfer mode and flexibility of label switching technology. It provides capabilities of guaranteeing QoS for time-sensitive applications and maintaining high network resource utilization.

Key Words: **QoS, switching, synchronization, appointed channel, filler channel, exact synchronization channel, less strict synchronization channel**