Internet QoS Signaling Protocols

* Rares SERBAN **Slim GARA *** Walid DABBOUS

Abstract
The aim of this paper is to survey the main Internet Quality of Service signaling protocols. We discuss some classification criteria and design issues.

I. Introduction

The classical transfer service offered by Internet is a point-to-point *best effort* service. For real-time traffic (e.g.Internet telephony, multimedia conferencing) does not seem suitable. The network should provide some adequate services with level of predictability and control beyond the current IP *best effort* service. Two framework QoS solutions were proposed by IETF: resource reservation (Integrated Services - IntServ) or service classification (Differentiated Services - Diffserv). QoS signaling mechanisms were developed inside these frameworks.
QoS signaling mechanisms defines all algorithms and parameters used by signaling systems in order to provide QoS between network nodes or applications - network nodes. To satisfy a QoS request each node of the network is necessary to intercept signaling messages and to process them. QoS signaling mechanisms improve the tradeoff between quality of guarantee and efficiency of the network. They help to provide differentiated delivery services for individual flows or aggregates, network provisioning, admission control, etc. Dynamic QoS Management could be provided using QoS signaling mechanisms.

II. Criteria classification

The classification of QoS signaling protocols is divided in global criteria scalability, complexity, adaptability) and specific criteria (type of bandwidth, initiate reservation, etc.).
Scalability is an important key word for criteria classification [3]. When the size of network (e.g. number of nodes, number of applications) is changing QoS signaling protocols must handle this situation. Problems with scalability are achieved in multicast communications.

*** INRIA, 2004, route des Lucioles, BP.93, 06902, Sophia Antipolis CEDEX, France,Walid.Dabbous@inria.fr
** CS Telecom, 4-16 avenue du General Leclerc, BP.74, 92263, Fontenay aux Roses, CEDEX, France, Slim.Gara@cstelecom.com
* Ph.D student of CS Telecom at INRIA Sophia Antipolis, Rares.Serban@inria.fr

The *complexity* of protocols could be a criterion classification. Here we are watching for the number of signalization type packets exchanged, size and the number of buffers and the number of interfaces with applications.
The *adaptability* criterion of the signaling mechanism depends on the resource configuration type. Two approaches can be characterized as *state-based* and *stateless*. The network could be configured with QoS parameters when the application process is starting and during the live time (Beagle protocol). A soft-state configuration requests dynamic change of the QoS parameters (RSVP protocol).
One classification criterion is *type of bandwidth* used: *in bandwidth* (YESSIR, MPLS) and *out of bandwidth* (RSVP, Beagle). In bandwidth means that on the same flow we have data and signalization signals and out of bandwidth we have two flows one for data and one for signalization.
Depending who is making the reservation, we can have *initiate reservation* classification criterion. There are differences between sender and receiver initiated reservation [4]. To initiate reservation, the QoS signals are generated by the *senders* and some times by the *receivers*. The main advantage for the sender signals is the small number of them in the network.
A work domain criterion differentiates in *inter-domains* and *intra-domains* QoS signal mechanisms. The traffic inter-domain amount allows more simplified signaling protocols and aggregate methods (BGRP protocol).

III. Design Issues

RSVP has been designed to support resource reservation in the Internet. It is a signaling protocol that provides reservation setup and control, to enable the integrated services, which is intended to provide circuit emulation on IP networks [3]. However it has two major problems: complexity and scalability. In a backbone environment, the amount of bandwidth consumed by refresh messages and the storage space that is needed to support a large number of flows at a router are too large. Solutions are: aggregation of signaling messages (increase scalability) and the signaling density control (decrease the complexity). A relatively sparse configuration of signaling and admission control devices, applications, users reduces the costs associated with signaling overhead but also compromises the benefits of signaling in terms of the quality of guarantees which can be offered or the efficiency with which network resources can be used.
Another resource reservation mechanism that simplifies the process of establishing reserved flows while preserving many unique features introduced in RSVP is handled by YESSIR protocol. The proposed mechanism, YESSIR (Yet another Sender Session Internet Protocol) generates reservation requests by

senders to reduce the processing overhead, builds on top of RTCP (Real-time Transport Control Protocol), uses softstate to maintain reservations states, supports shared reservation and associated flow merging . YESSIR extends the all-or-nothing reservation model to support partial reservations that improve over the duration of the session. This feature improves the advertising network availability.

The associated protocol of a distributed architecture for inter-domain aggregate resource reservation for unicast traffic is called BGRP (Border Gateway Routing Protocol). The reservations are aggregates along sink trees (resource scalability). BGRP is designed to work with DiffServ [8].

Complex applications will support cooperation among multiple parties by combining video conferencing with access to large amounts of archived data, real time data streams and distributed computing tasks. So, the new requirements placed on signaling protocols by emerging multiparty, multiflow applications are provided in Beagle signaling protocol. Beagle provides a way for applications to optimize resource allocation by expressing a wide range of policies to share resources amongst its flows. It allows applications to allocate computational and storage resources in the network. Beagle signaling protocol support the receiver -based resource sharing model in addition to sender-based sharing and also provide support for enforcement mechanisms such hierarchical scheduling. So, advertising the network availability increases the complexity of signalization.

MPLS (Multi-protocol Label Switching) provides bandwidth management for aggregates via network routing control according to labels in (encapsulating) packet headers. This is a way for improving the forwarding speed of routers but also offers new capabilities for Internet (Traffic engineering, VPN, adding Classes of Services). MPLS adds a connection-oriented paradigm into Internet. Between ingress and engress nodes, labels are distributed by LDP (Label Distribution Protocol) [7]. Complex functions are performed at network edge.

The advantages of using DiffServ model or MPLS are: no inherent signaling and little state required (high scalability). The disadvantage of DiffServ model or MPLS is that Internet Service Providers may implement them with different service definition.

A policy configuration is necessary to coordinate such combinations of signaling protocols in a policy domain. Two configuration models could be provided: outsourced and provisioned [11]. Outsourced policy is an execution model where a policy enforcement device issues a query to delegate a decision for a specific event to another component, external to it. Provisioned policy is an execution model where network elements are pre-configured, based on policy prior to processing events. For dynamic QoS environment COPS is very useful. COPS is an out of band protocol. His complexity increases for large networks. More devices involve more PEP's (Policy Enforce Point). COPS’s traffic could increase wasted bandwidth. Also, the complexity of PIB (Provisioning

Information Base) of each PDP (Policy Decision Point) is increasing. The states adaptability depends of the two policies network configuration models. Outsourced model could be more adaptable than provisioned model.

V. Conclusions

The challenge facing the QoS architectures lies on integrating the various elements of the architecture into a cohesive whole that is capable of sustaining end-to-end service models across a wide diversity of internet platforms. For QoS signaling protocols, the architectural direction that appears to offer the most promising outcome for QoS is not one of universal adoption of a single architecture, but instead use a tailored approach where aggregate service elements are used in the core of a network where scalability is a major design objective and use per-flow service elements at the edge of the network where accuracy of the service response is a sustainable outcome.

References

[1] A. Tannenbaum, *Computer Networks*, Addison Wesley, 1998
[2] P. Almquist, *Type of Service in the Internet Protocol Suite*, July 1992, RFC1349
[3] R.Braden, L.Zang, S.Berson, S.Jamin, *Resource Reservation Protocol-Version1 Functional Specification*, Request for Comments, RFC-2205, September 1997.
[4] P. Ferguson, G. Huston, *Quality of Service*, JohnWiley&Sons.Inc, 1998
[5] P.Pan, H. Schulzrinne, *YESSIR: A Simple Reservation Mechanisms for the Internet*, Computer Communication Review, volume 29, number 2, April 1999.
[6] P. Chandra, A. Fisher and P. Steenkiste, *A Signaling Protocol for Structured Resource Allocation*, IEEE Infocom '99, New York, March 1999.
[7] E. Rosen, A.Viswanathan, R.Callon, *Multiprotocol Label Switching Architecture*, IETF Draft August 1999, "draft-ietf-mpls-arch-06.txt"
[8] P. Pan, E. Hahne, H. Schulzrinne, *BGRP: A framework for Scalable Resource Reservation*, IETF Draft January 2000, "draft-pan-bgrp-framework.txt"
[9] Y. Snir, Y. Ramberg, J. Strassner, *QoS Policy Framework Information Model and Schema*, Draft January 2000, "draft-snir-policy-QoS-info-model-00.txt"
[10] Y. Snir, Y. Ramberg, J. Strassner, *QoS Policy Schema*, Draft February 2000, "draft-snir-qos-policy-schema-01.txt"
[11] W. Weiss, J. Strassner, A. Westerinen, *Terminology for describing network policy and services*, February 2000, Draft "draft-weiss-policy-device-qos-model-00.txt"
[12] J. Strassner, Ed. Ellesson, *Terminology for describing network policy and services*, February 2000, Draft "draft-ietf-policy-terms-00.txt"
[13] R. Yavatkar, D. Hoffman, Y. Bernet, F. Baker, *SBM (Subnet Bandwidth Manager): A Protocol for RSVP-based Admission Control over IEEE 802-style networks*, May 1999, Draft "draft-ietf-issll-is802-sbm-08.txt"
[14] R. Serban, *Internet QoS Signaling Protocols*, report for Intradiff Project, May 2000.