Differentiated Services (DiffServ) for IP Quality of Service (QoS)

EION Open IP Environment Differentiated Services (DiffServ) for IP Quality of Service (QoS) is a set of transparent and portable software components enabling policy-based QoS control and multiple levels of QoS. Leading edge applications such as ECN (Explicit Congestion Notification) facilitates the delivery of overall high performance networking for your customers.

Overview

EION Open IP Environment is a portable real-time software suite that IP-enables new and traditional network elements providing high performance interoperability across multiple platforms and products. Open IP Environment is based on a single, open, modular and scalable framework that allows system integrators and developers to incorporate services such as routing, Quality of Service (QoS), security, IP accounting and policy management into any type of device. Open IP Environment is platform and real-time operating system (RTOS) independent and can work on any type of device ranging from high end optical core switches to personal digital assistants (PDAs).

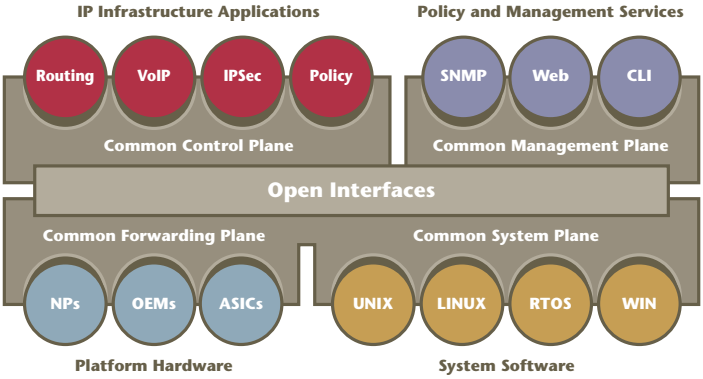
Framework Overview

EION Open IP Environment framework consists of four planes: Common Control Plane, Common System Plane, Common Forwarding Plane and Common Management Plane. Each of these planes contains a set of components that are built to use well-defined interfaces.

Open IP Environment Forwarding Plane provides a set of components to enable router forwarding engine support. The Open IP Environment DiffServ QoS module resides within the Common Forwarding Plane to deliver high performance packet classification, traffic conditioning and Per Hob Behaviour (PHB). This module, designed with modularity and flexibility can be reused in software-based router forwarding engines, in DSP-based firmware QoS engines or as reference models for developing QoS hardware ASICs. It has also been designed with enhanced classification capabilities and has been integrated with the Open IP Environment Forwarding Engine.

DiffServ QoS Overview

SION Open IP Environment DiffServ QoS library is a set of portable software components that provide differentiated classes of service for Internet traffic. It enables service differentiation based on application requirements and business prioritization. This packet marking based approach to IP-QoS is attractive due to its simplicity and ability to scale. Open IP Environment DiffServ architecture includes three key components: Edge device functionality, Core device functionality and Policy/ Network management.



One of the major features in the DiffServ Architecture is the Traffic Conditioner. Traffic Conditioners typically reside in devices at the network edge. These devices maintain subscribed traffic profiles on a per-customer basis. Traffic Conditioners include Traffic Meters and Traffic Policers. The Edge Node identifies per-customer traffic using a Traffic Classifier. The customer traffic stream is metered and its traffic characteristics compared against the traffic profile that has been contracted. Conformant traffic from the customer is marked with a specific DSCP (Differentiated Services Code Point) as per RFC 2474. Non-conformant traffic is either re-marked, dropped or shaped depending on SLA specification.

PHBs are the simple forwarding treatment accorded to packets by the core devices. This treatment includes dropping or delaying packets, but does not include routing decisions. The PHB is the externally observable forwarding behavior applied against a packet based on its particular DSCP marking. While the IETF standardizes DiffServ PHBs, it is up to vendor implementations to utilize specific algorithms to achieve the PHB. PHBs are implemented using a combination of Buffer Management and Scheduler mechanisms. Currently standardized PHBs supported by Open IP Environment include Class Selector (CS) [RFC 2474], Assured Forwarding (AF) [RFC 2597], Expedited Forwarding (EF) [RFC 2598], and Default (DE) PHB.

The third feature of the Open IP Environment DiffServ architecture is the Policy and Network Management (PNM). The PNM infrastructure facilitates the download of filters and traffic profiles used to classify, meter and police customer traffic on the router. The PNM also supports configuration and monitoring of the scheduler, buffer management and shaper components.

QoS Differentiation – Performance

SION Open IP Environment QoS module has been designed with performance as a key requirement. Since all the components operate in the fast-path of a software router, they are intended to scale to suitable forwarding speeds supported in software forwarding routers. The classifier has the potential to be the bottleneck in software forwarding routers. As the number of policies (filters + traffic profiles) increase, the search time could potentially increase. To minimize the classification time, Open IP Environment utilizes an extremely fast algorithm that takes advantage of space-time complexity tradeoffs to provide fast search times.

QoS Differentiation – Diversity of Algorithms

One of key differentiators of the Open IP Environment Diff-Serv, QoS module is the diversity of algorithms supported. For example, the QoS Forwarding Engine policer can be selected from a set of 4 different algorithms – three of which are based on IETF RFCs. Similarly, for buffer management schemes and schedulers, designers can select from a number of algorithms that are included as part of the library. Different algorithms have different cost-performance trade-offs and also, result in different behaviour.

The DiffServ QoS module integration with the Open IP Environment framework allows the network administrator to configure the specific component algorithms to be utilized. Well-defined APIs exist to allow setting of which algorithm to utilize for a particular component. These APIs are clearly outlined in the DiffServ QoS Open IP Environment User Guide.

QoS Differentiation – Explicit Congestion Notification (ECN)

SION Open IP Environment implementation of ECN (RFC 2481) enables DiffServ edge and core nodes with active queue management. The ECN module utilizes the RED (Random Early Detect) algorithm developed based on guidelines in IETF RFC 2309. The ECN feature allows routers to explicitly signal end-hosts of impending congestion before the queue overflows. This feature implementation will allow network nodes to inter-operate with ECN enabled hosts and allow management in the future of host-based ECN / DiffServ applications.

QoS Differentiation – Classifier with "Fast Switchover"

The fast-switchover feature is used to hot swap configuration information contained within the classifier data structures. Once new filters are added to the classifier, they must be preprocessed before they can be used. This preprocessing can be done as a background activity into an intermediate data structure. When preprocessing is complete, the new data structure can quickly replace the old structure, reducing downtime for the system. This way, you can update the access control list, i.e., the filter database, on the fly without rebooting of the node/router.

QoS Differentiation – Simple Classifier

SION Open IP Environment Diff-Serv module includes a separate classifier to classify packets generated by control/management protocols in a specific router. The classifier is configurable and allows classification of control/management packets based on the IP protocol number and/or the Layer-4 source port number.

DiffServ/QoS Interactions

SION Open IP Environment DiffServ/QoS module has been specifically designed to deliver time to market advantages through the built in Common Control, Common Forwarding, Common System and Common Management plane interactions. This allows for ease of integration with other Open IP Environment and third party modules.

Open IP Environment DiffServ QoS module is available as standalone libraries or integrated in the Open IP Environment framework. The Open IP Environment standard Forwarding Plane Interface (FPI) provides a portable means for allowing control and management protocols to communicate with various forwarding engines. A set of QoS extensions has been defined for the FPI. This allows QoS management protocols and agents in the Open IP Environment Common Management Plane and Common Control Plane to communicate with the forwarding engines using a single common set of application programming interface (APIs). QoS management agents that receive configuration information call the FPI APIs and report monitoring status to off-switch devices using COPS (e.g. COPS-PR) or HTTP (embedded web server) protocols.

For more details on other Open IP Environment planes and modules, please refer to the relevant product briefs.

DiffServ QoS Features

SION Open IP Environment DiffServ for IP QoS demonstrates the following key features::

- Configurable to run on either a DiffServ Edge device or a Core network device
- Enhanced packet classification and filtering capabilities: BA (Behaviour Aggregate) and MF (Microflow) Classification
- Flow Management[2] module that permits accurate classification of fragmented packets
- Configuration of filters and traffic profiles via COPS-client interface. It supports traffic Profiles' PIR (Peak Information Rate) and CIR (Committed Information Rate)
- Houses high performance meters at three levels: Filter-level Granularity, Interface-level granularity, and queue-level granularity. Supported Meter algorithms include: Sliding Window meter and Exponential Weighted Moving Average meter (EWMA)
- Supports different DiffServ Policers that operate on specified traffic profiles which are: single rate Three Colour Marker (srTCM, two rate Three Colour Marker (trTCM), Time Sliding Window Three Colour Marker (TSWTCM) and Two Color Token Bucket (tcTB).
- Allows Rate Limiting per Egress Interface
- Includes a number of hot-swappable packet schedulers. The schedulers supported are: Round Robin (RR), Weighted Round Robin (WRR), Weighted Interleaved Round Robin (WIRR), Bounded Strict Priority (BSP) and Weighted Fair Queuing (WFQ)

[2] A flow is defined by the 5-tuple set: source IP, destination IP, source port, destination port and a protocol number.

- Features configurable Traffic Shapers: Token Bucket and Leaky Bucket shaper
- Showcases a variety buffer management algorithms (e.g. Drop Tail, Random Early Detect (RED), Multi-Level RED (MRED), RED with In/Out (RIO-Coupled), Weighted RED (WRED), RIO-Decoupled and Explicit Congestion Notification (ECN)
- Provides support for defined PHBs standards: Class Selector (CS) PHB, Assured Forwarding (AF) PHB, Expedited Forwarding (EF) PHB and Default (Best Effort).

For a complete list of Open IP Environment DiffServ RFC support, please refer to the last page of this product brief.

DiffServ QoS Management Support

SION Open IP Environment DiffServ QoS module provides standard APIs to facilitate monitoring and configuration through a rich variety of control and management plane modules. The QoS module communicates with the control/management plane modules through the Open IP Environment Forwarding Plane Interface. Configurable settings include: number of queues per interface, scheduler weights, buffer management thresholds, PHB to DSCP mapping, meter parameters and shaper parameters. Monitored statistics include per-filter packet statistics and per queue packet statistics.

The QoS configuration API has been written such that Open IP Environment and third party COPS, HTTP, SNMP, CLI or other management protocols can be used for network management of the QoS module. Currently, filter configuration is performed via the Open IP Environment COPS-PR module while other QoS FE configuration is achieved through an embedded HTTP server.

DiffServ QoS Module Implementation

SION Open IP Environment DiffServ QoS module has been implemented in the "C" programming language. Through the publication of APIs, the Open IP Environment DiffServ QoS module has been designed for ease of portability and modularity. Open IP Environment provides an architecture to allow you to implement QoS libraries within the Open IP Environment framework, or alternatively to adapt it to your specific environment.

Ease of Portability

SION Open IP Environment provides a set of interoperable modules that are available for use in both established and "greenfield" products. The customer has the choice to pick and choose Open IP Environment modules to incorporate into the customer's established products, preserving the investment in prior development. The customer also has the option to use modules within the Open IP Environment framework to develop a new software base to address going-forward opportunities. It is also possible to compile the software for a variety of target processors. Therefore, protocol composition can be statically changed by modifying the configuration to suit your needs.

Established products typically have a well-developed architecture and an existing suite of applications, and these products will be looking to Open IP Environment for additional capabilities. The portable and modular Open IP Environment components can be integrated into an existing execution environment to work within an existing code base, with minimal modifications to the customer's environment.

Greenfield products typically require a full suite of applications plus the Open IP Environment framework to provide an appropriate execution environment. The Open IP Environment framework and modules are well-positioned to address such greenfield opportunities.

Benefits

In a market that demands ever-increasing IP support, it is difficult to maintain sufficient in-house expertise in every area. EION Open IP Environment framework and DiffServ QoS module solve this problem by:

- Allowing OEMs to focus on their real value added solutions, not underlying infrastructure
- Reducing the length of time to market via ease of integration of key components such as DiffServ QoS
- Enabling the freedom to choose among different software and hardware platforms
- Enabling ease of portability to traditional and new network enabled devices
- Enabling accelerated development of highly customized IP-enabled products via well documented APIs
- Enabling a pick and choose approach to Open IP Environment modules via a flexible open framework addressing various devices and applications from PDAs to carrier grade optical switches
- Delivering components of the framework that are scalable, modular, and portable that consistently demonstrate high performance attributes
- Delivering standards-based interfaces and common programming languages such as C, C++ and Java to developers, enhancing overall productivity with a small learning curve.
- Delivering configured and managed modules that use one or several of the following management capabilities:
  - EION Command Line Interface
  - Simple Network Management Protocol (SNMP)
  - Web-based management.

EION Open IP Environment DiffServ QoS Feature Summary

RFC and Draft Support

- RFC 2474 DS Field Definition
- RFC 2475 DiffServ Architecture
- RFC 2481 A Proposal to add Explicit Congestion Notification (ECN) to IP
- RFC 2597 AF Per Hop Behaviour
- RFC 2598 EF Per Hop Behaviour
- RFC 2697 srTCM (Single Rate Three Colour Marker)
- RFC 2698 trTCM (Two Rate Three Color Marker)
- RFC 2748 COPS (Common Open Policy Service Protocol)
- RFC 2859 TSWTCM (Time Sliding Window Three Colour Marker)
- RFC 2884 Performance Evaluation of Explicit Congestion Notification (ECN) in IP Networks (Informational)

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