



SolarisTM Bandwidth Manager

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Solaris™ Bandwidth Manager

The Solaris™ Bandwidth Manager software provides the means to manage your network so that Quality of Service (QoS) can be optimized for network users. It allows network traffic to be allocated to separate Classes of Service (CoS), so that urgent traffic is given higher priority than less important traffic. Different classes of service can be guaranteed a portion of the network bandwidth, leading to more predictable network loads and overall system behavior. Service Level Agreements (SLAs) can be defined and translated into Solaris Bandwidth Manager controls and policies. Tools and APIs provide interfaces to monitoring, billing, and accounting functions.

End-to-end Quality of Service

To manage network resources, it is not sufficient to simply monitor and control the network segment closest to the computer systems that supply the services. Clients can be located anywhere on the network, and the entire network path from client to server must be considered. This is what is meant by end-to-end Quality of Service, and this can be very difficult to achieve. If congestion takes place anywhere on the network, it affects the overall QoS. Therefore, routers must help supply QoS. In the Internet Engineering Task Force (IETF), several working groups have been addressing this problem, notably the Integrated Services working group (Int-Serv) and the Differentiated Services working group (Diff-Serv).

Integrated Services

In recent years, much activity in the IETF has focussed on the goal of bringing true end-to-end QoS to the Enterprise and the Internet. In order to provide a certain bandwidth to an application, each hop within the network from the client to the server must deliver the resources that are required.

The Integrated Services framework (Int-Serv) was developed by the IETF to give applications the ability to support multiple levels of QoS when delivering data across the network. Int-Serv is built around two main concepts:

- Network components along the path must support multiple levels of service.
- There must be a way for an application to communicate its desired level of service to the network components.

The RSVP protocol was developed to communicate desired QoS levels. For RSVP to work, each hop from end to end must be RSVP-enabled, including the application itself (through an API). Bandwidth is reserved at each hop along the way before transmission begins, enabling that sufficient resources to be available for the duration of the connection.

RSVP never received widespread acceptance for the Internet backbone. One reason is that backbone routers handle the forwarding and routing of very large amounts of concurrent flows (connections). Deploying RSVP means that routers need to keep state on each connection. This puts a very high load on these routers, which leads inevitably to performance, scalability, and management problems.

However, RSVP can be the right solution for certain applications, especially on better contained networks, such as corporate intranets. Solaris Bandwidth Manager does not use RSVP to manage bandwidth. However, Sun offers a separate product called Solstice™ Bandwidth Reservation Protocol 1.0 that does use RSVP. This product can be downloaded from <http://www.sun.com/solstice/telecom/bandwidth>.

Differentiated Services

More recently, the IETF's Diff-Serv (Differentiated Services) working group has been attempting to resolve issues related to overloaded backbone routers. Instead of requiring per-flow resource reservation at each hop, the new model attempts to move the complexity to the network edge, in order to simplify the packet forwarding mechanisms in the core of the network.

The IPv4 packet header includes a field called ToS (Type of Service) which can be used to mark a packet for different levels of service. In the Diff-Serv context, this IP header is renamed the DS header byte. The IPv6 header has a similar field. At the edge of the network, packets and flows are classified and shaped (scheduled). The DS field in the IP header is marked for a corresponding level of service, and the core routers in the network inspect the DS field and give the type of service that was requested. In the Diff-Serv specification, care was taken to provide as much support as possible for backwards compatibility with the original Type of Service header, as defined in RFC 791 (the original IP specification) and RFC 1349 which refines these definitions. For more information regarding Diff-Serv, see RFC 2474 and RFC 2475.

Solaris Bandwidth Manager is Diff-Serv compliant. The software can classify, filter, and mark network packets based on the DS field contents. This allows Solaris Bandwidth Manager to be deployed in a Diff-Serv environment along with networking equipment (such as routers and switches) from other vendors that are Diff-Serv compliant.

When to Use Solaris Bandwidth Manager

Without using any form of bandwidth management, it is very hard to maintain a network that has predictable performance characteristics. Nevertheless, this is how most networks are run today. Network usage is estimated or modeled, and then enough bandwidth is configured to achieve respectable latencies. This could mean that there will always be enough bandwidth for all applications that would possibly need it, or it could mean that the network is oversubscribed and that on average only a certain percentage of users will be creating traffic. When new applications are deployed, or existing applications become more popular, links become congested and users start complaining about slow application performance. This goes on until the network is upgraded. For many environments, this is a completely acceptable way to maintain network resources. New technologies such as switched networking equipment and gigabit ethernet have rapidly become available at continuously decreasing prices.

Deploying a Quality of Service solution is not a magical fix for bandwidth shortage on a network. When the network is overloaded, bandwidth management software can help determine which network traffic to penalize, and which network traffic to favor. If the network is not oversubscribed, deploying bandwidth management might be a futile exercise, since there is no network bandwidth shortage to begin with.

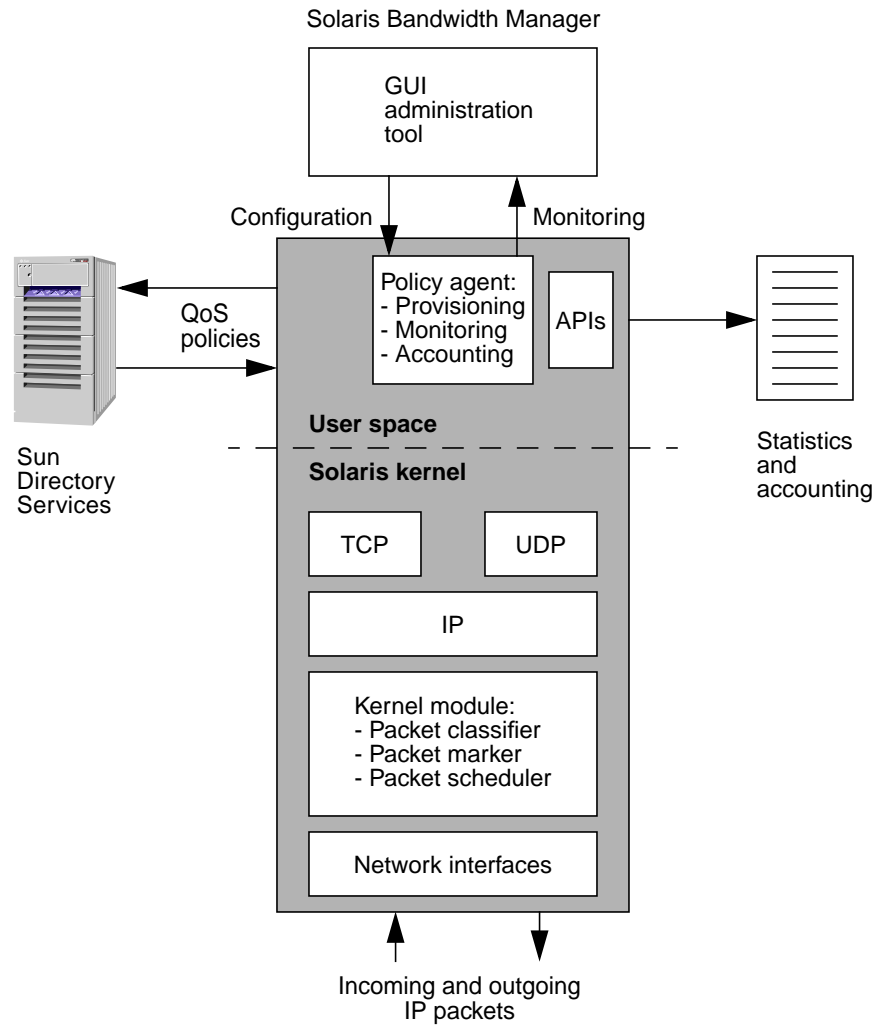
However, many networks are oversubscribed, and critical network services might be impacted during peak loads on the network. Solaris Bandwidth Manager can help define which network services are more important than others, and set priorities and bandwidth percentages that are to be enforced so that these services are not negatively impacted by less important traffic on the network. In addition, Solaris Bandwidth Manager can be used in environments where clients are billed based on their network usage; clients who pay more can be offered a larger piece of the network bandwidth.

Solaris Bandwidth Manager Architecture

Solaris Bandwidth Manager consists of the following major components:

- The *administration tool*, `batool`, provides a graphical interface for configuring Solaris Bandwidth Manager. This GUI can be run as an applet or an application from any machine on your network that hosts a Java™ Virtual Machine.
- The *policy agent* implements the configuration and handles communication with the kernel module.
- The *kernel module* is viewed as a STREAMS driver, `/dev/ipqos`, by the tools in user space, and is viewed as a STREAMS module, `ipqos`, by the IP stack. It contains the classifier and the scheduler:
 - The *classifier* allocates packets to a class queue.
 - The *scheduler* determines the order in which queued packets are forwarded across the network and applies the bandwidth limits and priorities configured for each type of traffic. Class Based Queuing (CBQ) is the underlying queuing technology used in Solaris Bandwidth Manager.
- Commands, utilities, and API's are provided for managing the Solaris Bandwidth Manager software and for monitoring your network.

The following illustration shows the basic architecture of Solaris Bandwidth Manager:



LDAP Directory Integration

Solaris Bandwidth Manager configuration information and policy information can be stored in a directory service such as Sun™ Directory Services 3.1. The advantage of storing configuration and policy information in a directory rather than in a configuration file is that the configuration can be dynamically updated upon

detection of user connections or traffic flows. Using a directory service also makes it possible to update the configuration of multiple instances of Bandwidth Manager from a single point, the directory.

When a remote user connects to the network through a remote access server or a network access server (NAS) using the RADIUS protocol, the IP address of the user's point of presence can be dynamically recorded in the user's directory entry. The policy agent detects this information and triggers a change to the dynamic configuration, to add the required policies for traffic associated with this user.

You could also write an application to detect the start of a flow, or the presence of traffic in a new flow, and update the configuration to take account of that flow. To support this dynamic configuration, you need a way to store information about the policies to be applied to traffic in a new flow. A directory service, such as Sun Directory Services 3.1, can be used to hold the policy rules and to relate them to a new flow.

When you want consistency in a configuration that contains multiple instances of Solaris Bandwidth Manager, a directory is the ideal location for storing and modifying the configuration information. Using standard directory replication processes, the configuration information can be loaded into the policy agents, making it unnecessary to configure each policy agent individually.

Directory Enabled Networks

Computer networks are becoming increasingly more complex to manage. Currently, most network devices are independently configured, usually in a static manner. Effective resource management is not feasible using this model. Ideally, Service Level Agreements and high level policies should be automatically translated into dynamic network configuration changes. To achieve this, some kind of centralized view of the network is required, and directories (such as those based on LDAP) are an ideal match for this.

Currently, directories mostly store user and application information. The goal of the Directory Enabled Networks working group (DEN) is to offer a standard information model and a set of directory schemas to tie together users and applications with network elements, protocols, and services. By complying with this information model and the DEN schemas, different network equipment and application vendors should be able to build interoperable network elements around a central directory.

Instead of reinventing the wheel, the DEN working group is taking advantage of work done by the Desktop Management Task Force (DMTF), which has already developed an information model called CIM (Common Information Model) for managing computer systems. DEN is using the CIM schema as much as possible,

and has been extending it by adding network-specific information. Because of the close relationship between the DEN information model and CIM, the DEN draft was recently transferred to the DMTF group for review and approval.

Solaris Bandwidth Manager is DEN-compliant; the LDAP schema it uses is based on DEN schemas. The DEN schema extensions that were defined for Solaris Bandwidth Manager are documented in the product manuals.

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