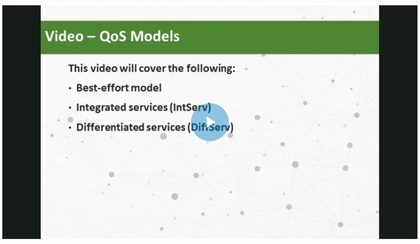
QoS Models

9.4.1

Video Tutorial - QoS Models

Click Play for a brief explanation of the purpose of QoS.



9.4.2

Selecting an Appropriate QoS Policy Model

How can QoS be implemented in a network? There are three models for implementing QoS:

- Best-effort model
- Integrated services (IntServ)
- Differentiated services (DiffServ)

The table summarizes these three models. QoS is implemented in a network using either IntServ or DiffServ. While IntServ provides the highest guarantee of QoS, it is very resource-intensive, and therefore, not easily scalable. In contrast, DiffServ is less resource-intensive and more scalable. The two are sometimes co-deployed in network QoS implementations.

Models for Implementing QoS

Model	Description
Best-effort model	• This is not really an implementation as QoS is not explicitly configured. • Use this when QoS is not required.
Integrated services (IntServ)	• IntServ provides very high QoS to IP packets with guaranteed delivery. • It defines a signaling process for applications to signal to the network that they require special QoS for a period and that bandwidth should be reserved. • IntServ can severely limit the scalability of a network.
Differentiated services (DiffServ)	• DiffServ provides high scalability and flexibility in implementing QoS. • Network devices recognize traffic classes and provide different levels of QoS to different traffic classes.

9.4.3

Best Effort

The basic design of the Internet is best-effort packet delivery and provides no guarantees. This approach is still predominant on the Internet today and remains appropriate for most purposes. The best-effort model treats all network packets in the same way, so an emergency voice message is treated the same way that a digital photograph attached to an email is treated. Without QoS, the network cannot tell the difference between packets and, as a result, cannot treat packets preferentially.

The best-effort model is similar in concept to sending a letter using standard postal mail. Your letter is treated exactly the same as every other letter. With the best-effort model, the letter may never arrive, and, unless you have a separate notification arrangement with the letter recipient, you may never know that the letter did not arrive.

The table lists the benefits and drawbacks of the best effort model.

Benefits and Drawbacks of Best-Effort Model

Benefits	Drawbacks
The model is the most scalable.	There are no guarantees of delivery.
Scalability is only limited by available bandwidth, in which case all traffic is equally affected.	Packets will arrive whenever they can and in any order possible, if they arrive at all.
No special QoS mechanisms are required.	No packets have preferential treatment.
It is the easiest and quickest model to deploy.	Critical data is treated the same as casual email is treated.

9.4.4

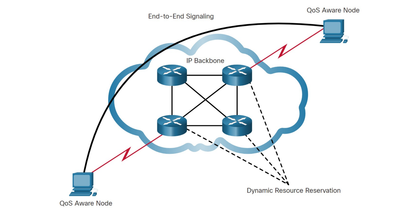
Integrated Services

The IntServ architecture model (RFC 1633, 2211, and 2212) was developed in 1994 to meet the needs of real-time applications, such as remote video, multimedia conferencing, data visualization applications, and virtual reality. IntServ is a multiple-service model that can accommodate many QoS requirements.

IntServ delivers the end-to-end QoS that real-time applications require. IntServ explicitly manages network resources to provide QoS to individual flows or streams, sometimes called microflows. It uses resource reservation and admission-control mechanisms as building blocks to establish and maintain QoS. This is similar to a concept known as "hard QoS." Hard QoS guarantees traffic characteristics, such as bandwidth, delay, and packet-loss rates, from end to end. Hard QoS ensures both predictable and guaranteed service levels for mission-critical applications.

The figure shows a simple illustration of the IntServ model.

Simple IntServ Example



IntServ uses a connection-oriented approach inherited from telephony network design. Each individual communication must explicitly specify its traffic descriptor and requested resources to the network. The edge router performs admission control to ensure that available resources are sufficient in the network. The IntServ standard assumes that routers along a path set and maintain the state for each individual communication.

In the IntServ model, the application requests a specific kind of service from the network before sending data. The application informs the network of its traffic profile and requests a particular kind of service that can encompass its bandwidth and delay requirements. IntServ uses the Resource Reservation Protocol (RSVP) to signal the QoS needs of an application's traffic along devices in the end-to-end path through the network. If network devices along the path can reserve the necessary bandwidth, the originating application can begin transmitting. If the requested reservation fails along the path, the originating application does not send any data.

The edge router performs admission control based on information from the application and available network resources. The network commits to meeting the QoS requirements of the application as long as the traffic remains within the profile specifications. The network fulfills its commitment by maintaining the per-flow state and then performing packet classification, policing, and intelligent queuing based on that state.

The table lists the benefits and drawbacks of the IntServ model.

Benefits and Drawbacks of IntServ Model

Benefits	Drawbacks
• Explicit end-to-end resource admission control • Per-request policy admission control • Signaling of dynamic port numbers	• Resource intensive due to the stateful architecture requirement for continuous signaling. • Flow-based approach not scalable to large implementations such as the Internet.

9.4.5

Differentiated Services

The differentiated services (DiffServ) QoS model specifies a simple and scalable mechanism for classifying and managing network traffic. For example, DiffServ can provide low-latency guaranteed service to critical network traffic such as voice or video, while providing simple best-effort traffic guarantees to non-critical services such as web traffic or file transfers.

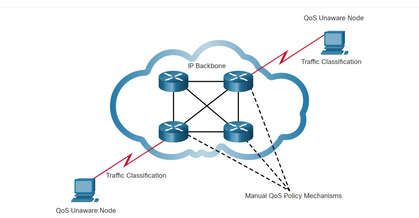
The DiffServ design overcomes the limitations of both the best-effort and IntServ models. The DiffServ model is described in RFCs 2474, 2597, 2598, 3246, 4594. DiffServ can provide an "almost guaranteed" QoS while still being cost-effective and scalable.

The DiffServ model is similar in concept to sending a package using a delivery service. You request (and pay for) a level of service when you send a package. Throughout the package network, the level of service you paid for is recognized and your package is given either preferential or normal service, depending on what you requested.

DiffServ is not an end-to-end QoS strategy because it cannot enforce end-to-end guarantees. However, DiffServ QoS is a more scalable approach to implementing QoS. Unlike IntServ and hard QoS, in which the end-hosts signal their QoS needs to the network, DiffServ does not use signaling. Instead, DiffServ uses a "soft QoS" approach. It works on the provisioned-QoS model, where network elements are set up to service multiple classes of traffic each with varying QoS requirements.

The figure shows a simple illustration of the DiffServ model.

Simple DiffServ Example



As a host forwards traffic to a router, the router classifies the flows into aggregates (classes) and provides the appropriate QoS policy for the classes. DiffServ enforces and applies QoS mechanisms on a hop-by-hop basis, uniformly applying global meaning to each traffic class to provide both flexibility and scalability. For example, DiffServ could be configured to group all TCP flows as a single class, and allocate bandwidth for that class, rather than for the individual flows as IntServ would do. In addition to classifying traffic, DiffServ minimizes signaling and state maintenance requirements on each network node.

Specifically, DiffServ divides network traffic into classes based on business requirements. Each of the classes can then be assigned a different level of service. As the packets traverse a network, each of the network devices identifies the packet class and services the packet according to that class. It is possible to choose many levels of service with DiffServ. For example, voice traffic from IP phones is usually given preferential treatment over all other application traffic; email is generally given best-effort service; and nonbusiness traffic can either be given very poor service or blocked entirely.

The figure lists the benefits and drawbacks of the DiffServ model.

Note: Modern networks primarily use the DiffServ model. However, due to the increasing volumes of delay- and jitter-sensitive traffic, IntServ and *RSVP* are sometimes co-deployed.

Benefits and Drawbacks of DiffServ Model

Benefits	Drawbacks
• Highly scalable • Provides many different levels of quality	• No absolute guarantee of service quality • Requires a set of complex mechanisms to work in concert throughout the network

9.4.6

Check Your Understanding - QoS Models

Check your understanding of QoS Models by choosing the BEST answer to the following questions.

1. Which QoS model provides per-request policy admission control?

- best effort
- **integrated services**
- differential services

2. Which QoS model requires no special QoS mechanisms?

- **best effort**
- integrated services
- differential services

3. Which QoS model provides many different levels of quality?

- best effort
- integrated services
- **differential services**

4. Which QoS model uses explicit end-to-end resource admission control?

- best effort
- **integrated services**
- differential services

5. Which QoS model is the most scalable?

- best effort
- integrated services
- **differential services**

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