UNIT 2 PART 1

UNIT 2 PART 1
Network Layer Design Issues: Store-and-Forward
Packet Switching, Services Provided to the Transport
Layer, Implementation of Connection-Oriented Service,
Implementation of Connection-Oriented Service, **UNIT 2 PART 1**
 Packet Switching, Services Provided to the Transport

Packet Switching, Services Provided to the Transport

Layer, Implementation of Connectionless Service,

Implementation of Connection-Oriented Service UNIT 2 PART 1
Network Layer Design Issues: Store-and-Forward
Packet Switching, Services Provided to the Transport
Layer, Implementation of Connectionless Service,
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Comparison o UNIT 2 PART 1

Network Layer Design Issues: Store-and-Forward

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Compari UNIT 2 PART 1

Network Layer Design Issues: Store-and-Forward

Packet Switching, Services Provided to the Transport

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Implementation of Connection-Oriented Service,

Compari

Network Layer

- **1998**
• The network layer is mainly responsible for
• The network layer is mainly responsible for
transmitting data packets from the source and
delivers them to the destination **Network Layer
The network layer is mainly responsible for
transmitting data packets from the source and
delivers them to the destination. CHE MET WATER SET AT A THE MANUTE THE MET A THE MANUST THE MET ANNUST THE SURFERENT SUM THE SURFERENT SUM THE DESTINGLY THE SURFERENT SUM THE SURFERE The network layer is mainly responsitransmitting data packets from the sould delivers them to the destination.**
This layer decides the route for packusing **Routing Algorithms**.
- This layer decides the route for packets by

Network Layer Design Issues

**Network Layer Design Issues
• The network layer design issues include the
service provided to the transport layer and the
internal design of the network Network Layer Design Issues**
The network layer design issues include the
service provided to the transport layer and the
internal design of the network. **Network Layer Design Issues**
The network layer design issues include the
service provided to the transport layer and the
internal design of the network.

Store-and-Forward Packet Switching

- Store-and-Forward Packet Switching
• The major components of the network are the
ISP's equipment (routers connected by
transmission lines) shown inside the shaded Store-and-Forward Packet Switching
The major components of the network are the
ISP's equipment (routers connected by
transmission lines), shown inside the shaded
oval and the customers' equipment shown Store-and-Forward Packet Switching
The major components of the network are the
ISP's equipment (routers connected by
transmission lines), shown inside the shaded
oval, and the customers' equipment, shown oval, and the customers' equipment, shown Store-and-Forward Packet Swi
The major components of the netwo
ISP's equipment (routers conne
transmission lines), shown inside th
oval, and the customers' equipmer
outside the oval.
Host H1 is directly connected to or • The major components of the network are the

ISP's equipment (routers connected by

transmission lines), shown inside the shaded

oval, and the customers' equipment, shown

outside the oval.

• Host H1 is directly connec The major components of the network are the
ISP's equipment (routers connected by
transmission lines), shown inside the shaded
oval, and the customers' equipment, shown
outside the oval.
Host H1 is directly connected to on
-

Store-and-Forward Packet Switching

The environment of the network layer protocols

Store-and-Forward Packet Switching

- Store-and-Forward Packet Switching
• In above figure, A host H1 send a packet to the
nearest router, either on its own LAN or over a
point-to-point link to the ISP. Store-and-Forward Packet Switching
In above figure, A host H1 send a packet to the
nearest router, either on its own LAN or over a
point-to-point link to the ISP.
The packet is stored there until it has fully arrived Store-and-Forward Packet Switching
In above figure, A host H1 send a packet to the
nearest router, either on its own LAN or over a
point-to-point link to the ISP.
The packet is stored there until it has fully arrived
and t
- Store-and-Forward Packet Switching
• In above figure, A host H1 send a packet to the
nearest router, either on its own LAN or over a
point-to-point link to the ISP.
• The packet is stored there until it has fully arrived
a and the link has finished its processing by Store-and-Forward Packet Switch

In above figure, A host H1 send a pack

nearest router, either on its own LAN

point-to-point link to the ISP.

The packet is stored there until it has fu

and the link has finished its pro • In above figure, A host H1 send a packet to the nearest router, either on its own LAN or over a point-to-point link to the ISP.
• The packet is stored there until it has fully arrived and the link has finished its proces In above figure, A host H1 send a packet to the
nearest router, either on its own LAN or over a
point-to-point link to the ISP.
The packet is stored there until it has fully arrived
and the link has finished its processing In above ligure, A nost H1 ser
nearest router, either on its o
point-to-point link to the ISP.
The packet is stored there until
and the link has finished
verifying the checksum.
Then it is forwarded to the ne:
path until i France Fourth link to the ISP.

• The packet is stored there until it has fully arrived

and the link has finished its processing by

verifying the checksum.

• Then it is forwarded to the next router along the

path until
-
- switching.

Services Provided to the Transport Layer Services Provided to the Transport

Layer

• The network layer provides services to the transport layer

• An important question is precisely what kind of services the

• An important question is precisely what kind of ser Services Provided to the Transport
Layer
The network layer provides services to the transport layer
at the network layer/transport layer interface.
An important question is precisely what kind of services the
retwork layer **Services Provided to the Transport**
 Layer

• The network layer provides services to the transport layer

• An important question is precisely what kind of services the

• An important question is precisely what kind of **Services Provided to the Transport**
 Layer

The network layer provides services to the transport layer

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An important question is precisely what kind of services the

netw **Services Provided to the Transport**
 Layer

• The network layer provides services to the transport layer

at the network layer/transport layer interface.

• An important question is precisely what kind of services the
 1. The network layer provides services to the transport layer

1. The network layer provides services to the transport layer

1. An important question is precisely what kind of services the

1. The services need to be care

-
-
- following goals in mind:
- technology.
- The network layer provides services to the transport layer

at the network layer/transport layer interface.

 An important question is precisely what kind of services the

network layer provides to the transport layer.

- he network layer provides services to the transport layer

t the network layer/transport layer interface.

n important question is precisely what kind of services the

etwork layer provides to the transport layer.

he serv 3. The network layer and the transport and the following goals in provides to the transport layer.

1. The services need to be carefully designed with the following goals in mind:

1. The services should be independent of n important question is precisely what kind of services the
etwork layer provides to the transport layer.
he services need to be carefully designed with the
pllowing goals in mind:
The services should be independent of the etwork layer provides to the transport laye
he services need to be carefully desi
bllowing goals in mind:
The services should be independent
technology.
The transport layer should be shielded fra
type, and topology of the

Services Provided to the Transport Layer Services Provided to the Transport
Layer
• Based on the connections there are two types
of services provided:
• Connectionless The revise and insertion of Services Provided to the Tran

Layer

Based on the connections there are

of services provided:

Connectionless – The routing and in

-
- Services Provided to the Transport
Layer
• Based on the connections there are two types
of services provided:
• **Connectionless** The routing and insertion of
packets into subnet is done individually. No
added setup is re packets into subnet is done individually. No Layer
Based on the connections there are two
of services provided:
Connectionless – The routing and insert
packets into subnet is done individual
added setup is required.
Connection-Oriented – Subnet must • Based on the connections there are two types

of services provided:

• **Connectionless** – The routing and insertion of

packets into subnet is done individually. No

added setup is required.

• **Connection-Oriented** – Su
- Based on the connections there are two types
of services provided:
Connectionless The routing and insertion of
packets into subnet is done individually. No
added setup is required.
Connection-Oriented Subnet must o **Connectionless** – The routing and insertion of
packets into subnet is done individually. No
added setup is required.
Connection-Oriented – Subnet must offer
reliable service and all the packets must be
transmitted over

Implementation of Connectionless Service

- Implementation of Connectionless
Service
• If connectionless service is offered, packets
are injected into the network individually and
routed independently of each other Implementation of Connectionless
Service
If connectionless service is offered, packets
are injected into the network individually and
routed independently of each other. Implementation of Connectionless
Service
If connectionless service is offered, packets
are injected into the network individually and
routed independently of each other.
No advance setup is needed. Service

• If connectionless service is offered, packets

are injected into the network individually and

• No advance setup is needed.

• In this context, the packets are frequently

called **datagrams** (in analogy with te
- No advance setup is needed.
- If connectionless service is offered, packets
are injected into the network individually and
routed independently of each other.
No advance setup is needed.
In this context, the packets are frequently
called **datagrams** (i In connectionless service is offered, packets
are injected into the network individually and
routed independently of each other.
No advance setup is needed.
In this context, the packets are frequently
called **datagrams** (i network.

Implementation of Connectionless Service

Routing within a diagram subnet

Implementation of Connectionless Service Implementation of Connectionless

Service

• Let us now see how a datagram network works.

• Suppose that the process P1 in above figure has a long

message for P2. Implementation of Connectionless

Service

• Let us now see how a datagram network works.

• Suppose that the process P1 in above figure has a long

message for P2.

• It hands the message to the transport layer, with

ins Implementation of Connect
Service
Let us now see how a datagram network wor
Suppose that the process P1 in above figu
message for P2.
It hands the message to the transpor
instructions to deliver it to process P2 on hos **Implementation of Connectionless**
 Service

• Let us now see how a datagram network works.

• Suppose that the process P1 in above figure has a long

message for P2.

• It hands the message to the transport layer, with
 Implementation of Connectionless
Service
Let us now see how a datagram network works.
Suppose that the process P1 in above figure has a long
message for P2.
It hands the message to the transport layer, with
instructions to

-
-
-
- The transport layer code runs on H1 prepends a transport
header to the front of the message and hands the result to **Service**
 Service

Let us now see how a datagram network works.

Suppose that the process P1 in above figure has a long

message for P2.

It hands the message to the transport layer, with

instructions to deliver it to **Service**
Let us now see how a datagram network worl
Suppose that the process P1 in above figu
message for P2.
It hands the message to the transpor
instructions to deliver it to process P2 on hos
The transport layer code r
- Let us now see how a datagram network works.
• Suppose that the process P1 in above figure has a long
message for P2.
• It hands the message to the transport layer, with
instructions to deliver it to process P2 on host H Let us now see how a datagram network works.

Suppose that the process P1 in above figure has a long

message for P2.

It hands the message to the transport layer, with

instructions to deliver it to process P2 on host H2. Suppose that the process P1 in above figure has a long
message for P2.
It hands the message to the transport layer, with
instructions to deliver it to process P2 on host H2.
The transport layer code runs on H1 prepends a t message for P2.
It hands the message to the transport layer, with
instructions to deliver it to process P2 on host H2.
The transport layer code runs on H1 prepends a transport
header to the front of the message and hands t • It hands the message to the transport layer, wit instructions to deliver it to process P2 on host H2.
• The transport layer code runs on H1 prepends a transpo
header to the front of the message and hands the result t
the
-

Implementation of Connectionless Service Implementation of Connectionless

Service

• Every router has an internal table telling it where to

• Each table entry is a pair consisting of a destination and Implementation of Connectionless
Service
Every router has an internal table telling it where to
send packets for each of the possible destinations.
Each table entry is a pair consisting of a destination and
the outgoing li

-
- Implementation of Connectionless

Service

 Every router has an internal table telling it where to

send packets for each of the possible destinations.

 Each table entry is a pair consisting of a destination and

the ou Implementation of Connectionless
Service
Every router has an internal table telling it where to
send packets for each of the possible destinations.
Each table entry is a pair consisting of a destination and
the outgoing li directly connected lines can be used.
- **Service**

 Every router has an internal table telling it where to

send packets for each of the possible destinations.

 Each table entry is a pair consisting of a destination and

the outgoing line to use for that de **Service**
 Every router has an internal table telling it where to

send packets for each of the possible destinations.

Each table entry is a pair consisting of a destination and

the outgoing line to use for that desti **Every router has an internal table** telling it where to send packets for each of the possible destinations.
Each table entry is a pair consisting of a destination and the outgoing line to use for that destination. Only di **Every router has an internal table** tening it where to send packets for each of the possible destinations.
Each table entry is a pair consisting of a destination and the outgoing line to use for that destination. Only dir • Each table entry is a pair consisting of a destinations.
• Each table entry is a pair consisting of a destination and the outgoing line to use for that destination. Only directly connected lines can be used.
• For exampl Each table entry is a pair consisting
the outgoing line to use for tha
directly connected lines can be used
For example, in above figure, A ha
lines—to B and to C—so every inc
be sent to one of these routers, e
destination
-

Implementation of Connectionless Service Implementation of Connecti
Service
At A, packets 1, 2, and 3 are stored bri
arrived on the incoming link and
checksums verified.
Then each packet is forwarded accor
table, onto the outgoing link to C wi

- Implementation of Connectionless
Service
• At A, packets 1, 2, and 3 are stored briefly, having
arrived on the incoming link and had their
checksums verified. Implementation of Connectionless
Service
At A, packets 1, 2, and 3 are stored briefly, having
arrived on the incoming link and had their
checksums verified.
Then each packet is forwarded according to A's
- Implementation of Connectionless

Service

 At A, packets 1, 2, and 3 are stored briefly, having

arrived on the incoming link and had their

checksums verified.

 Then each packet is forwarded according to A's

table, o table, onto the outgoing link to C within a new frame. Service

• At A, packets 1, 2, and 3 are stored briefly, having

arrived on the incoming link and had their

checksums verified.

• Then each packet is forwarded according to A's

table, onto the outgoing link to C within • At A, packets 1, 2, and 3 are stored briefly, having
arrived on the incoming link and had their
checksums verified.
• Then each packet is forwarded according to A's
table, onto the outgoing link to C within a new
frame. The LAN to H₂, and 3 are stored SH
arrived on the incoming link and
checksums verified.
Then each packet is forwarded accord
table, onto the outgoing link to C w
frame.
Packet 1 is then forwarded to E and th
When it gets • Then each packet is forwarded according to A's

• Then each packet is forwarded according to A's

table, onto the outgoing link to C within a new

• Packet 1 is then forwarded to E and then to F.

• When it gets to F, it
-
-
-

Implementation of Connectionless Service Implementation of Connectionless

Service

• However, something different happens to packet 4.

• When it gets to A it is sent to router B, even though it is

also destined for F. Implementation of Connectionless

Service

• However, something different happens to packet 4.

• When it gets to A it is sent to router B, even though it is

• For some reason, A decided to send packet 4 via a Implementation of Connection
Service
However, something different happens to packe
When it gets to A it is sent to router B, even the
also destined for F.
For some reason, A decided to send packet
different route than that Implementation of Connectionless

Service

• However, something different happens to packet 4.

• When it gets to A it is sent to router B, even though it is

also destined for F.

• For some reason, A decided to send pack

-
-
- different route than that of the first three packets.
- Service

 However, something different happens to packet 4.

 When it gets to A it is sent to router B, even though it is

also destined for F.

 For some reason, A decided to send packet 4 via a

different route than t SETVICE

However, something different happens to packet 4.

When it gets to A it is sent to router B, even though it is

also destined for F.

For some reason, A decided to send packet 4 via a

different route than that of However, something different happens to packet 4.
When it gets to A it is sent to router B, even though it
also destined for F.
For some reason, A decided to send packet 4 via
different route than that of the first three p • When it gets to A it is sent to router B, even though it is also destined for F.
• For some reason, A decided to send packet 4 via a different route than that of the first three packets.
• Perhaps it has learned of a tra routing decisions in the routing of performance also destined for F.
For some reason, A decided to send packet 4 via a
different route than that of the first three packets.
Perhaps it has learned of a traffic jam somewhere
-

- Implementation of Connection-
Oriented Service
• If connection-oriented service is used, a path
from the source router all the way to the
destination router must be established before Implementation of Connection-
Oriented Service
If connection-oriented service is used, a path
from the source router all the way to the
destination router must be established before
any data nackets can be sent Implementation of Connection-
Oriented Service
If connection-oriented service is used, a path
from the source router all the way to the
destination router must be established before
any data packets can be sent. any data packets can be sent. • If connection-oriented service is used, a path
from the source router all the way to the
destination router must be established before
any data packets can be sent.
• This connection is called a **VC (virtual circuit),**
i If connection-oriented service is used, a path
from the source router all the way to the
destination router must be established before
any data packets can be sent.
This connection is called a **VC (virtual circuit),**
in an
- It connection-oriented service is used, a path
from the source router all the way to the
destination router must be established before
any data packets can be sent.
This connection is called a **VC (virtual circuit),**
in an from the source router all the way to the
destination router must be established before
any data packets can be sent.
This connection is called a **VC (virtual circuit),**
in analogy with the physical circuits set up by
the

- Implementation of Connection-
Oriented Service
• In connection oriented service, when a
connection is established, a route from the
source machine to the destination machine is Implementation of Connection-
Oriented Service
In connection oriented service, when a
connection is established, a route from the
source machine to the destination machine is
chosen as part of the connection setup and Implementation of Connection-
Oriented Service
In connection oriented service, when a
connection is established, a route from the
source machine to the destination machine is
chosen as part of the connection setup and
stor Implementation of Connection-

Oriented Service

In connection oriented service, when a

connection is established, a route from the

source machine to the destination machine is

chosen as part of the connection setup and stored in tables inside the routers. Oriented Service

• In connection oriented service, when a

connection is established, a route from the

source machine to the destination machine is

chosen as part of the connection setup and

stored in tables inside the In connection oriented service, when a
connection is established, a route from the
source machine to the destination machine is
chosen as part of the connection setup and
stored in tables inside the routers.
That route is In connection oriented service, wher
connection is established, a route from
source machine to the destination machir
chosen as part of the connection setup
stored in tables inside the routers.
That route is used for all t • Connection is established, a route from the

source machine to the destination machine is

chosen as part of the connection setup and

stored in tables inside the routers.

• That route is used for all traffic flowing ov
- source machine to the destination m
chosen as part of the connection se
stored in tables inside the routers.
That route is used for all traffic flowing
connection, exactly the same way
telephone system works.
When the conn
-

- Implementation of Connection-
Oriented Service
• With connection-oriented service, each packet
carries an identifier telling which virtual circuit it
belongs to. Implementation of Connection-
Oriented Service
With connection-oriented service, each packet
carries an identifier telling which virtual circuit it
belongs to.
In virtual Circuit subnets, each VC is numbered Implementation of Conn
Oriented Service
With connection-oriented service
carries an identifier telling which v
belongs to.
In virtual Circuit subnets, each VC
and every router maintains a table. Implementation of Connection-

Oriented Service

• With connection-oriented service, each packet

carries an identifier telling which virtual circuit it

belongs to.

• In virtual Circuit subnets, each VC is numbered

and • With connection-oriented Service
• With connection-oriented service, each packet
carries an identifier telling which virtual circuit it
belongs to.
• In virtual Circuit subnets, each VC is numbered
and every router maint **Solution Confidence Contains Confidence Confidence**
With connection-oriented service, each packet
carries an identifier telling which virtual circuit it
belongs to.
In virtual Circuit subnets, each VC is numbered
and ever • With connection-oriented service, each packet
carries an identifier telling which virtual circuit it
belongs to.
• In virtual Circuit subnets, each VC is numbered
and every router maintains a table.
• Since all the packe
- and every router maintains a table.
-
- number.
- In virtual Circuit subnets, each VC is numbered

 In virtual Circuit subnets, each VC is numbered

 Since all the packets of the given virtual circuit

 follow the same route through the subnet.

 Each packet's heade In virtual Circuit subnets, each VC is numbered
and every router maintains a table.
Since all the packets of the given virtual circuit
follow the same route through the subnet.
Each packet's header contains virtual circuit

Routing within a virtual-circuit subnet

Implementation of Connection-Oriented Service Implementation of Connection-
Oriented Service
• As an example, consider the situation shown in
above figure.
• Here, host H1 has established connection 1 with Implementation of Con
Oriented Service
As an example, consider the site
above figure.
Here, host H1 has established co
host H2. Implementation of Connection-
Oriented Service
• As an example, consider the situation shown in
above figure.
• Here, host H1 has established connection 1 with
host H2.
• This connection is remembered as the first entry Implementation of Co
Oriented Servi
As an example, consider the sl
above figure.
Here, host H1 has established c
host H2.
This connection is remembered
in each of the routing tables. T

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-
- This connection is remembered as the first entry **COMBET OF SERVICE**

As an example, consider the situation shown in

above figure.

Here, host H1 has established connection 1 with

host H2.

This connection is remembered as the first entry

in each of the routing tables **Solution Service**
As an example, consider the situation shown in
above figure.
Here, host H1 has established connection 1 with
host H2.
This connection is remembered as the first entry
in each of the routing tables. The f As an example, consider the situation shown in
above figure.
Here, host H1 has established connection 1 with
host H2.
This connection is remembered as the first entry
in each of the routing tables. The first line of A's
ta As an example, consider the situation shown in
above figure.
Here, host H1 has established connection 1 with
host H2.
This connection is remembered as the first entry
in each of the routing tables. The first line of A's
ta • Here, host H1 has established connection 1 with
host H2.
• This connection is remembered as the first entry
in each of the routing tables. The first line of A's
table says that if a packet bearing connection
identifier Here, nost H1 has established connection 1 with
host H2.
This connection is remembered as the first entry
in each of the routing tables. The first line of A's
table says that if a packet bearing connection
identifier 1 com
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Implementation of Connection-Oriented Service Implementation of Connection-
Oriented Service
• Now let us consider what happens if H3 also wants to establish a
• It chooses connection identifier 1 (because it is initiating the
connection and this is its only connectio Implementation of Conners

Oriented Service

Now let us consider what happens if H3 also wan

connection to H2.

It chooses connection identifier 1 (because it

connection and this is its only connection) and tells

establ Implementation of Connection-

Oriented Service

• Now let us consider what happens if H3 also wants to establish a

connection to H2.

• It chooses connection identifier 1 (because it is initiating the

connection and thi Implementation of Connection-

Oriented Service

Now let us consider what happens if H3 also wants to establish a

connection to H2.

It chooses connection identifier 1 (because it is initiating the

connection and this is Implementation of Connection

Oriented Service

Now let us consider what happens if H3 also wants to

connection to H2.

It chooses connection identifier 1 (because it is iniconnection and this is its only connection) and Implementation of Connection-

Oriented Service

• Now let us consider what happens if H3 also wants to establish a

• It chooses connection identifier 1 (because it is initiating the

connection and this is its only conne

-
- **COMBET CONTRESS CONTRESS CONTRESS FROM SET CONTRESS CONDUCTS**
 Now let us consider what happens if H3 also wants to establish a
 Connection to H2.

It chooses connection identifier 1 (because it is initiating the

con **Criented Service**
 Now let us consider what happens if H3 also wants to establish
 connection to H2.

It chooses connection identifier 1 (because it is initiating th

connection and this is its only connection) and te • **Now let us consider what happens if H3 also wants to establish a**

• It chooses connection identifier 1 (because it is initiating the

connection and this is its only connection) and tells the network to

establish the **Now let us consider what happens if H3 also wants to establish a**
connection to H2.
It chooses connection identifier 1 (because it is initiating the
connection and this is its only connection) and tells the network to
e **• Connection to H2.**
• It chooses connection identifier 1 (because it is initiating the connection and this is its only connection) and tells the network to establish the virtual circuit.
• This leads to the second row in It chooses connection identifier 1 (because it is initiating the connection and this is its only connection) and tells the network to establish the virtual circuit.
This leads to the second row in the tables.
Note that we
-
- Note that we have a conflict here because although A can easily
distinguish connection 1 packets from H1 from connection 1 connection and this is its only connection) and tells the network to

establish the virtual circuit.

• This leads to the second row in the tables.

• Note that we have a conflict here because although A can easily

distin
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-
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Comparison of Virtual-Circuit and

Datagram Subnets

UNIT 2 PART 2

UNIT 2 PART 2
Routing Algorithms: The Optimality
Principle, Shortest Path Routing,
Flooding, Distance Vector Routing, Link UNIT 2 PART 2

Routing Algorithms: The Optimality

Principle, Shortest Path Routing,

Flooding, Distance Vector Routing, Link

State Routing, Hierarchical Routing UNIT 2 PART 2
Routing Algorithms: The Optimality
Principle, Shortest Path Routing,
Flooding, Distance Vector Routing, Link
State Routing, Hierarchical Routing **UNIT 2 PART 2

Routing Algorithms:** The Optimality

Principle, Shortest Path Routing,

Flooding, Distance Vector Routing, Link

State Routing, Hierarchical Routing

Routing Algorithms

- **Example 31 Follow Routing Algorithms**
• The **routing algorithm** is that part of the network layer
software called **routing protocol** that decides the path
to be used for routing a packet from source router to **Soluting Algorithms**
The **routing algorithm** is that part of the network layer
software called **routing protocol** that decides the path
to be used for routing a packet from source router to
destination router. **Routing Algorithms**
The **routing algorithm** is that part of the network layer
software called **routing protocol** that decides the path
to be used for routing a packet from source router to
destination router.
Given a set **Routing Algorithms**
The **routing algorithm** is that part of the
software called **routing protocol** that dec
to be used for routing a packet from sou
destination router.
Given a set of routers connected with lir
algorithm Routing Algorithms
The **routing algorithm** is that part of the network layer
software called **routing protocol** that decides the path
to be used for routing a packet from source router to
destination router.
Given a set The **routing algorithm** is that part of the network layer
software called **routing protocol** that decides the path
to be used for routing a packet from source router to
destination router.
Given a set of routers connected • The **routing algorithm** is that part of the network layer software called **routing protocol** that decides the path to be used for routing a packet from source router to destination router.
• Given a set of routers connec
- Given a set of routers connected with links, a routing corrective called **countify process** that declares the paint
to be used for routing a packet from source router to
destination router.
Given a set of routers connected with links, a **routing**
algorithm determines best pa Consumed the location reading a packet noth seat
destination router.
Given a set of routers connected with linl
algorithm determines best path for a
source router to destination router.
A path with least cost is referred t
-
-

Classification

- **Classification
• Routing algorithms can be classified into two
categories. They are:
1. Nan Adoptive Bouting Algorithms Classification
Routing algorithms can be classified into
Categories. They are:
Non-Adaptive Routing Algorithms Classification**

• Routing algorithms can be classified into two

categories. They are:

1. Non-Adaptive Routing Algorithms

2. Adaptive Routing Algorithms
-
- 2. Adaptive Routing Algorithms

Non-Adaptive Routing Algorithms

-
- **Non-Adaptive Routing Algorithms**
• These algorithms are static routing algorithms.
• In these algorithms the route to be used for routing
packets from source router to destination router is
decided in advance, offline, an **Jon-Adaptive Routing Algorithms**
These algorithms are static routing algorithms.
In these algorithms the route to be used for routing
packets from source router to destination router is
decided in advance, offline, and do **Jon-Adaptive Routing Algorithms**
These algorithms are static routing algorithms.
In these algorithms the route to be used for routing
packets from source router to destination router is
decided in advance, offline, and do **Ion-Adaptive Routing Algorithms**
These algorithms are static routing algorithms.
In these algorithms the route to be used for routing
packets from source router to destination router is
decided in advance, offline, and do **ION-AGAPTIVE ROUTING AIGOTITNMS**
These algorithms are static routing algorithms.
In these algorithms the route to be used for routing
packets from source router to destination router is
decided in advance, offline, and do These algorithms are **static routing algorithms**.
In these algorithms the route to be used for rou
packets from source router to destination route
decided in **advance**, offline, and downloaded to
routers when the network i • These algorithms are **static routing algorithms**.
• In these algorithms the route to be used for routing
packets from source router to destination router is
decided in **advance**, offline, and downloaded to the
routers wh makets from source router to destination router is
packets from source router to destination router is
decided in **advance**, offline, and downloaded to the
routers when the network is booted.
• Nonadaptive algorithms do **n**
- Nonadaptive algorithms do not base their routing decided in **advance**, offline, a
routers when the network is bo
• Nonadaptive algorithms do
decisions on any measuremer
current topology and traffic.
• There are two types of static
are
1. Shortest path Routing Algorith
2.
- are
-
-

Adaptive Routing Algorithms

- Adaptive Routing Algorithms
• Adaptive routing algorithms are the dynamic algorithm, routers
• Adaptive Routing tables dynamically.
• Adaptive Routing algorithms change their routing decisions to
• reflect changes in the t
- **Adaptive Routing Algorithms**
Adaptive routing algorithms are the dynamic algorithm, ro
build their routing tables dynamically.
Adaptive Routing algorithms change their routing decision
reflect changes in the topology, and **Adaptive Routing Algorithms**
• Adaptive routing algorithms are the dynamic algorithm, routers
build their routing tables dynamically.
• Adaptive Routing algorithms change their routing decisions to
reflect changes in the **Adaptive Routing Algorithms**
Adaptive routing algorithms are the dynamic algorithm, routers
build their routing tables dynamically.
Adaptive Routing algorithms change their routing decisions to
traffic as well.
These dyna **Adaptive Routing Alg**
Adaptive routing algorithms are the dynam
build their routing tables dynamically.
Adaptive Routing algorithms change their
reflect changes in the topology, and somet
traffic as well.
These dynamic ro
- **Adaptive Routing Algorithms**
• Adaptive routing algorithms are the dynamic algorithm, routers
build their routing tables dynamically.
• Adaptive Routing algorithms change their routing decisions to
reflect changes in the information (e.g., locally, from adjacent routers, or from all
routers), when they change the routes (e.g., when the topology Adaptive Routing Algorithms

Adaptive routing algorithms are the dynamic algorithm, routers

build their routing tables dynamically.

Adaptive Routing algorithms change their routing decisions to

reflect changes in the to **Adaptive NOUTHIS AISOTILIHIS**
Adaptive routing algorithms are the dynamic algorithm, routers
build their routing tables dynamically.
Adaptive Routing algorithms change their routing decisions to
reflect changes in the top Adaptive routing algorithms are the dynamic algorithm, routers
build their routing tables dynamically.
Adaptive Routing algorithms change their routing decisions to
reflect changes in the topology, and sometimes changes in Adaptive routing algorithms are the dynamic algor
build their routing tables dynamically.
Adaptive Routing algorithms change their routing
reflect changes in the topology, and sometimes ch
traffic as well.
These dynamic ro • Adaptive routing algorithms are the dynamic algorithm, routers

build their routing tables dynamically.

• Adaptive Routing algorithms change their routing decisions to

reflect changes in the topology, and sometimes cha **Example 1.1** Details algorithms change their routing decision reflect changes in the topology, and sometimes changes it traffic as well.

• These dynamic routing algorithms differ in where **they get information** (e.g., l Figure Field changes in the topology, and sometimes changed reflect changes in the topology, and sometimes changed traffic as well.

• These dynamic routing algorithms differ in where **the information** (e.g., locally, fro
-
-
-

The Optimality Principle

- The Optimality Principle
• The optimality principle says that optimal routes can
be made without the knowledge of the network
topology or traffic load. It can be stated as follows. The Optimality Principle
The optimality principle says that optimal routes can
be made without the knowledge of the network
topology or traffic load. It can be stated as follows.
It states that if router J is on the optima The Optimality Principle
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- **The Optimality Principle**
• The optimality principle says that optimal routes can
be made without the knowledge of the network
topology or traffic load. It can be stated as follows.
• It states that if router J is on the router I to router K, then the optimal path from J to K The Optimality Principle
The optimality principle says that optimal routes can
be made without the knowledge of the network
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It states that if router J is on the optima The optimality principle says that optimal routes can
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topology or traffic load. It can be stated as follows.
It states that if router J is on the optimal path from
router I to r2. • The optimality principle says that optimal routes can
be made without the knowledge of the network
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• It states that if router J is on the optimal path from
router I be made without the knowledge of the hetwork
topology or traffic load. It can be stated as follows.
It states that if router J is on the optimal path from
router I to router K, then the optimal path from J to K
also falls Explored in that the state of a follows.
It states that if router J is on the optimal path from
router I to router K, then the optimal path from J to K
also falls along the same route. To see this, call the part
of the rou
-

The Optimality Principle

- The Optimality Principle
• As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination The Optimality Principle
As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination
form a tree rooted at the destination. The Optimality Principle
As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination
form a tree rooted at the destination.
Such a tree is called a The Optimality Principle
As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination
form a tree is called a **sink tree** and is illustrated
in figu The Optimality Principle
As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination
form a tree rooted at the destination.
Such a tree is called a The Opentrumaty Timer
As a direct consequence of the
principle, we can see that the set
routes from all sources to a given
form a tree rooted at the destination.
Such a tree is called a **sink tree** and i
in figure(b), wher • As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination
form a tree is called a **sink tree** and is illustrated
in figure(b), where the distan As a direct consequence of the optimality
principle, we can see that the set of optimal
routes from all sources to a given destination
form a tree rooted at the destination.
Such a tree is called a **sink tree** and is illus
- Such a tree is called a sink tree and is illustrated • Finitial routes from all sources to a given destination
form a tree rooted at the destination.
• Such a tree is called a **sink tree** and is illustrated
in figure(b), where the distance metric is the
number of hops.
• Not Form a tree rooted at the destination.

Such a tree is called a **sink tree** and is illustrated

in figure(b), where the distance metric is the

number of hops.

Note that a sink tree is not necessarily unique;

other trees
-
-

(a) A subnet. (b) A sink tree for router B.

The Optimality Principle

- The Optimality Principle
• Since a sink tree is indeed a tree, it does not
contain any loops, so each packet will be
delivered within a finite and bounded number The Optimality Principle
Since a sink tree is indeed a tree, it does not
contain any loops, so each packet will be
delivered within a finite and bounded number
of hons The Optimality Principle
Since a sink tree is indeed a tree, it does not
contain any loops, so each packet will be
delivered within a finite and bounded number
of hops. of hops. • Since a sink tree is indeed a tree, it does not

contain any loops, so each packet will be

delivered within a finite and bounded number

of hops.

• Links and routers can go down and come back

up during operation, so d Since a sink tree is indeed a tree, it does not
contain any loops, so each packet will be
delivered within a finite and bounded number
of hops.
Links and routers can go down and come back
up during operation, so different
- Since a sink tree is indeed a tree, it does not
contain any loops, so each packet will be
delivered within a finite and bounded number
of hops.
Links and routers can go down and come back
up during operation, so different topology.

- **Shortest Path Routing
• The shortest path routing algorithm is a static
• The algorithm huilds a graph of the subnet Shortest Path Rout**
The shortest path routing algorit
routing algorithm.
The algorithm builds a graph compared and proteins
- **Shortest Path Routing
• The shortest path routing algorithm is a static
routing algorithm.
• The algorithm builds a graph of the subnet
where each node represents a router and
each arc represents a link or communication** where each node represents a router and **Shortest Path Routing**
The shortest path routing algorithm is a static
routing algorithm.
The algorithm builds a graph of the subnet
where each node represents a router and
each arc represents a link or communication
line The shortest path routing algorithm is a st
routing algorithm.
The algorithm builds a graph of the sub
where each node represents a router a
each arc represents a link or communicat
line between two routers.
The algorithm • The shortest path routing algorithm is a static
routing algorithm.
• The algorithm builds a graph of the subnet
where each node represents a router and
each arc represents a link or communication
line between two routers routing algorithm.
The algorithm builds a graph of the subnet
where each node represents a router and
each arc represents a link or communication
line between two routers.
The algorithm chooses a router between a
pair of n The algorithm builds a graph of
where each node represents a
each arc represents a link or con
line between two routers.
The algorithm chooses a router
pair of nodes by finding the sh
between them.
-

- **Shortest Path Routing**
• The metric used for measuring the length of a path
may be either the number of hops (or) physical
distance (or) cost. **Shortest Path Routing**
The metric used for measuring the length of a path
may be either the number of hops (or) physical
distance (or) cost.
Several algorithms are used for computing the shortest **Shortest Path Routing**
The metric used for measuring the lengt
may be either the number of hops (
distance (or) cost.
Several algorithms are used for computing
path between any two nodes. **Shortest Path Routing
• The metric used for measuring the length of a path
may be either the number of hops (or) physical
distance (or) cost.
• Several algorithms are used for computing the shortest
• The one is Dijkstras Shortest Path Routing**
The metric used for measuring the length of a pa
may be either the number of hops (or) physic
distance (or) cost.
Several algorithms are used for computing the shorte
path between any two nodes.
The The metric used for measuring the length of a path

may be either the number of hops (or) physical

listance (or) cost.

lieveral algorithms are used for computing the shortest

bath between any two nodes.

The one is Dijk e metric used for measuring the length of a path
y be either the number of hops (or) physical
tance (or) cost.
yeral algorithms are used for computing the shortest
th between any two nodes.
e one is Dijkstras Algorithm for
-
- The one is Dijkstras Algorithm for finding the shortest path.
	-
- The metric used for measuring the length of a path
have be either the number of hops (or) physical
listance (or) cost.
Everal algorithms are used for computing the shortest
path between any two nodes.
The one is Dijkstras tance (or) cost.

veral algorithms are used for computing the shortest

th between any two nodes.

e one is Dijkstras Algorithm for finding the shortest

th.

The algorithm works by labeling each node with its

distance fr reral algorithms are used for computing the shortest
th between any two nodes.
e one is Dijkstras Algorithm for finding the shortest
th.
The algorithm works by labeling each node with its
distance from source node current shorted any two nodes.
The one is Dijkstras Algorithm for finding the shortest
th.
The algorithm works by labeling each node with its
distance from source node current node along the best
known path.
Initially, all the nod

- **Shortest Path Routing
1.** Initially the algorithm marks the node **A** as
permanent. Now **A** becomes the working node
as shown in figure(a) indicated by filled circle. **Shortest Path Routing

Shortest Path Routing

initially the algorithm marks the node A as

permanent. Now A becomes the working node

as shown in figure(a) indicated by filled circle.

Next the nodes adiacent to the worki Shortest Path Routing

initially the algorithm marks the node A as

permanent. Now A becomes the working node

as shown in figure(a) indicated by filled circle.

Next the nodes adjacent to the working node i.e

A are B an Shortest Path Routing**

2. Initially the algorithm marks the node **A** as

permanent. Now **A** becomes the working node

as shown in figure(a) indicated by filled circle.

2. Next the nodes adjacent to the working node i.e

-
- **EXECUTE ART SERVIT SERVIT AND ALLET ASSET ASSET ASSET ASSET ASSET ASSET AND A becomes the working node as shown in figure(a) indicated by filled circle.

2. Next the nodes adjacent to the working node i.e

A** are **B** an Initially the algorithm marks the node **A** as
permanent. Now **A** becomes the working node
as shown in figure(a) indicated by filled circle.
Next the nodes adjacent to the working node i.e
A are **B** and **G**.
The adjacent Initially the algorithm marks the node **A** as
permanent. Now **A** becomes the working node
as shown in figure(a) indicated by filled circle.
Next the nodes adjacent to the working node i.e
A are **B** and **G**.
The adjacent permanent. Now **A** becomes the working node
as shown in figure(a) indicated by filled circle.
Next the nodes adjacent to the working node i.e
A are **B** and **G**.
The adjacent nodes are labeled with a pair of
values. In gi as shown in figure(a) indicated by filled circle.
Next the nodes adjacent to the working node i.e
A are **B** and **G**.
The adjacent nodes are labeled with a pair o
values. In given example **B** and **G** are relabeled
as (2,

- **Shortest Path Routing**
4. Finally the algorithm scans the graph for tentative
nodes to make a node with smallest label as
permanent. In above example **B** has the smallest path **Shortest Path Routing**
Finally the algorithm scans the graph for tentative
nodes to make a node with smallest label as
permanent. In above example **B** has the smallest path
than **G** so it is made permanent. **Shortest Path Routing**
Finally the algorithm scans the graph for tentative
nodes to make a node with smallest label as
permanent. In above example **B** has the smallest path
than **G** so it is made permanent.
The new perman **Shortest Path Routing**
Finally the algorithm scans the graph for tenta
nodes to make a node with smallest label
permanent. In above example **B** has the smallest p
than **G** so it is made permanent.
The new permanent node b **Shortest Path Routing**
Finally the algorithm scans the graph for tentative
nodes to make a node with smallest label as
permanent. In above example **B** has the smallest path
than **G** so it is made permanent.
The new perman **4.** Finally the algorithm scans the graph for tentative nodes to make a node with smallest label as permanent. In above example **B** has the smallest path than **G** so it is made permanent.
5. The new permanent node become Finally the algorithm scans the graph in

nodes to make a node with smalle

permanent. In above example **B** has the s

than **G** so it is made permanent.

The new permanent node becomes the in

node. This **B** becomes the n
- 5. The new permanent node becomes the new working
- **Example 19 The Following Shortest are used in the shortest and following**
Following Solution Shortest are used in computing the shortest parameters.
 Following 19 The shortest are used in computing the shortest
 Fol parameter in above chample D has the smallest path than \bf{G} so it is made permanent.
The new permanent node becomes the new working node. This \bf{B} becomes the new working node.
The algorithm repeats above steps wi
-

Figure: The first 5 steps used in computing the shortest path from A to D. The arrows indicate the working node.
Shortest Path Routing

Shortest Path Routing

**Shortest Path Routing
• The drawback** with this approach (shortest
path routing algorithm) is that, it requires
prior information about the entire network **Shortest Path Routing
The drawback** with this approach (shortest
path routing algorithm) is that, it requires
prior information about the entire network
topology which becomes very difficult **Shortest Path Routing**
The **drawback** with this approach (shortest
path routing algorithm) is that, it requires
prior information about the entire network
topology which becomes very difficult. topology which becomes very difficult.

- Flooding
• Another static algorithm (non adaptive) is
• flooding, in which the routers sends an incoming
• packet to every outgoing line except the line on Flooding
Another static algorithm (non adaptive) is
flooding, in which the routers sends an incoming
packet to every outgoing line except the line on
which it has arrived. This technique is called Flooding
Another static algorithm (non adaptive) is
flooding, in which the routers sends an incoming
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flooding. Flooding
Another static algorithm (non adaptive) is
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which it has arrived. This technique is called
flooding.
This approach flooding. • Another static algorithm (non adaptive) is
flooding, in which the routers sends an incoming
packet to every outgoing line except the line on
which it has arrived. This technique is called
flooding.
• This approach does Another static algorithm (non adaptive) is
flooding, in which the routers sends an incoming
packet to every outgoing line except the line on
which it has arrived. This technique is called
flooding.
This approach does not
- Another static algorithm (non adaptive) is
flooding, in which the routers sends an incoming
packet to every outgoing line except the line on
which it has arrived. This technique is called
flooding.
This approach does not flooding, in which the routers sends an incoming
packet to every outgoing line except the line on
which it has arrived. This technique is called
flooding.
This approach does not require any prior
information regarding ne packet to every outgoing line except the line on
which it has arrived. This technique is called
flooding.
This approach does not require any prior
information regarding network topology. The
main problem with this approa

- Flooding
• To prevent duplicate packets, the source
router put a sequence number in each packet
it receives from its bosts Flooding
To prevent duplicate packets, the source
router put a sequence number in each packet
it receives from its hosts. Flooding
To prevent duplicate packets, the sour
router put a sequence number in each pack
it receives from its hosts.
Each router needs a list that source rout
- Each router needs a list that source router FIOOOIINg
To prevent duplicate packets, the source
router put a sequence number in each packet
it receives from its hosts.
Each router needs a list that source router
telling which sequence numbers present at
the source ha To prevent duplicate packets, the source
router put a sequence number in each packet
it receives from its hosts.
Each router needs a list that source router
telling which sequence numbers present at
the source have already • To prevent duplicate packets, the source
router put a sequence number in each packet
it receives from its hosts.
• Each router needs a list that source router
telling which sequence numbers present at
the source have alr
- flooded

**Flooding
• Example:-** The following figure shows the
flooding process for the subnet: Flooding
Example:- The following figure shows the
flooding process for the subnet:

Flooding
• In selective flooding algorithm, routers send
every incoming packet only on those outgoing
lines that lead to the right path rather than Flooding
In selective flooding algorithm, routers send
every incoming packet only on those outgoing
lines that lead to the right path rather than
sending on every outgoing lines Flooding
In selective flooding algorithm, routers send
every incoming packet only on those outgoing
lines that lead to the right path rather than
sending on every outgoing lines. sending on every outgoing lines.

- Applications
	-
- Flooding

 Flooding is used in military applications

 It is used in distributed database applications

 It is used in wireless networks
	-

-
- **Drawbacks of flooding**
• **Drawbacks of flooding**
– It generates too many duplicate packets
– To identify duplicate packets, each router need to
store an identifier for every packet it has received
– It consumes too much store an identifier for every packet it has received
	-
	- FIOOdIng

	Drawbacks of flooding

	 It generates too many duplicate packets

	 To identify duplicate packets, each router need to

	store an identifier for every packet it has received

	 It increases the maximum traffic loa **awbacks of flooding**
It generates too many duplicate p
To identify duplicate packets, ea
store an identifier for every pack
It consumes too much bandwidtl
It increases the maximum traffi
the network

-
- **Distance Vector Routing Algorithm**
• This algorithm is a dynamic routing algorithm.
• This algorithm sometimes called as Bellman-
Ford routing algorithm and Ford-Fulkerson
algorithm)
Istance Vector Routing Algorithm
This algorithm is a dynamic routing algorithm.
This algorithm sometimes called as Bellman-
Ford-routing algorithm and Ford-Fulkerson
algorithm. algorithm.

- Distance Vector Routing Algorithm
• In this algorithm, each router maintains a
table containing the information about the
hest known distance to each destination Vistance Vector Routing Algorithm
In this algorithm, each router maintains a
table containing the information about the
best known distance to each destination. Distance Vector Routing Algorithm
In this algorithm, each router maintains a
table containing the information about the
best known distance to each destination.
Each router receives some information from
- Each router receives some information from one or more of its directly attached neighbors, In this algorithm, each router maintains a
table containing the information about the
best known distance to each destination.
Each router receives some information from
one or more of its directly attached neighbors,
perf In this algorithm, each router maintains a
table containing the information about the
best known distance to each destination.
Each router receives some information from
one or more of its directly attached neighbors,
perf neighbors.

- Distance Vector Routing Algorithm
• The routing table entry consists of two parts:
The preferred outgoing line to use for that
destination and An estimate of the distance Vistance Vector Routing Algorithm
The routing table entry consists of two parts:
The preferred outgoing line to use for that
destination and An estimate of the distance
to that destination. Distance Vector Routing Algorithm
The routing table entry consists of two parts:
The preferred outgoing line to use for that
destination and An estimate of the distance
to that destination.
The metric used for routing coul Distance Vector Routing Algorithm
• The routing table entry consists of two parts:
The preferred outgoing line to use for that
destination and An estimate of the distance
to that destination.
• The metric used for routing The routing table entry consists of two parts:
The preferred outgoing line to use for that
destination and An estimate of the distance
to that destination.
The metric used for routing could be the
number of hops, the queue The routing table entry consists
 The preferred outgoing line to
 destination and **An estimate of**
 to that destination.

The metric used for routing c

number of hops, the queue leng

delay in milliseconds.

The tab The preferred outgoing line to use for that
destination and An estimate of the distance
to that destination.
• The metric used for routing could be the
number of hops, the queue length (or) time
delay in milliseconds.
• Th
- destination and An estimate of the distance
to that destination.
The metric used for routing could be the
number of hops, the queue length (or) time
delay in milliseconds.
The tables are updated by exchanging
information t
-

- **Distance Vector Routing Algorithm**
• If the delay metric is used then the router
knows the time delay to reach each of its
neighbors Vistance Vector Routing Algorithm
If the delay metric is used then the router
knows the time delay to reach each of its
neighbors. neighbors.
- After every T ms routers exchange their VISTANCE VECTOR ROUTING AIGONTINITI
If the delay metric is used then the router
knows the time delay to reach each of its
neighbors.
After every T ms routers exchange their
vectors update their tables with newly
estimated If the delay metric is used then the router
knows the time delay to reach each of its
neighbors.
After every T ms routers exchange their
vectors update their tables with newly
estimated delay to each destination.

- Distance Vector Routing Algorithm
• Assume that the estimated delay of router **x** to
reach the router **I** is xi. The router knows delay to
reach the router **x** itself is 'm' ms, then the delay **Distance Vector Routing Algorithm**
Assume that the estimated delay of router **x** to
reach the router **I** is xi. The router knows delay to
reach the router **X** itself is 'm' ms, then the delay
to reach to router **I** via **Distance Vector Routing Algorithm**
Assume that the estimated delay of router **X** to
reach the router **I** is xi. The router knows delay to
reach the router **X** itself is 'm' ms, then the delay
to reach to router **I** via **Distance Vector Routing Algorithm**
Assume that the estimated delay of router **X** to
reach the router **I** is xi. The router knows delay to
reach the router **X** itself is 'm' ms, then the delay
to reach to router **I** via
- The router calculates the estimated delay for Assume that the estimated delay of router **X** to
reach the router **I** is xi. The router knows delay to
reach the router **X** itself is 'm' ms, then the delay
to reach to router **I** via **X** is (xi+m) ms.
The router calculat Assume that the estimated delay of router **X** to
reach the router **I** is xi. The router knows delay to
reach the router **X** itself is 'm' ms, then the delay
to reach to router **I** via **X** is (xi+m) ms.
The router calculat Assume that the estimated delay of router **X** to
reach the router **I** is xi. The router knows delay to
reach the router **X** itself is 'm' ms, then the delay
to reach to router **I** via **X** is (xi+m) ms.
The router calculat reach the router **I** is **xi**. The router
reach the router **X** itself is 'm' ms,
to reach to router **I** via **X** is (xi+m) n
The router calculates the estima
each neighbor and chooses the
delay which is the lowest value. T
 reach the router **x** itself is 'm' ms, then the delay
to reach to router **l** via **X** is $(xi+m)$ ms.

• The router calculates the estimated delay for

each neighbor and chooses the best estimated

delay which is the lowest
-

For example, consider the following subnet as shown below:

(a) A subnet. (b) Input from A, I, H, K, and the new routing table for J.

-
- Distance Vector Routing Algorithm
• In above figure, the fig (a) shows a network.
• The first four columns of fig (b) show the delay
vectors received from the neighbors of router Distance Vector Routing Algorithm
• In above figure, the fig (a) shows a network.
• The first four columns of fig (b) show the delay
vectors received from the neighbors of router
J. Vistance Vector Routing Algorithm
In above figure, the fig (a) shows a network.
The first four columns of fig (b) show the delay
vectors received from the neighbors of router
J.
A's delay vector shows that it can reach to J. Distance Vector Routing Algorithm
• In above figure, the fig (a) shows a network.
• The first four columns of fig (b) show the delay
vectors received from the neighbors of router
1.
• A's delay vector shows that it can rea
- In above figure, the fig (a) shows a network.
The first four columns of fig (b) show the delay
vectors received from the neighbors of router
J.
A's delay vector shows that it can reach to
router B in 12-msec, to router C i In above figure, the fig (a) shows a net
The first four columns of fig (b) show
vectors received from the neighbors
J.
A's delay vector shows that it can
router B in 12-msec, to router C in 2!
router D in 9-msec.
Suppose J • The first four columns of fig (b) show the delay
vectors received from the neighbors of router
J.
 \bullet A's delay vector shows that it can reach to
router B in 12-msec, to router C in 25-msec, to
router D in 9-msec.
• Su vectors received from the neighbors of router
J.
A's delay vector shows that it can reach to
router B in 12-msec, to router C in 25-msec, to
router D in 9-msec.
Suppose J's estimated delay to its neighbors,
A, I, H, and K,
-

- Distance Vector Routing Algorithm
• Now, consider how the router J uses the
distance vector routing to compute its new
router G Vistance Vector Routing Algorithm
Now, consider how the router J uses the
distance vector routing to compute its new
router G. Vistance Vector Routing
Now, consider how the route
distance vector routing to con
router G.
Router J knows its delay to its r
- Router J knows its delay to its neighbor A is 8 Mow, consider how the router J uses the
distance vector routing to compute its new
router G.
Router J knows its delay to its neighbor A is 8
ms and A can reach to G is 18 ms. The total
delay is 8+18=26 ms Now, consider how the router J uses
distance vector routing to compute its
router G.
Router J knows its delay to its neighbor A
ms and A can reach to G is 18 ms. The t
delay is 8+18=26 ms
Similarly, it computes the delay • Now, consider now the Touter J uses the
distance vector routing to compute its new
router G.
• Router J knows its delay to its neighbor A is 8
ms and A can reach to G is 18 ms. The total
delay is 8+18=26 ms
• Similarly, distance vector routing to compute its new
router G.
Router J knows its delay to its neighbor A is 8
ms and A can reach to G is 18 ms. The total
delay is 8+18=26 ms
Similarly, it computes the delay to G via I, H, K
as 41(3
-

- Distance Vector Routing Algorithm
• The best estimated delay is 18 ms which is
possible if J forward packets via H. So, J makes
an entry in its routing table the delay to G as Distance Vector Routing Algorithm
The best estimated delay is 18 ms which is
possible if J forward packets via H. So, J makes
an entry in its routing table the delay to G as
18 ms Distance Vector Routing Algorithm
The best estimated delay is 18 ms which is
possible if J forward packets via H. So, J makes
an entry in its routing table the delay to G as
18 ms. 18 ms. UISTANCE VECTOT ROUTTING AIGOTITINT

• The best estimated delay is 18 ms which is

possible if J forward packets via H. So, J makes

an entry in its routing table the delay to G as

18 ms.

• Similarly the same calculation The best estimated delay is 18 ms which is
possible if J forward packets via H. So, J makes
an entry in its routing table the delay to G as
18 ms.
Similarly the same calculation is used to
calculate the delay to each desti
- The best estimated delay is 18 ms which is
possible if J forward packets via H. So, J makes
an entry in its routing table the delay to G as
18 ms.
Similarly the same calculation is used to
calculate the delay to each desti column.

• In Brief

- Distance Vector Routing Algorithm
• In Distance vector routing, routers identify the
best path to reach the destination from each
neighbor. Distance Vector Routing Algorithm
In Distance vector routing, routers identify the
best path to reach the destination from each
neighbor.
It depend upon information from their neighbor.
- It depend upon information from their Distance Vector Routing Algorithm

In Distance vector routing, routers identify the

best path to reach the destination from each

neighbor.

It depend upon information from their

adjacent neighbors to calculate and colle In Distance vector routing, routers identify the
best path to reach the destination from each
neighbor.
It depend upon information from their
adjacent neighbors to calculate and collect
route information. They pass copies In Distance vector routing, routers identify the
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best path to reach the destination from each
neighbor.
It depend upon information from their
adjacent neighbors to calculate and collect
route information. They pass copies o best path to reach the assumation non-each
neighbor.
It depend upon information from their
adjacent neighbors to calculate and collect
route information. They pass copies of routing
table to their neighboring routers and g

- Drawback
- istance Vector Routing Algorithm
Drawback
— Distance vector routing finds the correct shortest
path but it may be slowly. Traince Vector Routing Algorithr
Translam but it may be slowly.
Thath but it may be slowly.

- **The Count-to-Infinity Problem**
• The distance vector routing algorithm has a
serious problem when a link goes down (or)
comes up otherwise it works well when all the **The Count-to-Infinity Problem**
The distance vector routing algorithm has a
serious problem when a link goes down (or)
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nodes exchange their updated distance **The Count-to-Infinity Problem**
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nodes exchange their updated distance
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prob Fire distance vector roating algorithm has a
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comes up otherwise it works well when all the
nodes exchange their updated distance
vectors. This is called **Count-to-infinity**
probl Scribas problem when a m
comes up otherwise it work
nodes exchange their
vectors. This is called
problem.
Example: Consider the
subnet, where the delay me
of hops.
-

The count-to-infinity problem

- Initially, A is down and all other routers know this and made as infinity.
- When A comes up, at first exchange, B learns that its left neighbor has '0' delay to A. So B makes an entry in routing table that A is one hop away to left.

The Count-to-Infinity Problem
• All other routers still think that A is down on
the second exchange, C learns that B has a
nath of length 1 to A so it undates its routing **The Count-to-Infinity Problem**
All other routers still think that A is down on
the second exchange, C learns that B has a
path of length 1 to A, so it updates its routing
table to indicate a path of length 2 similarly **The Count-to-Infinity Problem**
All other routers still think that A is down on
the second exchange, C learns that B has a
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table to indicate a path of length 2. similarly
pr table to indicate a path of length 2. similarly **The Count-to-Infinity Problem**
All other routers still think that A is down on
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table to indicate a path of length 2. similarly
pr All other routers still think the second exchange, C lea
path of length 1 to A, so it u
table to indicate a path of le
process is done for all other
the subnet.

The Count-to-Infinity Problem
• Now let us consider the other situation in
fig(b), in which all the lines and routers are
initially un Routers B C D and E have **The Count-to-Infinity Problem**
Now let us consider the other situation in
fig(b), in which all the lines and routers are
initially up. Routers B, C, D and E have
distances to A of 1 2 3 and 4 If suddenly **The Count-to-Infinity Problem**
Now let us consider the other situation in
fig(b), in which all the lines and routers are
initially up. Routers B, C, D and E have
distances to A of 1, 2, 3 and 4. If suddenly
router A goes distances to A of 1, 2, 3 and 4. If suddenly **The Count-to-Infinity Problem**
Now let us consider the other situation in
fig(b), in which all the lines and routers are
initially up. Routers B, C, D and E have
distances to A of 1, 2, 3 and 4. If suddenly
router A goes

 (b) The count-to-infinity problem

The Count-to-Infinity Problem
• At the first packet exchange, B does not hear
anything from A. Then router C says: Do not
worry: I have a nath to A of length 2. So. B **The Count-to-Infinity Problem**
At the first packet exchange, B does not hear
anything from A. Then router C says: Do not
worry; I have a path to A of length 2. So, B
thinks it can reach A via C with a path length **The Count-to-Infinity Problem**
At the first packet exchange, B does not hear
anything from A. Then router C says: Do not
worry; I have a path to A of length 2. So, B
thinks it can reach A via C, with a path length
of 3. S thinks it can reach A via C, with a path length **The Count-to-Infinity Problem**
At the first packet exchange, B does not hear
anything from A. Then router C says: Do not
worry; I have a path to A of length 2. So, B
thinks it can reach A via C, with a path length
of 3. S At the first packet exchange, B does not hear
anything from A. Then router C says: Do not
worry; I have a path to A of length 2. So, B
thinks it can reach A via C, with a path length
of 3. Similar process is done for throu At the first packet exchange, B does not hear
anything from A. Then router C says: Do not
worry; I have a path to A of length 2. So, B
thinks it can reach A via C, with a path length
of 3. Similar process is done for throu

- **The Count-to-Infinity Problem**
• To overcome the drawback of count-to-infinity
• To overcome the drawback of count-to-infinity
• In split-horizon algorithm, a router never **The Count-to-Infinity Problem**
To overcome the drawback of count-to-infinity
problem we use split-horizon algorithm.
In split-horizon algorithm, a router never
advertises the distance to router X to its neighbor
- **The Count-to-Infinity Problem**
• To overcome the drawback of count-to-infinity
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• In split-horizon algorithm, a router never
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N. In **The Count-to-Infinity Problem**
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In split-horizon algorithm, a router never
advertises the distance to router X to its neighbor
N. In abo N. In above example, when C sends packets to A The COUTTE-TO-HITTINTY FTODIETT
To overcome the drawback of count-to-infinity
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In split-horizon algorithm, a router never
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N. In above example, when C sends packets problem we use split-horizon algorithm.

In split-horizon algorithm, a router never

advertises the distance to router X to its neighbor

N. In above example, when C sends packets to A

via B, C tells simply like "I don't In split-horizon algorithm, a router never
advertises the distance to router X to its neighbor
N. In above example, when C sends packets to A
via B, C tells simply like "I don't know". When the
router A goes down, at first

The Count-to-Infinity Problem
• On the next exchange C realizes that A is not
reachable since neighbor of its neighbors can
reach A Therefore C also sets its distance to A **The Count-to-Infinity Problem**
On the next exchange C realizes that A is not
reachable since neighbor of its neighbors can
reach A. Therefore C also sets its distance to A
is infinity. Thus the count-to-infinity problem **The Count-to-Infinity Problem**
On the next exchange C realizes that A is not
reachable since neighbor of its neighbors can
reach A. Therefore C also sets its distance to A
is infinity. Thus the count-to-infinity problem
i is infinity. Thus the count-to-infinity problem **The Count-to-Infin**
On the next exchange C re
reachable since neighbor c
reach A. Therefore C also se
is infinity. Thus the count-
is solved.

Link State Routing

- Link State Routing
• Link state algorithm is a dynamic routing
• Link state algorithm is a dynamic routing
• all delays and bandwidth
• complete topology all delays and bandwidth Link State Routing
Link state algorithm is a dynamic routing
algorithm that takes into account the
complete topology, all delays and bandwidth
when choosing routes Link State Routing
Link state algorithm is a dynamic routing
algorithm that takes into account the
complete topology, all delays and bandwidth
when choosing routes. when choosing routes. • Link state algorithm is a dynamic routing
• Link state algorithm is a dynamic routing
algorithm, that takes into account the
complete topology, all delays and bandwidth
when choosing routes.
• In this algorithm, each nod Link state algorithm is a dynamic routing
algorithm that takes into account the
complete topology, all delays and bandwidth
when choosing routes.
In this algorithm, each node sends only the
state of the directly connected
- Link state algorithm is a dynamic routing
algorithm that takes into account the
complete topology, all delays and bandwidth
when choosing routes.
In this algorithm, each node sends only the
state of the directly connected subnet.

Link State Routing

Link State Routing
In this algorithm, each router must do the following:
1. Discover its neighbors, learn their network address.
2. Moasure the delay or sest to each of its peighbors.

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- 1. Link State Routing
1. Discover its neighbors, learn their network address.
1. Discover its neighbors, learn their network address.
2. Measure the delay or cost to each of its neighbors. 2. Measure the State Routing
2. Measure the delay or cost to each of its neighbors.
2. Measure the delay or cost to each of its neighbors.
2. Construct a packet telling all it has just learned.
2. Sond this packet to all o
-
-
- **3. Construct a packet telling all it has algorithm, each router must do the following:**
1. Discover its neighbors, learn their network address.
2. Measure the delay or cost to each of its neighbors.
3. Construct a packet
- In this algorithm, each router must do the following:
1. Discover its neighbors, learn their network address.
2. Measure the delay or cost to each of its neighbors.
3. Construct a packet telling all it has just learned.
4. In this algorithm, each router must do the following:
1. Discover its neighbors, learn their network address.
2. Measure the delay or cost to each of its neighbors.
3. Construct a packet telling all it has just learned.
4. Discover its neighbors, learn their network address.
Measure the delay or cost to each of its neighbors.
Construct a packet telling all it has just learned.
Send this packet to all other routers.
Compute the shortest path

Learning about the Neighbors

**Learning about the Neighbors
• When a router joins the network, it first learns
• about it neighbors. To achieve this, it sends a
special HELLO packet on each outgoing line** Learning about the Neighbors
When a router joins the network, it first learns
about it neighbors. To achieve this, it sends a
special HELLO packet on each outgoing line.
When the packet arrive at the receiver each Learning about the Neighbors
When a router joins the network, it first learns
about it neighbors. To achieve this, it sends a
special HELLO packet on each outgoing line.
When the packet arrive at the receiver, each
receive When the packet arrive at the receiver, each Learning about the Neighbors
When a router joins the network, it first learns
about it neighbors. To achieve this, it sends a
special HELLO packet on each outgoing line.
When the packet arrive at the receiver, each
receive

Learning about the Neighbors

Fig (a) Nine routers and a LAN. Fig(b) A graph model of (a).

Measuring Line Cost

- **Measuring Line Cost**
• Next the router must estimate the delay to
• To know this delay the router send FCHO Measuring Line Cost
Next the router must estimate the dela
reach each of its neighbors.
To know this delay the router send E
- **Measuring Line Cost**
• Next the router must estimate the delay to
reach each of its neighbors.
• To know this delay the router send ECHO
packet on each point-to-point line.
• The router on other end sends back it packet on each point-to-point line.
- Next the router must estimate the delay to
• Next the router must estimate the delay to
• To know this delay the router send ECHO
packet on each point-to-point line.
• The router on other end sends back it
• The router c immediately.
- Next the router must estimate the delay to
reach each of its neighbors.
• To know this delay the router send ECHO
packet on each point-to-point line.
• The router on other end sends back it
immediately.
• The router calc reach each of its neighbors.
To know this delay the router send ECHO
packet on each point-to-point line.
The router on other end sends back it
immediately.
The router calculate the delay by dividing the
Round-Trip Time (Th To know this delay the router send ECHO
packet on each point-to-point line.
The router on other end sends back it
immediately.
The router calculate the delay by dividing the
Round-Trip Time (The time a packet take to
reach
Measuring Line Cost

A subnet in which the East and West parts are connected by two lines.

Building Link State Packets

- **Building Link State Packets
• Once the router gets the information about its
• neighbors it calculates its delay to them, the
next step for each router is to construct a Building Link State Packets**
Once the router gets the information about its
neighbors it calculates its delay to them, the
next step for each router is to construct a
nacket including all the information Building Link State Packets
Once the router gets the information about its
neighbors it calculates its delay to them, the
next step for each router is to construct a
packet including all the information. packet including all the information. • Once the router gets the information about its
• Once the router gets the information about its
neighbors it calculates its delay to them, the
next step for each router is to construct a
packet including all the informat Once the router gets the information about its
neighbors it calculates its delay to them, the
next step for each router is to construct a
packet including all the information.
The packets includes the identity of the
sende
- Once the router gets the information about its
neighbors it calculates its delay to them, the
next step for each router is to construct a
packet including all the information.
The packets includes the identity of the
sende neighbors it calculates its delay to them
next step for each router is to constru
packet including all the information.
The packets includes the identity of
sender, the sequence number and
followed by the list of each of i

Building Link State Packets

Building Link State Packets
• Example: Consider the subnet shown in Fig(a). The
link state packets that each router construct for this
subnet in Fig(b). **Building Link State Packets**
Example: Consider the subnet shown in Fig(a). The
link state packets that each router construct for this
subnet in Fig(b). **Building Link State Particular State State State State packets that each router consubnet in Fig(b).**
 $\frac{B}{2}$ $\frac{2}{3}$ $\frac{C}{2}$ $\frac{A}{2}$ $\frac{B}{2}$ $\frac{C}{2}$ $\frac{C}{2}$

 (a)

 (b)

(a) A subnet. (b) The link state packets for this subnet.

Distributing the Link State Packets

- Distributing the Link State Packets
• The next step after building the link state packets is to
• Flooding is used as basic algorithm for distributing links
- **Distributing the Link State Packets**
The next step after building the link state packets is to
distribute them across the network.
Flooding is used as basic algorithm for distributing links
state packet. To avoid flooding **Distributing the Link State Packets**
• The next step after building the link state packets is to
distribute them across the network.
• Flooding is used as basic algorithm for distributing links
state packet. To avoid floo Distributing the Link State Packets
The next step after building the link state packets is to
distribute them across the network.
Flooding is used as basic algorithm for distributing links
state packet. To avoid flooding s packet is given a sequence number. When a packet **Distributing the Link State Packets**
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Flooding is used as basic algorithm for distributing links
state packet. To avoid flooding The next step after building the link state packets is to
distribute them across the network.
Flooding is used as basic algorithm for distributing links
state packet. To avoid flooding same packet, each new
packet is given The next step after building the link state packets is to
distribute them across the network.
Flooding is used as basic algorithm for distributing link
state packet. To avoid flooding same packet, each nev
packet is given • The next step after bunding the fink state packets is to distribute them across the network.
• Flooding is used as basic algorithm for distributing links state packet. To avoid flooding same packet, each new packet is gi distribute them across the network.
Flooding is used as basic algorithm for distributing links
state packet. To avoid flooding same packet, each new
packet is given a sequence number. When a packet
arrives at router for fl
-

Distributing the Link State Packets

- Distributing the Link State Packets
• Each router uses a data structure with the field
• source router, packets sequence number and age,
• send flags and acknowledgment flags and the Distributing the Link State Packets
Each router uses a data structure with the field
source router, packets sequence number and age,
send flags and acknowledgment flags and the
data. **Distributing the Link State Packets**
Each router uses a data structure with the field
source router, packets sequence number and age,
send flags and acknowledgment flags and the
data.
Once the age becomes zero, the router data. SISTINUTHING THE LITIK STATE PACKETS

Each router uses a data structure with the fiel

source router, packets sequence number and age

send flags and acknowledgment flags and th

data.

Once the age becomes zero, the route • Each router uses a data structure with the field
source router, packets sequence number and age,
send flags and acknowledgment flags and the
data.
• Once the age becomes zero, the router discards
the information from it.
- Once the age becomes zero, the router discards
- Each router uses a data structure with the field
source router, packets sequence number and age,
send flags and acknowledgment flags and the
data.
Once the age becomes zero, the router discards
the information from it.
The source router, packets sequence number and age,
send flags and acknowledgment flags and the
data.
Once the age becomes zero, the router discards
the information from it.
The sends flags specify the line on which to send
th send flags and acknowledgment flags and the
data.
Once the age becomes zero, the router discards
the information from it.
The sends flags specify the line on which to send
the incoming packet and the acknowledgment
flags s

Distributing the Link State Packets

The packet buffer for router B in the previous slide (Fig. 5-13).

Compute the new route

**Compute the new route
• The link state algorithm uses the Dijkstra's
• algorithm to compute the shortest path to all
• possible destinations** Compute the new route
The link state algorithm uses the Dijkstra's
algorithm to compute the shortest path to all
possible destinations. **Compute the new ro
The link state algorithm uses t
algorithm to compute the shorte:**
possible destinations.

Link State Routing

Disadvantage

- Link State Routing
1. Large memory is required at each node to store
1. Large memory is required at each node to store
2. More computation time is needed to calculate **Link State Rout**
 Consulting
 Consulting
 Consulting that is the information.

More computation time is ne

end-to-end routes. Link State Routing

Disadvantage

1. Large memory is required at each node to store

the information.

2. More computation time is needed to calculate

end-to-end routes.

3. It creates problems if the router does the
-
- **EXECUTE CONTING**
 CONTITY: Units Consider the information.

2. More computation time is needed to calculate

end-to-end routes.

3. It creates problems if the router does the

routing / calculation wrong.

Uses **Example 15 Solution**
 Example 18 Solution
 Example 18 Solution State 18 Solution
 Example 16 Solution Wave 18 Solution
 Example 16 Solution Wave 18 Solution Wave 16 Solution Wave 16 Solution Wave 16 Solution Uses
 1. Large memory is required at each node to store
the information.
2. More computation time is needed to calculate
end-to-end routes.
3. It creates problems if the router does the
routing / calculation wrong.
Uses
1. Lin

Uses

networks

Solutions to link state routing

- Solutions to link state routing
• The solution to the scaling problem is to do
the routing hierarchically. **Solutions to link state routify**
The solution to the scaling problem
the routing hierarchically.
Hierarchically routing divides the ro
- Solutions to link state routing
• The solution to the scaling problem is to do
the routing hierarchically.
• Hierarchically routing divides the routers into
regions, regions into clusters, the clusters into
zones regions, regions into clusters, the clusters into zones. • The solution to the scaling problem is to do
the routing hierarchically.
• Hierarchically routing divides the routers into
regions, regions into clusters, the clusters into
zones.
• By using this routing reduces the memo The solution to the scaling problem is to
the routing hierarchically.
Hierarchically routing divides the routers
regions, regions into clusters, the clusters
zones.
By using this routing reduces the mer
required at each no
-

- **Fierarchical Routing
• Hierarchical routing is an algorithm for routing packets
hierarchically. This routing is used due to following
reasons,** Hierarchical Routing
Hierarchical routing is an algorithm for routing packets
hierarchically. This routing is used due to following
reasons,
Routers need more memory space to store routing reasons, 1. Routing

1. Routing is an algorithm for routing packets

hierarchically. This routing is used due to following

reasons,

1. Routers need more memory space to store routing

table which increased with increase in the ne **Hierarchical Routing**

ierarchical routing is an algorithm for routing packets

ierarchically. This routing is used due to following

reasons,

Routers need more memory space to store routing

table which increased with i **Size 1.1 The Controlled Houting**
 Size. 2. Moreon is an algorithm for routing packets

hierarchically. This routing is used due to following

reasons,

1. Routers need more memory space to store routing

table which inc • Hierarchical routing is an algorithm for routing packets
hierarchically. This routing is used due to following
reasons,
1. Routers need more memory space to store routing
table which increased with increase in the networ • Hierarchical routing is an algorithm for routing packets
hierarchically. This routing is used due to following
reasons,
1. Routers need more memory space to store routing
table which increased with increase in the networ
- ierarchically. This routing is used due to following
easons,
Routers need more memory space to store routing
table which increased with increase in the network
size.
More CPU time is needed to scan each routing table
More reasons,

1. Routers need more memory space to store routing

table which increased with increase in the network

size.

2. More CPU time is needed to scan each routing table

3. More bandwidth is required to send scanning
-
-
-
-

**Fierarchical Routing
• Hierarchical routing algorithm divides the
• Frances into regions with a few number of
• Fouters with a few number of routers per** Hierarchical Routing
Hierarchical routing algorithm divides the
routers into regions with a few number of
regions With this algorithm each router Hierarchical Routing
Hierarchical routing algorithm divides the
routers into regions with a few number of
routers with a few number of routers per
regions. With this algorithm, each router
maintains a routing table that gi regions. With this algorithm, each router Hierarchical routing algorithm divides the
routers into regions with a few number of
routers with a few number of routers per
regions. With this algorithm, each router
maintains a routing table that gives detail
informatio Hierarchical routing algorithm divides the
routers into regions with a few number of
routers with a few number of routers per
regions. With this algorithm, each router
maintains a routing table that gives detail
informatio Hierarchical routing algorithm divides the
routers into regions with a few number of
routers with a few number of routers per
regions. With this algorithm, each router
maintains a routing table that gives detail
informatio routers into regions with a few number of
routers with a few number of routers per
regions. With this algorithm, each router
maintains a routing table that gives detail
information about how to route packets to
destination routers with a few number of rou
regions. With this algorithm, each
maintains a routing table that give
information about how to route pa
destinations within its own region bu
not tell how to route the same to des[.]
withi

- Fierarchical Routing
• Thus the use of regions reduces the space
required by each router and the CPU time
needed to scan the routing tables Hierarchical Routing
Thus the use of regions reduces the space
required by each router and the CPU time
needed to scan the routing tables. Hierarchical Routing
Thus the use of regions reduces the space
required by each router and the CPU time
needed to scan the routing tables.
For huge networks, the division of routers into
- For huge networks, the division of routers into Thus the use of regions reduces the space
required by each router and the CPU time
needed to scan the routing tables.
For huge networks, the division of routers into
regions is a two-level hierarchy which is
insufficient. insufficient. • Thus the use of regions reduces the space
required by each router and the CPU time
needed to scan the routing tables.
• For huge networks, the division of routers into
regions is a two-level hierarchy which is
insufficie required by each fouter and the CPO the
needed to scan the routing tables.
For huge networks, the division of routers in
regions is a two-level hierarchy which
insufficient.
Consider the example of routing in a two-lev
hie
-

Full table for 1A

Hierarchical table for 1A

 (a)

 (c)

Hierarchical routing.

- **Hierarchical Routing
• In the full routing table, the router 1A has 17
• entries as shown in fig(b). When the routing is
done hierarchical there are only 7 entries for** Hierarchical Routing
In the full routing table, the router 1A has 17
entries as shown in fig(b). When the routing is
done hierarchical there are only 7 entries for
router 1A. Hierarchical Routing

In the full routing table, the router 1A has 17

entries as shown in fig(b). When the routing is

done hierarchical there are only 7 entries for

router 1A.

These are entries for local routers but al router 1A. • In the full routing table, the router 1A has 17
• In the full routing table, the router 1A has 17
entries as shown in fig(b). When the routing is
done hierarchical there are only 7 entries for
router 1A.
• These are entr In the full routing table, the router 1A has 17
entries as shown in fig(b). When the routing is
done hierarchical there are only 7 entries for
router 1A.
These are entries for local routers but all other
regions have been In the full routing table, the router intries as shown in fig(b). When the done hierarchical there are only 7 ϵ router 1A.
These are entries for local routers bu regions have been present within a sir as shown in fig(c
- entries as shown in fig(b). When the routing is

done hierarchical there are only 7 entries for

router 1A.

 These are entries for local routers but all other

regions have been present within a single router

as shown done hierarchical there are only 7 entries for
router 1A.
These are entries for local routers but all other
regions have been present within a single router
as shown in fig(c).
This routing increases saving the table space
-

- **Hierarchical Routing
• Hierarchical routing has reduced the table
• from 17 to 7 entries. When the single network
• becomes very huge, now we can use number** Hierarchical Routing
Hierarchical routing has reduced the table
from 17 to 7 entries. When the single network
becomes very huge, now we can use number
of levels of hierarchy. Hierarchical Routing
Hierarchical routing has reduced the table
from 17 to 7 entries. When the single network
becomes very huge, now we can use number
of levels of hierarchy.
Three level hierarchy means group the regions Hierarchical Routing
Hierarchical routing has reduced
from 17 to 7 entries. When the singl
becomes very huge, now we can us
of levels of hierarchy.
Three level hierarchy means group tl
into clusters the clusters into zones • Hierarchical Routing
• Hierarchical routing has reduced the table
from 17 to 7 entries. When the single network
becomes very huge, now we can use number
of levels of hierarchy.
• Three level hierarchy means group the reg Hierarchical routing has reduced the table
from 17 to 7 entries. When the single network
becomes very huge, now we can use number
of levels of hierarchy.
Three level hierarchy,
into clusters, the clusters into zones, the z Hierarchical routing has reduced the ta
from 17 to 7 entries. When the single netw
becomes very huge, now we can use num
of levels of hierarchy.
Three level hierarchy means group the regi
into clusters, the clusters into z from 17 to 7 entries. When the single network
becomes very huge, now we can use number
of levels of hierarchy.
• Three level hierarchy means group the regions
into clusters, the clusters into zones, the zones
into group an
-
- insufficient.

- **Hierarchical Routing
• Consider a subnet with 720 routers. If there is no
hierarchy, each router needs 720 routing table entries.
If there is two-level hierarchy used, then the subnet is
partitioned into 24 regions of 30** Hierarchical Routing

Consider a subnet with 720 routers. If there is no

hierarchy, each router needs 720 routing table entries.

If there is **two-level hierarchy** used, then the subnet is

partitioned into 24 regions of Hierarchical Routing

Consider a subnet with 720 routers. If there is no

hierarchy, each router needs 720 routing table entries.

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Consider a subnet with 720 routers. If there is no

hierarchy, each router needs 720 routing table entries.

If there is two-level hierarchy used, then the subnet is

partitioned into 24 regions of 30 Hierarchical Routing
Consider a subnet with 720 routers. If there is no
hierarchy, each router needs 720 routing table entries.
If there is two-level hierarchy used, then the subnet is
partitioned into 24 regions of 30 rou a total of 53 entries. • Consider a subnet with 720 routers. If there is no

hierarchy, each router needs 720 routing table entries.

If there is **two-level hierarchy** used, then the subnet is

partitioned into 24 regions of 30 routers each, eac Consider a subnet with **720 routers**. If there is **no**
hierarchy, each router needs 720 routing table entries.
If there is **two-level hierarchy** used, then the subnet is
partitioned into 24 regions of 30 routers each, eac Consider a subnet with **720 routers**. If there is **no**
hierarchy, each router needs 720 routing table entries.
If there is **two-level hierarchy** used, then the subnet is
partitioned into 24 regions of 30 routers each, ea
- Consider a subnet with **720 routers**. If there is **no**
hierarchy, each router needs 720 routing table entries.
If there is **two-level hierarchy** used, then the subnet is
partitioned into 24 regions of 30 routers each, each hierarchy, each router needs 720 routing table entries.
If there is **two-level hierarchy** used, then the subnet is
partitioned into 24 regions of 30 routers each, each
router needs 30 local entries plus 23 remote entries f If there is **two-level hierarchy** used, then the subnet is
partitioned into 24 regions of 30 routers each, each
router needs 30 local entries plus 23 remote entries for
a total of **53 entries**.
Consider a subnet consists o

• Advantage

- Hierarchical Routing

Hierarchical Routing

Homes of regions reduces the memory space and

Scan time

Andwidth is reduced **Hierarchical Rout**
Advantage
- The use of regions reduces the merage
- Bandwidth is reduced
-

UNIT 2 PART 3

UNIT 2 PART 3

Congestion Control Algorithms: General

Principles of Congestion Control, Congestion

Prevention Policies, Congestion Control in Virtual-UNIT 2 PART 3

Congestion Control Algorithms: General

Principles of Congestion Control, Congestion

Prevention Policies, Congestion Control in Virtual-

Circuit Subnets, Congestion Control in Datagram **UNIT 2 PART 3**
 Congestion Control Algorithms: General

Principles of Congestion Control, Congestion

Prevention Policies, Congestion Control in Virtual-

Circuit Subnets, Congestion Control in Datagram

Subnets, Load S UNIT 2 PART 3

Congestion Control Algorithms: General

Principles of Congestion Control, Congestion

Prevention Policies, Congestion Control in Virtual-

Circuit Subnets, Congestion Control in Datagram

Subnets, Load Shedd Subnets, Load Shedding, Jitter Control.

Congestion

Congestion
• When too many packets are present in the
subnet and as traffic increases then the
network performance degrades and no **Congestion
When too many packets are present in the
subnet and as traffic increases then the
network performance degrades and no
nackets are delivered to destination. This Congestion**
When too many packets are present in the
subnet and as traffic increases then the
network performance degrades and no
packets are delivered to destination. This
situation is called a **congestion** packets are delivered to destination. This **Congestion**
When too many packets are present in
subnet and as traffic increases then
network performance degrades and
packets are delivered to destination.
situation is called a **congestion**.

Congestion Control

**Congestion Control
•** It is a process of maintaining the number of
packets in a network at certain level. It make
sure that subpet is able to carry the offered **Congestion Control**
It is a process of maintaining the number of
packets in a network at certain level. It make
sure that subnet is able to carry the offered
traffic **Sure 19 Separate Source 19 Separate 19 Separate 15 Separate is a process of maintaining the number of packets in a network at certain level. It make sure that subnet is able to carry the offered traffic.** traffic.

Effects on congestion

Effects on congestion
• When too many packets are present in the subnet, congestion
occur and network performance degrades as shown in below
figure. The number of packets delivered are proportional to **Effects on congestion**
When too many packets are present in the subnet, congestion
occur and network performance degrades as shown in below
figure. The number of packets delivered are proportional to
the number of packets Effects on congestion
When too many packets are present in the subnet, congestion
occur and network performance degrades as shown in below
figure. The number of packets delivered are proportional to
the number of packets s Effects on congestion
When too many packets are present in the subnet, conge
occur and network performance degrades as shown in t
figure. The number of packets delivered are proportion
the number of packets sent.
Maximum c

Fig: Effects on congestion

Causes (or) Reasons for congestions

- Causes (or) Reasons for congestions
• If there is inefficient memory, to hold all of them,
packets will be lost.
– Solution is to add additional memory. Causes (or) Reasons for congestions
If there is inefficient memory, to hold all of them,
packets will be lost.
– Solution is to add additional memory.
If the CPU processing speed is slow. If CPU is busy
in updating the rou
	-
- Causes (or) Reasons for congestions
• If there is inefficient memory, to hold all of them,
packets will be lost.
– Solution is to add additional memory.
• If the CPU processing speed is slow. If CPU is busy
in updating the in updating the routing tables it ignores the Lauses (OF) NeasOFTS TOT COTTgeStTOTTS

If there is inefficient memory, to hold all of then

packets will be lost.

- Solution is to add additional memory.

If the CPU processing speed is slow. If CPU is bus

in updating t • If there is inefficient memory, to hold all of them,
packets will be lost.
– Solution is to add additional memory.
• If the CPU processing speed is slow. If CPU is busy
in updating the routing tables it ignores the
packe – solution is to add additional memory.
• If the CPU processing speed is slow. If CPU is busy
in updating the routing tables it ignores the
packets stored in the CPU.
• If there is low bandwidth lines.
– Solution is upgrad
- - processors.
-

General Principles of Congestion Control

- General Principles of Congestion Control
• Congestion control is concerned about
controlling traffic entry into a network. General Principles of Congestion Control
Congestion control is concerned about
controlling traffic entry into a network.
Congestion control strategy is divided into two
- General Principles of Congestion Control
• Congestion control is concerned about
controlling traffic entry into a network.
• Congestion control strategy is divided into two
types. They are types. They are • Congestion control is concerned about

controlling traffic entry into a network.

• Congestion control strategy is divided into two

types. They are

1. Open loop congestion control

2. Closed loop congestion control • Congestion control is concerned about

controlling traffic entry into a network.

• Congestion control strategy is divided into two

types. They are

1. Open loop congestion control

2. Closed loop congestion control
-
-

Open loop congestion control

- Open loop congestion control
• It is used for preventing congestion from
happening to occur on first place. It is a static
control. **Open loop congestion control**
It is used for preventing congestion from
happening to occur on first place. It is a static
control.
Various open loop congestion control techniques control. **Open loop congestion control**
• It is used for preventing congestion from
happening to occur on first place. It is a static
control.
• Various open loop congestion control techniques
are as follows.
a. Retransmission poli **Open loop congestion contro**

• It is used for preventing congestion

happening to occur on first place. It is a

control.

• Various open loop congestion control techn

are as follows.

a. Retransmission policy

b. Windo • It is used for preventing congort the impremise to occur on first place.

• Various open loop congestion contro

• Various open loop congestion contro

are as follows.

a. Retransmission policy

b. Window policy

c. Ackn • It is used for preventing congestion from

happening to occur on first place. It is a stand

control.

• Various open loop congestion control technique

are as follows.

a. Retransmission policy

b. Window policy

c. Ack
- happening to occur on first place. It
control.
• Various open loop congestion control
are as follows.
a. Retransmission policy
b. Window policy
c. Acknowledgement policy
d. Discarding policy
e. Admission policy e. Various open loop congestion control

• Various open loop congestion control

a. Retransmission policy

b. Window policy

c. Acknowledgement policy

d. Discarding policy

e. Admission policy
-
-
-
-
-

Retransmission Policy

- **Paramerical Finder State Set Theory**
• If sender feels that a sent packet is lost, the packets needs to be retransmitted. Retransmission Policy
If sender feels that a sent packet is lost, the
packets needs to be retransmitted.
Retransmission may increase congestion in the
- **Produce Set Theory**
• If sender feels that a sent packet is lost, the
packets needs to be retransmitted.
• Retransmission may increase congestion in the
network. network.
- If sender feels that a sent packet is lost, the
packets needs to be retransmitted.
• Retransmission may increase congestion in the
network.
• By using effective retransmission policy and
timer, congestion can be controll If sender feels that a sent packet is lost, the
packets needs to be retransmitted.
Retransmission may increase congestion in the
network.
By using effective retransmission policy and
timer, congestion can be controlled.

Window policy

**Window policy
• By** specifying the receiver's window size
before the transmission starts, congestion can
be avoided as sender transmits the packet Window policy
By specifying the receiver's window size
before the transmission starts, congestion can
be avoided as sender transmits the packet
according to the size of receiver's window Window policy
By specifying the receiver's window size
before the transmission starts, congestion can
be avoided as sender transmits the packet
according to the size of receiver's window. according to the size of receiver's window.

Acknowledgment policy

- Acknowledgment policy
• This policy make by receivers may also effect
congestion. congestion.
- **Acknowledgment policy**
• This policy make by receivers may also effect
congestion.
• If the receiver doesn't acknowledge every
packet it receives, it may slow down the
sender and congestion occurs packet it receives, it may slow down the ACKHOWIEQBITIETIL POIICY
This policy make by receivers may also effect
congestion.
If the receiver doesn't acknowledge every
packet it receives, it may slow down the
sender and congestion occurs.
A receiver may send an ack • This policy make by receivers may also effect
congestion.
• If the receiver doesn't acknowledge every
packet it receives, it may slow down the
sender and congestion occurs.
• A receiver may send an acknowledgment only
if This policy make by receivers may also enect
congestion.
If the receiver doesn't acknowledge every
packet it receives, it may slow down the
sender and congestion occurs.
A receiver may send an acknowledgment only
if it has congestion.
If the receiver doesn't acknowledge ever
packet it receives, it may slow down t
sender and congestion occurs.
A receiver may send an acknowledgment o
if it has a packet to be sent, then t
congestion can be cont
-

Discarding policy

**Discarding policy
• A good discarding policy by the routers may
prevent congestion, at the same time it
doesn't affect the transmission packets** Discarding policy
A good discarding policy by the routers may
prevent congestion, at the same time it
doesn't affect the transmission packets. Discarding policy
A good discarding policy by the routers may
prevent congestion, at the same time it
doesn't affect the transmission packets.

Admission policy

Admission policy
• In this policy, a new virtual connection request
is not accepted if that request leads to
congestion Admission policy
In this policy, a new virtual connection request
is not accepted if that request leads to
congestion. congestion.

Drawbacks

Solution Concerts
• The drawback of open-loop congestion control
is that once the system has started running in
hetween connection can not be adjusted is that once the system has started running in **between Starts Drawbacks**
The drawback of open-loop congestion control
is that once the system has started running in
between, connection can not be adjusted.

Closed loop congestion control

- Closed loop congestion control
• It is used to remove the congestion, after it
occurred. These congestion control strategies are
based on feedback mechanisms. This approach **Closed loop congestion control**
It is used to remove the congestion, after it
occurred. These congestion control strategies are
based on feedback mechanisms. This approach
has three parts when applied to congestion **Closed loop congestion control**
It is used to remove the congestion, after it
occurred. These congestion control strategies are
based on feedback mechanisms. This approach
has three parts when applied to congestion
contro **Closed loop congestion control**
It is used to remove the congestion, after it
occurred. These congestion control strategies are
based on feedback mechanisms. This approach
has three parts when applied to congestion
contro control: 1. It is used to remove the congestion, after it

1. It is used to remove the congestion, after it

1. These congestion control strategies are

1. Started parts when applied to congestion

1. Monitor the system to detect w I is used to remove the congestion

ccurred. These congestion control strandsed on feedback mechanisms. This

as three parts when applied to control:

Monitor the system to detect when a

congestion occurs.

Pass this info • It is used to remove the congestion, atter it
occurred. These congestion control strategies are
based on feedback mechanisms. This approach
has three parts when applied to congestion
control:
1. Monitor the system to det Eccurred. These congestion corrections
ased on feedback mechanism
as three parts when appli
ontrol:
Monitor the system to detect
congestion occurs.
Pass this information to place:
be taken.
Adjust system operation to col Figure 1. Adjust system operation to conduct the problem.

1. Monitor the system to detect when and where

congestion occurs.

2. Pass this information to places where action can

be taken.

3. Adjust system operation to c
-
-
-

Closed loop congestion control

- Closed loop congestion control
• Different kinds of closed loop congestion
control techniques as follows: Closed loop congestion control
Different kinds of closed loop congestion
control techniques as follows:
Choke packets Closed loop congestion

• Different kinds of closed loop

control techniques as follows:

1. Choke packets

2. Implicit signaling • Different kinds of closed loop
control techniques as follows:
1. Choke packets
2. Implicit signaling
3. Explicit signaling
-
- 2. Implicit signaling
-

Choke packets

- **Choke packets
• A choke packet is a packet sent by a node to
the source to inform it of congestion.** Choke packets

A choke packet is a packet sent by a node to

the source to inform it of congestion.

In this method, the warning is from the router
- **Choke packets**
• A choke packet is a packet sent by a node to
the source to inform it of congestion.
• In this method, the warning is from the router
about congestion occur, to the source stations
directly about congestion occur, to the source stations directly.

Choke Packets Mechanism

Implicit signaling

Implicit signaling
• In this, the source automatically learn about
congestion by observing the delay in packets
acknowledgement time-out determination It Implicit signaling

In this, the source automatically learn about

congestion by observing the delay in packets

acknowledgement, time-out determination. It

thinks that congestion occur in network Implicit signaling
acknowledgement, time-out determination. It
thinks that congestion cocur in network.
thinks that congestion occur in network. thinks that congestion occur in network.

Explicit signaling

- **Explicit signaling
• In explicit signaling, packets are sent back
from the point of congestion to warn the
source** Explicit signaling
In explicit signaling, packets are sent back
from the point of congestion to warn the
source. source.
- In this, the information about congestion is EXPIICIL SIgNaIIIIg
In explicit signaling, packets are sent back
from the point of congestion to warn the
source.
In this, the information about congestion is
send along with the packet carrying data
which is different fro In explicit signaling, packets are sent back
from the point of congestion to warn the
source.
In this, the information about congestion is
send along with the packet carrying data
which is different from choke packets. It In explicit signaling, packets are sent back
from the point of congestion to warn the
source.
In this, the information about congestion is
send along with the packet carrying data
which is different from choke packets. It signaling.
Backward signaling

**Backward signaling
• A bit can be set in a packet moves in the
pposite direction to the congestion. This bit
tells the source that there is a congestion** Backward signaling
A bit can be set in a packet moves in the
opposite direction to the congestion. This bit
tells the source that there is a congestion. Backward signaling
A bit can be set in a packet moves in the
opposite direction to the congestion. This bit
tells the source that there is a congestion.

Forward signaling

- **Forward signaling**
• A bit can be set in a packet moving in the direction of congestion. This bit can warn the destination that there is a congestion. **Forward signaling**
A bit can be set in a packet moving in the direction of
congestion. This bit can warn the destination that there is a
congestion.
Mainly congestion means load is greater than the resources
that they can congestion. • A bit can be set in a packet moving in the direction of congestion. This bit can warn the destination that there is a congestion.
• Mainly congestion means load is greater than the resources that they can handle.
• Two s **Forward signaling**
A bit can be set in a packet moving in the
congestion. This bit can warn the destination to
congestion.
Mainly congestion means load is greater than
that they can handle.
Two solutions can be applied to **Forward signaling**
A bit can be set in a packet moving in the direction of
congestion. This bit can warn the destination that there is a
congestion.
Mainly congestion means load is greater than the resources
that they can • A bit can be set in a packet moving in the direction of congestion. This bit can warn the destination that there is a congestion.
• Mainly congestion means load is greater than the resources that they can handle.
• Two s increase the set in a packet moving in the direction of
congestion. This bit can warn the destination that there is a
congestion.
Aainly congestion means load is greater than the resources
hat they can handle.
wo solutions
-
- Two solutions can be applied to control the congestion are increase the resources and decrease the load. ongestion.

Mainly congestion means load is greater than the resources

hat they can handle.

Wo solutions can be applied to control the congestion are

ncrease the resources

— The subnet may use dial-up telephone line to mat they can handle.

Solutions can be applied to control the

rease the resources and decrease the load

rease the resources

The subnet may use dial-up telephone lin

increase the bandwidth

Split the traffic over multip
- -
	-
	-

Summary

- **Summary
• In open loop by considering congestion
problems it should design the subnet
statically** Summary

In open loop by considering congestion

problems it should design the subnet

statically. statically. SUITIITIATY

In open loop by considering cor

problems it should design the

statically.

In closed-loop after arising problems

given as feed back
- In closed-loop after arising problems it was

Congestion prevention policies

Congestion prevention policies
• There are some congestion prevention policies for different
layers like Datalink, Network, Transport layer as shown in
below table. **Congestion prevention policies**
There are some congestion prevention policies for different
layers like Datalink, Network, Transport layer as shown in
below table. **Congestion preventio**
There are some congestion prevention
layers like Datalink, Network, Transpo
below table.
Transport **Conser Policie**
Transport **Conser Policie**

Policies that affect congestion

Out-of-order caching policy

- Out-of-order caching policy
• If receiver continuously discard all Out-of-
order packets, these packets will have to be
transmitted again later creating extra load by Out-of-order caching policy
If receiver continuously discard all Out-of-
order packets, these packets will have to be
transmitted again later, creating extra load by
using protocol like Go-Back-N and selective Out-of-order caching policy
If receiver continuously discard all Out-of-
order packets, these packets will have to be
transmitted again later, creating extra load by
using protocol like Go-Back-N and selective using protocol like Go-Back-N and selective repeat. • If receiver continuously discard all Out-of-
order packets, these packets will have to be
transmitted again later, creating extra load by
using protocol like Go-Back-N and selective
repeat.
• With respect to congestion c It receiver continuously discard all Out-ot-
order packets, these packets will have to be
transmitted again later, creating extra load by
using protocol like Go-Back-N and selective
repeat.
With respect to congestion contr
-

Flow control policy

- Flow control policy
• When sender sending data at very high rate
and receivers receiving at very low rate then
automatically congestion will occur. So we Flow control policy
When sender sending data at very high rate
and receivers receiving at very low rate then
automatically congestion will occur. So we
have to use flow control mechanism Flow control policy
When sender sending data at very high rate
and receivers receiving at very low rate then
automatically congestion will occur. So we
have to use flow control mechanism. have to use flow control mechanism. • When sender sending data at very high rate

• When sender sending data at very high rate

and receivers receiving at very low rate then

automatically congestion will occur. So we

have to use flow control mechanism.

•
-

Routing Algorithm

**Producing Algorithm
• A good routing algorithm can help avoid
congestion by spreading the traffic over all the
lines whereas a had one can send too much** Routing Algorithm
A good routing algorithm can help avoid
congestion by spreading the traffic over all the
lines, whereas a bad one can send too much
traffic over already congested lines Routing Algorithm
A good routing algorithm can help avoid
congestion by spreading the traffic over all the
lines, whereas a bad one can send too much
traffic over already congested lines. traffic over already congested lines.

Packet lifetime management

- Packet lifetime management
• It deals with how long a packet may live
before being discarded. Packet lifetime manageme
It deals with how long a packet r
before being discarded.
If it is too long, lost packets may clog
- **Packet lifetime management**
• It deals with how long a packet may live
before being discarded.
• If it is too long, lost packets may clog up the
works for a long time, but if it is too short,
packets may sometimes time ou works for a long time, but if it is too short, PaCKET IIIETIME Mandgement
It deals with how long a packet may live
before being discarded.
If it is too long, lost packets may clog up the
works for a long time, but if it is too short,
packets may sometimes time out befo It deals with how long a packet may live
before being discarded.
If it is too long, lost packets may clog up the
works for a long time, but if it is too short,
packets may sometimes time out before
reaching their destinati retransmissions.

Packet queuing and service policy

- Packet queuing and service policy
• It relates to whether routers have one queue
per input line, one queue per output line or
hoth Packet queuing and service policy
It relates to whether routers have one queue
per input line, one queue per output line or
both. both. • It relates to whether routers have one queue
• It relates to whether routers have one queue
per input line, one queue per output line or
both.
• It relates to order, packets are processed.
(Priority, Round Robin, FIFO)
-

Packet Discard Policy

- **Packet Discard Policy
• When there is no sufficient space in the
queues, discard policy is used to decide which
packet has to be discarded** Packet Discard Policy
When there is no sufficient space in the
queues, discard policy is used to decide which
packet has to be discarded. Packet Discard Policy
When there is no sufficient space in
queues, discard policy is used to decide w
packet has to be discarded.
If the time out is too short, extra packets PACKEL DISCATO POI
When there is no sufficient s
queues, discard policy is used to
packet has to be discarded.
If the time out is too short, extra
be sent unnecessarily.
If it is too long, congestion will be • When there is no sufficient space in the
queues, discard policy is used to decide which
packet has to be discarded.
• If the time out is too short, extra packets will
be sent unnecessarily.
• If it is too long, congestio
- If the time out is too short, extra packets will
- When there is no sumclent space in the
queues, discard policy is used to decide which
packet has to be discarded.
If the time out is too short, extra packets will
be sent unnecessarily.
If it is too long, congestion will b queues, uiscard policy is used to d
packet has to be discarded.
If the time out is too short, extra
be sent unnecessarily.
If it is too long, congestion will be
the response time will suffer y
packet is lost.

Organizing the subnet

- **Canadian Control Control Control Control Control Control of the Subnet.**
• There are two ways for organizing the subnet.
• Nittual site wheat **Organizing the su**
There are two ways for organi:
They are
Virtual-circuit subnet Organizing the subnet
• There are two ways for organizing the sub
They are
a) Virtual-circuit subnet
b) Datagram subnet
-
- b) Datagram subnet

Virtual circuit subnet

- **Virtual circuit subnet
• Virtual circuit subnet is a connection-oriented
• Sirvice, a path is established from source to
estination before the transmitting data** Virtual circuit subnet
Virtual circuit subnet is a connection-oriented
service, a path is established from source to
destination before the transmitting data
packet Virtual circuit subnet
Virtual circuit subnet is a connection-oriented
service, a path is established from source to
destination before the transmitting data
packet. packet. • Virtual circuit subnet is a connection-oriented

• Virtual circuit subnet is a connection-oriented

service, a path is established from source to

destination before the transmitting data

packet.

• This path is called Virtual circuit subnet is a connection-oriented
service, a path is established from source to
destination before the transmitting data
packet.
This path is called virtual circuit and
corresponding subnet is called virtual
- subnet.

Advantages and Disadvantages

Advantages

-
- Advantages and Disadvantages

Holdantages

 Sequence of packets is guaranteed

 Header of shorter length can be used that

contains virtual circuit number

Nisadvantages contains virtual circuit number **Advantages**

- Sequence of packets is guaranteed

- Header of shorter length can be used that

contains virtual circuit number
 Disadvantages

- For each ongoing connection, tables are needed

to be stored at each route **Advantages**

— Sequence of packets is guaranteed

— Header of shorter length can be used that

contains virtual circuit number
 Disadvantages

— For each ongoing connection, tables are needed

to be stored at each route

Disadvantages

-
-

Datagram Subnet

- **Datagram Subnet
• Datagrams are connection-less and the subnet
• corresponding to datagram is called datagram
• subnet Catagram Subnet**
Datagrams are connection-less and the subnet
corresponding to datagram is called **datagram**
subnet. subnet.
- Router maintains the table which specify the Datagram Jubrict
Datagrams are connection-less and the subnet
corresponding to datagram is called **datagram**
subnet.
Router maintains the table which specify the
destination and output link that is used to
send datagram Datagrams are connection-less and the subnet
corresponding to datagram is called **datagram**
subnet.
Router maintains the table which specify the
destination and output link that is used to
send datagram to that destinati

Advantages and Disadvantages Advantages and Disadvantages

Holdantages

- Robust to deal with router fails

- It has capability to deal with congestion.

Disadvantage

• Advantages

-
-

• Disadvantage

- Advantages and Disauvantages

Advantages

 Robust to deal with router fails

 It has capability to deal with congestion.

Disadvantage

 Sequence of packet is not guaranteed at the

destination.

 Quality of service ca destination.
- **Advantages**

 Robust to deal with router fails

 It has capability to deal with congestion.
 Disadvantage

 Sequence of packet is not guaranteed at the

destination.

 Quality of service cannot be provided to real-t application.

Congestion Control in Virtual-Circuit Subnets Congestion Control in Virtual-Circuit
Subnets
• Various mechanisms that are used for controlling
congestion in virtual circuit subnet are,
– New virtual circuit connection are not established

-
- **Congestion Control in Virtual-Circuit**
 Subnets

Various mechanisms that are used for controlling

congestion in virtual circuit subnet are,
 New virtual circuit connection are not established
 into the subnet once Impresses the Subnets

Subnets

Fious mechanisms that are used for controlling

Ingestion in virtual circuit subnet are,
 New virtual circuit connection are not established
 into the subnet once congestion is triggered Subnets
Subnets
strategy is the adminismed of the adminismeration in virtual circuit subnet are,
New virtual circuit connection are not established
Into the subnet once congestion is triggered. This
strategy is known a connection called admission control . In this **Subnets**

Various mechanisms that are used for controlling

congestion in virtual circuit subnet are,

- **New virtual circuit connection are not established**
 into the subnet once congestion is triggered. This

strategy rious mechanisms that are used for controlling
ngestion in virtual circuit subnet are,
New virtual circuit connection are not established
into the subnet once congestion is triggered. This
strategy is known as controllin Congestion in virtual circuit submet are,

- **New virtual circuit connection are not established**
 into the subnet once congestion is triggered. This

strategy is known as controlling the admission of the

connection cal **New virtual circuit connection are not established**
into the subnet once congestion is triggered. This
strategy is known as controlling the admission of the
connection called **admission control**. In this
congestion alread
	- congested.
	-

Congestion Control in Virtual-Circuit Subnets

(a) A congested subnet. (b) A redrawn subnet, eliminates congestion and a virtual circuit from A to B.

Congestion Control in Virtual-Circuit Subnets

- Congestion Control in Virtual-Circuit
Subnets
• Suppose that a host attached to router A wants to
setup a connection to a host attached to router B.
Normally this connection would pass through one Congestion Control in Virtual-Circuit
Subnets
Suppose that a host attached to router A wants to
setup a connection to a host attached to router B.
Normally this connection would pass through one
of the congested routers. Congestion Control in Virtual-Circuit
Subnets
Suppose that a host attached to router A wants to
setup a connection to a host attached to router B.
Normally this connection would pass through one
of the congested routers. of the congested routers. Subnets

Subnets

• Suppose that a host attached to router A wants to

setup a connection to a host attached to router B.

Normally this connection would pass through one

of the congested routers.

• To avoid this situati Suppose that a host attached to router A wants to
setup a connection to a host attached to router B.
Normally this connection would pass through one
of the congested routers.
To avoid this situation we can redraw the subne Suppose that a host attached to router A wants t
setup a connection to a host attached to router E
Normally this connection would pass through on
of the congested routers.
To avoid this situation we can redraw the subne
as
- Setup a connection to a host attached to router B.

Normally this connection would pass through one

of the congested routers.

 To avoid this situation we can redraw the subnet

as shown in above fig(b) omitting the co Normally this connection would pass through one
of the congested routers.
To avoid this situation we can redraw the subnet
as shown in above fig(b) omitting the congested
routers and all of this lines.
The dashed lines sho
-

Disadvantage

- **bisadvantage
• By using this, in the subnet there is a wastage
• bandwidth (resources).** Disadvantage
By using this, in the subnet there is
bandwidth (resources).
If 6 virtual circuits reserves 6 Mbps I
- **Disadvantage**
• By using this, in the subnet there is a wastage
bandwidth (resources).
• If 6 virtual circuits reserves 6 Mbps line. But if
they use only 1 Mbps to pass all the traffic
(nackets) remaining is wasted they use only 1 Mbps to pass all the traffic **DISAUVATILAGE**

By using this, in the subnet there is a wastage

bandwidth (resources).

If 6 virtual circuits reserves 6 Mbps line. But if

they use only 1 Mbps to pass all the traffic

(packets) remaining is wasted.

Congestion control in Datagram subnets

- **Congestion control in Datagram subnets**
• Congestion can be controlled in datagram
subnet by using the **choke packet** is sent by a
node to the source to inform it of congestion **Congestion control in Datagram subnets**
Congestion can be controlled in datagram
subnet by using the **choke packet** is sent by a
node to the source to inform it of congestion. **Congestion control in Datagram subnets**
Congestion can be controlled in datagram
subnet by using the **choke packet** is sent by a
node to the source to inform it of congestion.
In this method the warning is from the router **Congestion control in Datagram subnets**
• Congestion can be controlled in datagram
subnet by using the **choke packet** is sent by a
node to the source to inform it of congestion.
• In this method the warning is from the ro
- about congestion occurs to the source station directly.

Congestion control in Datagram subnets

- **Congestion control in Datagram subnets**
• There are three ways for reducing the traffic.
They are **Congestion control in Datag
There are three ways for redution**
They are
The warning bit **Congestion control in Datagram sulof**
• There are three ways for reducing the
They are
a) The warning bit
b) Choke packets • There are three ways for reducing the traffi

They are

a) The warning bit

b) Choke packets

c) Hop-by hop choke packet
-
- b) Choke packets
-

The warning bit

- **The warning bit
• The old DECNET architecture signaled the
• warning state by setting a special bit in the
packet's header So does frame relay** The warning bit
The old DECNET architecture signaled the
warning state by setting a special bit in the
packet's header. So does frame relay. The warning bit
The old DECNET architecture signaled the
warning state by setting a special bit in the
packet's header. So does frame relay.
When the packet arrived at its destination, the
- When the packet arrived at its destination, the The old DECNET architecture signaled the
warning state by setting a special bit in the
packet's header. So does frame relay.
When the packet arrived at its destination, the
transport entity copied the bit into the next
ack The old DECNET architecture signaled the
warning state by setting a special bit in the
packet's header. So does frame relay.
When the packet arrived at its destination, the
transport entity copied the bit into the next
ack • The old Deciver altified the signated the
warning state by setting a special bit in the
packet's header. So does frame relay.
• When the packet arrived at its destination, the
transport entity copied the bit into the nex
-

Choke packets

- **Choke packets
• The choke packets will have the effect of stopping
(or) slowing down the rate of transmission from
source and hence limit the total number of Choke packets**
The choke packets will have the effect of stopping
(or) slowing down the rate of transmission from
source and hence limit the total number of
packets in the network. **Choke packets**
The choke packets will have the effect of stopping
(or) slowing down the rate of transmission from
source and hence limit the total number of
packets in the network.
Whenever vou moves above the threshold, **Choke packets**
The choke packets will have the effect of
(or) slowing down the rate of transmissi
source and hence limit the total nur
packets in the network.
Whenever you moves above the thresh
output line enter a "warni CITOKE PACKELS
The choke packets will have the effect of stopping
(or) slowing down the rate of transmission from
source and hence limit the total number of
packets in the network.
Whenever you moves above the threshold, t
- Whenever you moves above the threshold, the The choke packets will have the effect of stopping
(or) slowing down the rate of transmission from
source and hence limit the total number of
packets in the network.
Whenever you moves above the threshold, the
output line The choke packets will have the effect of stopping
(or) slowing down the rate of transmission from
source and hence limit the total number of
packets in the network.
Whenever you moves above the threshold, the
output line (or) slowing down the rate of transmission from
source and hence limit the total number of
packets in the network.
Whenever you moves above the threshold, the
output line enter a "warning state". Each newly
arriving packet source and hence limit the total number of
packets in the network.
Whenever you moves above the threshold, the
output line enter a "warning state". Each newly
arriving packet is checked to see if the output line
is in warn

Choke packets

- Choke packets
• When the source hosts get the choke packet,
it is required to reduce the traffic sent to the
specified destination. Typically the first choke Choke packets
When the source hosts get the choke packet,
it is required to reduce the traffic sent to the
specified destination. Typically the first choke
packet causes the data rate, to be reduced to **Choke packets**
When the source hosts get the choke packet,
it is required to reduce the traffic sent to the
specified destination. Typically the first choke
packet causes the data rate to be reduced to
50% of its previous packet causes the data rate to be reduced to **Choke packets**
When the source hosts get the choke packet,
it is required to reduce the traffic sent to the
specified destination. Typically the first choke
packet causes the data rate to be reduced to
50% of its previous When the source hosts get the choke packet,
it is required to reduce the traffic sent to the
specified destination. Typically the first choke
packet causes the data rate to be reduced to
50% of its previous rate, the next • When the source hosts get the choke packet,
it is required to reduce the traffic sent to the
specified destination. Typically the first choke
packet causes the data rate to be reduced to
50% of its previous rate, the nex It is required to reduce the traffic sent to the
specified destination. Typically the first choke
packet causes the data rate to be reduced to
50% of its previous rate, the next one causes a
reduction to 25%, and so on.
In
-

- **Hop-by-Hop choke packets**
• At high speeds or over long distances, sending
• At high speeds or over long distances, sending
• a choke packet to the source hosts does not
• work well because the reaction is so slow. Hop-by-Hop choke packets
At high speeds or over long distances, sending
a choke packet to the source hosts does not
work well because the reaction is so slow. Hop-by-Hop choke packets
At high speeds or over long distances, sending
a choke packet to the source hosts does not
work well because the reaction is so slow.
Example: Congestion control using choke **HOP-DY-HOP CHOKE PACKELS**
At high speeds or over long distances, sending
a choke packet to the source hosts does not
work well because the reaction is so slow.
Example: Congestion control using choke
packets can be done b • At high speeds or over long distances, sending
a choke packet to the source hosts does not
work well because the reaction is so slow.
• Example: Congestion control using choke
packets can be done by two ways.
• In first At fight speeds of over forig distances, sending a choke packet to the source hosts does n work well because the reaction is so slow.
Example: Congestion control using chol
packets can be done by two ways.
In first type, t
- Example: Congestion control using choke
-

Hop-by-Hop choke packets
• A subnet with 6 nodes A, B, C, D, E, F in below
figure, here source node A and destination
node is D Hop-by-Hop choke packets
A subnet with 6 nodes A, B, C, D, E, F in below
figure, here source node A and destination
node is D. Hop-by-Hop choke pa
A subnet with 6 nodes A, B, C, D,
figure, here source node A an
node is D.

Hop-by-Hop choke packets
• When link utilization increased above its
threshold, destination D starts sending choke
packets towards source pode A Hop-by-Hop choke packets
When link utilization increased above its
threshold, destination D starts sending choke
packets towards source node A. Hop-by-Hop choke packets
When link utilization increased above its
threshold, destination D starts sending choke
packets towards source node A.

Hop-by-Hop choke packets
• The choke packet travels through source node
A. A.

Hop-by-Hop choke packets
• After receiving first choke packet source node
• A reduces its flow towards destination Hop-by-Hop choke packets
After receiving first choke packet source node
A reduces its flow towards destination

Hop-by-Hop choke packets
• The reduced packet flow follows the same
reverse path. Hop-by-Hop choke pa
The reduced packet flow follow
reverse path.

Hop-by-Hop choke packets
• The reduced flow reaches to destination node
D. D.

Hop-by-Hop choke packets Hop-by-Hop choke pa
• Flow is reduced

- **Hop-by-Hop choke packets**
• Another way of reducing congestion is that
necessary action is taken at each hop to
reduce the traffic towards the congested Hop-by-Hop choke packets
Another way of reducing congestion is that
necessary action is taken at each hop to
reduce the traffic towards the congested
destination after receiving the choke packet Hop-by-Hop choke packets
Another way of reducing congestion is that
necessary action is taken at each hop to
reduce the traffic towards the congested
destination after receiving the choke packet.
Using this method congesti HOP-by-HOP ChOKe packets
Another way of reducing congestion is that
necessary action is taken at each hop to
reduce the traffic towards the congested
destination after receiving the choke packet.
Using this method, congest faster. • Another way of reducing congestion is that
necessary action is taken at each hop to
reduce the traffic towards the congested
destination after receiving the choke packet.
Using this method, congestion is reduced
faster.
 necessary action is taken at each hop to
reduce the traffic towards the congested
destination after receiving the choke packet.
Using this method, congestion is reduced
faster.
Below figure shows that a choke packet that
a
-

Hop-by-Hop choke packets
• Example: The choke packets that affects on
each hop it passes through. For the same
subpet baying podes A B C D E E source Hop-by-Hop choke packets
Example: The choke packets that affects on
each hop it passes through. For the same
subnet having nodes A, B, C, D, E, F source
node A and destination node D Hop-by-Hop choke packets
Example: The choke packets that affects on
each hop it passes through. For the same
subnet having nodes A, B, C, D, E, F source
node A and destination node D. node A and destination node D.

**D Choke packets
After reaching choke
packets to source node A,
the traffic flow between p choke packets
After Freaching Choke
packets to source node A,
the traffic flow between
node A node E and hence 1 choke packets
After Freaching Choke
packets to source node A,
the traffic flow between
node A, node E and hence
the unto destination node** node A, node E and hence After reaching choke
packets to source node A,
the traffic flow between
node A, node E and hence
the upto destination node
D is reduced. After reaching choke
packets to source node A,
the traffic flow between
node A, node E and hence
the upto destination node
D is reduced.

Load Shedding

- **Load Shedding
• It is applied when none of the technique solve
• Load shedding is a discarding nolicy in which** Load Sheddi
It is applied when none of th
the congestion.
Load shedding is a **discardin**
nackets can be discarded if th
- **Load Shedding
• It is applied when none of the technique solve
the congestion.
• Load shedding is a discarding policy in which
packets can be discarded if the load of packets
are not handled by the router.** packets can be discarded if the load of packets **Load Shedding**
It is applied when none of the technique solve
the congestion.
Load shedding is a **discarding policy** in which
packets can be discarded if the load of packets
are not handled by the router.
It is analogous • It is applied when none of the technique solve
the congestion.
• Load shedding is a **discarding policy** in which
packets can be discarded if the load of packets
are not handled by the router.
• It is analogous to distrib
- It is applied when none of the technique solve
the congestion.
Load shedding is a **discarding policy** in which
packets can be discarded if the load of packets
are not handled by the router.
It is analogous to distribution the congestion.
Load shedding is a **discarding policy** in which
packets can be discarded if the load of packets
are not handled by the router.
It is analogous to distribution of electricity to
certain areas which is ON and Load shedding is a **discarding policy** in wh
packets can be discarded if the load of pack
are not handled by the router.
It is analogous to distribution of electricity
certain areas which is ON and OFF in son
another area,
- **Load Shedding
• When a packet arrives, which packet will be
discarded is basically depends on type of
application and their importance** Load Shedding
When a packet arrives, which packet will be
discarded is basically depends on type of
application and their importance. Load Shedding
When a packet arrives, which packet will be
discarded is basically depends on type of
application and their importance.
There are two policies LOAU JITEUUITIB

When a packet arrives, which packet will be

discarded is basically depends on type of

application and their importance.

There are two policies

— Wine Policy \rightarrow Old is better than new

— Milk Policy When a packet arrives, which packet will be
discarded is basically depends on type of
application and their importance.
There are two policies
— Wine Policy \rightarrow Old is better than new
— Milk Policy \rightarrow New is better tha
- There are two policies
	-
	-

- **Load Shedding
• While transferring a file, old packets are more
valuable and of greater importance than new**
packets Load Shedding
While transferring a file, old packets are more
valuable and of greater importance than new
packets. packets.
- If a new packet is accepted by discarding the **LOAU SHEUUIHS**
While transferring a file, old packets are more
valuable and of greater importance than new
packets.
If a new packet is accepted by discarding the
old one, it will cause retransmission of packet
from an old While transferring a file, old packets
valuable and of greater importance t
packets.
If a new packet is accepted by disca
old one, it will cause retransmission
from an old packet.
This strategy is called the **wine strate** • wrillie transferring a file, old packets are more
valuable and of greater importance than new
packets.
• If a new packet is accepted by discarding the
old one, it will cause retransmission of packet
from an old packet.
•
-

- **Load Shedding
• While transferring real-time** data such as
audio, video, multimedia packet, a new packet
is more important than an old packet **Load Shedding
While transferring real-time** data such as
audio, video, multimedia packet, a new packet
is more important than an old packet. Load Shedding
While transferring real-time data such as
audio, video, multimedia packet, a new packet
is more important than an old packet.
This strategy is called milk strategy. • While transferring **real-time** data such a audio, video, multimedia packet, a new packe is more important than an old packet.
• This strategy is called **milk strategy**.
Ex: Multimedia Application
-

- **Load Shedding
• Another useful way of discarding the packets is by
• assigning priorities to each packet. Packets with
low priority will be discarded first and packets** Load Shedding
Another useful way of discarding the packets is by
assigning priorities to each packet. Packets with
low priority will be discarded first and packets
with very high priority will never be discarded. **Load Shedding**
Another useful way of discarding the packets is by
assigning priorities to each packet. Packets with
low priority will be discarded first and packets
with very high priority will never be discarded.
Ex - **F** with very high priority will never be discarded. **Load Shedding**
• Another useful way of discarding the packets is by
assigning priorities to each packet. Packets with
low priority will be discarded first and packets
with very high priority will never be discarded.
• Ex Another useful way of discarding the packets is by
assigning priorities to each packet. Packets with
low priority will be discarded first and packets
with very high priority will never be discarded.
Ex - **For ATM networks**
- Another useful way of discarding the packets is by
assigning priorities to each packet. Packets with
low priority will be discarded first and packets
with very high priority will never be discarded.
Ex **For ATM networks** assigning priorities to each packet. Packets with
low priority will be discarded first and packets
with very high priority will never be discarded.
Ex - **For ATM networks** priority is marked with
using the cell loss priori low priority will be discarded first and packets
with very high priority will never be discarded.
Ex - **For ATM networks** priority is marked with
using the cell loss priority (CLP) in which value of
"1" specifies that the

- **Standard Standard Stand**
- **packet arrival times is called jitter.**
• The variation (i.e. standard deviation) in the packet arrival times is called **jitter**.
• Jitter control is a mechanism that is used to set
the **transmission speed**, so that all t **Jitter Control**
The variation (i.e. standard deviation) in the
packet arrival times is called **jitter**.
Jitter control is a mechanism that is used to set
the **transmission speed**, so that all the packets
are transmitted w are transmitted with the same transmission speed. • The variation (i.e. standard deviation) in the packet arrival times is called **jitter**.
• Jitter control is a mechanism that is used to set the **transmission speed**, so that all the packets are transmitted with the same
- The variation (i.e. standard deviation) in the
packet arrival times is called **jitter**.
Jitter control is a mechanism that is used to set
the **transmission speed**, so that all the packets
are transmitted with the same tran The Variation (i.e. standard deviation) in the
packet arrival times is called **jitter**.
Jitter control is a mechanism that is used to set
the **transmission speed**, so that all the packets
are transmitted with the same tran packet arrival times is called **Jitter**.
Jitter control is a mechanism that is used to set
the **transmission speed**, so that all the packets
are transmitted with the same transmission
speed.
It is basically used to avoid a Jitter control is a mechanism that is used to s
the **transmission speed**, so that all the packe
are transmitted with the same transmissic
speed.
It is basically used to avoid any speed mismatch
among the packets that are t

- **Fighthary Fight State of State 1**
• Hight jitter, example having some packets
taking 20msec and other taking 30msec to
arrive will give an uneven quality to sound (or) Jitter Control
High jitter, example having some packets
taking 20msec and other taking 30msec to
arrive will give an uneven quality to sound (or)
movie as shown in below figure Jitter Control
High jitter, example having some packets
taking 20msec and other taking 30msec to
arrive will give an uneven quality to sound (or)
movie as shown in below figure. movie as shown in below figure. • High jitter, example having some packets
taking 20msec and other taking 30msec to
arrive will give an uneven quality to sound (or)
movie as shown in below figure.
• In an agreement that 99% of packets be
delivered with a High jitter, example having some packets
taking 20msec and other taking 30msec to
arrive will give an uneven quality to sound (or)
movie as shown in below figure.
In an agreement that 99% of packets be
delivered with a del High jitter, example having some packe
taking 20msec and other taking 30msec t
arrive will give an uneven quality to sound (o
movie as shown in below figure.
In an agreement that 99% of packets k
delivered with a delay in
-

- **State of State 11**
• Jitter control does this by calculating the jitter that is,
the transmit time expected for each hop along the
path. This jitter information is maintained at each **State of State of State of State of State of State State State is and State intermol does this by calculating the jitter that is, the transmit time expected for each hop along the path. This jitter information is maintain Jitter Control**
Jitter control does this by calculating the jitter that is,
the transmit time expected for each hop along the
path. This jitter information is maintained at each
intermediate router and is updated with eac **Jitter Control**
Jitter control does this by calculating the jitter that is,
the transmit time expected for each hop along the
path. This jitter information is maintained at each
intermediate router and is updated with eac **Jitter Control**
Jitter control does this by calculating the jitter that is,
the transmit time expected for each hop along the
path. This jitter information is maintained at each
intermediate router and is updated with eac • Jitter control does this by calculating the jitter that is,
the transmit time expected for each hop along the
path. This jitter information is maintained at each
intermediate router and is updated with each hop.
• The ro
- The router checks if a packet that has arrived is behind
- Jitter control does this by calculating the jitter that is,
the transmit time expected for each hop along the
path. This jitter information is maintained at each
intermediate router and is updated with each hop.
The router The term is the transmit time expected for each hop along the
path. This jitter information is maintained at each
intermediate router and is updated with each hop.
The router checks if a packet that has arrived is behind
(speed. From the pitter internation is internationed at each intermediate router and is updated with each hop.
• The router checks if a packet that has arrived is behind (or) ahead of its transmit time.
• If the packet is **behind**
-

Solution State of State 1 Sta State of the State State is the path. When a packet arrives at a router, the router checks to see how much the packet is Jitter Control
Jitter can be bounded by computing the
expected transit time for each hop along the
path. When a packet arrives at a router, the
router checks to see how much the packet is
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information Jitter can be bounded by computing
expected transit time for each hop along
path. When a packet arrives at a router,
router checks to see how much the pack
behind or ahead of its schedule.
information is stored in the pack

Fig. 4
• In some applications, such as **video on**
demand, jitter can be eliminated by buffering
at the receivers and then fetching data for **Jitter Control**
In some applications, such as **video on**
demand, jitter can be eliminated by buffering
at the receivers and then fetching data for
display from the buffer **Jitter Control**
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