Demystifying Networking

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Lecture – 47
Dynamic Routing with Distance Vector

As we saw routers need to compute the information in order to deliver a packet from the source to any destination in the network. And in order to do so, they exchange information with other routers on the network, to create what are called routing tables.

If we look at it a little more in detail, there are actually three types of routing mechanisms that are possible.

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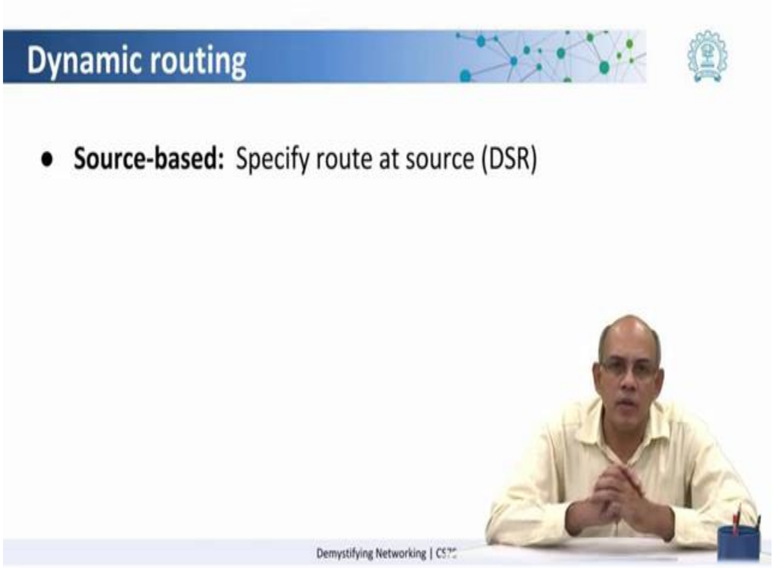

Dynamic routing

- **Source-based:** Specify route at source (DSR)

One mechanism is called source-based routing, wherein the entire route is specified at the source itself. There are some algorithms which work in this manner such as Dynamic Source Routing or DSR, but we will not be getting into details of these algorithms.

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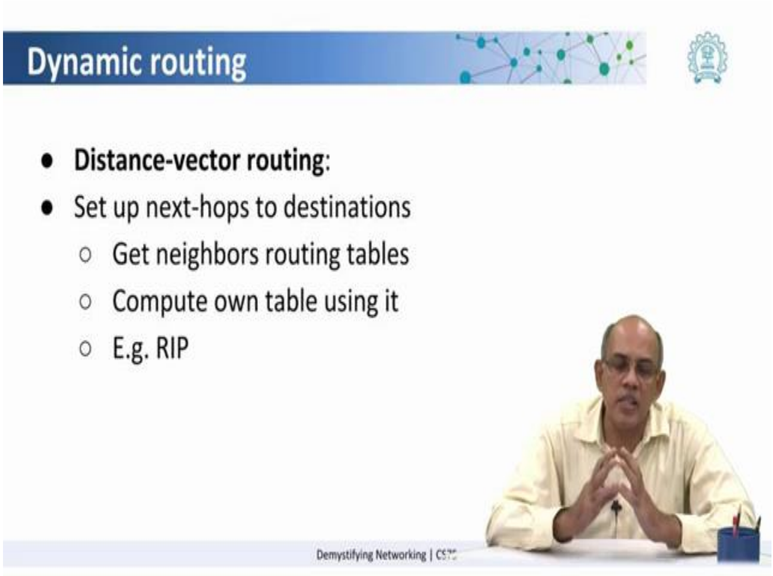

Dynamic routing

- **Distance-vector routing**:
- Set up next-hops to destinations
  - Get neighbors routing tables
  - Compute own table using it
  - E.g. RIP

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Another mechanism is to specify the next hop to the route, wherein each router has a picture of what are the links that is connected to and what are the hops to different destinations. This is called distance vector routing.

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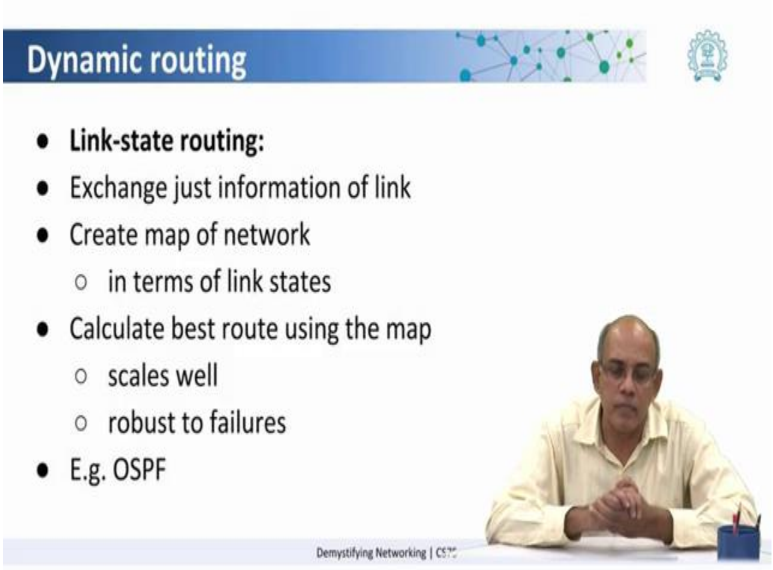

Dynamic routing

- **Link-state routing:**
- Exchange just information of link
- Create map of network
  - in terms of link states
- Calculate best route using the map
  - scales well
  - robust to failures
- E.g. OSPF

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A third mechanism is called link-state routing, where in the routers only exchange information about the links. Instead of exchanging the entire routing table, all they do is, they exchange information about the next hop or the links to which they are directly connected. And as the router gets the information of the links from all over the network, the router is able to create a topology or a picture of the network.

Then the router uses this topology in order to determine what is the next hop for sending a given packet. This is a very commonly used mechanism in internet routing because it scales quite well and it is also robust to failures in the network. One example of such link-state routing is called the Open Shortest Path First Algorithm or OSPF.

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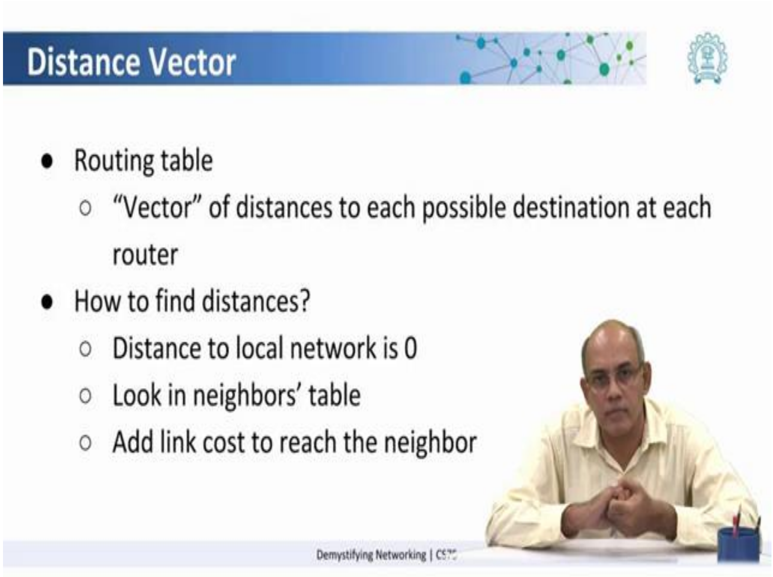

Distance Vector

- Routing table
  - "Vector" of distances to each possible destination at each router
- How to find distances?
  - Distance to local network is 0
  - Look in neighbors' table
  - Add link cost to reach the neighbor

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Now, let us look at an example of how the distance vector algorithm works. Basic idea is that each router has a routing table. The routing table is nothing but a vector of distances to every other router that it knows of in the network. So, the question is how to find these distances? So, very simple idea is used that the distance to the local network is 0, that is the first point. The second point is that when routers exchange tables, they look in their neighbors routing tables and they add the link cost to reach the neighbor.

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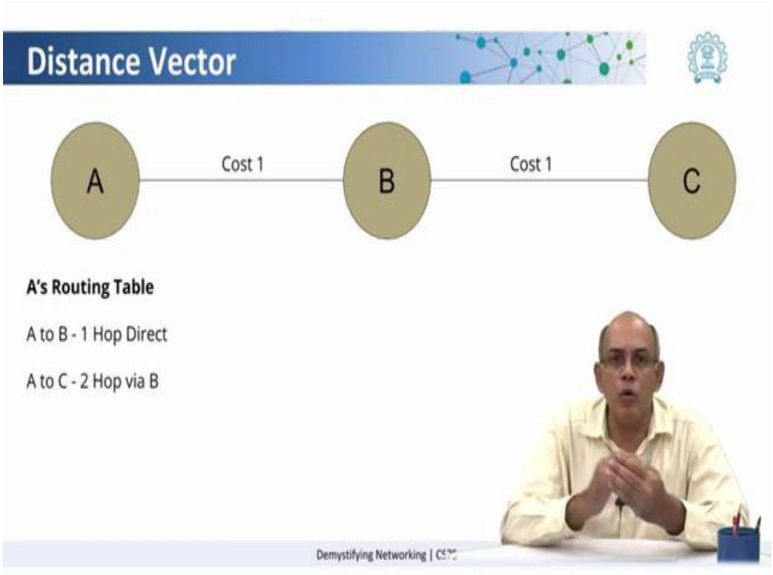

Distance Vector

A's Routing Table

A to B - 1 Hop Direct

A to C - 2 Hop via B

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So, for example, if A is connected to B which is connected to C. Initially, A knows only the route up to B and when it receives the update from B, saying that B is connected to C with the cost of 1, he now knows that it can reach C with a cost of 2, because it can send the packet to B that is one cost and then B can forward it in turn to C that is a cost of 2. So, this is the basic idea of how the routing table is constructed in a distance vector algorithm.

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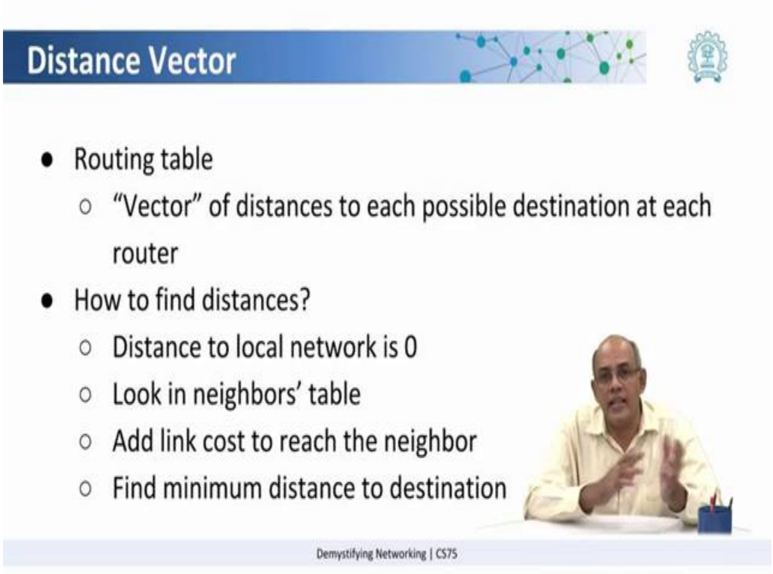

Distance Vector

- Routing table
  - "Vector" of distances to each possible destination at each router
- How to find distances?
  - Distance to local network is 0
  - Look in neighbors' table
  - Add link cost to reach the neighbor
  - Find minimum distance to destination

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Now, using this table, the routers find the minimum distances to various destinations in the network.

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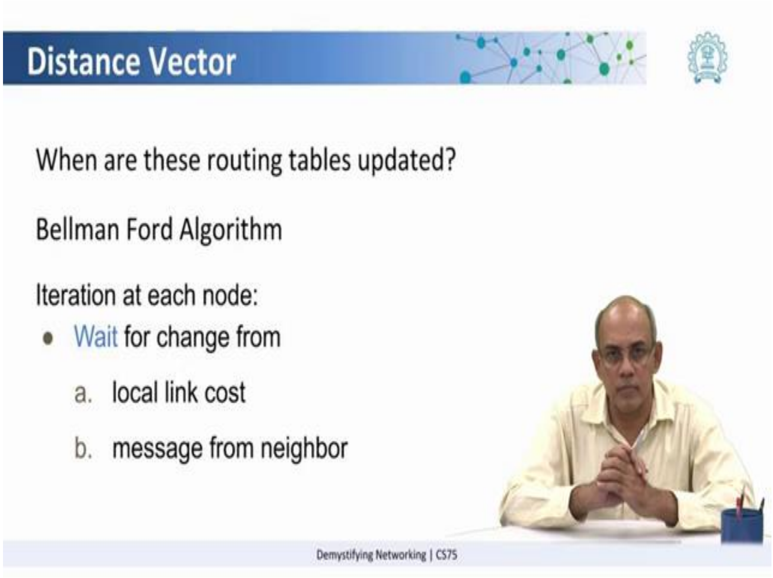

Distance Vector

When are these routing tables updated?

Bellman Ford Algorithm

Iteration at each node:

- Wait for change from
  a. local link cost
  b. message from neighbor

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When are these routing tables updated? In order to update the routing table, the algorithm that is used is actually called the Bellman Ford algorithm. It works iteratively and has three steps.

In the first step, it simply waits for something to change. What can be the change? The change can either be local, that some link that is connected to me as a router that has gone down or the change can be that I received a packet from one of my neighbors, a routing table update from one of my neighbors.

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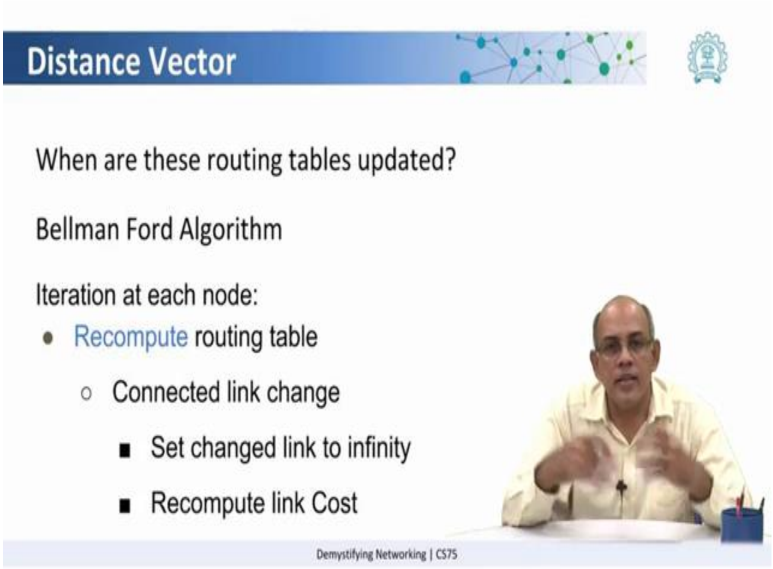

Distance Vector

When are these routing tables updated?

Bellman Ford Algorithm

Iteration at each node:

- Recompute routing table
  - Connected link change
    - Set changed link to infinity
    - Recompute link Cost

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So, once the has happened then what the Bellman Ford algorithm does is, it says recompute the distance table based on the change. So, if the link has gone down or if some changes happened in my link, then I have to set that link cost to infinity and recompute the routing table. If I have received new information from my neighbor, then I have to merge that neighbor's information into my current routing table.

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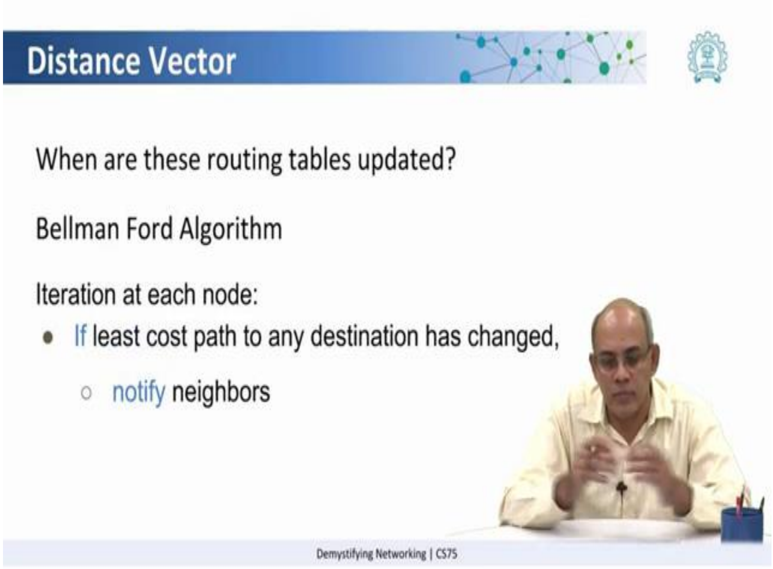

Distance Vector

When are these routing tables updated?

Bellman Ford Algorithm

Iteration at each node:

- If least cost path to any destination has changed,
  - notify neighbors

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The third step is, as a result of this, if the least cost to any destination in the network is changed, then I have to propagate this information to my own neighbors. So that, that information can be updated in all the routers in the network.

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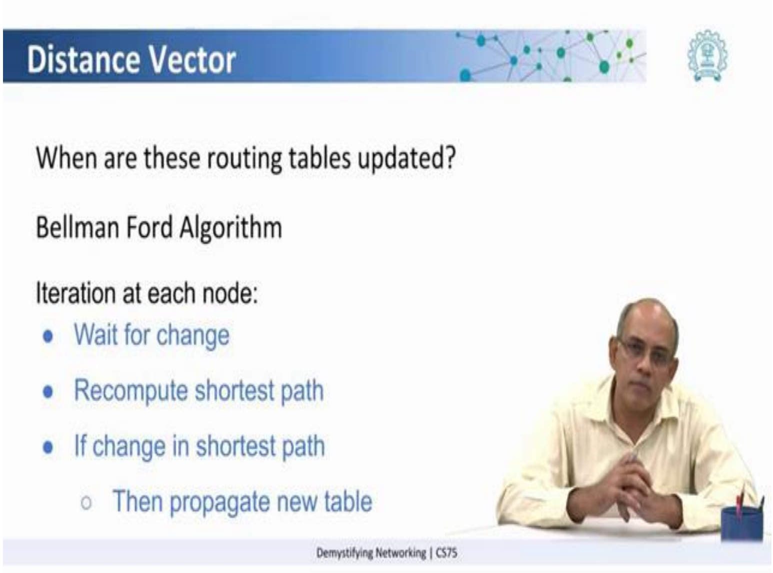

Distance Vector

When are these routing tables updated?

Bellman Ford Algorithm

Iteration at each node:

- Wait for change
- Recompute shortest path
- If change in shortest path
    - Then propagate new table

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So essentially, the Bellman Ford algorithm has three steps one is to wait for some change to happen, second is as a result of the change if some recomputation has to be done, it is done and third as a result of the recomputation, if the information has to be repropagated through the network, it is propagated.

Now, we will see an example of how this algorithm works in a typical network.