IT/CYBR 4323, Chapter 13:

Routing-Update Algorithms

- Mr. Donald Privitera
- Kennesaw State University
- Marietta Campus
- College of Computing and Software Engineering
- IT Department
- dprivit2@kennesaw.edu

Concepts:

1. Distance-Vector Routing-Update Algorithm
2. Distance-Vector Slow-Convergence Problem
3. Observations on Minimizing Route Cost
4. Loop-Free Distance Vector Algorithms
5. Link-State Routing-Update Algorithm
6. Routing on Other Attributes
7. ECMP (Equal-Cost MultiPath routing)

Major Algorithms: Distance-Vector and Link-State

Distance Vector Routing	Link State Routing
Typically for smaller sites	Preferred for larger sites
Uses less bandwidth	Uses more bandwidth
Bellman-Ford Algorithm	Dijkstra's Algorithm
Less traffic	More traffic
Slow convergence	Fast convergence
Count to infinity problem	No count to infinity problem
Looping problem with some implementations	May have transient loops (not persistent)
Local knowledge based on neighbors	Global knowledge needed about entire network
RIP, RIPv2, DSDV, AODV, HWMP, EIGRP	OSPF, ISIS

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1. Distance-Vector Routing-Update Algorithm

Ideal for small sites.

Used by the Routing Information Protocol (RIP [classful routing only] & RIPv2 [supports CIDR]).

Costs are administratively assigned to each link.

Total cost to a destination: number of links to that destination ("hopcount")

Each router reports the ⟨destination,cost⟩ portion of its table ("vector") to its neighboring routers at regular intervals

Distance-Vector Update Rules:

1. New destination
2. Lower cost
3. Next_hop increase (bad-news case)

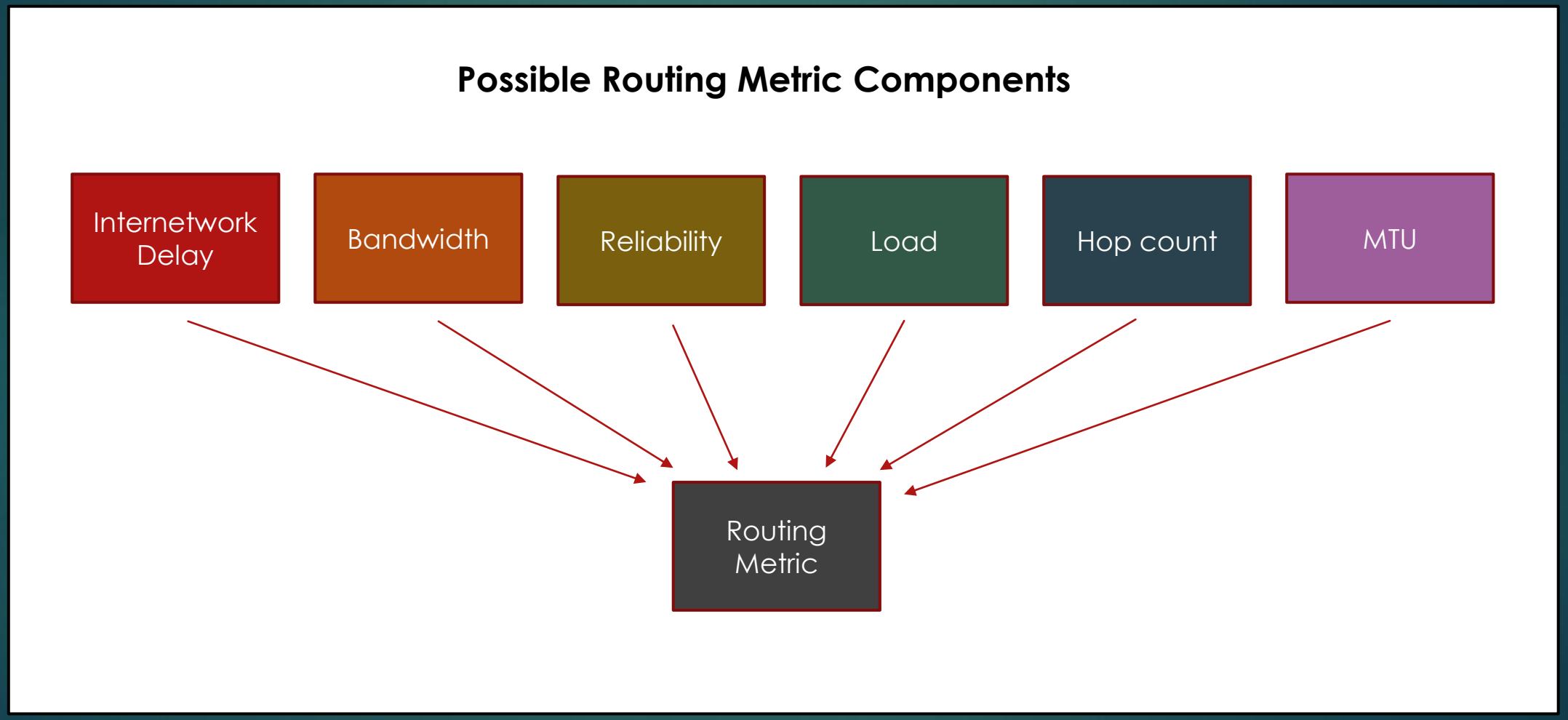
2. Distance-Vector Slow-Convergence Problem

Good news travels fast.
Bad news travels slow making routes inefficient or problematic until convergence occurs.

Mechanisms to compensate:

1. **Limit infinity value (RIP = 16, updates every 30 sec)**
2. **Split-horizon fix** (often includes **poison reverse)**:
3. **Triggered updates**
4. **Hold down**

3. Observations On Minimizing Route Cost



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4. Loop-Free Distance Vector Algorithms

1. Destination-Sequenced Distance Vector (DSDV):
   Avoids routing loops by the introduction of sequence numbers: each router will always prefer routes with the most recent sequence number.
   Ideal for wired networks and small stable MANETS.
   Forwarding tables contain entries for every node.

2. Ad-hoc On-demand Distance Vector routing (AODV):
   Messages circulate only if a link breaks, or when a node is looking for a route to some other node.
   Ideal for larger MANETS.
   100% loop free.
   Can take time to identify shortest routes.
   Can accommodate mobile MANETS.

4. Loop-Free Distance Vector Algorithms (cont.)

3. Hybrid Wireless Mesh Protocol (HWMP):
   Based on AODV.
   Ideal for (but not limited to) 802.11s WiFi mesh networks

4. Enhanced Interior Gateway Routing Protocol (EIGRP):
   Originally proprietary developed by CISCO
   Eliminates risk of routing loops.
   Based on the Distributed Update Algorithm (DUAL)

5. Link-State Routing-Update Algorithm

- Alternative to Distance-Vector.
- Often ideal for large networks such as ISP's.
- Can have loops that exist for a short time (ephemeral)
- 2 key protocols: OSPF and ISIS
- Maximum information about network required (full map of all nodes and links).
- Suitable for QOS
- Bad news travels fast.
- Fast route recalculation on bad news.
- Distributes network map information through a modified form of broadcast (reliable flooding) of the status of each individual link (link-state packets).
- Allows calculation of routes on demand (results are then cached).
- Uses sequence numbers to keep messages fresh.

6. Routing on Other Attributes

- Policy-based routing, because packets are routed according to attributes specified by local administrative policy.
- Route packets based in part on the packet source or on the TCP port number.
- Important component of traffic engineering.
- Sometimes used to *mark* packets for special processing.
- The collection of tables and rules is known as the routing policy database.

7. ECMP (Equal-Cost MultiPath routing)

- A technique for combining two (or more) routes to a destination into a single unit to better leverage available bandwidth.
- Traffic to that destination is distributed (not necessarily equally) among the routes.
- Does not necessarily mean equal-propagation-delay.
- Usually configured to send all the packets of any one TCP connection over just one of the links (as determined by a hash function). Multiple TCP links can be routed over separate paths.