Distance-Vector Routing

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Outline

- Recap on link-state routing
- Distance-vector routing
- Bellman-Ford equation
- Distance-vector algorithm
- Examples

Recap on Routing

- Goal: each router *u* must compute, for every other router *v*, the next-hop neighbor *x* that is on the least-cost path from *u* to *v*

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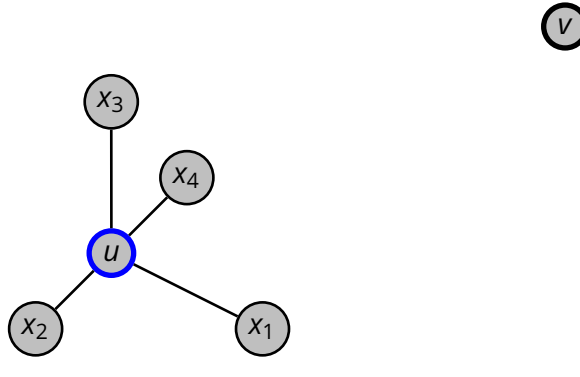

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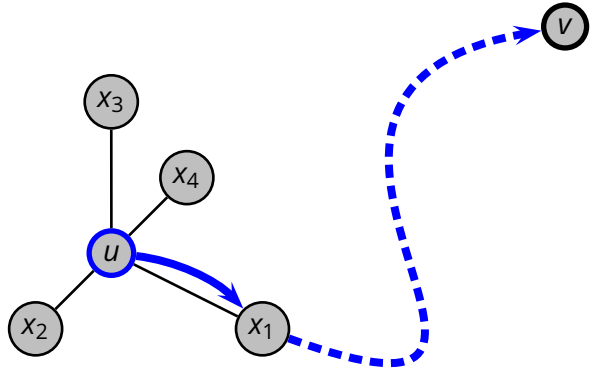

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- Routers use LSAs from other routers to compile an image of the entire network
- With a complete knowledge of the network topology, routers perform a local computation (Dijkstra's algorithm) to find the least-cost paths to every other router
- In essence
  - *broadcast transmission of topology information*
  - *global knowledge of the network*
  - *local computation*

Changes in Link Costs

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- The measured costs are used to build LSAs, which are issued also at regular intervals
- Changes in link costs are propagated quickly to all routers
- Routers can then react by recomputing paths and by updating their forwarding tables accordingly
  - in fact, this “reaction” is not different from the normal behavior of the protocol

Distance-Vector Routing

Distance-Vector Routing

- Every router u maintains a *"distance vector"*
  - v is a destination node in the network
  - $D_u[v]$ is the best known distance between u and v
  - $n_u[v]$ is the next-hop router on the best known path to v

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- After a number of iterations, *the algorithm converges to a point where every router has a minimal distance vector*

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  - router u does not know about any link cost except its adjacent links
- Global computation
  - the computation is actually distributed

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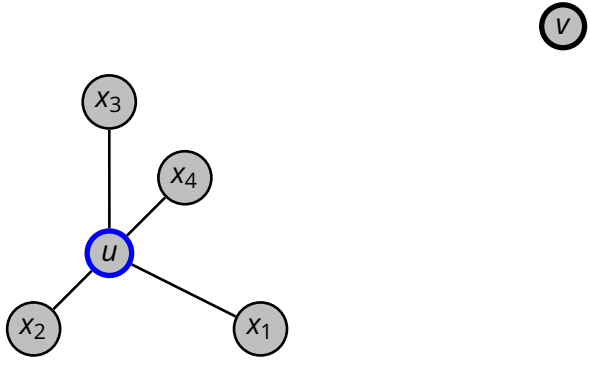

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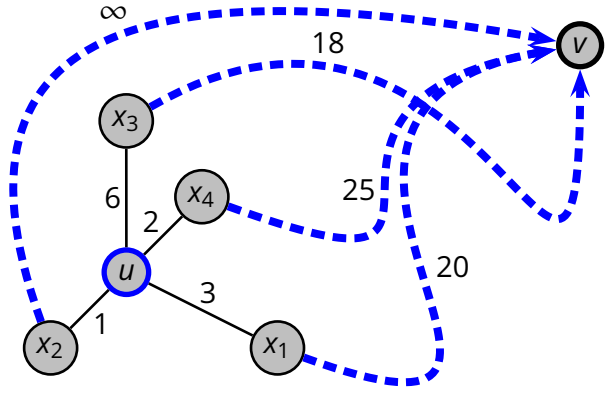

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  - $D_u[v]$, cost of the least-cost path from u to v (distance vector)
  - $n_u[v]$, next-hop node (neighbor of u) on the least-cost path from u to v
  - $D_x[v]$, distance vectors of every neighbor node x

Distance-Vector Algorithm: Initialization

```
    ▷ Initialization
1   for v ∈ V
2         do if v ∈ neighbors(u)
3               then D_u[v] ← c(u, v)
4                    n_u[v] ← v
5               else  D_u[v] ← ∞
6   for x ∈ neighbors(u)
7         do for v ∈ V
8                  do D_x[v] ← ∞
9   send D_u to all neighbor nodes
```

Distance-Vector Algorithm: Loop

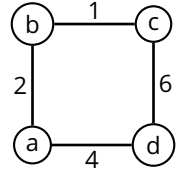
```
1  when D'_x is received from neighbor x
2       do D_x ← D'_x
3          for v ∈ N
4               do D_u[v] ← min_{x∈neighbors(u)}(c(u, x) + D_x[v])
5          if D_u was updated
6            then send D_u to all neighbor nodes

7  when link cost c(u, x) changes
8       do for v ∈ N
9               do D_u[v] ← min_{x∈neighbors(u)}(c(u, x) + D_x[v])
10         if D_u was updated
11           then send D_u to all neighbor nodes
```

Distance-Vector Algorithm: D_u Update

```
    ▷ updating D_u:
    ▷ ∀v ∈ N : D_u[v] ← min_{x∈neighbors(u)}(c(u,x) + D_x[v])
1   updated ← FALSE
2   for v ∈ N
3         do for x ∈ neighbors(u)
4               do if D_u[v] > c(u,x) + D_x[v]
5                     then D_u[v] ← c(u,x) + D_x[v]
6                          n_u[v] ← x
7                          updated ← TRUE
```

Example



Example

(a)	a	b	c	d
D_a	0	2	∞	4
D_b	∞	∞	∞	∞
D_d	∞	∞	∞	∞

(b)	a	b	c	d
D_b	2	0	1	∞
D_a	∞	∞	∞	∞
D_c	∞	∞	∞	∞

(c)	a	b	c	d
D_c	∞	1	0	6
D_b	∞	∞	∞	∞
D_d	∞	∞	∞	∞

(d)	a	b	c	d
D_d	4	∞	6	0
D_a	∞	∞	∞	∞
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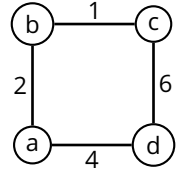

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D_a	0	2	**3**	4
D_b	2	0	1	∞
D_d	4	∞	6	0

(b)	a	b	c	d
D_b	2	0	1	∞
D_a	∞	∞	∞	∞
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(b)	a	b	c	d
D_b	2	0	1	**6**
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(c)	a	b	c	d
D_c	∞	1	0	6
D_b	∞	∞	∞	∞
D_d	∞	∞	∞	∞

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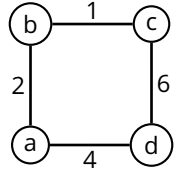

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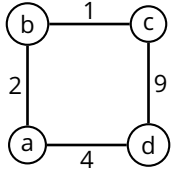

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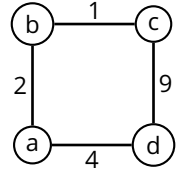

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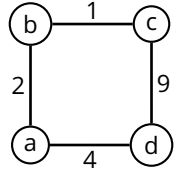

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