Basics of Routing and Link-State Routing

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Outline

- Routing problem
- Graph model
- Classes of routing algorithms
- Broadcast routing
- Link-state routing
- Dijkstra’s algorithm

Routing Problem

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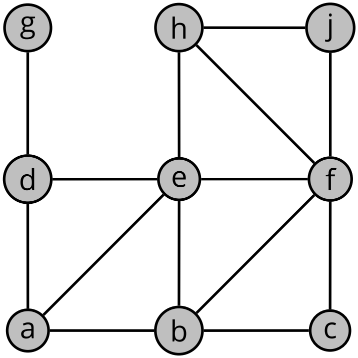

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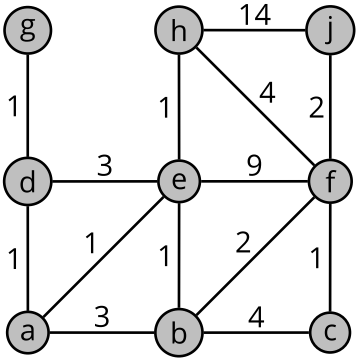

- Example: $a \longrightarrow j$?

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  - A ***cost*** function $c : E \rightarrow \mathbb{R}$
    - costs are always positive: $c(e) > 0$ for all $e \in E$
    - links are symmetric: $c(u, v) = c(v, u)$ for all $u, v \in N$

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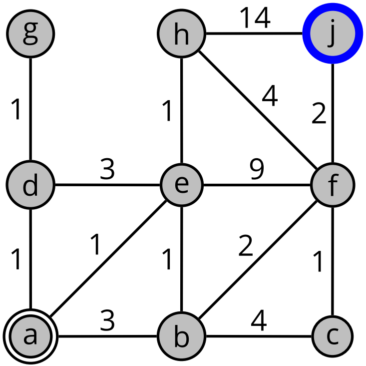
- Compile u's forwarding table by adding the following entry:

$$A(v) \longrightarrow I_u(x_1)$$

  - $A(v)$ is the address (or set of addresses) of router v
  - $I_u(x_1)$ is the interface that connects u to the first next-hop router x_1 in $P_{u \to v} = u, x_1, x_2, \ldots, x_n, v$

Back To The Example



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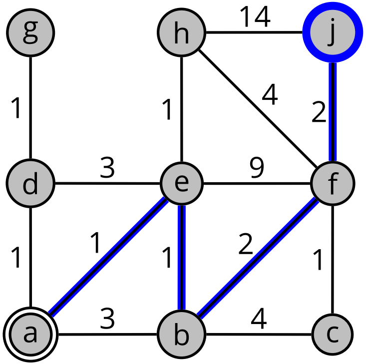

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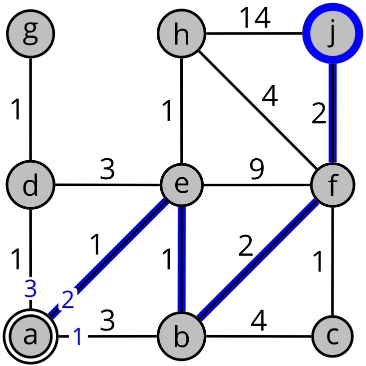

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  - least-cost path is $P_{a \to j} = a, e, b, f, j$
  - a's forwarding table will contain an entry $\boxed{j \rightarrow 2}$ since $l_a(e) = 2$

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  - the computation is local

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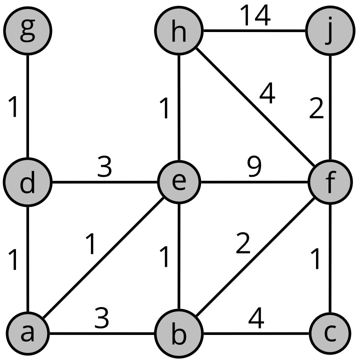

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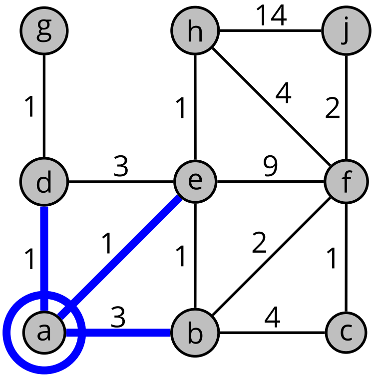

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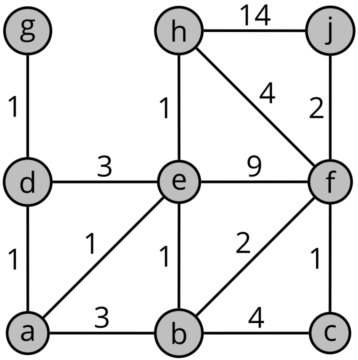

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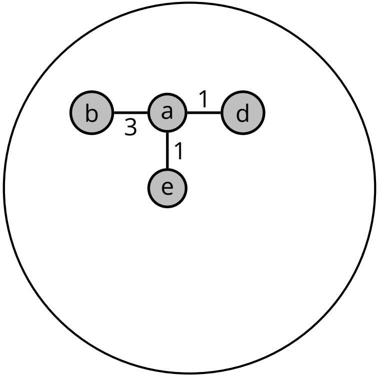

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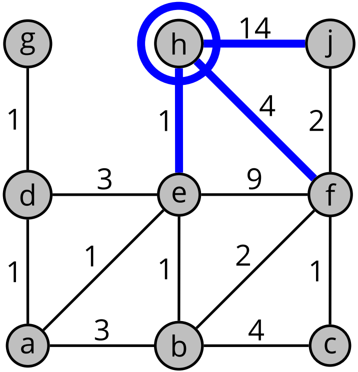

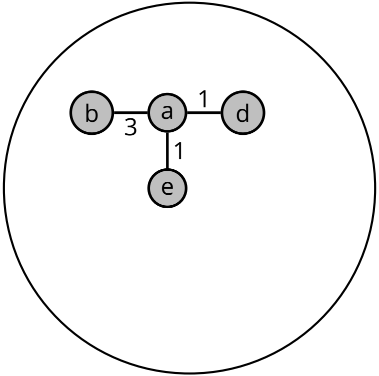

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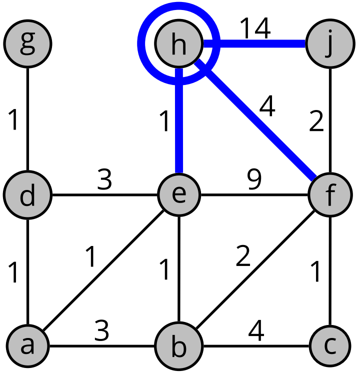

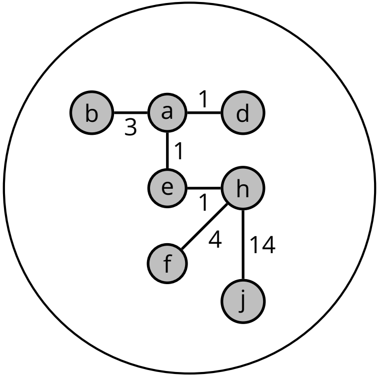

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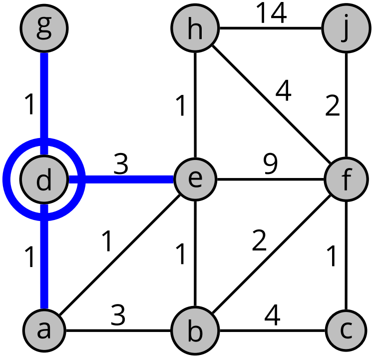

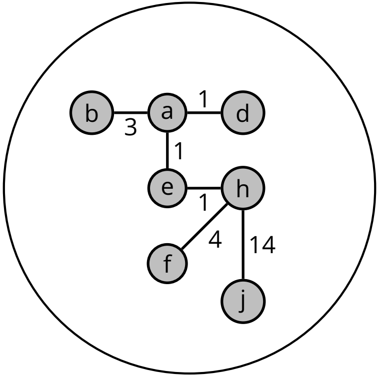

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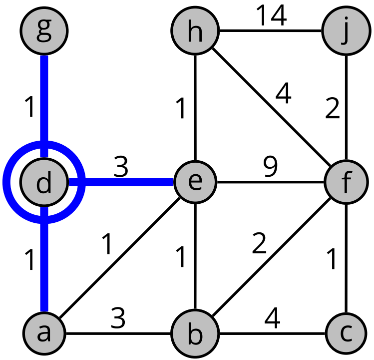

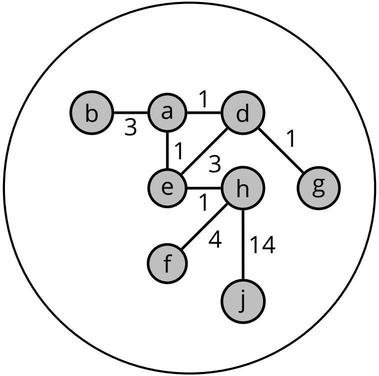

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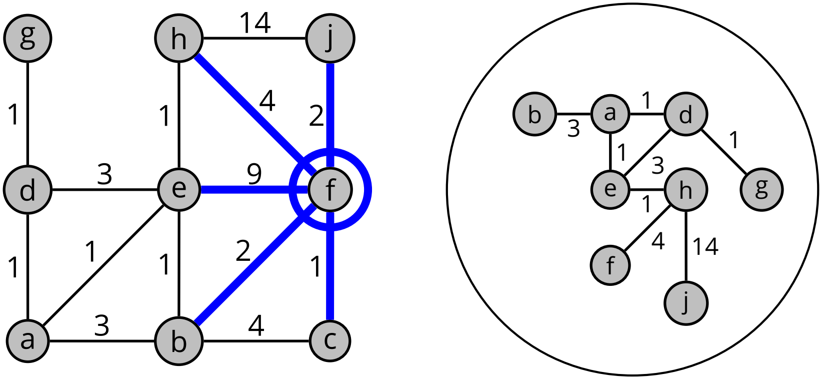

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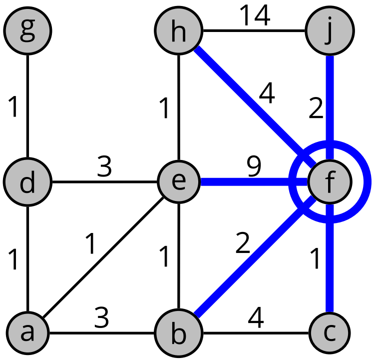

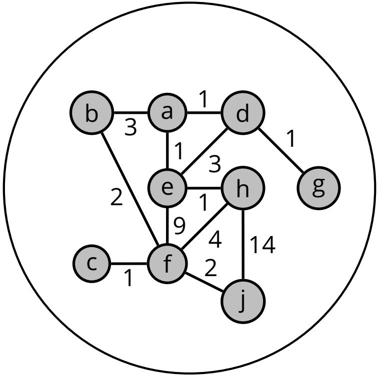

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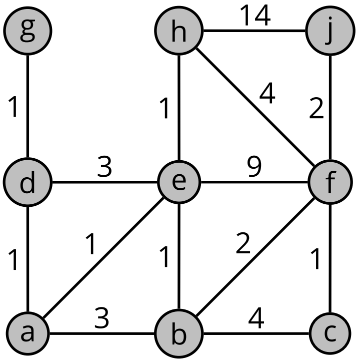

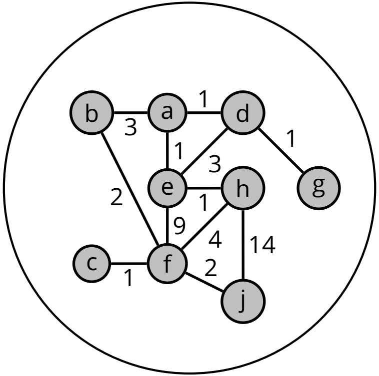

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- Once we have all the LSAs from every router, and therefore we complete knowledge of G, we need an ***algorithm to compute least-cost paths in a graph***

Broadcast Routing

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  - cycles in the network create *packet storms*

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  - it requires (unicast) routing information
  - so it is obviously useless to implement a routing algorithm

Broadcast Routing (3)

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  - u updates its table of sequence numbers $n_s \leftarrow seq(p)$

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  - $D[v]$, cost of the least-cost path from u to v
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  - N, nodes of G whose least-cost path from u is definitely known

Dijkstra's Algorithm

```
DIJKSTRA(G = (V, E), u)
N ← {u}
for all v ∈ V
      do if v ∈ neighbors(u)
            then D[v] ← c(u, v)
                 p[v] ← u
            else  D[v] ← ∞
while N ≠ V
      do find w ∉ N such that D[w] is minimum
         N ← N ∪ {w}
         for all v ∈ neighbors(w) \ N
              do if D[w] + c(w, v) < D[v]
                    then D[v] ← D[w] + c(w, v)
                         p[v] ← w
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Example

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