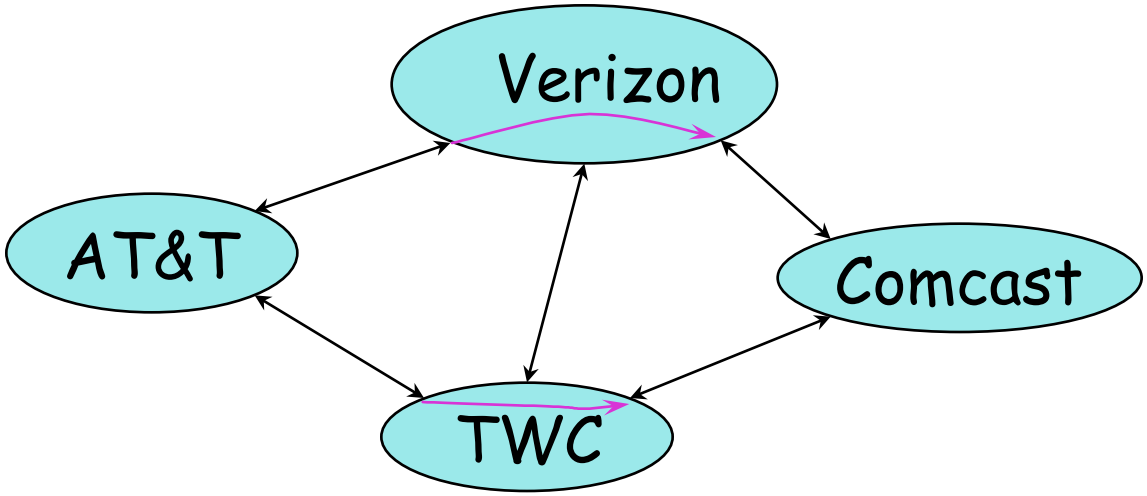
Interdomain Routing

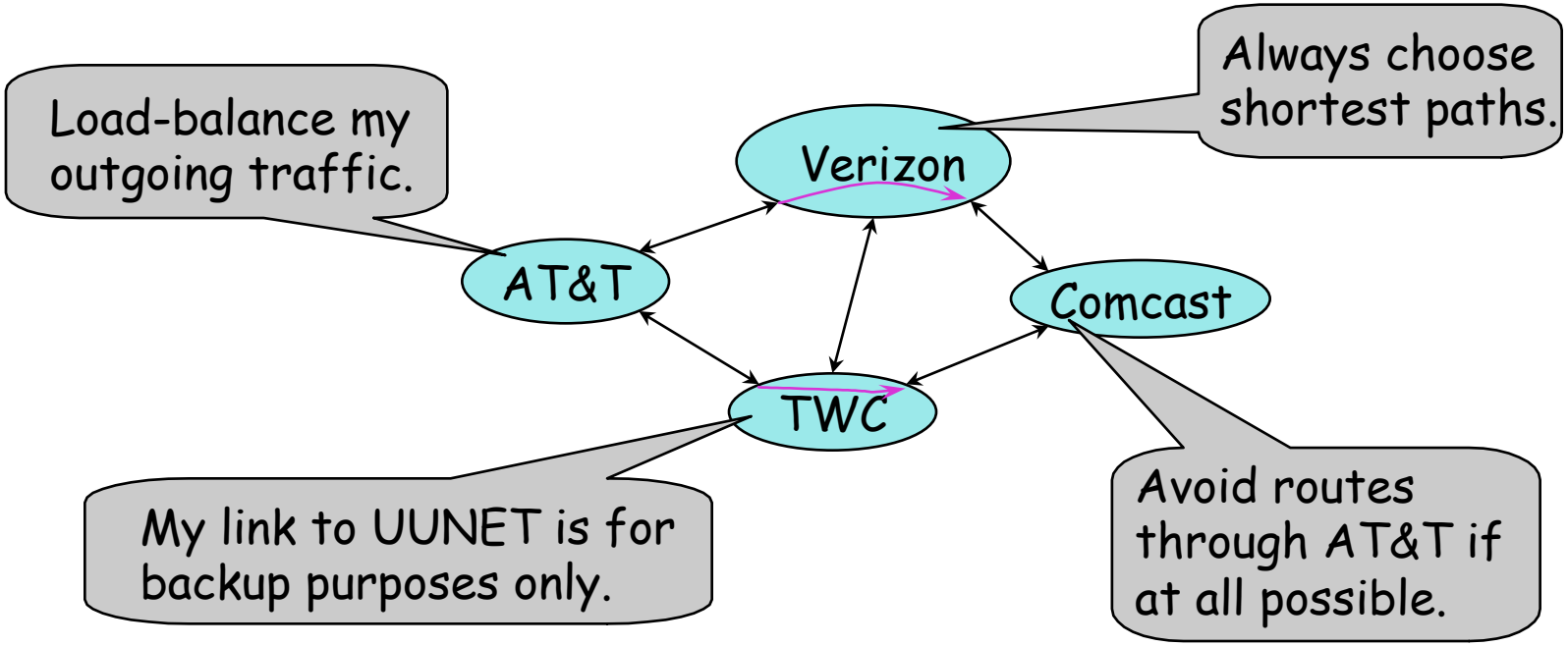
Establish routes between autonomous systems (ASes).



Currently done with the Border Gateway Protocol (BGP).

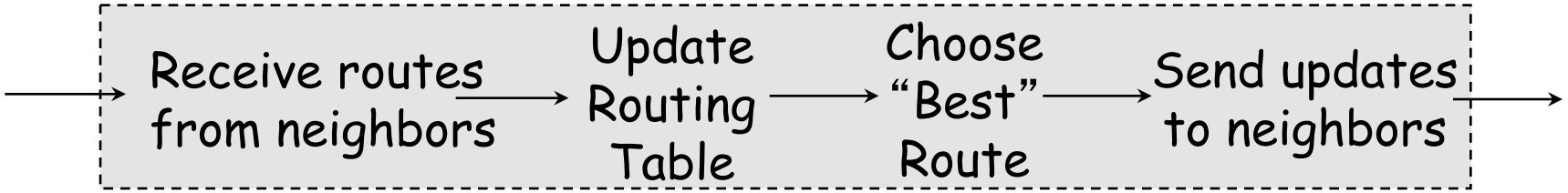
Why is Interdomain Routing Hard?

- Route choices are based on *local policies*.
- Autonomy: Policies are uncoordinated.
- Expressiveness: Policies are complex.



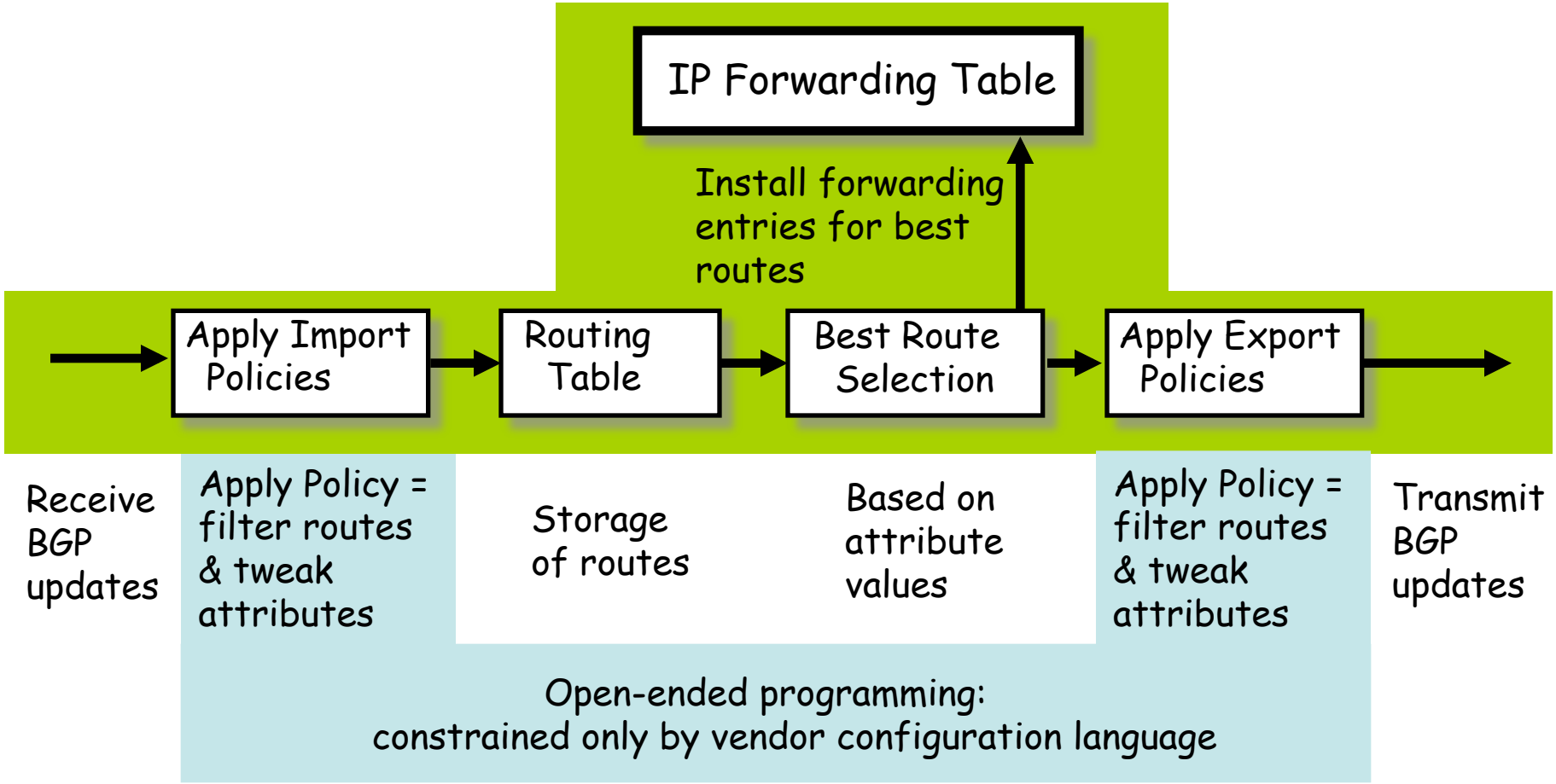
BGP Route Processing (1)

- The computation of a single node repeats the following:

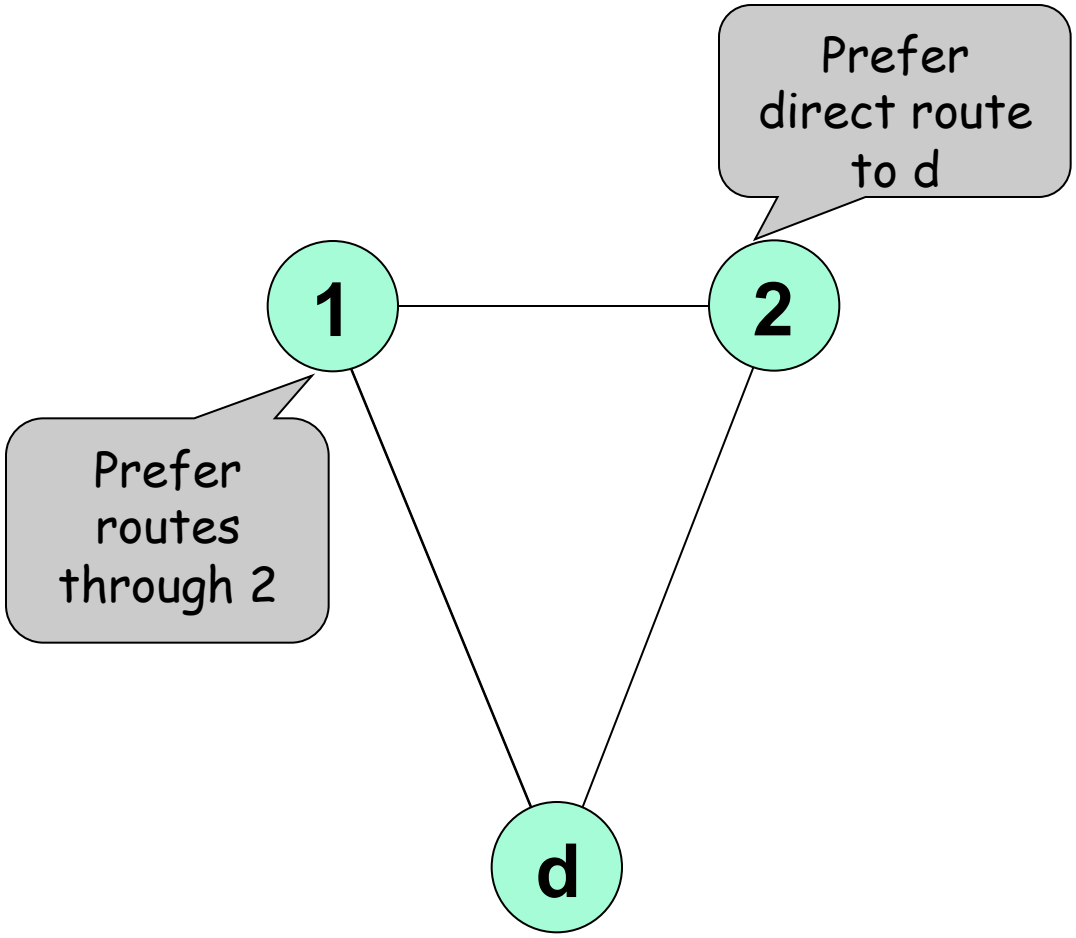


- Paths go through neighbors' choices, which enforces consistency.
- Decisions are made locally, which preserves autonomy.
- Uncoordinated policies can induce protocol oscillations. (Much recent work addresses BGP convergence.)
- Recently, private information, optimization, and incentive-compatibility have also been studied.

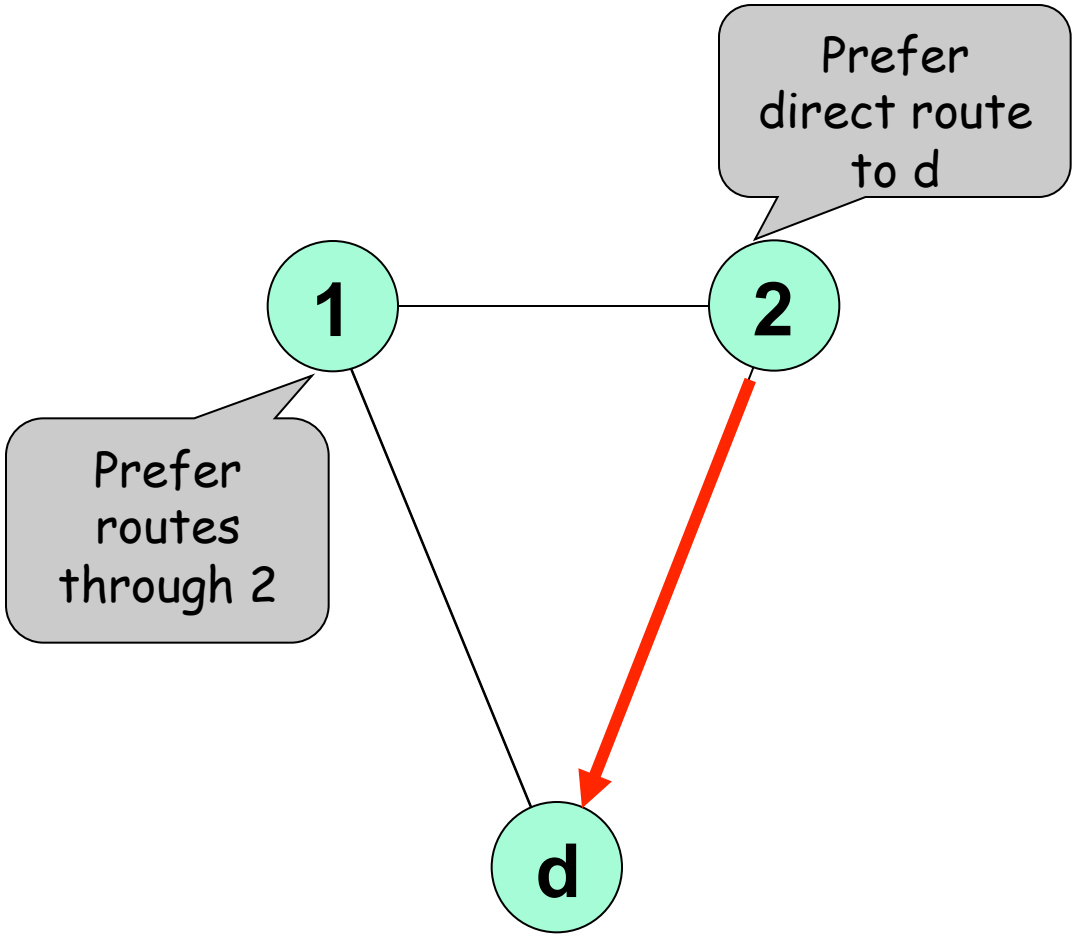
BGP Route Processing (2)



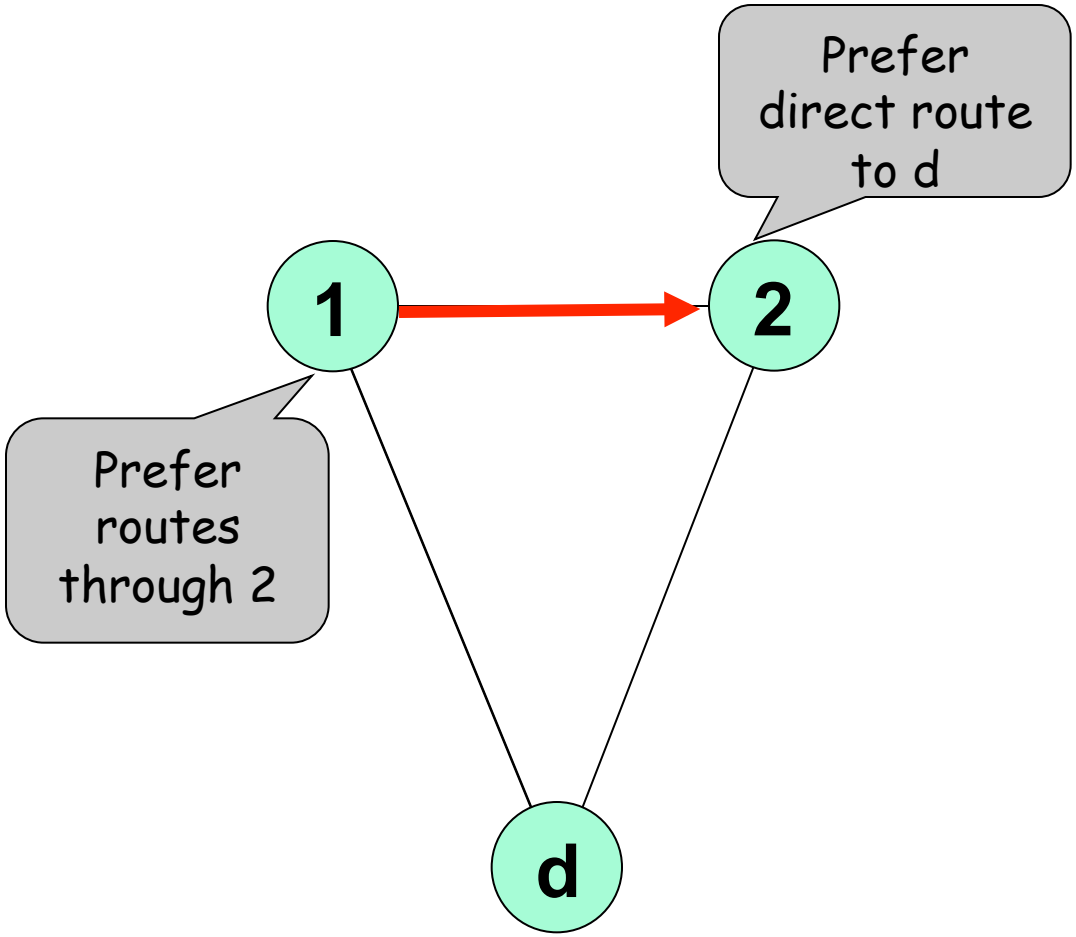
Example: Convergence



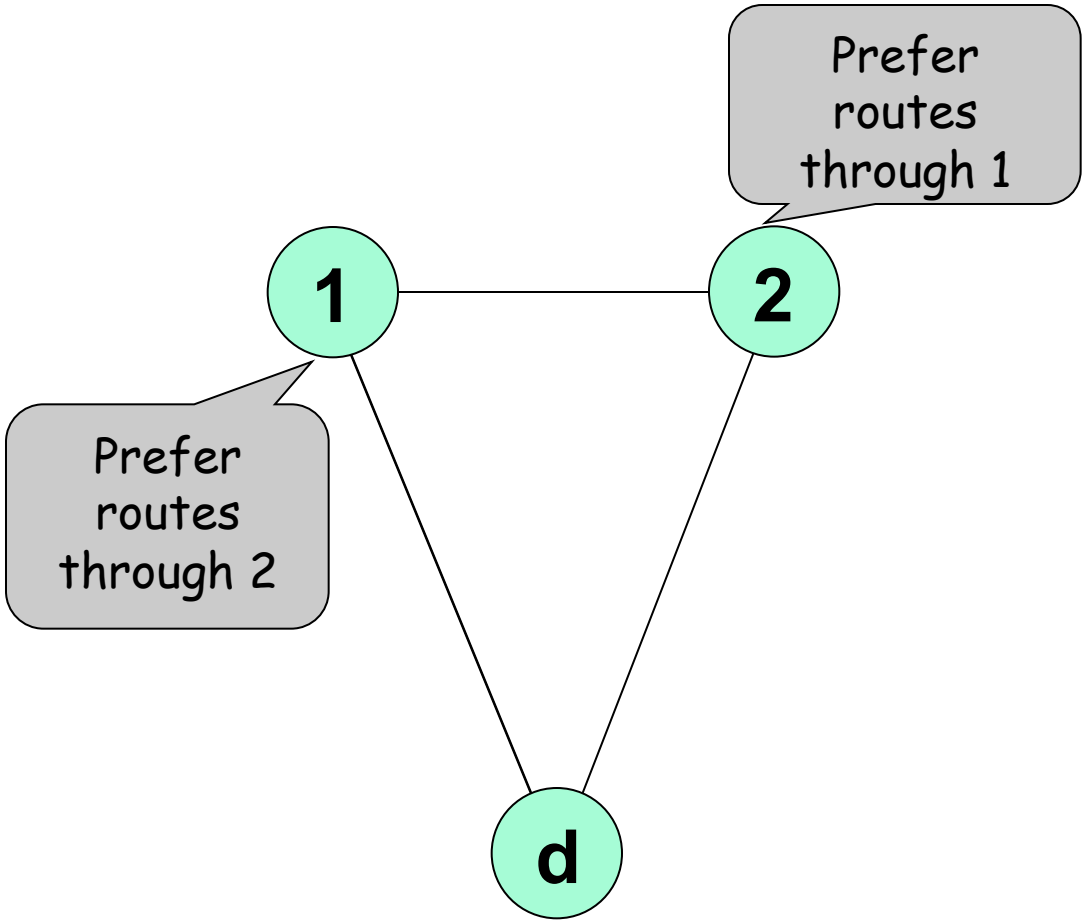
Example: Convergence



Example: Convergence



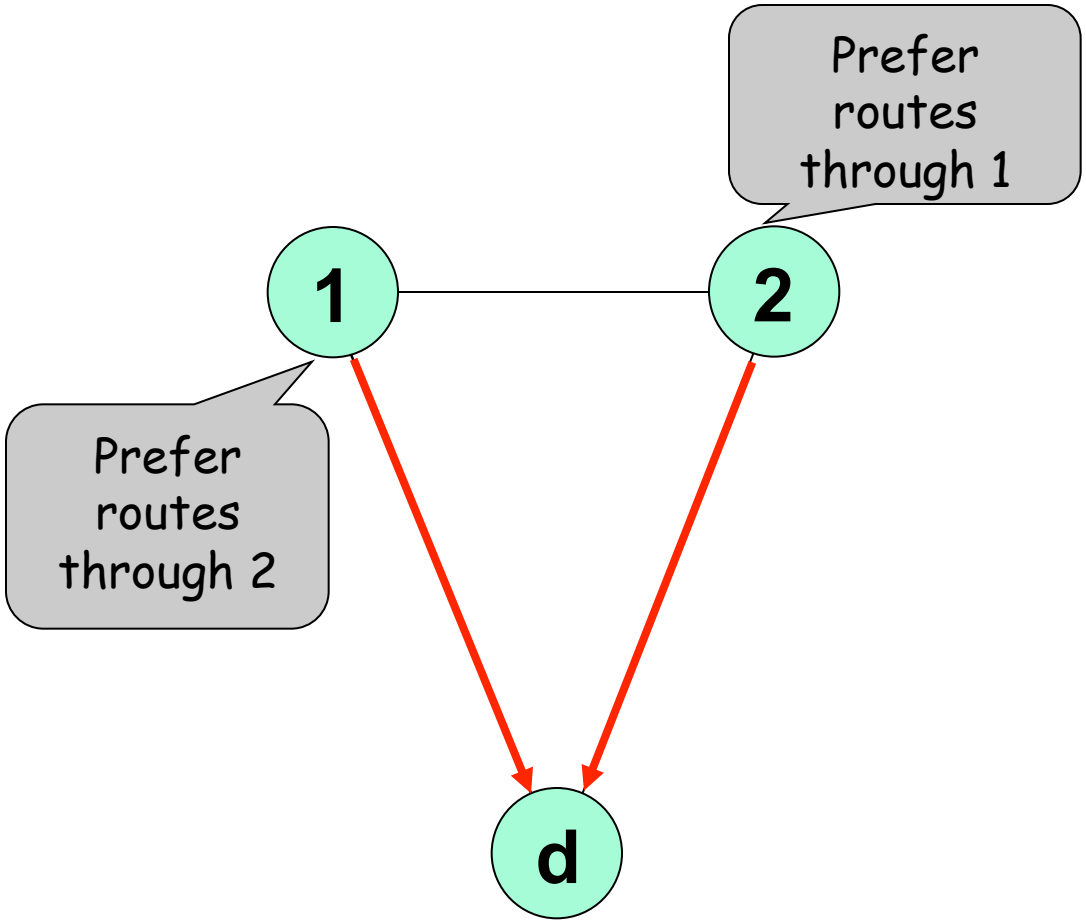
Example: Oscillation



BGP might oscillate forever between

1*d*, 2*d*
and
12*d*, 21*d*

Example: Oscillation



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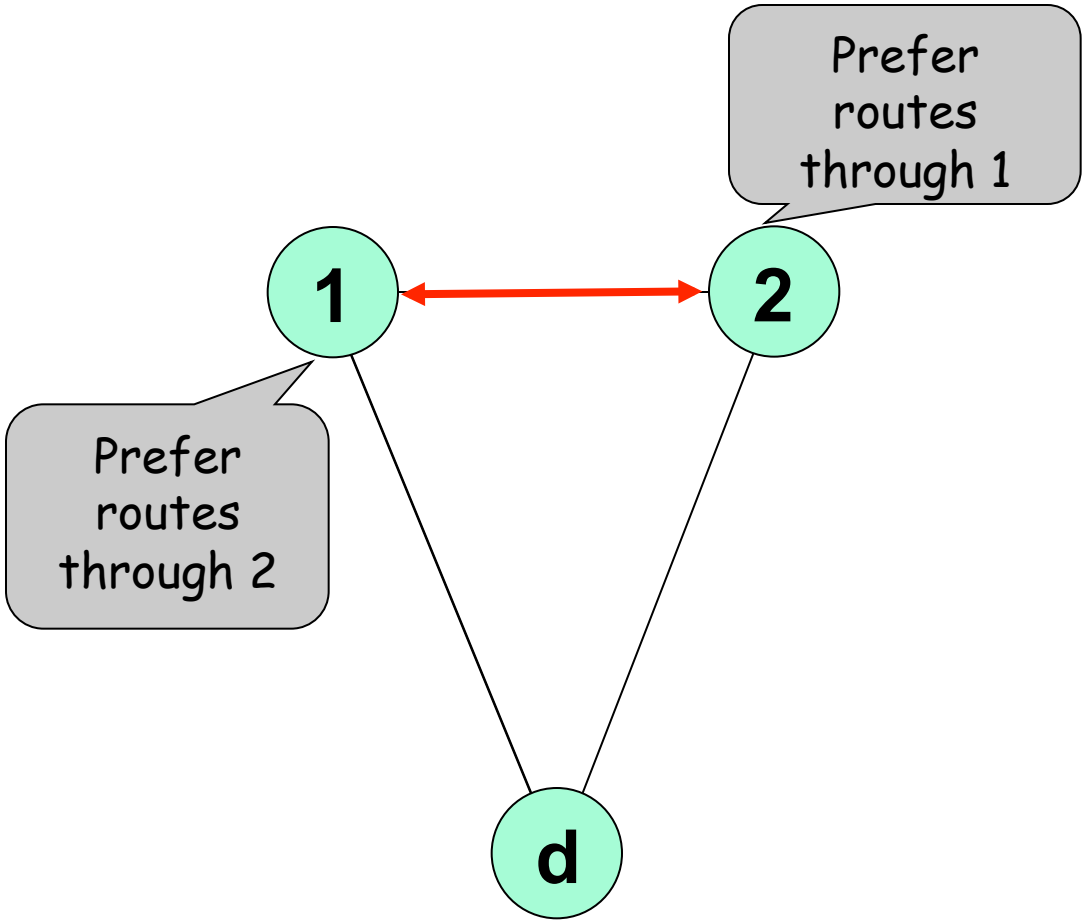

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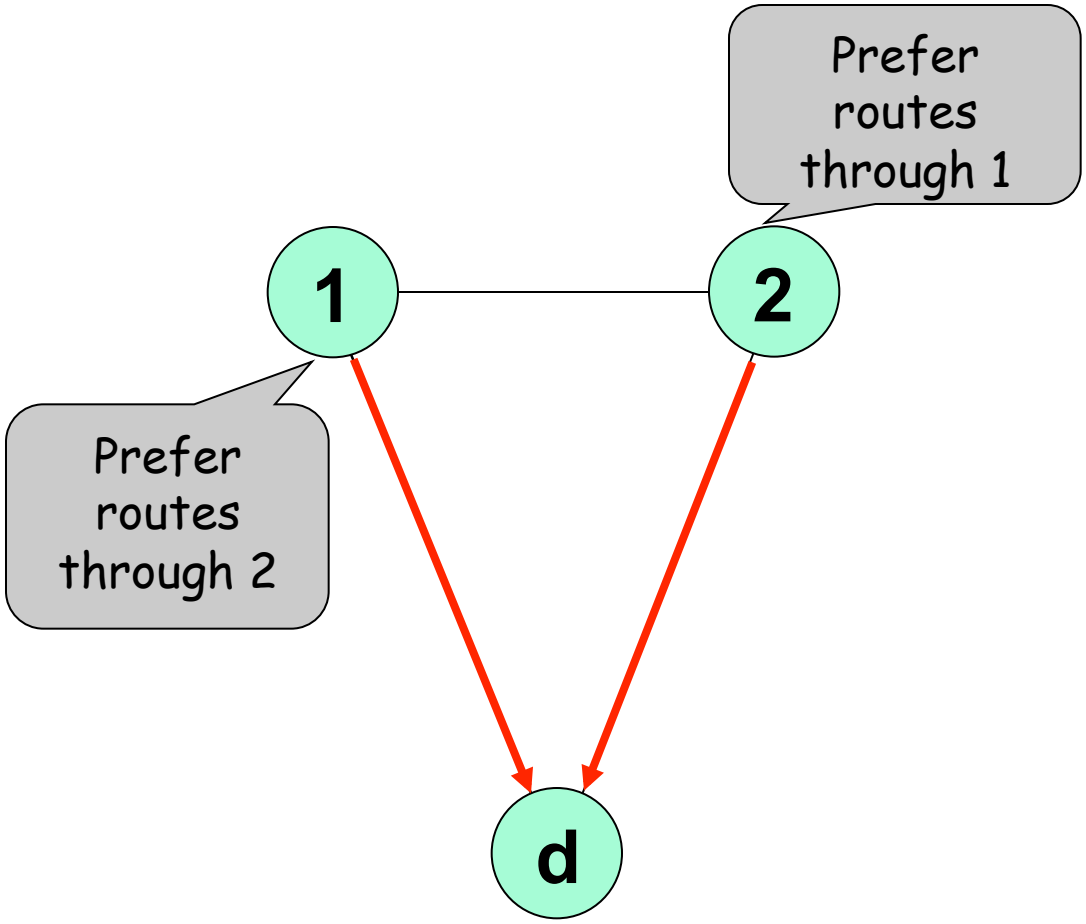
Example: Oscillation



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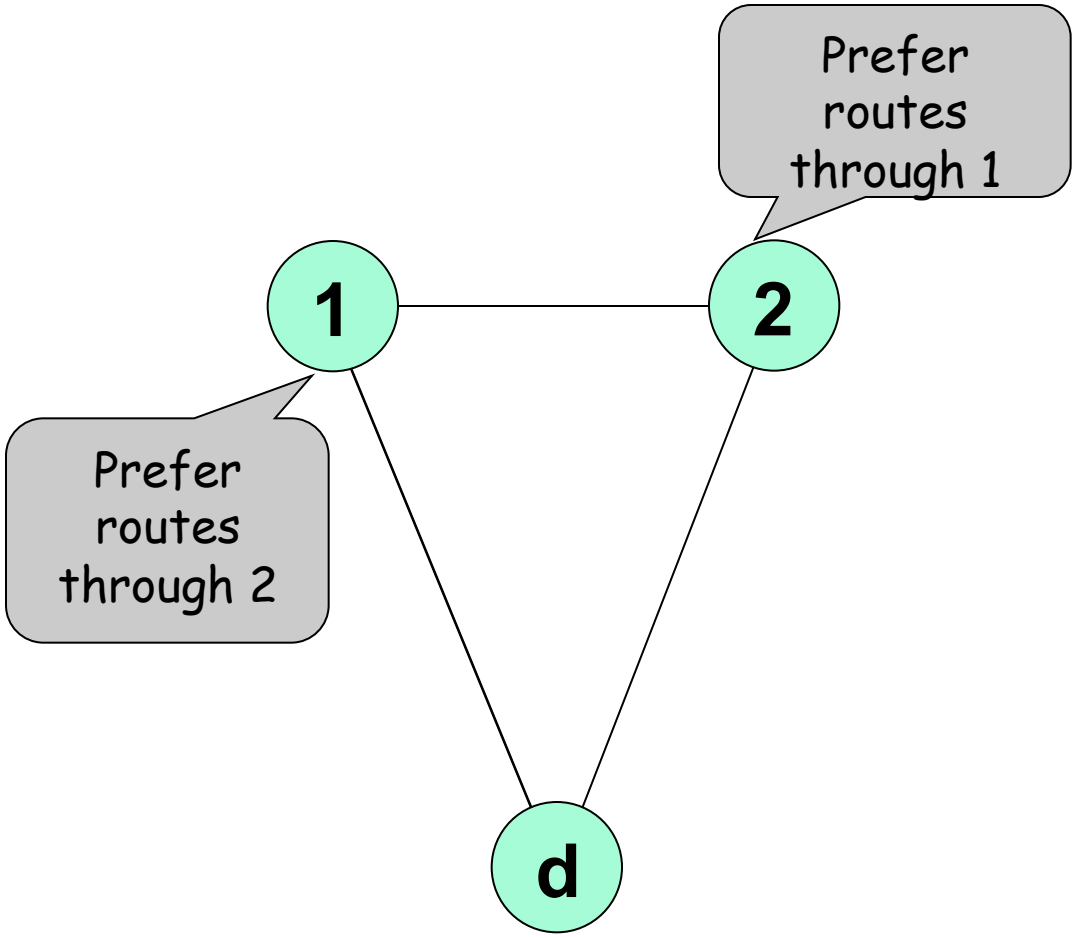
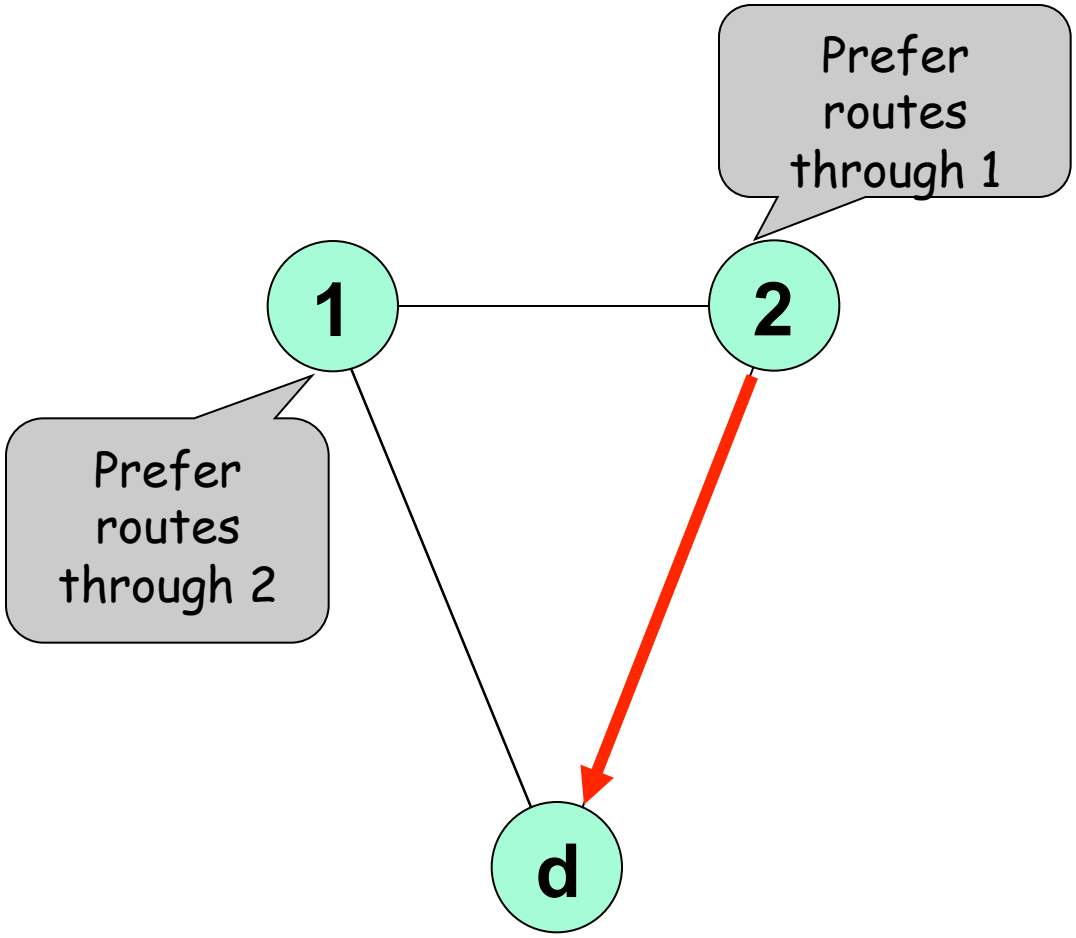
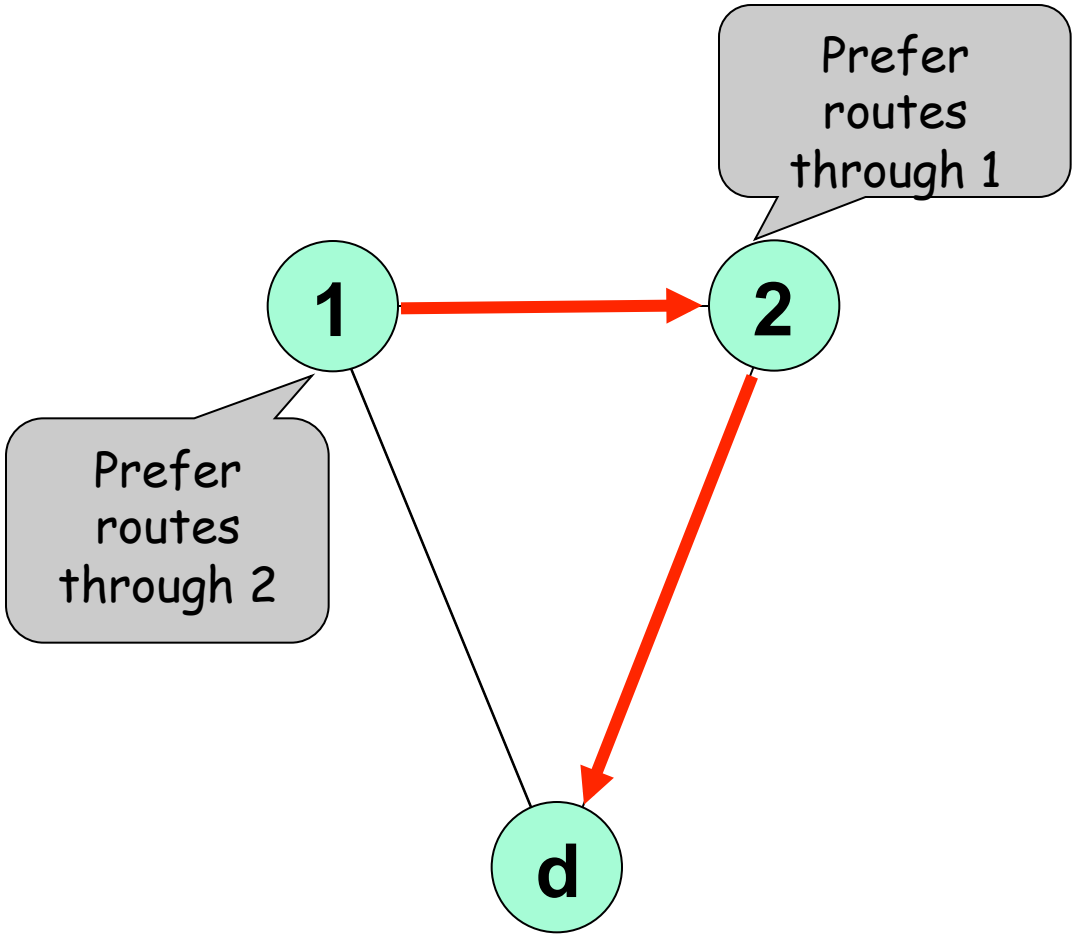


Example: Convergence



Example: Convergence



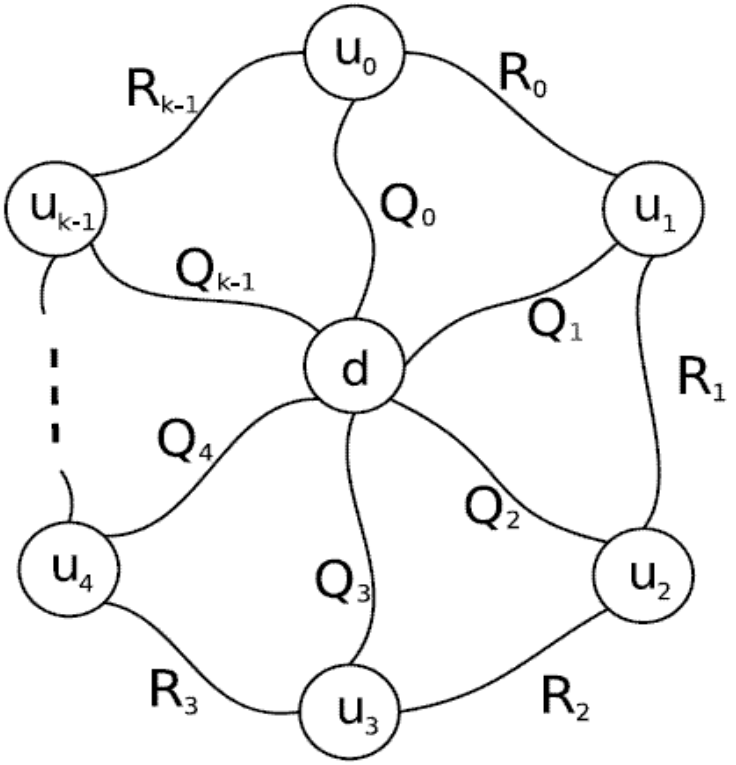
Dispute Wheels

Nodes u_i, hub routes R_i, and spoke routes Q_i.
Each u_i prefers R_iQ_{i+1} to Q_i.

"No dispute wheel"

—>

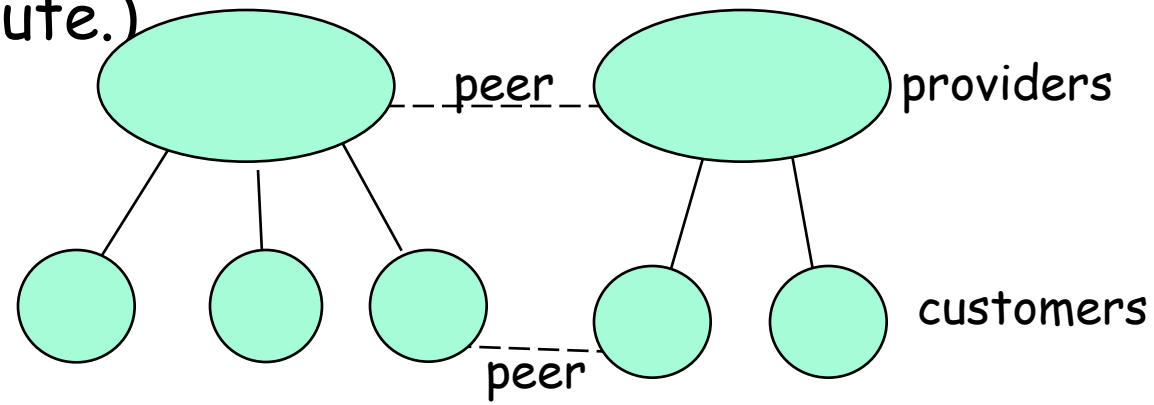
robust convergence



Gao-Rexford Framework (1)

Neighboring pairs of ASes have one of:

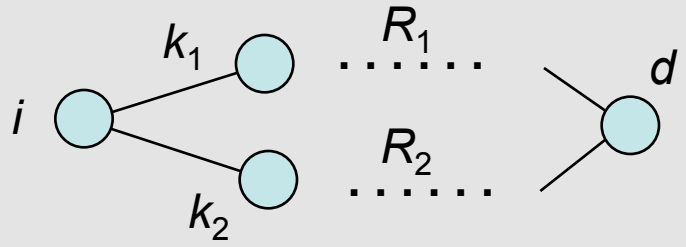
- a *customer-provider* relationship
  (One node is purchasing connectivity from the other node.)
- a *peering* relationship
  (Nodes have offered to carry each other's transit traffic, often to shortcut a longer route.)



Gao-Rexford Framework (2)

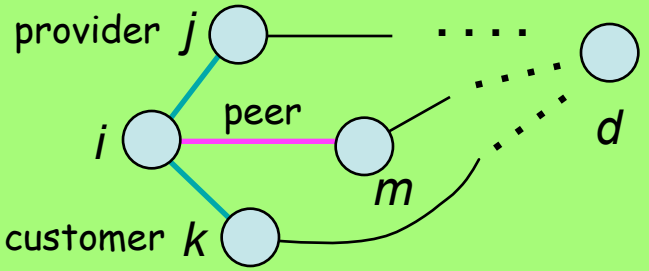
- Global constraint: **no customer-provider cycles**
- Local *preference* and *scoping* constraints, which are consistent with Internet economics:

Preference Constraints



- If k_1 and k_2 are both customers, peers, or providers of i, then either ik_1R_1 or ik_2R_2 can be more valued at i.
- If one is a customer, prefer the route through it. If not, prefer the peer route.

Scoping Constraints



- Export customer routes to all neighbors and export all routes to customers.
- Export peer and provider routes to all customers only.

- Gao-Rexford conditions => BGP always converges [GR01]