# 6.033 Spring 2017

Lecture #9

- **Scalable Routing**
- **Policy Routing**
- **BGP**

# Internet of Problems

How do we **route** (and address) scalably, while dealing with issues of policy and economy? → BGP

How do we **transport** data scalably, while dealing with varying application demands?

How do we **adapt** new applications and technologies to an inflexible architecture?

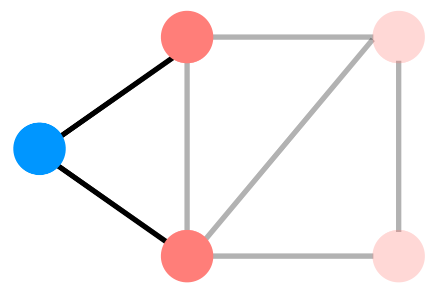
**goal of a routing protocol:** allow each switch to know, for every node `dst` in the network, a route to `dst`

**goal of a routing protocol:** allow each switch to know, for every node `dst` in the network, a **minimum-cost** route to `dst`

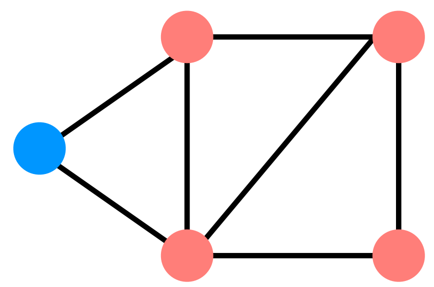
**goal of a routing protocol:** build a routing table at each switch, such that `routing_table[dst]` contains a **minimum-cost route** to `dst`

# Distributed Routing

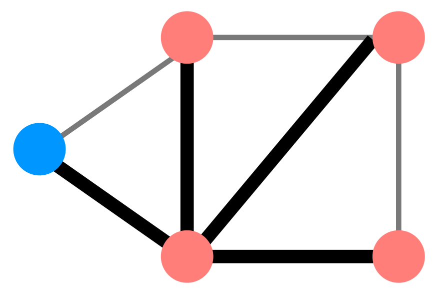
1. Nodes learn about their neighbors via the `HELLO` protocol



2. Nodes learn about other reachable nodes via advertisements



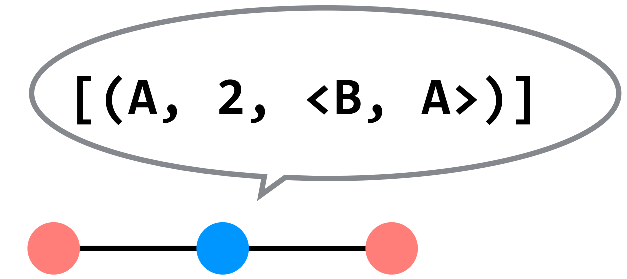
3. Nodes determine the minimum-cost routes (of the routes they know about)



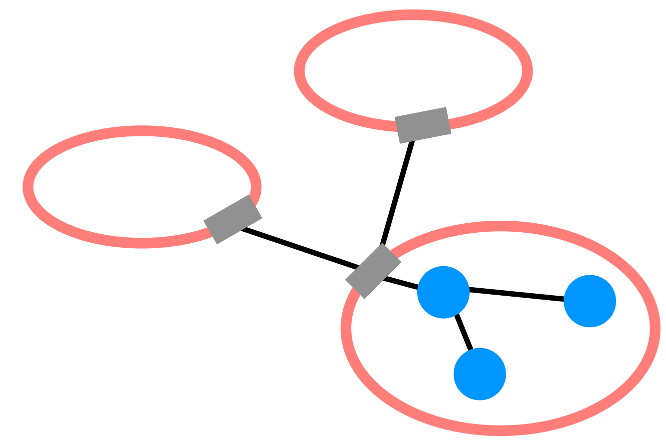
**problem:** neither distance-vector nor link-state routing will scale to the size of the Internet

# Scalable Routing

1. **path-vector routing:** advertisements include the path, to better detect routing loops




2. **hierarchy of routing:** route between ASes, and then within an AS



3. **topological addressing:** assign addresses in contiguous blocks to make advertisements smaller

`18.0.0.0, … ,18.0.0.255`

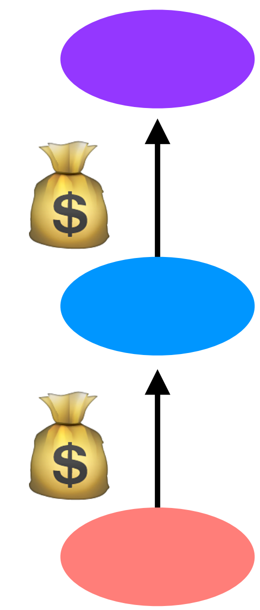
↓

`18.0.0.0/24`

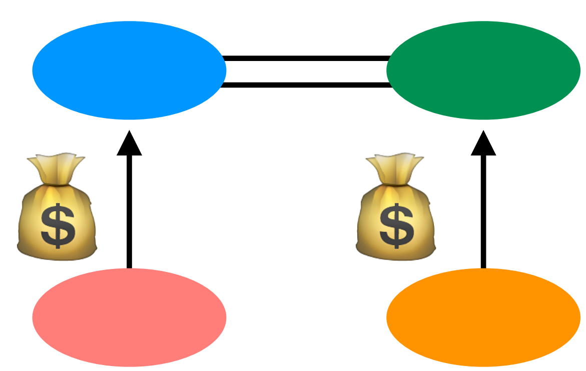
**problem:** ASes also need a means to implement **policy**

# Common AS Relationships

**customer/provider ("transit")**
customer pays provider for transit



**peers**
peers allow (free*) mutual access to each other's customers

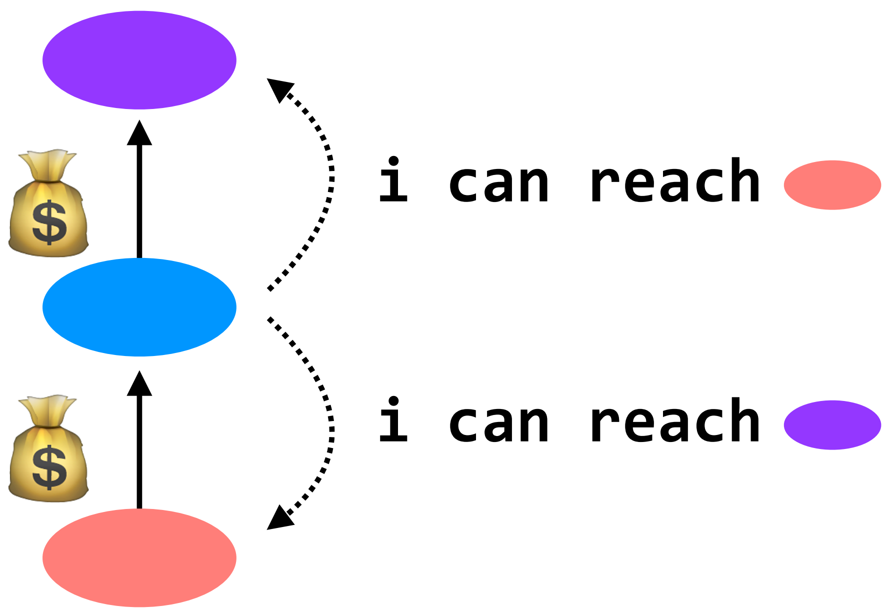


*as long as the amount of traffic in each direction is roughly equal

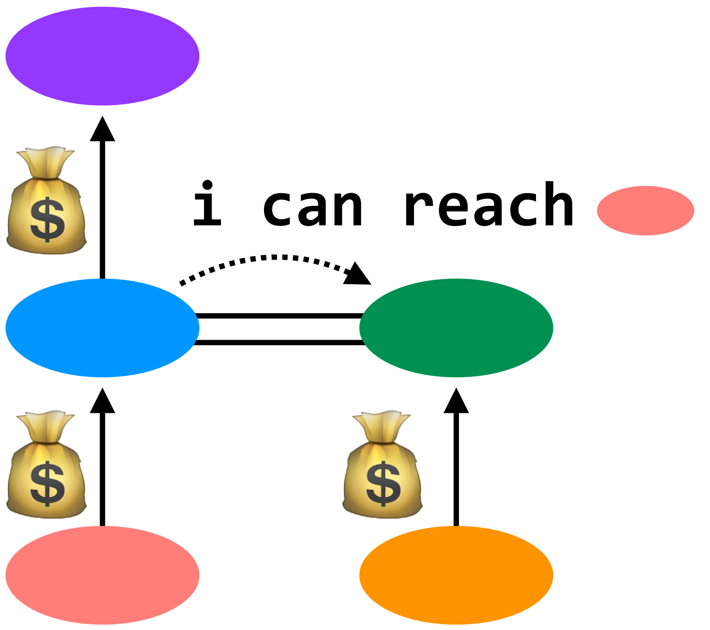
# Export Policies

goal: make money

**customer/provider ("transit")**
providers tell everyone about themselves their customers, and tell their customers about everyone




**peers**
peers tell each other about their customers



# Import Policies

goal: make money

**customer > peer > provider**

(and then a variety of other attributes when this rule isn't sufficient)

# Distributed Routing

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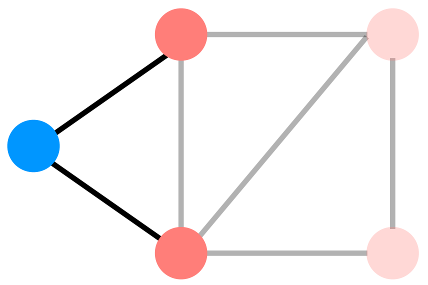

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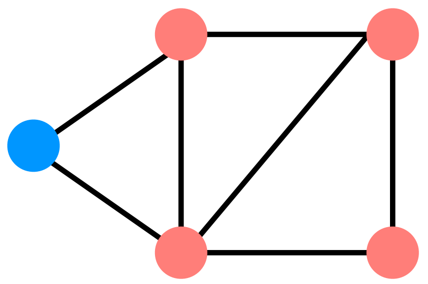

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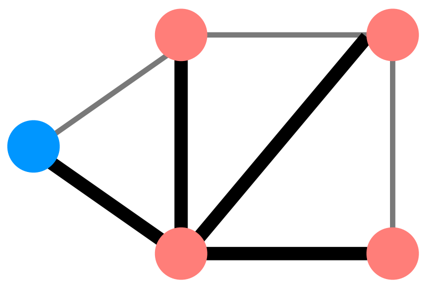

# does BGP scale?

- To route on the Internet means to route at an enormous scale. We deal with scale via three techniques: **path-vector routing**, a **hierarchy of routing**, and **topological addressing**.

- **BGP** provides a means for autonomous systems to do **policy routing**. While the protocol is simple, how it works in practice is enormously complex due to competing economic interests, among other things.

- Though BGP works on the Internet today, its ability (or inability) to **scale** is becoming a concern as the Internet continues to grow.