6.033 Spring 2019
Lecture #10

- **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?

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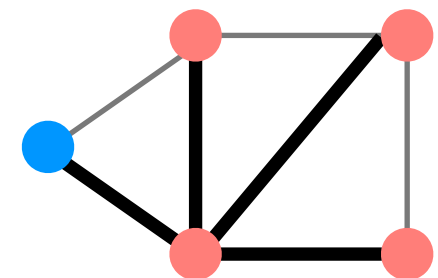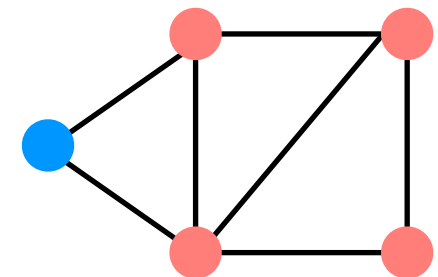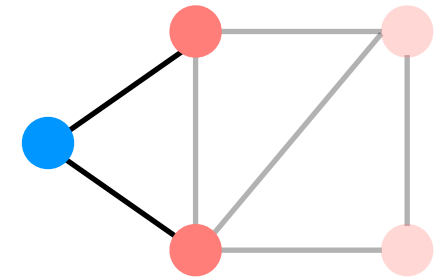
problem: neither distance-vector nor link-state routing will scale to the size of the Internet

Scalable Routing

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

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

```
[(A, 2, <B, A>)]
```


3. **topological addressing:** assign addresses in contiguous blocks to make advertisements smaller
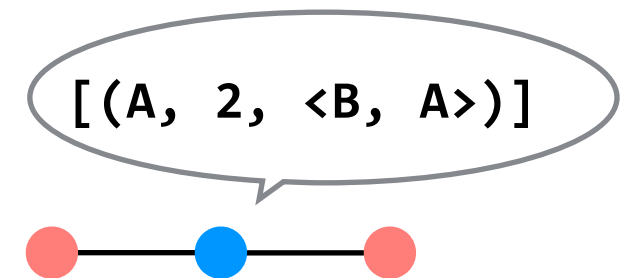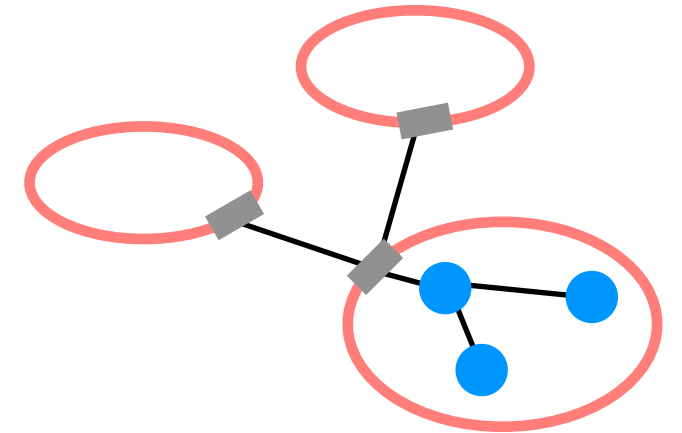
```
18.0.0.0, … ,18.0.0.255
          ↓
      18.0.0.0/24
```
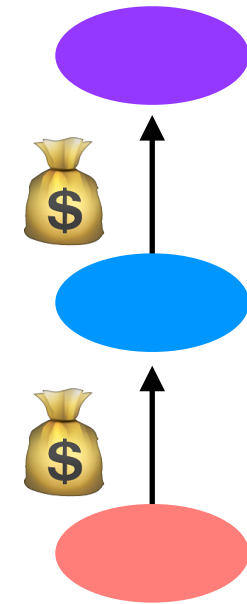
problem: ASes also need a means to implement **policy**

Common AS Relationships

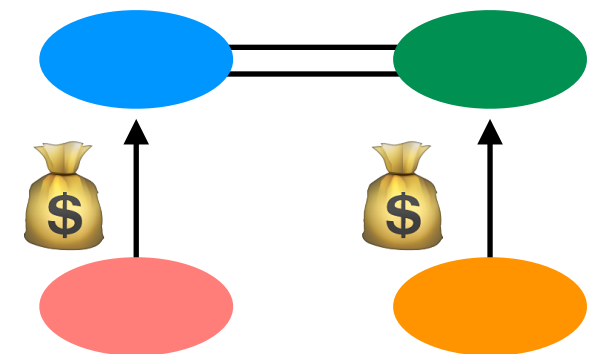arrows describe the flow of money; traffic may flow in both directions

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

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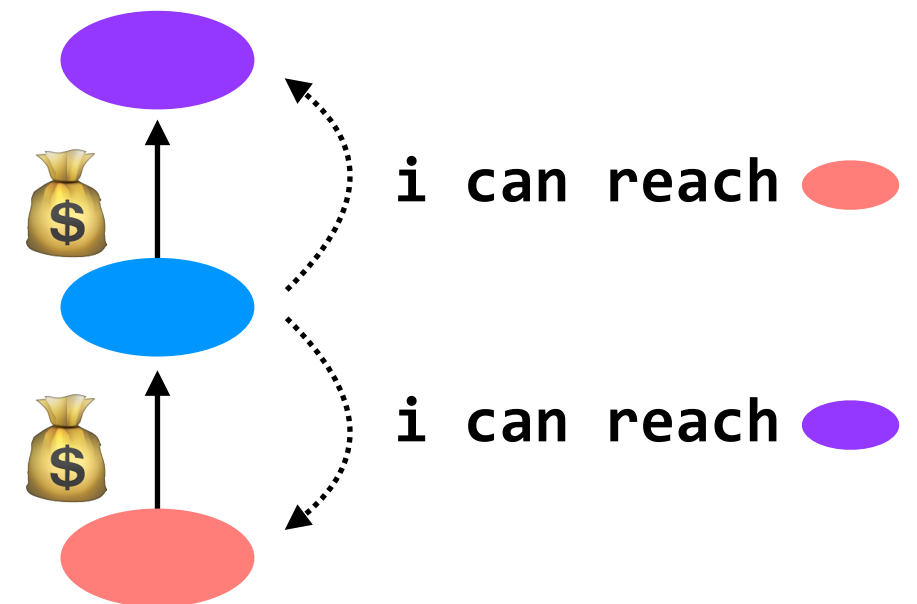each other's customers

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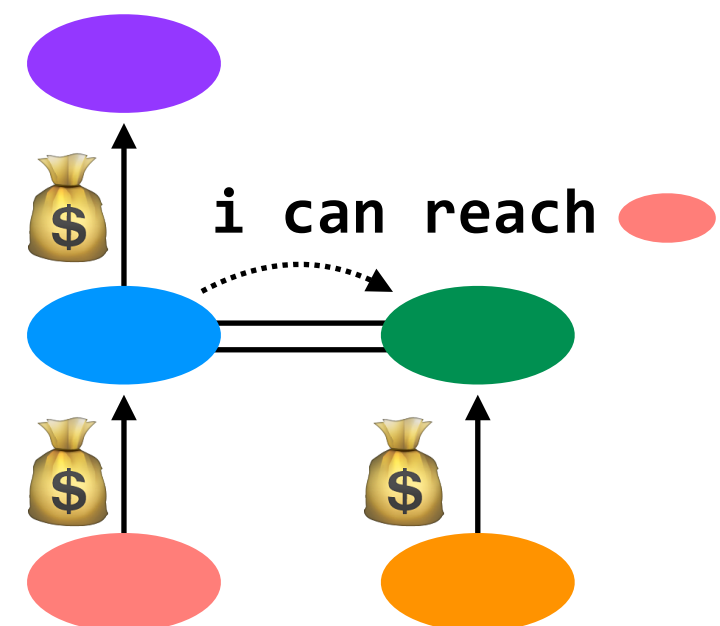equal

Export Policies
goal: make money

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

peers
peers tell each other about their customers

i can reach
i can reach
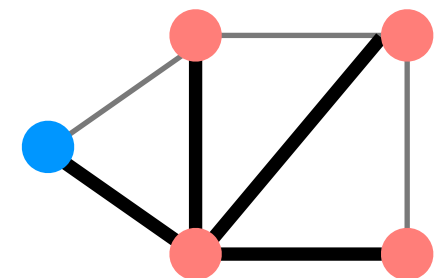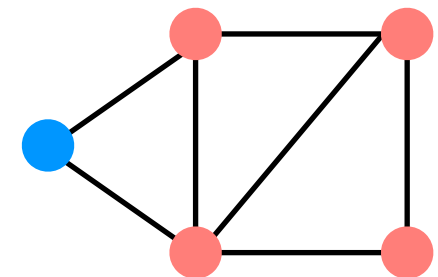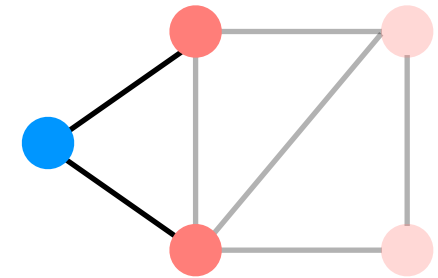i can reach

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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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.