BGP
Border Gateway Protocol
EE122 Section 3
Border Gateway Protocol

• Protocol for inter-domain routing
• Designed for policy and privacy
• Why not distance-vector?
  – Shortest path may not be policy-compliant
  – ...and policies vary across domains!
• Why not link-state?
  – Everybody knows everything – privacy goes for a toss!
• Enter path vector!
BGP: Path Vector

A: 1
B: 2

A: 1
B: 2
BGP: Path Vector

Diagram:

- Node 0:
  - A: 01
  - B: 02

- Node 1:
  - A: 1

- Node 2:
  - B: 2
BGP: Path Vector

A: 1
B: 1 0 2

A: 2 0 1
B: 2
BGP: Path Vector

Withdrawal - B: 0 2
Advertise - B: 0

A: 1
B: 1 0

A: 0 1
B: 0

A: 2 0 1
B: 2
BGP Relationships

- Provider -> Customer:
- Peer <-> Peer:

A: 1
B: 1
C: 0

1

A: 1
B: 1
C: 0

2

A: 12
B: 2
C: 02

0

A: 10
B: 10
C: 0

A

B

C
It’s all about the money!

- Customer pays provider
- Peers don’t pay each other
  - Assume equal flow both ways

- Routing *policies* try to minimize payment
Typical Export Policy

<table>
<thead>
<tr>
<th>Destination prefix advertised by...</th>
<th>Export route to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>Everyone (providers, peers, other customers)</td>
</tr>
<tr>
<td>Peer</td>
<td>Customers</td>
</tr>
<tr>
<td>Provider</td>
<td>Customers</td>
</tr>
</tbody>
</table>

We’ll refer to these as the “Gao-Rexford” rules (capture common -- but not required! -- practice!)
With Gao-Rexford, the AS policy graph is a DAG (directed acyclic graph) and routes are “valley free”
Packets flow where money flows

• **Route Selection**
  – Preference Order: Customer > Peer > Provider

• **Route Export Policy**
  – Peers provide transit between their customers
  – Peers do not provide transit to each other
**Route Selection: Customer > Peer**

- **Provider -> Customer:** 
- **Peer <-> Peer:** 

![Diagram](image)
Route Selection: Peer > Provider

- Provider -> Customer:  
- Peer <-> Peer:  

```
A: 1
B: 1
C: 0

A: 1
B: 2
C: 0
```
Route Selection: Provider (no choice)

- Provider -> Customer:
- Peer <-> Peer:
Route Export policy: Advertise customers

- Provider -> Customer:
- Peer <-> Peer:
BGP Routing Game!

• No talking! Communicate via pieces of paper
• **Route selection precedence**
  – Customer > Peer > Provider
• **Export policy**: Advertise customers
• Message format:
  – Withdrawal - <host network>: <path>
  – Advertise - <host network>: <path>
  – Ping - <destination>
• **Goal**: Reach steady state