

# Boycotting and Extorting Nodes in an Internetwork

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Neil Spring    Bobby Bhattacharjee

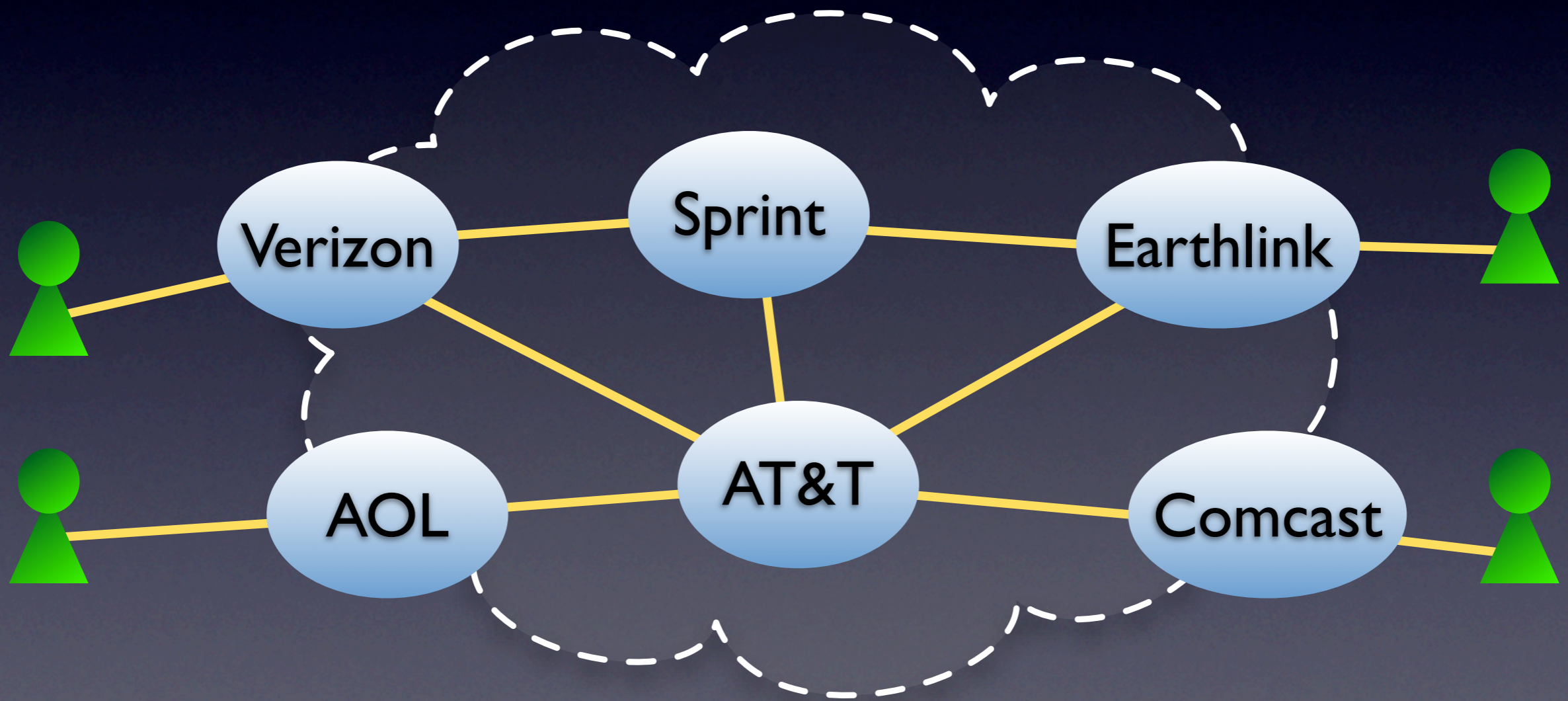
University of Maryland, College Park

# Consumer Choice

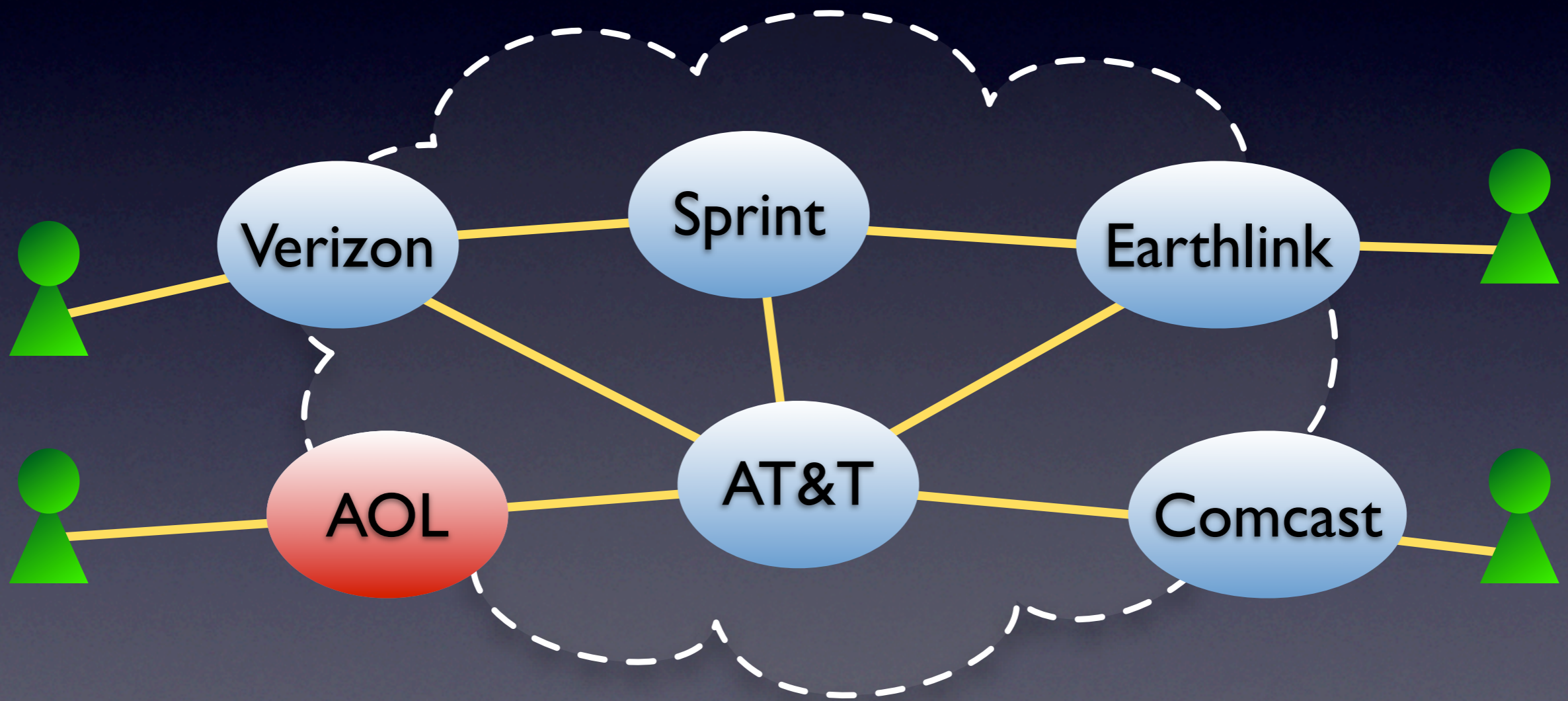
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- What products to buy
- What companies to buy from
- What companies to *not* buy from
  
- Driving force in many markets
  
- In the Internet
  - First-hop ISPs
  - Destinations
  - *At the fringe of the network*
  
- *This talk*: Consumer choice in the *core* of the Internet

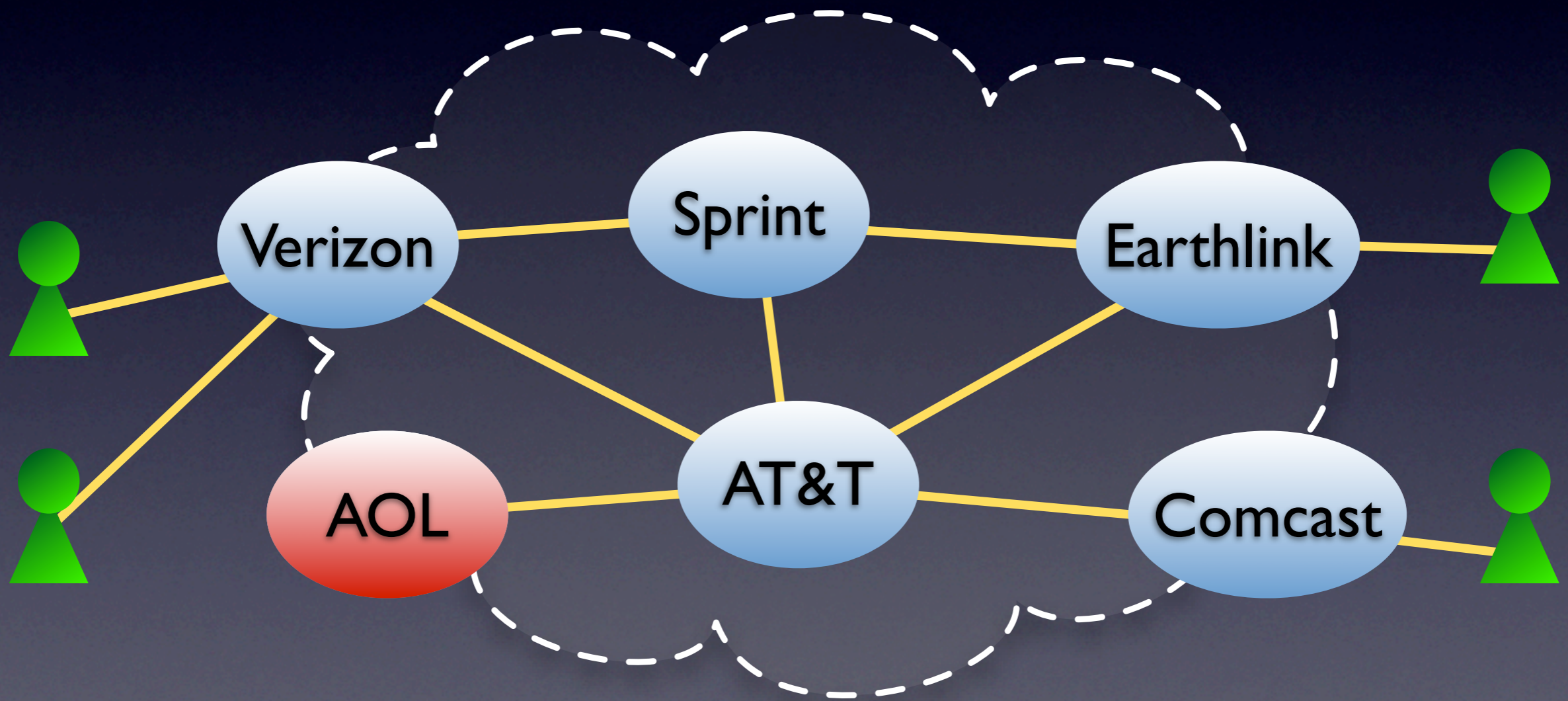
# Choice in Today's Internet



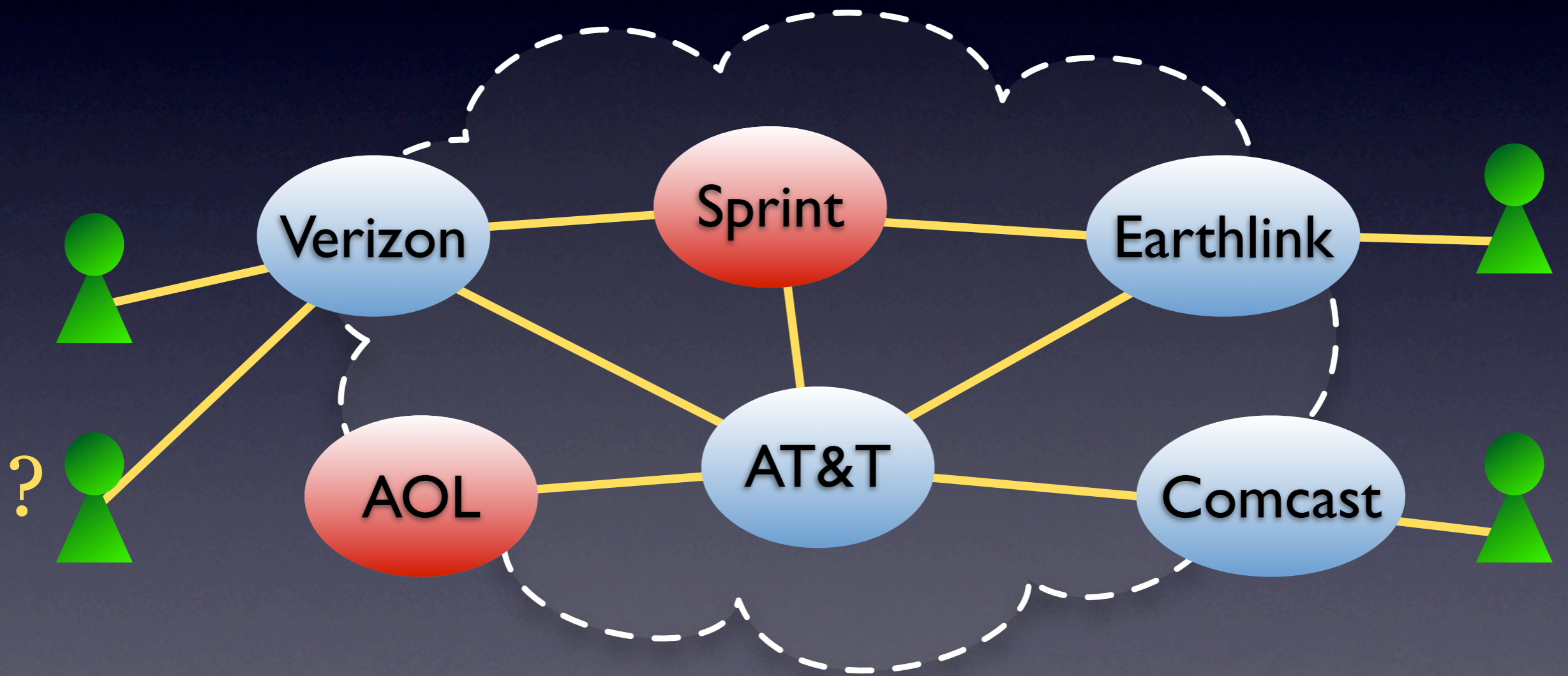
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# Goal

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- Boycotting as a routing policy
  - *Do not* allow packets to go through the following nodes
- Assurances that the policy is maintained

# Why Boycott?

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- **Questionable business practices**
  - AOL published users' searches
  - Google complied with China's censorship laws
  - Verisign redirected mistyped DNS queries to their advertising
- **Questionable network policies**
  - Snooping
  - Traffic shaping
- **Conflict of interest**
  - Pending lawsuits
  - Competing products



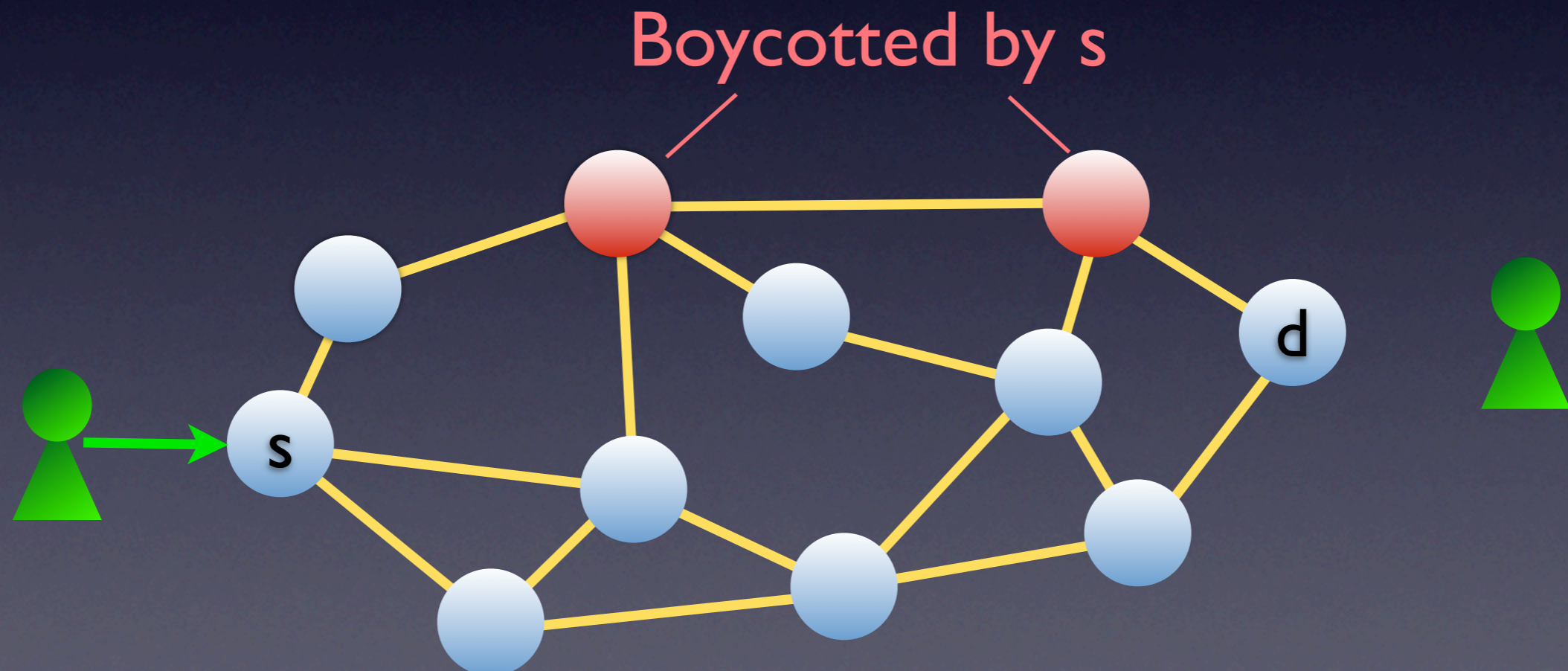
# Can Incentives Help?

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- Incentives generally used to ensure something *does happen*
  - Perform the task or else you do not get paid
  - Must prove it gets done
  - Coupled with *accountability*
- Can we provide incentive to ensure something *does not happen*?
  - Accountability alone is not enough
  - Offer economic *disincentive* from deviating
  - “If you can’t prove you’re good, I’ll make it expensive to be bad.”

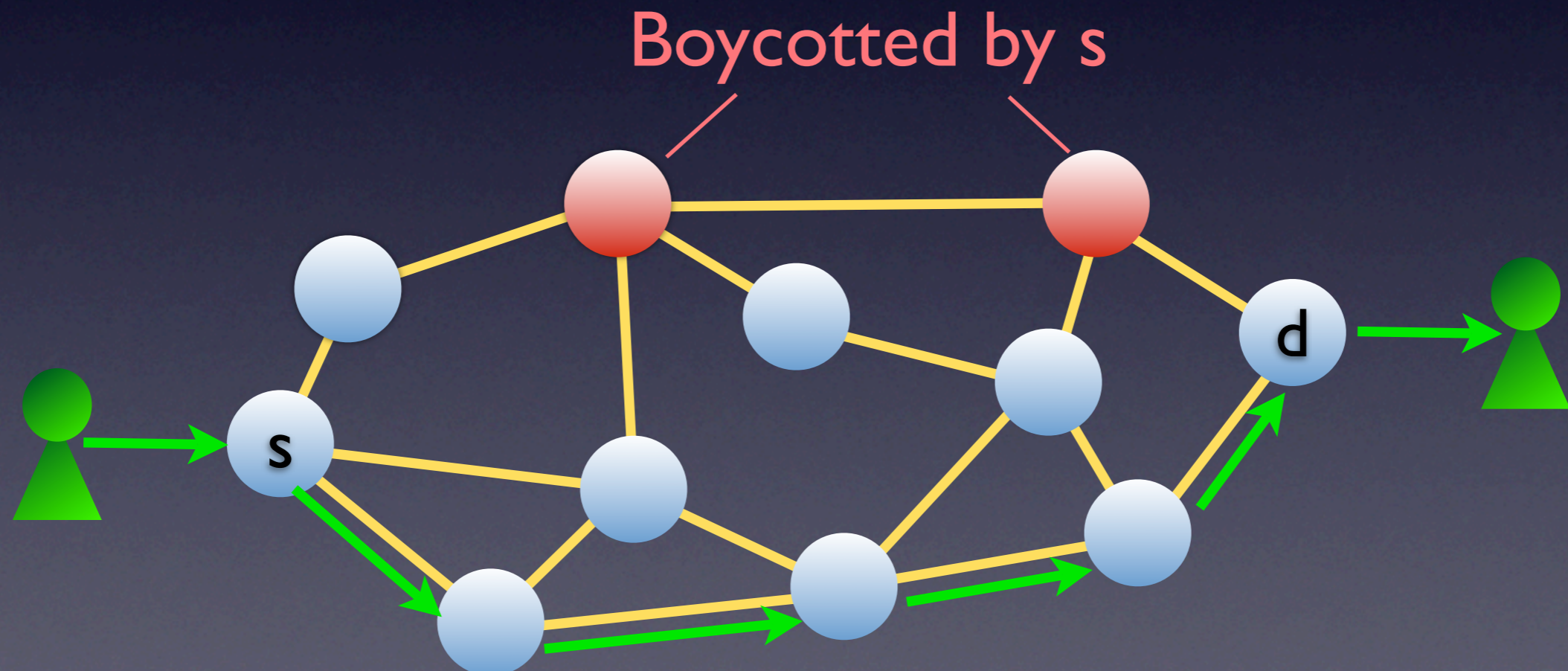
# Our Solution

- Choose routes that are “far” away from boycotted nodes
- Far enough away to *remove any economic incentive*



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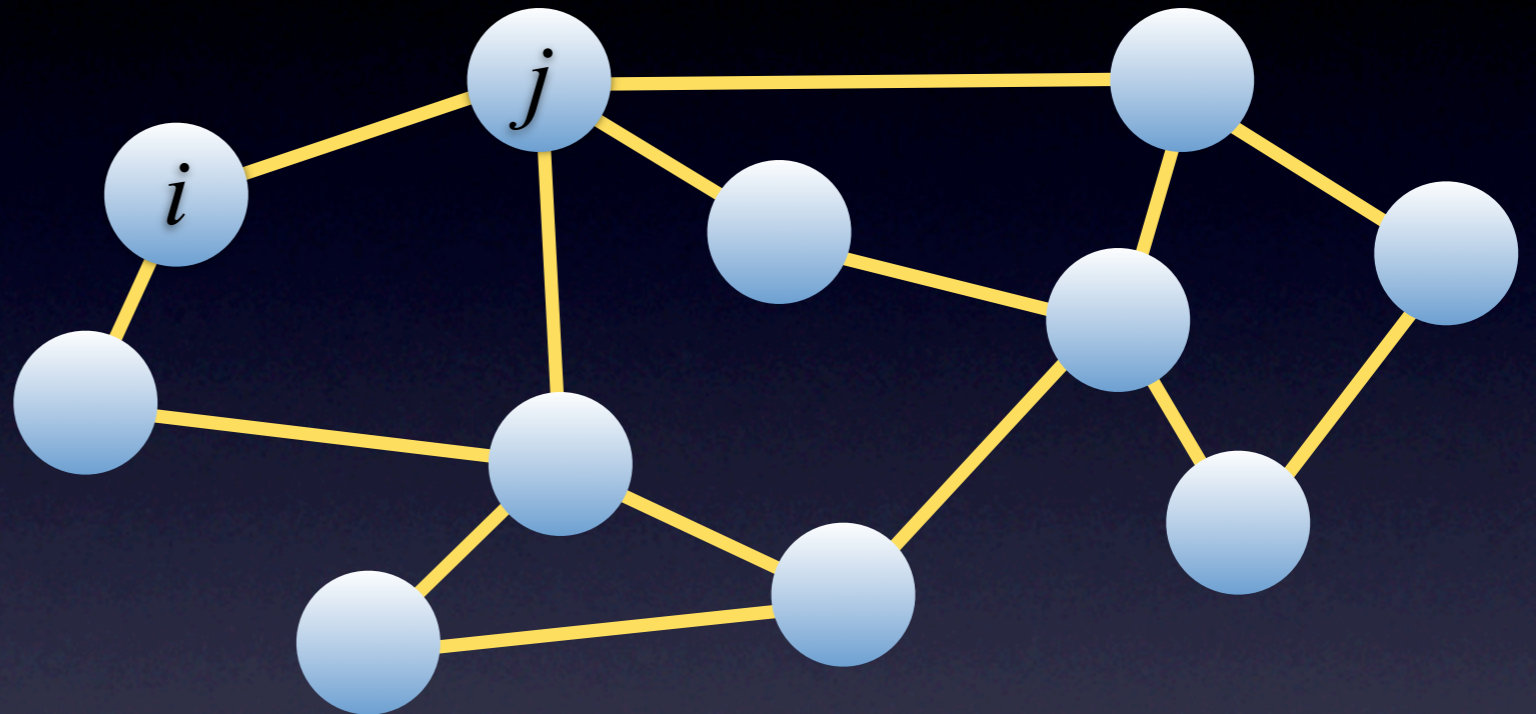
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# Model

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Graph  $G = (V, E)$

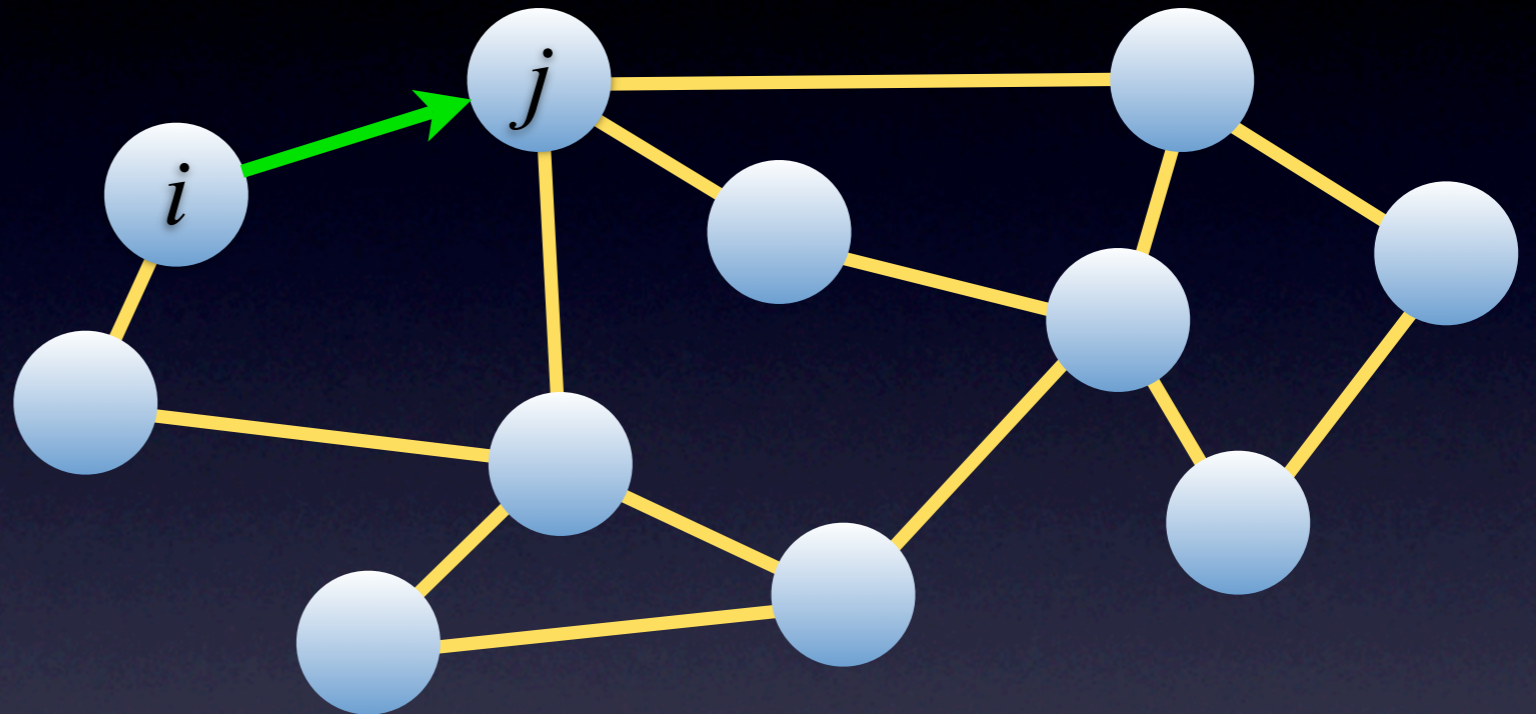


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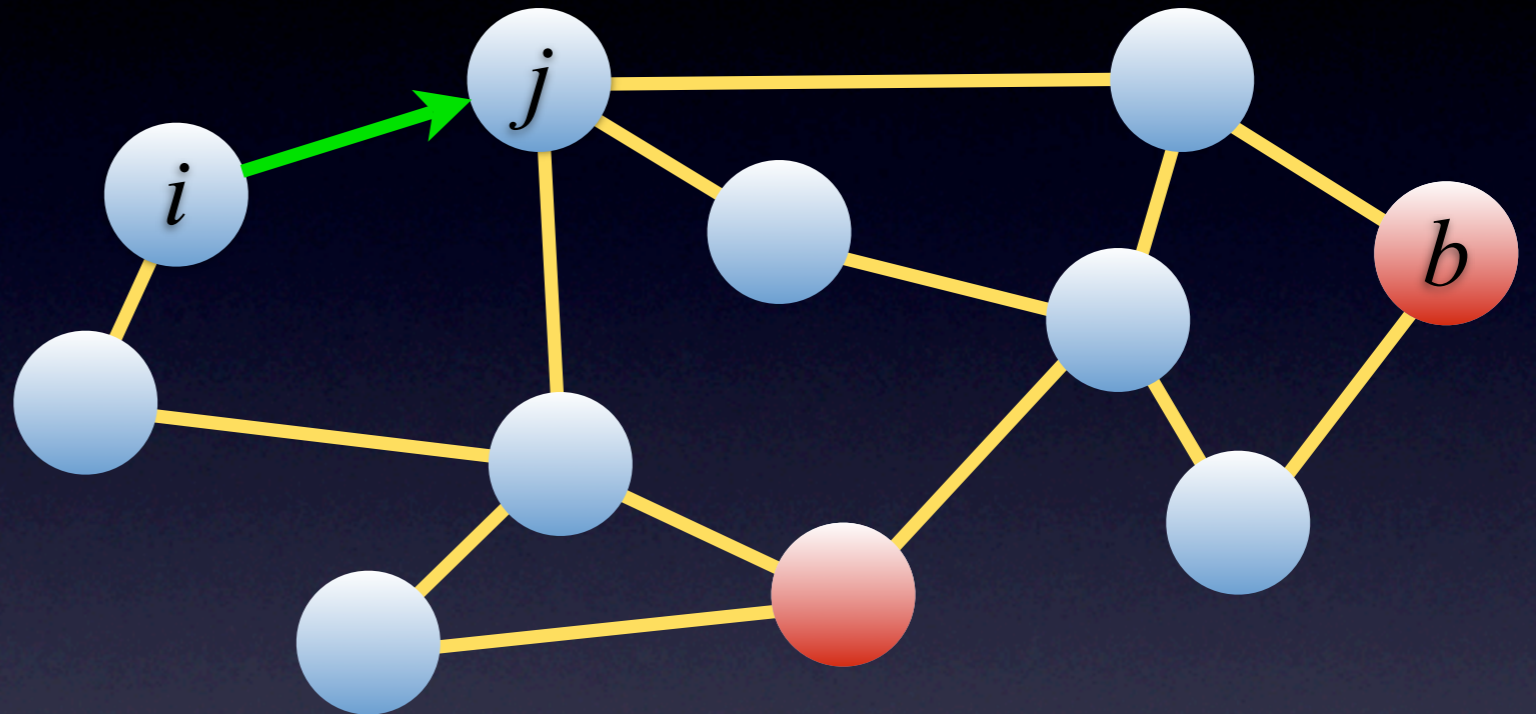
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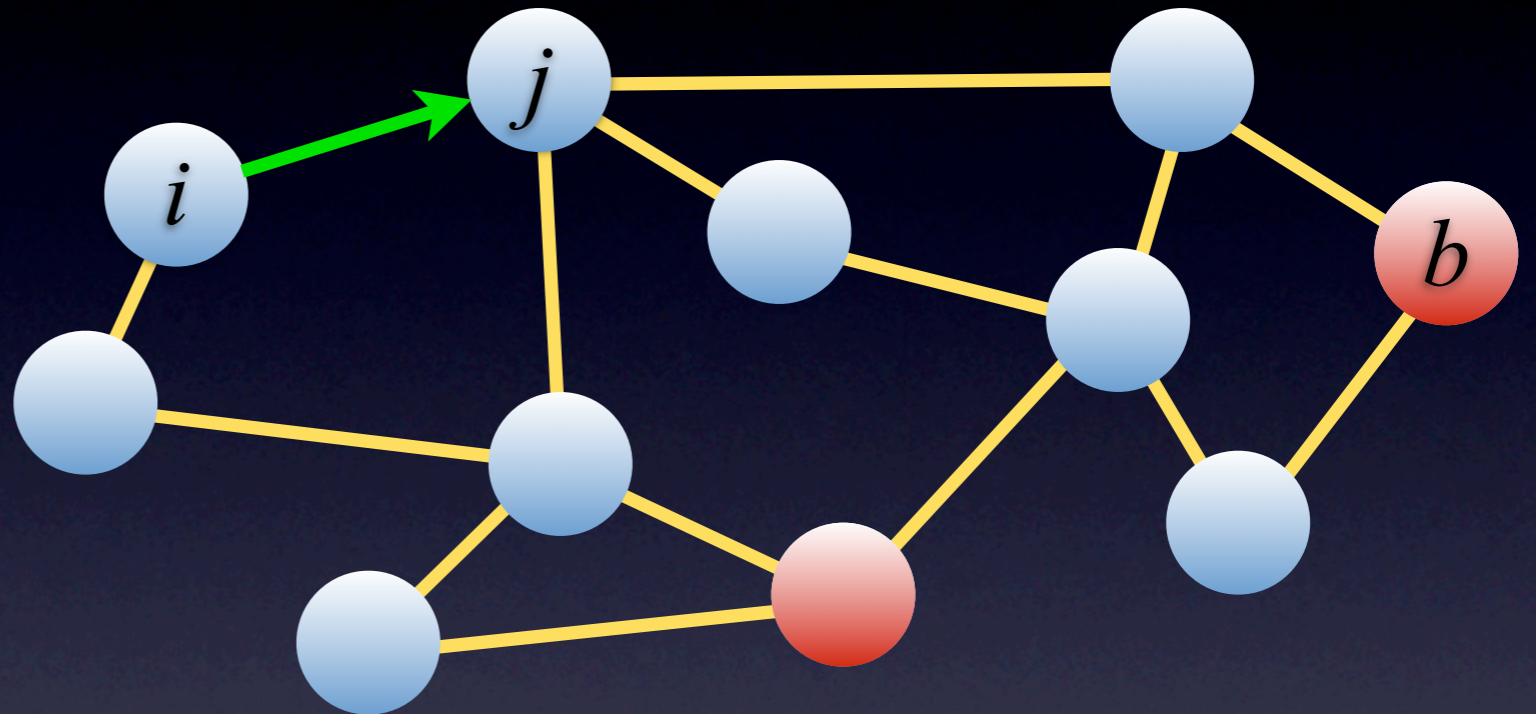
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Source node  $s$  pays  
for the whole path

Nodes can lie about  $c(i, j)$



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# Problem

A **mechanism** that gives

- A **short-cost** path with no boycotted nodes
- Economic **incentive** to truthfully report  $c(i, j)$
- Economic **disincentive** from going through boycotted nodes instead



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# VCG

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1. Gather  $c'(i, j)$  from each  $i$  for each  $(i, j) \in E$
2. Compute the shortest cost path (SCP) from  $s$  to  $d$
3. For each node  $i$  on the path,  $s$  pays  $i$

$$\mathcal{C}(\text{SCP}(s, d, G_{-i})) - \mathcal{C}(\text{SCP}(s, d, G)) + c'(i, j)$$

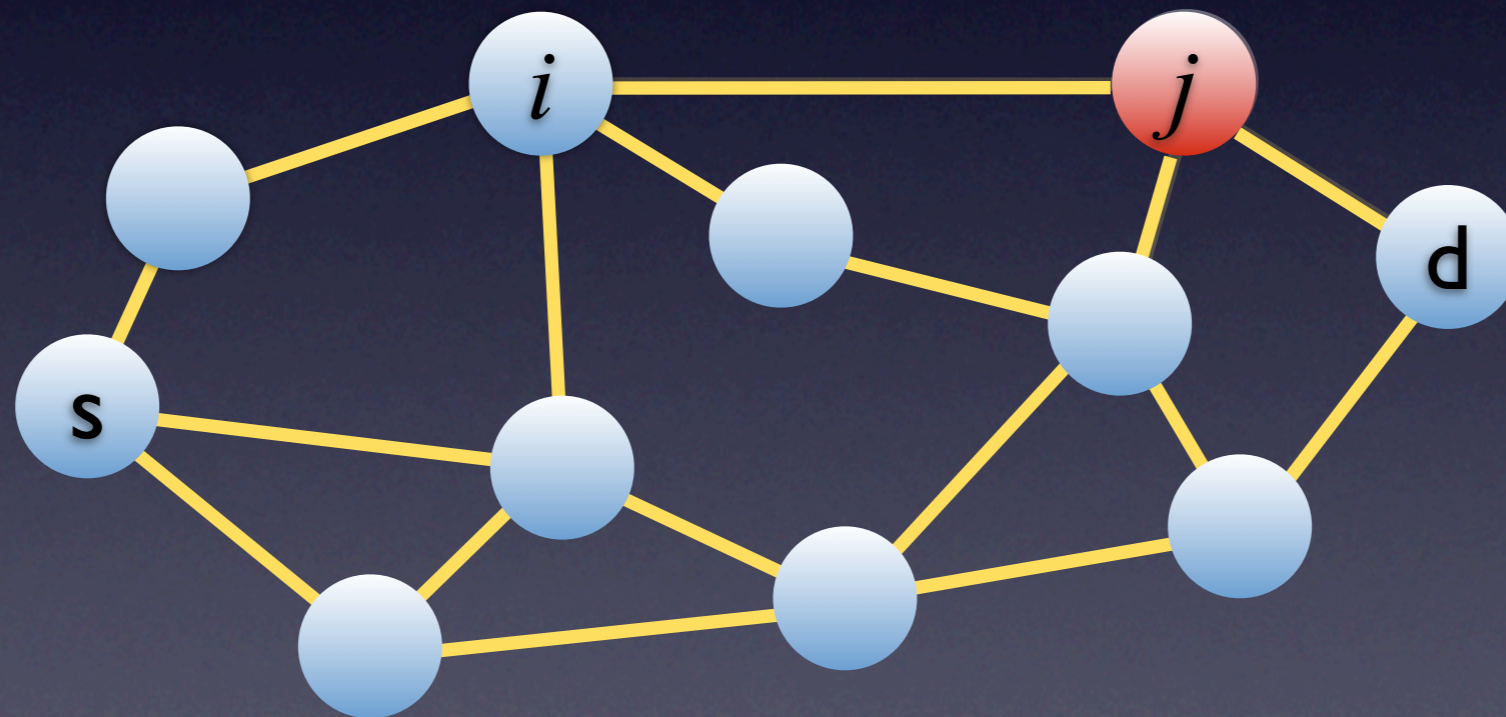
Marginal benefit of  $i$

$i$ 's stated cost

# Mechanism 1: Culled-VCG

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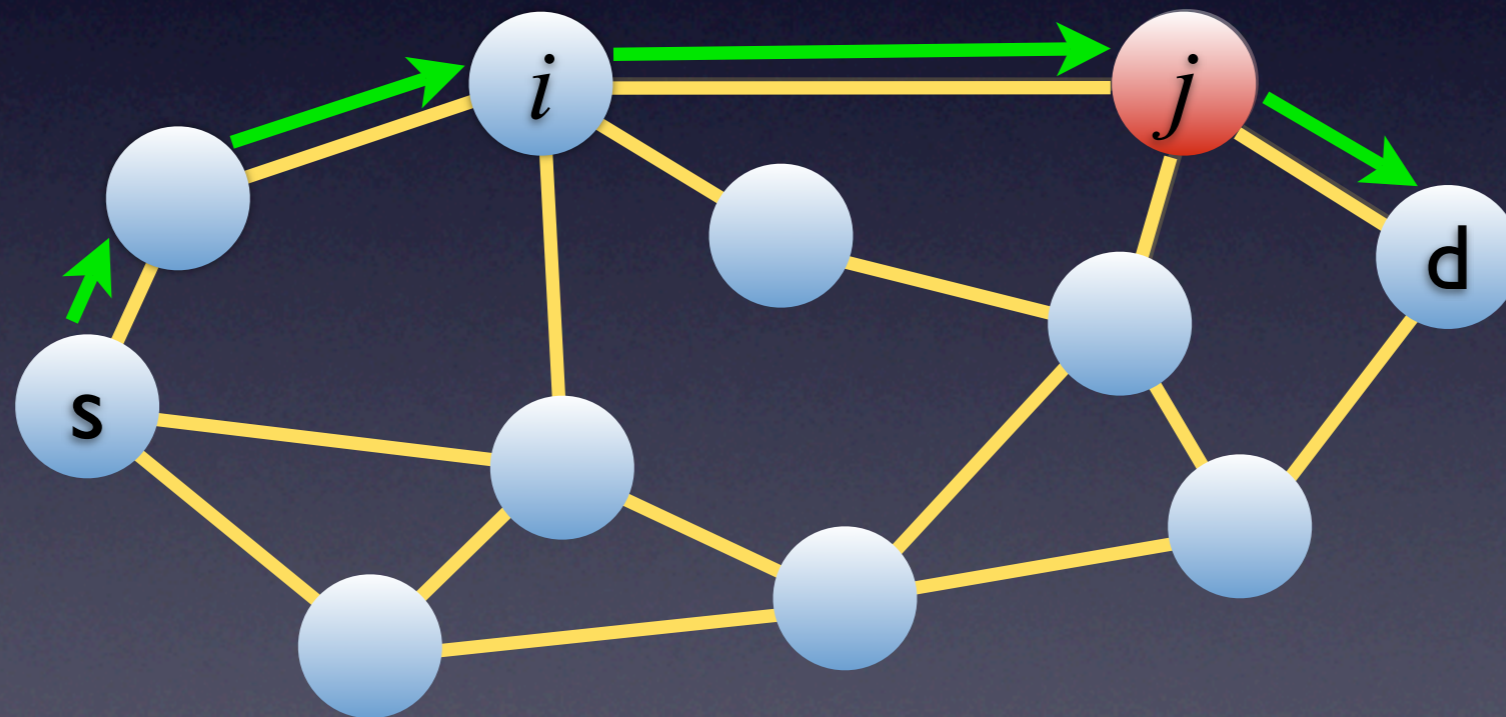
**Idea:** simply remove the boycotted nodes



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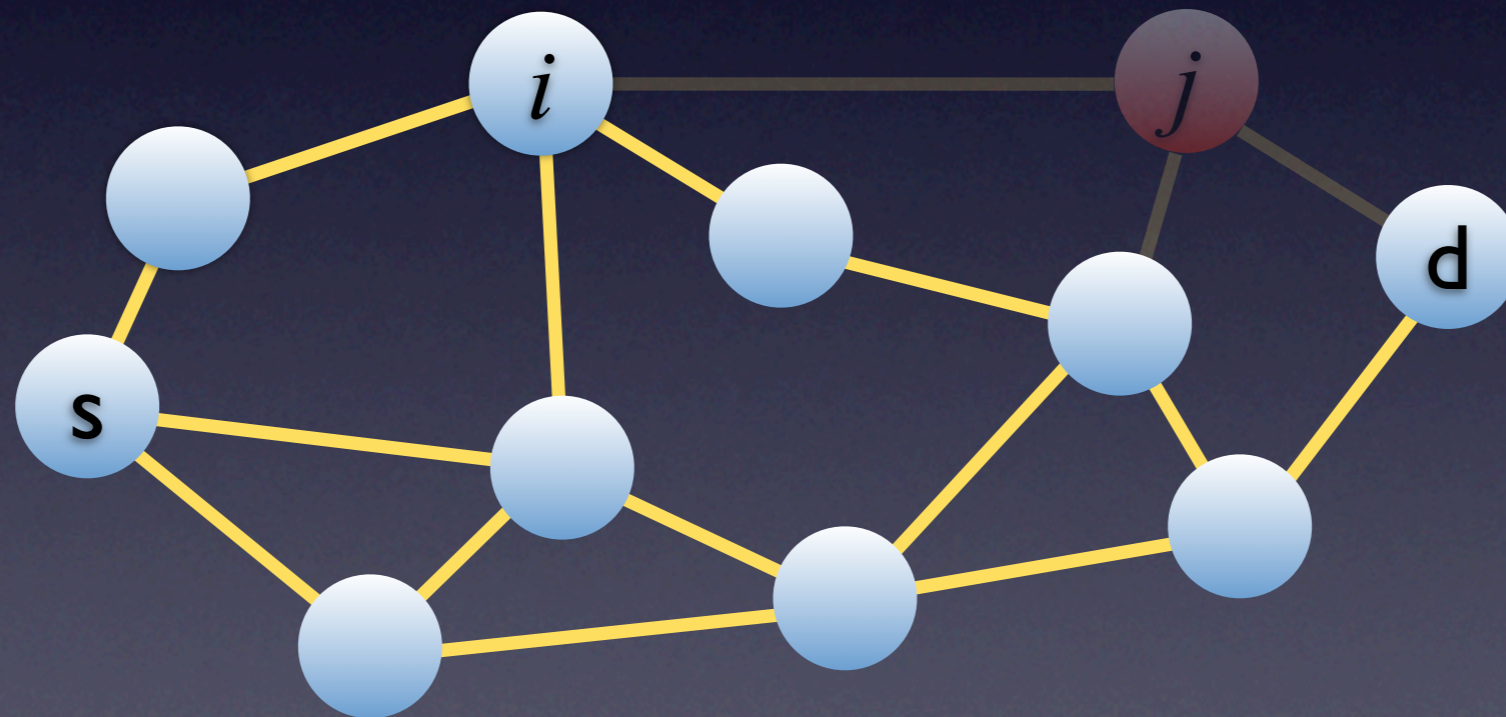
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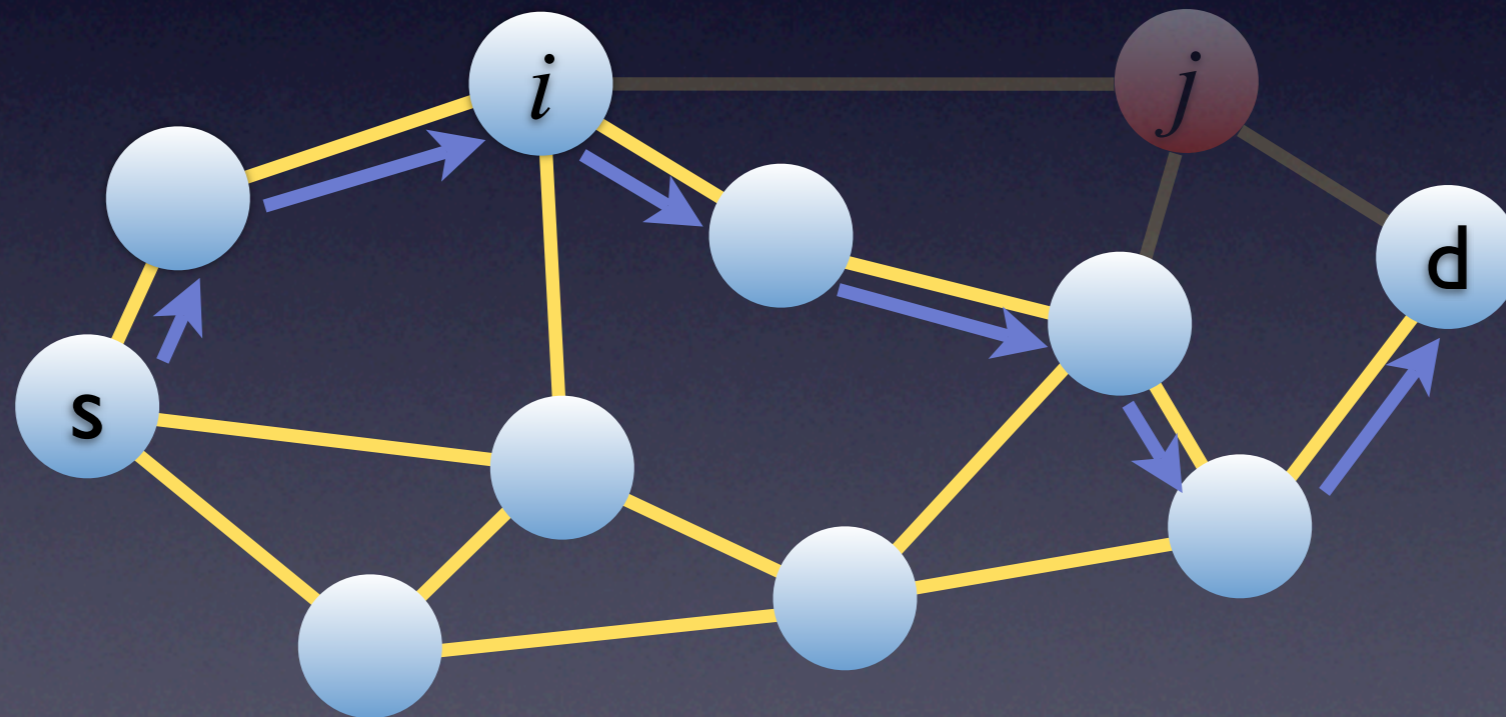
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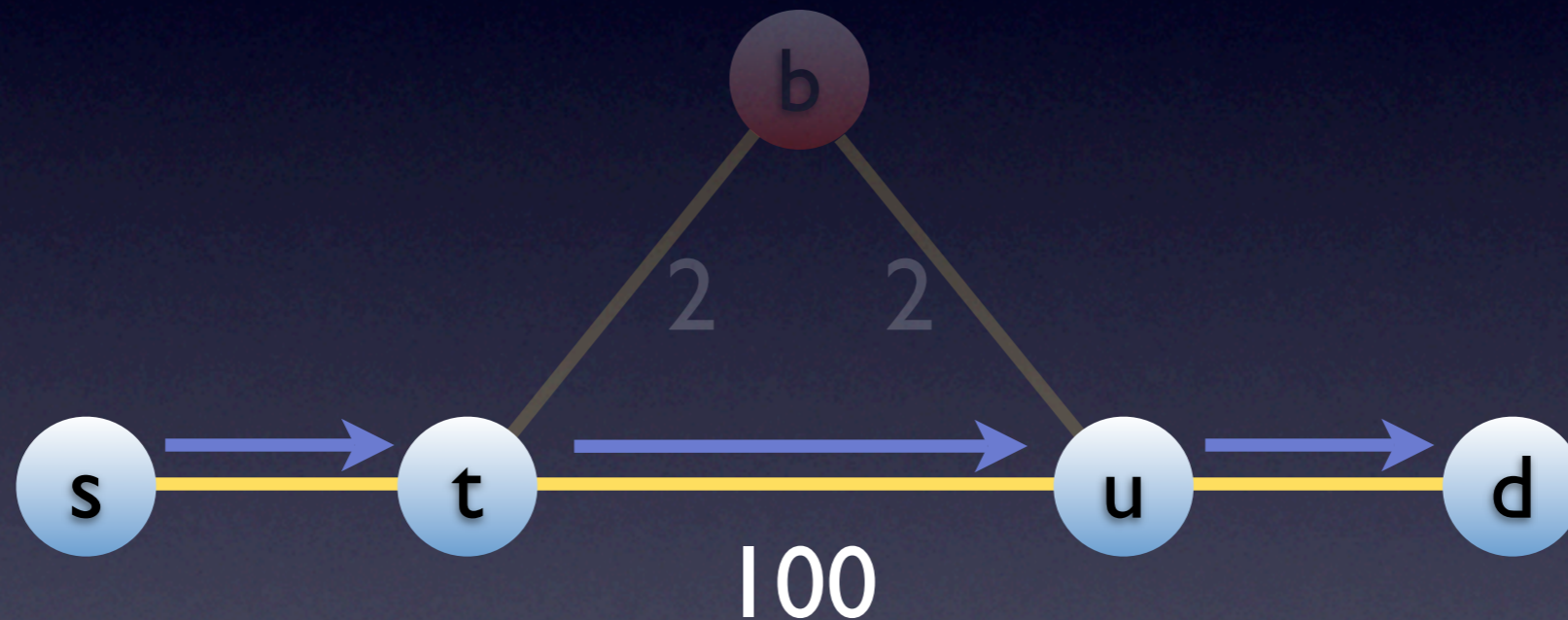
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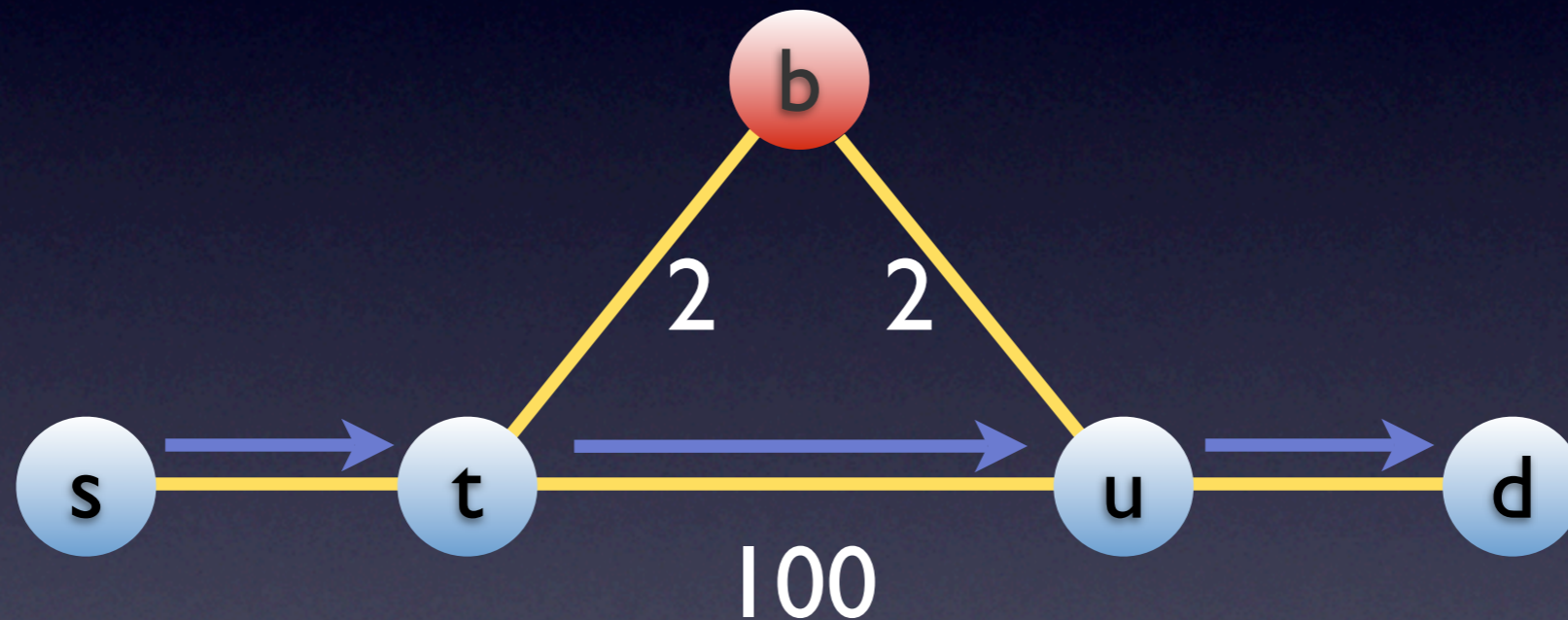
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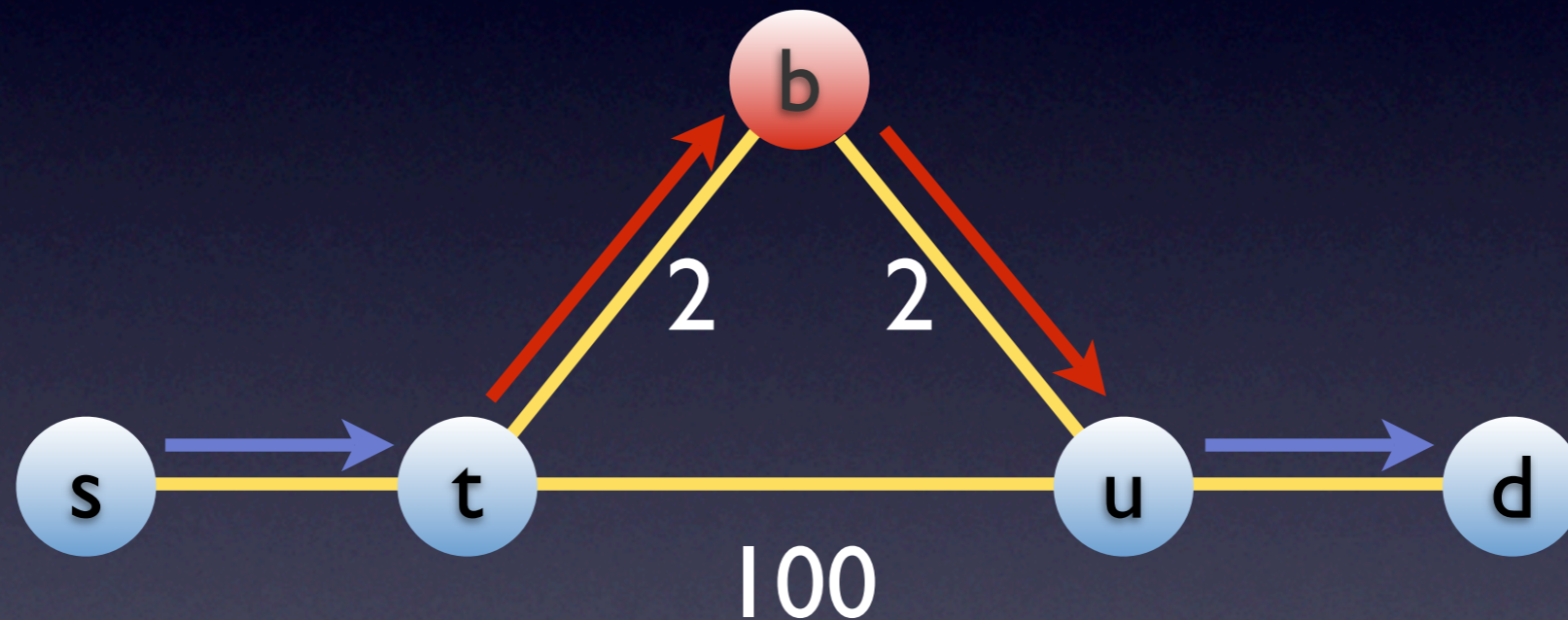




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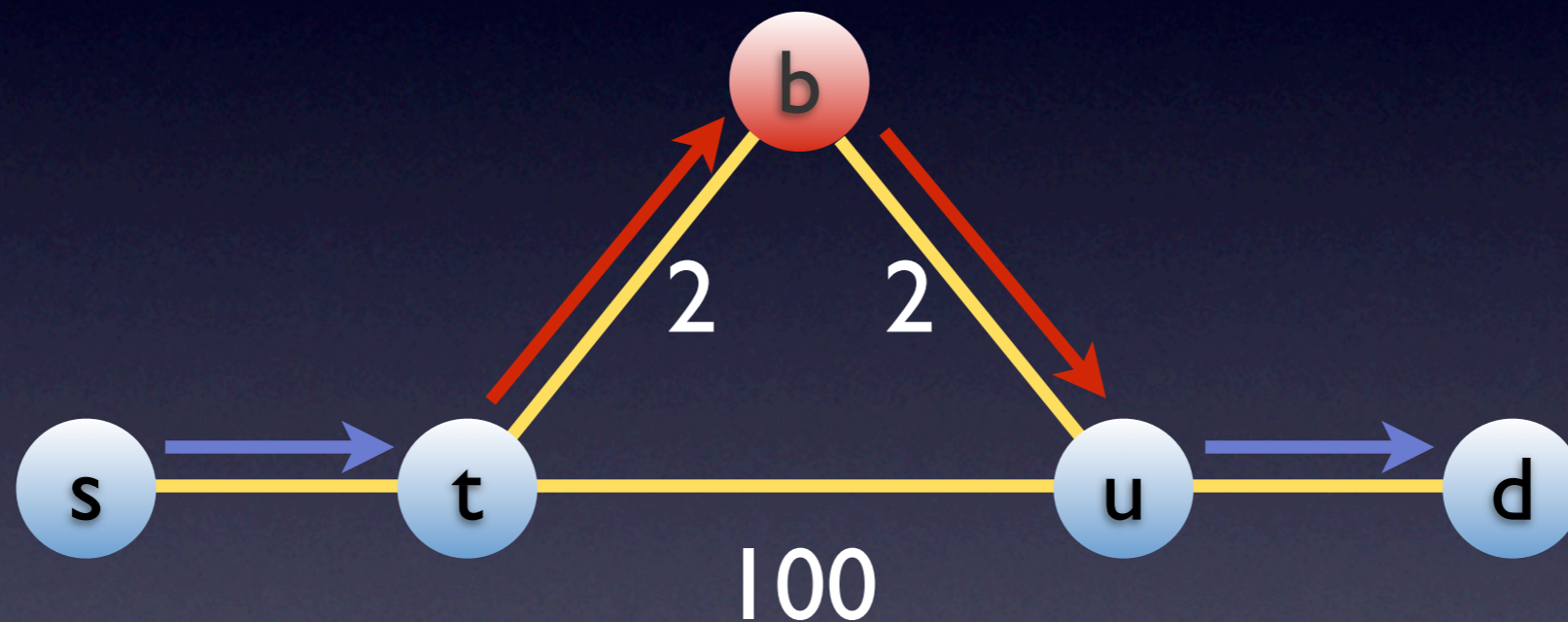
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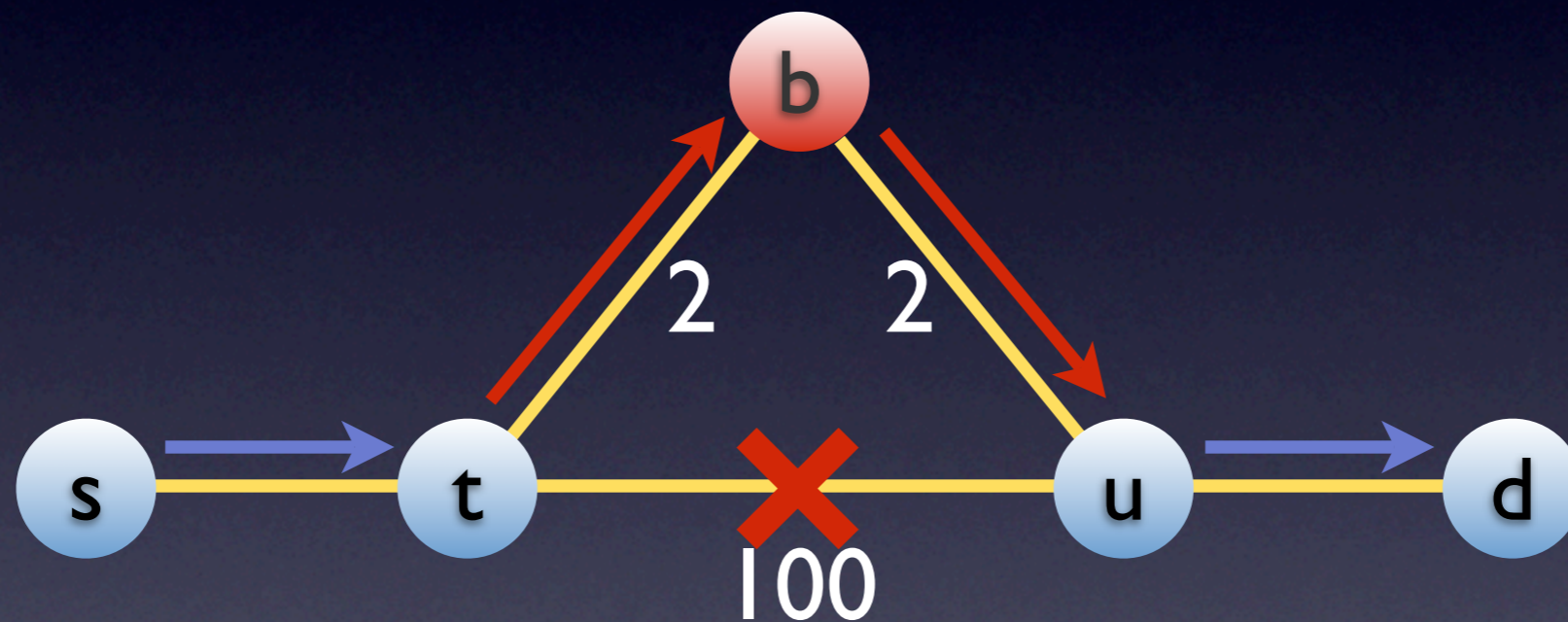
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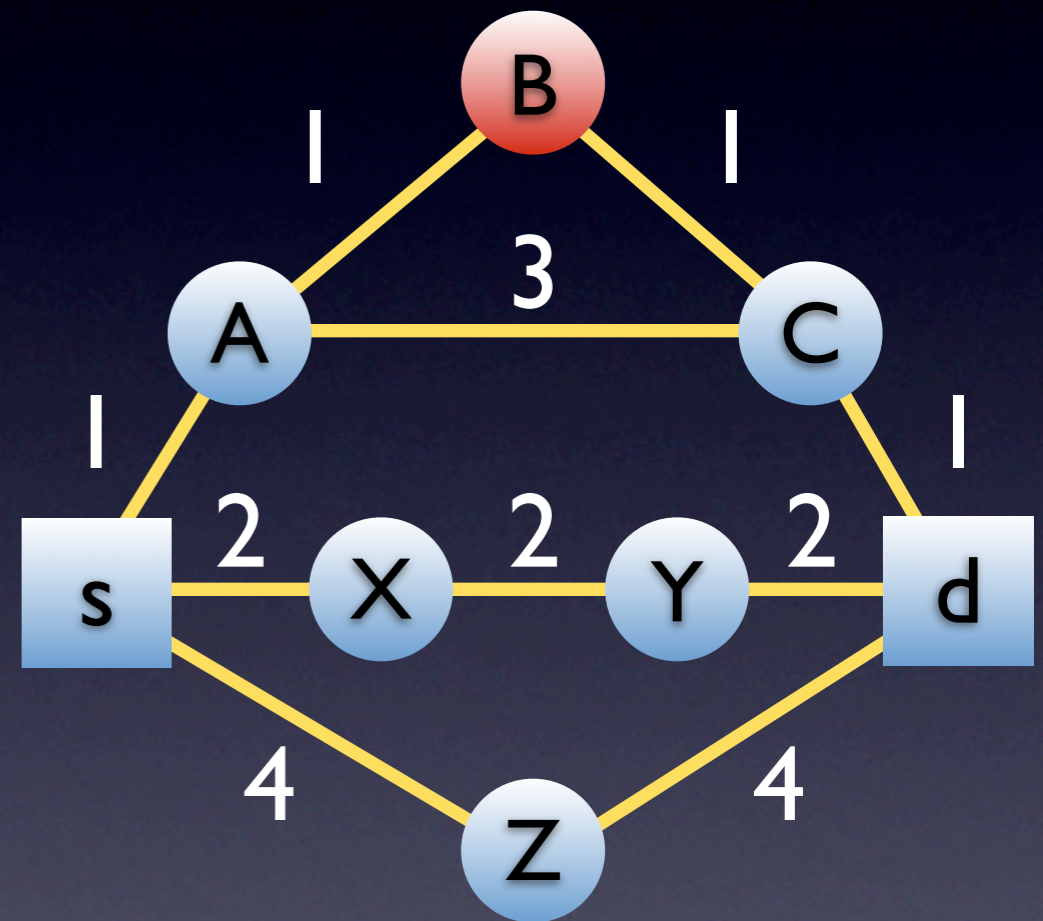
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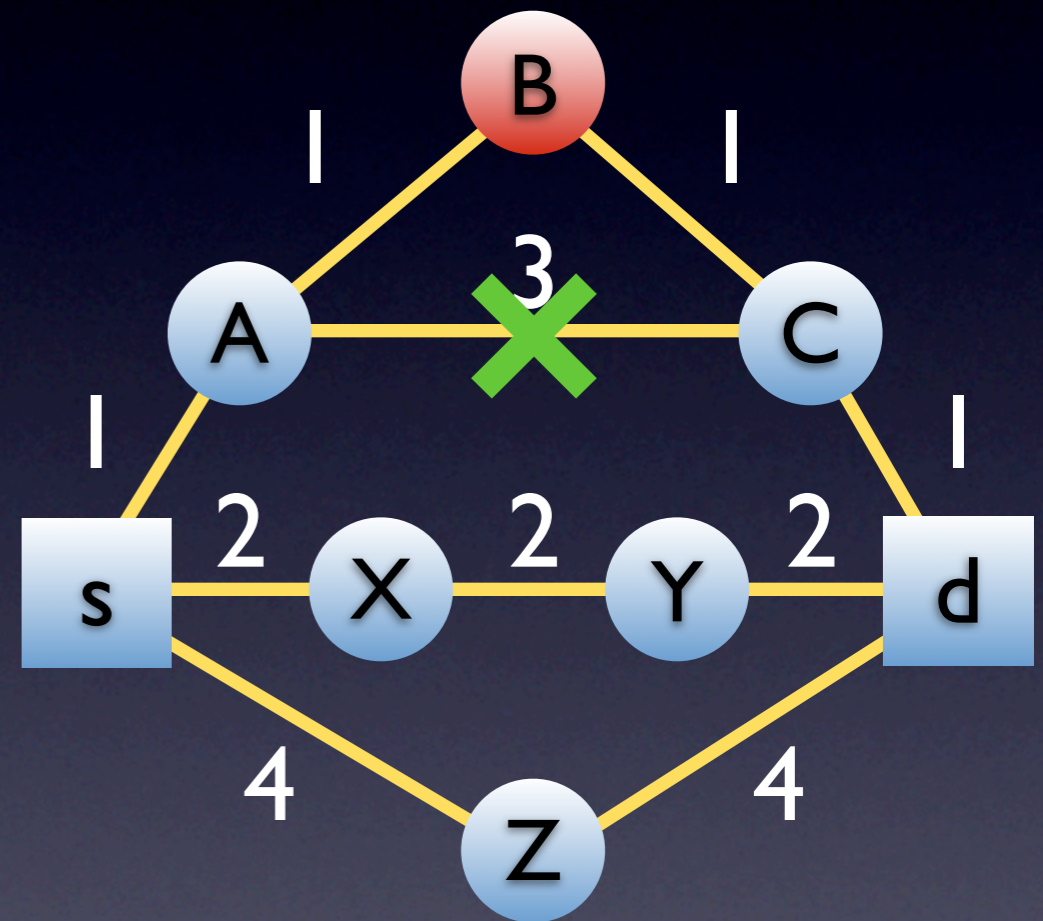
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1. Gather  $c'(i, j)$  from everyone
2. Compute *all-pairs* shortest paths
3. Remove all edges  $(i, j)$  where the shortest *path* from  $i$  to  $j$  goes through a boycotted node
4. Run culled-VCG on this graph



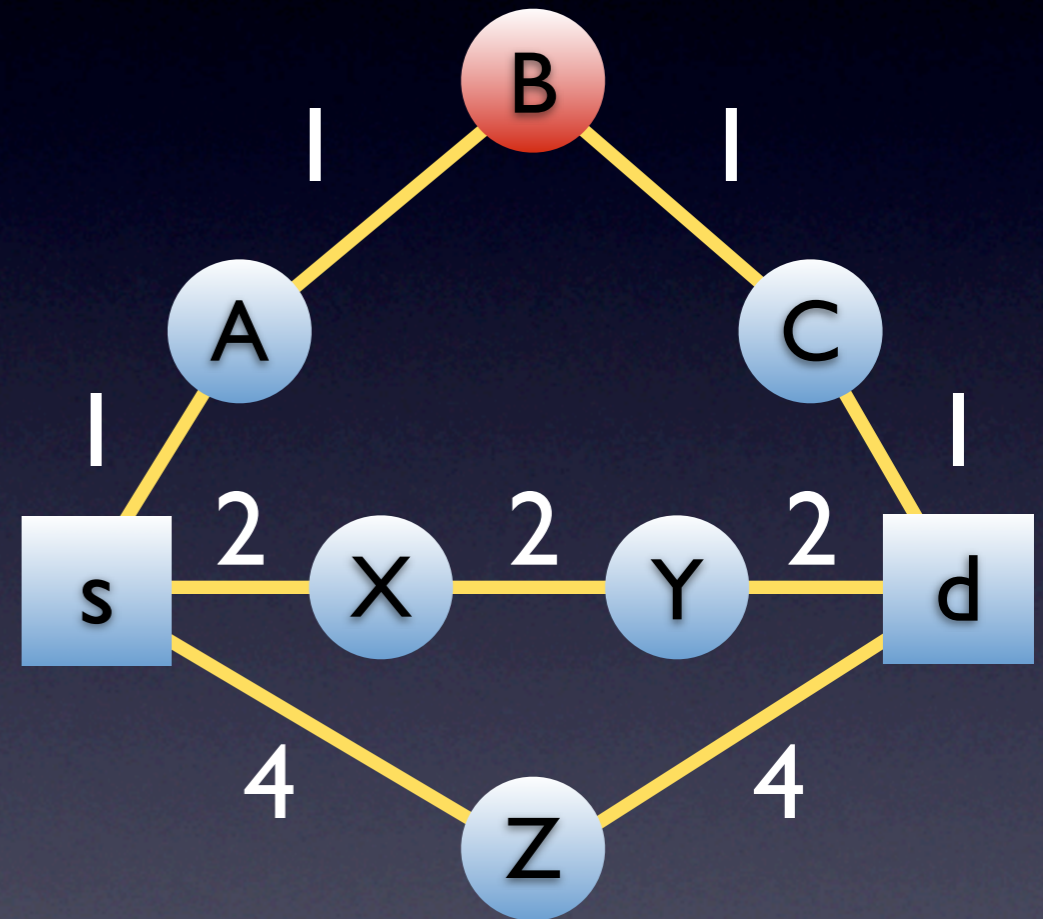
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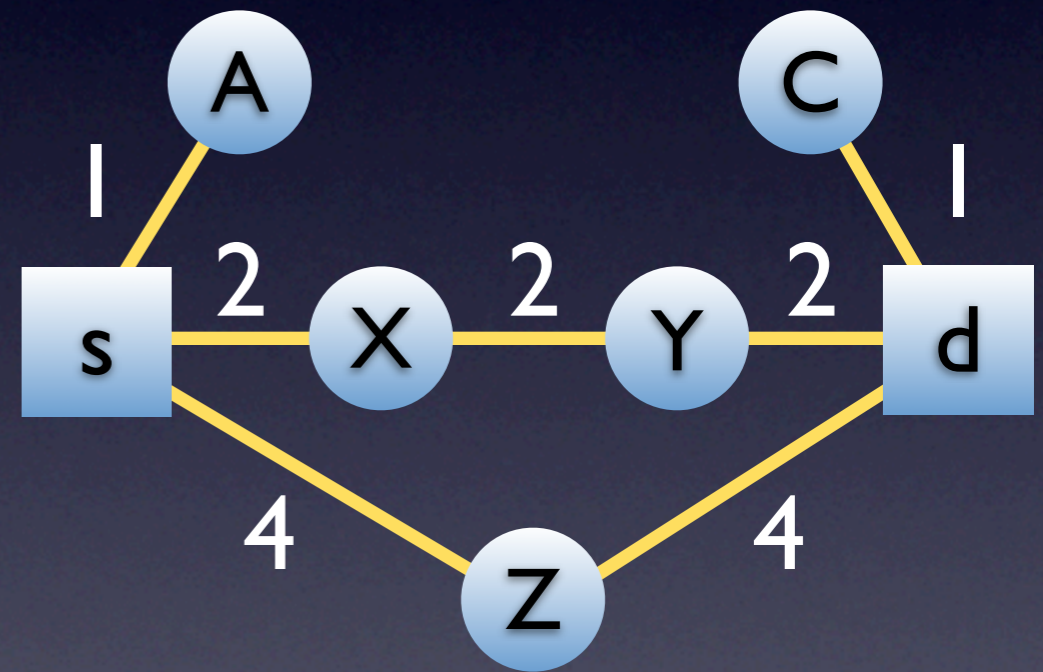
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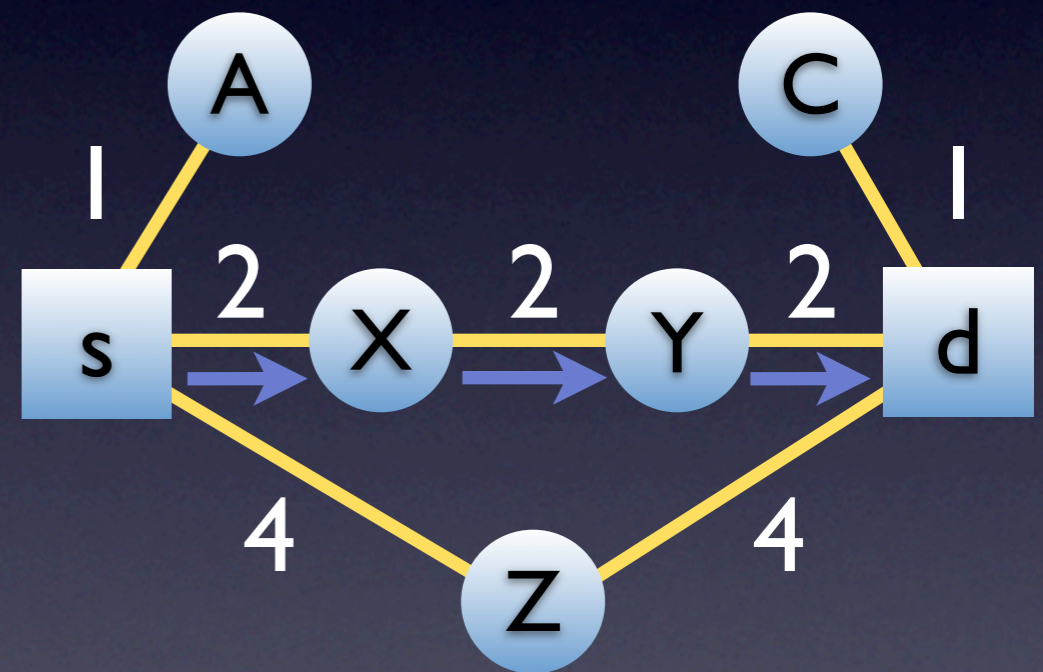


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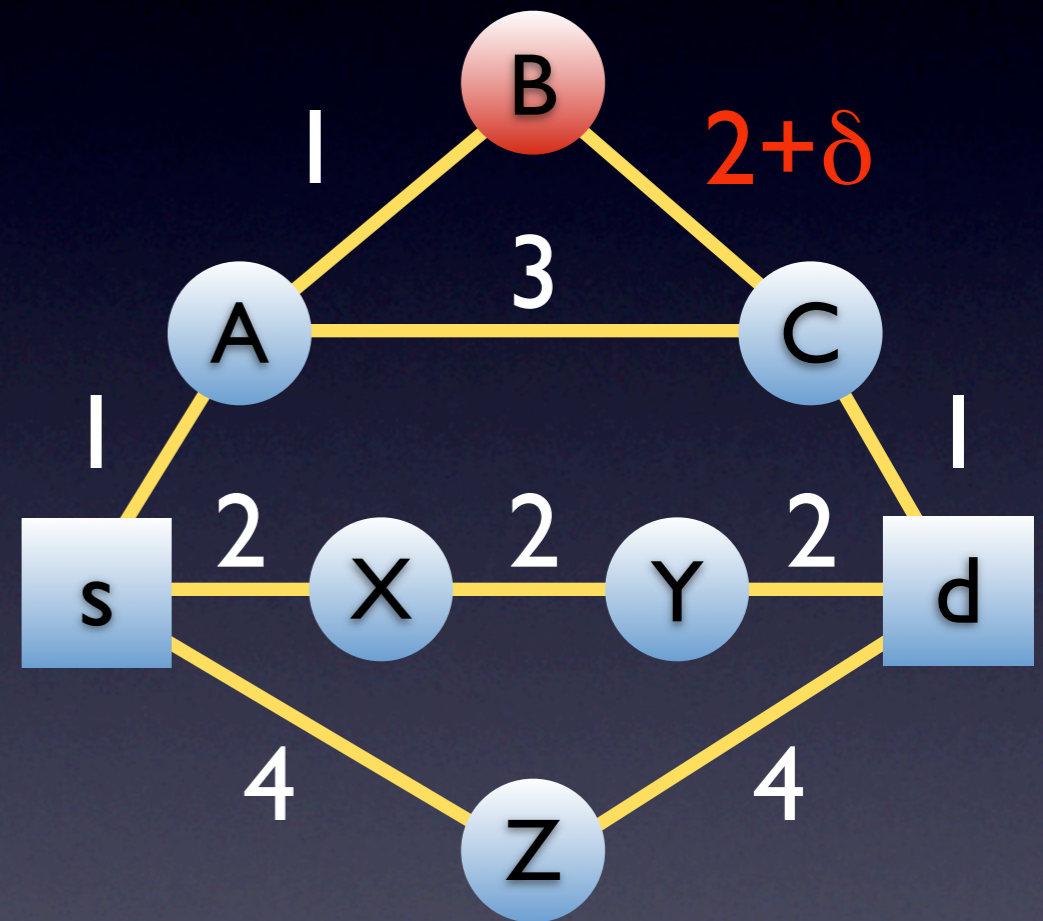
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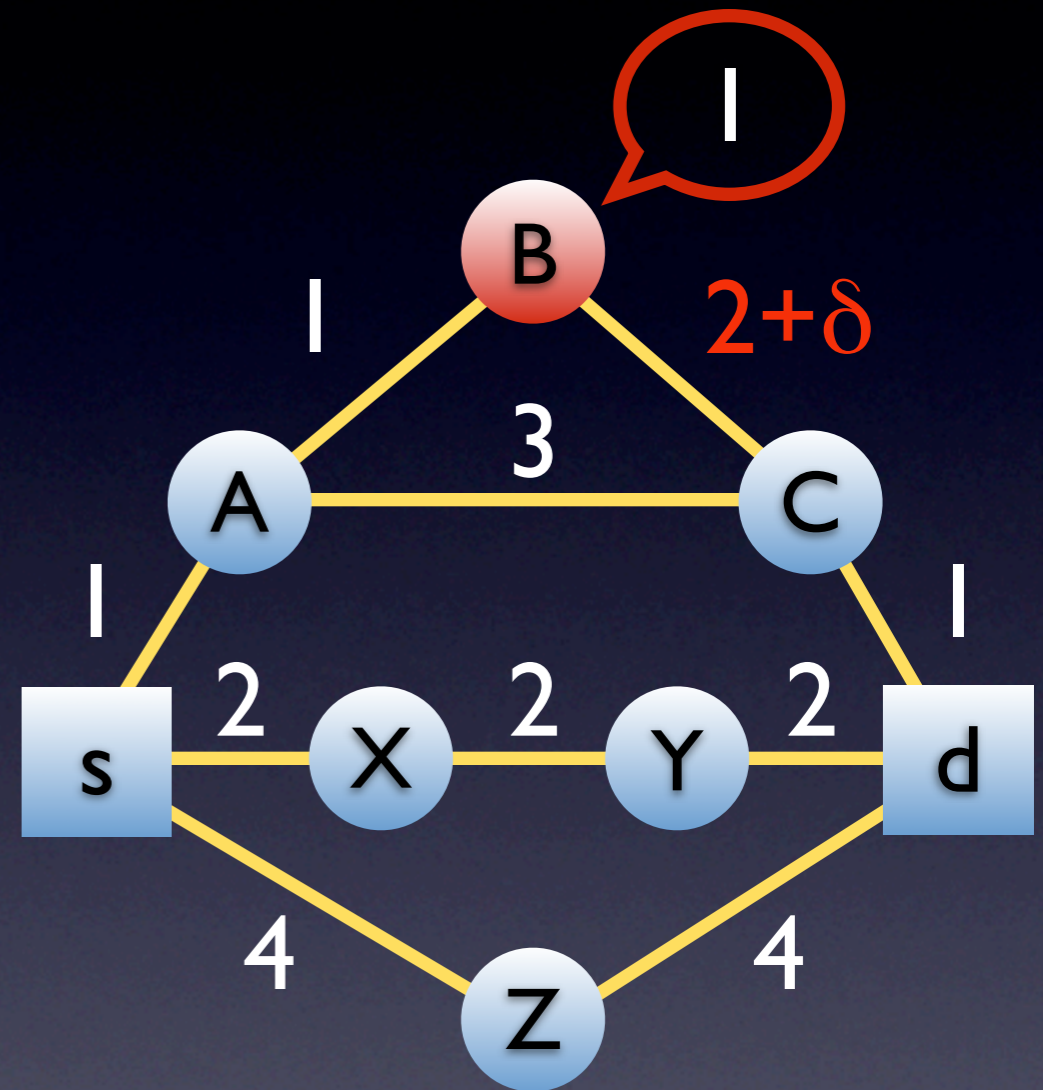
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- **Problem: B** can threaten **A**
  - “I will **understate** unless you pay me 99% of your profit”
- **Credible threat?**
  - ✓ Both **A** and **B** profit
  - X **B** risks global understatement
    - Only if profit from extortion > loss from understating



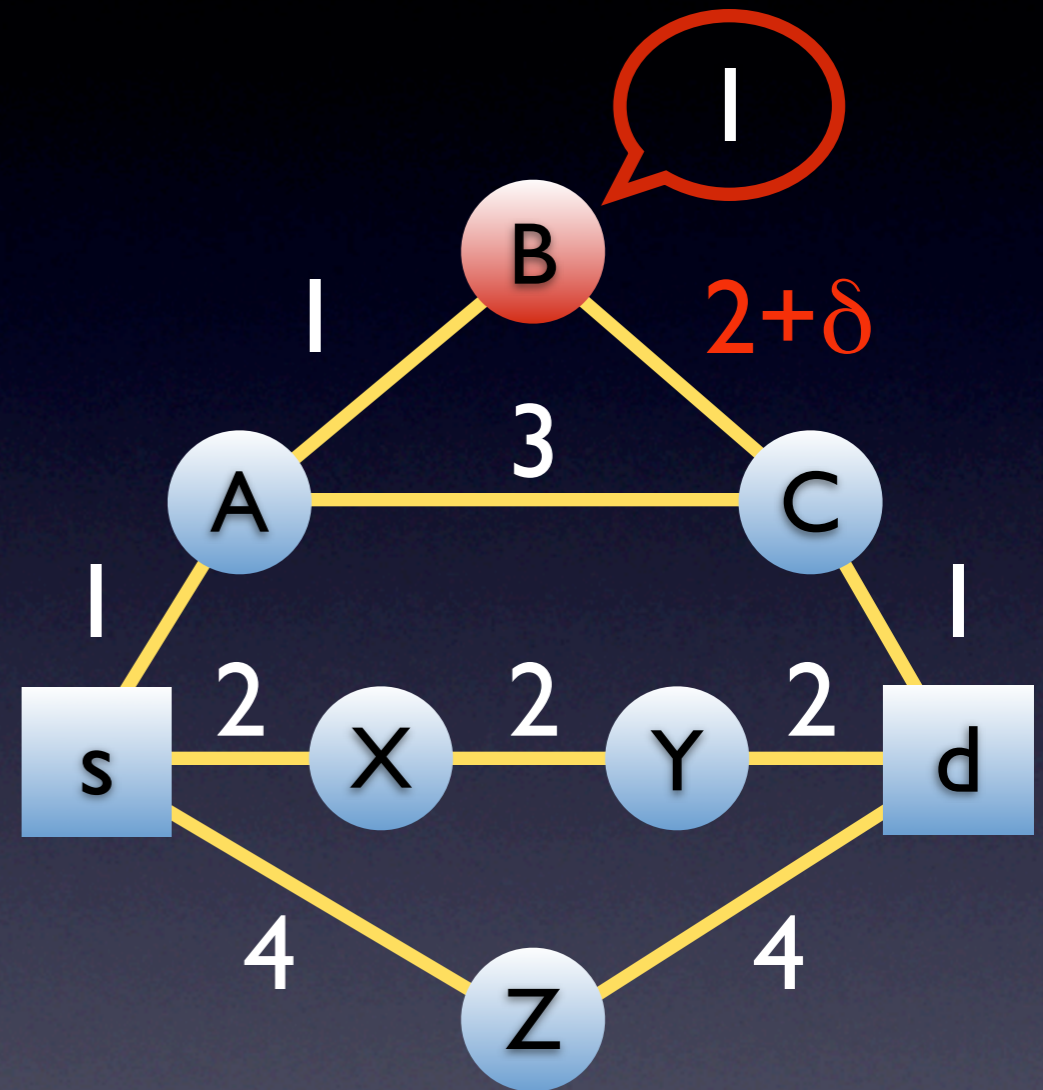
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- **Solution:** Ignore everything **B** says



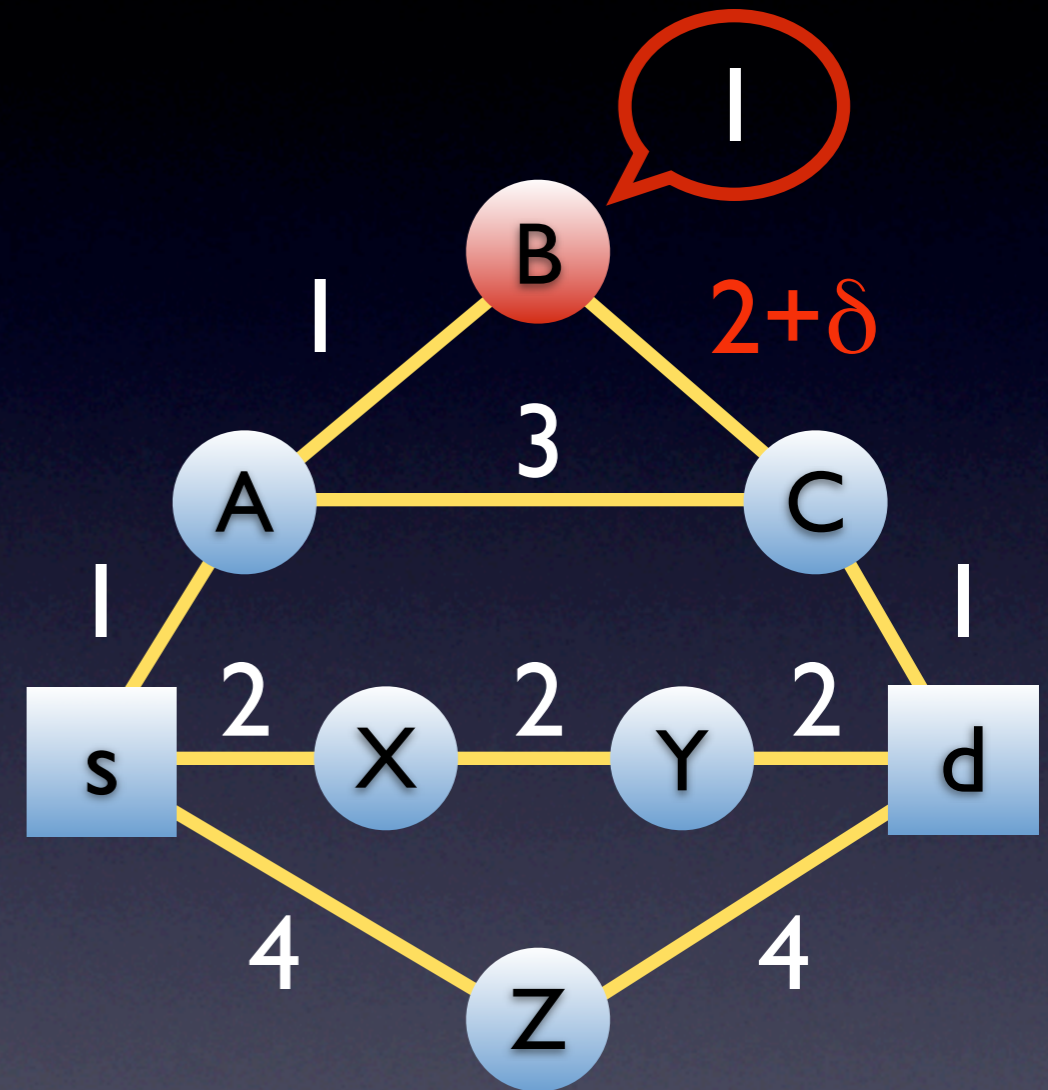
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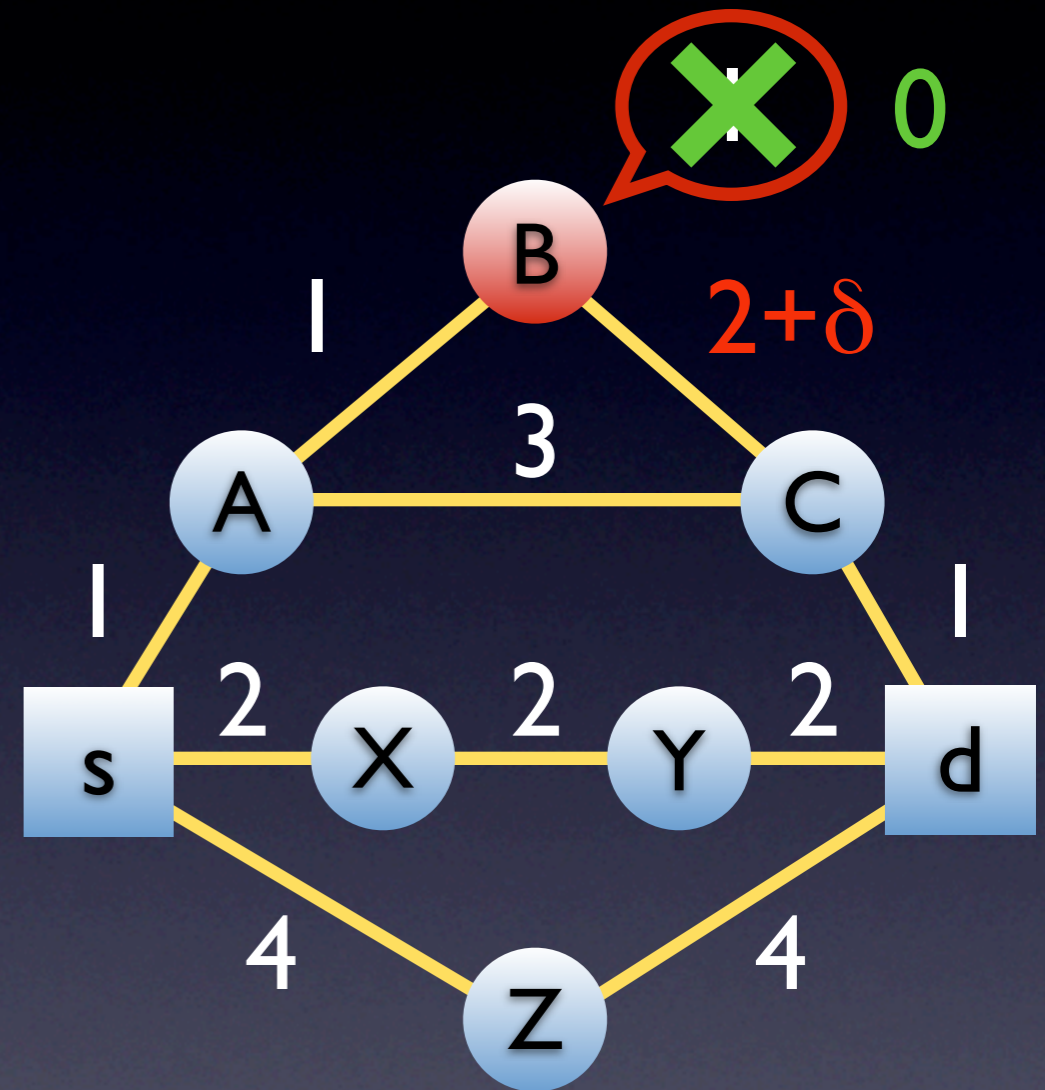
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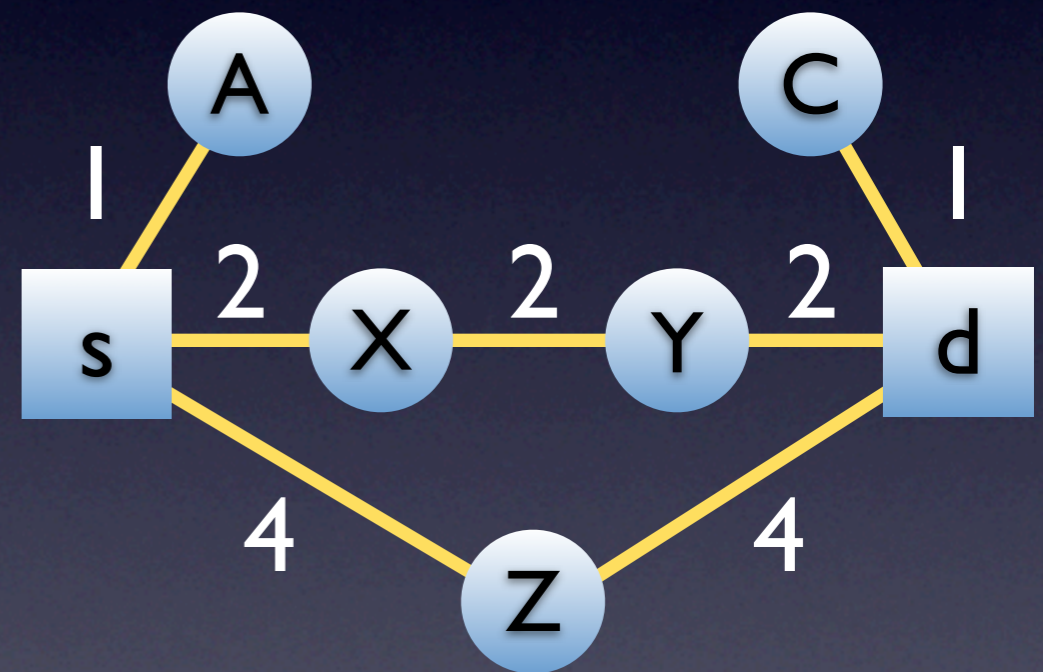
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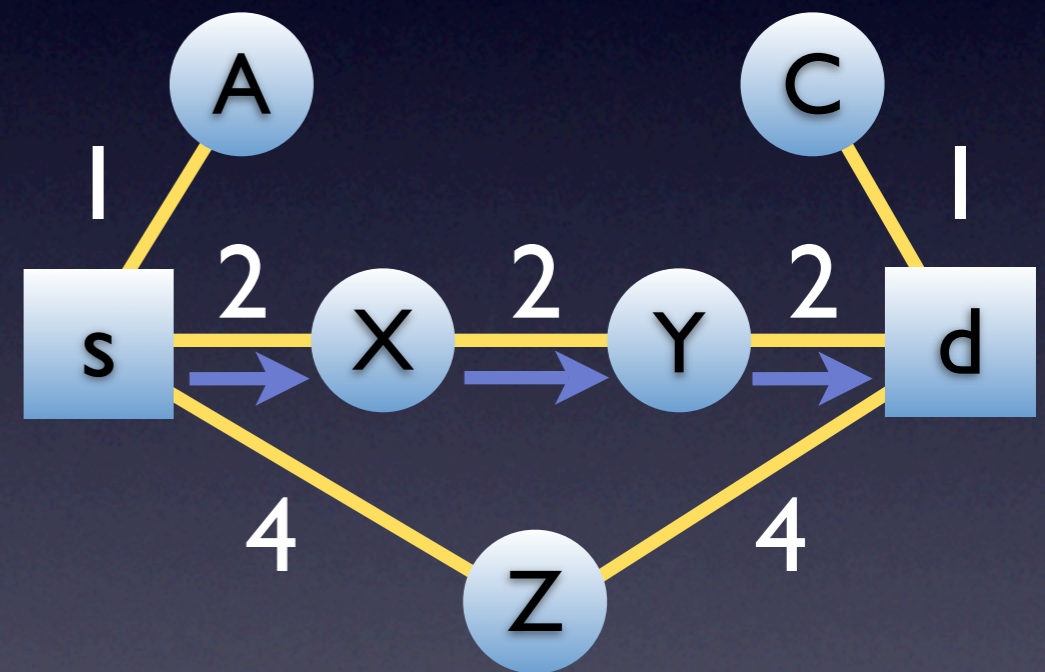
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# Quality of the Mechanism

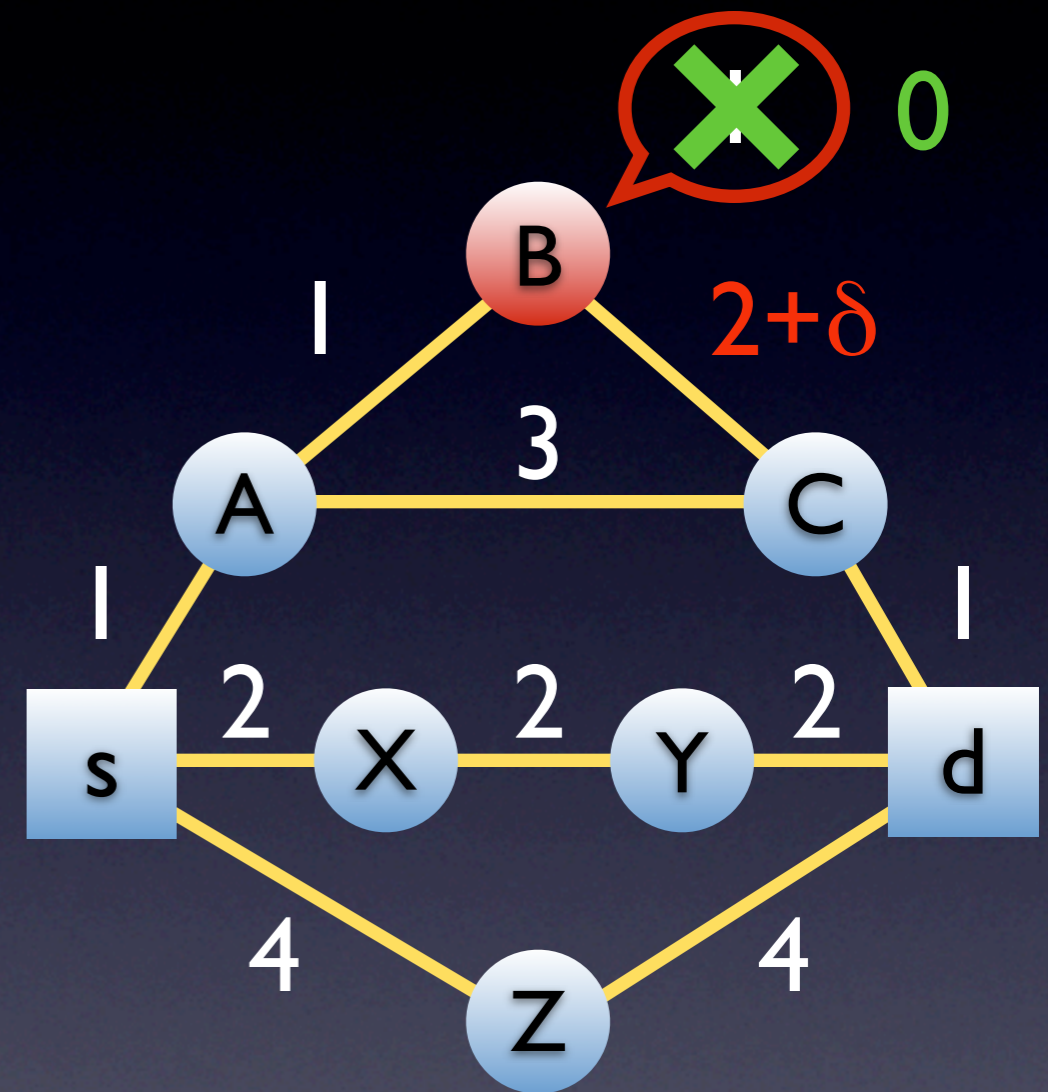
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- Truthfulness
- Relative cost of paths
- Ease of deployment



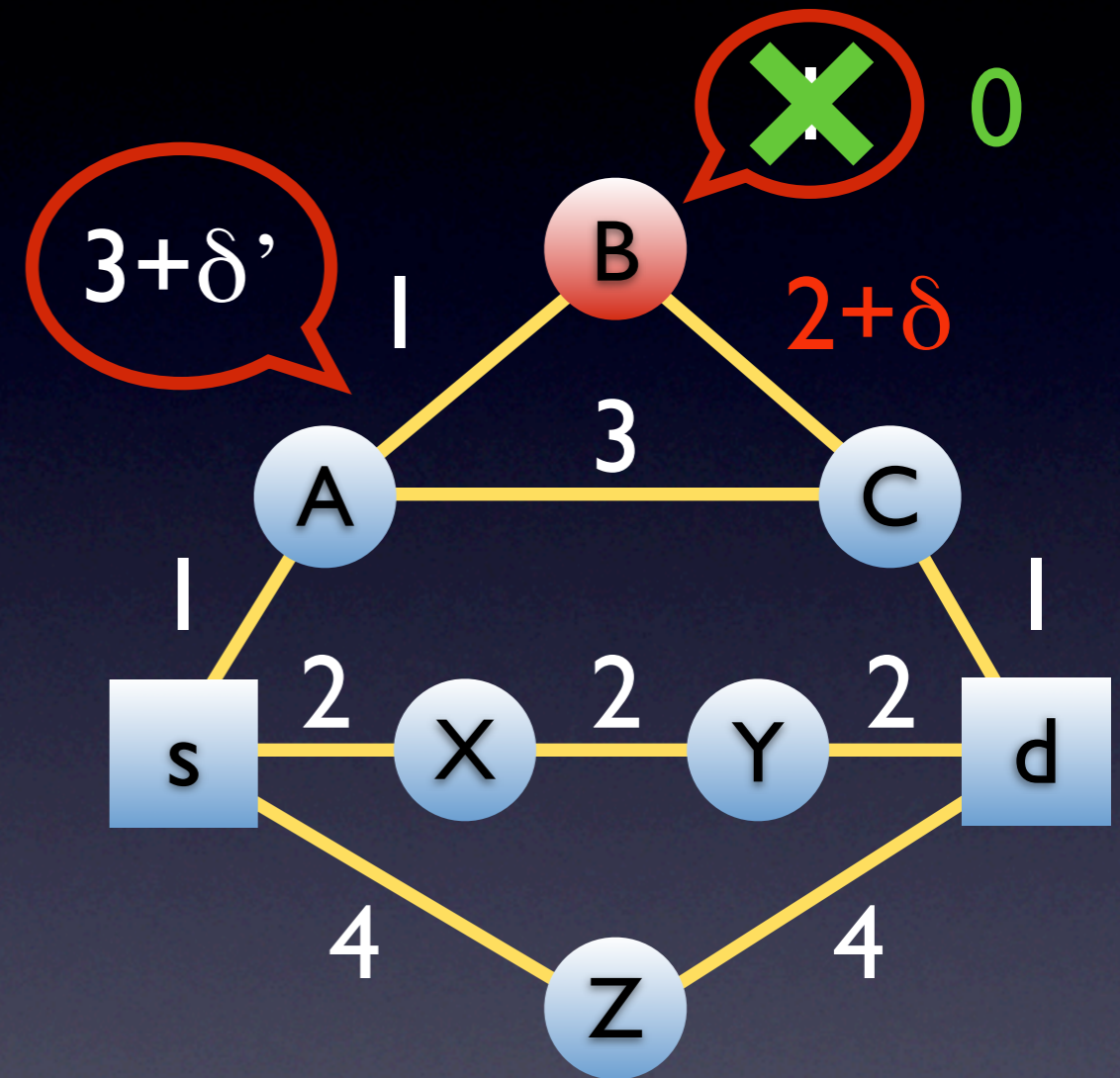
# Truthfulness

- Truthfulness is not always a dominant strategy
- **A** can **overstate** to ensure that **A-C** will not get trimmed
- Only if gain  $>$  loss in profit from overstating
- **How do we resolve this?**
  - Other ways to infer costs?



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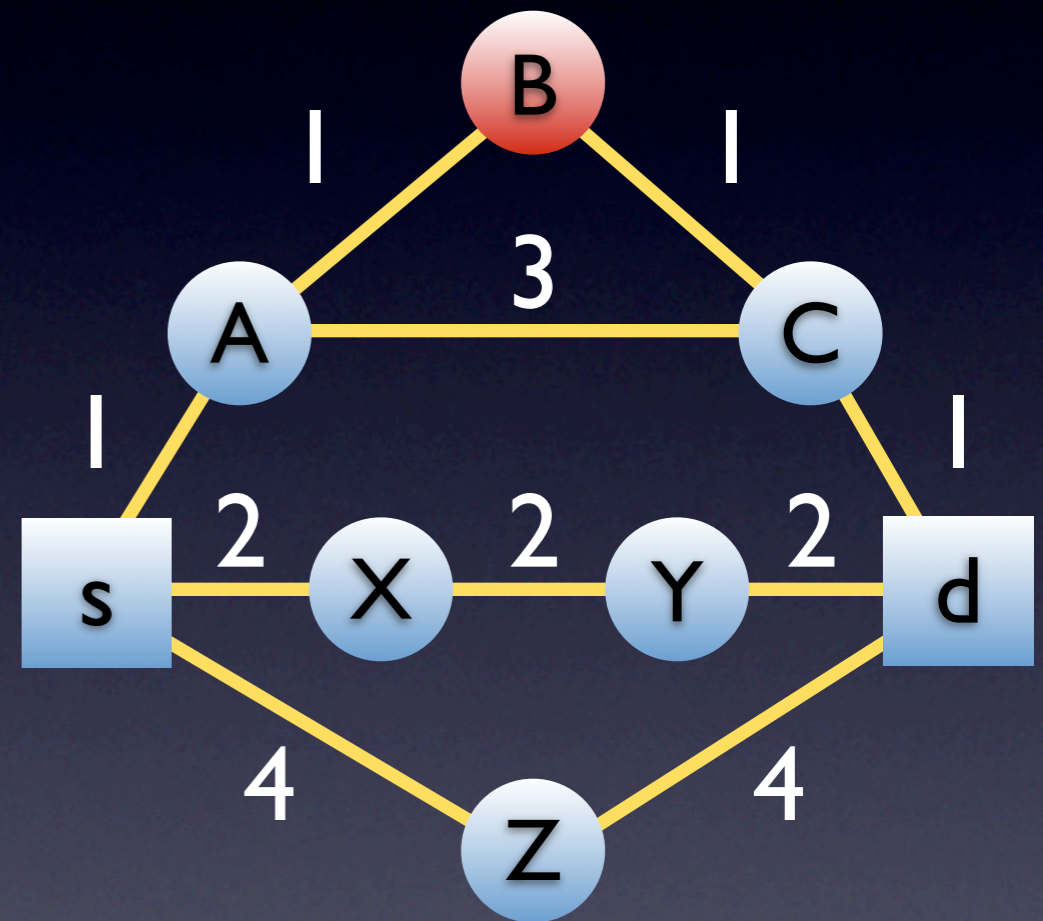


# Relative Costs of Paths

- “Cost of boycotting” set  $\mathcal{B} =$

Total \$ paid when boycotting  $\mathcal{B}$

Total \$ paid without boycotting  $\mathcal{B}$

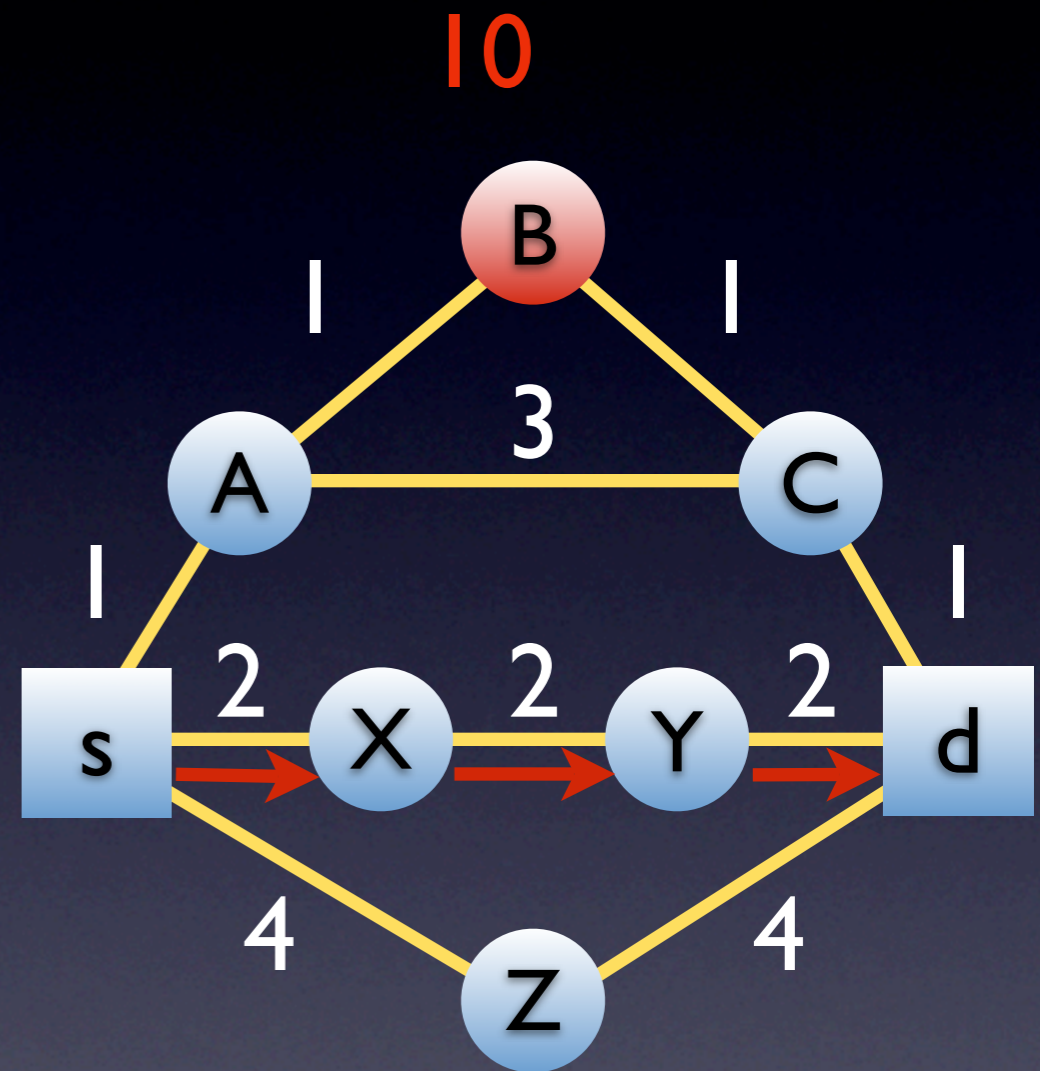


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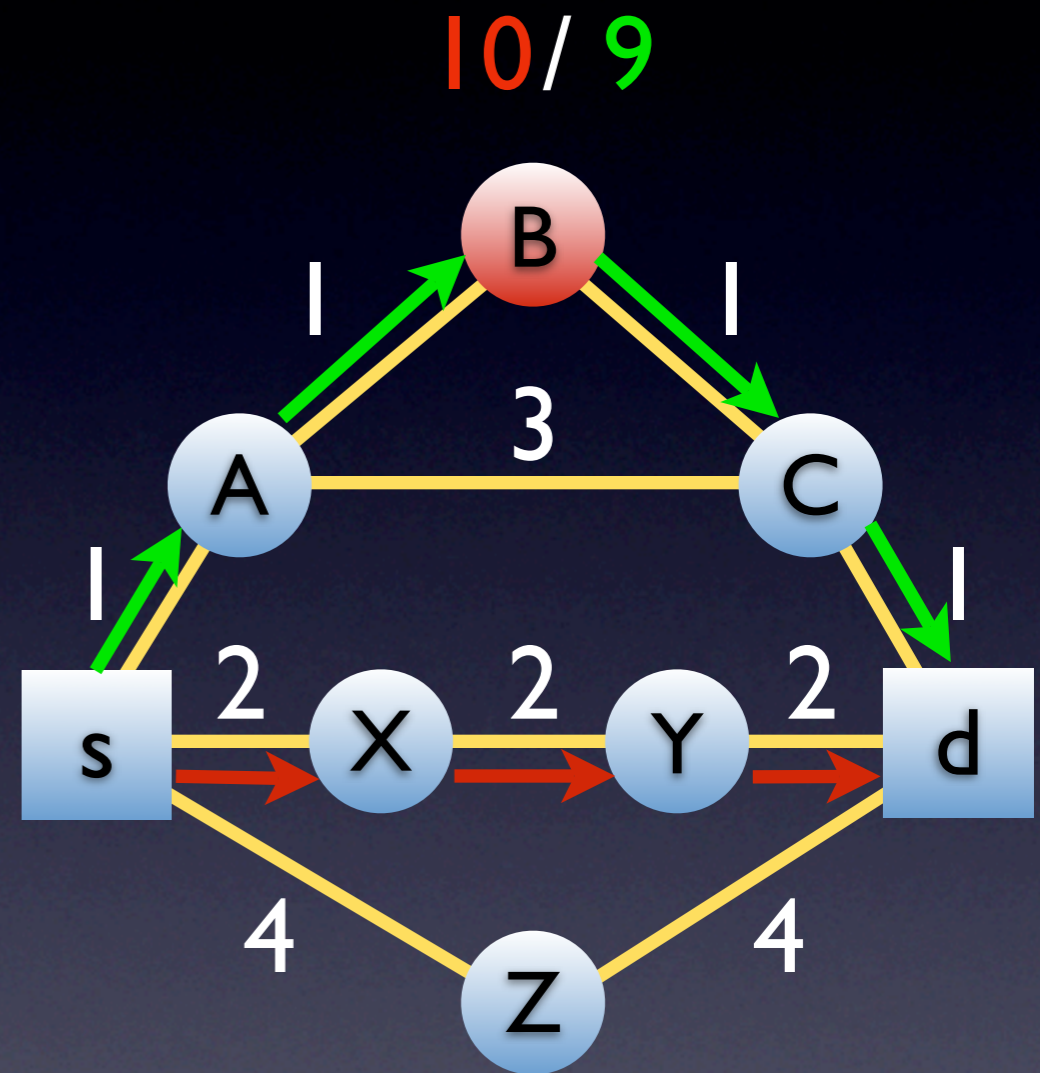


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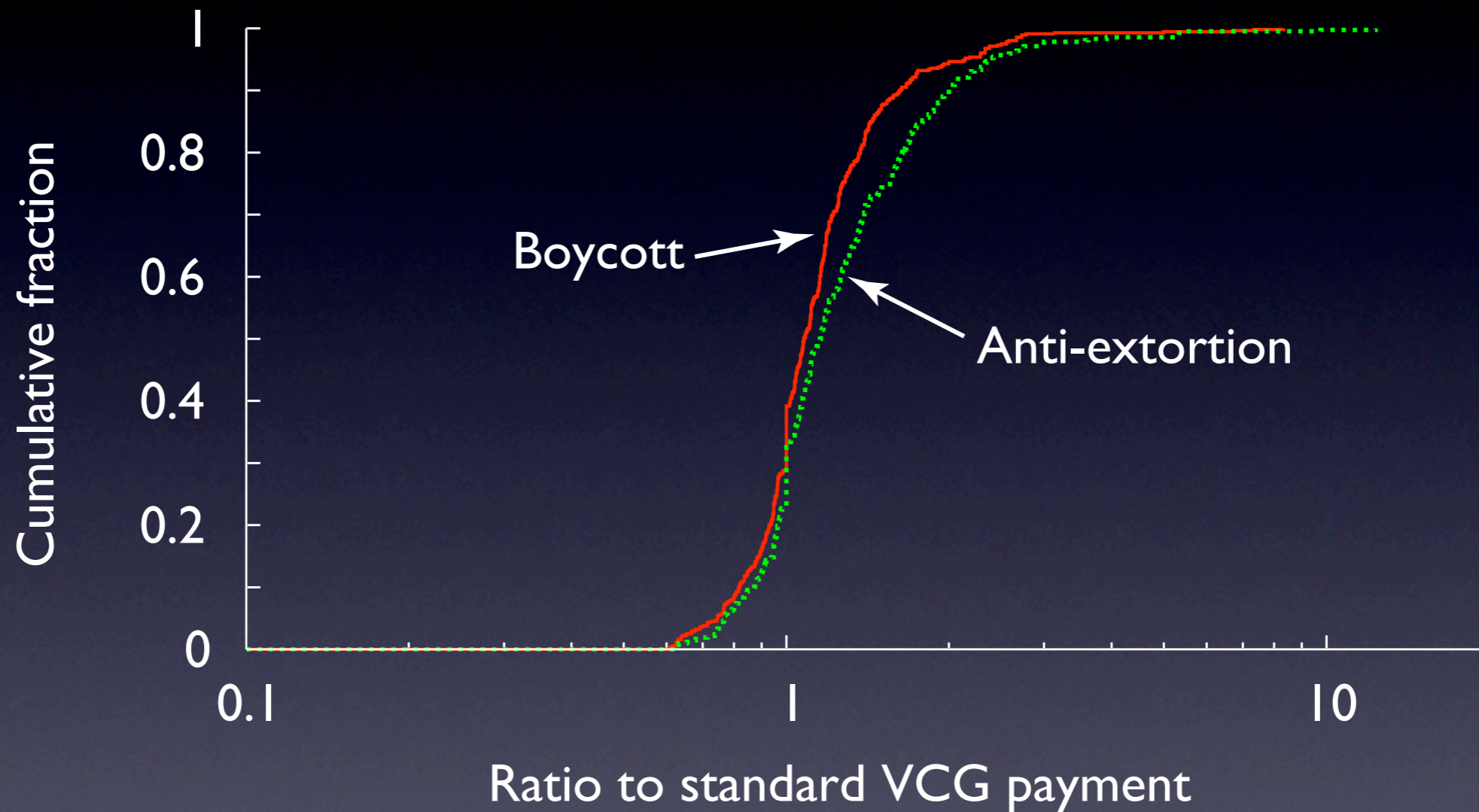
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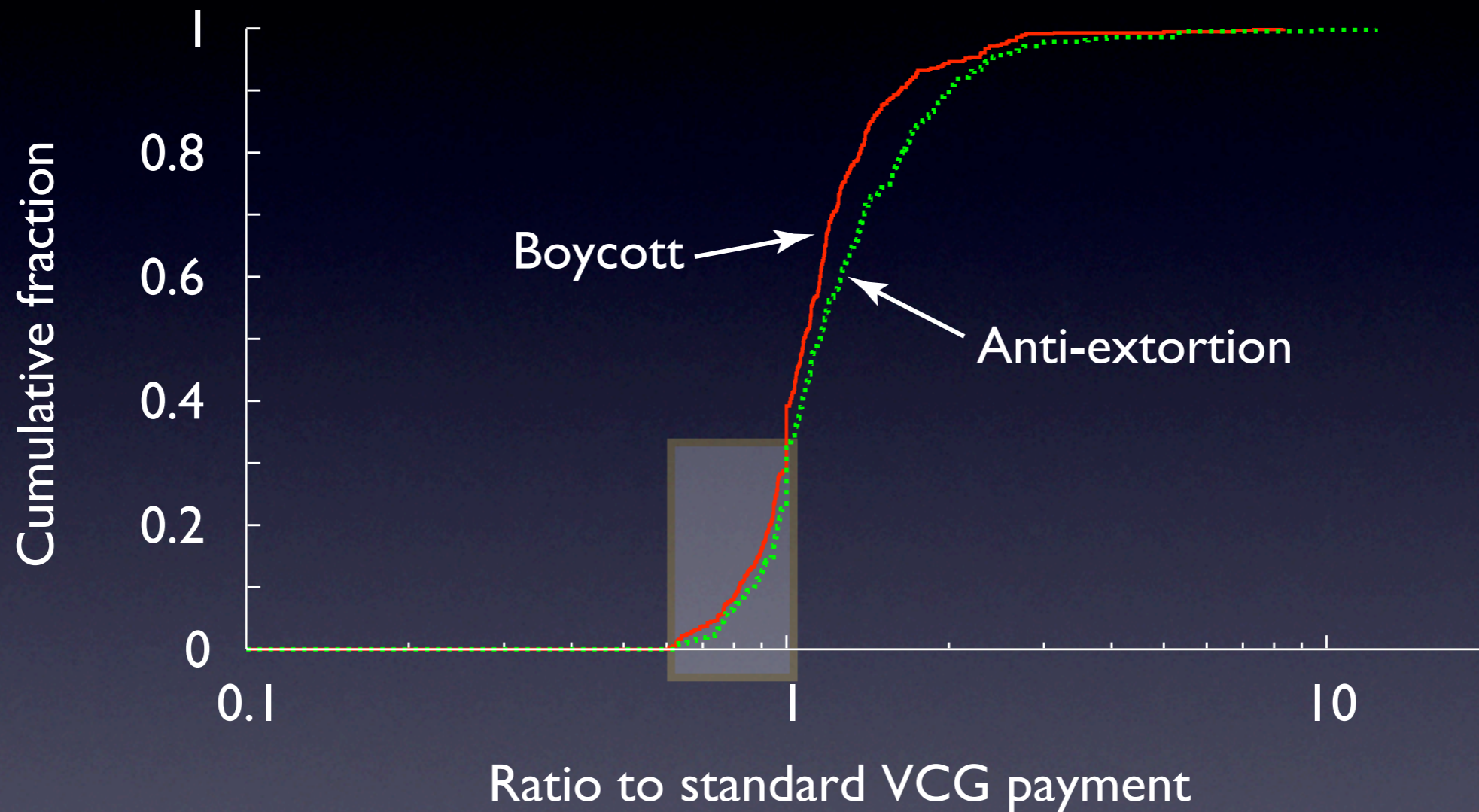


# Total Payment Made by the Source



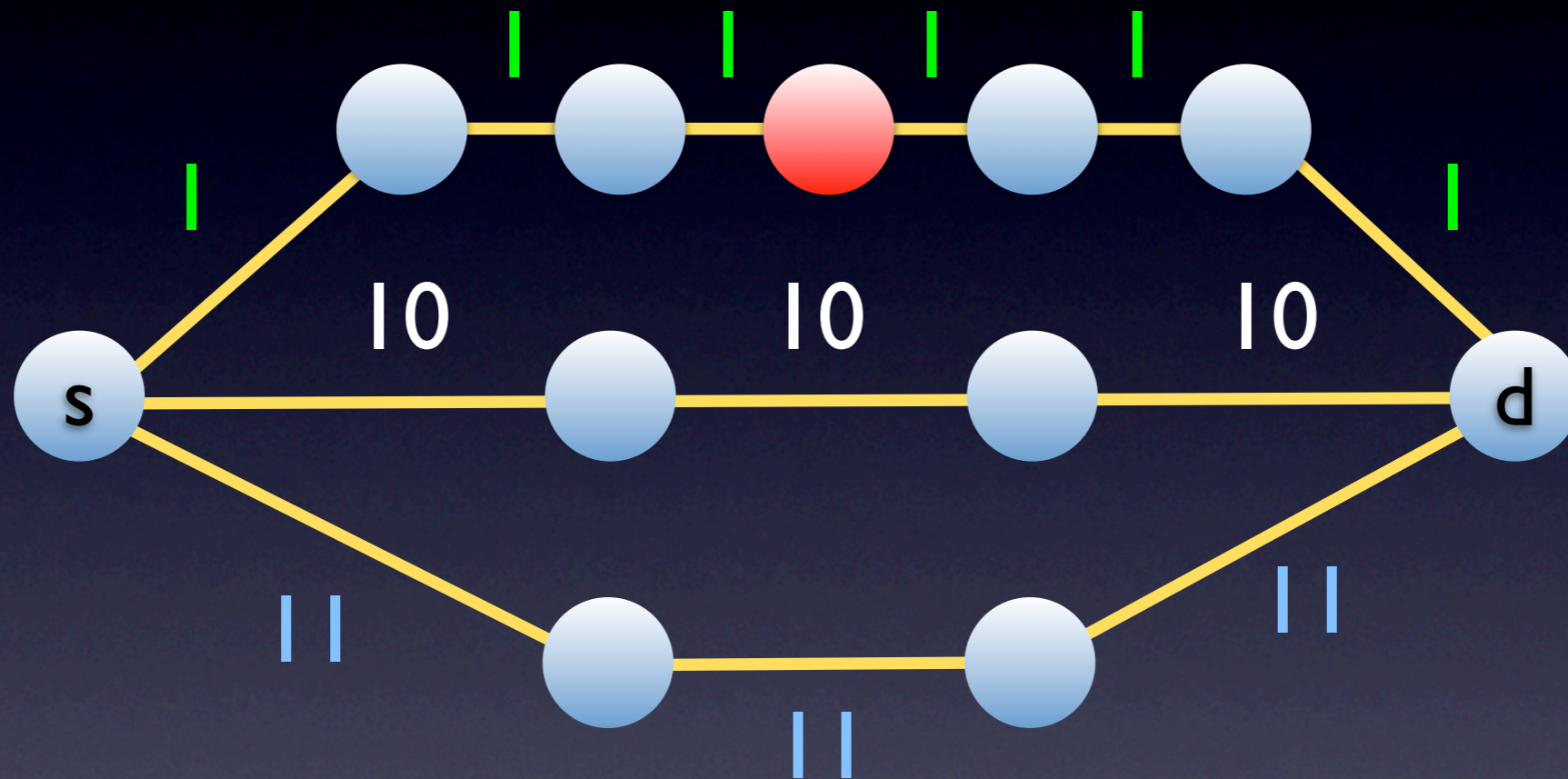
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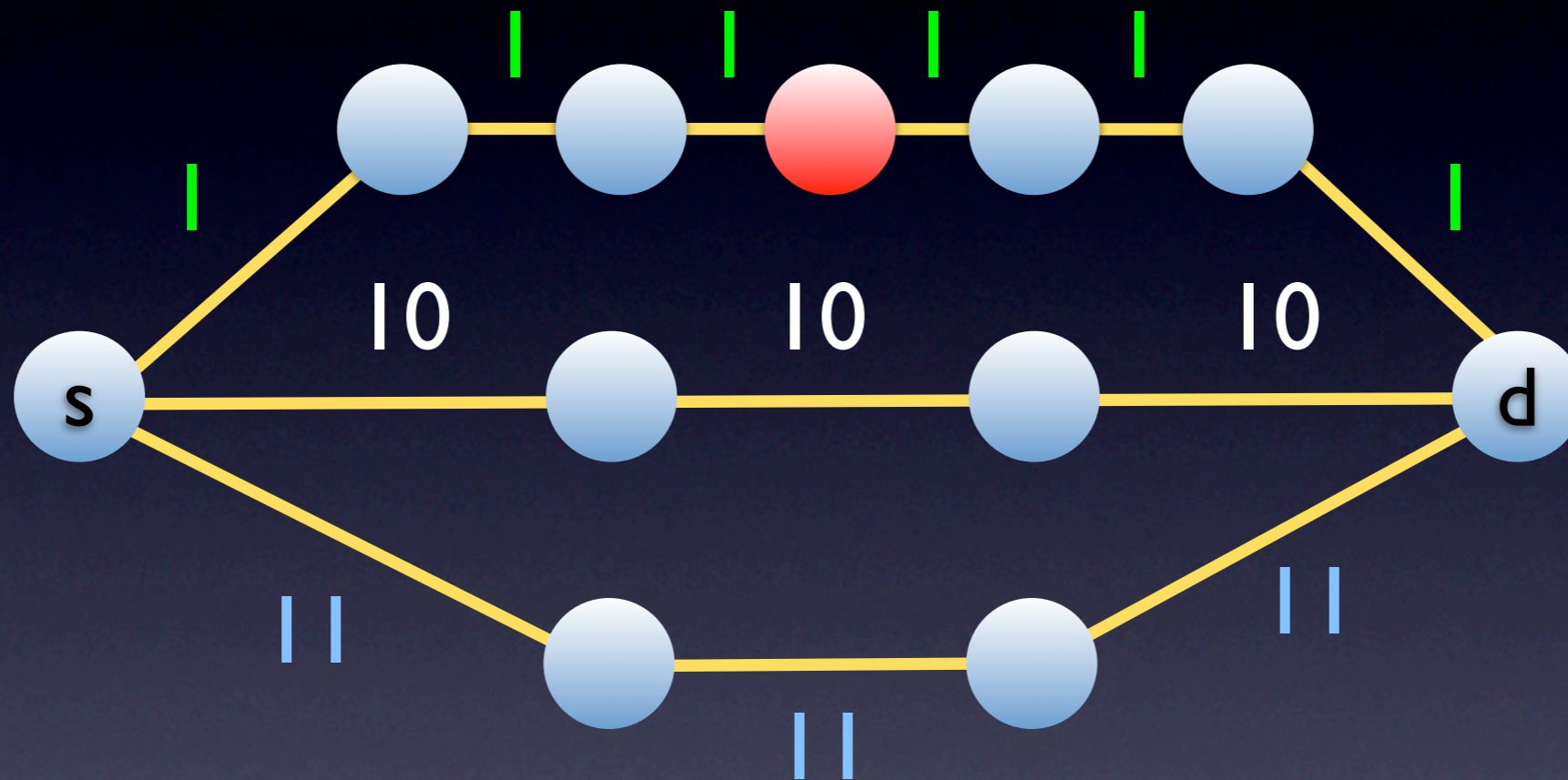
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# Saving Money with Boycotting





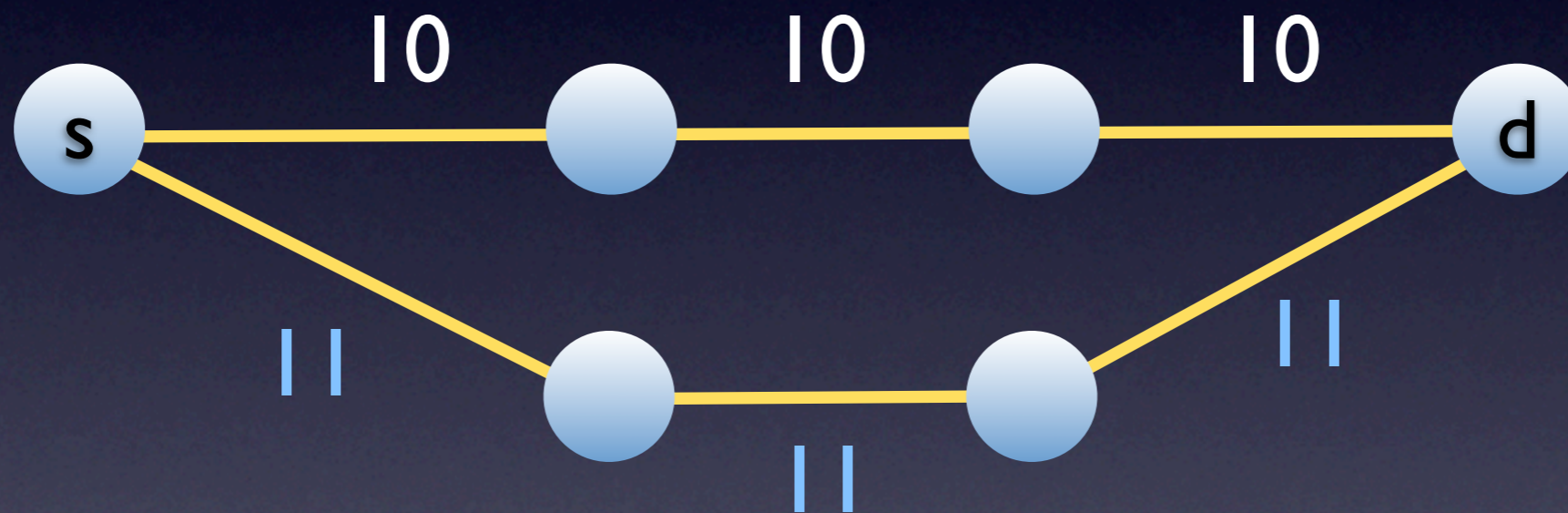
# Saving Money with Boycotting



$$1 + 5*(24+1) = 126$$

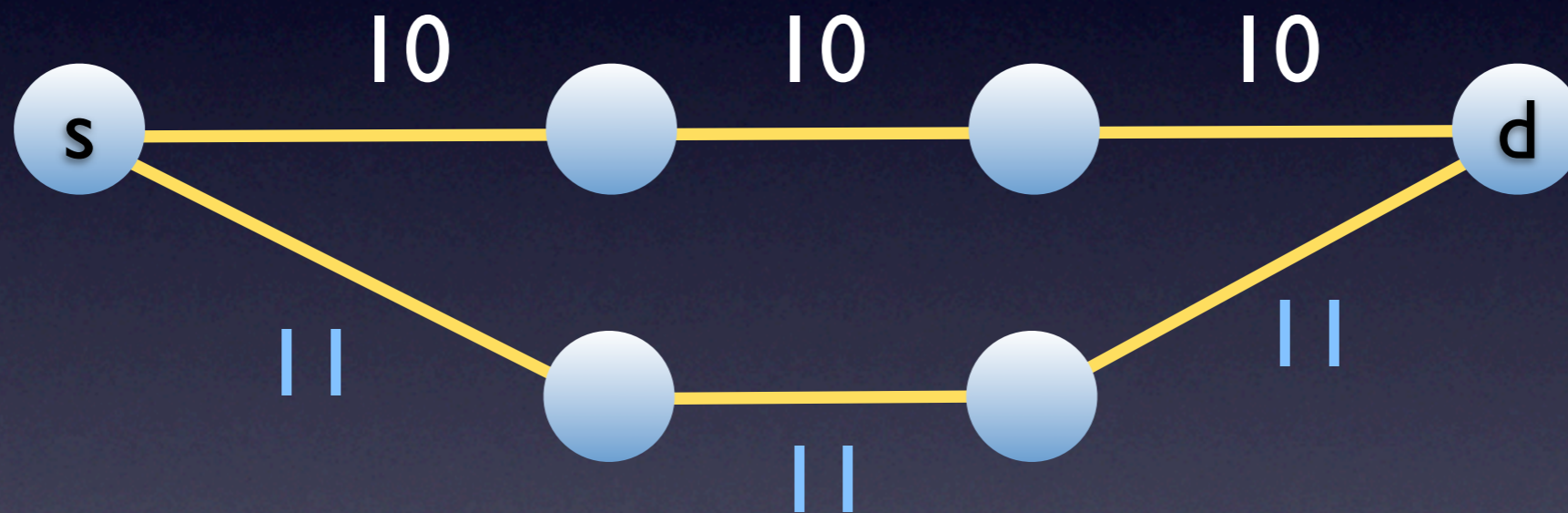
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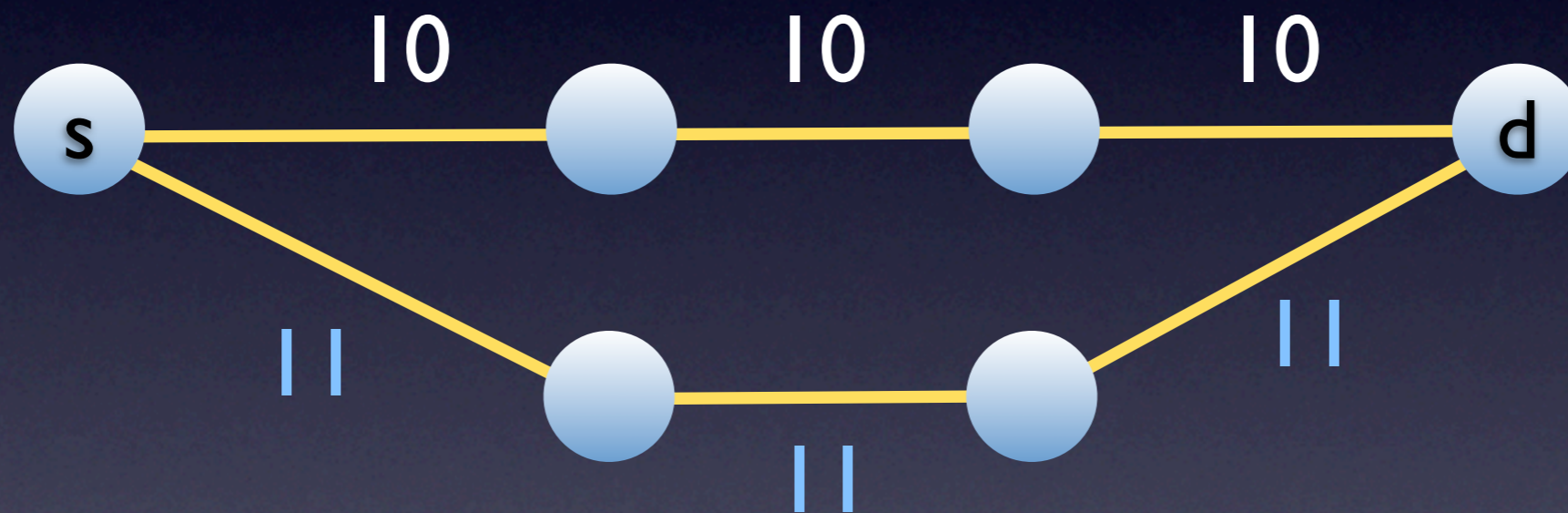
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$$1 + 5*(24+1) = 126$$

$$10 + 2*(3+10) = 36$$

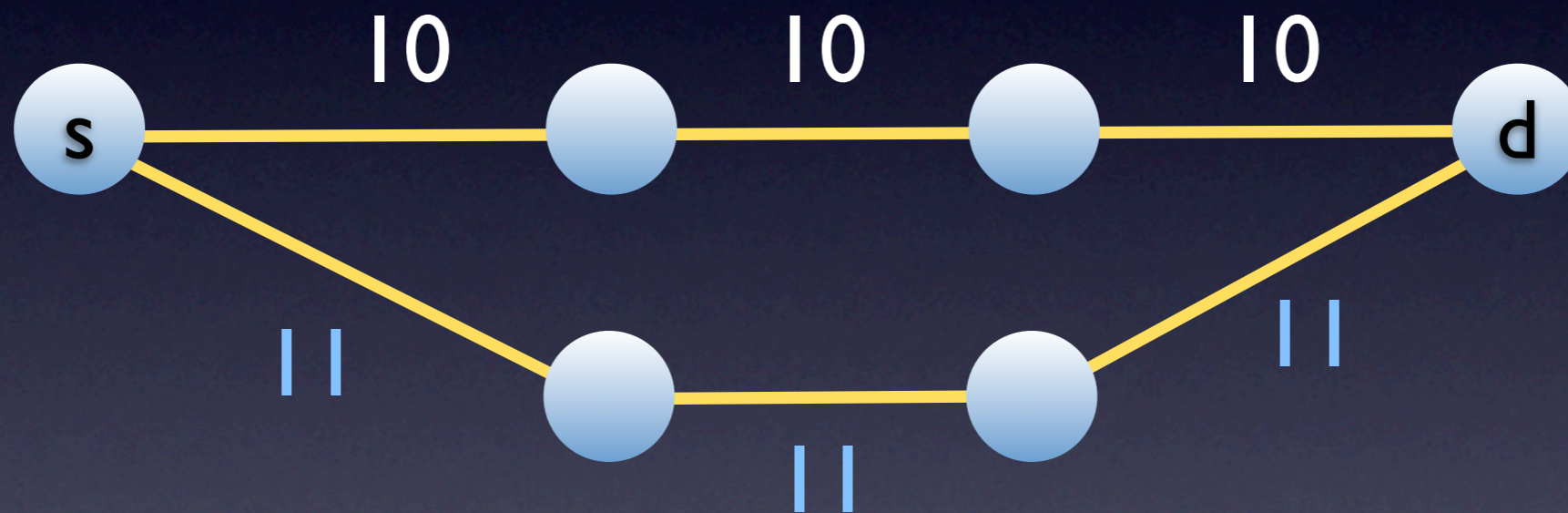
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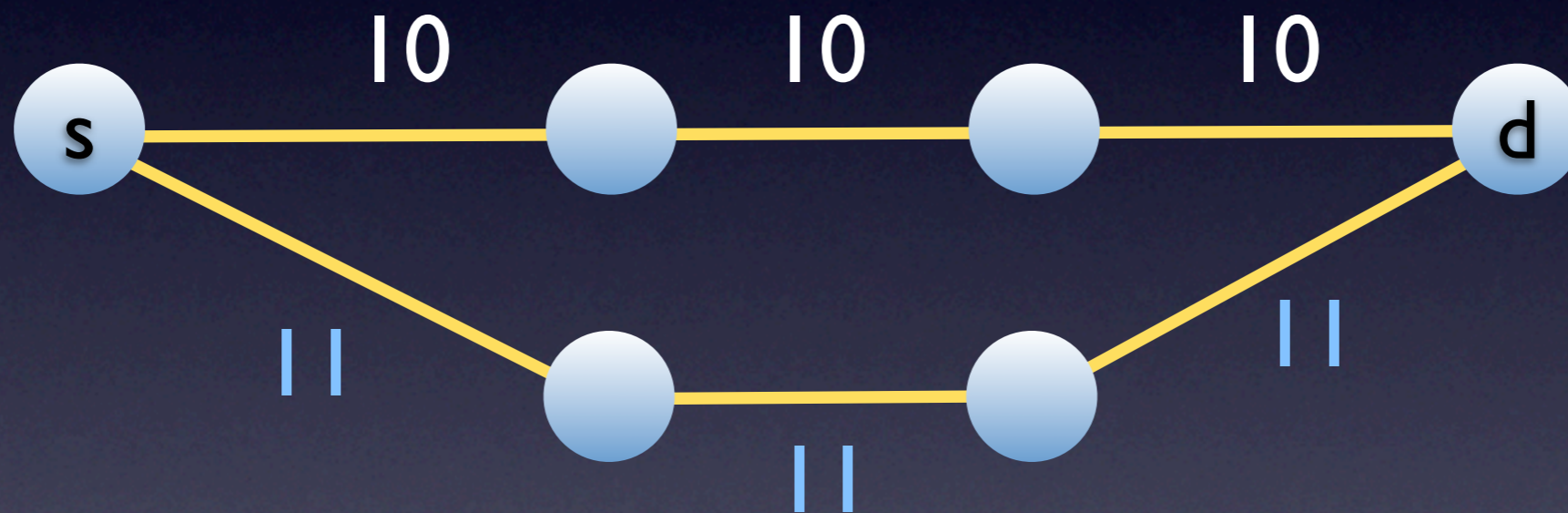


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Decreased marginal benefit

# Saving Money with Boycotting



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Decreased marginal benefit

*Is this necessarily a bad thing?*

# Can We Deploy This in the Internet?

---

- Not any time soon
- We currently **lack infrastructure**
  - Micropayments
  - Accountability
- Many **remaining technical challenges**
  - User policy vs. network policy
- *We can*
  - Deploy in **ad hoc networks**
  - Use **overlays** as an approximation to source routing

# Should We Deploy This?

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- Consumer choice drives most markets
  - Why not Internet routing?
- **Pro:** Places the tussle in-band
  - Customer vs. ISP companies
- **Con:** Introduces new tussles
  - User policy vs. Network admin policies
  - Boycotting at the cost of performance?



# Summary

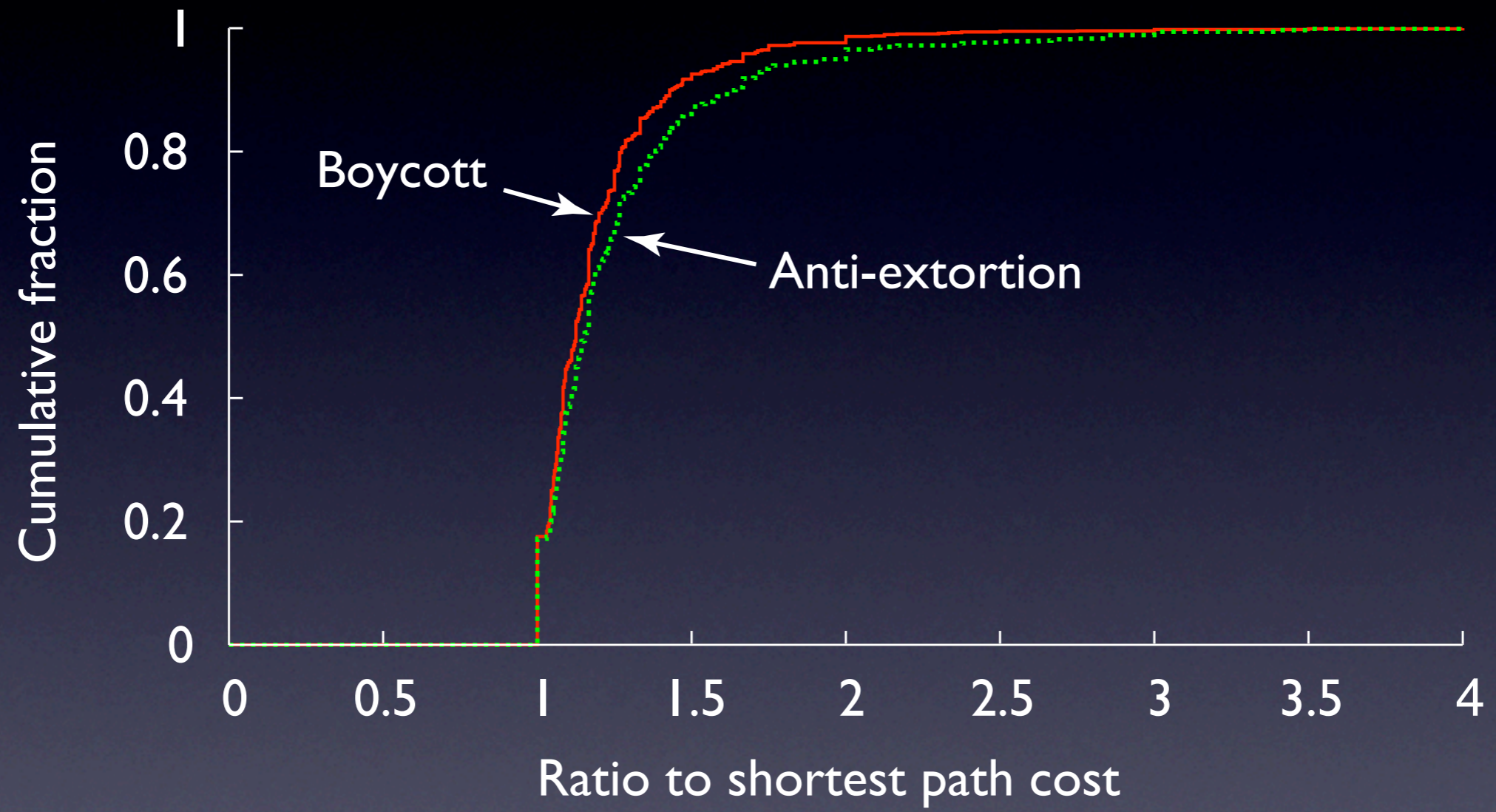
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- Accountability alone is not enough; use incentives
  - “If you can’t prove you’re good, I’ll make it expensive to be bad.”
- Variations on VCG
  - Anti-boycott, anti-extortion
- Open (theoretical):
  - **Overstating** to disassociate from boycotted nodes
  - Boycotting to use paths with **lower marginal cost**
  - Infrastructure to support this: **overlays?**
- Can / Should we deploy this?

# Supplemental

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# Path Costs

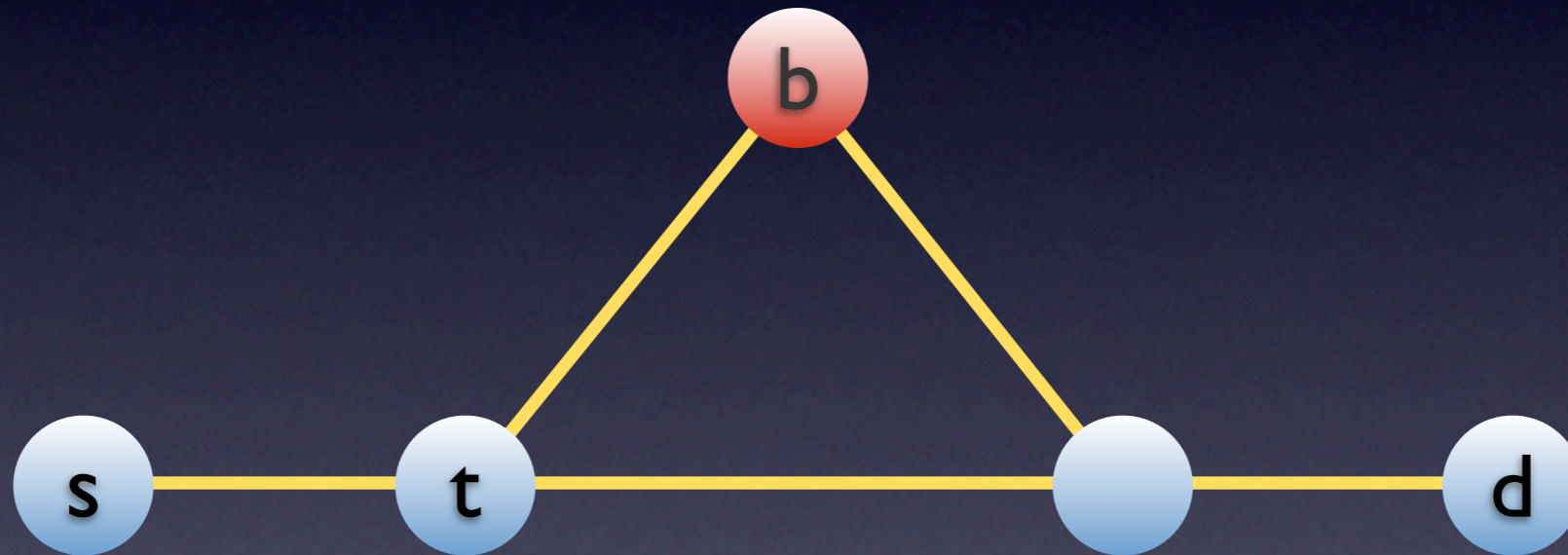


Always longer paths; generally not much longer

# Accountability in Routing

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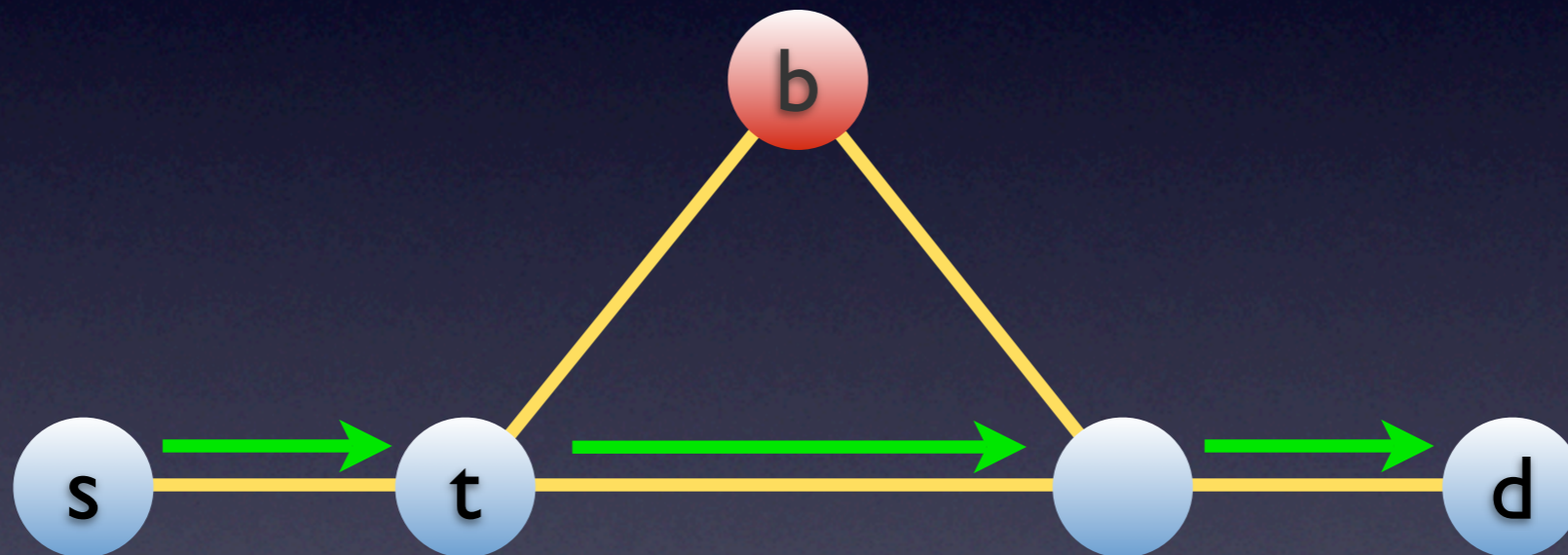
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- **Tunnel** between hops
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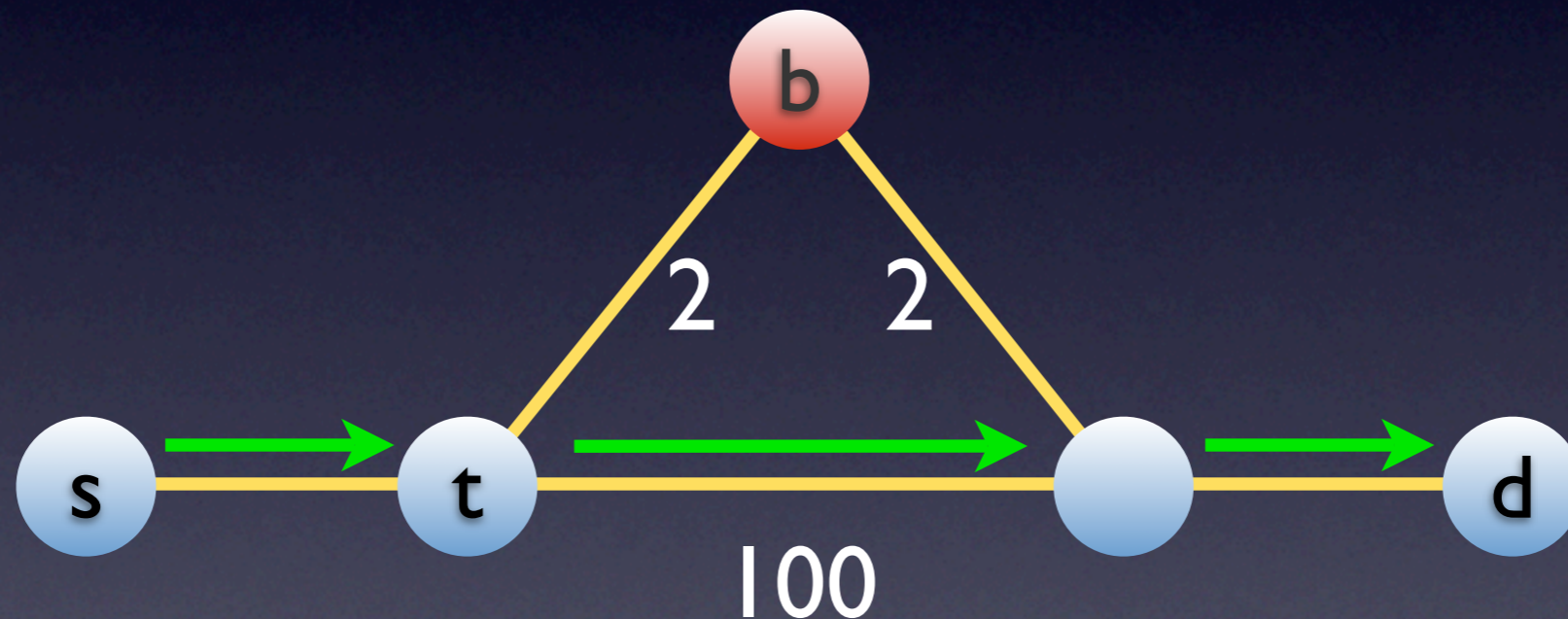
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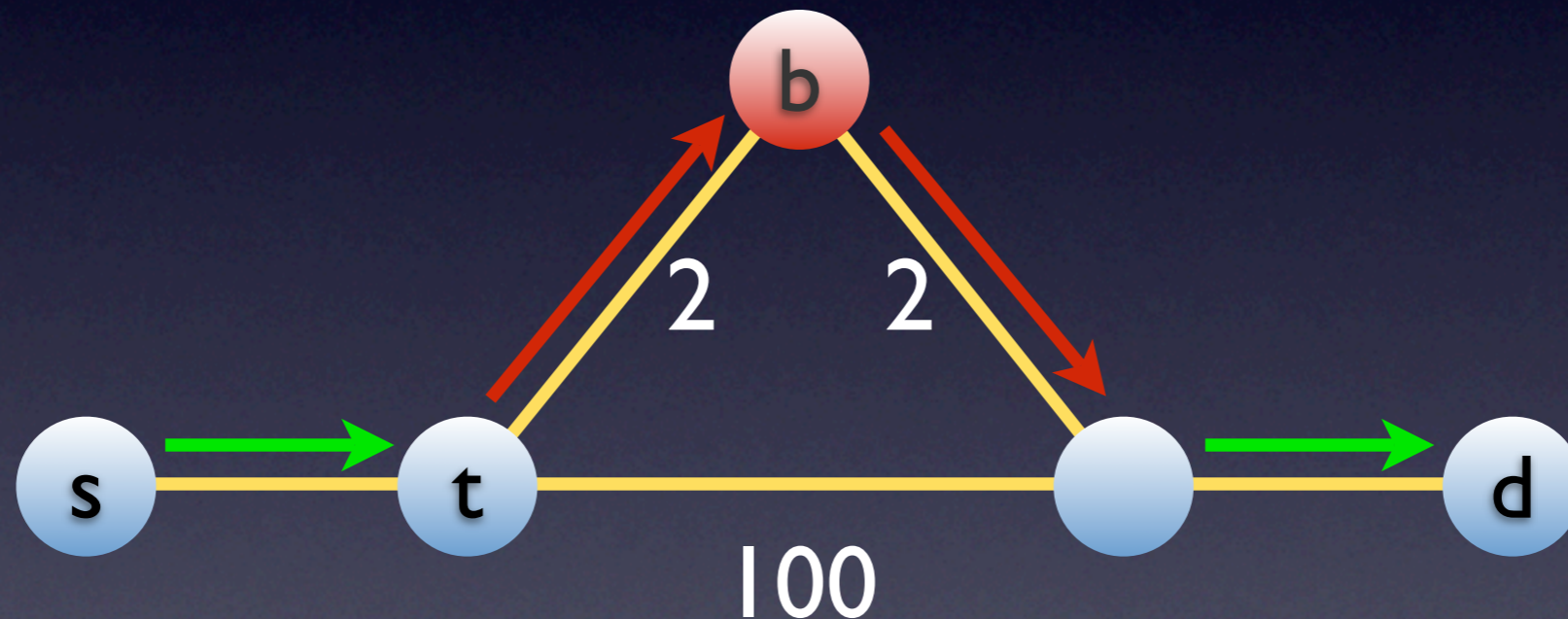
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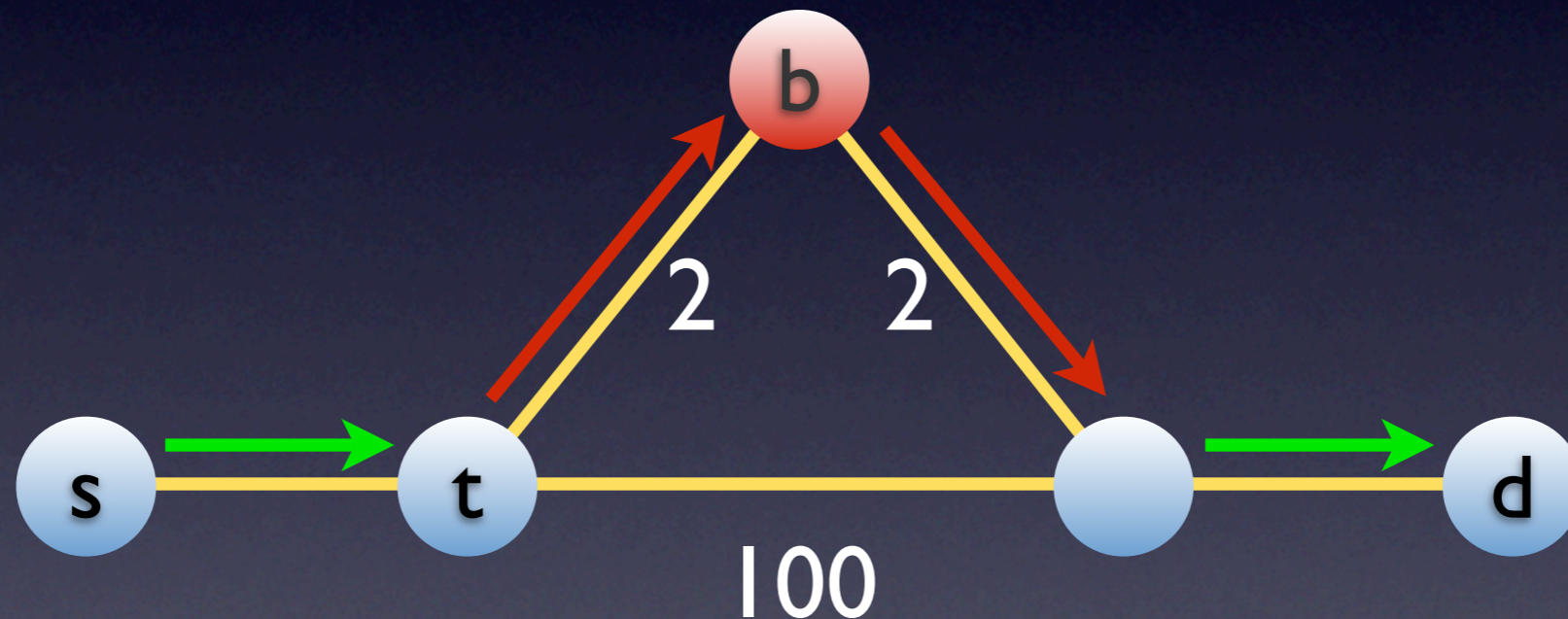
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- Suppose each node signs the packet
- **Tunnel** between hops
  - “Virtualize” the bad links



As long as you allow virtualized links (always),  
**accountability is not enough**



# Extreme Case: A Sybil Attack

- Overstate costs to infinity to appear disconnected
- One Sybil per each pair of neighbors



- **Difficult for ISPs to perform**
  - Need to lie about connectivity
  - Need multiple companies