

# A Value-based Framework for Internet Peering Agreements

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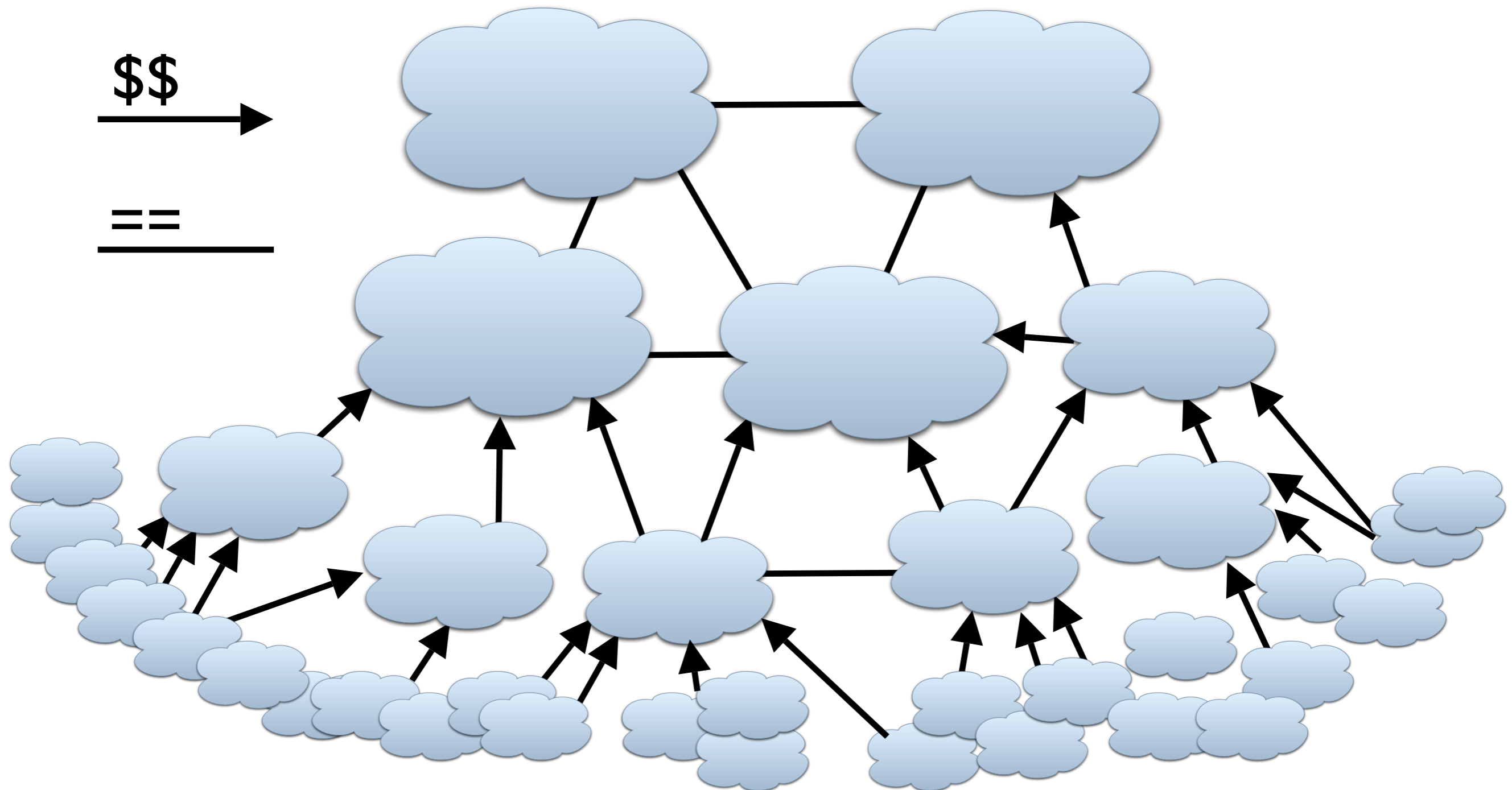
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# Agenda

- Analysis of (paid-)peering requirements
- Value-based model of bilateral paid-peering strategy
- Practical considerations for finding value of links
- Analysis of impact of paid peerings on the Internet Ecosystem

# Internet Peering



# Internet Peering

- Exchange paths **between customer bases**
- **Bypass** Transit Providers (-\$ - Transit's Added Value) by interconnecting with other ISPs (-\$)
- **Attract** traffic shares by providing better/shorter paths

# THE Question

Who should you try to / accept to peer with ?

# THE Sub-Question

Who should you try to / accept to peer with ?

At which price ?

# Settlement Free ?

- All peerings are paid peerings,  
(“Transit”, **restricted** to *customer bases*)
- Settlement-Free peerings are just paid-peerings  
where each party would pay the same to the other

# What happens in the real world ?

- Black Art
- ...constrained by a laundry list of specific requirements



# Free's peering policy

## Excerpt

Free S.A.S (AS12322) has a **selective** peering policy. Applicants must meet each of the following pre-qualifications:

- Applicant must operate a fully staffed Network Operation Center (NOC) **24 x 7 x 365**.

- Applicant must peer with AS12322 in **at least two different locations**

# Free's peering policy

## Excerpt

- Traffic exchanged must be at least **1000Mbps average** in each direction and traffic **ratio** should be no more than **2:1**

[...]

# Traffic ratios ???

- The one “Hot Potatoeing” the most is more likely to make a more extensive use of the other’s infrastructure
- Not good to be a CDN under ratio-based peering model...

# If not met...

## Free's policy excerpt

For applicants who **do not qualify** for a Settlement Free Interconnection or who do not have a nation wide network to establish Regional Settlement Free Interconnection, it's possible to **request a Paid Peering**

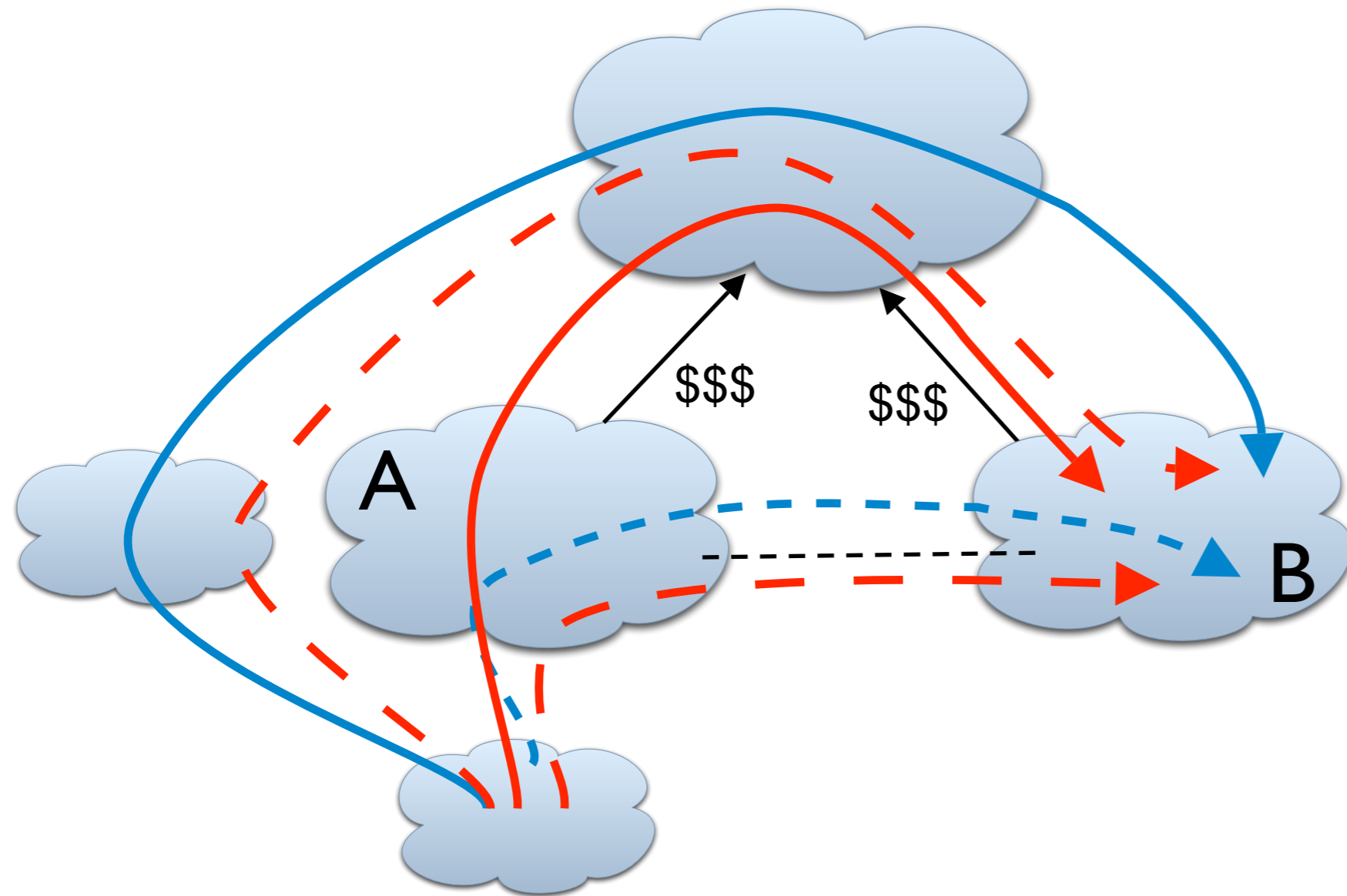
# What this is all about ?

*Heuristics* to find networks with which it makes sense to exchange traffic for “free”

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# Impact of peering



- Interconnect cost changes: Avoid a transit provider
- Backhaul cost changes: Peering link changes how traffic is routed in a network
- Revenue changes: Attract/lose traffic due to new peering link

# Peering Value

- Peering link fitness of a network:
  - $f = \text{revenue} - \text{interconnect costs} - \text{backhaul cost}$
- Value of the link is the difference in fitness with and without the link
  - $V = f_{\text{with}} - f_{\text{without}}$



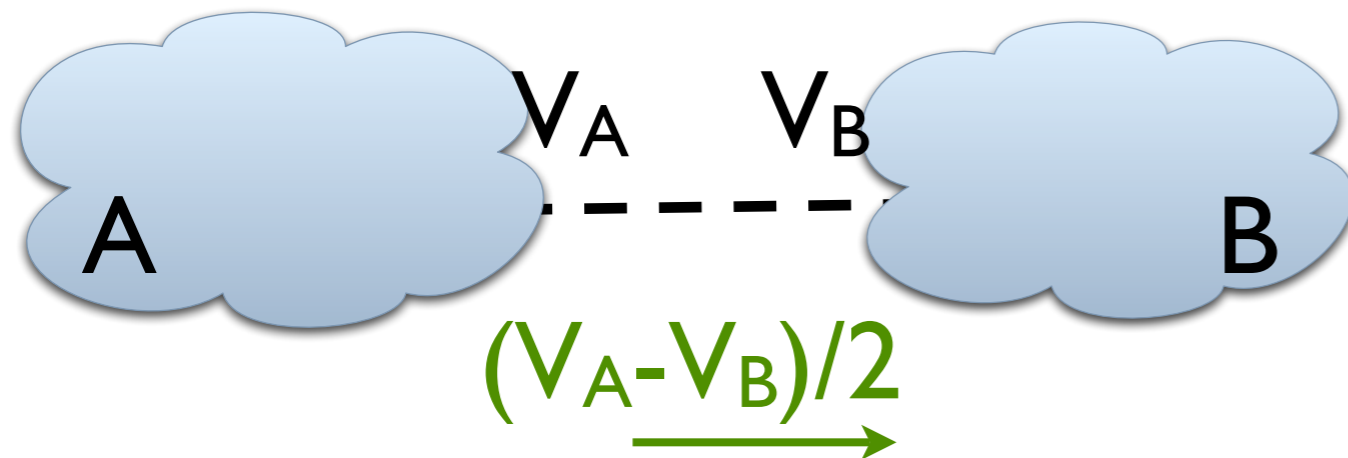
# Setting the price

- Paid peerings open new questions

Who should pay whom ?

What is the right price ?

# From Value to Price



- An oracle knows  $V_A$  and  $V_B$
- Oracle sets up the (fair) price

The fair price equalizes the benefit that A and B see from the link

# Why Peer at the Fair Price?

- Peering with the fair price is optimal
  - Both networks see better fitness by peering at the fair price
- Peering with the fair price is stable
  - No network has the incentive to unilaterally depeer the other network
  - Unique Nash Equilibrium
- Optimal and stable as long as  $V_A + V_B > 0$ 
  - Either  $V_A$  or  $V_B$  can be negative, as long as total is positive

# Playing chicken...

## Is there an incentive to be fair ?

- No Oracles in the real world
- A pretends  $V_A$  is much smaller than it is, claims  $V_L \ll V_A$
- If A estimates  $V_B$  correctly, and gets through
  - B will pay more:  $(V_B - V_L)/2$
- If A doesn't estimate  $V_B$  correctly, and  $V_L + V_B < 0...$ 
  - A loses out on any payment

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# No oracles in the real world ?

## **Underpin The Broadband Ecosystem Via A Trusted Clearinghouse System**

nuMetra's solution facilitates a new paradigm: from a competitive, cutthroat broadband environment to a cooperative ecosystem aimed at improving the efficiency, security and reliability of the Internet's existing infrastructure. Rather than crafting and mandating an arbitrary set of policies to govern business relationships, nuMetra's policies follow a substantive set of terms and procedures currently being developed and drafted by a proactive group of ISPs, [...]

<http://numetra.com/>

# Measuring Peering Value

- How do A and B **measure**  $V_A$  and  $V_B$ ?
- With **Peering trials**:
  - Collect: Netflow, routing data
  - Know: topology, costs, transit providers
- With peering trials, A and B can measure **their own value** for the peering link reasonably well
- **Hard** for A to accurately measure  $V_B$

**United States Patent**

**7,764,628**

**Gerber, et al.**

**July 27, 2010**

Method for controlling traffic balance between peering networks

**Abstract**

A method that measures ratio, relative to a peering network, of traffic burden of incoming traffic to traffic burden of outgoing traffic, where traffic burden takes into account traffic volume and distance that the traffic traverses through the network. A determination is made from this ratio as to whether an imbalance exists with the peering network. With the assistance of a simulation of changes in routing policy and their effects, an existing or impending imbalance is remedied by changing the routing policy relative to particular customers, for example from a "hot potato" routing policy to a "best exit" routing policy.

<http://patft.uspto.gov/>



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# Modeling the Internet Ecosystem

- What are the effects of provider and peer selection strategies on the involved networks?
- What are the global, long-term effects of these strategies on the whole Internet?

# ITER Model

- ITER: Agent-based computational model to answer “what-if” questions about Internet evolution
- Inputs: According to the best available data...
  - Network types: transit provider, content provider, stub
  - Peer selection methods, provider selection methods
  - Geographical constraints
  - Pricing/cost parameters
  - Interdomain traffic matrix
- Output: Equilibrium internetwork topology, traffic flow, per-network fitness

# ITER parameters

- Used recent trends from Arbor study
  - Large fraction of traffic from top content providers
  - Increased geographical coverage of content providers
  - Peering openness

# Value-based Peering Model

## Global impact

- Higher density of peering links with value-based peering
- Tier-1 are even more bypassed
- Less revenue for all types of transit providers
- Incorrect value estimation can preclude peering link forming  
Impact varies among network types

# Value-based Peering Model

## CDNs

- CDNs peer more when value-based peering is assumed  
They never make it with traffic-ratio peering  
They make it less often with cost-benefit peering
- CDNs end up paying large transit providers (?!?!)
- CDNs accept peering with smaller providers thanks to financial compensation  
(else, they stick to the large providers)

# Next

- Model chicken playing
- Support transit from a paid peer to another

**Thanks !**