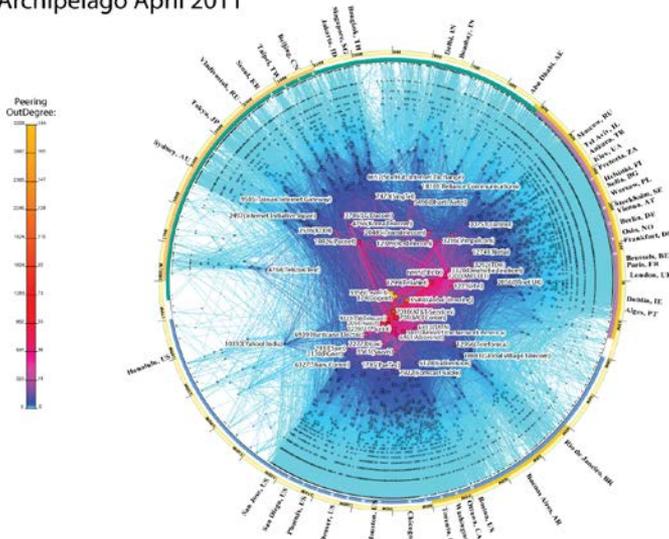


Understanding policy Issues of NetNeutrality

So ... what is a network

CAIDA'S IPv4 AS Core AS-level INTERNET GRAPH

Archipelago April 2011



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- **A NETWORK CONSISTS OF A SET OF DISTRIBUTED ELEMENTS THAT ARE COOPERATING TO EXCHANGE INFORMATION**

- An information exchange market

Several ill defined term

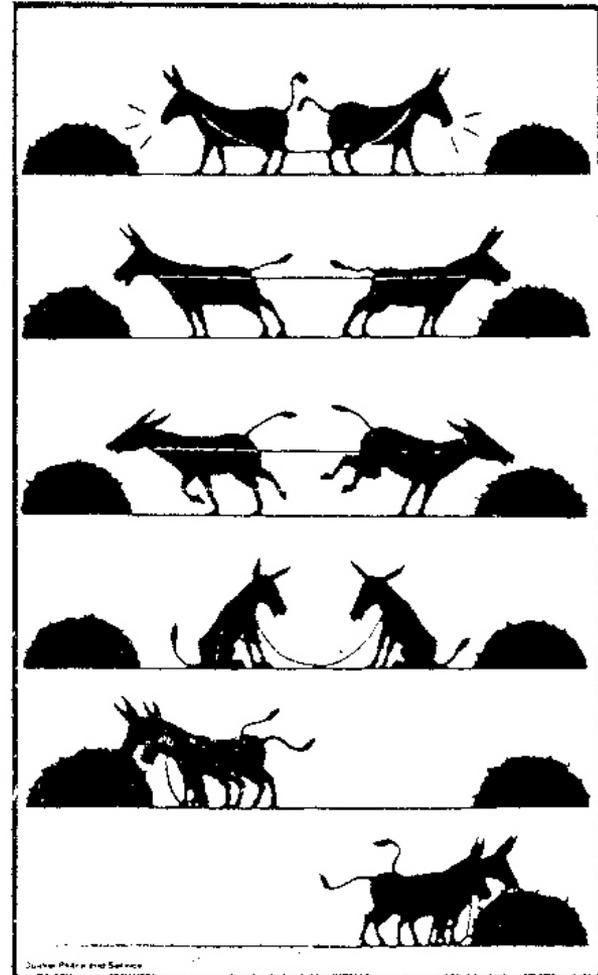
- Cooperation
- Information ...

Internet is a network that strictly exchange information in Shannon terms

- Other network might transport other type of information
 - Migration network transporting DNA

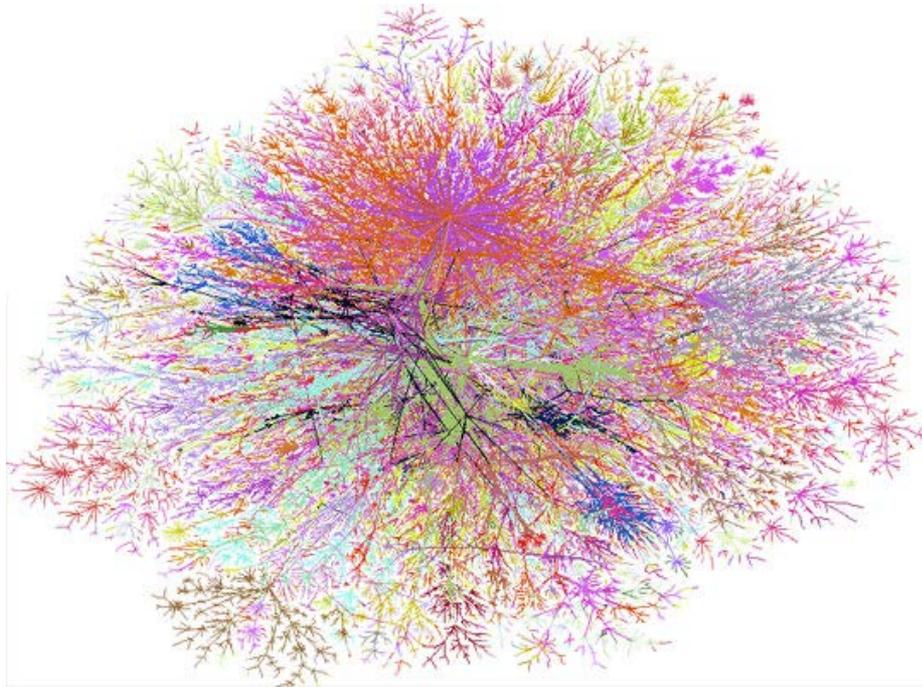
Cooperation ?

- Two levels of cooperation
 - The connection or making the possibility for cooperating
 - Generally at large time scale
 - Forwarding on established links.
 - Short time scale



How networks emerge and grow ?

- Small world properties and power laws have been consistently observed
 - Several constructive model trying to recover the observed macroscopic and global power law properties
 - “preferential attachment” principle and the “Barabasi-Albert” model
 - No one explains really why networks have emerged



Prisoners dilemma

- A simple game that has become the dominant paradigm for social scientists since it was invented about 1960.
 - Game theoretic problems: payoffs for each player depend on actions of both
 - Two possible strategies: A party **cooperates** when he performs value-increasing promises, and **defects** when he breaches
 - While cooperation is **collectively rational**, defection is **individually rational**.



		Player 2	
		Cooperate	Defect
Player 1	Cooperate	3, 3	Player 1 cooperates, Player 2 defects
	Defect	Player 1 defects, Player 2 cooperates	0, 0

Iterated Prisoner's Dilemma

- IPD
 - n-stages;
 - n is known or not
 - Backward induction;
 - Nash equilibrium;
 - Strategies
 - Tit for Tat
 - Tit for Two Tat
 - Suspicious Tit for Tat
 - Free Rider
 - Always Cooperate
 - Axelrod's Tournament
 - Altruistic strategies does better
- Networks extend the possibility of cooperation between N actors from $O(N^2)$ to $O(2^N)$



"The way I see it, Russia thinks we think they think we're not willing to go to war."

Net Neutrality Question

- Net Neutrality is not just a question of access network
- It has to deal with cooperation between all actors in Internet
 - Content provider/ISP
 - ISP/ISP
 - End Users/ISP
 - End Users/Content Provider
 - End Users/End Users
- Opacity generate Prisoner Dilemma
 - Defection is the default
 - How to improve cooperation
 - Improve transparency

State of transparency ?

- In March 2013 ARCEP (French telecommunication regulator), observed that “one cannot regulate the market without a deep and timely analysis of the inter-domain market and its complex structure”.
 - ARCEP published a directive asking ISPs, content provider and network service providers as CDNs operating in France, to provide twice-yearly details of their inter-domain agreements.
 - The directive was challenged by AT&T and Verizon in the Conseil d’Etat (administrative judicial authority), claiming that: “as even a mild regulation of inter-domain market might result in unexpected consequences that can distort market behaviour, we contest this unprecedented global regulation by the ARCEP”.
- UK OFCOM initiative launched in June 2011 asked UK ISP’s to voluntary adhere to a Code of Practice : the Key Facts Indicator (KFI).
- In China any inter-domain agreement between operators inside or outside should be implement through China Telecom or China Unicom companies, or go through a process of agreement by the Chinese government that involves full disclosure of the details of the agreement

State of transparency

- While ISPs consider their topology and interdomain structure to be highly confidential
 - “almost a third of the critical Default-Free (DFZ) ASes register partly their interconnection options in PeeringDB ... on a voluntary basis”.
 - Developed inference techniques and methodologies uncovering details of inter-AS topology and peering agreements
 - Client-provider (c2p) and peering relationship can be detected with accuracy higher than 80%

State of transparency (3)?

- Multiple jurisdiction
 - When source of a flow and its destination are in different countries.
 - Even when the source and destination are in the same country, but traffic transits a foreign AS.
 - Recent Draft Resolution proposed by India in the recent ITU 2014 Plenipotentiary Conference that recommended ITU enforce a “a public telecom network architecture” that localizes both routing and address resolution for local/domestic traffic to “within the country”.

IDR's 'ménage à trois'

- The bilateral relationships between two domain actors A and B
 - client-provider relationship between A and B,
 - client-provider relationship between B and A,
 - peering relation between them,
 - no connectivity between them.

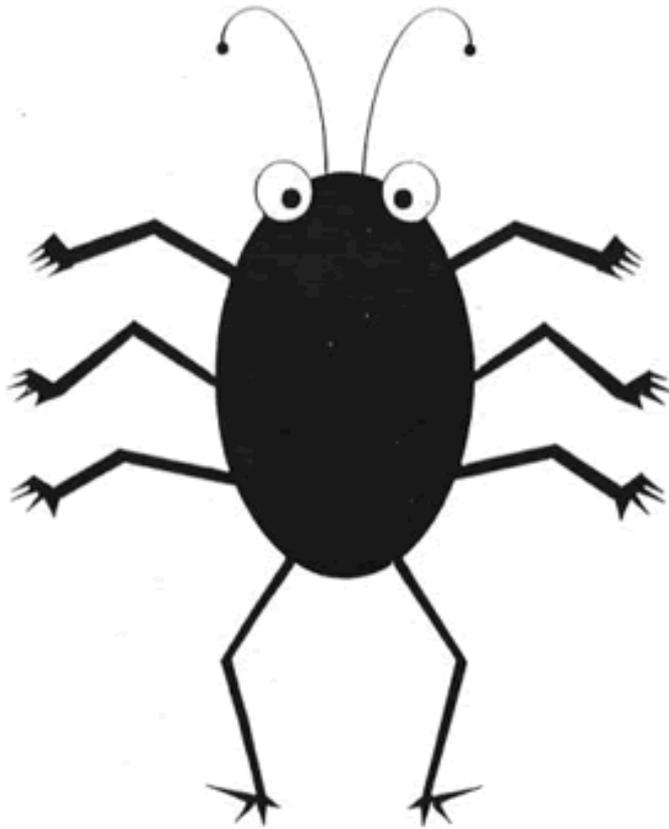
Game theoretic Insights

- Final client or downstream perspective, one would like to access content as fast as possible, with the minimal cost.
 - Client-provider relationship with an ISP playing the role of transit operator, and propagating in a transitive way in the chain of client-provider relationships that link upstream
- Content Providers want to diffusing their contents as much as possible and harvest the direct (in form of per-view or subscription fees) or indirect (in form of advertisement) revenue from their final consumers.
 - However in order to get any income this content should become accessible and with acceptable quality to the final customer through the transit operator.
 - Content provider and transit operators have to choose in the palette of the four types of relationships the one to use. A content provider has to connect to a transit operator, however he might not be connected directly to all of them.
 - In some cases, an ISP is the client of a content provider, e.g., TV over ADSL
 - Transit operators would like to the content provider to become a client for the transport of their content.
 - However, content providers, observing that the final receiver is already a client (or a by delegation client) of the transit operator, considers that they do have not to double-pay the transit operator. They propose peering with any transit operator under generic inter-domain policy.

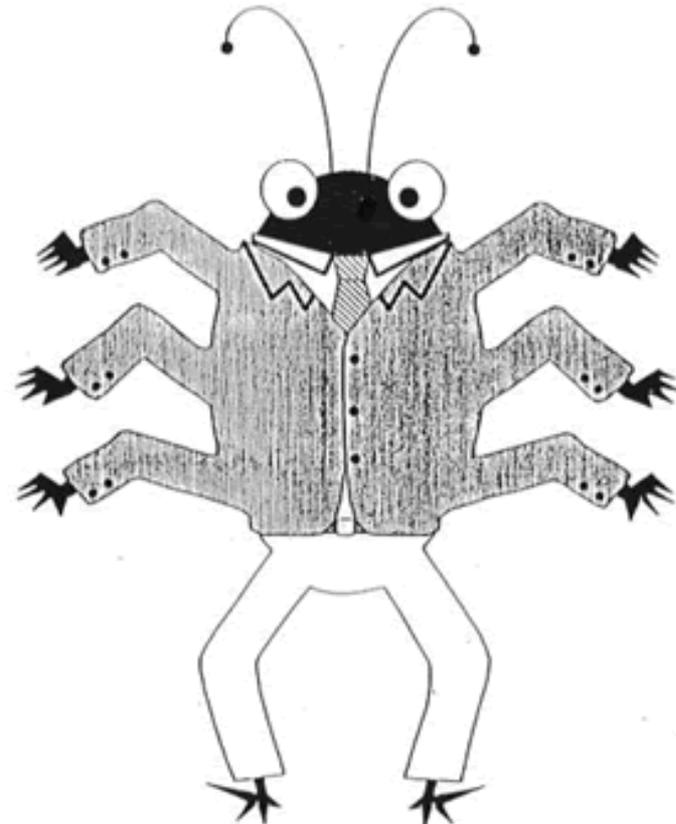
Game theoretic Insights (2)

- The transit operator has invested in building a network with a given capacity.
 - Increasing the capacity is only possible at the cost of costly investment.
 - The transit operator has to manage finite capacity and maximize its revenue.
 - The revenue of the operator
 - client-provider relationships
 - Added value services that he deploys
 - The cost of the operator
 - investment costs
 - operational costs
 - transit fees he pays as a client of upstream transit networks.
 - Several studies have analysed the static transit domain problem
 - Optimise the revenue of the transit operator by maximizing the amount paid btdownstream client subject to cost elasticity, i.e., the maximal price the client will pay for the provided service before leaving to a concurrent.
 - However, most of these works have not integrated the decision to connect to a content provider and the type of relationship involved, while IDR makes it mandatory to examine connectivity.

Is surveillance an addition to networks
or is it intrinsic ?



BUG



FEATURE