Analysis of Cooperation Strategies of QoS Platform Providers

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Agenda

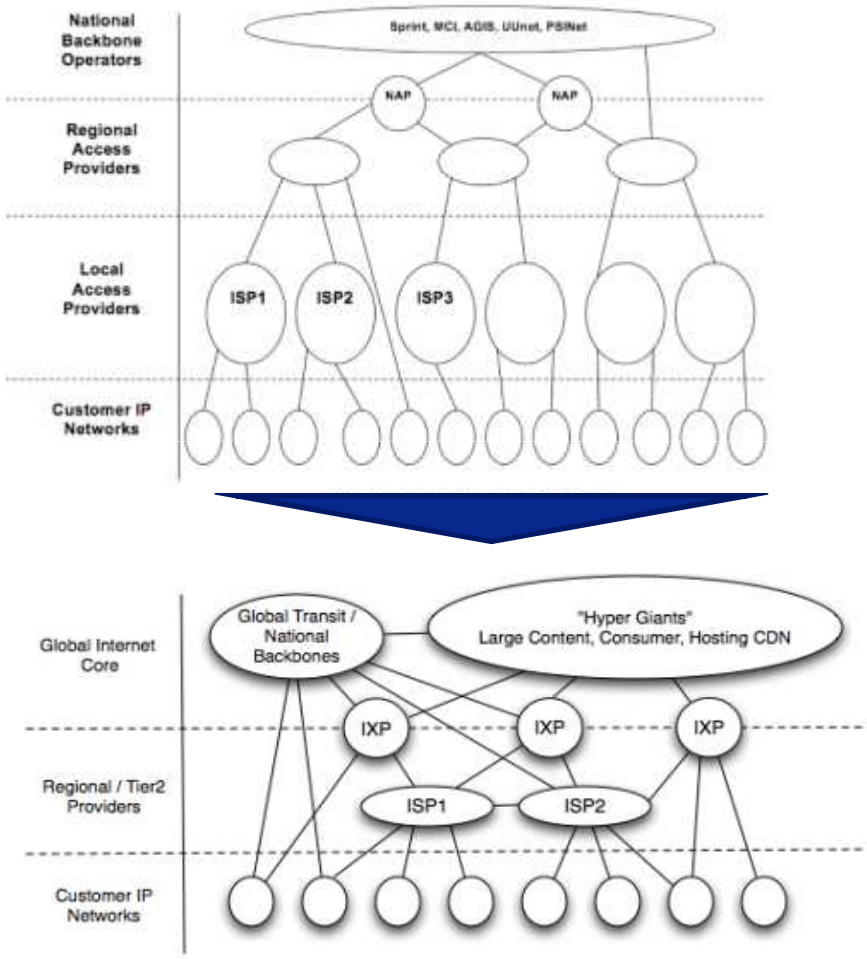
- Motivation and research question
- Top down approach
- Bottom up approach
- Expected results

Emerging technologies increase the need for QoS-Interconnections

- Growing demand for VoD, IPTV, Cloud computing services, HDTV, VoIP
- Applications and data migrate from the PC to the browser

The demand for QoS-interconnections, that is connections with guarantied delay, packet-loss and bandwidth properties, is constantly increasing

The internet topology is changing in favor of less QoS-bottlenecks



Then

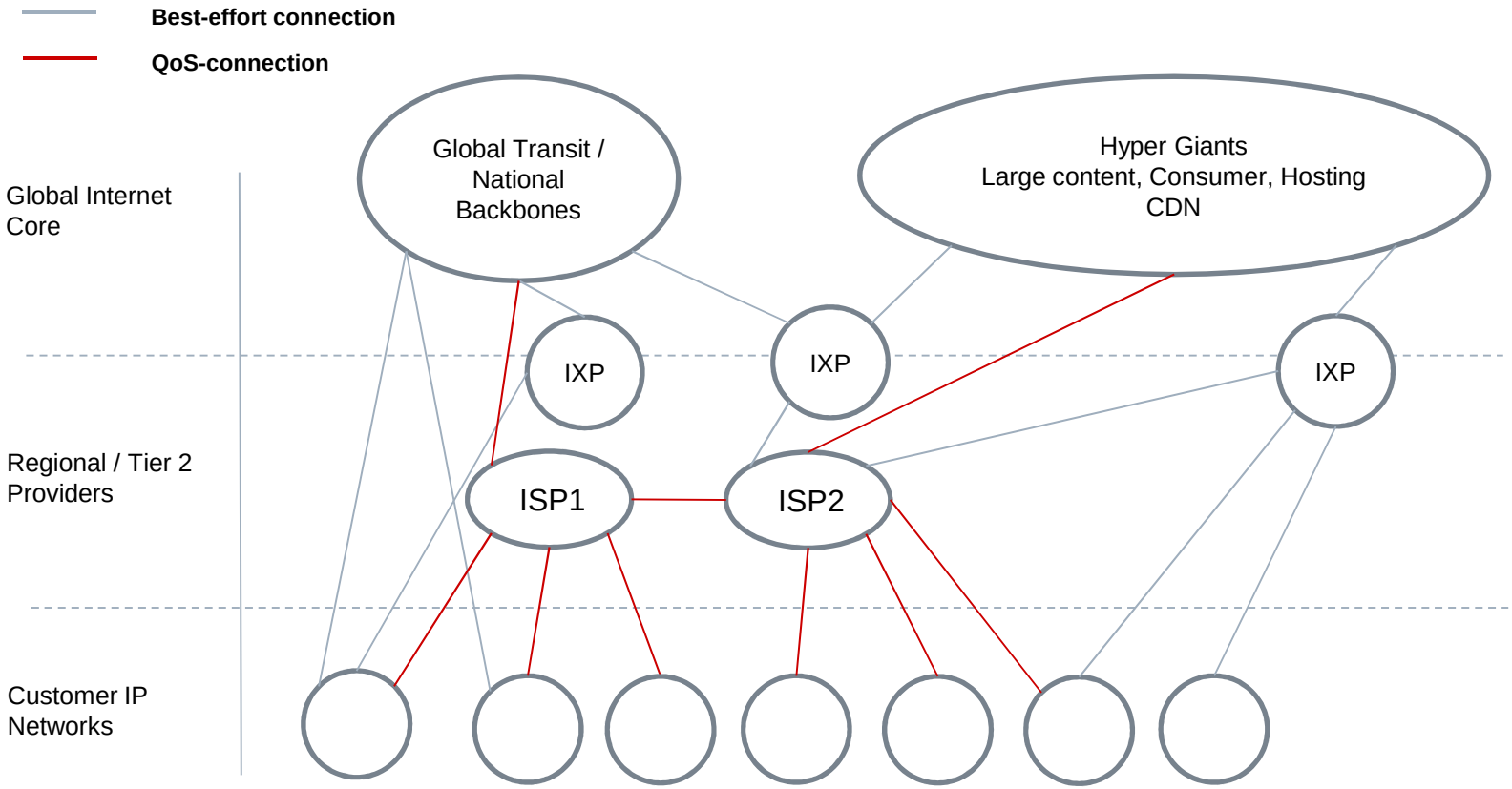
- Traditionally the customer networks relayed on transit providers in order to reach other networks
- A request between two customer IP networks had to pass several exchange points and networks

Today

- Disintermediation of transit providers
- Content migrated out of enterprises
- Consolidation of large Internet properties

Sources: ATLAS Study 2009 and Dhamdhere A., Dovrolis. A Model of Interdomain Network Formation, Economics and Routing

How does the current internet topology change if small ISPs constitute QoS-interconnections?



We seek to answer this question by applying Two-sided market Theory, Game Theory and Agend-based Computational Economics (ACE)

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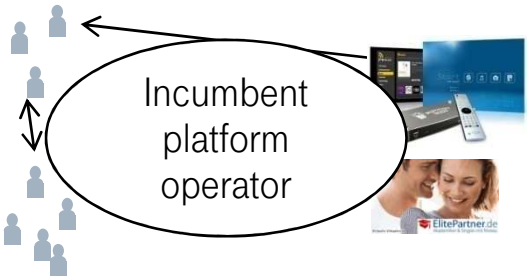
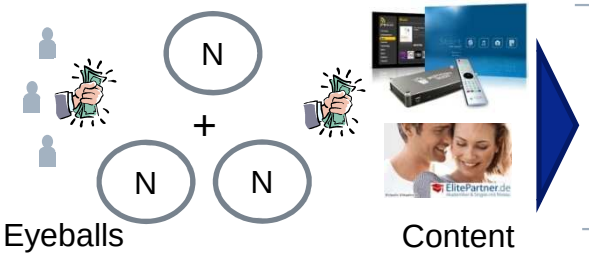
Today QoS-Applications are often isolated proprietary solutions and constitute a two-sided market

Direct network effects occur when end-customers benefit from the presents of other end-customers (If users can share content fast within a network, they benefit from every new user who also shares content [Collaboration Tools, VoIP, Online-Games])



Indirect network effects occur when end-customers can choose from many content providers (The more end-customers belong to a platform, the more content providers will find it profitable to join the platform [Video-on-Demand, HDTV])

- A two-sided market enables platform operators to apply value based pricing on both sides of the market
- Given that every transaction must be paid by the customer, we argue that QoS interconnections increase the number of interactions



QoS-Platform pricing in co-operations:

$$b^i + \frac{B^i}{N^j} \geq a^i + \frac{A^i}{N^j}$$

- b^i: benefits per transaction
- B^i: Membership benefits
- N^j: eyeball size
- a^i: transaction fees
- A^i: fixed fee for platform access

The revenues generated by a coalition is calculated taking into account cross-side externalities

The customer access charge is calculated as follows:

$$A = b_{CS} \sum_{q} k_q$$

The overall number of transactions carried out by a consumer is calculated with the term $\sum_{q} k_q$

In contrast to consumers, content providers are only obliged to pay transaction fees (*a*) to delivery platforms in our model. Additionally, content providers have to make investments ($-B_{CP}$) to establish a platform connection. Therefore, the transaction fees are calculated as follows:

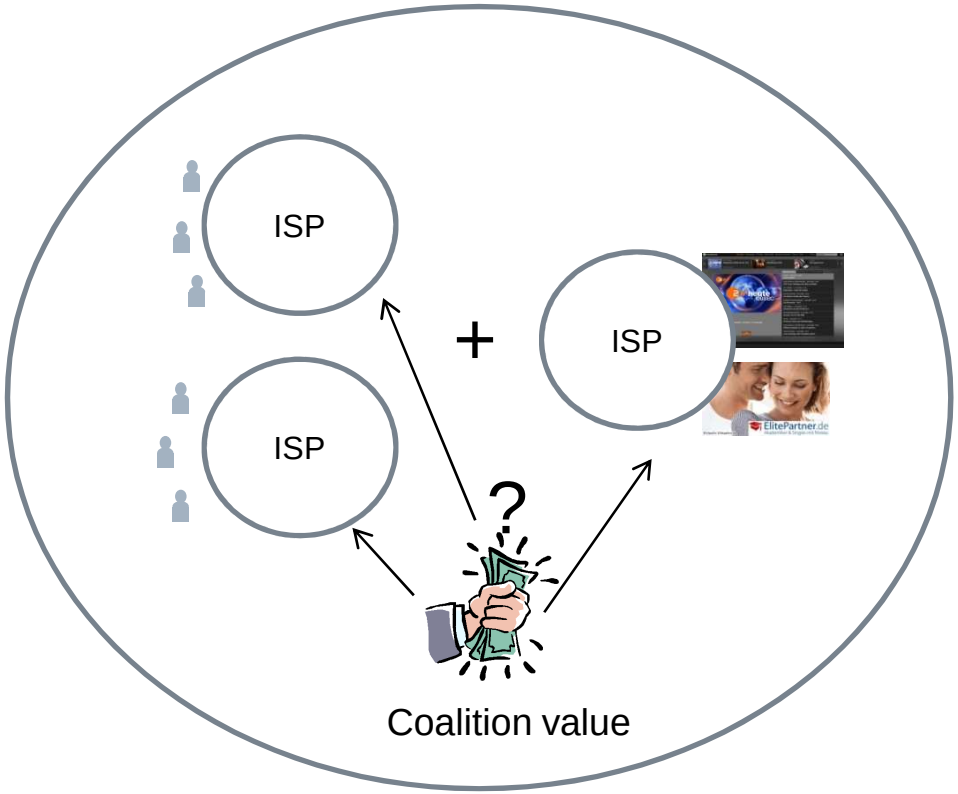
$$a_q = b_{CP} + \frac{B_{CP}}{k_q (x_1 + x_2)}$$

- k_q: number of transactions of content provider q with each customer
- b_{CS}: customer benefit
- b_{CP}: content provider benefit from transaction
- B_{CP}: Investments for platform connection
- x_i: eyeball size
- q: content q
- A: Access charge

As a consequence, the value of carriers in a delivery network is positively correlated with the overall number of content providers and consumers connected to a platform.

Cooperating platforms need to decide how they set their external pricing

Internal coalition view:



The Shapley value is a well-known mechanism for distributing value that was created by coalitions by evaluating the average contribution of an entity to a coalition.

Shapley value properties

- **Individual Fairness**: i.e. every actor gets at least as much as he or she would have got had they not collaborated at all.
- **Efficiency**: The total gain is distributed.
- Symmetry: if two actors are identical in terms of their value function
- **Additivity**: if we combine two coalition games described by gain functions *v* and *w*, then the distributed gains should correspond to the gains derived from *v* and the gains derived from *w*:
- **Zero Player** (Null player): A null player receives zero if he does not contribute to a coalition

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Agent based Computational Economics and the Telco Ecosystem

ACE definition

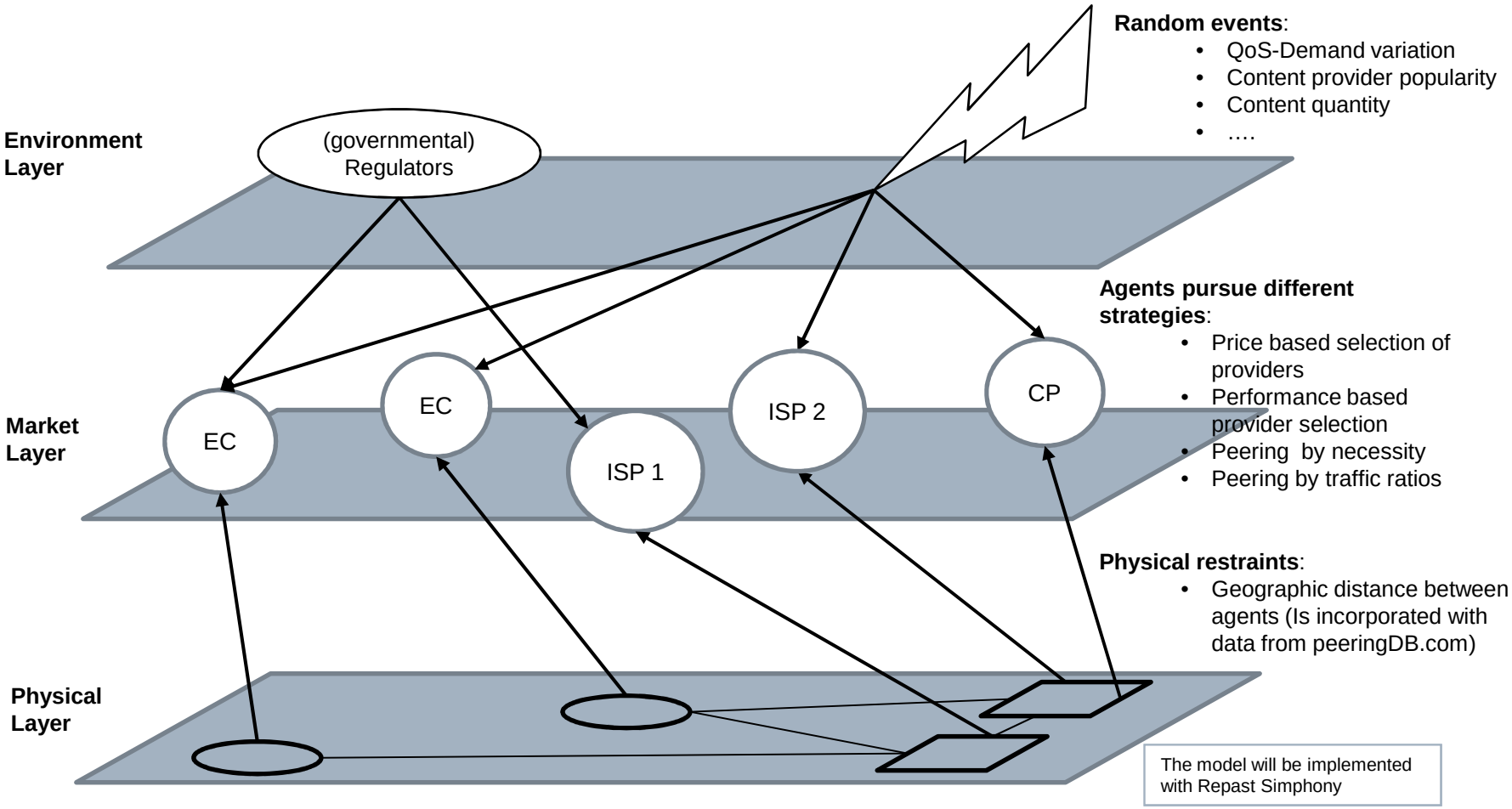
- ACE is applied to analyze the evolution of complex adaptive systems, i.e., systems composed of interacting units which exhibit emergent properties, that is, properties arising from the interactions of the units that are not properties of the individual units themselves.
- ACE is being applied to study the evolution of the Internet Ecosystem. Focus of previous work:
  - System stability
  - Degree distribution
  - Rebuilding real world systems

Implications for ACE use

- The past is a bad indicator for future developments
- Market participants have dynamic relations which form and dissolve over time
- As the number of market participants increases it becomes increasingly difficult to find the optimal investments strategies analytically

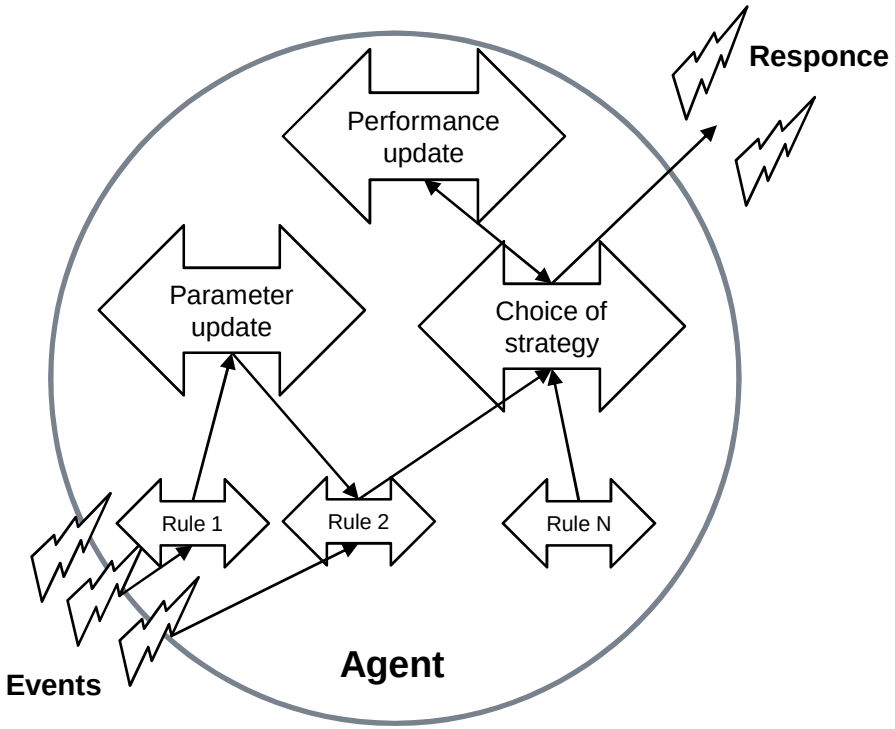
Source: LEIGH TESFATSION (2005): „AGENT-BASED COMPUTATIONAL ECONOMICS: A CONSTRUCTIVE APPROACH TO ECONOMIC THEORY"

Environmental and physical restrains of the Telco industry are modeled with different layers



Adapted from: Michael J. North and Charles M. Macal (2007): „Discovering Strategic Solutions with Agent-Based Modeling and Simulation", Oxford Press

The agent reacts to its environment with a four step procedure



Agent behavior

1. Perception of the environment
2. Update of internal parameters such as the budget, customer satisfaction, market coverage
3. Decision making, which corresponds to the choice of a strategy according to the current context
4. Update of the performances of the firm

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- We plan to identify QoS-interconnections which are optimal in terms of co-opetition, that is co-operations that increase a networks revenue but consider competitive restrains
- We want to study the effects of QoS-Demand variations and variations in content provider popularity
- We want to analyze if the internet topology is converging towards a steady state if ISPs offer novel QoS-Interconnections
- Are QoS-interconnections suitable for increasing the revenue of ISPs?

Thank you!

Any Questions?