Inter-Carrier Interconnection Services: QoS, Economics and Business Issues

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Inter-Carrier Interconnection Services: QoS, Economics and Business Issues

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Purpose of this paper

- The aim of this paper is introduce main Economic issues and problems occurred in increasing rate of QoS assurance in internet.
- They provide the solution with game-theoretic tool.
Content

1. Introduction

2. Main economic issue and problems
   – Is a Best-Effort Internet Enough?
   – Going beyond Best Effort: Pros and Cons

3. Potential solution
   – Market-based approaches
   – Cooperative Game theoretic approaches

4. Conclusion
Introduction

- This is a necessary for their provision as high value products in the market, thus also creating significant revenue opportunities for both the network service provider (NSPs) and the Over-The-Top providers (OTTs).
Introduction

• This requirement for E2E QoS assurance poses significant challenges both in the access and the interdomain part of the network.

• Existing peering and transit interconnection agreements do not provide any type of QoS assurance and pertain to interdomain traffic aggregates of multiple services.

• The interconnected heterogeneous network architectures must be both technically and economically reconsidered.
Main economic issue and problems

• Is a Best-Effort Internet Enough?
  1) Best-Effort and Uncertainty

  • There is no way to guarantee E2E QoS, which is required by the emerging QoS sensitive services, rendering their deployment infeasible

  • It is not a sustainable business model and can lead deploying QoS-sensitive services and lost business opportunities.
Main economic issue and problems

• Is a Best-Effort Internet Enough?

2) Information Asymmetry

• NSP (Network service provider)s control all the information pertaining to the characteristics of their networks (e.g. capacity, usage etc.) and may or may not disclose it to potential interconnection partners.

• New types of interconnection agreements based on incentive mechanisms, could mitigate the adverse implications of asymmetric information and serve as a sound basis for providing QoS assurance.
Main economic issue and problems

• Is a Best-Effort Internet Enough?
  3) Interconnection Quality as a Strategic Variable

• Degradation the quality of the interconnection can comprise a profitable strategy that large ISPs follow against competitors

• Large ISPs prohibit the expansion of smaller networks and increase the market share by selective degradation of interconnection quality.
Main economic issue and problems

- Is a Best-Effort Internet Enough?

  4) Backbones Pricing, Investments and Revenue Sharing

• A very important issue is the way the interconnected Internet backbones set their prices.

• This pricing strategy is proven to be robust for various model variations and also can result in significant deviations from the social optimum.
Main economic issue and problems

• Is a Best-Effort Internet Enough?

5) Revenue Sharing and Net Neutrality

• The revenue sharing issue is of prominent importance not only among NSPs, but also between NSPs and OTTs

• OTTs generate value by providing services that are of high interest to the users.

• The additional effort of the NSPs is not directly rewarded, since OTTs solely extract the revenue from the provision of these services.
Main economic issue and problems

- Is a Best-Effort Internet Enough?
  6) Unmet Market Needs

<table>
<thead>
<tr>
<th>End-users</th>
<th>Users who deal with the unpredictable behaviour of the best-effort services offered.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network operators</td>
<td>No differentiation of the network performance based on how users value different services and Quality of Experience (QoE). Thus, provisioning QoS-sensitive services is not sustainable under this business model.</td>
</tr>
<tr>
<td>OTTs</td>
<td>They create positive and negative externalities, due to the added value and cost of their services. The lack of interdomain premium network transport capabilities greatly affects their business.</td>
</tr>
</tbody>
</table>
Main economic issue and problems

• Going Beyond Best Effort: Pros and Cons
  1) Market Expectations and Technology Support

  • Considering the evolution towards ASQ services, it is clear that new business models are required, in order to provide the needed incentives for all parties involved to make the necessary infrastructure investments and impose fair revenue sharing
Main economic issue and problems

• Going Beyond Best Effort: Pros and Cons
  
  2) Improving Best-effort Services

  • The current Internet implements multiple schemes that make the best-effort service as good as possible, yet without ensuring QoS.

  • However, with the proliferation of QoS-sensitive services, such infrastructure have already pushed the envelop, bringing it close to its limits.

  • The evolution from best-effort towards quality-assured infrastructure is inevitable
Main economic issue and problems

• Going Beyond Best Effort: Pros and Cons

  3) Are ASQ Services Feasible?

  • The additional revenue generated by ASQ services suffices to fund the underlying infrastructure.

  • Yet, careful analysis of this cost-benefit formula should be conducted, in order to deduce if the incentives to augment the best-effort model with quality-assured one are there.

  • ASQ services are available on a global basis and they also can be deployed in a cost-effective way.
Potential solution

• Market-based approaches

  • The main challenge for market-based approaches and mechanisms is to specify a revenue sharing mechanism by all parties.

  • The high dynamicity is expected due to the varying network and market conditions, that are greatly affected by the way end user demanded is exhibited over time.
Potential solution

• Cooperative Game theoretic approaches
  1) ISP Coalitions, For Preserving Network Neutrality

• With high advertisement revenue and low flat rate internet access fees, a two sided pricing scheme is advantageous

• Considering cooperative game theory, ISPs might be able to form a coalition, which improves their situation while keeping the network neutral.

• The Coalition of ISPs and its dynamics can be modeled using other various concepts from cooperative game theory.
Potential solution

• Cooperative Game theoretic approaches
  2) Nash Bargaining Solution (NBS)

  • NBS is fair and Pareto optimal; and therefore players will never find themselves ‘losing’.

  • It can be used for interaction among ISPs or between ISPs and CPs, in order to reach a Pareto efficient equilibrium.

  • It can be also used in optional solution by leveraging its fair and opaque property

  • It can conclude the utility of the ISPs and CPs will always improve by using Pareto Optimal NBS.
Potential solution

- Cooperative Game theoretic approaches
  
  3) Strong Nash Equilibrium or Coalition proof Nash Equilibrium

- It is special Nash Equilibrium which can provide insights into cooperative games through a non-cooperative setting.

- It can help identify tighter bounds for may networking games, consideration the formation of a coalition between diverse entities.

- it characterized the improved equilibrium that can be reached when entities/users engage in coalitions.
Potential solution

• Cooperative Game theoretic approaches
  4) Shapley Value

  • It is another concept taken from cooperative game theory, which gives players/entities ‘fair’ playoffs, proportional to what they contribute.

  • It can be used in a cooperative market context as the basis for specifying revenue sharing mechanism among the federation’s ISPs.

  • It can be of use when calculating a fair allocation of revenue among all the ISPs in the chain.
Conclusion

• This paper has presented the main economic challenges and issues that network operators face in order to support the emerging high performance services, which require some form of E2E QoS assurance.

• It has also provided a brief overview of candidate economic mechanisms and game-theoretic tools that could be used and discussed their merits and limitations.
Q&A

THANK YOU 😊