Internet Interconnection Techno-Economics: A Proposal for Assured Quality Services and Business Models

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Abstract

The Internet is constructed by means of complex business interconnection agreements among multiple networks. However, the most commonly used agreements do not contain explicit Quality of Service reference. In this study a business rationale for Assured Service Quality (ASQ) inter-network services is presented and potential business models for their realization are proposed and analyzed. It is argued that ASQ products and business models could greatly enhance the health of the Internet interconnection ecosystem. A business model design framework that encompasses the key strategic decisions that would enable ASQ provisioning and generic collaboration is also provided. This framework is then elaborated using a number of off-net content delivery scenarios. Conclusions are hence drawn on the role of ASQ and ASQ-driven business models for the sustainable development of the "Future Internet".

1. Introduction

The Internet has become a unique infrastructure for digital and value-added services [1]. Increased bandwidth of access networks has enabled new applications such as video-on-demand and time-shifted television to become a reality in many homes, while online gaming and person-to-person video communication is also in frequent use [2] [3]. The transition of such services from best-effort delivery to predictable, standard quality levels is believed to be a prerequisite for further enhancing their popularity and generating market value. Tele-presence and e-health provide examples of services that can generally not rely only on best-effort Internet today, due to quality concerns [3].

High quality services place significant requirements on the underlying networks in terms of supported bandwidth with low packet loss, low latency and high availability [4]. Such requirements can be met by individual network operators willing to invest, but there is no generally accepted way to ensure end-to-end performance for services that cross network borders [1] [4]. Currently network operators monetize solely on flows originating from their own network customers. Since there is no reward for providing good performance for flows of other operators' customers, operators may refrain from doing so [5]. This is also reflected in the current Internet interconnection agreements: in the case of Internet transit, customer networks pay for global connectivity [6]. Because the existing transit providers rely on settlement-free peering and downstream customers to deliver this connectivity, networks do not have commercial control of performance beyond their own borders [7] [8]. Thus, the market is unable to "decide itself" on optimal routes. Even detecting or replacing the inefficient operators in a chain of operators involved in an end-to-end service is not possible for the source operator, which thus cannot "protect" the quality of his customers' inter-domain flows. Indeed, networks currently are "black boxes" to the outside world, exchanging solely data and Border Gateway Protocol (BGP) route announcements. Practical ways of

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ensuring acceptable inter-domain Quality of Service (QoS) have been the deployment of additional network links, i.e. connections among operators and content providers and throwing more bandwidth at congested links under an assumption of mutual benefit for both sides. Widespread adoption of capacity overprovisioning in anticipation of strong growth, combined with competition for customers have thus resulted in acceptable best-effort quality for many value added services adopted today [4] [8]. However, new applications especially those that involve (or offered by) mobile networks, may need more strict quality guarantees [9]. Business end-customers requiring strong quality guarantees have been limited so far, to buying Virtual Private Network (VPN) services from operators with appropriate geographic coverage.

As currently shaped and structured, the Internet interconnection market contains strong inefficiencies, rendering the traditional business models based on overprovisioning insufficient to meet the requirements of new envisioned applications [10]. In particular, these inefficiencies make some applications non-viable over certain parts of the Internet today [11]. At the surface level, the inefficiencies are seen as congestion, high latency routing and unstable traffic patterns, e.g. due to business conflicts [1]. At a deeper level, this is caused by *information asymmetry* and a lack of common quality definitions that could guide commercial bargaining. The famous “Lemon market” theory of Akerlof [12] explains how bad quality can drive good quality out of the marketplace: sellers know more about the underlying quality than the buyers. Rational buyers on their side bias their willingness to pay on *average market* quality expectations: they cannot estimate the precise value of each good because the sellers are not able to disclose quality accurately. The average quality expectations thus imply that sellers do not receive a fair price for high-quality products, whose value is by definition larger than the average in the market. The sellers therefore tend to avoid offering them. This tendency serves to further lower the average quality in the market, creating a vicious circle of even lower prices that in the end drives all high quality products out of the market. The bilateral transactions in the Internet connectivity market are characterized by information asymmetries of this kind, giving rise to opportunistic behavior [13].

To this end, the EU-funded project ETICS [10] has proposed a set of products enabling end-to-end quality-assured traffic exchange through new interconnection agreements. The gradual realization of such agreements aims to contribute to the health of the Internet ecosystem, enriching the current service offerings and creating new market opportunities for most of the stakeholders.

In this paper we focus on the business models for Assured Service Quality (ASQ) products [14], which comprise the novel additional interconnect options. We begin with an overview of the proposed ASQ products in Section 2. Then in Section 3 we present the business model framework that encompasses the key strategic decisions enabling ASQ provisioning and in Section 4 the generic collaboration models. We then apply the business model framework in different off-net content delivery scenarios in Section 5, before we summarize our conclusions in Section 6.

2. Assured Service Quality Products

The ETICS ASQ products are a family of novel interconnection services exchanged between actors in one or more commercial ecosystems such as the one illustrated in Figure 1. As illustrated in Figure 2, the ASQ products support end-to-end paths with predefined assured performance in terms of business and technical attributes, described in a Service Level Agreement (SLA). There can be several instantiations of the feasible set of ASQ products, depending on the values of the SLA parameters e.g. whether the source or the destination is a point or a region (set of IP prefixes) [10] [14]. This novel set of products, implemented as software enhancements of the Control and Management planes of the network active elements, enables the Network Service Providers (NSPs) to collaborate in new ways beyond transit, peering and dedicated VPNs/leased lines.

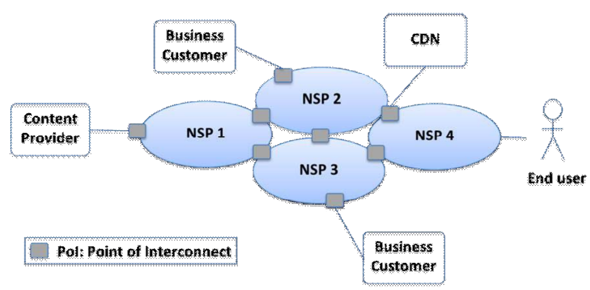

Figure 1. An example ETICS ecosystem with major actors

The ASQ products guarantee inter-domain network performance by allowing a fine degree of traffic control over inter-domain network paths and regions. They may e.g. restrict routing to areas not operating according to acceptable market principles. In particular, the main ASQ features are a) providing *quality assurance* to the inter-domain interconnection services, b) allowing the verification of the individual effort/quality of each of the NSPs involved in service provisioning, via c) *monitoring capabilities* and d) enforcing *reward/penalty schemes for SLA conformance/violation*. As opposed to typical peering and transit interconnection agreements, the ASQ products allow fine-grained information sharing and price setting in order to promote quality-based competition that can mitigate the adverse implications of asymmetric information and resulting inefficiencies [13].

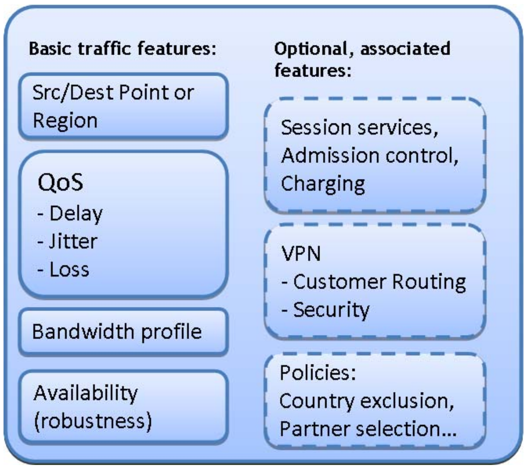

Figure 2. The definition of the ASQ product

This enables business models where otherwise competing actors can collaborate on service management.

3. Business Model Framework

Alongside the definition of ASQ products, a framework is proposed to support the design of interconnection business models in a Future Internet context, also considering value creation beyond pure ASQ connectivity. The multi-dimensional business model concept generally refers to the "architecture of a business" or the way firms structure their activities in order to create and capture value (see e.g. [15] [16] [Mandec] Amit][).

Though related literature review on the subject appears fragmented, the largest share of such studies agree on shaping the Business Model framework around a few key parameters or building blocks [17][18], such as value proposition, value capture, value network relationships, and financial configuration (in terms of revenue model and cost structure).

Our study grounds the formulation of its business model proposal on the conceptual framework developed by [19], who claims that the business model components broadly refers to the underlying concepts of "control", i.e. the inter-firm or Value Network relationships that the firm is involved in and controls over, and "value", i.e. the way a firm creates actual benefits to its customers and to itself through its value proposition and financial configuration.

In line with the reviewed literature (see [15] [16] [17] [18] [19] [20]) and the study's objectives, the framework encompasses three design themes: i) Value Proposition, ii) Value Network, and iii) Financial Configuration. Each theme includes four parameters or key decisions to be made. For each parameter, the "value range" is identified, i.e. the extreme values or the key alternatives that the parameters can take. This represents the major trade-off between opposite choices; discussing the main strategic implications of alternative parameter values. The business model framework for ASQ products is shown in Table 1.

This proposal of reference framework for interconnection business models should both disclose a number of emerging alternatives rising within the Internet interconnection market (e.g. Sending Party Network Pays [21]), and provide NSPs with a straightforward checklist of strategic and tactical decisions to be made when deploying a strategy based on ASQ products.

Table 1. The Business Model framework for ASQ products

	Business Model Parameter	Value Range (Trade-off)	Strategic Implications
Value Proposition	*Product/Service Delivered*	Basic connectivity	Traditional business for NSPs. Easier diffusion-substitution.
		Assured Service Quality (ASQ)	Higher potential margins from connectivity. Service differentiation. Two-tiered internet.
		Content	Traditional business for Over-The-Top (OTT) providers. Higher margins from content market making. Higher complexity, business diversification.

	Target Customer	Content Provider/OTT	Comparable relative bargaining power. High data traffic. Peering agreements potentially required.
		End-user	Higher relative bargaining power.
	Customer Value	Basic connectivity	Lower expenses for meeting customer requirements. Lower service differentiation potential.
		Assured Service Quality (ASQ)	Higher expenses for meeting customer requirements (ASQ path). Higher service differentiation potential. Increase in value creation opportunities among customers (ASQ as service enabler).
		Content	Coverage of Content Management activities. Higher margins from content market. Higher complexity, business diversification. Additional source of Content for service creation for OTTs. Possible competition with Content Providers.
	Resources & Competences	Technology-oriented	Disposition towards technology partnership.
		Content-oriented	Disposition towards editorial partnership for service creation.
Value Network	*Vertical Integration*	Infrastructure Layer coverage	Technology enabler role. Focus on infrastructural investments, network operation and management.
		Internet Service Layer coverage	More invasive role within the Value Network. Investments in both network infrastructure and content management. Potential NSP-OTT competition.
	Customer Ownership	Intermediated	Increased dependence on OTT. Indirect revenue flows.
		Direct	More central role in the Value Network, direct revenues. Potential competition with OTT.
	Interconnection Modality	Transit prevalence	Indirect interconnection. Lower transaction costs for agreement setting. Higher risk of opportunistic behaviour in traffic management. Need for compensation.
		Peering prevalence	Direct interconnection of peers. Higher transaction costs for peering agreement. Higher interconnection efficiency. Lower need for compensation.
	Content-Data delivery model	Client-server	Basic data delivery model. Simpler model. No distribution of intelligence.
		Cloud	Pool of virtualized resources. Higher resource multiplexing, scalability and flexibility. Introduction of the Cloud Provider in the Value Network.
		Content Delivery Network (CDN)	Content distribution/storage/management. Improved reliability, throughput, origin server load balancing; lower latencies for consumers. Introduction of the CDN Provider in the Value Network.
Financial Configuration	*Revenue Model*	Single Transaction	One-shot revenues for connectivity consumption and/or content purchasing. Higher margins for single transaction. No customer lock-in.
		Subscription	Flat rate with/without time/traffic/ usage/n° downloads caps. Customer lock-in and future revenues assured.
	Revenue Sharing	Present	Business sharing (opportunities/risks) between ISP-OTT-End-user.
		Absent	Clear separation between NSP and NSP-OTT-End-user businesses.

	Model		
	Traffic Charging scheme	Receiving Party Pays	Traditional charging scheme favouring OTT. Lower incentives to invest for NSPs.
		Sender Party Pays	Incentives alignment: NSPs to invest in capacity and QoS; OTT to use network capacity efficiently and keep traffic on net (when possible). Option to establish Initiating Party Network Pays (IPNP) charging on top of Sender Party Pays, thus facilitating direct money flows.
	Cost Model	Concentrated Investment	Increased independence. Increased risk.
		Joint Investment	Risk sharing. Increased dependence on partnering actors.

Note that as highlighted also by the value range of the Business Model Framework parameters, ASQ products allow individual customers of an NSP, i.e. other NSPs or Content/Application Service Providers to choose the level of service that they receive end-to-end; this is then guaranteed by the inter-NSP SLAs at the various Points of Interconnect (PoIs). This way, multiple novel business models can be instantiated, as discussed in the next sections.

4. Collaboration Models for ASQ Interconnection

The exchange of ASQ interconnect products essentially enables NSPs to use each other's network resources and compensate each other for it. As opposed to typical peering and transit agreements, ASQ collaboration models provide finer-grained mechanisms for price setting in order to promote quality-based competition.

When more than two NSPs are involved, there are two main alternatives for materializing collaboration [22]. These two models can be seen as inspired by the two main classes of routing paradigms, known as distance vector and link-state routing.

The first collaboration model is based on *cascading bilateral* relations, where NSPs create offers to their neighbors by aggregating their own network resources with incoming offers from other neighbors. Routing decisions for each packet can then be based on a price/quality tradeoff, taking account of specific SLA information. This collaboration model is similar to the BGP-based approach that is used to distribute best-effort routes today, and can be seen as a bootstrapping solution for the introduction of the ASQ products in the market. This would be an initial step in a transition from the current best-effort only paradigm, and ASQ connectivity for the business market is anticipated as the main initial driver. Routing will, however, rely on a myopic view of the network resource situation and not be able to adapt to fast changes in congestion levels. This is the case whether using BGP or other cascading mechanisms for the propagation of the ASQ-enabled routes.

The second main option is to let a customer agent NSP perform ASQ path computation based on more detailed knowledge of the actual network state. This has similarities to link state routing and is referred to as the *coordinated ASQ composition* model. Since routing decisions in this model can be based on more detailed dynamic state information, overall network utilization can be improved compared to the cascading bilateral model and each customer's needs can be matched and met more efficiently. However the establishment of necessary information exchange and possibly even explicit revenue sharing/penalty models between several NSPs make the transition to coordinated ASQ composition more difficult. We therefore assume that this will happen mostly after the cascading bilateral model has been implemented.

Both these models are intended to create aggregate traffic pipes where network charging is done according to the Sending Party Network Pays (SPNP) principle. In order to enable money to flow even more directly towards network bottlenecks, additional collaboration options can be established for VPN tunnels and application level sessions, where Initiating Party Network Pays charging is established on top of the SPNP paths. Note that by purchasing ASQ products, an NSP can add purchased "virtual" infrastructure so as to extend its network coverage.

These collaboration models along with the ASQ interconnect products can be applicable, guided by the above framework, also in new markets, such as Cloud Computing.

5. The Off-net Content Delivery Market

Having presented the business model framework and generic collaboration models for ASQ traffic interconnection in the previous sections, the framework is now applied to the off-net content delivery market.

5.1. Motivation and business case

Off-net content delivery describes an emerging trend where premium content is delivered by (Telco or OTT) CDNs to end-users that reside in other networks (off-net). This forms an attractive long-tail market, where end-users or other actors are willing to pay for assured quality delivery. The business motivation would be similar to hierarchical CDNi-like agreements [23] with advanced content aggregation/in-network caching capabilities. The value flow will be discussed for several use cases, all illustrated in Figure 3.

5.2. Use cases

The baseline use case in Figure 3 involves an NSP (Transit/Origin NSP 1) having its own CDN, as well as two edge NSPs (Edge NSP2 and 3) as actors in the value chain. NSP 1 is buying a wholesale ASQ service from the Edge NSP 2 (E-NSP) in order to obtain the permission for traffic termination to the delivery Region 2. This service is called ASQ Traffic Termination (ASQ TT) and allows traffic separation, assured delivery and even session-based management of premium content (e.g. HD Streaming/Video) to the Region 2 customers. This purchase can be performed by means of both the generic collaboration models described in Section 4.

While ASQ TT is a product that pertains to aggregate-level traffic delivered at a given point of interconnection (PoI) between the NSPs, end-user content delivery sessions on the other hand, are handled by the so-called Service Enhancement Functions (SEF) [22], as shown by the dashed line in Figure 3. This function enables, if needed, the triggering of end-user specific ASQ connectivity policy enforcement by NSP 2. ASQ TT is based on the SPNP charging principle and may also be an aggregate for any ASQ traffic from any upstream source, not only for content delivery traffic, while the SEF enables many variants of per end-user session charging and money flow. This is considered an efficient approach for ASQ traffic delivery and charging.

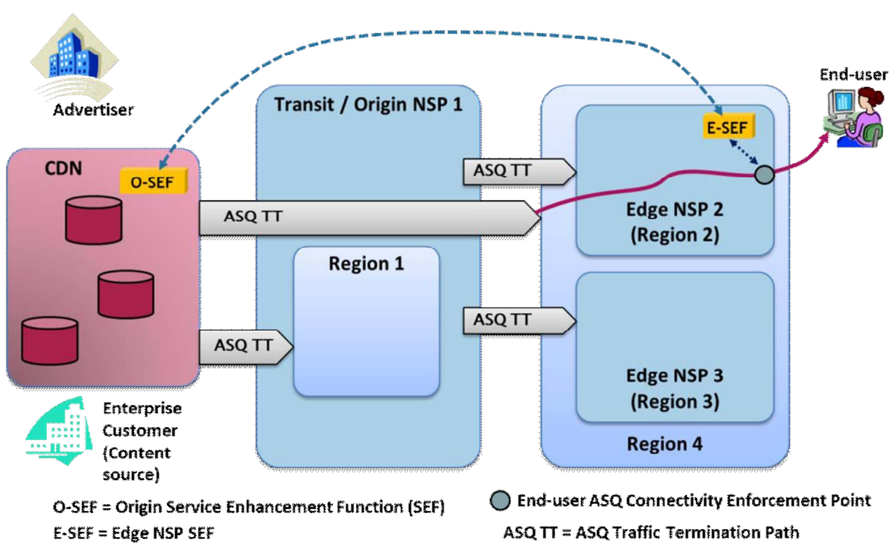

Figure 3. Off-net Content Delivery- Example topology

In the second use case, NSP1 is performing a transit role by serving an OTT CDN. NSP1 then aggregates the content delivery to end-users belonging to the regions of NSP 2 and NSP 3, which is defined as the aggregated Region 4. In this case the OTT CDN buys from NSP1 the capability to deliver ASQ content delivery session services to end-users in Region 2 and Region 3. Typically NSP1 will also offer an ASQ TT to his own end-user customers as well, which is illustrated as the ASQ TT towards Region 1. In addition, this use case can also correspond with the case where the CDN is a Telco CDN business unit under the same enterprise group as the NSP1 business unit. The baseline case anticipates that the end-customer is paying for the content delivery service typically directly to the OTT CDN (cf. the illustrated SEF interactions). However, a third use case (not explicitly illustrated) is created when an NSP (that may act as an edge and/or a transit) that does not have any CDN capabilities or own CDN deployed, agrees with another NSP – namely the Origin NSP – to become his customer for the content delivery service, thus becoming a Content Reseller NSP. In this case, the Content Reseller NSP delivers to his client E-NSP the content with ASQ, which is actually coming via an interconnection with the Origin NSP. This scenario is interesting when the Content Reseller NSP and the Origin NSP both have client E-NSPs who reside in countries where users have similar interests on content due to cultural reasons. The end-customer can pay either to the content reseller NSP or directly to the CDN (the origin NSP in this case).

A fourth use case is created when two NSPs with respective Telco CDNs merge their services and provide them to their users. Each Telco keeps servicing its own users; however, there are richer content and services due to the combination of content from both Telco CDNs. Once again it is implicitly assumed that both NSPs have (in general multiple) client E-NSPs who reside in countries where their users have similar interest on content due to cultural reasons. The difference with the third use case is that both NSPs have their own Telco CDN and they have a mutual interest in aggregating their respective content/services in order to be more competitive in the various national markets where their clients reside. Note that the purchase of ASQ goods over multiple regions can be used by an operator to support its mobile roaming users with predictable quality, regardless of their location.

Additional use cases assuming payment by actors other than the end-users are also very relevant, in particular for showing how money can flow to less developed parts of the Internet, which is not the case for current Internet inter-networking business models. This could have positive implications for the technological development of societies in emerging markets. Advertiser-based business models are of interest and can, to some extent, be relevant for premium content delivery. However, of even more interest are business models where an enterprise customer (e.g. the corporate headquarter of an Enterprise customer in Figure 3) is buying a CDN service in order to reach partners or branch offices in several remote locations. Here the money will flow from this enterprise to the CDN, to the transit NSP(s) and finally towards the edge NSPs.

Finally, note that ASQs enhance the competition in the market, allowing for NSPs to establish presence in areas or PoIs currently not being served by them. This is expected to contribute to revealing real network costs across the Internet infrastructure and sustainable prices under fair competition. Attempts from NSPs to create monopolies can be broken easier than before, due to increased competition. Also the SPNP principle associated with ASQ can mitigate frauds since the sender of ASQ traffic has to compensate the downstream carriers for it, thus also limiting spam.

5.3. Application of the Business Model Framework

The business model reference framework of Section 3 is then applied to the market under scrutiny.

Value proposition design theme parameters as described in Table 1 are the first to be considered and applied.

Product/Service Delivered: ASQ products support premium transfer of content from the content server to the end-user. In particular, for the basic bootstrap use case the Origin NSP is buying ASQ TT from the Edge NSP. The role of the Service Enhancement Function is also important in order to support the micropayments coming from the user session layer e.g. via subscription or usage-based charging models.

Target Customer: target customer is the CDN (Telco or OTT) who is providing assured quality services to end customers. This could also include Content Providers, e.g. studios owning movies, who may wish to provide their services on top of the ASQ infrastructure as a cost-effective means compared to other alternatives.

Customer Value: quality guarantees on the content delivery via the ASQ goods.

Resources and Competencies: the NSPs and CDNs utilize their resources and competencies in their core business, i.e. is technology-oriented, and the cost-effective operation of the actors in their core business is enhanced via the ASQ market opportunities.

Next, the parameters of the **Value Network** design theme are provided.

Vertical Integration: it is likely that NSPs perform vertical integration by aggregating the roles of CDN, Origin NSP, Transit NSP and even possible Edge NSP, thus having Infrastructure Layer coverage. This could be the case for substantially large NSPs.

Customer Ownership and Relationship: there is some initial end-user interaction with some content web portal / server in order to trigger the premium content delivery. This portal creates an intermediated relationship and indirect revenue flows across the Infrastructure and Internet Service Layer.

Interconnection Modality-Business Agreements: end-users have a contract with the CDN/Server (e.g. a portal) for the services it provides. This can be a long-term contract (e.g. monthly fee for being able to stream e.g. a certain number of movies per day) or on-demand and volume-based. For the business agreements among the NSPs and CDNs involved in the service provisioning, wholesale transit-like ASQ agreements are likely, while settlement-free peering-like agreements are also possible.

Content-Data Delivery Model: the CDN model is the dominant one. CDNs can provide (via purchasing ASQ) even better quality services than those currently offered. Also, they may face competition by NSPs, which can bundle in-network (close to their end-users) caching and ASQ products to target specific regional content delivery markets.

Last, the parameters of the **Financial Configuration** theme are investigated.

Revenue model, revenue sharing, charging issues and money flows: for all the use cases the services can be subsidized by advertisement and also possibly paid per-view by the end- users who subscribe to those services e.g. via a Content on-demand portal. This subscription could either be explicit (pay per-view case) or implicit (subscription is bundled in the end-user contract paid by the end-user to his provider). For the management of the aggregate ASQ traffic flows, it is expected that the purchaser of the involved ASQ goods will have to compensate the involved networks (if any) for carrying this traffic on top of their network, according to the Sending Party Network Pays principle. Figure 4 illustrates the aggregate level traffic charging as well as the per-session based charging at the application layer.

For the two use cases where partnering Telco CDNs merge their services as a way of market extensions, it is likely that there is no charge on the bilateral traffic exchange of the NSPs, as the revenue exchange will take place on the Content / Application plane. However, this will require ASQ TTs that are dedicated to this content delivery partnership.

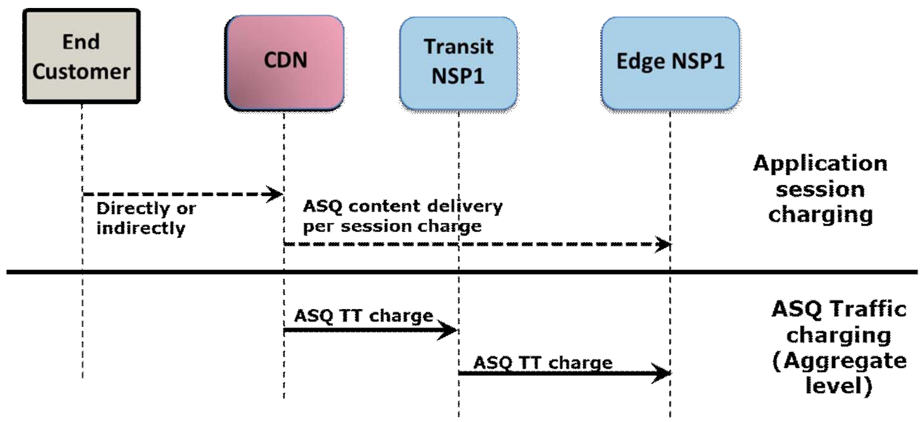

Figure 4. Money flow and charging - Example

Cost Model: concentrated Investment is selected, since the NSPs must invest to compete for the ASQ traffic. Also interconnection costs for the creation of ASQ paths may be imposed. The management of the ASQ traffic flows may also impede costs to the NSPs. A long-term agreement between the edge NSP and the content provider (or CDN) is also possible.

6. Conclusions

This study introduces, specifies and develops the Assured Service Quality (ASQ) interconnection products, a set of novel interconnection products that support paths with assured performance in terms of business and technical attributes, described in an SLA. This study is focused on the business models for Assured Service Quality (ASQ) products.

A business model framework suitable for the interconnection market is introduced that lists the key strategic decisions for NSPs to enable ASQ provisioning. The proposed framework encompasses three design themes: i) Value Proposition; ii) Value Network; and iii) Financial Configuration. This framework can represent a fundamental starting point for an NSP offer based on ASQ products.

Furthermore, the two main generic collaboration models for Network Service Providers (NSPs) are presented. These models, namely the *cascading bilateral* relations and the *coordinated ASQ composition* have been inspired by the two main classes of routing paradigms, known as distance vector and link-state routing. They are intended to create aggregate traffic pipes where network charging is done according to the Sending Party Network Pays (SPNP) principle, while additional collaboration options can be established e.g. for application level *sessions*.

The business model framework is then applied in different off-net content delivery scenarios that are of market interest and highlighted the respective actors, their interactions and choices, as well as money flows.

We have also depicted how certain instances of ASQ products, namely the ASQ Traffic Termination service, can support a wide range of content delivery scenarios and the respective business interactions and money flows among the stakeholders involved in each of them.

Concerning the study's limitations, the proposed Business Model framework's focus is limited to Internet interconnection. In order for it to be applied in other domains, its variables and value ranges should be modified according to the domain's needs and respective actors' strategic choices.

Although the ASQ products have been designed to increase competition, it is beyond their reach to overcome potential monopolistic behavior supported by the authorities in a country. However, with new mechanisms for economic compensation beyond end-user payment, it could be possible to create economic incentives that could lead to increased consumption of network services also under such circumstances.

The ASQ products can generate additional revenue streams for the NSPs whose profit margins are constantly being squeezed, and can provide more choices to the consumers, also enabling the rollout of new richer applications. These virtuous goals can be achieved provided that NSPs properly design their innovative business models according to a comprehensive set of emerging strategic and technical alternatives, which are described in the business model framework envisioned. Then the deployment of the ASQ products as an additional market choice complementing the traditional best-effort services can have a positive impact on the customers and the Internet interconnection market as a whole. In turn, this can have a positive effect on the sustainable and fair evolution of the "Future Internet" ecosystem.

Further research should be devoted to bridging the remaining barriers and transitions between the best-effort paradigm, the cascading bilateral coordination model and the coordinated ASQ composition model, leading to efficient and attractive ASQ products in the global market place.

7. Acknowledgements

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8. References

[1] D. Clark, Dd., J. Wroclawski, K. Sollins, R. Braden (2005)., "Tussle in Cyberspace: Defining Tomorrow's Internet.", IEEE Transaction on Networking, Vol 13, No 3, June 2005.

[2] R. Frieden, J. Adams, L. Roberts, and A. Jsselmuiden, "Changing the Internet to Support Real-Time Content Supply from a Large Fraction of Broadband Residential User," BT Technology Journal (BTTJ), vol. 23, no. 2, 2005.

[3] R. Braden, D. Clark, and S. Shenker, "Integrated Services in the Internet Architecture: an Overview," RFC 1633, 1994.

[4] M. Weiser, "The Computer for the 21st Century," IEEE Pervasive Computing Journal, vol. 13, no. 1, 2002.

[5] P. Buccirossi, L. F. Bravo, and P. Siciliani, "Competition in the Internet Backbone Market," World Competition, vol. 28, no. 2, pp. 235–254, 2005.

[6] J. Hwang, M. B. H. Weiss, and S.-J. Shin, "Dynamic Bandwidth Provisioning Economy of a Market-Based IP QoS Interconnection IntServ-DiffServ," White paper, School of Information Studies, Syracuse University, 2000.

[7] D. M. Turner, V. Prevelakis, and A. D. Keromytis, "The Bandwidth Exchange Architecture," in Proceedings of 10th IEEE Symposium on Computers and Communications (ISCC). IEEE Press, 2005, pp. 939–944.

[8] H. Yamaki, M. Wellmann, and T. Ishida, "A Market-Based Approach to Allocating QoS for Multimedia Application," in Proceedings of the 2nd International Conference on Multiagent Systems (ICMAS-96). MIT Press, 1996.

[9] T. Yang and D. Makrakis, "Hierarchical Mobile MPLS: Supporting Delay Sensitive Applications Over Wireless Internet," in Proceedings of the International Conferences on Info-Tech and Info-Net. IEEE Press, 2001.

[10] Le Sauze, N., Chiosi, A., Douville, R., Pouyllau, H., Lonsethagen, H., Fantini, P., Palasciano, C., Cimmino, A., Callejo Rodriguez, M. A., Dugeon, O., Kofman, D., Gadefait, X., Cuer, P., Ciulli, N., Carrozzo, G., Soppera, A., Briscoe, B., Bornstaedt, F., Andreou, M., Stamoulis, G., Courcoubetis, C., Reichl, P., Gojmerac, I., Rougier, J.-L., Vaton, S., Barth, D., and Orda, A. 2010. ETICS: QoS-enabled interconnection for Future Internet Services. In Proceedings of the Future Network & Mobile Summit 2010, (Florence, Italy, June 2010).

[11] A. Ghezzi, M. Georgadis, P. Reichl, C. Di-Cairano Gilfedder, R. Mangiaracina, and N. Le-Sauze, "Generating Innovative Business Models for the Future Internet" Info, Vol. 15, Issue 4, 2013, pp. 43-68.

[12] Akerlof, G. A.: "The Market for Lemons: Quality Uncertainty and the Market Mechanism". The Quarterly Journal of Economics Vol. 84, No 3: pp. 488-500, August 1970.

[13] Courcoubetis, C., Dramitinos, M. and Stamoulis. G. D.: "Internet Interconnection Assured Quality Services: Issues and Strategic Impact". Proceedings of the Future Network & Mobile Summit, pp. 1-9, 2012.

[14] P. Zwickl, P. Reichl, A. Ghezzi, F.T. Johansen, H. Lønsethagen, M. Georgiades, and C. Di Cairano-Gilfedder C., "ASQ Meta-Scenarios: A Generalized Approach for Requirements Classification of Interconnection Goods", CTTE 2011 - 10th Conference of Conference of Telecommunication, Media and Internet Techno-Economics, Berlin, Germany, 16-18 May 2011, p. 1-9, Print ISBN: 978-3-8007-3348-4.

[15] Timmers, P., "Business Models for electronic commerce". Electronic Markets, Vol. 8, No 2: pp. 3-8, 1998.
[16] Zott, C., Amit, R. and Massa, L. 2011. The Business Model: Recent Developments and Future Research. Journal of Management, Vol. 4, No.1: 21 – 44.
[17] Osterwalder, A.: "The business model ontology—A proposition in a design science approach". Dissertation 173, University of Lausanne, Switzerland, 2004.
[18] A. Ghezzi, "Emerging Business Models and Strategies for Mobile Platforms Providers: a Reference Framework". Info, Vol. 14, n° 5, 2012, pp. 36-56.
[19] Ballon, P.: "Business modelling revisited: the configuration of control and value" . I nfo, Vol. 9 No. 5, pp. 6–19, 2007.
[20] A. Ghezzi, "A proposal of Business Model Design parameters for Future Internet Carriers", IFIP Networking 2012 (11th International Conference on Networking), In: Lecture Notes in Computer Science, 2012, Volume 7291/2012, 72-79, DOI: 10.1007/978-3-642-30039-4_9.
[21] von Bornsteadt, F, Roettgermann, M., Korthals, I., Johansen, F.T., Lønsethagen, H.: "The Sending Party Network Pays: A first step towards end-to-end quality of service". Proceedings of the 15th International Conference on Intelligence in Next Generation Networks (ICIN), pp. 1-5, 2011.
[22] P. Zwickl, P. Reichl and A. Ghezzi, "On the Quantification of Value Networks: A Dependency Model for Interconnection Scenarios", In: Springer Verlag (Eds.), Economics of Converged, Internet-Based Networks – Lecture Notes in Computer Science, 2011, Volume 6995/2011, 63-74, DOI: 10.1007/978-3-642-24547-3_7
[23] CDNi info page: https://www.ietf.org/mailman/listinfo/cdni.
[24] R. Mangiaracina, A. Perego, "Payment systems in the B2c eCommerce: Are they a barrier for the online customer?", Journal of Internet Banking and Commerce, Vol. 14, No. 3, 2009.
[25] A. Ghezzi, R. Balocco, A. Rangone, "Strategic Planning, Environmental Dynamicity and their Impact on Business Model Design: the Case of Mobile Middleware Technology Providers". In: M.S. Obaidat and J. Filipe (Eds.): ICETE 2009, Communications in Computer and Information Science, CCIS 130, Vol. 130, Part 2, pp. 94--109. Springer, Heidelberg (2011).
[26] A. Ghezzi, F. Renga, R. Balocco, "A Technology Classification Model for Mobile Content and Service Delivery Platforms". In: Joaquim Filipe, José Cordeiro (Eds.). Enterprise Information Systems – Lecture Notes in Business Information Processing, Springer Verlag, 2009, Volume 24, III, 600-614.
[27] A. Ghezzi, R. Balocco, A. Rangone, "How a new distribution paradigm changes the core resources, competences and capabilities endowment: the case of Mobile Application Stores". In: Proceedings of the 9th International Conference on Mobile Business and 9th Global Mobility Roundtable. Athens, Greece, 13-15 June 2010, pp. 33-42.
[28] C. Dell'Era, F. Frattini, A. Ghezzi, "The Role of the Adoption Network in the Early market survival of Innovations: the Italian Mobile VAS Industry". European Journal of Innovation Management, 2013, Vol. 13, No. 1: 118-140.
[29] A. Ghezzi, "Revisiting Business Strategy under Discontinuity", Management Decision, 2013 Vol. 51, No: 7.
[30] Corso M., Gastaldi L., Martini A, "The Role of ICT in the New (Virtual) Working Space: An Empirical Investigation on Enterprise 2.0", Communication in Computer and Information Science, Vol. 278), Berlin (Germany): Springer-Verlag, pp. 546–556, 2012.
[31] A. Ghezzi, M. Cortimiglia, R. Balocco, "Mobile Content & Service Delivery Platforms: a technology classification model", Info, 2012, Vol. 14, n° 2, pp. 72-88.
[32] M. Cortimiglia, A. Ghezzi, F. Renga, "Mobile Applications and their Delivery Platforms". IT Professional – Vol.13, Issue 5, p. 51-56 , September-October 2011.
[33] M. Cortimiglia, A. Ghezzi, F. Renga, "Social Applications: Revenue Models, Delivery Channels, and Critical Success Factors – An Exploratory Study and Evidence from the Spanish-Speaking Market", Journal of Theoretical and Applied E-commerce Research, Special Issue on Business Models for Mobile platforms – Vol. 6, Issue 2, August 2011, p. 108-122.
[34] A. Ghezzi, F. Renga, R. Balocco, P. Pescetto, "Mobile Payment Applications: offer state of the art in the Italian market". Info,2012, Vol. 12, No. 5, pp. 3-22.
[35] R. Balocco, A. Ghezzi, G. Bonometti, F. Renga, "Mobile Payment Applications: An Exploratory Analysis of the Italian Diffusion Process". In: Proceedings of the 2008 7th International Conference on Mobile Business. Barcelona, Spain, July 7-8 2008., pp. 153-163.
[36] A. Ghezzi, F. Renga, M. Cortimiglia, "Value Networks: Scenarios on the Mobile Content Market Configurations". In: 8th International Conference on Mobile Business (ICMB 2009). Dalian, Liaoning, China, 27/06/2009 - 28/06/2009.
[37] A. Ghezzi, "A Strategic Analysis Reference Model for Mobile Middleware Technology Providers". In: 8th International Conference on Mobile Business (ICMB 2009). Dalian, Liaoning, China, June 27 – 28, 2009.
[38] A. Ghezzi, R. Mangiaracina, A. Perego, "Shaping the E-Commerce Logistics Strategy: a Decision Framework", International Journal of Engineering Business Management, 2012, Vol. 4, No. 1, pp. 1-13.
[39] A. Ghezzi, R. Balocco, R. Mangiaracina, "Technology Provisioning in the Mobile Industry: a Strategic Clustering", International Journal of Engineering Business Management, 2012, Vol. 4, No. 1, pp. 1-9.
[40] R. Balocco, A. Ghezzi, A. Rangone, G. Toletti, "A strategic Analysis of the European Companies in the ICT Sales Channel", International Journal of Engineering Business Management, 2012, Vol. 4, No. 1, pp. 1-10.
[41] A. Ghezzi, M. Cortimiglia, A. Frank, R. Balocco. Strategic Planning in highly dynamic competitive contexts: A study of Italian Mobile Network Operators. In: Proceedings of the 7th International Conference on E-Business (ICE-B 2009). Rome, Italy, 24/7/2012 - 27/7/2012.