Internet and 5G Tussles and How to Mitigate Them by Re-Engineering SPNP

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***Abstract*—In this paper we study the most prominent tussles related to Internet and 5G services We present our proposal of combining the Sending Party Network Pays principle with the 95^{th}-percentile charging scheme as a means to charge for Internet and especially for 5G wholesale infrastructure inter-provider services and discuss its impact on the identified tussles.**

I. 5G and Internet Tussles

Multiple network (including 5G access), cloud and service providers constitute the multi-actor value chain of 5G and Internet services. The diverse and merely conflicting goals and interests of these stakeloders often result in tussles. 5G PPP project 5GEx [1] envisions the 5G Exchange framework that enables NSPs and Clouds to orchestrate, trade and integrate virtual resources and services on-demand to support 5G services. Exchanges facilitate service provisioning by harmonizing the operation of all the involved stakeholders. Yet, most Internet tussles remain unresolved and some new ones arise; these are presented below.

Optimal Destination/End-point Selection. Cloud and IoT are part of many 5G services, where e.g. a VM migration or CDN traffic flow may have multiple candidate destinations, e.g. for redundancy. Currently, destination selection is done by the Service provider without any knowledge on the underlying network, potentially causing extra congestion even in expensive *inter-domain* links. Thus, there is a control tussle over the decision on optimal traffic destination.

Intra-Domain Traffic Management. NSPs apply traffic management serving their own optimization objectives, which also affect traffic flows generated by their 5G enterprise customers (Clouds, Service providers), whose business relies on providing the best QoS to their customers. Therefore, a tussle over the management of the intra-domain flows applies.

Inter-Domain Traffic Management. NSPs are primarily concerned with the quality of their services to their residential and business customers, where they obtain their revenue from. Inter-domain flows initiating outside the NSP's domain by definition belong to other NSPs, which are also potential competitors. Hence, NSPs if not properly compensated, have an incentive to either ignore the QoS requirements or even degrade the quality of such inter-domain flows, resulting in poor QoS and highly inefficient situations [2]. That is, there is a tussle on inter-domain routing and traffic management.

Discrimination. 5G will support a variety of new business models and multiple types of traffic. Potentially, an NSP may be tempted to assign some traffic to a lower priority class inside his network so as to provide better QoS to other preferred classes such as NSP-provided IPTV without baring the upgrade costs. Thus, there is a tussle between that NSP and OTT Service Providers, regarding the extent of the NSP rational traffic management. Similarly, in the context of an *exchange*, providers may put higher effort to own traffic/services and provide inferior performance to the exchange/federation partners.

Information Asymmetry and Hidden Effort. NSPs do not disclose internal topology, load or monitoring information, rendering impossible to deduce whether e.g. the delay experienced in a data transfer is due to network congestion or due to low effort by the NSP(s). Consequently, there is a tussle among NSPs and Service Providers over the information revealed and the actual effort exercised, since current SLAs neither reward the network performance nor allow information exposure.

Exchange Member Admittance. Economics indicate that in coopetitive environments larger players are less eager to cooperate with smaller ones. On the other hand, a larger exchange implies lower costs for infrastructure providers, due to larger geographical "footprint", economices of scale and higher multiplexing gains. Thus, there is a tussle on joining and admitting a new member in the exchange.

Negotiation of Exchange Policies and Rules. Exchanges such as 5GEx are crucial for 5G business and service coordination. Exchange policies-rules are very important, since they determine customer ownership, service orchestration, revenue sharing. Different stakeholders' conflicting interests result in a major control tussle on setting these rules.

II. SPNP and 95^{th}-Percentile Charging

Sending Party Network Pays (SPNP), shown in Fig. 1, was introduced in [3]: Two networks exchange assured quality traffic over Assured Service Quality paths (ASQs) according to agreed SLAs. That is, when Network A (buyer) sends ASQ traffic to Network B (provider) Network A pays Network B for transporting the IP packets according to the SLA (A-to-B) to destination end-points of an agreed destination region (set of IP prefixes) R-x. For traffic in the opposite direction, the roles of A and B, and the destination region R-y change. The SPNP traffic charges in the two directions are in principle separate.

SPNP applies between NSPs; NSP offerings to the Service Provider is a different issue, depending on the service type and the specific vertical. In conclusion, SPNP is relevant for wholesale bulk traffic aggregates/slices and should not be confused with the end-customer application service. The

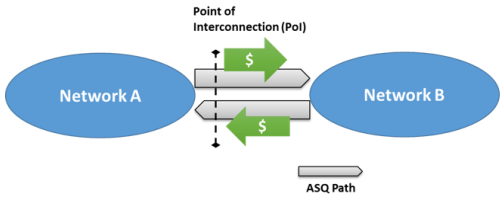

Fig. 1. The Sending Party Network Pays principle.

original SPNP proposal left unexplored several topics: The specific charging formula of the SPNP principle, the impact on tussles, the feasibility of SPNP for 5G are the most prominent topics not studied; these are considered further below.

The 95^{th}-percentile rule is widely used in charging transit links: within each billing period, typically a month, the link throughput is sampled over 5-min intervals and the charge is derived from the highest sample after removing the top 5% values. This traffic sample is typically much higher than the average throughput, thus traffic peaks are penalized. This is why 95^{th}-percentile rule is preferable to other schemes.

The emerging Internet and 5G services require innovative *network infrastructure services of assured quality*, possibly within exchange solutions [1]. To ensure these services are low-cost and scalable, no end-user flow awareness is needed at the Point of Interconnection (PoI). Sending-Party-Network-Pays (SPNP) is suggested as the charging principle for the wholesale SLA-based assured quality traffic exchange. These ASQ-infrastructure services should also prepare for the on-demand and real-time end-to-end quality management of the end-user connectivity, in order to meet the respective 5G services requirements. The way to do this is by coordinating the policy control and enforcement at the service nodes of the edge NSPs that serve the end-points of 5G verticals. By these policies, the traffic is steered onto the ASQ paths for carrying the traffic across multiple legacy and SDN networks.

We propose SPNP with 95^{th}-percentile charging to charge 5G infrastructure network services. 95^{th}-percentile charging is common for Internet transit, thus NSPs are familiar with its merits. Our proposal can be complemented with a variety of end-customer (retail) related and service related business models for ASQ connectivity, from any to any end-point. We foresee the evolution of 5G related exchange points so that traffic, network capacities, NFVI and VNF are traded among NSPs to support Anything as a Service (XaaS). SPNP with 95^{th}-percentile charging also fits nicely inter-domain DC-2-DC traffic exchange, for aggregate ASQ traffic charging.

III. Tussle Mitigation by means of SPNP and 95^{th}-Percentile Charging

To evaluate SPNP and 95^{th}-percentile charging, we make use of the simulation results reported in [4] (authored by two of the authors of the present paper) in the context of DC-2-DC communication: 95^{th}-percentile charging provides incentives for traffic shaping of delay-tolerant traffic to both NSPs and Clouds/Service Providers, resulting in increasing multiplexing efficiency of the underlying network; this is crucial for 5G given the exponential increase of huge traffic volumes.

In the context of 5G and SDN networks we envision our proposal as a VNF in the network, shaping when needed the traffic of multi-domain multi-operator slices. Having discussed the merits of our proposal in terms of incentives and efficient network usage, we investigate whether the 5G tussles are mitigated and how.

The *Optimal Destination/End-point Selection* tussle is resolved since the ASQ buyer decides on the end points based on ASQ information specified by himself or published by the 5G network providers. Different unit prices for different regions reflect the different transit and service network costs. The *Intra-Domain Traffic Management* and *Inter-Domain Traffic Management* and the *Discrimination* tussles are also resolved since both NSPs and OTTs have the incentive to shape delay-tolerant traffic in order to reduce the 95^{th}-percentile sample and the corresponding charge. In fact, due to the incentive compatibility of our proposal and of schemes that employ it [4], shaping is performed by the traffic source itself, i.e. the source NSP and/or OTT. No throttling is imposed, since it would only reduce the NSP business customers' satisfaction and potentially violate SLAs. *Information Asymmetry and Hidden Effort* tussle is also resolved, because the service information is part of the SLA, while SLA monitoring to verify SLA conformance resolves hidden effort issues.

The *Exchange Member Admittance* and *Negotiation of Exchange Policies and Rules* tussles are orthogonal to our proposal; these tussles can only be mitigated by proper policies, as in [5]. Our proposal enforces that QoS is provided to the traffic that really needs it; abuse of network resources and/or sending spam traffic as a means to generate revenue are penalized due to charging, as opposed to the case of Receiving Party Network Pays. The 95^{th}-percentile charging provides additional incentives and rewards for 5G network infrastructure providers to offer the 5G high-value network services needed.

IV. Conclusions

We overviewed Internet and 5G tussles that arise due to the multi-operator nature of the services and the conflicting interests of the stakeholders. We propose the combination of the Sending Party Network Pays principle with the 95^{th}-percentile charging scheme as the way to charge 5G infrastructure services and show the effectiveness of our approach.

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