Vertical Integration in Content Provisioning With Cloud Migration

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INTRODUCTION

The continuous growth of Internet traffic is significantly pushed by emerging high bandwidth demanding contents. All participants in the content provisioning process including content providers, service providers, Content Delivery Networks (CDN) and customers are influenced by bandwidth requirements. Appropriate bandwidth demand estimation and consequently network dimensioning, are of great importance for addressing resource investment. However, peak bandwidth demand varies during the day. Provisioning of self-owned resources that satisfy peak bandwidth demand leads to network underutilization in the periods of low or normal traffic load. Hence, the over-provisioning is cost ineffective. On the other hand, under-provisioning of network resources leads to rejection of customers' requests for service provisioning. Considering all aforementioned, providers in content provisioning process need to consider cloud migration in order to minimize costs and improve Quality of Service (QoS) and hence Quality of Experience (QoE) of their customers. Cloud providers maintain large-scale data centers to offer storage and computational resources in the form of Virtual Machines instances at a relatively low cost. Depending on the characteristics, cloud instances are available at different prices. In general, cloud providers offer three different pricing plans, such as reservation, on-demand and spot pricing.

In order to provide content to the customers, the vertical interconnection between involved providers is necessary. Larger undertakings in content provisioning process often perform vertical integration, thus ensuring a higher control over different segments of the process. Involvement of cloud providers into a content provisioning process introduces additional complexity for choosing appropriate interconnection contract between providers. The vertically integrated content provider's incentives for cloud migration can induce significant changes in interconnection contracts, and consequently in costs and requests' rejection rate. With the aim of obtaining optimal integration charging strategy, concepts like Revenue Sharing, Cost Sharing, and Wholesale Price etc. are applied frequently.

In this chapter different methods of vertical interconnection charging among vertically integrated providers are analyzed and compared. With the aim of QoS and QoE improvement, providers can perform cloud migration. Cloud resources utilization concepts like reservation, on demand, and spot-pricing are analyzed.

BACKGROUND

Interconnection refers to physical and logical connecting between involved providers with the aim of provisioning the access to contents, applications or services. Intrinsically, interconnection enables customers connected to one network to communicate with customers of the same or different network. More precisely, vertical interconnection represents interconnection between undertakings on different network's levels. It is a set of legal rules, technical and operational arrangements which providers use to connect their equipment, networks and services. The actors in the content provisioning process often perform vertical integration that is the process of regrouping several segments of the content provisioning process under the control of a single undertaking. Vertical integration can internalize costs for big actors in the content provisioning process, such as global content providers, but also for service providers, which also can benefit from offering their own contents, applications or services. In addition, vertical integration is economical, efficient and it enables achievement of economies of scale (Dai & Tang, 2009). Vertical integration eliminates double marginalization (the effects of market power at consecutive vertical layers) which occurs when undertakings at consecutive layers have monopoly power and each undertaking reduces the output from the competitive level to the monopoly level, leading to overall losses. Also, vertical integration provides better adjustment of supply and demand. Therefore, it improves efficiency, provides more opportunities for profit maximization, and makes innovations more relevant (Maille & Tuffin, 2014).

Vertical integration is a common practice in telecommunications (often form is bundling content and access into a single service). Google is one of the most well-known examples of vertical integration. Initially, Google offered its search-engine service, generating revenues through advertizing. Afterwards, Google expanded the range of services, offering e-mail services, Google Calendar, Google Earth, the browser Chrome, and the operating system Android. The aim was to incorporate Google search tools into the services in order to generate more advertizing revenues, to increase competition at those service levels, and to reduce costs for customers. Another prominent example of vertical integration is Microsoft, which provides operating systems, but also commercializes software included in the Windows Office suite, search engine Bing, and other hardware devices. Apple also performs vertical integration, combining hardware (computers, iPhone, iPad, iPod) and software services (operating systems, Apple Store).

Content providers may perform vertical integration along the process of content provisioning. Big content providers may establish their own hosting capabilities, deploy their own network infrastructures or may provide CDN services themselves (BEREC Report BoR (12) 130, 2012). If a content provider is large enough, vertical integration is an economically viable solution. Additional costs from the establishment of vertical integration are compensated by enhanced economies of scope. Also, the QoS and QoE of the content provisioning process are improved. Some issues of the vertically integrated content provider in content provisioning process are analyzed by Mikavica & Kostic-Ljubisavljevic (2016), Mikavica, Kostic-Ljubisavljevic & Radonjic Djogatovic (2017) and Mikavica & Kostic-Ljubisavljevic (2018a). Often applied contracts of vertical interconnection between vertically integrated content providers and service providers are Revenue Sharing, Cost Sharing and Wholesale Price.

Instead of explicitly defined interconnection tariffs, operators often apply Revenue Sharing, which establishes a fixed revenue share among providers. This type of contract is characterized by operational simplicity, and it can rebalance providers' returns when retail prices are distorted for any reason. Some of the greatest challenges that providers are dealing with are increasing the profitability of the offered services, assuring higher charges for improved services and obtaining a fair share of the increased revenues. A fair Revenue Sharing contract based on the weighted proportional fairness criterion is proposed

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