EVOLVING INTERNET SERVICES: WHAT IS THE MARKET OPPORTUNITY?

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Abstract: Analyst forecasts predict that annual consumer spending on connected devices, services and content will almost double by 2015. Intuitive front end technologies – such as touch screen interfaces and gesture recognition - and new form factors suited for on the go applications are driving telcos to adapt their business model to adopt the new patterns including the migration of more advanced applications into the cloud. The need for additional bandwidth capacity for cloud computing, high-accessibility to content, low-latency and security features make the submarine "dumb" pipes, which are smart enough (by design) to grow into bigger pipes, a perfect fit to meet these demands.

1. INTRODUCTION

A few industry segments, such as mobile applications and cloud computing, have emerged and then changed very quickly. Just five years ago, few consumers owned smart phones - and even fewer considered downloading apps. Three years ago, the most accepted evolution trend about cloud and mobile application was that it was expected to allow selective off-loading of computing from the mobile terminal to the cloud to which then provides the results to the mobile terminal via the network [1].

Today, we are in the midst of a gold rush on the enterprise mobile app side. The growing mobile workforce and explosion in mobile smart devices caused by both consumerization and the Bring Your Own Device (BYOD) trend are spurring enterprises to look at increasingly purchasing - and developing - mobile apps for work purposes. This phenomenon builds on the employees' familiarity with apps and mobile app stores from their personal lives and the growing importance of mobile as a channel for brands to engage their customers. This drives both growth and IT tolerance when it comes to using consumer apps at work.

This paper focuses on understanding how submarine telecommunications infrastructure will become essential for the evolution of new services or local services that require additional connectivity and capacity to meet rising demand for cloud computing, together with high-accessibility, low-latency and security features.

2. INTERNATIONAL TRAFFIC EVOLUTION

According to a recent study published from TeleGeography, a persistent demand for international capacity increase is expected at a compounded annual rate (CAGR) of 34% between 2012 and 2019 [2]. In 2011, the percentage of Internet traffic accounted for more than 80% of international capacity and included corporate IP VPN traffic implemented over public Internet connections. Before analysing in the following sections how major trends are likely to influence the growth of international bandwidth usage, and, in particular, how the impact of cloud applications would further shape the traffic growth, it is noteworthy that in 2010, Internet video displaced peer-to-peer (P2P) as the largest source of consumer internet

traffic, a position that P2P had claimed for the previous decade [3] [4].

3. THE EVOLUTION OF INTERNET SERVICES (AND TRAFFIC!)

Several of the most recent future-looking reports ([4] [5]) state that video represents and will continue to represent the vast majority of internet traffic in the future. But a closer look at the nature of traffic shows that its composition is constantly evolving. One of the most interesting patterns today is real-time entertainment - either streamed or buffered (audio/video). Today the most recurrent service with a peak of around 60% is seen in the North America region. This is mostly due to the growth of the on-demand video provider, Netflix, which delivers twice the amount of video traffic than YouTube to fixed access.

Home roaming (the use of tablets and smartphones in the home), which leads to more devices concurrently using the network, is one reason the median monthly usage on North America's fixed access networks has increased from 10.3GB per house to 16.8GB during the last six months of 2012 [5]. Over the same period, mean monthly usage has grown over 70% increasing from 32.1GB to 51.3GB. This means that home roaming users have induced heavier bandwidth usage. By 2015 it is forecast that this traffic will account for 20% of all fixed access.

Traffic from wireless devices will exceed traffic from wired devices by 2016 when wired devices are expected to account for 39% of the IP traffic, while Wi-Fi and mobile devices for 61% of the IP traffic [4]. In 2011, wired devices accounted for 55% of IP traffic. Social networking is mostly run from wireless devices.

A growing amount of internet traffic is originating from non-PC devices. In 2011, only 6% of consumer internet traffic originated from non-PC devices but by 2016 it is estimated that this share will grow to 19% [9].

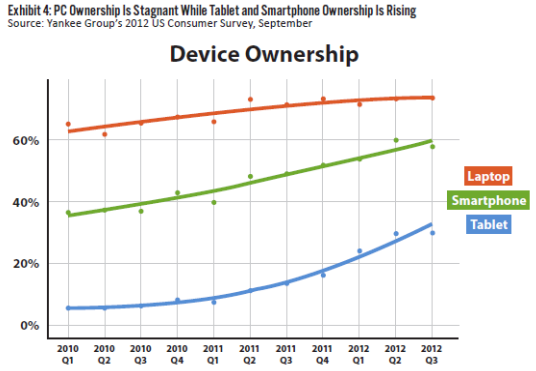


Figure 1 : Evolution of device ownership

Global data centre traffic is expected to grow at 31% CAGR in the 2011-2016 period, but traffic generated by data centres architected with a cloud approach (starting to be known as "cloud data centres") is forecast to increase at a faster rate, 44% CAGR, or six-fold growth for the period from 2011 to 2016 [7].

On storage, the traffic seems very low. Why is it so low? It appears low as it has been hidden [4]. A large - and increasing - amount of this traffic is transported via secure tunnels, so it is often indistinguishable from applications like mobile banking and other encrypted applications. As such the traffic associated with storage cloud application is counted as cloud.

Mobile Internet

During 2012, the average smartphone usage increased by 81% on the previous year [8]. Although 4G connections represented only 0.9% of all mobile connections, they already accounted for 14% of mobile data traffic. But the type of mobile traffic is changing even faster.

A first trend is that user applications are driving mobile data consumption. The top three application types are the same for smartphones and tablets globally – with little or no difference in percentage rates. Similar to the fixed access ranking, video

streaming and communication applications such as Netflix, YouTube, Hulu, are the highest ranking, although data consumption is slightly higher on tablets. Social networking (Facebook, Twitter) ranks higher on smartphones, perhaps due to the increased number of smartphones that allows users to instantly connect to social network sites.

A second trend is the so-called device diversification: Smartphone, Tablet, Phablet and other portable devices (i.e. machine-to-machine connections) which are major generators of traffic. These new device types offer content and applications that were not supported by previous generations of mobile devices. Each new type of high-end device is pushing up the usage per device: in 2012, mobile data traffic per tablet was 820MB per month, compared to 342MB per month per smartphone. It is estimated that mobile-connected tablets will generate more traffic in 2017 than the entire global mobile network did in 2012.

Improvements in memory and speed on portable are focused on enhancing the customer experience. However, their resources are still limited in the content elaboration phase. Cloud applications and services such as Netflix, YouTube, Pandora, and Spotify allow mobile users to overcome the memory capacity and processing power limitations of mobile devices. Cloud applications will continue to increase more rapidly than mobile traffic and reach 84% of the total mobile data traffic in 2017. Mobile cloud traffic will grow 14-fold from 2012 to 2017, a compound annual growth rate of 70% [8].

Mobile traffic does not always pass via a mobile network: globally, 33% of total mobile data traffic was offloaded onto the fixed network through Wi-Fi connectivity of mobile devices. This can be attributed to multiple reasons, ranging from how the new devices are used (mostly entertainment-related), to available performance of the network (Wi-Fi vs. 3G) or economic (use of Wi-Fi allows users not to exceed the cap of their mobile data plan). The dimension of the phenomenon is interesting and the distinction of mobile and fixed network becomes more and more blurred.

The (Mobile) Internet of Things

Machine-to-machine (M2M) modules are expected to grow 4.6-fold, from 369 million in 2012 to 1.7 billion in 2017 (a CAGR of 36%). Despite this growth in the number of modules, M2M traffic is estimated as 5% of total mobile data traffic in 2017, compared to 3% at the end of 2012.

The mobile and connected devices marketplace - from smartphones and tablets to M2M modules and more - is characterized by unprecedented growth. Yankee Group - cf. Figure 2 below - expects the sector, which is currently a $US436B business globally, to almost double to $US847B by 2016 [9]. That is a strong statement considering that many of its aspects (tablets, smartphones, and smart meters) are relative newcomers on the technology scene.

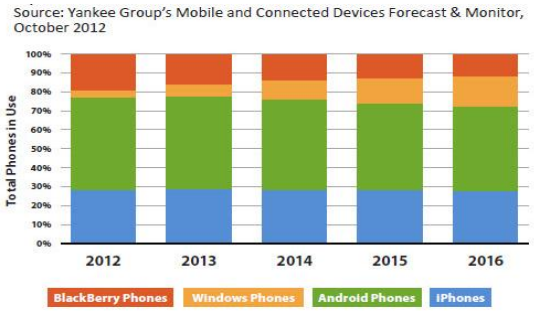


Figure 2: Repartition of business by device

In summary,

- The definition of mobile internet no longer applies to mobile networks,
- Mobile and cloud services are good friends.

Content Delivery Network evolution

In simple term, content delivery networks (CDNs) are a collection of servers, storage, and software that processes content, make decisions about the best source of content, the best path for content to travel, and where and how long to store content.

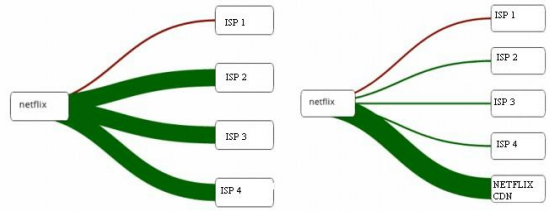
CDNs became commercially available in 1996, fuelled by the growth of bandwidth intensive services over the internet (especially video, cf. Section 2). For the majority of telecoms network operators the main purpose of having their own CDN was to improve their Capex and Opex figures, as well as supporting their core business of winning and retaining customers.

Commoditization of services tends to hurt the growth of the overall market, with few vendors gaining revenue acceleration corresponding to the consumption trends. A trend toward specialising on more lucrative "premium" CDN services such as website and application acceleration, online security and cloud storage is emerging [10]. Akamai, Limelight Networks, EdgeCast, Level 3 and Amazon are all adding non-video services to their product portfolio to capture revenues and profits from non-CDN business including extension of content within wireless networks and on multiple devices (cf. Section 3.1 – device proliferation).

Threats and opportunities

The CDN market is facing some threats and opportunities. In the effort to reach a global scale, leading CDN providers can act as a single partner to improve the delivery of their services to internet users worldwide. For almost all other companies - federated CDNs may be the way forward. Federated CDNs means that carriers and telcos combine their resources, thereby creating a "federation" of several content delivery networks trading traffic across CDNs, instead of a single CDN. With less than 15 carriers controlling roughly 85% of the video CDN market [11], the current CDN landscape would see a dramatic change if a federated CDN model was introduced.

The exception of hyper giants is notable. To gain market efficiencies through controlling or building their own low-level infrastructure, these companies invested a significant amount of resources to build their own servers and data centers (e.g. Google and Facebook) or more recently to deploy their own caching infrastructure. Figure 3 below represents a scheme of the traffic relation between Netflix and the ISP delivering its traffic before and after Netflix introduced its own CDN [12].



Before **After**

Figure 3 : Netflix traffic delivery before and after implementation of Netflix CDN

A second threat is represented by the highly personal and interactive online experiences expected by the evolving web audience. The days of websites with mainly static, cacheable content are behind us and today the expectation is for a "personalized" user experience. How CDNs will evolve to generate and accelerate a more personalized service could drastically change the current equilibrium.

CLOUD and DATA CENTERS

The use of the word 'Cloud' is a synonym for the ability to access files through the web browser, e.g. being able to start a virtual machine from a web browser; or to view documents over iPhone and Android devices and so on. Barriers to buying cloud services have reduced in the past two years

which has led to greater business adoption. Behind the hype associated with cloud computing and cloud services, it is interesting to note that since 2008 most internet traffic has originated or terminated in a data center.

Forecast studies confirm that this trend will continue and data center traffic will dominate internet traffic for the foreseeable future. What's even more interesting for this paper is that the nature of data center traffic is undergoing a fundamental transformation brought about by cloud applications, services, and infrastructure. A recent report shows how the data center to user traffic (in essence the majority of internet traffic) only represents 17% of the total traffic generated by the data centers [7]. The majority of the traffic generated (76%) is used inside the data center itself for communication among servers, but the remaining 7% is accounted for by data center to data center communication for replication purposes, content distribution etc.

Often an end-user application can be supported by several workloads distributed across servers. This can generate multiple streams of traffic within and between data centers, in addition to traffic to and from the end user.

Data centers employed by large on-line service providers are rapidly building geographically diverse cloud data centers, often containing more than 10,000 servers to offer a variety of cloud-based services such as email, web servers, storage, search, gaming, and instant messaging.

A significant driver of cloud traffic growth is the rapid adoption of and migration to cloud architectures (cloud data centers) which is forecast to drive traffic to increase six-fold in the period 2011-2016 and will represent nearly two-thirds of all data center traffic by 2016.). In particular, because many internet video applications for both fixed and mobile devices can be categorized as cloud applications, cloud traffic follows a growth curve similar to the growth of video. Clouds also represent a promising and naturally powerful tool to develop applications for enterprise mobility or to serve the growing requirements of "enterprises going social".

What is interesting about the above is that moving from isolated data centres into global scale computing (interconnection of warehouse-scale-computers to further expand data centre capabilities) is a common trend for all players that need to expand globally. While the location of user-facing data centers is mainly driven by user geography, the location of large macro-data centers is driven by cost considerations only, and other parameters such as availability of networking infrastructure are not a priority.

A consideration that emerged from evaluating the trend into cloud data centers and the growth in the hardware capability utilized in the warehouse-scale computer (WSC) infrastructure is that the processing and storage capacity of the servers is growing at the same rate as the famous Moore's Law, doubling every year. The traffic between data centers is mostly machine generated by cloud computing applications, and therefore using Moore's law to predict the trend seems correct. Using the average CAGR of 60% traffic growth seen in processing-power and storage capacity to estimate the growth of traffic interconnecting data centers, would suggest that traffic flowing between data centers will represent a significant portion of the overall traffic [13]. A proportion of this network demand could remain invisible to market research firms as this bandwidth does not represent a publicly measurable bandwidth between ASs but internal and "private" traffic that tends to remain very secretively managed by major WSC players.

Internet and Peering

The internet is a collection of networks linked to other, that are responsible for self maintenance, and that interact via commercial agreements that may be as informal as "handshakes". Over time it has evolved from a simple hierarchical topology where backbone ISP were selling access to the internet (IP transit business relation) into a more complex topology where business relations have generated multiple and complex traffic relations and where each player can have multiple roles (transit and peering).

Most of the evolution involved the internet peering model – originally a business relationship between "equals" by which two companies reciprocally provided free access to each other's customers. Mutual benefits could have been volume of traffic peered bi-directionally, or the desirability and/or uniqueness of the routes.

Thanks to the evolution of the internet services, some of which were discussed earlier, some of the largest content providers have, in effect, created networks equivalent to those of Tier-1 ISPs with extensive peering that grew on the availability of low-cost physical networks (either owned or leased) that allowed them to reach key locations where they could "direct peer" without using a 3rd party transit provider, or via public peering at interexchange points.

The imbalance of exchanged traffic leads to the introduction of "Paid Peering" service, thus starting a potentially huge shift in power in the ecosystem from the provider connecting to the internet to the user's provider. A definition that starts to emerge is Access Peering Power, that defines a situation when an access provider is able to leverage its "captive" customer base to obtain a favourable paid peering agreement with a particular content provider that needs to reach a growing number of users [14].

It is too early to forecast where this model could lead, but it is a tremendous shift from the original model that would cause the hyper-giants (large CDN, cloud and content providers) to play major roles.

4. THE ROLE OF SUBSEA CONNECTIONS IN THE CHANGING PARADIGM

As discussed earlier, major players in the internet are pushed by consumer and enterprise behaviours to continuously reshape the way services are created and delivered. This reflects directly into a reshaping of the internet structure as most of the above services will be deployed using cloud-based architectures.

When considering the geography of the WSC, data security leads to storing data on multiple sites located far away from each other to provide robustness against major disasters. Maximization of redundancy between the WSC calls for the principle of connecting each WSC with more than one WSC (optimization of the number of connections goes beyond the scope of the paper); the use of algorithms to reach an optimal overall balance in the use of precious resources (including CPU power, work load distribution, electrical power balance) calls for big connectivity pipes between WSCs [13].

Cost optimization suggests that building WSC in remote, low populated areas; ultra long-haul optical infrastructure is key to provide the right trade off between the cost of the transported bandwidth and scarce availability of fiber resources in those areas. The volume of bandwidth generate by these "cities of machines" requires highly efficient optical modulation schemes and fiber capacity; minimization

of the number of hops, minimization of unnecessary regenerations and simplification of the transport network topology. This is a set of common requirements that are shared with the internet backbone traffic requirements representing a common ground for common growth.

The role of international and/or intercontinental connectivity and the development of new subsea routes would appear to be the foundation for a successful growth of the services generated over such platforms.

5. CONCLUSION

The proliferation and ubiquity of connected devices including PCs, smartphones and media tablets has created the interconnected consumer experience; while the proliferation of increasingly mobile devices has led to the creation of new services and features based on time, location, presence and proximity. The ability to deliver those services on a global base, with ever increasing bandwidth requirements and the rising importance of cloud computing and cloud data centers are causing the consequent reshaping of the internet backbone structure where the interconnectivity of the main nodes is vital.

Submarine networks can already address any reach and provide scalable infrastructures to address any type of demand, independently of the geographical position. However, the evolutions described in this paper will most likely manifest themselves in some (or all) of the following ways in the coming years:

- Increasing role for internet content providers and 'hyper-giants' in particular in submarine cable investments due to huge and rapidly growing capacity needs.
- Decreasing role for traditional local/regional internet players due to dis-intermediation (or flattening) of the traditional tiered content delivery model.
- Alternative routes for new submarine cables resulting from the requirement of interconnecting large data centres ("cities of machines") which are quite geographically distinct from the major cities of human beings.
- Extension of submarine-type of connectivity to data centres located at a significant distance from landing stations.

Connectivity and capacity requirements remain the main drivers for the evolution of a submarine cable infrastructure. On top of that, the growth of machine-to-machine communications may place new challenges on cable system developers in order to deliver the right infrastructure able to serve end-users with the services they want. The combination of these requirements is a call for the submarine cable industry to establish a tighter dialogue with both service and content providers to open up new opportunities for the community.

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