How can online content efficiently reach the end user?

Whitepaper

Contents		Page

1 Introduction

"All roads lead to Rome" also applies to the distribution of online content. This old saying, which means there are many ways to reach one's destination, also applies to the Internet. Content is delivered to consumers through server and storage systems with Internet connections. Using the properties of the IP protocol and routing mechanisms, the data is routed to its destination "somehow" – there are no direct links between two points.

But the devil lies in the details; if content was actually disseminated in this manner, most web services would be unusable. Popular websites, in particular, have huge visitor numbers that would quickly overwhelm the standard channels for data traffic. To solve this problem, we must first analyze the expectations of the consumers who use Internet content. It is also important to determine which types of content are provided and ultimately used. Lastly, the network topology of the Internet backbones and broadband coverage of the end-users must also be considered.

This white paper is intended to give you insights into each of these areas.

2 What the users expect

Web pages should load instantly, videos start immediately and without freezing, downloads should only take a few seconds and web apps have to function smoothly without delays – end-user expectations are high, regardless of whether media content, applications or the use of cloud services is involved. These same expectations apply equally to all devices: users want to have the same experience on their desktops, smartphones and any other device where content is consumed.

2.1 Usability and user-friendliness

Companies must be aware of these expectations. In competitive markets, even the slightest advantage in user navigation or the speed of downloads and page display can prove decisive. Anything that is not immediately visible and usable has a negative impact on the uses.

In their white paper "Visual Networking Index: Forecast and Methodology, 2015–2020"[1], Cisco Systems forecast that by 2020, the number of IP-connected devices will be three times as large as the global population and that total data traffic sent to smartphones will surpass data sent to PCs. They also expect that data traffic from wireless and mobile devices will make up around two-thirds of all IP traffic by 2020.

This analysis shows that end-user expectations of content will continue to increase. But what do usability and user-friendliness really mean for an end-user? Three factors are especially important:

1. The services must be intuitive to use. The UI must be self-explanatory and respond to inputs quickly.

2. The content offerings must be usable without interruptions or perceptible loading times.

3. Interactive links in an application must be executed out seamlessly; subsequent downloads must not be noticeable.

2.2 Network infrastructures

All these factors translate to high requirements for providers, being intensified by the constant growth of Internet traffic and the increasing heterogeneity of user devices. Bandwidth isn't necessarily the greatest

challenge, however: latency is the crux for providers – the wait time between calling a service and its "arrival" on the requesting user device.

Simply connecting a server with the necessary content to the Internet is not enough. The conventional client/server infrastructure that serves as the foundation for the Internet is not capable of providing satisfactory transfer rates to the masses. While major providers' web servers usually have enough performance to serve several thousand connections concurrently, they hit their limits when larger amounts of data from audio, video and downloads are involved. What's more, development trends point to even more data in future, such as the increasing spread of 360° videos.

Therefore, content providers of all sizes will have to expand their network infrastructures, develop smart distribution systems and spread their content throughout the Internet, using powerful, sufficiently sized cache storage. One cost-effective solution is content delivery networks (CDNs), which are offered by specialized service providers. The servers in these networks are distributed regionally and connected by a broadband backbone. A CDN delivers content from websites: primarily large media files, downloads and apps. The service providers have high-availability, scalable storage and data transmission capacity that guarantee optimized data throughput even under extreme peak loads.

3 The diversity of online content

Online content is diverse and there are many types of data that generally aren't even considered "content" in the broad definition – such as applications. Based on the value chain of content delivery networks, online content can be divided into three large categories:

1. **Core content**: this category generally includes conventional content, whose delivery to consumers has given rise to the establishment of CDNs. CDN professionals differentiate between media content and streaming content here. The former includes downloads of software, games and documents in addition to audiovisual media. Streaming content is the blanket term for all types of video, TV; music and live events that are offered as audio or video streams.

2. **Premium content**: this category includes websites and applications whose working speed has to be increased, through delivery over CDNs. It also includes content from social media as well as some business content and even cloud services and mobile content.

3. **Advanced content**: this category refers to special business content, big data streams as well as data with high security requirements and special access privileges that demand stricter checks.

4 Broadband supply for consumers

From the end-user perspective, the type and speed of the Internet connection is decisive for the supply of online content

4.1 Market overview

A look at an overview of market shares among the leading broadband providers in Germany shows that Deutsche Telekom is the largest provider by far, with around 42 percent of all fixed-network-based broadband connections. Around 12.7 million people get their Internet connections from this provider. The market shares in mobile communications are similar. Deutsche Telekom has a significant market share here, as well: it supplies mobile data links to more than a third of all end-users.

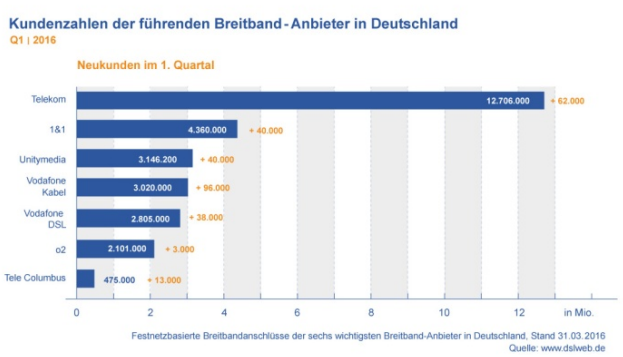

Figure 1 - Source: dslweb.de

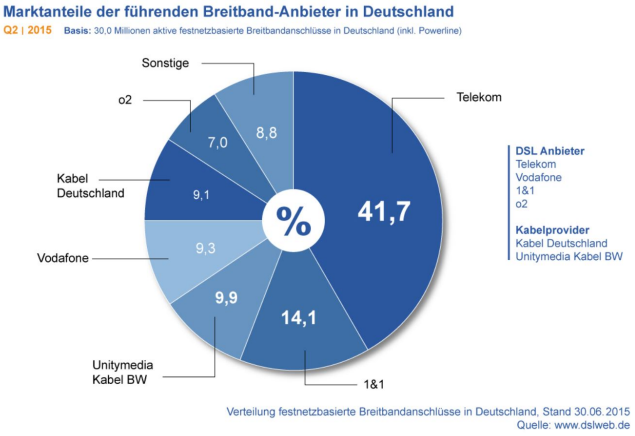

Figure 2 - Source: dslweb.de

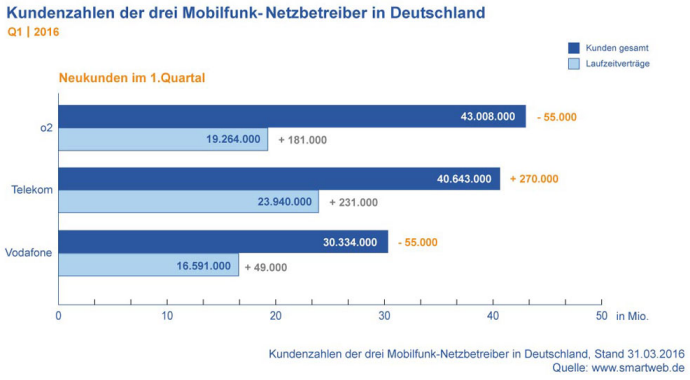

Figure 3 - Source: dslweb.de

As such, Deutsche Telekom gives a large share of end-users in Germany access to Internet content over its network. This kind of communications network is sometimes referred to as an "eyeball network": There are similar constellations in other telecommunications markets, such as France Telecom in France, BT in the United Kingdom and Telekom Austria in Austria, to name just a few. The strong position held by these companies is rooted in developments during the liberalization of telecoms markets in the 1990s and the transformation of formerly state-owned monopolies to private companies. While each country passed regulations and rules, the physical network infrastructure largely remained under the control of the ex-monopolists.

4.1 Demand is increasing

The current situation is characterized by increasing demand for broadband links. A 2016 broadband survey conducted by BREKO, the Federal Association for Broadband Communications, among its more than 260 member companies, showed that demand for broadband will increase dramatically through 2025. In 2025, more than 75 percent of households will enjoy bandwidths of more than 500 Mbps.

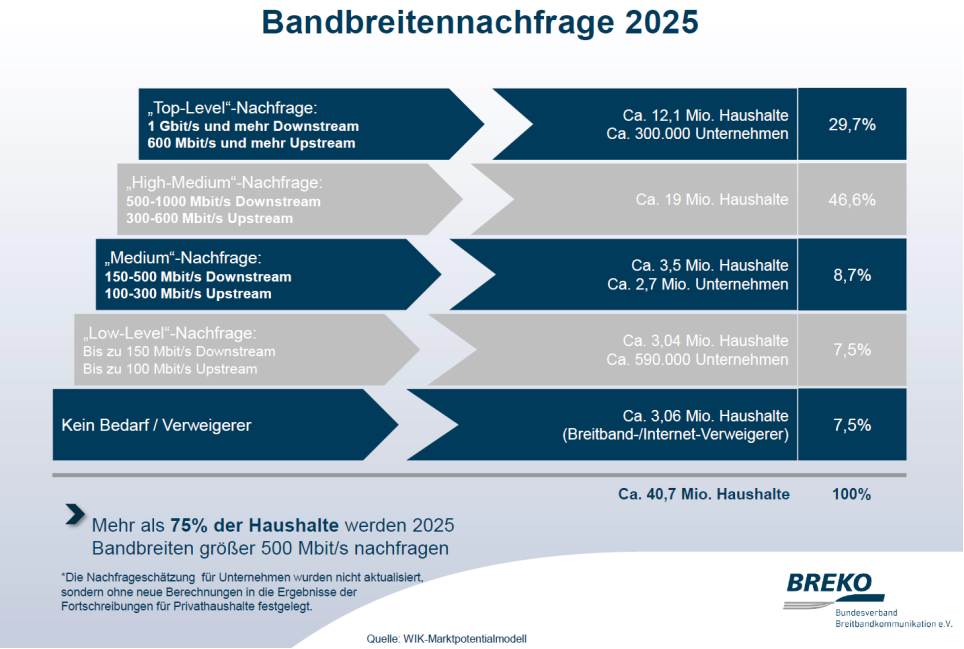

Figure 4 - Source: Bundesverband Breitbandkommunikation e.V. / WIK Market Potential Model

This has consequences for telecoms providers: They will have to boost broadband supply by a factor of 30 in the next ten years. The drivers for this development are easy to find: In addition to the constantly growing numbers of content and cloud providers, applications in the Internet of Things and big data will be key components.

5 Network topology of the Internet backbone

None of the existing Internet backbones is large enough to reach all end-users. That's why service providers are implementing interconnections to link their networks. This involves both peering agreements, for exchanging available data transport capacities with one another, and transit agreements, for forwarding data to other networks.

5.1 Data interchange between Internet providers

Depending on the size of their networks, Internet service providers can be divided into the following categories: Tier 3 (local providers), Tier 2 (operators of large, important, nationwide networks) and Tier 1 (operators of global Internet backbones). Data transfer with Tier 1 providers can cause particularly high costs, so providers seek the most efficient solutions.

Two different approaches have established themselves. One is the "Internet exchange", such as the DE-CIX in Frankfurt. Such exchange hubs often interconnect several hundred providers, enabling the cost-neutral

interchange of data traffic over their respective networks. Under the second approach, some providers use co-location data centers that are connected to a large number of networks for their data logistics.

Although direct WAN links are still used in practice, their importance continues to decrease. They are generally only used in areas where important eyeball networks have to be connected, but the market situation does not allow a proprietary point of presence.

5.2 Direct access through co-location data centers

The large number of network connections and data interchange with peering and transit results in highly interconnected networks, which in turn reduces the risk of total Internet breakdown. On the other hand, however, providers have to expend a lot of effort in managing their routings in order to satisfy user expectations.

The network operators who have recognized the value of their connected end-users are exploiting this scenario. They define the commercial conditions for using their own eyeball networks. However, access to external networks is a basic prerequisite for reaching the end-users directly and for ensuring that network operators can guarantee the quality of their offerings.

Therefore, we highly recommend that content providers establish a presence in co-location data centers, to gain direct access to the local eyeball networks.

6 Content distribution

Content is distributed in two ways: conventionally, in which content is sent to an Internet service provider directly over server structures, and secondly, through content delivery networks (CDNs, also called "content distribution networks"). The latter is used primarily when large amounts of data have to be transferred to many users and when latency for time-critical data has to be minimized.

6.1 How CDNs work

A CDN is a software solution that serves as an overlay over existing Internet structures. It consists of centrally managed cache and storage systems that are distributed throughout a network. This gets online content closer to the end-users, ensures more efficient use of available bandwidths and improves data access by reducing latency.

To achieve this, CDN providers use broadband backbones – either their own or leased ones – that connect the globally distributed cache servers. These servers are located in different geographic regions strategically, to handle peak loads effectively.

The way CDNs work can be simplified as follows: during provisioning, copies of the content are first distributed to the cache servers. Initial access takes place as usual, for example, through a provider's central website. The web server then analyzes the accesses geographically and forwards them to the best reachable cache server in the CDN. As a result, the browser receives some of the website content directly from the web server and other content from the closest cache server in the CDN.

6.2 Selecting a data center

This approach enables a CDN to optimize content transmission over the Internet. There is a number of criteria for the best possible technical structure of a CDN. Data logistics co-location data centers are used to get as close to end-users as possible and to link with as many Internet backbones as possible. Criteria for choosing the right data center include the number of available networks and the presence of Internet

exchanges. In addition, the local geographical coverage of the co-location provider has to be taken into account.

CDNs are part of a complex Internet ecosystem and have diverse relationships with other players, such as Internet service providers, content providers and end-users. The direct customers of a CDN, however, are content providers, which usually need to transfer large amounts of data to a variety of end-users over the Internet or want to distribute time-critical content without latency. The demand for CDN solutions is growing and will continue to be driven by this dynamic development in the coming years.

7 Executive summary

In a study of the German Internet industry 2015-2019 the German ECO Internet Business Association and consulting firm Arthur D. Little clearly elaborated the individual value creation levels.

The segments in Tier 1, "Network, Infrastructure & Operations" form the most important basic pillars for the Internet industry in general, as well as ensure the distribution of online content. As such, the projected growth rates of 17 percent annually for operators of co-location data centers should be seen as the foundation for the complete Internet ecosystem. Without it, the higher levels 2-4 cannot function technically or work economically. A second point also must be derived from this assessment, however: in particular, CDN upstream products and basic services that are easy to implement continue to gain in importance, along with the actual co-location offerings.

Figure 5 - Source: Die deutsche Internetwirtschaft 2015-2019; ECO Verband der Internetwirtschaft e.V. and Arthur D. Little

ITENOS GmbH is breaking new ground here. The experienced specialist for secure IT and telecommunications solutions, with its own carrier-neutral data centers in Germany, is expanding its co-location offerings with network access options to Deutsche Telekom's eyeball network, as well as other data logistics services. This enables CDN providers to enter the German market quickly and easily. The offering also boasts further advantages, such as the reduction of latencies and the elimination of restrictions in using Deutsche Telekom peering partners. Content providers benefit from these offers as much as CDNs, since all services are rendered from a single source and from German data centers, where they are subject to Germany's strict data privacy and protection laws.

7.1 References and figures

1. White paper: Cisco Visual Networking Index: Forecast and Methodology, 2015–2020

Figures 1-3: Source: dslweb.de

Figure 4: Source: WIK Marktpotentialmodell from BREKO Breitbandstudie 2016

Figure 5: Source: Die deutsche Internetwirtschaft 2015-2019; ECO Verband der Internetwirtschaft e.V. and Arthur D. Little

8 About ITENOS GmbH

ITENOS - From expert group to IT service provider

Established in 1993 as an expert group for data communication and network management, ITENOS is fully integrated in the Deutsche Telekom Group. ITENOS was involved with major projects from its beginnings and quickly became a leading specialist for secure information and communications technology (ICT).

Within the Deutsche Telekom AG group, ITENOS and its three business areas Data Centers, Networks and Managed IT Services is specialized in meeting the needs of SME customers. ITENOS serves as a flexible, reliable partner whose independence ensures that decisions are always made in favor of custom-tailored solutions in long-term partnerships with its customers, while at the same time being able to draw on the resources of a major corporation on demand whenever needed.

Certification

ITENOS operates certified management systems throughout the company, including IT service management under ISO 20000, quality management under ISO 9001, information security management under ISO 27001 and energy management under ISO 50001. Compliance with these strict international specifications is checked annually and independently by DQS GmbH.

Figure 2: ITENOS GmbH certifications