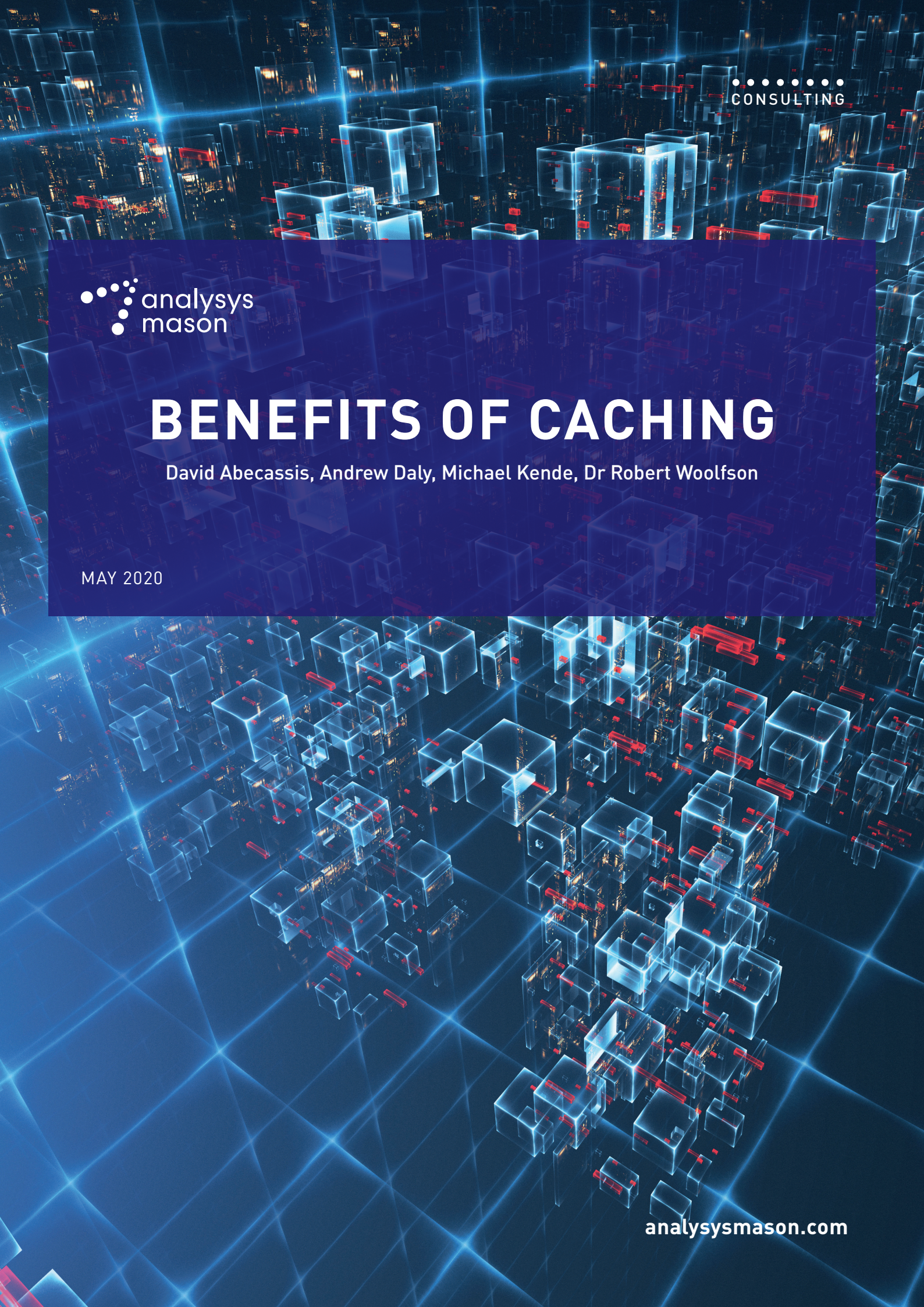

BENEFITS OF CACHING

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Contents

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1 Executive summary

The Internet is a fundamental component of 21st century society and has supported the development of innovative services that underpin modern life. Traffic carried over the Internet has grown at an exponential rate in the last decade as more and more people are online and new services are developed, launched and adopted (see Figure 1.1).

The caching industry was born as a result of this massive growth in Internet traffic, as a technical solution to meet the needs of different market sectors for efficient, cost-effective and high-performance content delivery.

Caching providers act as intermediaries between the hosts (who offer the content) and the consumers (who access the content). As shown in Figure 1.2, caching enables some types of content (for example websites and video libraries) to be replicated closer to consumers.

Caching services provide benefits to content providers, consumers and the entire Internet ecosystem across three key areas:

- **Improved quality of experience:** Caching can deliver material improvements in the quality of experience (QoE) provided by content providers to consumers.
- **Increased network and energy efficiency:** Caching enables more efficient use of network capacity by reducing the number of 'trips' to request and serve content. This effect can significantly reduce the need for duplicated infrastructure deployment – resulting in significant cost savings and economic benefits for the entire Internet ecosystem. For example, by reducing network congestion, caching services free up capacity to support other services such as video calling (e.g. via Zoom or WhatsApp) which require an Internet connection with consistent bandwidth to ensure high quality real-time video transmission. Furthermore, commercial caching providers can operate at scale, making extensive use of infrastructure shared between multiple customers, which is energy efficient.

FIGURE 1.1: GROWTH IN INTERNET TRAFFIC
[SOURCE: CISCO, 2017]

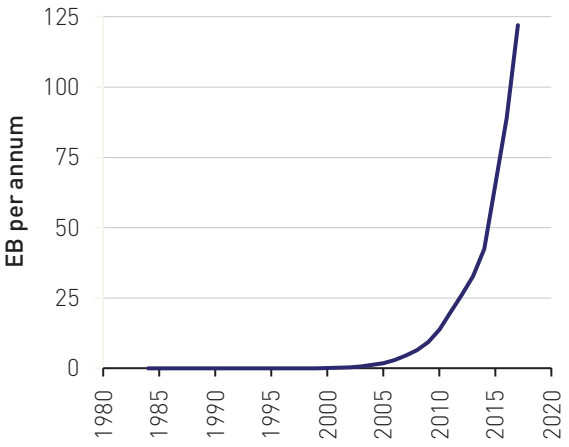
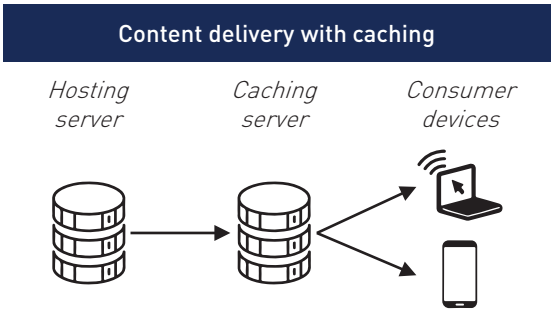


FIGURE 1.2: OVERVIEW OF CACHING
[ANALYSYS MASON, 2020]



A content provider sends the content once from the hosting server to the caching server, and the caching provider then distributes the content directly to consumer devices

- **More dynamic competition and innovation:** Access to caching services lowers barriers to entry for emerging content providers (including SMEs launching new services) and supports these companies in delivering innovative services to consumers. Caching allows new or emerging content providers to provide a good user experience from service launch without making costly infrastructure investments, enabling them to compete with more established players. Caching can also be used to provide enterprise level security features to a wide range of organisations.

These benefits ultimately benefit the broader Internet community, including content providers, ISPs and consumers. Caching services help make the entire Internet more reliable and resilient by ensuring the shared resources of the Internet are used efficiently and can cope with unforeseen demand (e.g. a rapid increase in demand for video calling services and for public services such as health information and social services in the Covid-19 crisis).

A commercial caching provider's business model relies on acting as an intermediary to cache content on technical platforms on behalf of content providers. As intermediaries, caching providers in many legal jurisdictions are exempt from liability for the content they cache. Under some of these laws, they have to satisfy certain conditions such as clearing the cache once they are made aware of particular content being held on their caches and action has been taken by the hosting provider. This protection from liability has enabled a wide range of technical intermediaries to flourish, which in turn has been instrumental in enabling the remarkable growth of the Internet.

Overall, the existing regulatory regime has allowed caching providers to develop innovative approaches in response to consumer and content provider demand. Changes to regulations must be approached carefully, to avoid harmful disruption to legitimate content delivery, the quality of experience of end users, and the cost of carrying and delivering traffic for content providers and ISPs.

Case study: Impact of Covid-19

Caching has been key to support the rapid change in Internet demand following the widespread coronavirus-driven lockdown in early 2020. Cloudflare observed that the increase in traffic on its European network during this period was approximately double the available submarine cable capacity between Europe and North America. Without the availability of caching, much of this traffic would have had to be carried on the transatlantic links, resulting in significant congestion and service degradation for all users of the Internet.

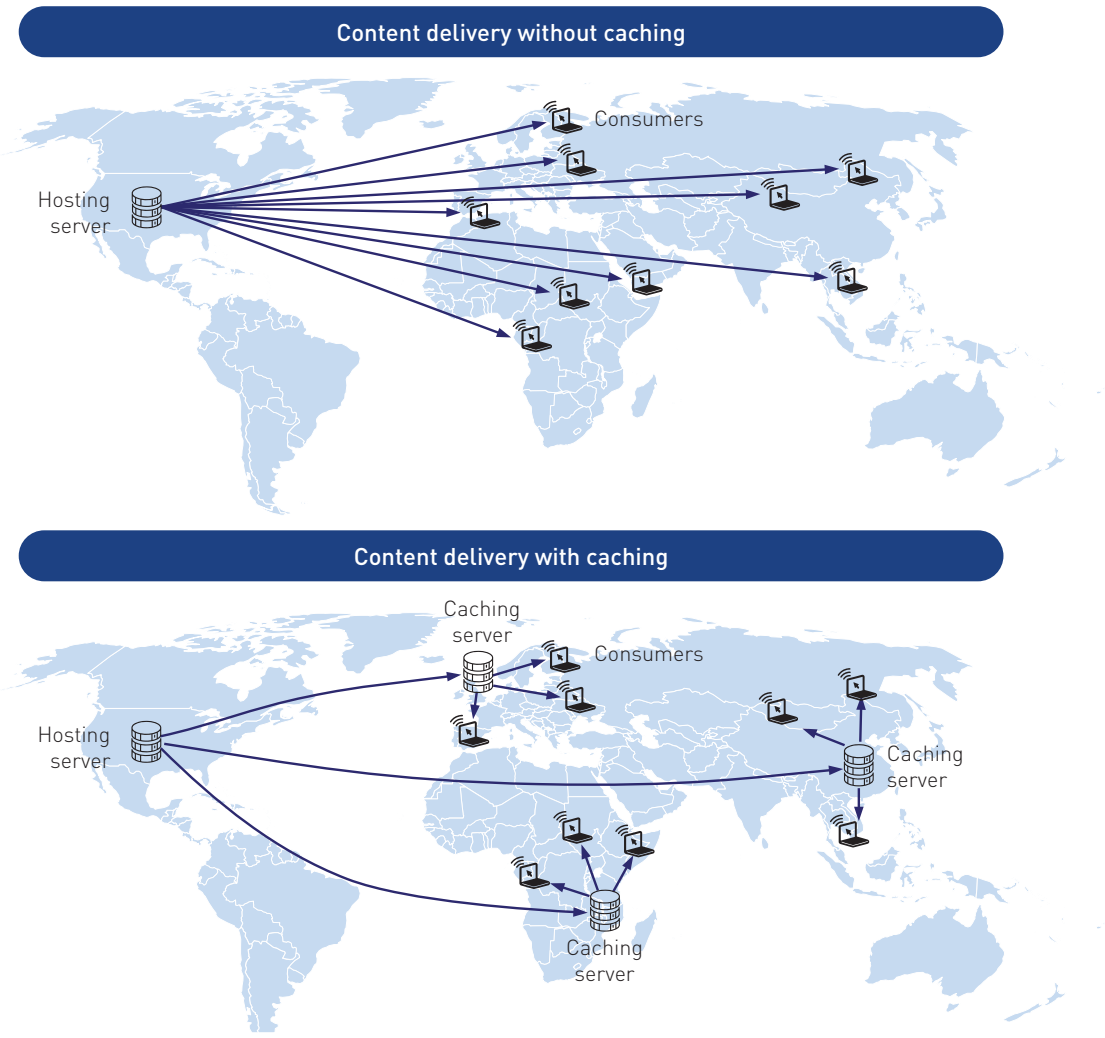
2 Fundamentals of caching

The Internet is a fundamental component of life in the 21st century and underpins key activities across the globe. The Internet has enabled the development of new services, such as e-commerce, on-demand video streaming and home-working platforms. These services are crucial to modern life and have the potential to deliver significant long-term economic and societal benefits.

At its core, the Internet is a mechanism that allows networks to communicate and for content to be exchanged between these networks. The Internet can be used to share almost any content, ranging from mission-critical data on the operation of utility networks, to enterprise-focused remote working platforms, to consumer-focused services such as online shopping platforms and video streaming services. Much of the content that we are familiar with is part of the World Wide Web (which operates over the Internet), which allows content to be discovered and accessed by Internet users.

Caching has developed as a critical aspect of the content delivery chain between hosts (who store the content but are not necessarily content creators) and consumers (who access the content). Caches (which include both hardware and software) are intermediary steps that enable some types of content to be replicated temporarily in multiple locations, closer to consumers, in order to make the transmission of the content more efficient. This is illustrated in Figure 2.1.

FIGURE 2.1: THE FUNDAMENTAL CONCEPT OF CACHING [SOURCE: ANALYSYS MASON, 2020]



The widespread adoption of caching has supported the exponential growth of the Internet by:

- enabling efficient use of infrastructure by allowing content to be delivered with fewer "trips" between content providers and consumers
    - as the content can be delivered from a point close to consumers (such as a caching server) this reduces the need for bandwidth on the Internet, and in particular on major international links (which are not as easily upgradable as national or local links).
- enabling content providers to rapidly scale capacity in response to demand, particularly SMEs, who would otherwise not be able to support rapidly changing demand.

The benefits of caching are discussed in more detail in Section 3.

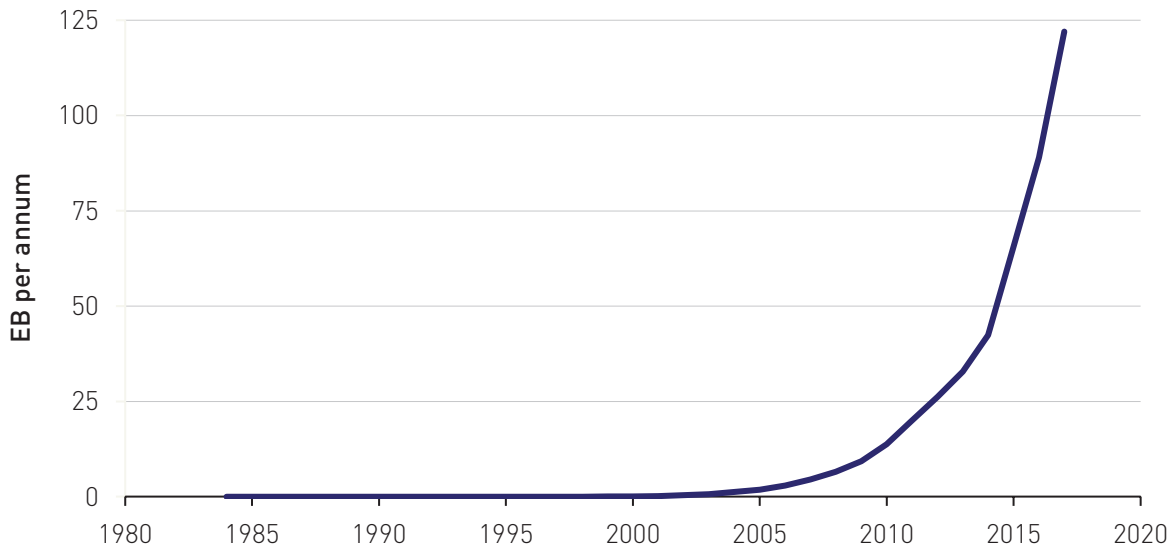
Caching developed to meet the exponential increase in Internet traffic as adoption grew and the range of services increased. In the early days of the Internet, content was delivered directly from hosting servers to consumers. However, as adoption of the Internet grew in the 1990s, content providers struggled to deliver content quickly and reliably due to increasing demand for content causing congestion on the transmission links underpinning the Internet. This congestion was being caused by the large number of multiple parallel requests from individual consumers.

In the late 1990s, the first commercial caching services were launched to manage the delivery of content from many hosts to many consumers with a high standard of performance and availability. These services, known as content delivery networks (CDNs[1]), use multiple caches to help content providers bring content close to consumers, at little or no cost to Internet service providers (ISPs).

The total market for caching and CDN providers was estimated to be worth USD12.4 billion in 2019. Cisco reports average growth of 27% per annum between 2012 and 2017 with forecast growth of 26% per annum from 2017 to 2022. The exponential growth in Internet traffic is shown in Figure 2.2 below.[1]

The exponential growth in Internet traffic has been underpinned by rapidly increasing take-up of Internet-based services combined with increasing connection speeds – leading to more users consuming more content. Growth in Internet traffic is also being driven by the increasing importance of online services to everyday life. For example, Internet traffic increased significantly in response to the Covid-19 pandemic in early 2020 as strict restrictions on mobility were introduced around the world. These restrictions led to a

FIGURE 2.2: GROWTH IN INTERNET TRAFFIC [SOURCE: CISCO, 2017]



[1] Hosting servers and caches are connected by transmission links carrying Internet traffic. Content delivery networks (CDNs) include both the caching servers (which they may own) and transmission links (which they may lease from third parties or own directly) as an integrated service. Therefore, caches can be thought of as an integral part of CDN services, though caches are also found outside CDNs.

significant increase in bandwidth-heavy services such as remote working, remote education and video on demand services which drove rapid increases in Internet traffic globally, as shown in Figure 2.3 below.

Traffic on the Internet is primarily driven by demand for video streaming content offered by the largest content providers, with 43% of worldwide traffic accounted for by demand for content offered or hosted by Google, Netflix, Facebook, Amazon and Apple. Over 60% of traffic on the Internet is video based, with a further 13% related to Web browsing (see Figure 2.4 below).[ii]

FIGURE 2.3: IMPACT OF COVID-19 ON INTERNET TRAFFIC [SOURCE: CLOUDFLARE, 2020]

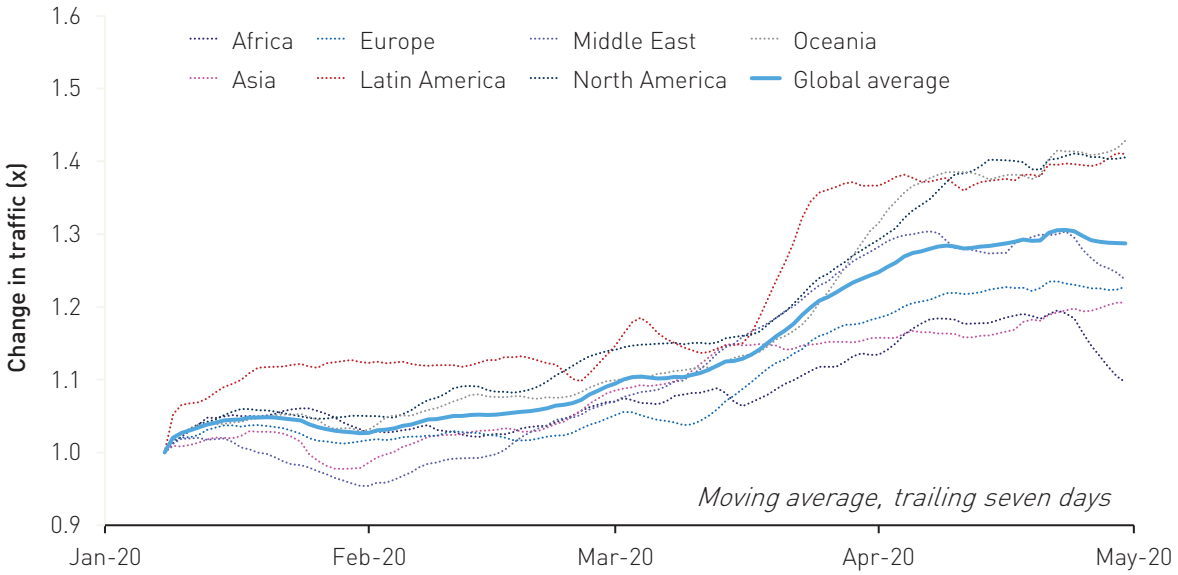
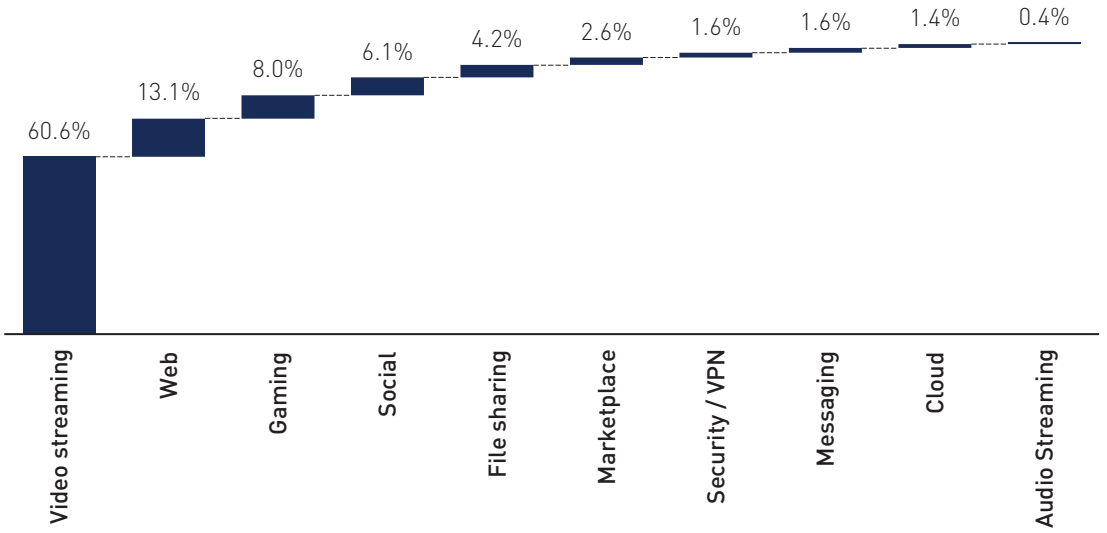


FIGURE 2.4: 2019 GLOBAL SHARE OF DOWNLOAD TRAFFIC [SOURCE: SANDVINE, 2019]



Caching providers take up a central role in the overall value chain of the Internet. A summary of the Internet value chain in the context of caching is shown in Figure 2.5.

Caching is a type of 'intermediary' service, which facilitates the delivery of content to consumers. Caches can either be located directly in ISPs' networks or in CDNs, which are in some cases part of the content providers' own network.

Content on the Internet can be broken down into three broad types, each with a different suitability for caching, as summarised in Figure 2.6 below.

FIGURE 2.5: SUMMARY OF THE INTERNET VALUE CHAIN RELEVANT TO CACHING [SOURCE: ANALYSYS MASON, 2020]

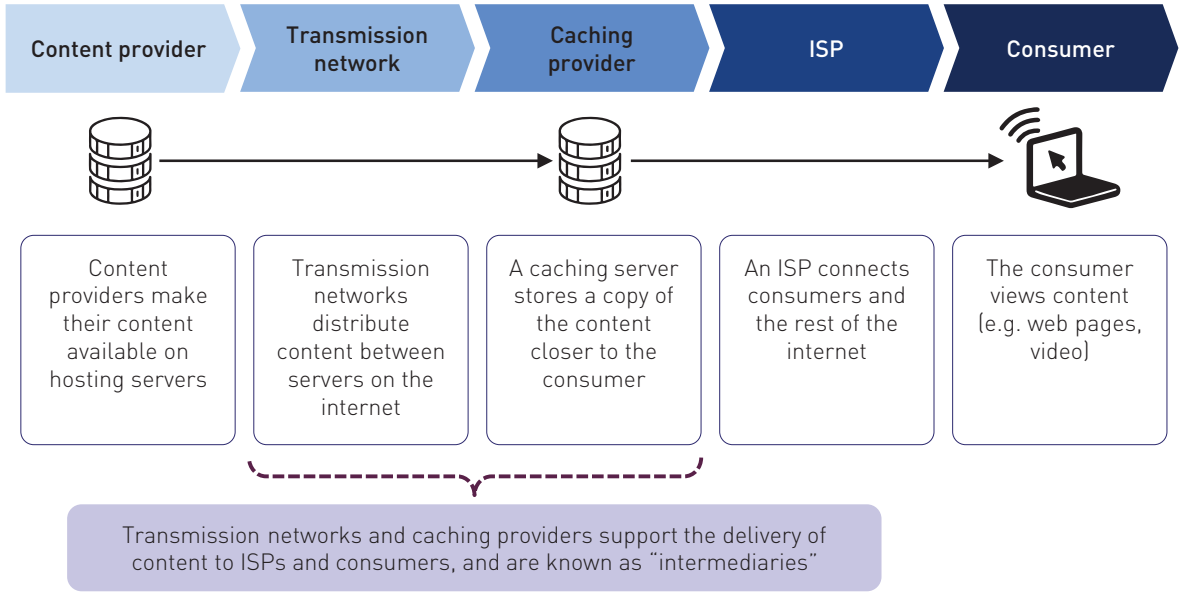


FIGURE 2.6: SUMMARY OF CONTENT TYPES AND SUITABILITY FOR CACHING [SOURCE: ANALYSYS MASON, 2020]

Content type	Description	Examples	Suitability for caching
Static	Each consumer receives the same version of the content	• Video on demand (VOD) libraries • Software updates	High
Dynamic	Part of the content is static, and part is customised for each consumer based on character-istics (e.g. location)	• Some websites (e.g. weather services) • VOD home pages	Dependent on content provider capabilities
Live	Time dependent and live content	• Live TV broadcasts • Online gaming • Video calls	Not easily cacheable

The combination of the high proportion of Internet traffic due to video streaming and the high suitability of VOD libraries for caching, is a significant driver in the demand for caching as an essential service.

As the content shared over the Internet has evolved, caching providers have developed three broad models to meet a diverse range of commercial requirements. These models are summarised in Figure 2.7 below.

FIGURE 2.7: CACHING MODELS [SOURCE: ANALYSYS MASON, 2020]

Type	Description	Example providers
Commercial caches	• Shared caches deployed by CDNs to deliver a range of content • Content is cached on behalf of content providers that do not deploy their own caches • Cache providers do not necessarily know what content they help deliver due to encryption and the volume of content cached (they are true intermediaries)	• Cloudflare • Akamai • Fastly
Captive caches	• Dedicated caches deployed by a content provider to deliver their own content • Cache providers will know what content is on their caches, though may still also have an intermediary role (e.g. Google's YouTube caches)	• Netflix (Open Connect) • Google (Google Global Cache) • Facebook (Facebook Network Appliances)
ISP caches	• Caches deployed directly by ISPs to deliver commonly accessed content • Store-cached versions of commonly accessed websites and content, to reduce the bandwidth demands on their external network connections	• BT • AT&T • Vodafone • Orange • Telstra • China Telecom

3 Overview of the caching industry

Caching is an essential component of modern online service delivery. Virtually all organisations with a significant online presence are underpinning online service delivery with caching services. Organisations use caching to provide cost-effective and scalable capacity to distribute content via a secure and reliable service. Some examples of market segments using caching services, along with selected customers, are shown in Figure 3.1 below.

FIGURE 3.1: MARKET SEGMENTS USING CACHING AND SELECTED CUSTOMERS [SOURCE: ANALYSYS MASON, CACHING PROVIDER WEBSITES, 2020]

Segment	Requirement for caching	Selected customers	
E-commerce	• Improving website performance to ensure a good customer experience	• Airbnb • ao.com	• Instacart • Shopify
Gaming	• Delivering software and updates efficiently	• Activision • Ankama	• Hypixel
Media and communication	• Delivering large volumes of video, audio and text traffic efficiently	• Hulu • RTE	• Sky News • Spotify
Social media	• Delivering large volumes of video, audio and text traffic efficiently	• Discord • Nextdoor	• Slack
Software as a service	• Delivering software and updates efficiently	• GitHub • Optimizely	• Zendesk
Public sector	• Ensuring network resiliency and security	• NASA Jet Propulsion	• Gov.uk
Financial services	• Ensuring network resiliency and security • Improving website and application	• Intuit • Macquarie Bank	• Stripe • Virgin Money
Large enterprises	• Ensuring network resiliency and security	• Asus • Audi	• Marriott International

Case study: Disney+

Disney launched its standalone streaming service, Disney+, in selected markets (including the USA) in November 2019 with wider rollout over the following months. Disney launched the service to more directly monetise its significant back-catalogue of video content. Disney had a key need to ensure that the service delivered a good experience for consumers, to encourage its fanbase to move away from physical media (e.g. DVDs and Blu-Rays), and also to compete with established VOD providers (e.g. Netflix and Amazon Prime).

Case study: VOST Portugal

VOST (Virtual Operations Support Team) Portugal is a volunteer-run non-profit association founded during the outbreak of forest fires in Portugal in August 2018. VOST Portugal aims to provide real-time emergency updates by using a dedicated website along with social media platforms to rapidly share official, trusted information and updates. VOST Portugal is part of a European wide network of VOSTs (VOST Europe).[iii] VOST Portugal required caching to manage spikes in demand on its website during national emergencies.

As the Internet has evolved and demand for content has grown, a wide range of organisations have developed the capabilities to provide caching and CDN services. Caching providers have adopted different strategies depending on whether their CDN is for internal use (captive cache) or external use (commercial cache), and some organisations that had deployed captive caches to support internal use cases have since commercialised their CDNs (e.g. Amazon and Google). An overview of selected caching providers is provided in Figure 3.2 below.

FIGURE 3.2: CACHING MODELS [SOURCE: ANALYSYS MASON, 2020]

Provider	Company type	Cache types	Scale of caches
Netflix	Content provider	Captive	• Caches located with the networks of hundreds of ISPs[iv, v]
Amazon CloudFront	Caching provider/ Content provider	Captive + Commercial	• 216 cache locations in 84 cities across 42 countries[vi]
Google Cloud	Caching provider/ Content provider	Captive + Commercial	• Caches at more than 90 locations across 37 countries[vii]
Akamai	Caching provider	Commercial	• Caches across 136 countries[viii]
Cloudflare	Caching provider	Commercial	• Caches in 200 cities across 90 countries[ix]
Fastly	Caching provider	Commercial	• Centralised CDN with 69 cache locations across 24 countries[x]

4 Benefits of caching

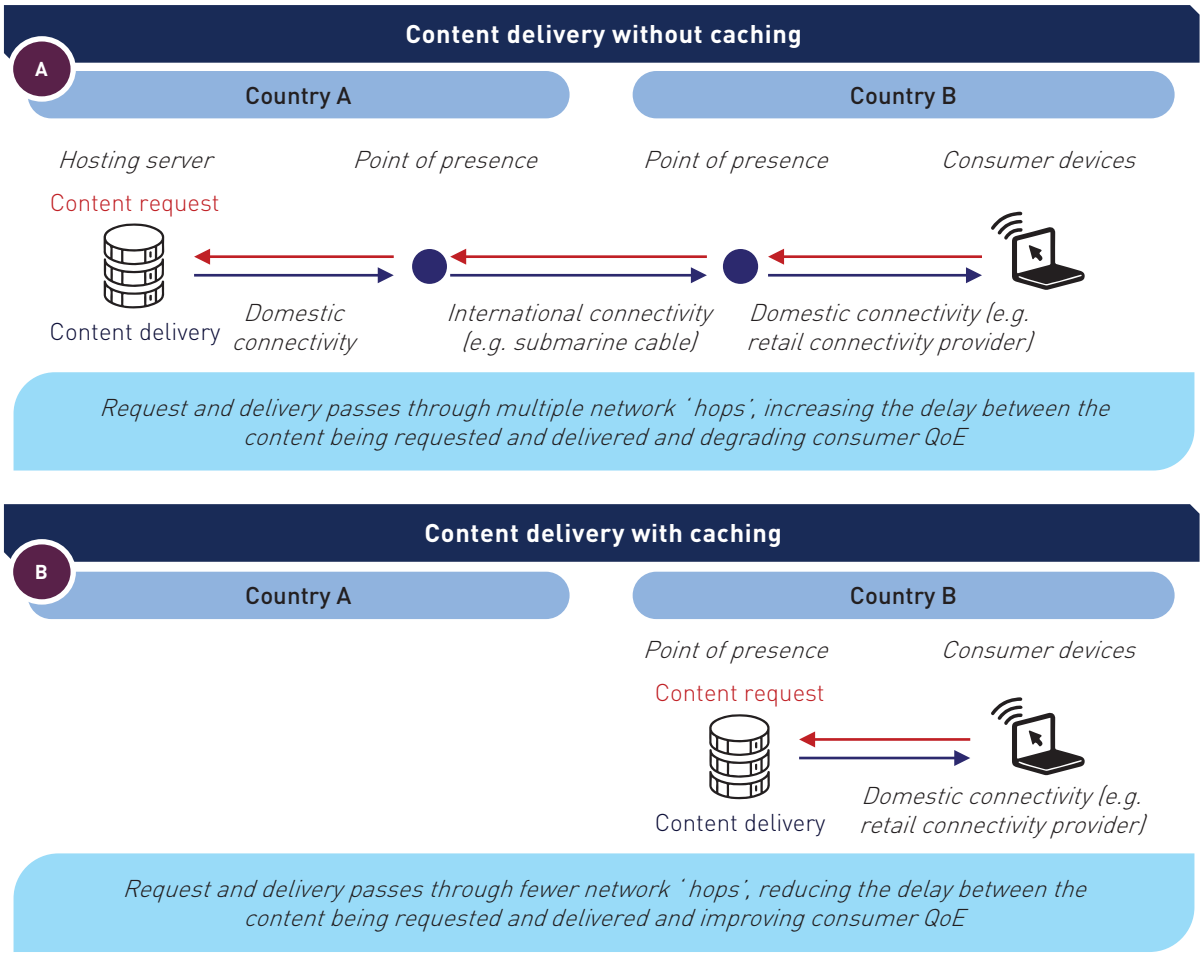
The use of caching (and CDNs) has created three broad types of benefits for both consumers and content providers: improved quality of experience for consumers, increased network efficiency and more dynamic competition (including faster innovation). These benefits extend beyond just the content providers using the caches and their consumers, to the broader ecosystem.

4.1 Improved quality of experience

Caching can deliver material improvements in the quality of experience (QoE) provided by content providers to consumers. A key QoE metric is the delay between a consumer requesting a service and receiving a response from that service. Delays in website load time can have a significant impact on consumers' QoE, for example:

- The BBC has reported that 10% fewer users visit its website for every extra second of delay in site load time.[xi]
- Google has reported that 53% of mobile site visits are abandoned if the site takes longer than three seconds to load.[xii]
- Caching can significantly reduce website load times, thereby improving overall QoE for consumers whilst driving more traffic to online services, , as shown in Figure 4.1.

FIGURE 4.1: ILLUSTRATION OF IMPACT OF CACHING [SOURCE: ANALYSYS MASON, 2020]



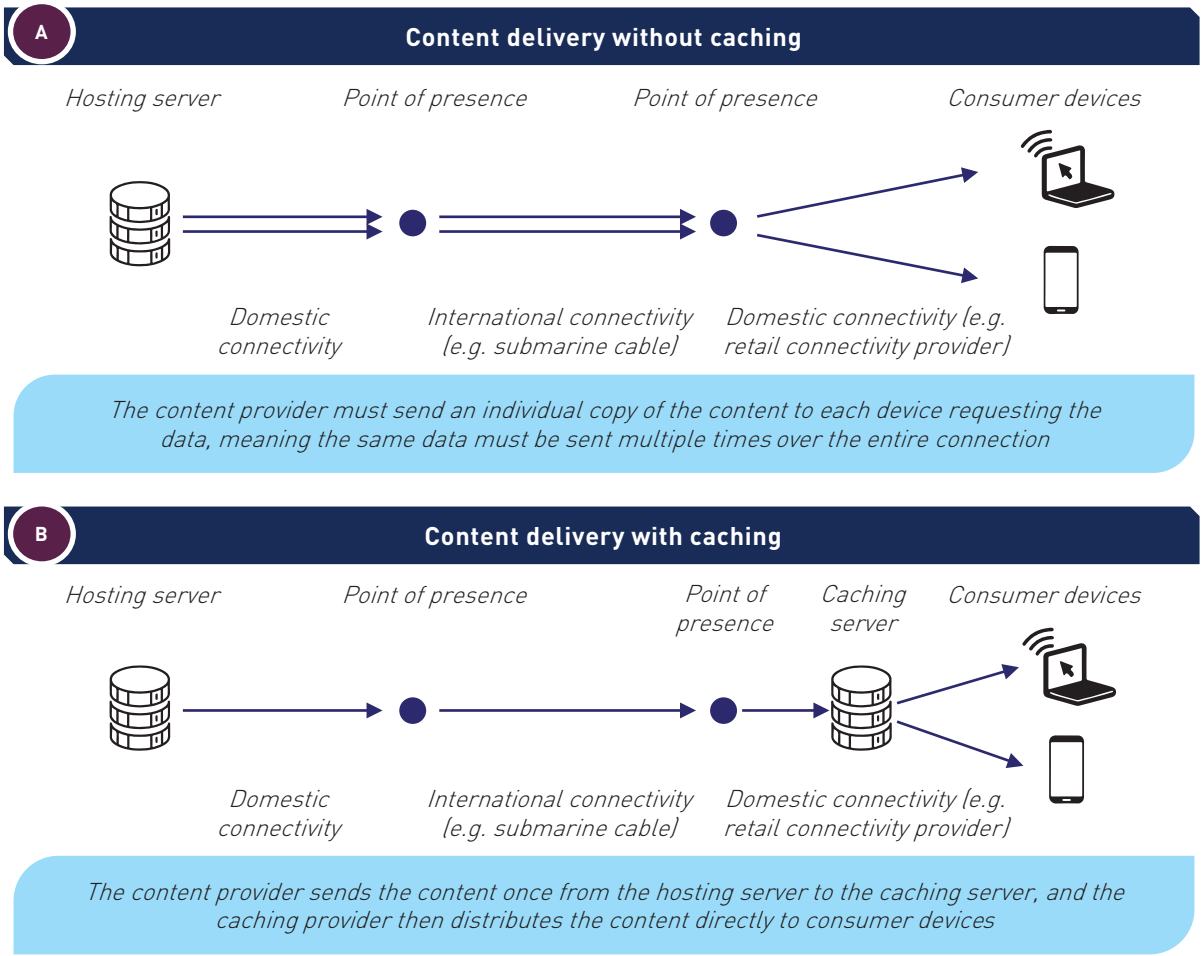
Impact of caching on content providers	Impact of caching on consumers
• Improved availability and reliability	• Improved quality of experience

4.2 Increased network efficiency

Caching providers can aggregate demand for content from multiple consumers. By aggregating this demand, caching providers enable a more efficient use of network capacity and can significantly reduce the need for duplicated infrastructure deployment – resulting in significant cost savings and economic benefits, as shown in Figure 4.2.

Caching enables efficient use of long-distance international Internet capacity by enabling content to be sent only once across these links between the hosting server and the caches. These links are mainly provided by submarine and terrestrial fibre-optic cables, which are very costly to deploy and, in the case of submarine cables, very hard to upgrade. Although

FIGURE 4.2: NETWORK EFFICIENCY BENEFITS OF CACHING [SOURCE: ANALYSYS MASON, 2020]



new cables continue to be needed, caching helps to optimise the use of this infrastructure, slowing the rate at which new cables are deployed, and therefore reducing costs for content providers and ISPs.

Caching does not just help the content providers using the caches, and their consumers: caching delivers significant benefits to the wider Internet ecosystem. By using existing cables efficiently, it lowers congestion and latency for all content going to a country, regardless of whether the content is cached. Further, by reducing the need for new cables, it lowers the costs for all ISPs and content providers. For example, by reducing network congestion, caching services free up capacity to support other services such as video calling (e.g. via Zoom or WhatsApp) which require consistent bandwidth to ensure high quality real-time video transmission.

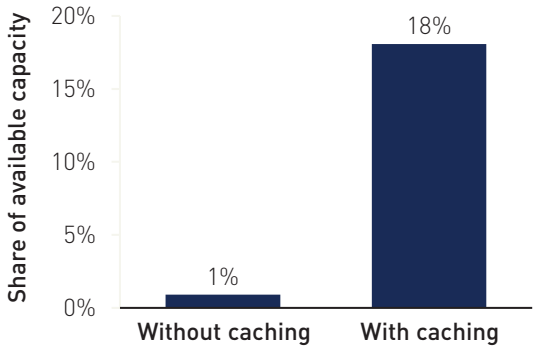
Caching can also result in environmental benefits by making extensive use of shared infrastructure rather than standalone infrastructure. For example, Cloudflare has reported that using its infrastructure can result in a 30% more efficient use of processing units compared to standalone infrastructure – leading to significant reductions in power consumption.[xiii]

Widespread availability of caching services also helps content providers, particularly SMEs who would otherwise not be able to afford rapid infrastructure expansion, to scale rapidly in response to changes in consumer demand or unexpected external events:

- **Caching enables network loads to be balanced across multiple caches rather than a single hosting server.** For example, a March 2020 update to Activision's popular "Call of Duty: Warzone" video game was between 83GB and 101GB (depending on the user) and caused traffic on UK networks to increase by 45% in a two-hour period.[xiv] Without the use of a caching service, the entire traffic would have to be carried from Activision's hosting servers in California to the UK, rather than simply transiting from caches located within UK networks. Under such a scenario, the cost would have been much greater for either Activision or ISPs, and/or the update would have taken much longer to roll out, significantly affecting the consumer experience. Without the use of caching, the update would have placed significant demands on international connectivity links, negatively affecting the transmission of unrelated content.

- **Caching enables service providers to scale their services to meet increases in demand.** Caching provides the ability to deliver high-quality video content to large numbers of consumers simultaneously without overwhelming major Internet links. For example, with 95% of Netflix traffic delivered from caches, demand from Netflix is estimated to have represented 1% of the available bandwidth on transatlantic cables in 2019. Without caching, Netflix's traffic would have to be delivered in its entirety directly from Netflix's servers in California, which would have resulted in Netflix using ~18% of the available transatlantic capacity (see Figure 4.3). Without the use of caching, Netflix would place unsustainable demand on Europe's international connectivity links.

FIGURE 4.3: 2019 TRAFFIC SPLIT [ANALYSYS MASON, 2020 AND SANDVINE, 2019]



- **Caching reduces the reliance of ISPs on international links for static content, freeing up capacity for dynamic content and helping ISPs manage their bandwidth costs.** In many developing countries, the relatively high price of international connectivity can mean that international links are under-provisioned compared to the demand. The use of caches can alleviate the demand on these links, which can significantly improve the usability of Internet services during peak times (e.g. for downloading software updates for Windows).

Impact on content providers

- Increased efficiency (and lower cost) of service delivery
- Ability to rapidly scale in response to demand or unexpected events

Impact on consumers

- Lower cost services
- Faster access to new services
- More reliable and resilient services

4.3 More dynamic innovation and competition

Caching providers lower barriers to entry for emerging content providers. By acting as an intermediary and aggregating demand from multiple content providers, caching providers can provide services at a significantly lower overall cost than building and operating an in-house network solution. The cost-savings made available by commercial caching providers enable SMEs and emerging content providers to compete for consumers with more established players by rapidly rolling out new services without the high up-front cost of building their own caches.

Caching can also have an impact on how a website is prioritised in search results. The order of search results is very important for companies, and Google includes the time a page takes to load in its algorithm to determine the order of search results.[xv] Such prioritisation is very valuable to content providers, and they invest significant effort in optimising content deliver to lower the time it takes for them to respond to consumer requests.

Caching also provides new and existing content providers with immediate access to enterprise level security features – including protection from common network attacks such as distributed denial of service (DDoS).[2] These benefits of caching are especially important in developing countries, where the local Internet economy would not support the standalone deployment of infrastructure (rather than as part of wider infrastructure network) with sufficient scale to be able to successfully mitigate the impact of security threats such as DDoS attacks.

Impact on content providers

- Low cost for caching when introducing new services
- Immediate access to enterprise-level security functionality

Impact on consumers

- Access to new and innovative services
- Improved service availability in developing countries

[2] See https://www.cloudflare.com/ddos for further discussion of DDoS attacks and the role of caching in mitigating them.

Case study: Disney+

The availability of caching services ensured that Disney+ delivered a good experience for its consumers. By moving the source of the content closer to the consumer, movies and other videos start streaming promptly, and can also stream in very high quality (including in 4K Ultra High Definition and with High Dynamic Range colouring).

Case study: VOST Portugal

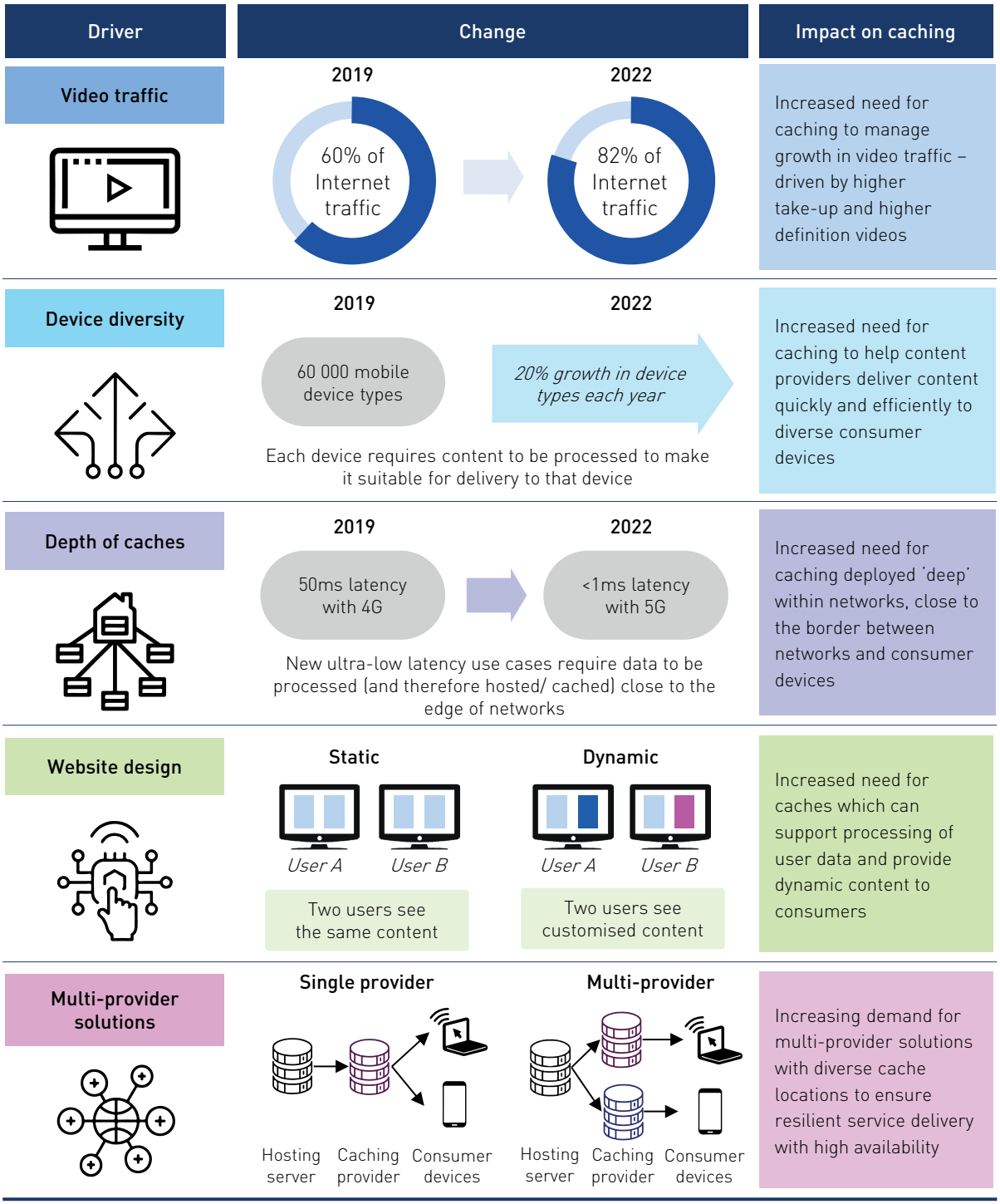
Caching services helped VOST Portugal to meet a rapid increase in demand for its services during a nationwide energy and fuel shortage in 2019. Over a two-day hour period, VOST Portugal's website had more than 12 million visits, and at one stage VOST Portugal saw the number of simultaneous viewers on its website increase from 465 to more than 10,000. By using caching services VOST Portugal was able to take advantage of a network architecture which was able to meet these spikes in demand.[xvi]

5 Main trends in caching

5.1 Trends in the demand for caching

Internet traffic is expected to continue to grow by 26% per annum, reaching almost 34EB (34 billion GB) per month by 2022, doubling from ~17EB in 2019. An verview of the trends driving this growth, and their impact on caching, is shown in Figure 5.1 below.[xvii]

FIGURE 5.1: OVERVIEW OF TRENDS IN THE DEMAND FOR CACHING [SOURCE: ANALYSYS MASON, 2020]



Case study: Case study: Disney+

To further ensure the reliability and quality if its service, Disney employed a multi CDN strategy for the delivery of Disney+, relying on at least six different CDNs to help cache its content.[xvii,xix] Disney has not publicly commented on its CDN strategy, but external analysis suggests that Disney is using different combinations of CDNs in different geographies to ensure it can obtain the best performance for content delivery.

5.2 Trends in the supply of caching

There are three broad areas where caching providers are adapting to differentiate themselves and meet the changing demand from content providers and changing expectations from consumers.

FIGURE 5.2: OVERVIEW OF TRENDS IN THE SUPPLY OF CACHING [SOURCE: ANALYSYS MASON, 2020 AND CISCO VISUAL NETWORKING INDEX 2017–2022]

Trend	Details
Product offering	• Caching providers are increasingly offering innovative and differentiated products to meet demand from different segments of the market • For example, Cloudflare provides a free service to new customers – which is attractive to small businesses looking to explore the benefits of caching. They are then able to upgrade to more advanced solutions as their needs evolve • Another approach, taken by CloudFront for example, offers low-cost services that are easy to integrate with a supplier's other services, e.g. cloud services.
New capabilities	• Caching providers are developing new technology solutions to continue to support the delivery of webpages as they evolve from static to dynamic implementations • For example, Cloudflare has developed 'Workers' – programmable functions that can be deployed alongside Cloudflare's caches. Workers enable websites to support dynamic website content that can be delivered from caches, rather than requiring the dynamic content to be delivered directly from the content provider.

Infrastructure strategies	• Caching providers continue to develop different approaches to deploying infrastructure, exploring the trade-offs between latency and performance
	• There are two broad approaches to deploying caching networks which are being explored by caching providers:
	  • centralised: caching providers such as Fastly have focused on deploying fewer but larger caches to provide high levels of computing power and large caches at strategic network locations around the world. The use of larger caches can enable efficient use of expensive hardware by maximising utilisation, but can increase round-trip delay in content delivery to consumers due to the fewer number of locations
	  • distributed: caching providers such as Cloudflare have deployed a more distributed network of caches, with a larger number of smaller caches located closer to the edge of networks and to consumers. Proximity to consumers allows near real-time responses to changes in network performance.

6 Regulatory and policy implications if caching is curtailed

Many Internet providers are designated as intermediaries, defined by the OECD as follows:

"Internet intermediaries' bring together or facilitate transactions between third parties on the Internet. They give access to, host, transmit and index content, products and services originated by third parties on the Internet or provide Internet-based services to third parties." [xx]

This designation applies to a wide variety of companies, including ISPs, Web hosting providers, Internet search engines, Internet platforms and others including commercial caching providers. The key distinguishing feature is that these intermediaries help to transmit or disseminate content and services developed by third-party producers to consumers.

In the early days of the commercial Internet, online content platforms were being held liable for content that they were hosting. As a result, a number of laws were enacted – including in the United States and Europe – that exempt intermediaries from liability under certain conditions. Under some of these laws, intermediaries have to satisfy certain conditions (e.g. clearing caches), once they are made aware of particular content being held on their caches and action has been taken by the hosting provider.

A commercial caching provider's business model relies on acting as an intermediary to cache content on technical platforms, in a neutral way, on behalf of content providers. Commercial caching providers do not exert any editorial control over the content they deliver to consumers. Other intermediaries, such as online platforms, can filter or remove objectionable content subject to their terms and conditions.

The protection from liability for intermediaries, in the EU under the E-Commerce Directive and in the USA and elsewhere under separate regimes, has enabled a wide range of technical intermediaries to flourish, which in turn has been instrumental in enabling the remarkable growth of the Internet. Commercial caching providers have been able to develop innovative approaches to delivering content in response to changing demand – and to rapidly scale capacity in response to unforeseen developments (see Section 4.2).

This exemption from liability is important, and commercial caching providers may choose not to enter markets where they may be liable for the content they are delivering for their customers. This protection shifts the balance of risks for a commercial caching provider, as caching providers may not be aware of the full nature of content they are caching (e.g. due to the high volume of content and/or its encryption). This exemption from liability enables the benefits delivered by caching services for the entire content delivery value chain:

- Connectivity providers need less long-distance capacity to meet increased demand because of the more efficient approach to distributing content by commercial caching providers, which results in lower costs and savings on infrastructure (such as new international submarine cables)

These savings may be passed on to content providers and consumers in the form of lower pricing.

- Content providers do not have to deploy their own caching services, and thus benefit from the scale economies of the commercial caching providers, not just in delivering content but also in providing security. This also lowers barriers to entry for innovative content providers, allowing increased competition.

- The result is benefits for consumers, who benefit from increased quality of service, potentially lower costs, increased variety of content, and better security.

Overall, the exemption from intermediary liability has allowed caching providers to develop services in response to consumer and content provider demand. Changes to regulations must be approached carefully, to avoid harmful disruption to legitimate content delivery, the quality of experience of end users, and the cost of carrying and delivering traffic for content providers and ISPs.

Case study: Disney+

Without the availability of commercial caching services, Disney would have faced significant additional risk and/or cost when launching its Disney+ service:

- Disney could have attempted to deliver the content from its own servers. While Disney has a presence in many countries outside the US, it is unlikely that this delivery model would be able to deliver the required quality or reliability to its global fanbase
- Disney could have deployed its own caching solution, in a large number of locations around the world. This would have ensured the quality and reliability of the service, but exposed Disney to significant commercial and economic risk, due to the large upfront cost – which Akamai estimated could be in excess of USD2 billion dollars

Case study: VOST Portugal

Without the availability of commercial caching services, the rapid and unpredictable increases in demand during emergency situations experienced by VOST Portugal would lead to significant issues in service delivery. VOST Portugal's website would have been unable to provide real-time emergency updates in a rapidly developing emergency to millions of users, as they would have been unable to scale the underlying infrastructure in a rapid and cost-effective manner.

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