Course Code 005636 (Fall 2021)

Multimedia

Content Distribution, Social Media, and Cloud Computing

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MM Content Sharing, Social Media, and Cloud Computing

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Content Distribution: Proxy Caching

Caching frequently used data at proxies close to clients.

- ✓ It reduces latencies as well as server/network loads.
- ✓ It also enhances the availability of objects and mitigates packet losses, as a local transmission is generally more reliable than a remote transmission.

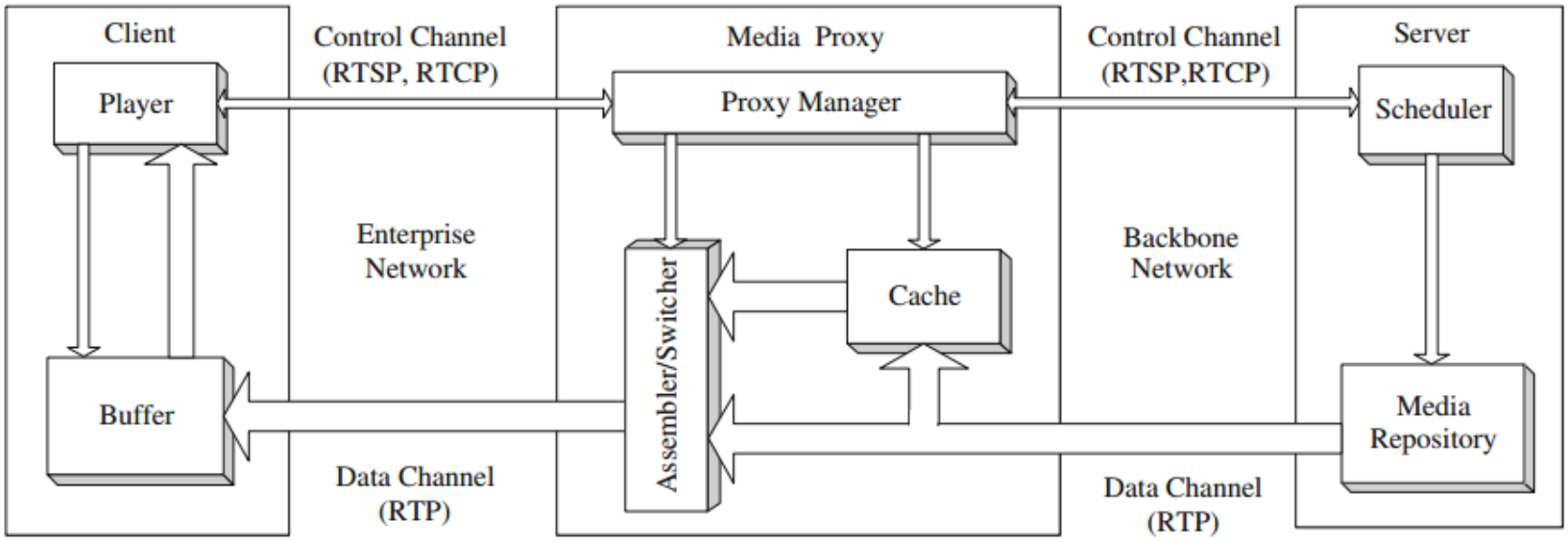

Fig. 16.2 A generic system diagram of proxy-assisted media streaming using RTP/RTCP/RTSP

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Content Distribution: Content Distribution Networks (CDNs)

Issue with Proxy Caching:

- ❑ Caching is generally passive, in the sense that only if a user fetches an object would the object be cached at a proxy.
- ❑ In other words, a proxy needs time to fill up its cache space and there will be no immediate benefit for the first user accessing an object.

Solution: Content Delivery Network or Content Distribution Network (CDN)

A large geo-distributed system of servers deployed in datacenters across the Internet

- ✓ These servers replicate content from the origin server.

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Content Distribution: Content Distribution Networks (CDNs)

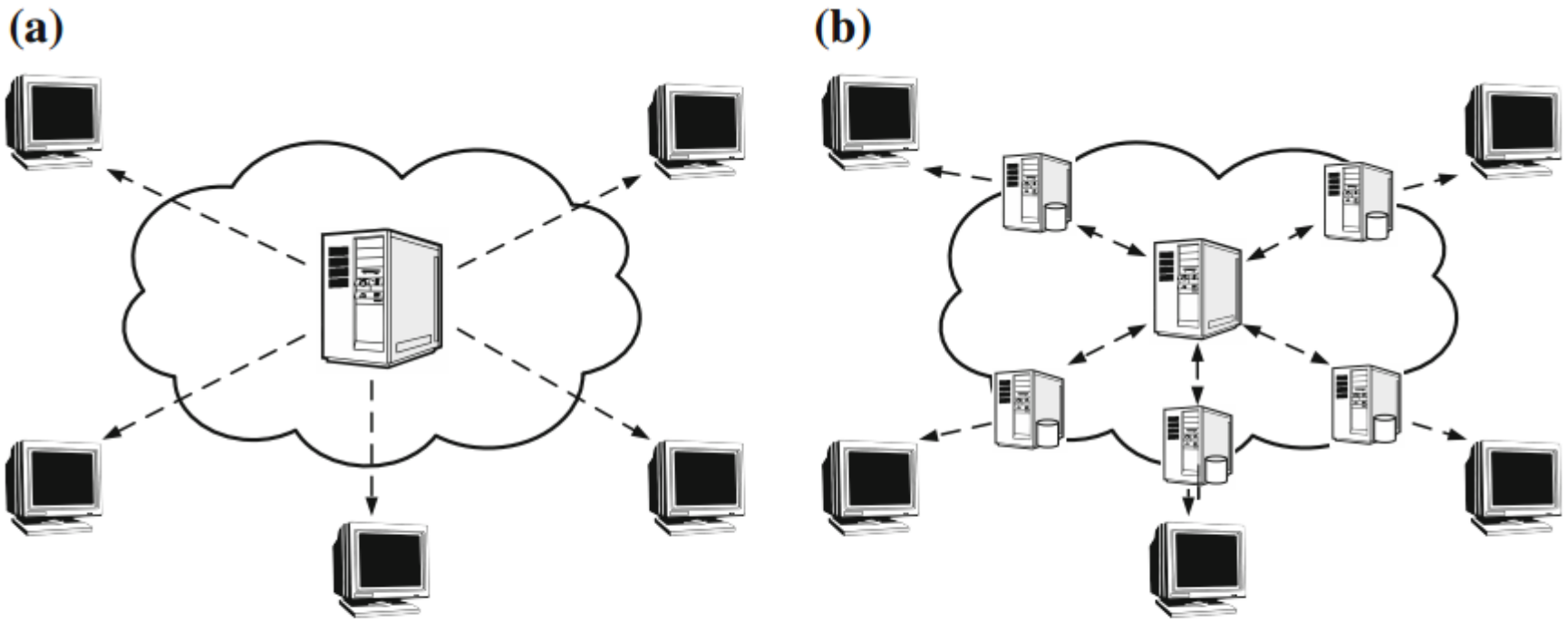

Fig. 16.9 Comparison between traditional single server and CDN. **a** Traditional Client/Server solution. **b** Content distribution network (CDN) solution

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Content Distribution: Content Distribution Network (CDNs)

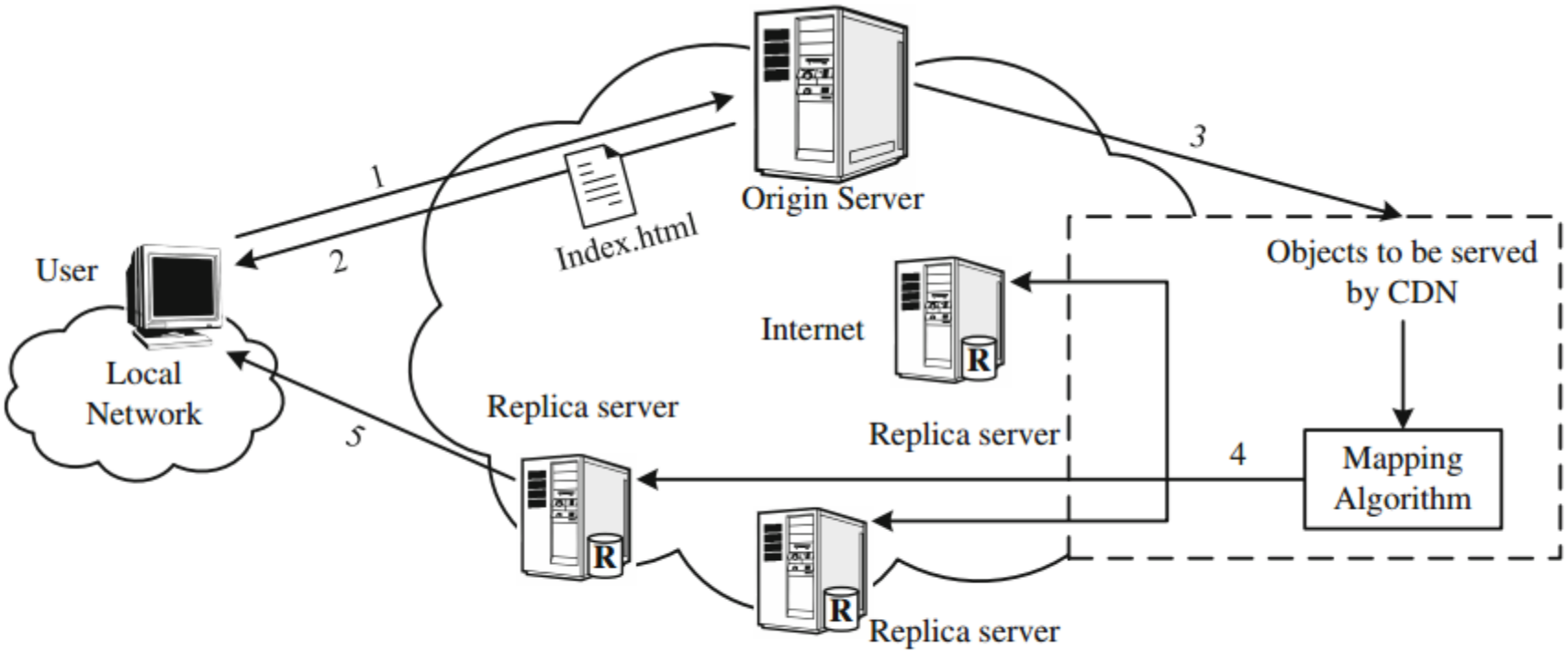

Fig. 16.10 A high-level view of request-routing in a CDN

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Content Distribution: Content Distribution Network (CDNs)

Step 1. The user requests content from the content provider by specifying its URL in the web browser, and the request is directed to its origin server.

Step 2. When the origin server receives the request, it makes a decision to provide only the basic content (e.g. index page of the website), leaving others to CDN.

Step 3. To serve the high bandwidth demanding and frequently asked content (e.g., embedded objects fresh content, navigation bar, banner ads, etc.), the origin server redirects user's request to the CDN provider.

Step 4. Using the mapping algorithm, the CDN provider selects the replica server.

Step 5. The selected server serves the user by providing the replicated copy of the requested object.

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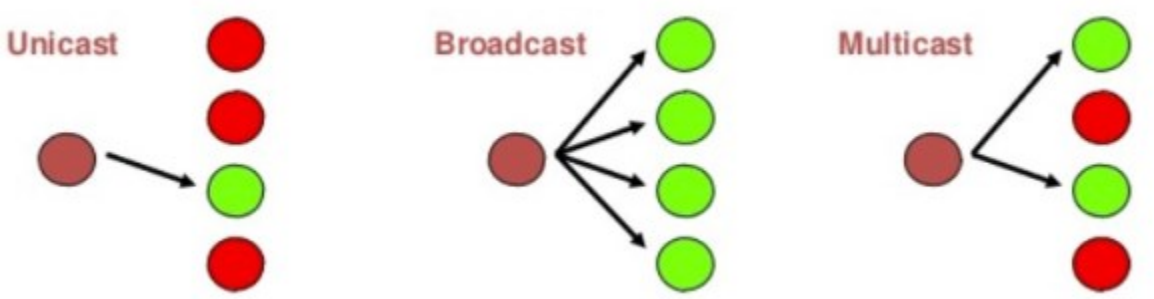
Content Distribution: Broadcast/Multicast Video-on-Demand

Both proxy caching and CDN explore the temporal and geographical locality of users' interests in media objects.

Such locality can also be explored through broadcast or multicast services to deliver the same content simultaneously to a massive amount of concurrent users. It works well for live media streaming.

However, for media-on-demand services, the users' requests are asynchronous!
One broadcast/multicast channel cannot serve the requests arriving at different times, even if they are for the same audio/video.



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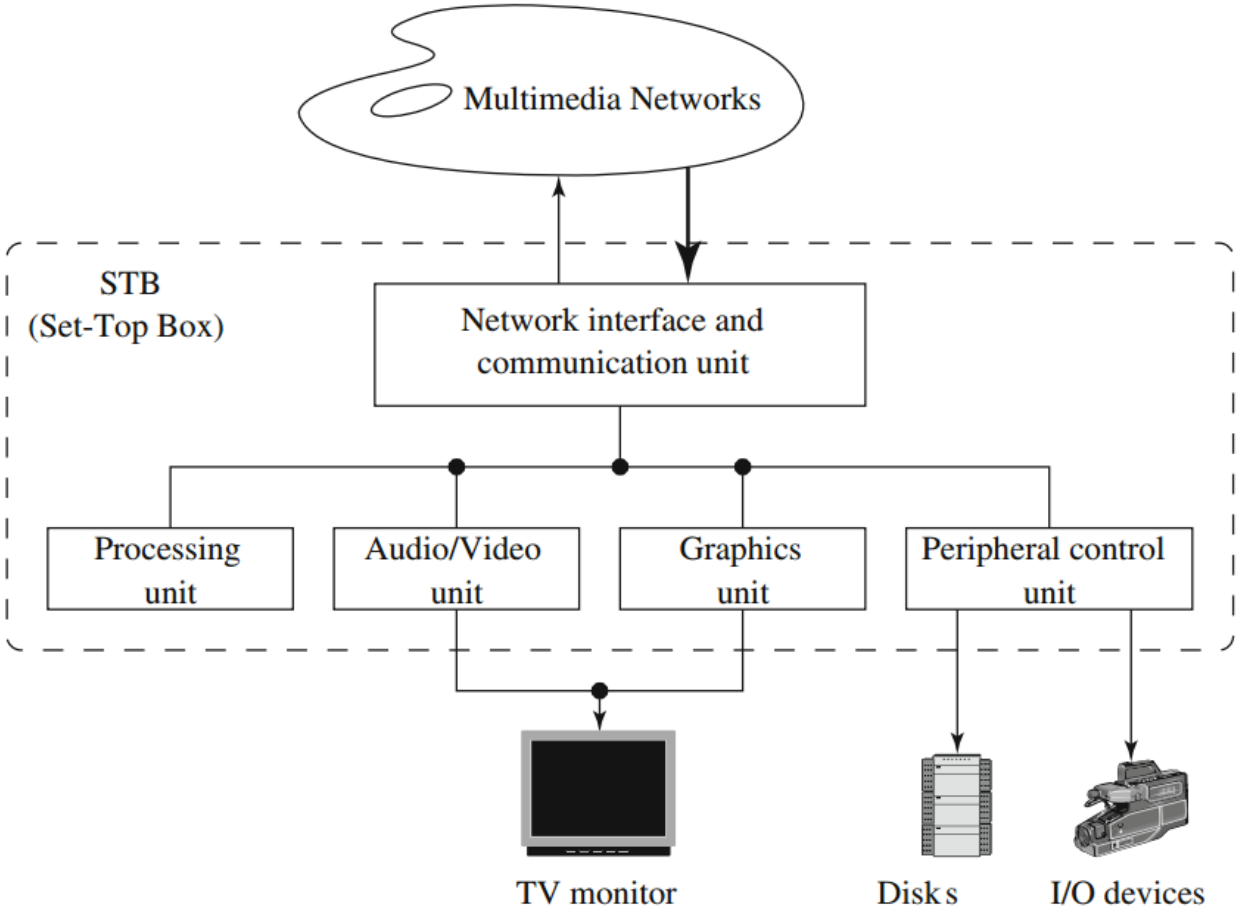
Content Distribution: Broadcast/Multicast Video-on-Demand

Among all possible Media-on-Demand services, the most popular is likely to be subscription to video: Customers can specify the movies or TV programs they want and the time they want to view them.

Requires Two-way traffic: Interactive TV (iTV) or Smart TV.



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Content Distribution: Broadcast/Multicast Video-on-Demand

Staggered Broadcasting: Assuming the server broadcasts up to M videos (M ≥ 1), all can be periodically broadcast on all these channels with the start-time of each video staggered.

The available high bandwidth W is divided by the playback rate b to yield the bandwidth ratio B.

Access time for any video

$$\delta = \frac{M \cdot L}{B}$$

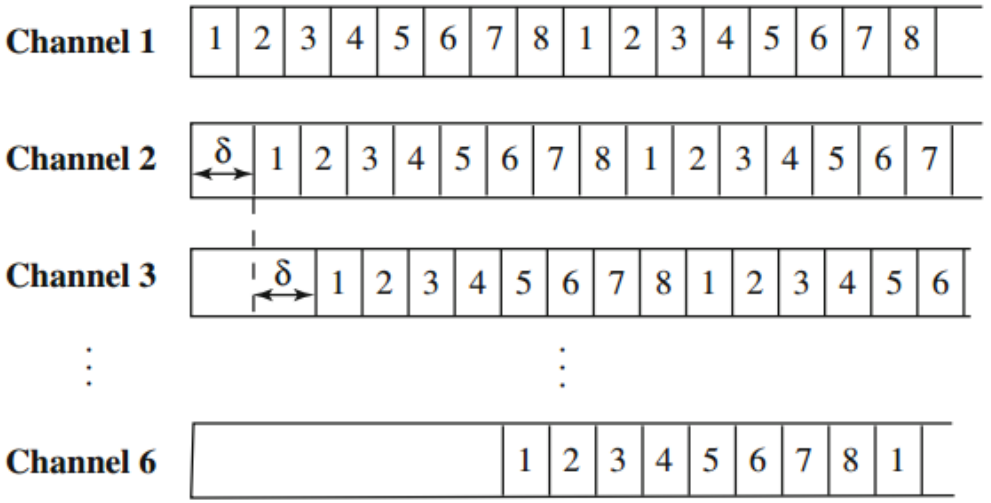

Fig. 16.13 Staggered broadcasting with $M = 8$ videos and $K = 6$ channels

Other Methods: Pyramid Broadcasting, Harmonic Broadcasting, Stream Merging

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Social Media Sharing

In traditional video on-demand and live streaming services, videos are offered by enterprise content providers, stored in servers, and then streamed to users.

User-generated content (UGC) Sharing: Having arisen in web publishing and new media content production circles, UGC plays a key role in today's social media services.

Example: YouTube.

Online Social Networking: Provides an Internet-based platform to connect people with social relations

Examples: Facebook and Twitter

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Social Media Sharing: Characteristics of YouTube Video

While sharing similar characteristics, many of the video statistics of these traditional media servers are quite different from YouTube-like sites, e.g., the video length distribution and user access pattern.

Table 18.2 List of YouTube video categories

Rank	Category	Count	Percentage (%)
1	Entertainment	1,304,724	25.4
2	Music	1,274,825	24.8
3	Comedy	449,652	8.7
4	People and blogs	447,581	8.7
5	Film and animation	442,109	8.6
6	Sports	390, 619	7.6
7	News and politics	186,753	3.6
8	Autos and vehicles	169,883	3.3
9	Howto and style	124,885	2.4
10	Pets and animals	86,444	1.7
11	Travel and events	82,068	1.6
12	Education	54,133	1.1
13	Science and echnology	50,925	1.0
14	Unavailable	42,928	0.8
15	Nonprofits and activism	16,925	0.3
16	Gaming	10,182	0.2
17	Removed	9,131	0.2

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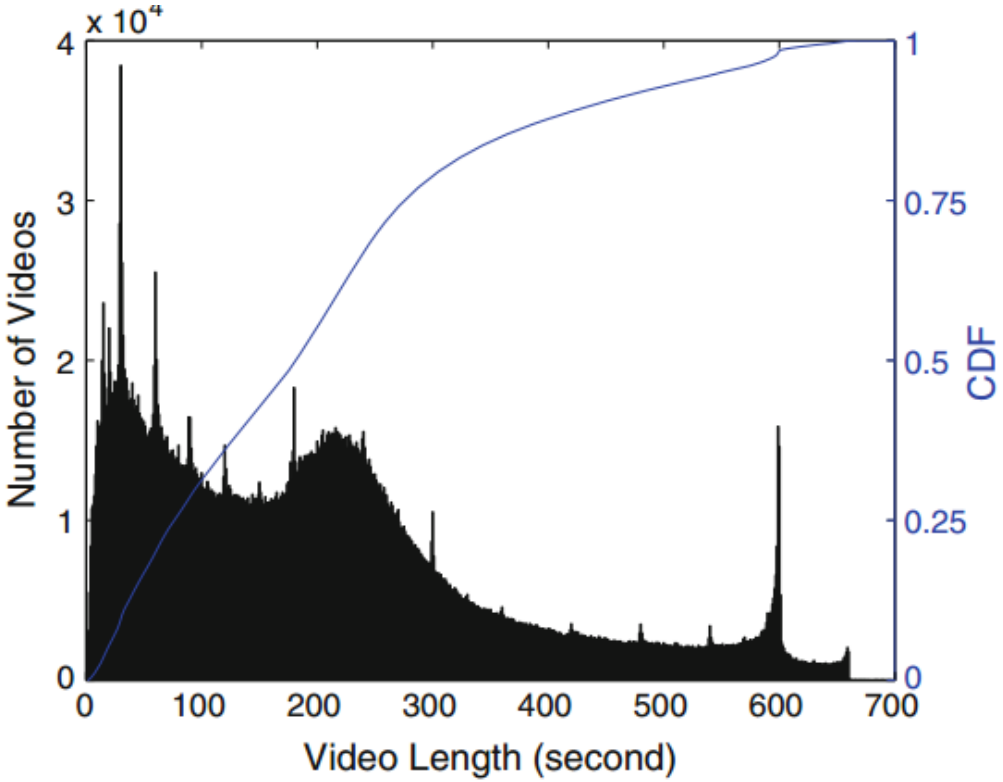
Social Media Sharing: Characteristics of YouTube Video

Traditional servers contain long videos, typically 1–2 hour movies, YouTube mostly comprises short video clips, and 98.0 % of the videos' lengths are within 600 s.



Three peaks: The first peak is within 1 mins (20.0 % of the videos). The second peak is between 3 and 4 min, and contains about 17.4 % of the videos.

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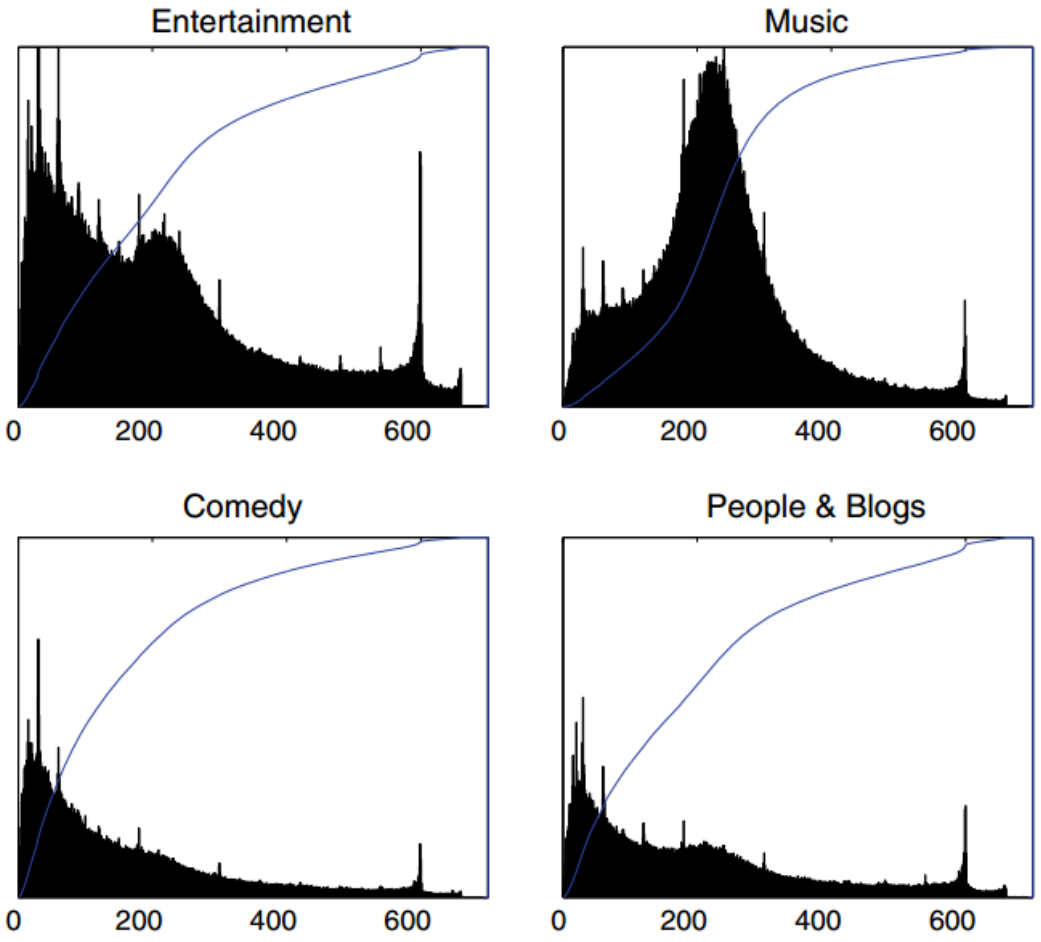
Social Media Sharing: Characteristics of YouTube Video

- ✓ "Entertainment" videos have a distribution similar to the entire videos.
- ✓ "Music" videos have a high peak between 3 and 4 min (29.1 %), which is the typical length range for music TVs.
- ✓ "Comedy" and "People & Blogs' videos have more videos within 2 min (53.1 % and 41.7 % respectively), likely corresponding to "highlight" type of clips.



Length histograms and cumulative distributions for the four *top* categories

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Social Media Sharing: Characteristics of YouTube Video

Small-world Characteristics: There is a strong **correlation** between the **number of views** of a video **and** that of its **top related videos**, and this also provides more diversity on video views, helping users discover more videos of their own interest rather than the popular videos only.

The clustering behavior is very obvious in these two graphs, due to the user generated nature of the tags, titles, and descriptions of the videos that are used by YouTube to find related ones.

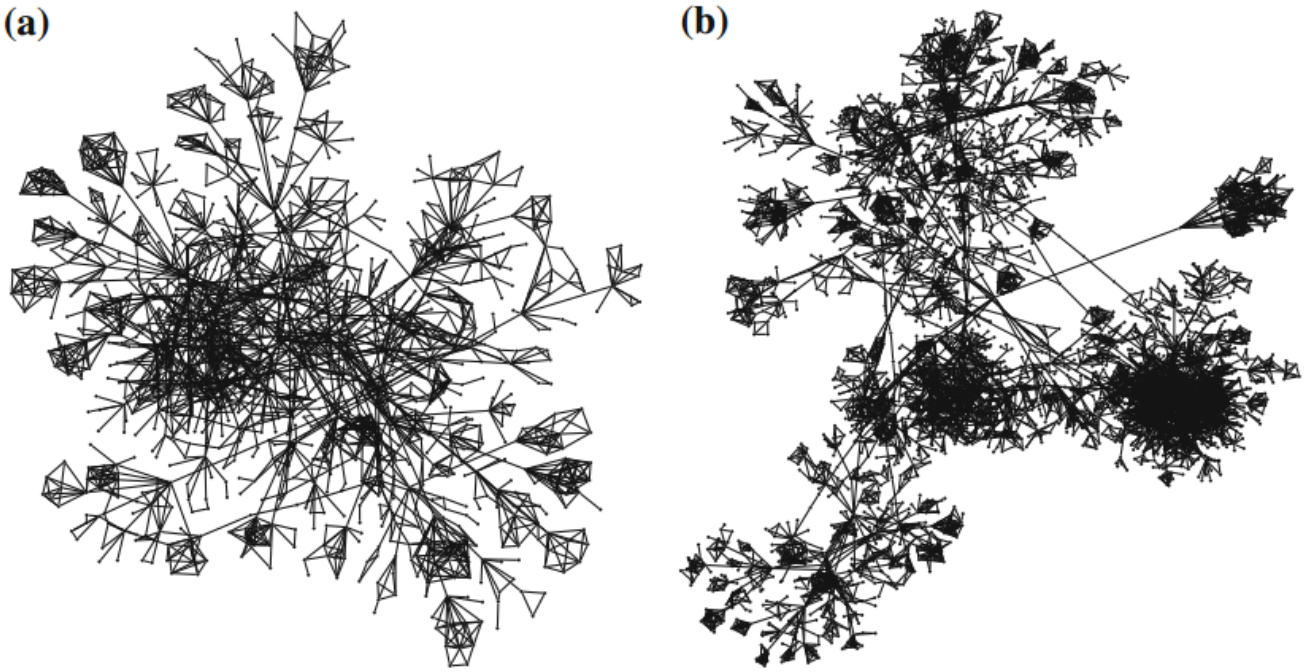

Fig. 18.4 Two sample graphs of YouTube videos and their links

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Social Media Sharing: Characteristics of YouTube Video

Partner's View: YouTube users have various means to reach YouTube videos. The last webpages where the viewers come from is called referral sources. Understanding referrals is essential for YouTube partners to adapt their user engagement strategy.

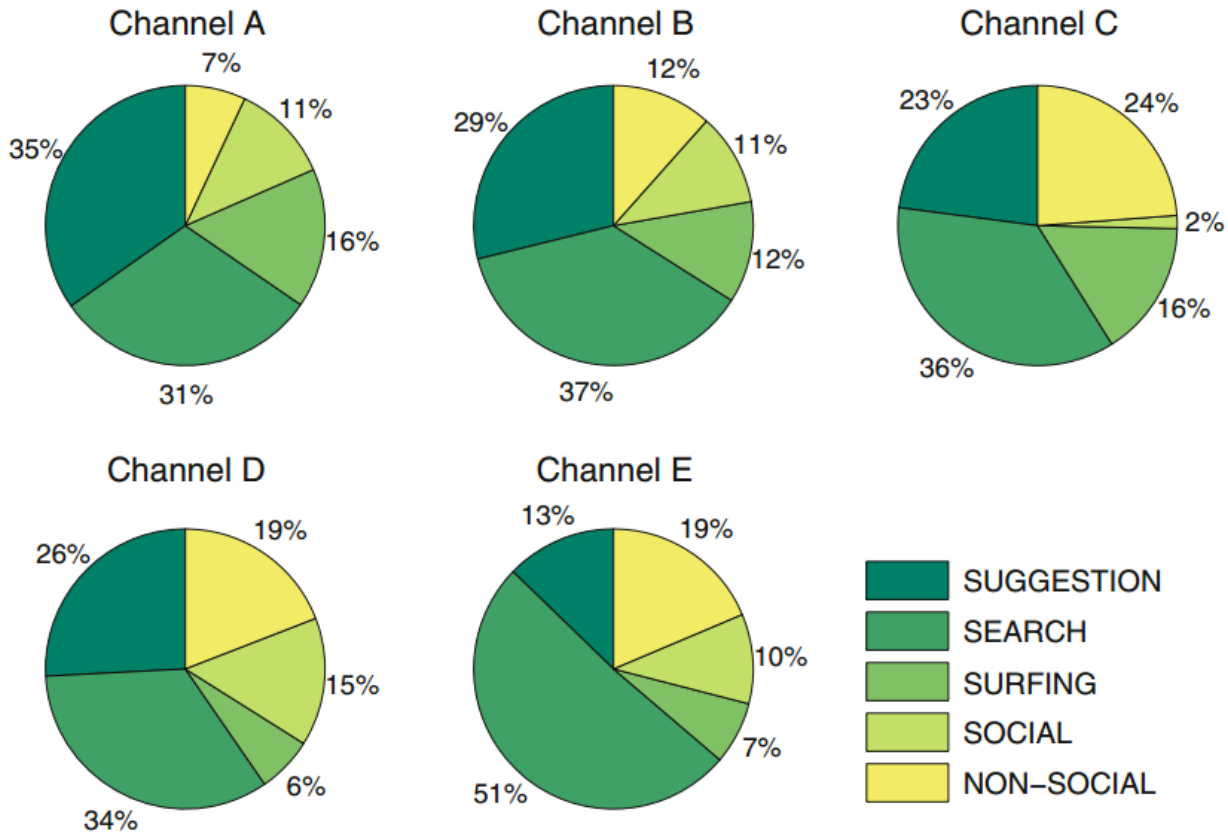

Fig. 18.6 Breakdown of the referral source

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Cloud Computing: What's it?

Cloud users can run their applications on powerful server clusters offered by the cloud service provider, with system and development software readily deployed inside the cloud, mitigating the users' burden of full installation and continual upgrade on their local hardware/software. A cloud user can also store their data in the cloud instead of on their own devices, making ubiquitous data access possible.

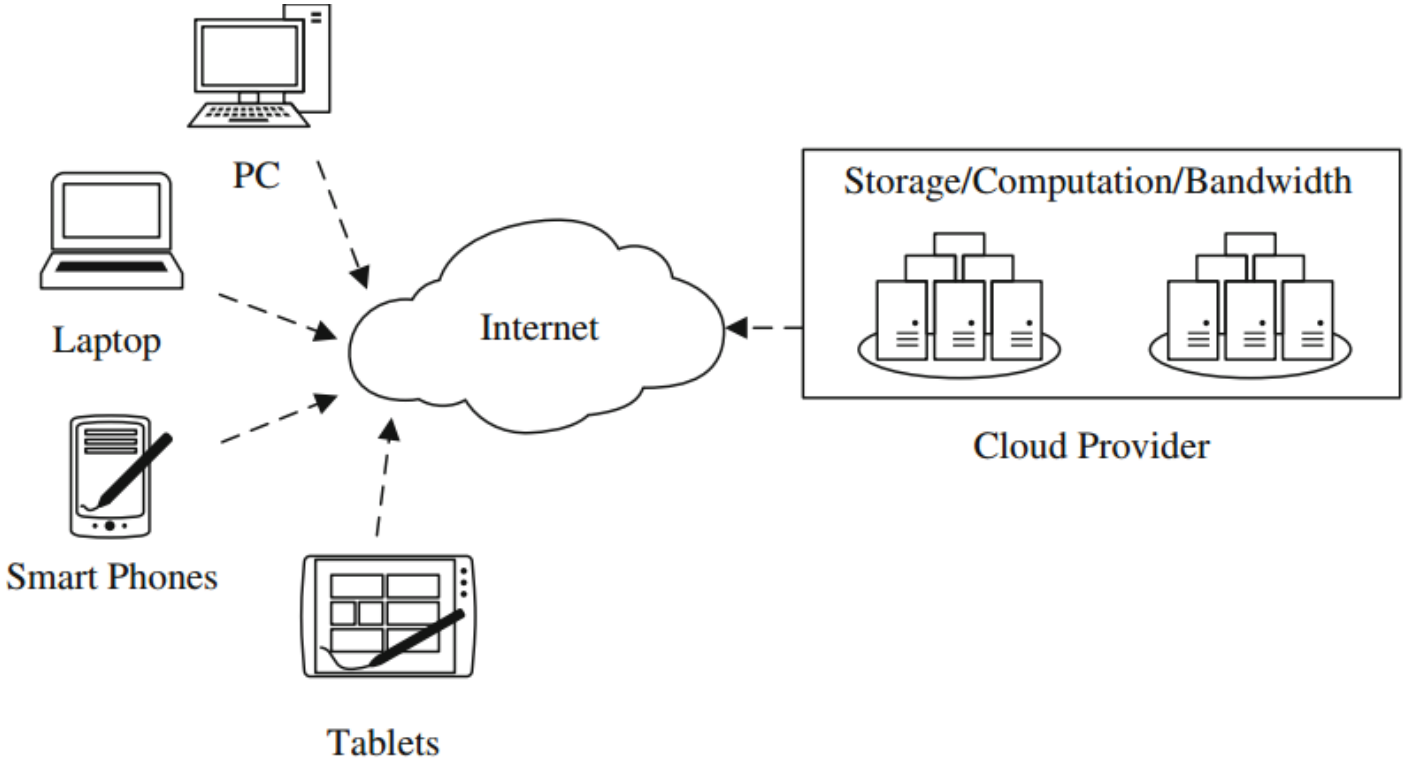

Fig. 19.1 A conceptual overview of cloud computing

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Cloud Computing: Service Models

Cloud services are mostly offered from data centers with powerful server clusters in three fundamental models.

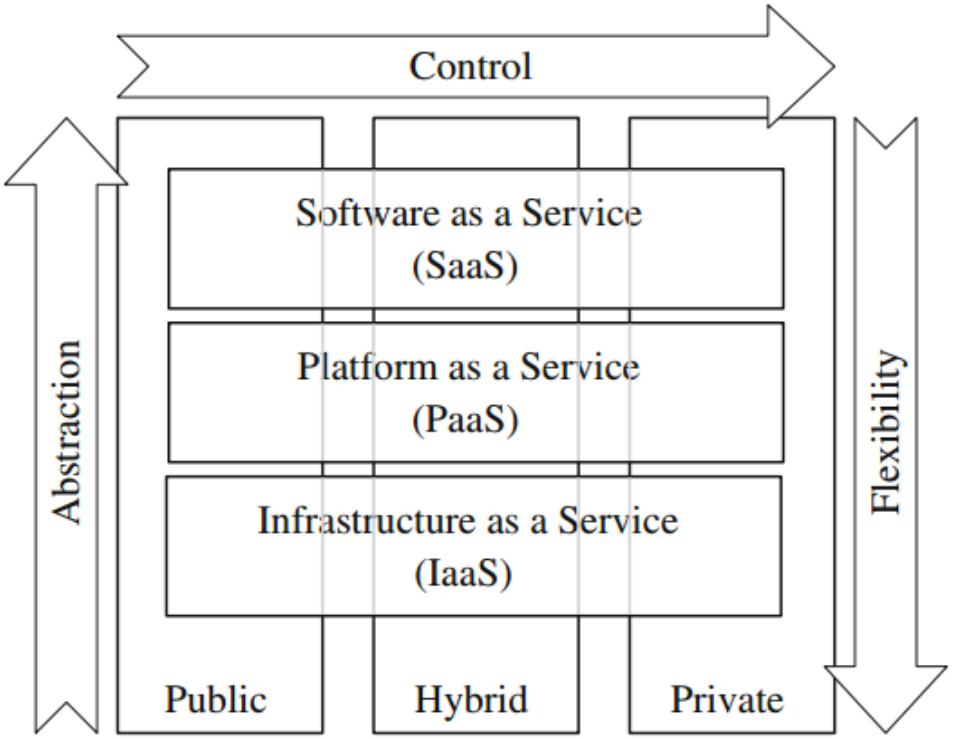

Fig. 19.2 An illustration of cloud service models

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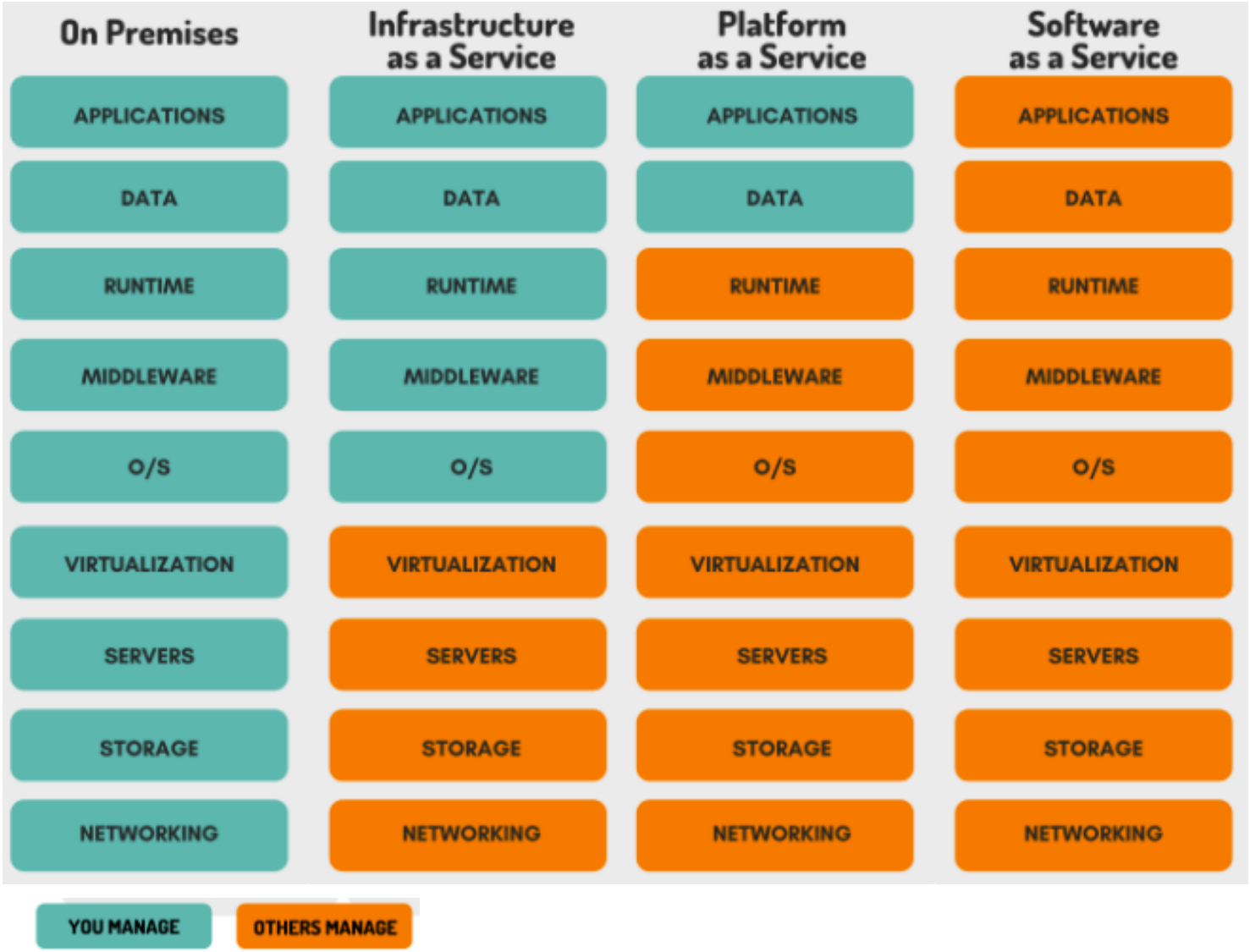
Cloud Computing: IaaS, PaaS, and SaaS



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Cloud Computing: Examples of Service Models

SaaS	Google Workspace, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting
PaaS	AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, OpenShift
IaaS	DigitalOcean, Linode, Rackspace, Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE)

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Cloud Computing: Cloud-assisted Media Sharing: Example Netflix

One of the most successful migration of media sharing applications to the cloud is Netflix, which now takes up a third of US download Internet traffic during peak traffic hours.

Established in 1997, Netflix began to move away from its original core business model of mailing DVDs by introducing video-on-demand via the Internet in early 2007.

Later in 2008, it had suffered from storage data corruption bugs that took service down.

Since 2009, Netflix started using Amazon's AWS for part of its services, and moved its entire technology infrastructure to AWS in 2012.

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Cloud Computing: Cloud-assisted Media Sharing: Example Netflix

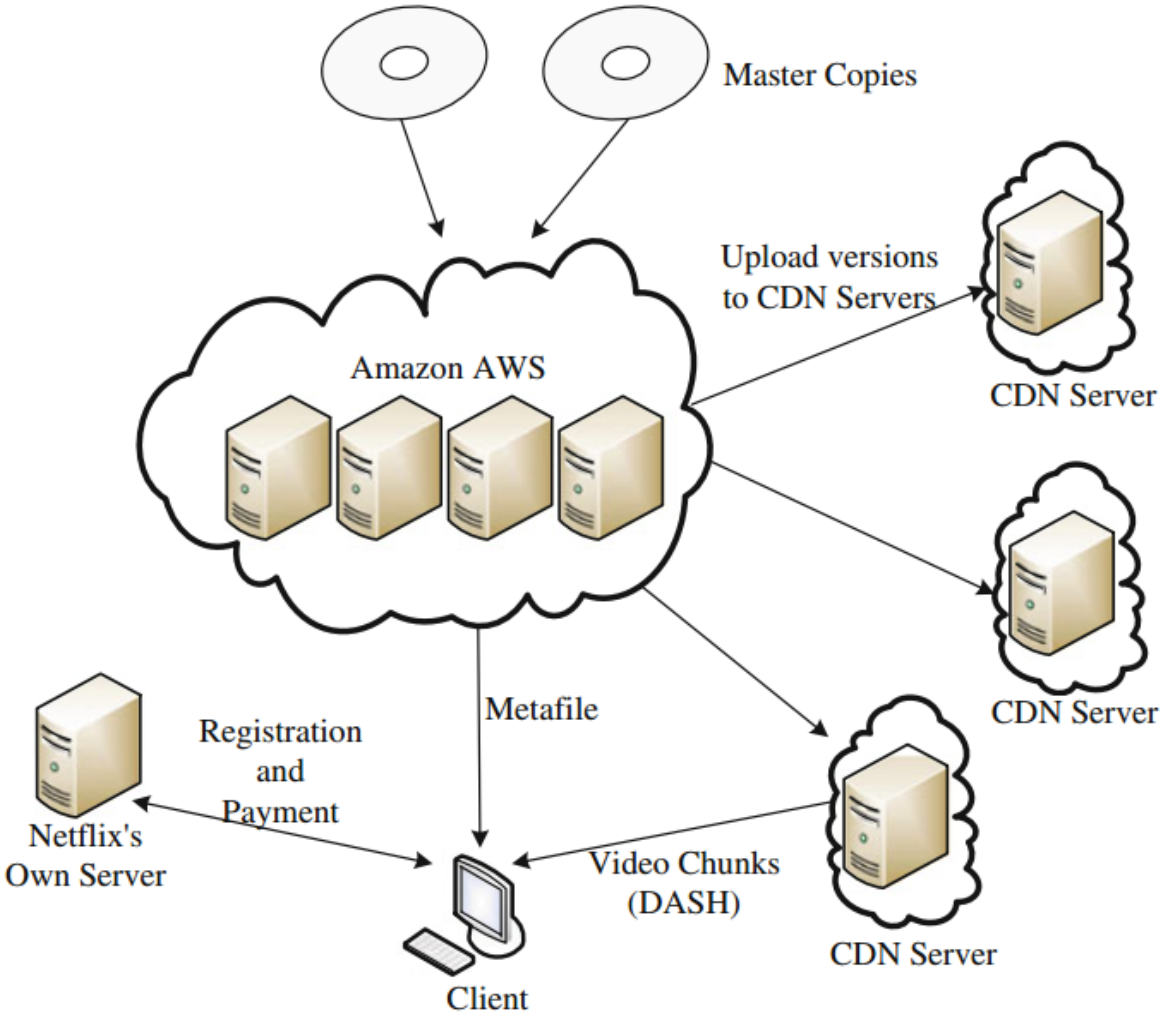
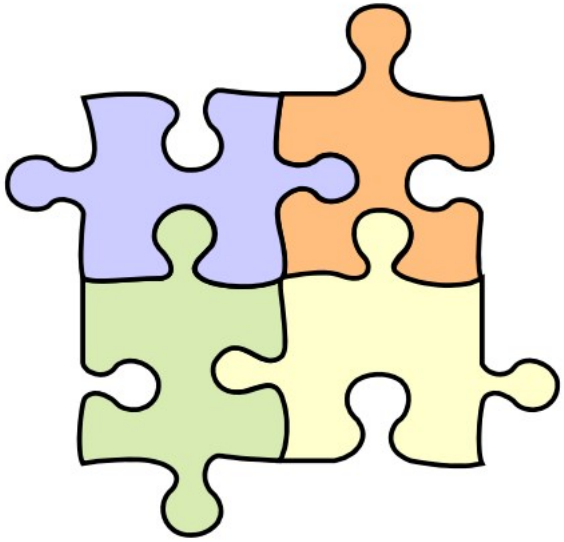


Fig. 19.11 The cloud-based Netflix architecture

Q&A