

Management Information Systems

MIS 310

Larisa Cherkasov, MBA

Martin V. Smith School of Business and Economics

CSU Channel Islands

Email: Larisa.Cherkasov@csuci.edu

Open Source, Cloud Computing, Virtualization and Mobile Computing



Open Source Software: Definition

- The Rise Of Open-Source Software
- **Open source software** is software with source code that anyone can inspect, modify, enhance, learn from it, or share it.
 - Usually developed as a public collaboration
 - Users must accept the terms of a license
 - Licenses promote collaboration and sharing





Open Source Software: Examples

Mozilla Firefox
web browser



Marketcetera
financial trading platform



MySQL
relational database management system



Apache OpenOffice
office suite



Zimbra
collaborative software
suite



GIMP
graphics editor



Alfresco
content management platform



SugarCRM
customer relationship management system



Asterisk
platform for building communications applications



Apache HBase
non-relational distributed database



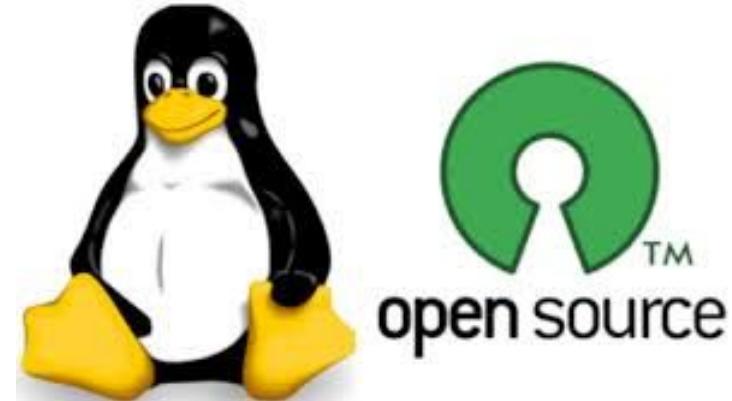
FreeBSD
operating system





Open Source Software: Reasons to Choose

- Cost
- Control
- Reliability
- Security
 - Perceived as the biggest open-source software advantage
 - More people are inspecting the code
 - Vulnerabilities are fixed much faster and updates are more frequent
- Scalability
 - Ability to handle increasing workloads or to be expanded to manage workload increases.
- Agility and time to market
 - Allows for multiple ways to solve a single problem



Open Source Software: As Business

- Doesn't "open source" just mean something is free of charge?
 - No
- Vendors make money on OSS by selling support and consulting services.
 - freemium



Open Source Software: As Business

- Accessibility of variety of computing options to smaller firms.
- Redirect funds from spending on fixed costs to innovation and competitive initiatives.
- Industry's evolution:
 - Pre-Linux days: Almost every major hardware manufacturer made its own version of the Unix operating system.
 - Difficulty attracting third-party vendors to write application software.
 - Now all major hardware firms run Linux
 - Large, unified market attracting software developers.
- Hardware firms spend less money on competition

Open Source Software: As Business

- Linux is common on
 - Mobiles
 - Consumer electronics
 - Enterprise solutions
- But not on desktop computers:
 - It is not easy to install.
 - Its complexity can raise the total cost of ownership.
 - **Total cost of ownership (TCO):** All costs associated with the design, development, testing, implementation, documentation, training, and maintenance of a software system.
 - Limited desktop application availability

Open Source Software: Challenges



- Installation and maintenance difficulties
- Support problems
 - Support Contracts or
 - Uncertain community of volunteers for support and upgrades
- Legal exposure.
 - Firms adopting OSS may be at risk if they distribute code and aren't aware of the licensing implications.
 - Varying open source license agreements.

Review Questions

- Who can contribute to open source software and how?
- What is perceived to be the main benefit of open source software and why?
- How do the open source software companies make money?

Cloud Computing



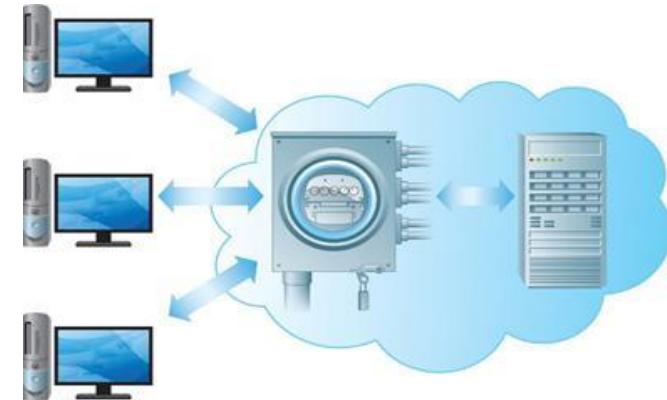
- **Cloud Computing:**

- The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

Cloud Computing



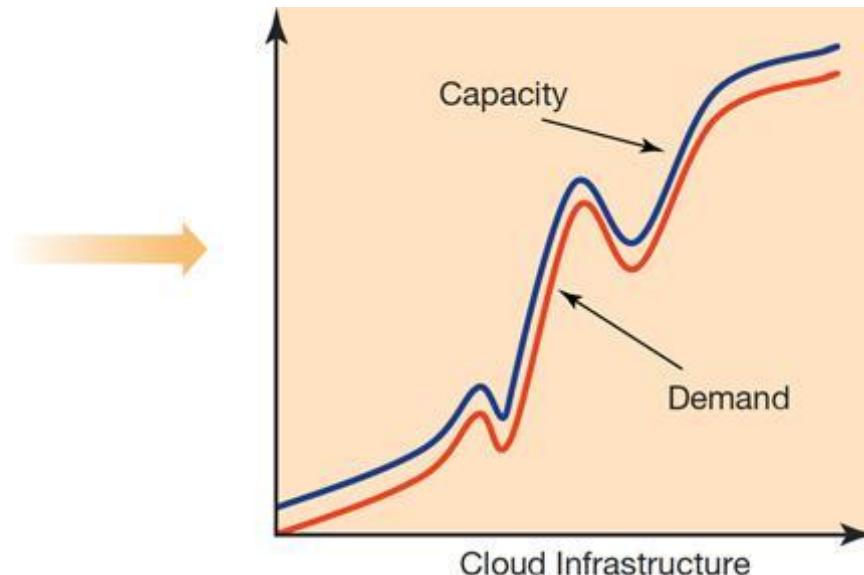
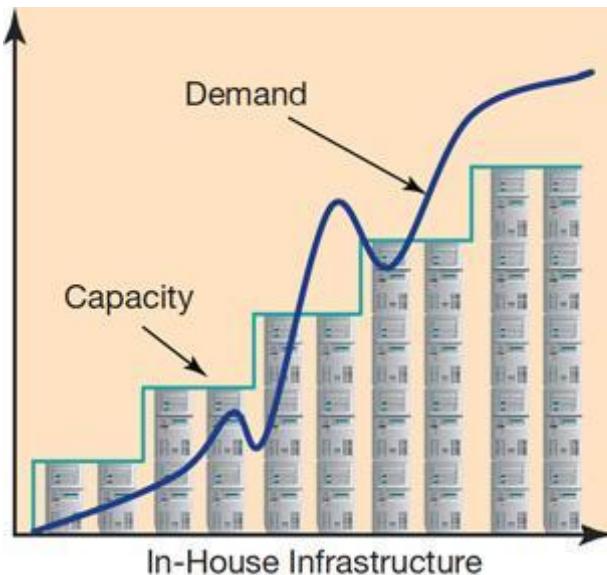
- Cloud Computing is a way to allocate resources much like a utility sells power
- Resources are used “on-demand,” as needed
- Customers only pay for what they consume
- Resources can be rapidly allocated and reallocated
- Consumption becomes an operating expense
- % utilization and efficiency increase dramatically



Cloud Computing: Characteristics



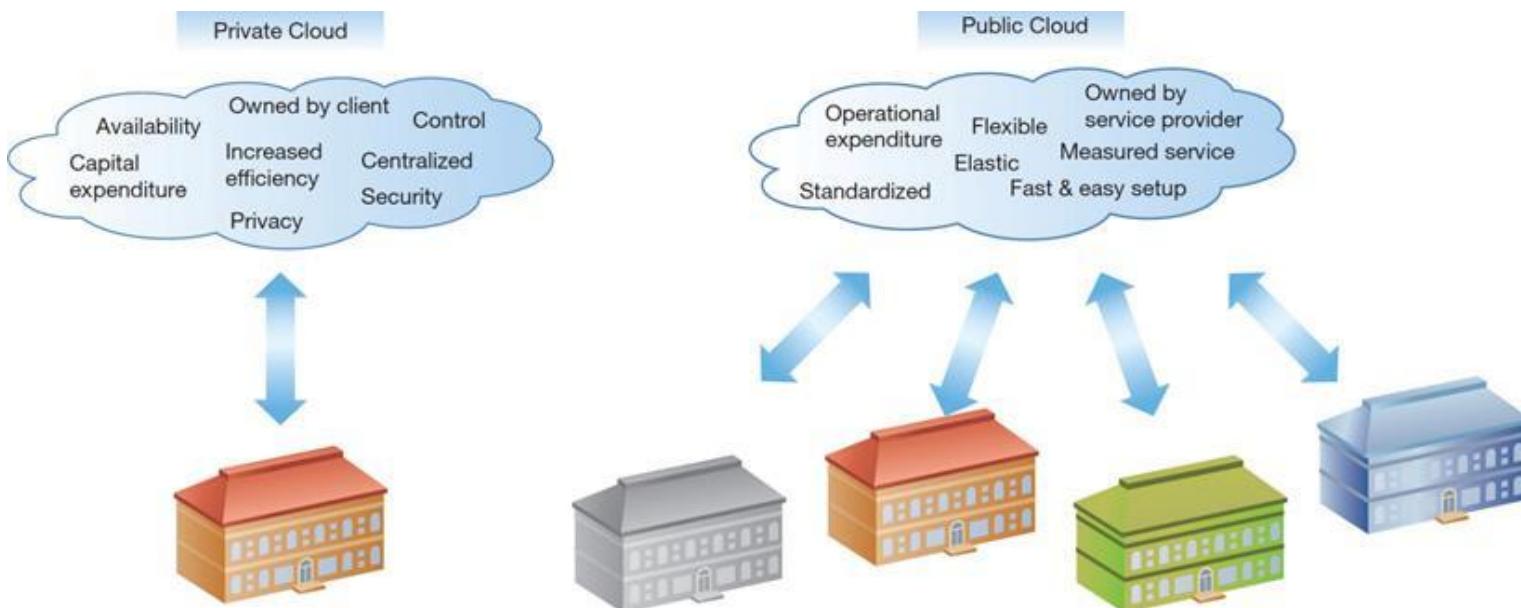
- On-Demand Self Service
- Rapid Elasticity
- Broad Network Access
- Resource Pooling
- Measured Service



Types of Clouds



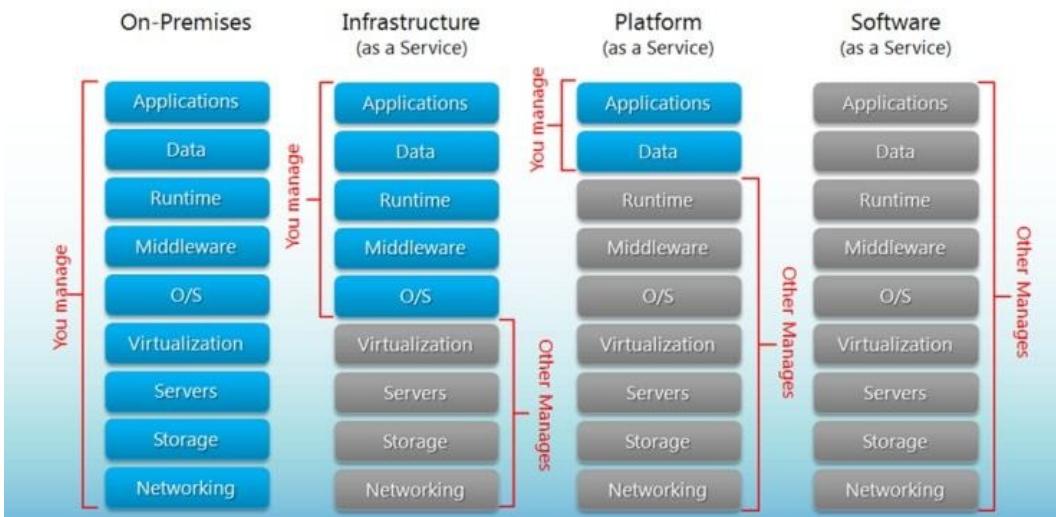
- **Private Clouds:** Pools of computing resources that reside inside an organization and that can be served up for specific tasks as need arrives.
- **Public Clouds:** Services that can be used by any interested party on a pay-per-use basis



Cloud Computing Service Models

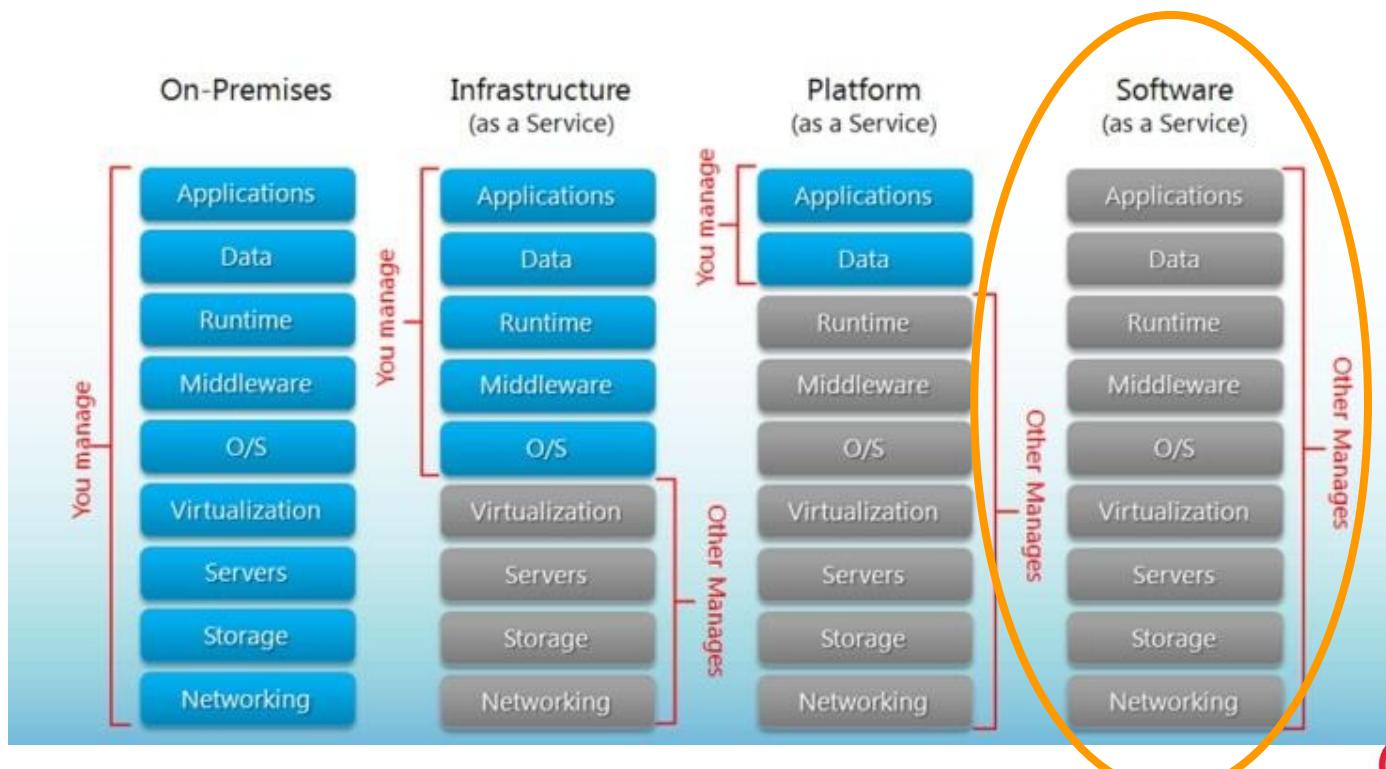


- Replacing computing with services provided over the Internet.
 - Software as a service (SaaS)
 - Software that is made available by a third party online.
 - Utility computing:
 - Platform as a service (PaaS)
 - Infrastructure as a service (IaaS).



Cloud Computing Service Models: SaaS

- SaaS provides the software and hardware to replace an internal information system.
 - Replaces software and hardware with a service provided by a third party online.
 - SaaS examples: BigCommerce, Google Apps, Salesforce, Dropbox, MailChimp, ZenDesk, DocuSign, Slack, Hubspot
 - Accounts for 24% of all enterprise workloads (up from 14% in 2016)



SaaS: Earning Money



- Money can be earned via
 - Usage-based pricing model
 - Offering free services that are supported by advertising.
 - Sale of upgraded or premium versions for additional fees.



SaaS: Benefits to Users



- Lower costs and financial risk mitigation
 - Forgo upfront costs of buying and installing software packages and cost for the IT staff needed to run these systems
- Faster deployment times
- Scalable systems
 - Vendor is responsible for ensuring that systems meet demand fluctuation
- Higher quality and service levels.
- Remote access and availability.
- Limits development to a single platform.
- Tighter feedback loop.
- Ability to instantly deploy bug fixes and product enhancements.
- Lower distribution costs.
- Greater accessibility.
- Reducing software piracy.



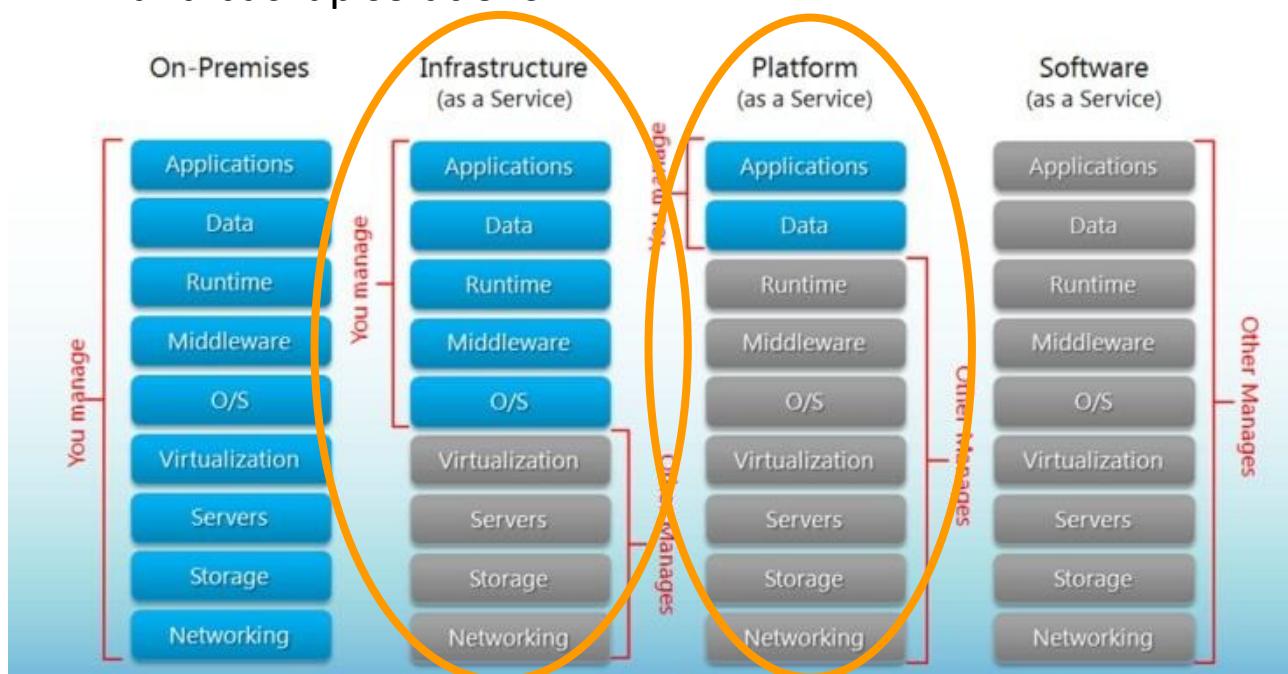
SaaS: Associated Risk



- Dependence on a single vendor
 - Difficult task of transferring very large data files over the Internet when switching vendor
 - Concern about the long-term viability of partner firms.
- Users may be forced to migrate to new versions.
 - Training costs and shifts in operating procedures.
- Reliance on a network connection
- Data assets stored off-site may lead to security and legal concerns.
- Limited configuration, customization, and system integration options compared to alternatives.
- Less sophisticated user interface
- Ease of adoption lead to pockets of unauthorized IT being used throughout a firm.

Cloud Computing Service Models: PaaS & IaaS

- Platform as a Service (PaaS), Infrastructure as a Service (IaaS)
 - Firm develops its own custom software but wants to pay someone else to run it for them
 - Firm pays for the amount of processing, storage, and telecommunications used.
 - Cloud vendors host firm's software on their systems.
 - Provide a virtual replacement for a subset of operational hardware like storage and backup solutions.

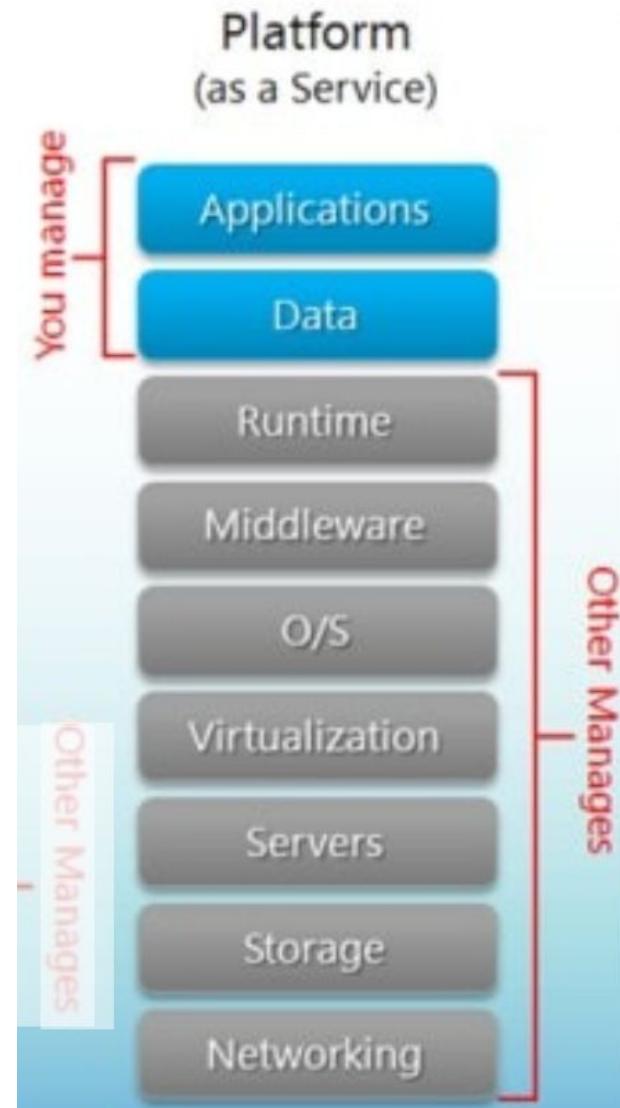


Cloud Providers: PaaS & IaaS



Platform as a service (PaaS): Cloud providers offer services for customers to build their own applications on the provider's infrastructure.

- Services include hardware, operating system, tools, and hosting
- PaaS is the most popular model, accounting for around 32% and expected to grow in 2020.
- AWS Elastic Beanstalk, Heroku, Force.com, Google App Engine, Apache Stratos, Apprenda

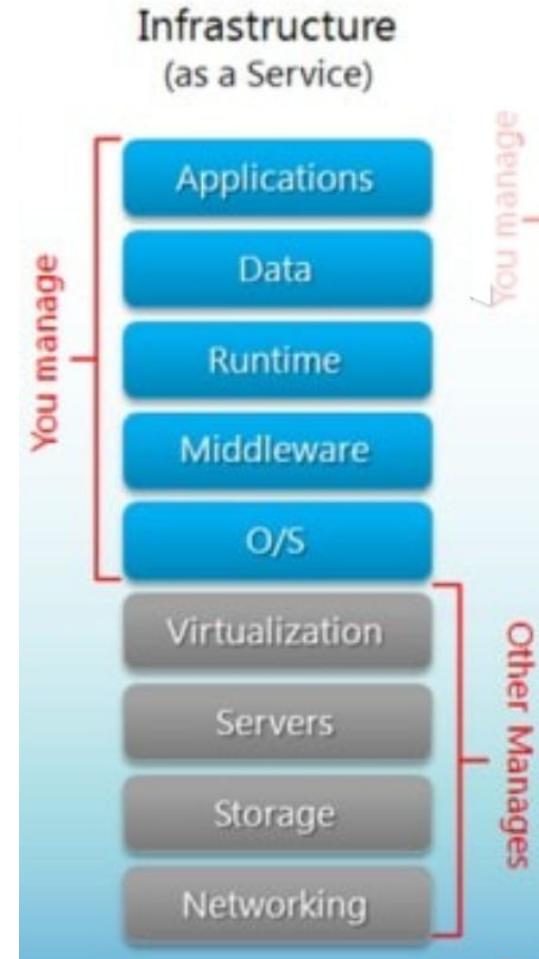


Cloud Providers: PaaS & IaaS



- **Infrastructure as a service (IaaS):** Cloud providers manages the infrastructure including running the remote hardware, storage, and networking.

- IaaS offers more direct control over operating systems than PaaS
- Client firms choose the software and development environment
- IaaS is around 12% (up from 6% in 2016).
- Amazon EC2 (with pre-installed OC), Amazon S3, Windows Azure, Rackspace, Google Compute Engine.



Cloud Providers: Challenges



- Installing a complex set of systems on someone else's hardware is very difficult.
- Firms considering cloud computing need to do a thorough financial analysis
 - Comparing the costs of owning and operating own systems over time against the variable costs for moving portions to the cloud.
- Firms should enter the cloud cautiously, particularly where mission-critical systems are concerned.

Cloud Impact On Tech Industry

- Shifting to cloud computing modifies the margin structure for many in the computing industry
 - Deploying SaaS and operating a commercial cloud is still very expensive.
- Cloud computing can accelerate innovation.
- Changes the desired skills mix and job outlook for IS workers.
 - Demand for nonstrategic skills like hardware operations and maintenance are likely to decrease
 - Organizations will need more business-focused technologists
- Enables organizations to spend less on hardware infrastructure and reinvest in strategic efforts and innovation.

Review Questions

- What is Cloud?
- How do you pay for cloud computing resources?
- Name at least 3 key benefits of SaaS.
- How can you tell the difference between PaaS and IaaS?

Virtualization



- **Virtualization:** A type of software that allows a single computer or cluster of connected computers to function as if it were several different computers
 - Each computer runs its own operating system and software.
 - Can be used to reduce an organization's hardware needs.
 - Can create a firm's own private cloud of scalable assets.
 - Can cut energy consumption and lower carbon footprint.
- **Containers:** Allow applications to share an operating system for more resource savings and faster execution.
- **Virtual desktops:** Running an instance of a PC's software on another machine and delivering the image of what is executing to the remote device.
 - [CI Virtual Computer Labs.](#)

Cloud Computing: Server Farms

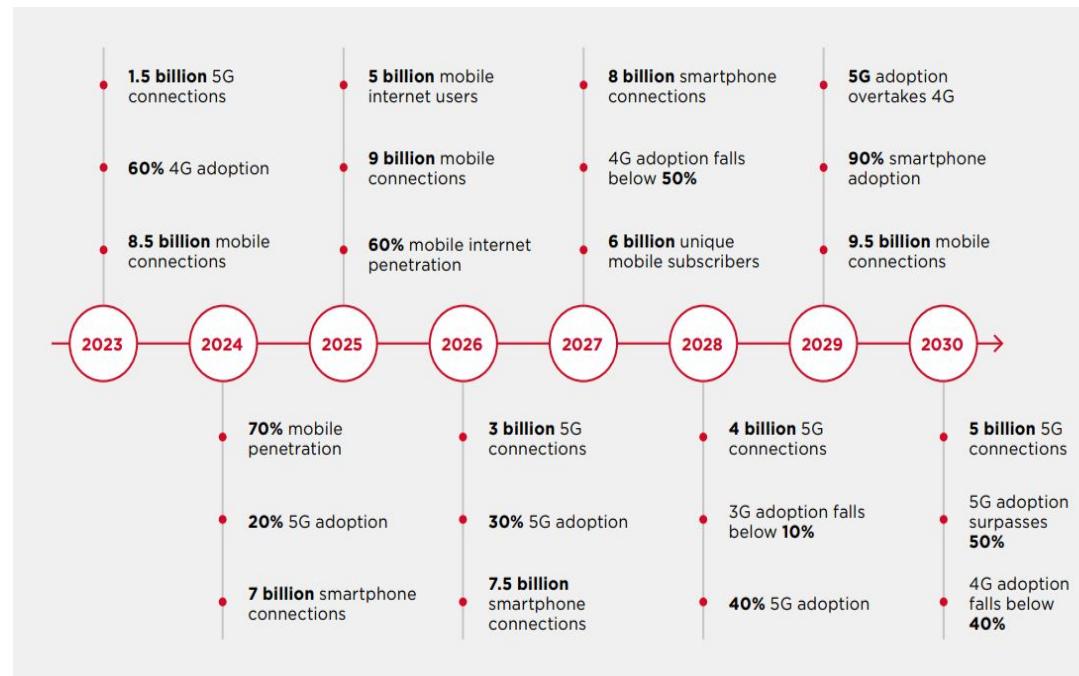
- Provide the infrastructure backbone to SaaS, hardware cloud efforts, and large-scale Internet services.
- Require plenty of cheap land, low-cost power, ultrafast fiber-optic connections
- Google, Sun, Microsoft, IBM, and HP have developed rapid-deployment server farm modules
 - Preconfigured and packed inside shipping containers.



Server-packed shipping container from Oracle's Sun unit

Mobile Computing

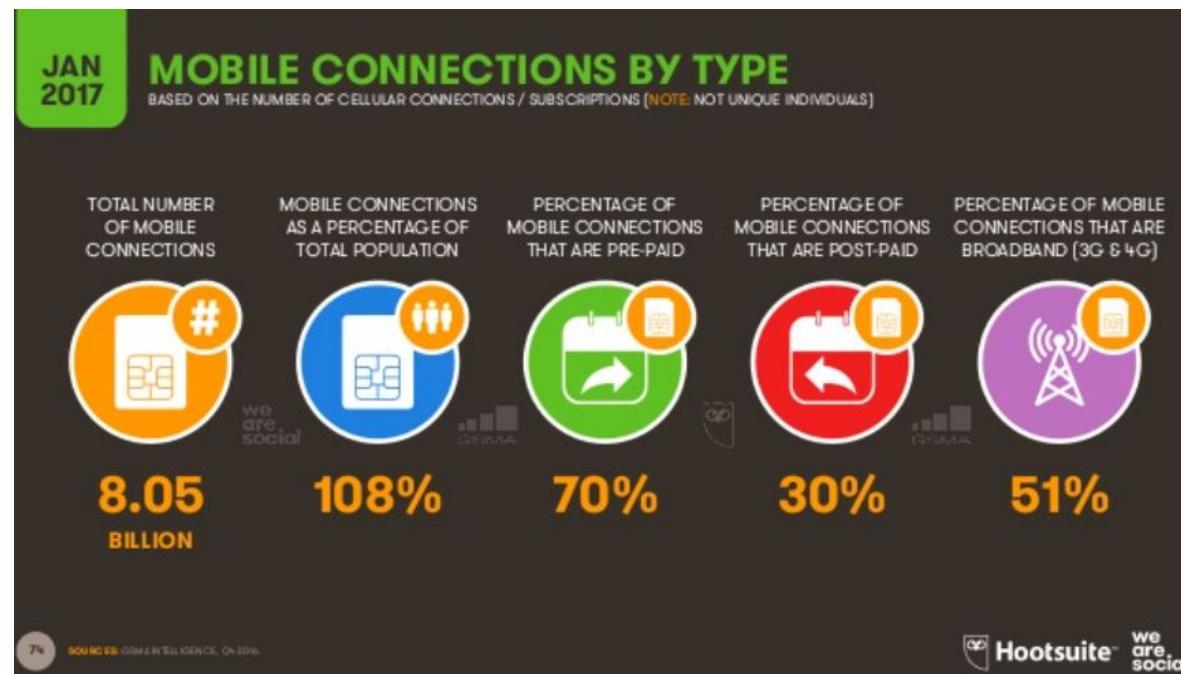
- **Mobile Computing:** Variety of devices that allow people to access data and information from wherever they are
 - Mobile communication
 - Mobile hardware
 - Mobile software
- There are more mobile devices accessing the Internet than there are human beings living on Earth.
 - In 2024, the number of **total mobile connections worldwide** reached about **11.6 billion** — which is roughly **143% of the global population**.



The Mobile Economy

Mobile Computing: Communication

- **Mobile Communication:** Infrastructure put in place to ensure that seamless and reliable communication goes on.
 - Mobile wireless
 - Wi-Fi
 - Bluetooth



<https://datareportal.com/reports/digital-2020-global-digital-overview>

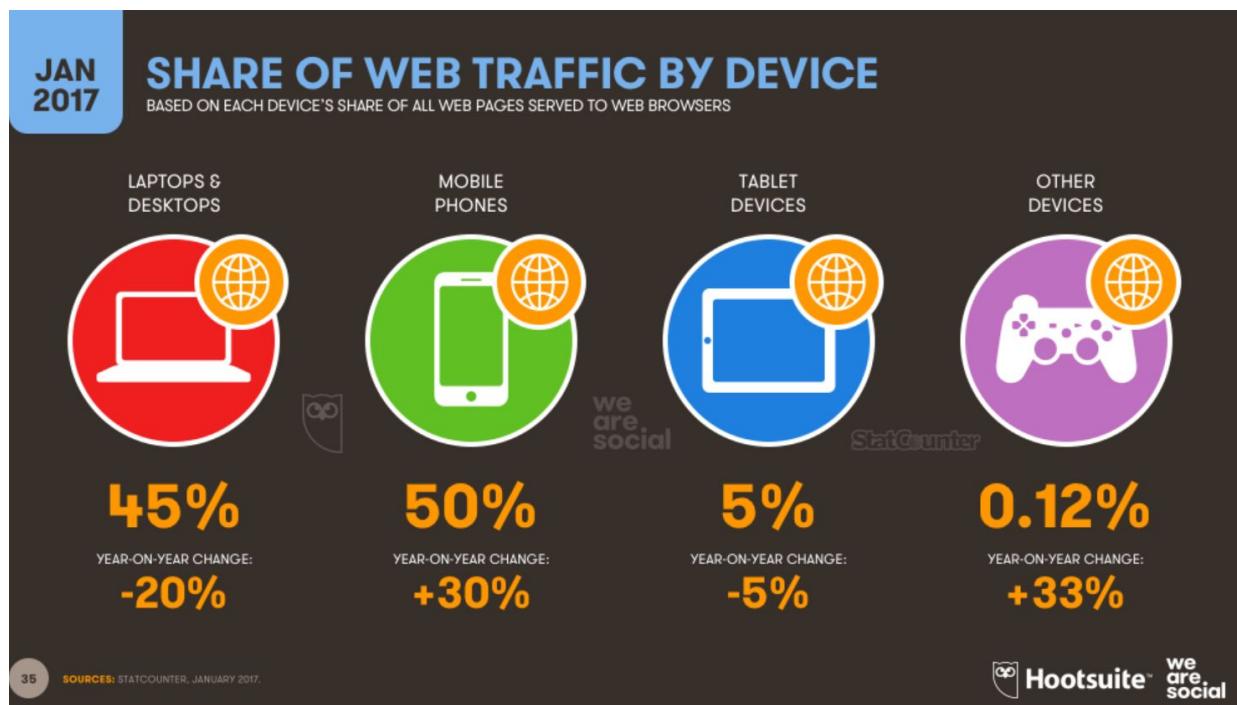
Mobile Computing: Hardware

- Smartphones
 - History of the Cell Phone
- Tablets
- eReaders
- Scanners
- Point of Sale (POS) device



Mobile Computing: Hardware

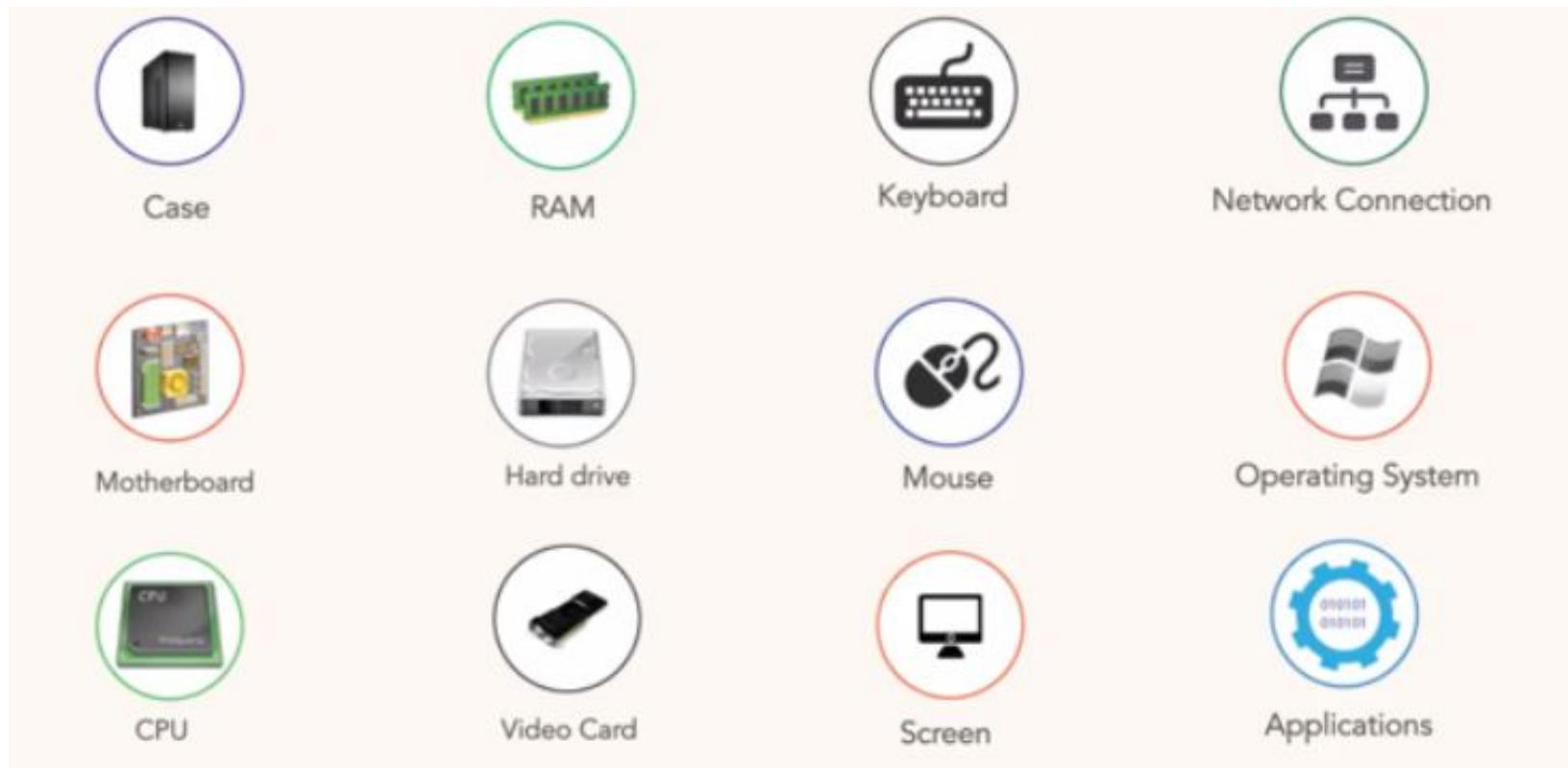
- Global tablet sales recently surpassed desk and laptop computer sales
- Over 55% of website traffic comes from mobile devices.
- 92.3% of internet users access the internet using a mobile phone.
- The average person spends 3 hours and 15 minutes on their phone every day



<https://datareportal.com/reports/digital-2020-global-digital-overview>

Mobile Computing: Hardware

- Mobile Devices have the same components of the personal computers plus a few extra



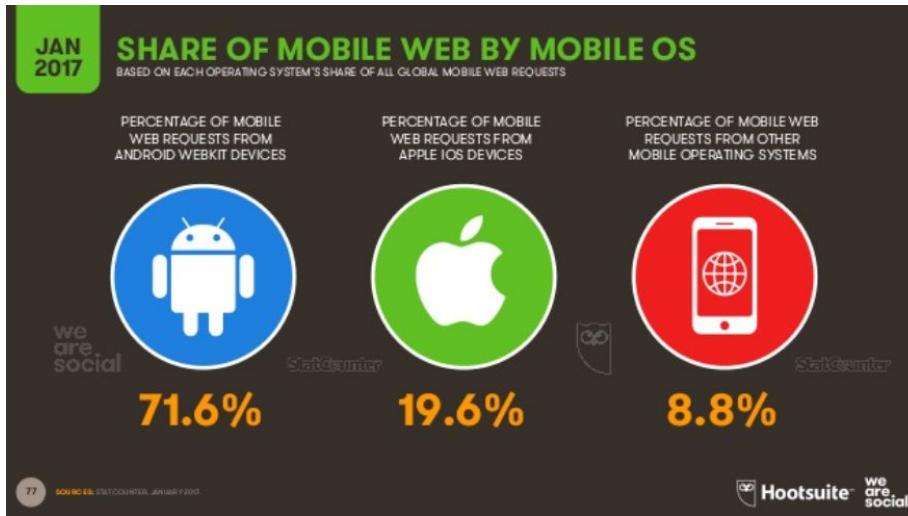
Mobile Computing: Hardware

- What makes a Mobile Computing Device different?
 - Size
 - Operating System
 - Access to Mobile Broadband network
 - Battery life
 - Applications
 - GPS capability
 - Accelerometer
 - Compass/magnetometer



Mobile Computing: Operating Systems

- Apple's iOS
 - Started for iPhone
 - Expanded to iPad
- Google's Android
 - Originally for smartphones
 - Found on more devices than any other OS



<https://datareportal.com/reports/digital-2020-global-digital-overview>

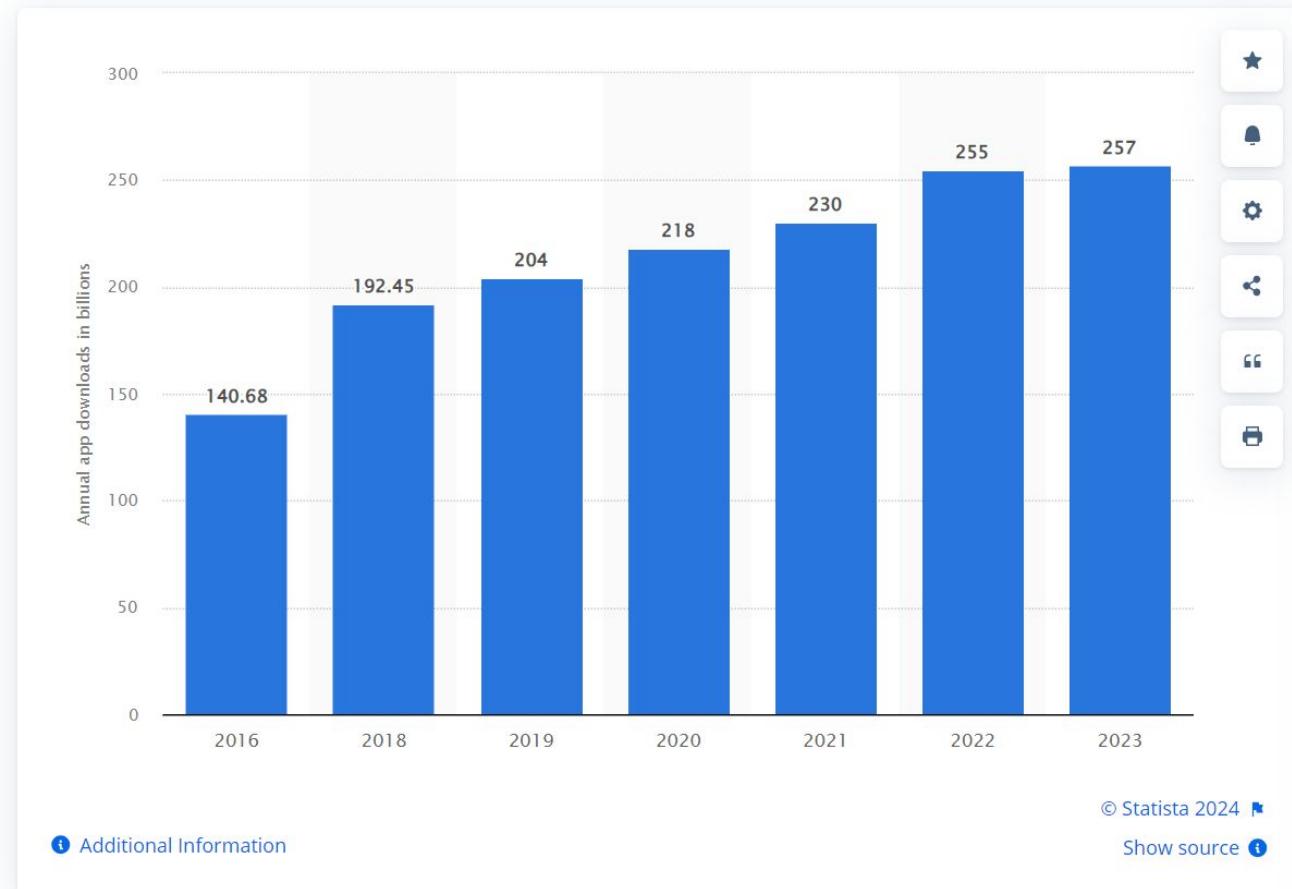
Mobile Computing: Operating Systems

- iOS
 - 1.8 million apps
 - Multitasking
 - 94% of apps are free
 - More games
- Android
 - 3.55 million apps
 - Multitasking
 - 97% of apps are free

<https://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/>

Mobile Computing: Applications

- App-focused digital landscape
- 257 billion mobile apps were downloaded in 2024

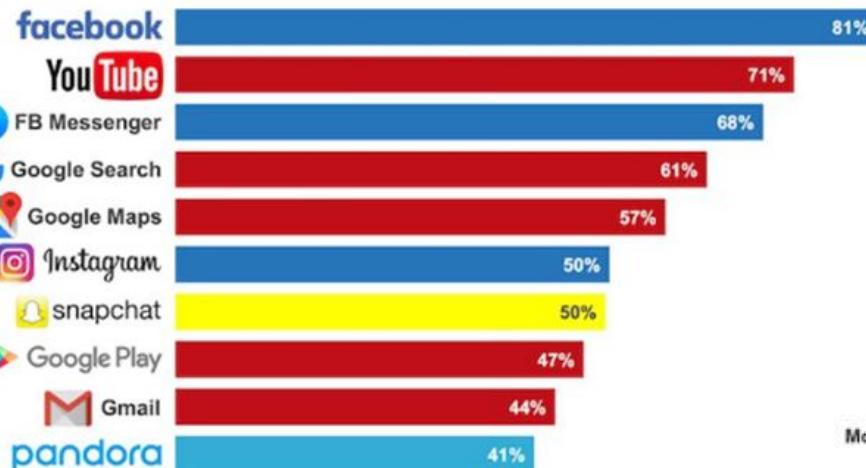


<https://www.statista.com/statistics/271644/worldwide-free-and-paid-mobile-app-store-downloads/#:~:text=While%20the%20number%20of%20downloads,year%2Dover%2Dyear%20increase.>

Mobile Computing: Applications

Top 10 Mobile Apps by Penetration of App Audience

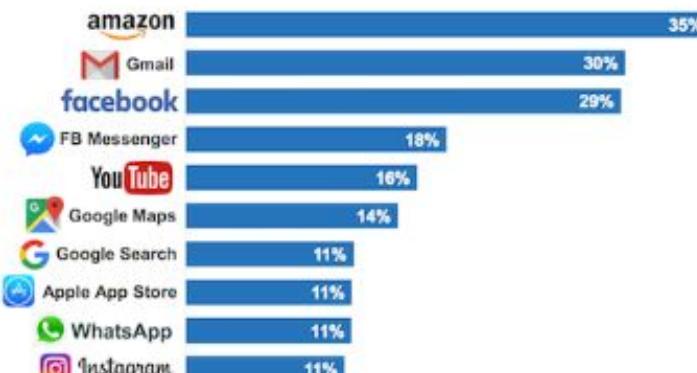
Source: comScore Mobile Metrix, U.S., Age 18+, June 2017



Source: [comScore](#)

Most Essential Apps 18-34 Year-Olds Said They 'Can't Go Without'

Source: comScore Custom Survey, U.S., Age 18+, 2017 Wave



comSCORE

* Survey respondents were asked to select their top 3 'most essential' apps (i.e. the apps they couldn't go without) of the apps they own.

© comScore, Inc. Proprietary

Source: [comScore](#)

<http://www.businessofapps.com/data/app-statistics/>

Mobile Computing: App Revenue Models

- In-app advertising
 - Selling data-driven advertising space through the use of a mobile ad partner
 - Freemium
- In-app purchases
 - Utilize the app as a channel for making purchases that can only be made via app
- Paid-for
 - Requires users to pay before they can use the app
 - Subscription

Mobile Computing: App Revenue Models

- Key App Revenue Statistics:
 - Total Global Mobile App Revenue (2024): \$522 billion
 - In-App Advertising (IAA): Largest revenue source, accounting for ~60%+ of app revenue
 - In-App Purchases (IAP): ~36% of total revenue
 - Paid app downloads: Less than 5% of revenue
 - Mobile app revenues are projected to surpass \$750 billion by 2028, driven mainly by gaming, entertainment (streaming, video), and e-commerce apps.

Mobile Computing: App Development Basics

- Mobile Platform Specific

- Respect the native platform

- Apple's Human Interface Guidelines:

- <https://developer.apple.com/design/human-interface-guidelines/>

- Google's Material Design Guidelines:

- <https://material.io/guidelines/>

- Differences

	iOS	Android
Devices	iPhone, iPad, Apple Watch, Apple TV	Samsung, HTC, LG, & Moto phones, Android Wear Watch, Samsung Tablets, Smart TVs
Programming Language	Swift or Objective-C	Java or C++
Development Tools	Cocoa Touch	Android Software Development Kit
Integrated Development Environment (IDE)	Xcode	Android Studio, Android SDK

- Benefits Comparison

iOS	Android
Higher app revenue	Higher ad revenue
Fewer lines of code	Fewer requirements for development
Dedicated user base	Biggest market share

Source: njit.edu, Guide Basics Mobile App Development

Mobile Computing: App Development Basics

- Nothing is more important than your users and their goals
 - Design from the user's perspective
- Think device first
 - Leverage device capabilities
- App Navigation should be easy
 - Simplicity and convenience
- Bigger is better
 - Key elements are limited to a person's vision, dexterity, and finger size
- Compatibility on different platforms
- Test everything you build

Sources:

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John Gallaugher, *Information Systems: A Manager's Guide to Harnessing Technology*, v. 7.0

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