

# Management Information Systems MIS 310

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# 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



## Apache OpenOffice

office suite



## GIMP

graphics editor



## Alfresco

content management platform



## Marketcetera

financial trading platform



## Zimbra

collaborative software suite



## SugarCRM

customer relationship management system



## Asterisk

platform for building communications applications



## MySQL

relational database management system



## Apache HBase

non-relational distributed database



## FreeBSD

operating system

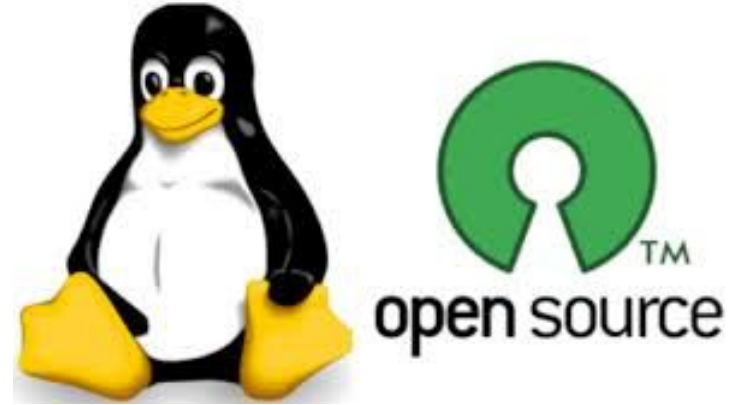




# Open Source Software: Reasons to Choose

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- 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

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- 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

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- 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

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- 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

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- 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

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- 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



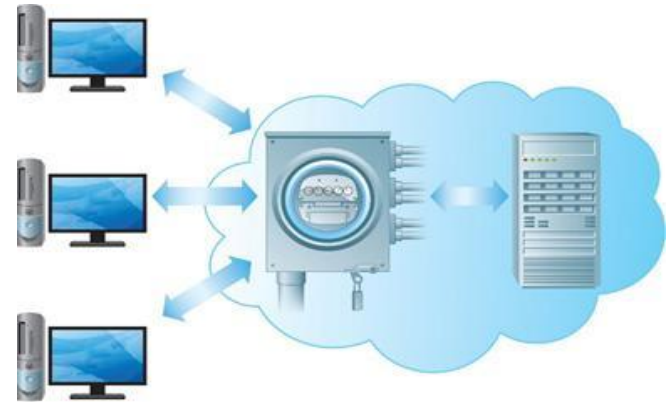
- **Cloud Computing:**

- 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



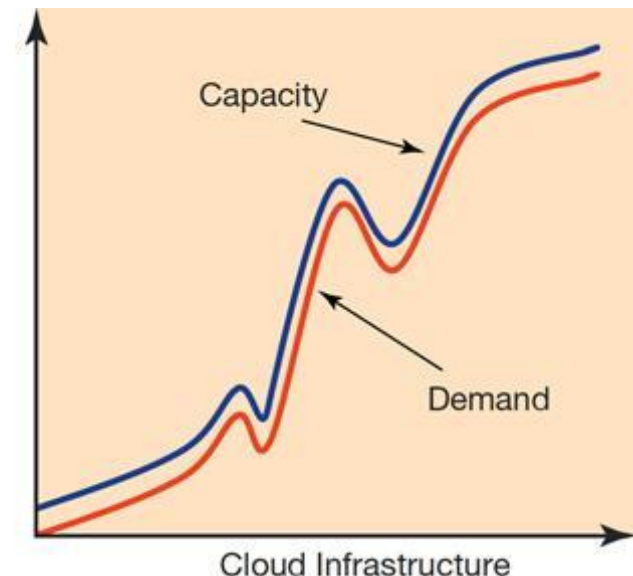
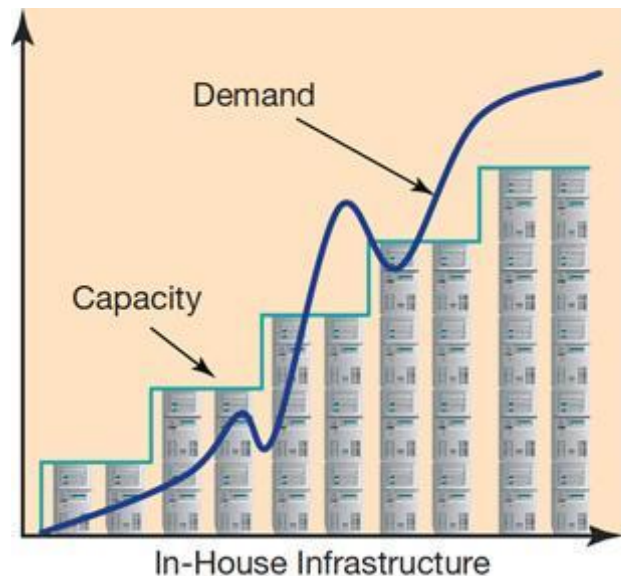
- Cloud Computing is a way to allocate resources much like a utility sells power
- Resources are used “on-demand,” as needed
- Customers only pay for what they consume
- Resources can be rapidly allocated and reallocated
- Consumption becomes an operating expense
- % utilization and efficiency increase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



# Cloud Computing: Characteristics



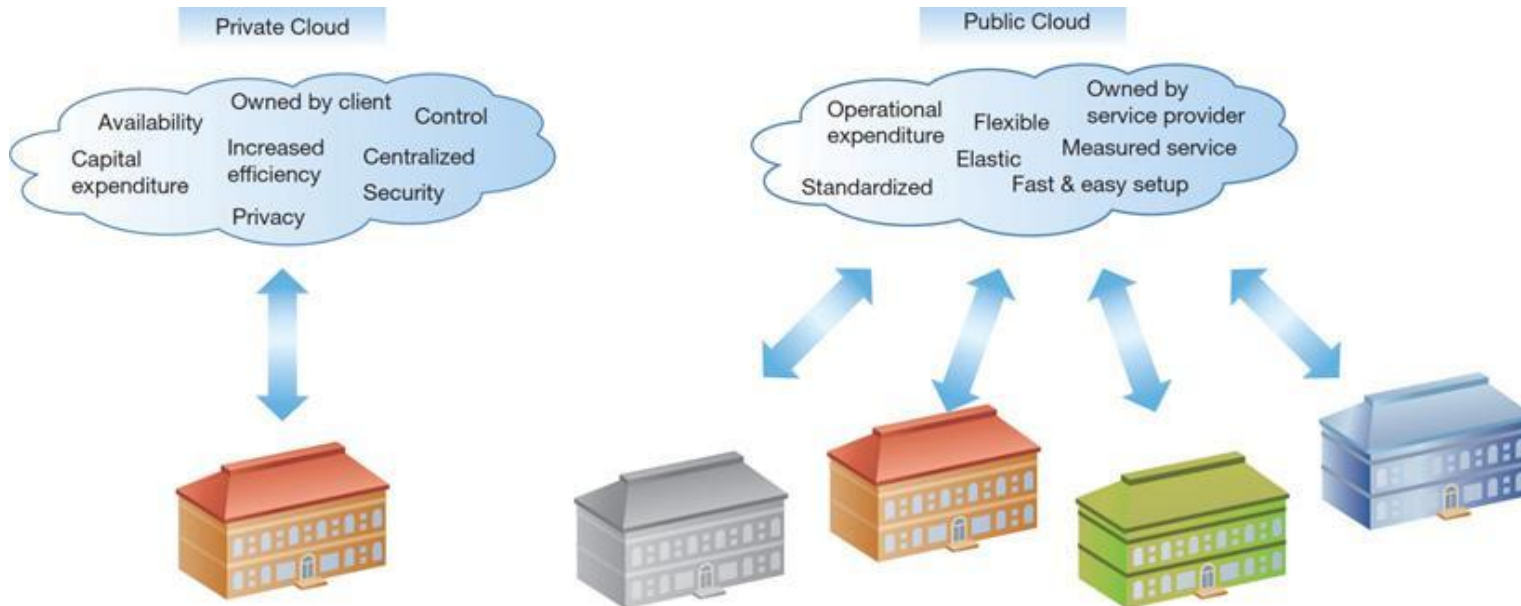
- On-Demand Self Service
- Rapid Elasticity
- Broad Network Access
- Resource Pooling
- Measured Service



# Types of Clouds



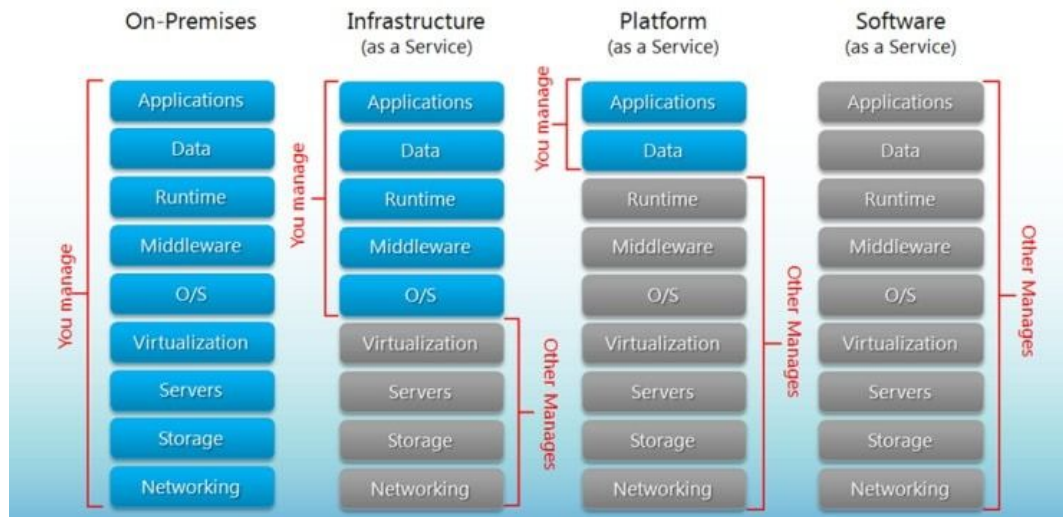
- **Private Clouds:** Pools of computing resources that reside inside an organization and that can be served up for specific tasks as need arrives.
- **Public Clouds:** Services that can be used by any interested party on a pay-per-use basis



# Cloud Computing Service Models

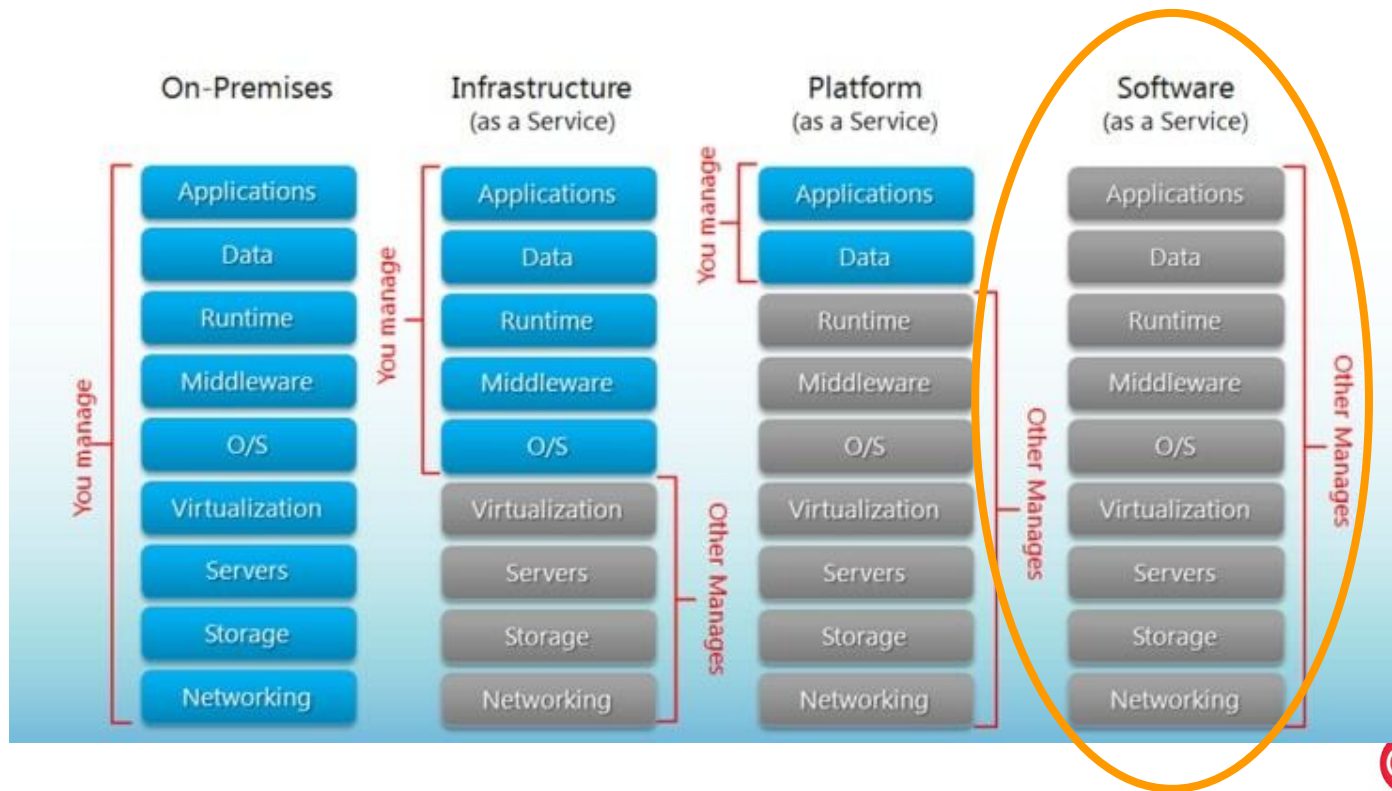


- Replacing computing with services provided over the Internet.
  - Software as a service (SaaS)
    - Software that is made available by a third party online.
  - Utility computing:
    - Platform as a service (PaaS)
    - Infrastructure as a service (IaaS).



# 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

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- 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

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- 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

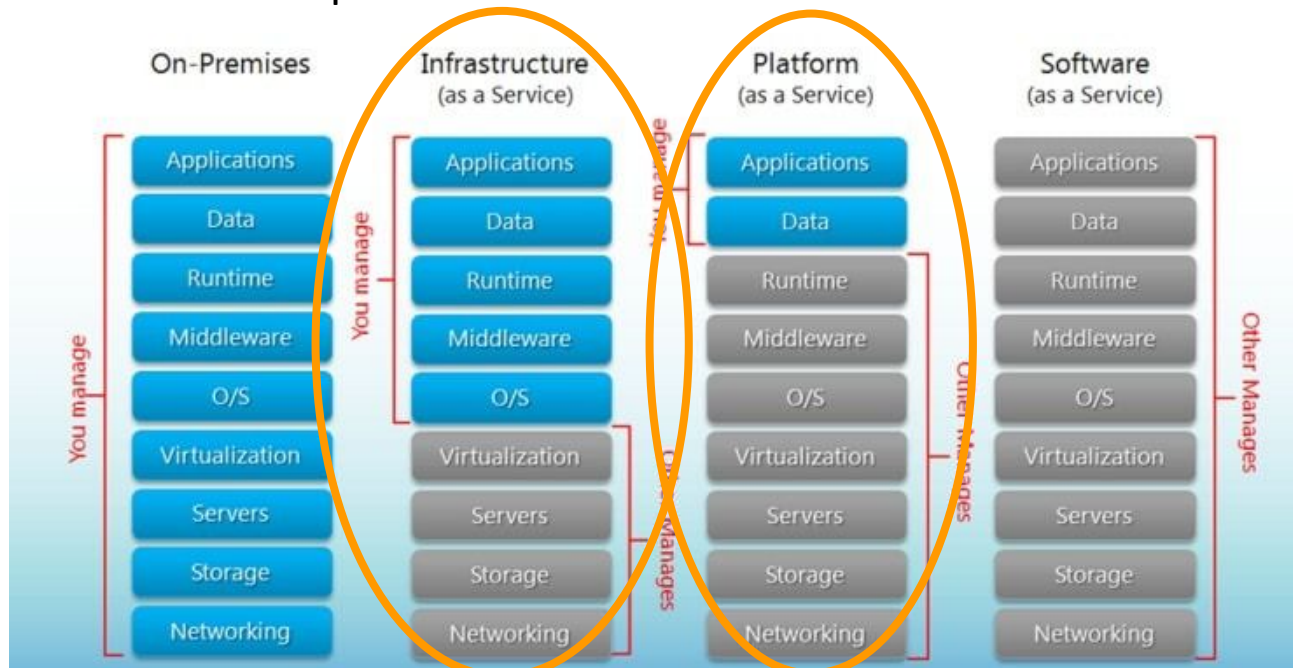
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- Dependence on a single vendor
  - Difficult task of transferring very large data files over the Internet when switching vendor
  - Concern about the long-term viability of partner firms.
- Users may be forced to migrate to new versions.
  - Training 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

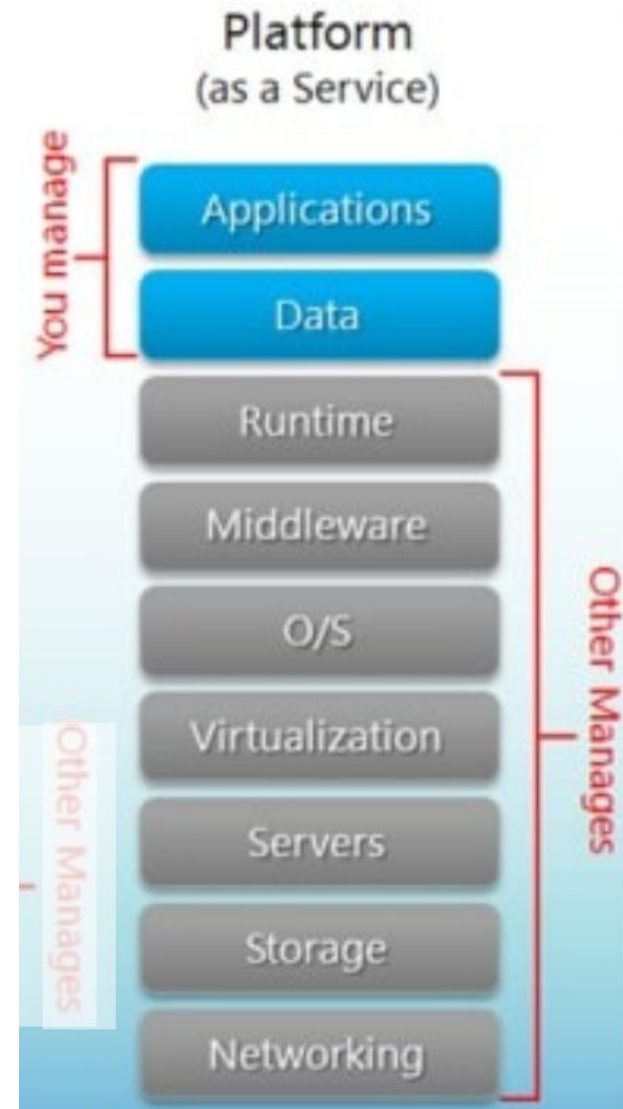
- Platform as a Service (PaaS), Infrastructure as a Service (IaaS)
  - Firm develops its own custom software but wants to pay someone else to run it for them
    - Firm pays for the amount of processing, storage, and telecommunications used.
    - Cloud vendors host firm's software on their systems.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

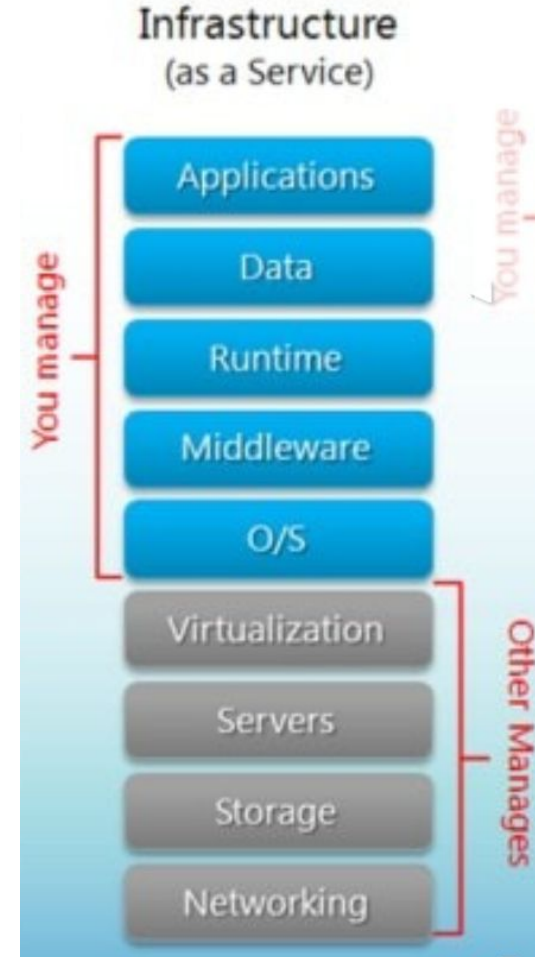
- Services include hardware, operating system, tools, and hosting
- PaaS is the most popular model, accounting for around 32% and expected to grow in 2020.
- AWS Elastic Beanstalk, Heroku, Force.com, Google App Engine, Apache Stratos, Apprenda



# Cloud Providers: PaaS & IaaS



- **Infrastructure as a service (IaaS):** Cloud providers manage 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 OS), Amazon S3, Windows Azure, Rackspace, Google Compute Engine.



# Cloud Providers: Challenges

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- 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

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- 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

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- 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

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- **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.

# 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.

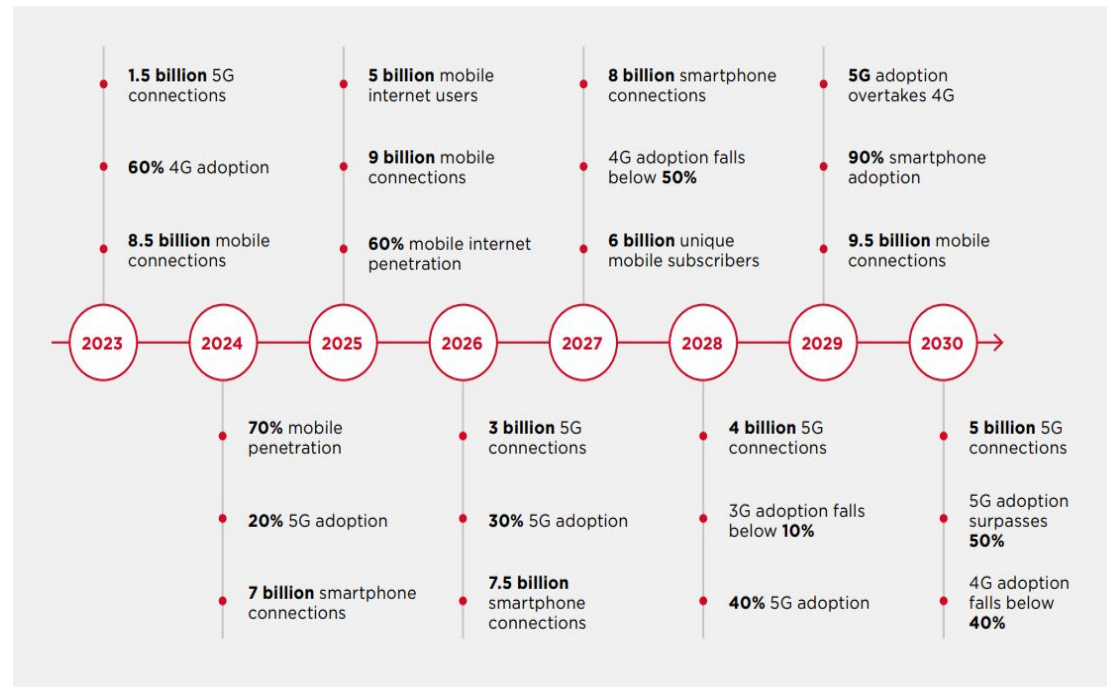


Server-packed shipping container from Oracle's Sun unit

# Mobile Computing

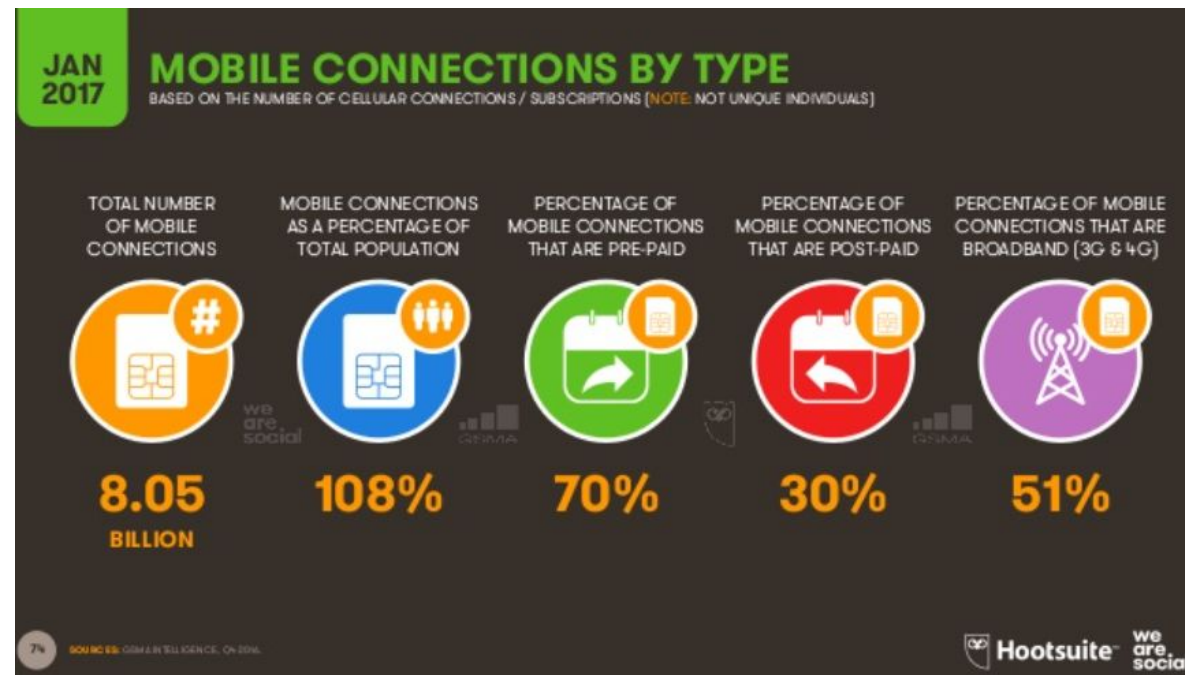
- **Mobile Computing:** Variety of devices that allow people to access data and information from wherever they are
  - Mobile communication
  - Mobile hardware
  - Mobile software
- There are more mobile devices accessing the Internet than there are human beings living on Earth.
  - In **2024**, the 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



# Mobile Computing: Hardware

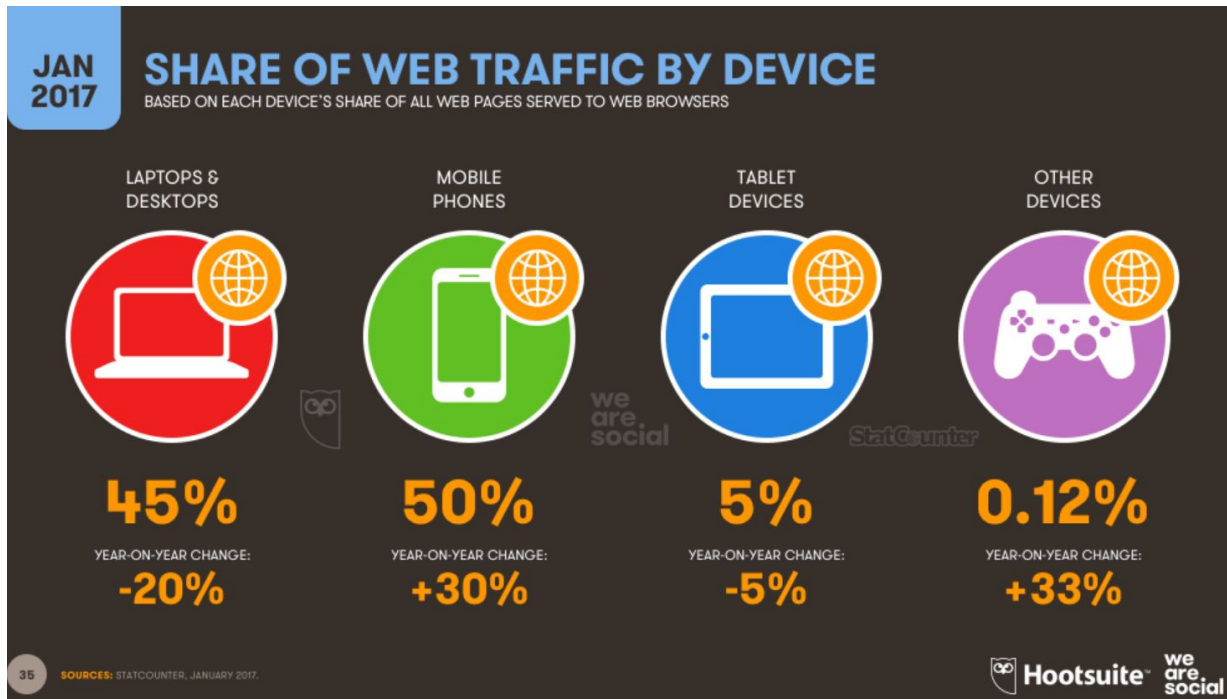
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- Smartphones
  - [History of the Cell Phone](#)
- Tablets
- eReaders
- Scanners
- Point of Sale (POS) device



# 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





# Mobile Computing: Hardware

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



Case



RAM



Keyboard



Network Connection



Motherboard



Hard drive



Mouse



Operating System



CPU



Video Card



Screen

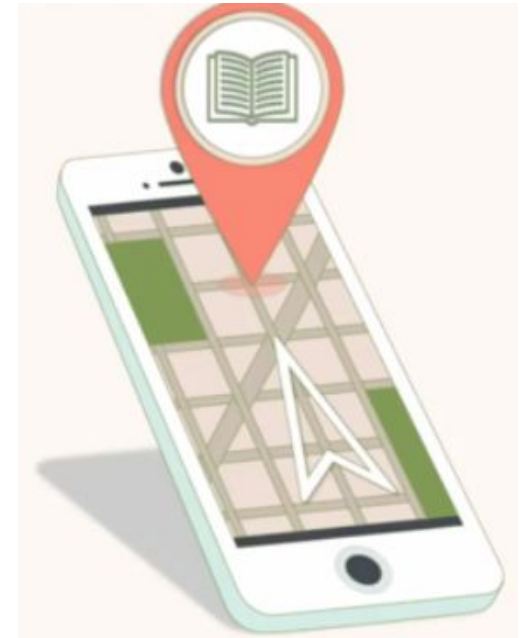


Applications



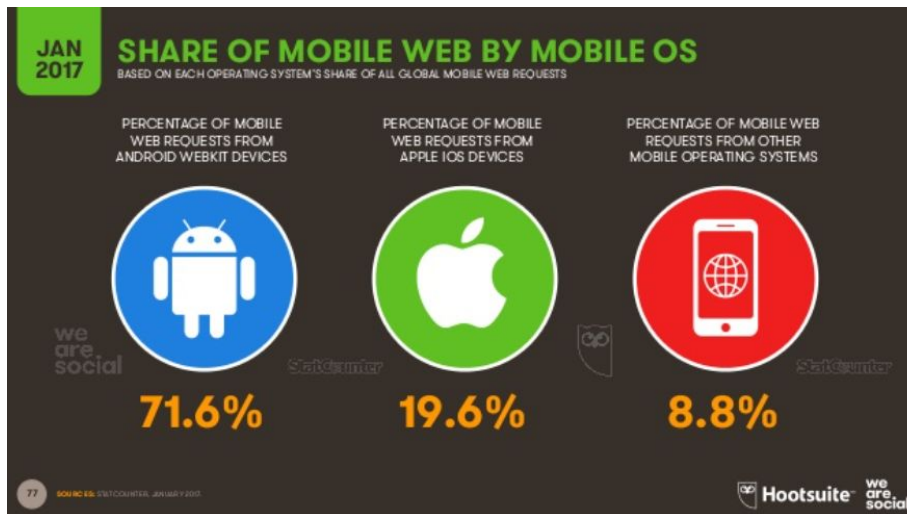
# Mobile Computing: Hardware

- 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



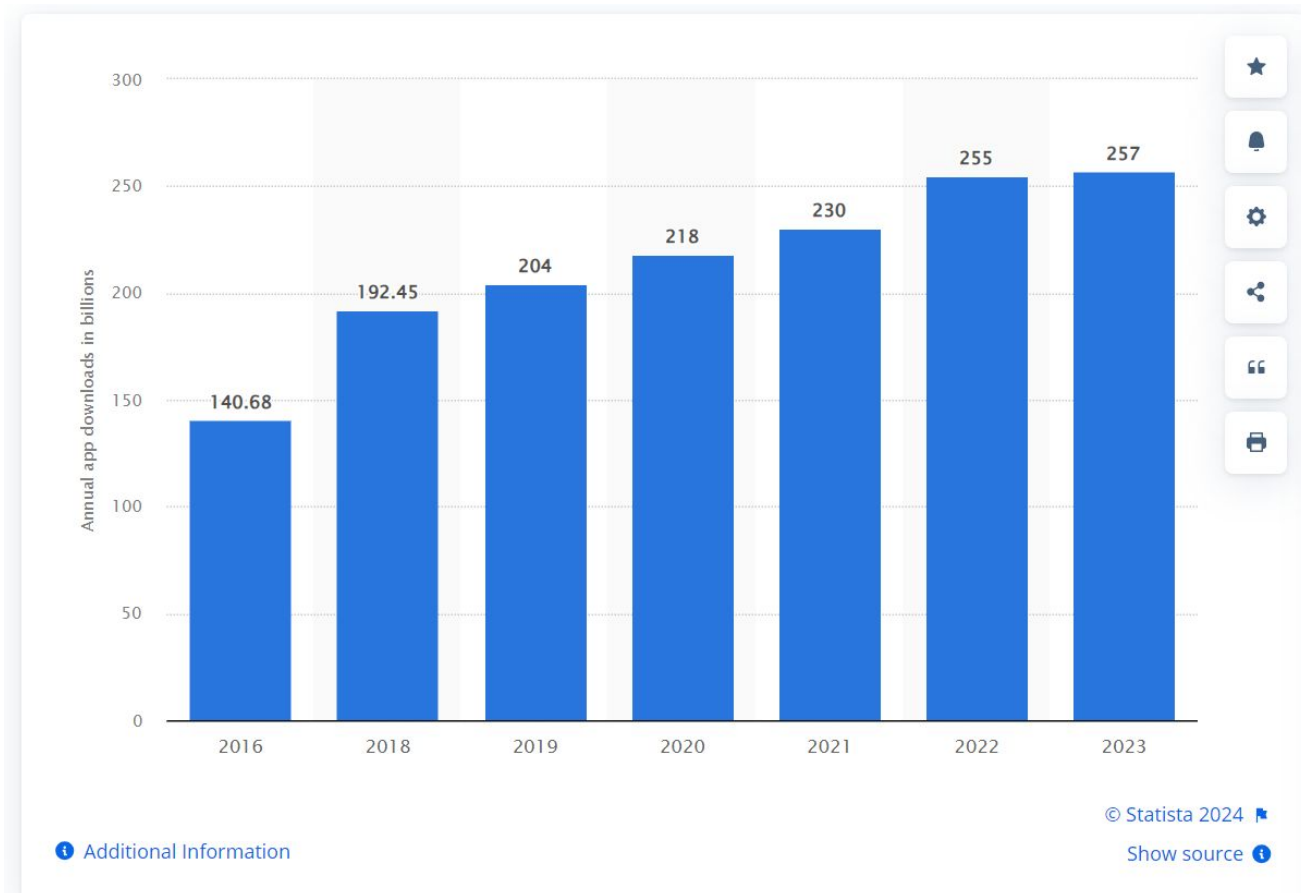
# Mobile Computing: Operating Systems

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

# Mobile Computing: Applications

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

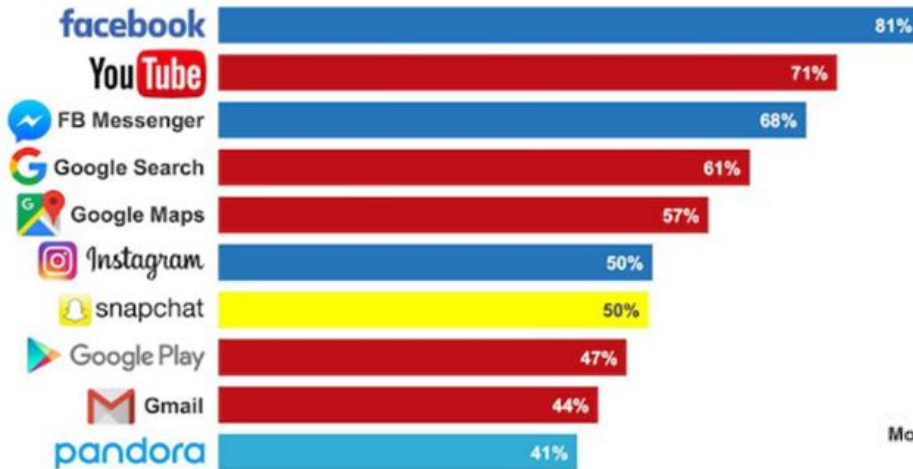


<https://www.statista.com/statistics/271644/worldwide-free-and-paid-mobile-app-store-downloads/#:~:text=While%20the%20number%20of%20downloads,year%2Dover%2Dyear%20increase.>

# Mobile Computing: Applications

## Top 10 Mobile Apps by Penetration of App Audience

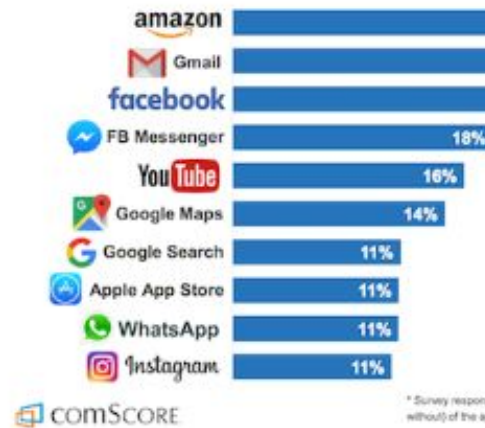
Source: comScore Mobile Metrix, U.S., Age 18+, June 2017



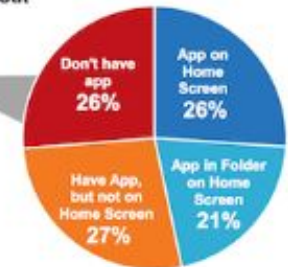
Source: [comScore](http://comscore.com)

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

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



Source: [comScore](http://comscore.com)



\* 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.

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# Mobile Computing: App Revenue Models

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- 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

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- 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/>

- Development with iOS and Android Differences

	iOS Apple	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](http://njit.edu), Guide Basics Mobile App Development



# Mobile Computing: App Development Basics

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- 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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