

MOBILE COMPUTING

CSE-4225



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The Comprehensive Academic Study Platform for University Students in Bangladesh (www.onebyzeroedu.com)

Course Goals

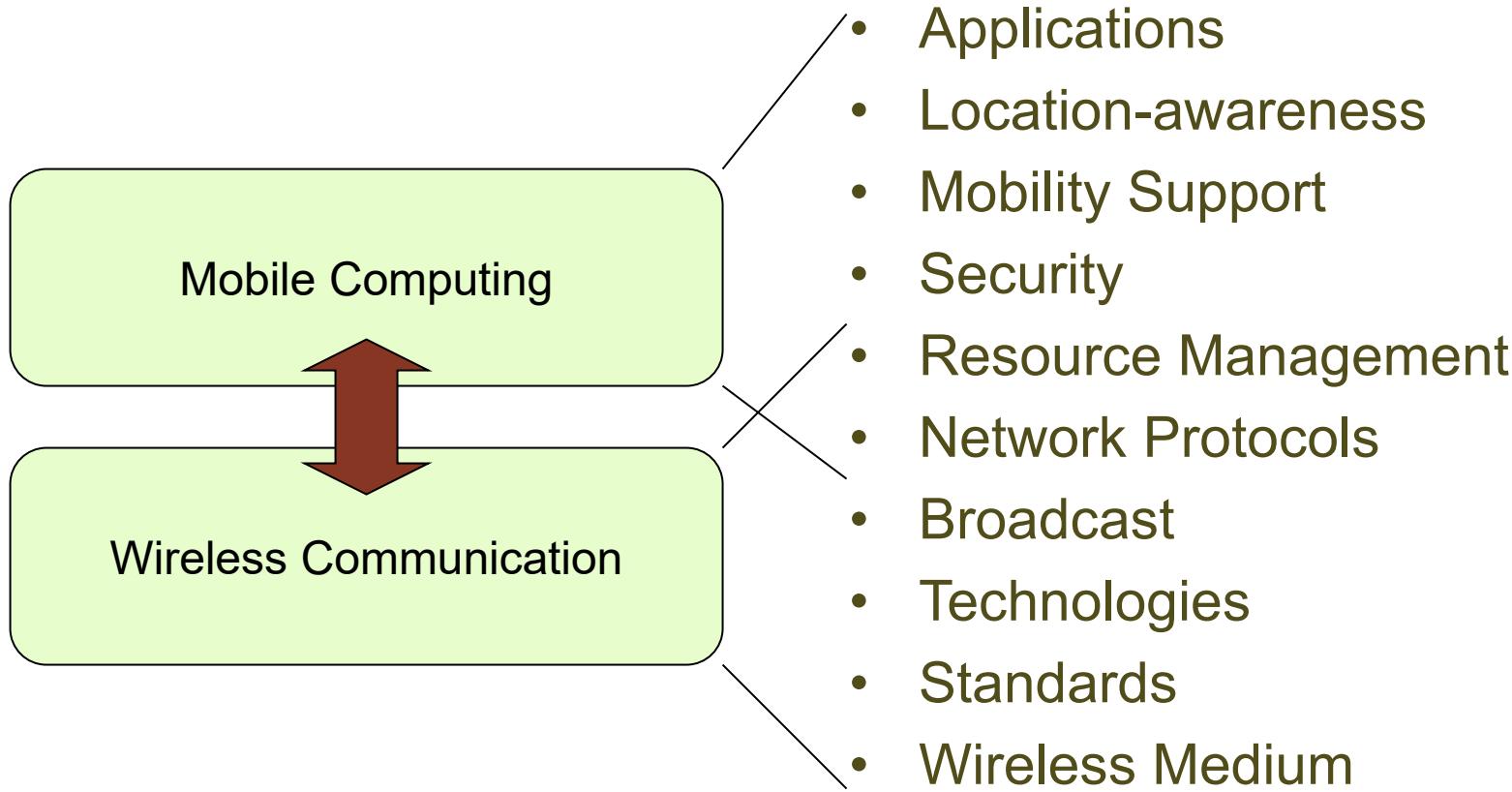
- Fundamentals of mobile computing
- Fundamentals of wireless networking
- Topics from closely related areas:
 - Pervasive Computing
 - Wearables
 - Internet of Things
 - Real-Time Systems
 - Embedded Systems
 - Wireless sensor networks
- Acquire and practice development skills

Mobile Computing (MC)



- Umbrella term used to describe technologies that enable people to access services **anytime** and **anywhere**
- Allows transmission of **data, voice and video** via a **computer or any other wireless enabled device** without having to be connected to a fixed physical link
- Main concept involves
 - Mobile Communication
 - Mobile Hardware
 - Mobile Software

Mobile Computing



Wired vs Wireless

• **Wired Networks**

- high bandwidth
- low bandwidth variability
- can listen on wire
- high power machines
- high resource machines
- need physical access (security)
- low delay
- connected operation

• **Mobile Networks**

- low bandwidth
- high bandwidth variability
- hidden terminal problem
- low power machines
- low resource machines
- need proximity
- higher delay
- disconnected operation

Main Concept: Mobile Comm.

- Refers infrastructure to ensure seamless and reliable communication
- Protocols, services, bandwidth, and portals
- No collision with other existing systems (as well as same service)

Main Concept: Mobile H/W

- Includes mobile devices or device components that receive or access the service of mobility
- Capable of sensing and receiving signals
- Capable of sending and receiving signals at the same time
 - Which transmission mode?
- Example
 - portable laptops, smartphones, tablet PCs, Personal Digital Assistants

Main Concept: Mobile S/W



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Mobile Computing: Aspects

- **User Mobility**

- Users communicate “anytime, anywhere, with anyone”
- Example: read/write email on web browser

- **Device Portability**

- Can be connected anytime, anywhere to the network (using different mechanisms)

- **Communication Device Characteristics**

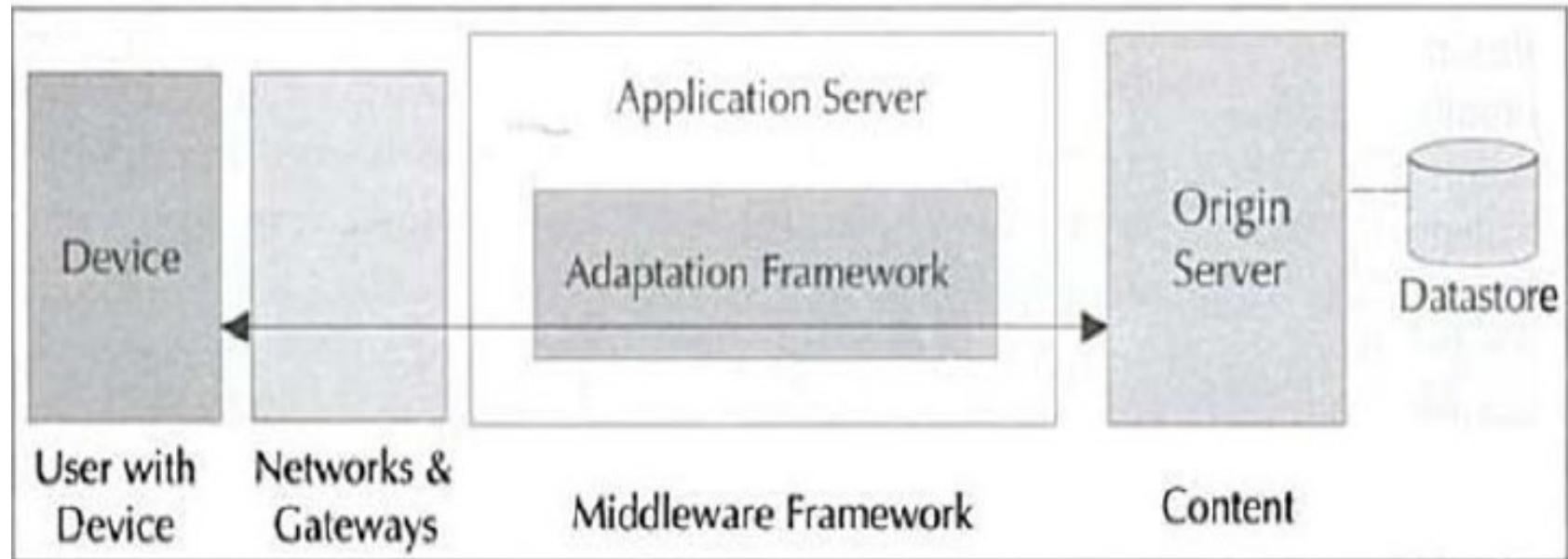
- Fixed and wired
- Mobile and wired
- Fixed and wireless
- Mobile and wireless (most interesting)
 - Most successful: GSM with more than 800 million users

Mobile Computing: Functions

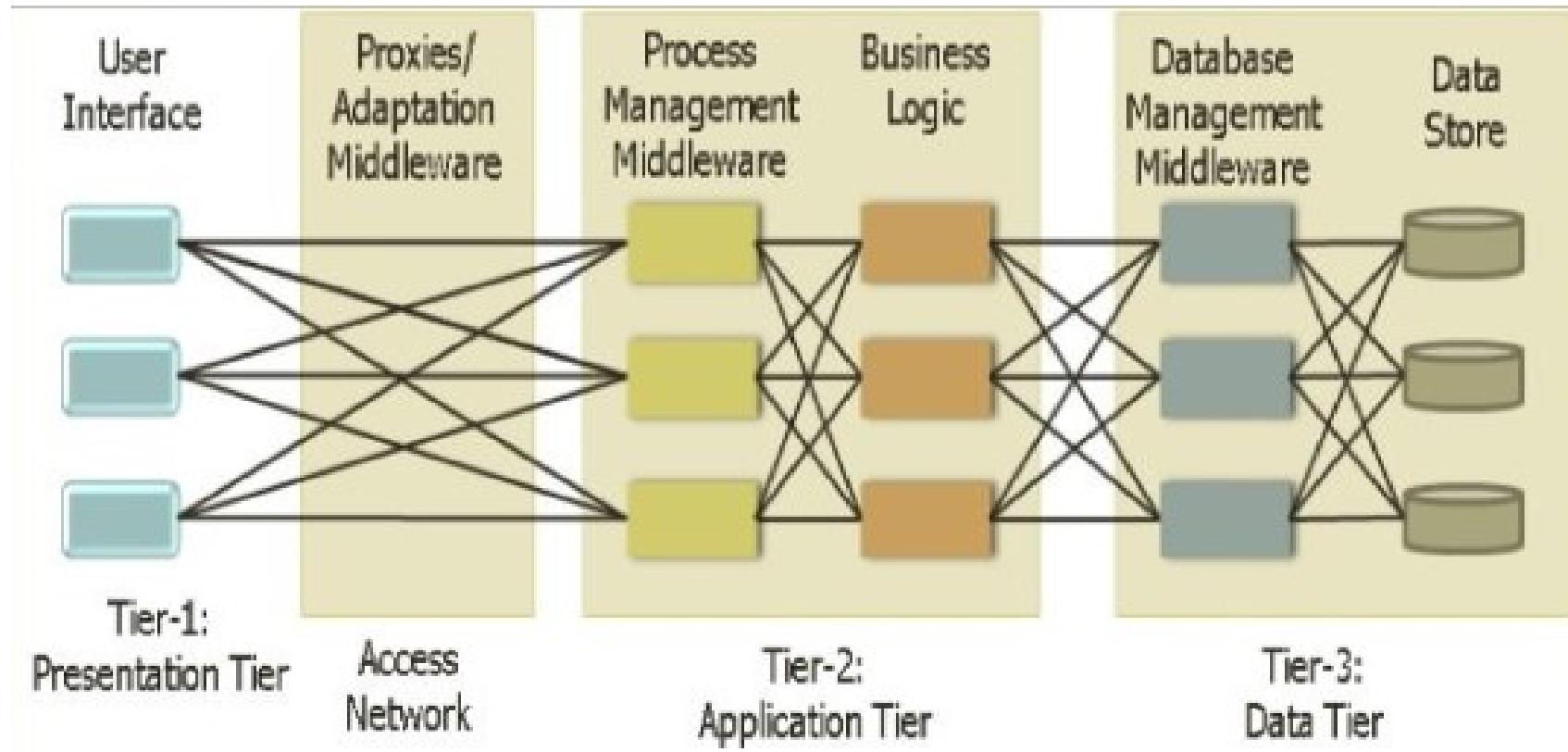
- **User Mobility**
- **Device Mobility**
- **Network Mobility**
 - Able to move from one network to another network (can be another country)
- **Bearer Mobility**
 - Allows a device to change bearers (WLAN, 3G, GPRS) without interruption to the user's data sessions
- **Session Mobility**
 - Able to move from one user-agent (acting on behalf of a user, such as a web browser) environment to another
- **Service Mobility**
 - Able to move from one service to another
- **Host Mobility**
 - Either a client or server

Logical Functions of MC

- User with device
- Network
- Gateways
- Middleware
- Contents



Mobile Computing: Architecture



Mobile Computing: Architecture

- **Presentation Layer (UI)**

- Presents data to the user
- Permits data manipulation and data entry
- Requests the data from Business layer
- Accomplished through use of Dynamic HTML and client-side data sources and data cursors

Mobile Computing: Architecture

- **Business Logic Layer**

- Acts as the server for client requests from workstations according to Business rules fetch or insert data through the Data Layer
- Determines what data is needed (and where it is located) and acts as a client in relation to a third tier of programming that might be located on a local or mainframe computer
- As not tied to a specific client, it can be used by all applications and can be moved to different locations, as response time and other rules require

Mobile Computing: Architecture

- **Data Access Layer**

- Made up of the DBMS that provides all the data for the above two layers.
- Avoiding dependencies on the storage mechanisms
 - Allows for **updates or changes** without the application tier clients being affected by or even aware of the change

Mobile Computing: Applications

- **Vehicles**
- **Emergencies**
- **Business**
- **Credit Card Verification**
- **Infotainment**
 - Broadcast material that is intended both to entertain and to inform
- Where not?

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Mobile Computing: Limitations

- Resource constraints: Battery
- Interference
- Bandwidth
- Dynamic changes in communication environment
- Network Issues
- Interoperability issues
 - varying protocol standards
- Security constraints

Example: Smartphone

- **Portability:** carry it anywhere you want
- **Miniaturization:** make it possible to build device to fit in your pocket
- **Connectivity:** Wi-Fi, LTE/4G, cellular, Bluetooth
- **Convergence:** phone, camera, gaming device, movie streaming, music player, ...
- **Divergence:** ?
- **Applications:** “Rise of the Apps”
- **Digital Ecosystem:** social networks, distributed gaming, video streaming, work apps, ...

App Store (iOS)

- 2003: iTunes Music Store
- 2008: iPhone App Store (iPhone 3G with App Store support)
- 2015: > 100 billion app downloads
- 2016: > 2 million apps
- 2016: China biggest App Store market
- 2016: App developers earned \$20 billions
- Most downloaded app: Minecraft Pocket Edition (paid) and Pokemon GO (free)

Trends in Mobile: Phone Subscribers

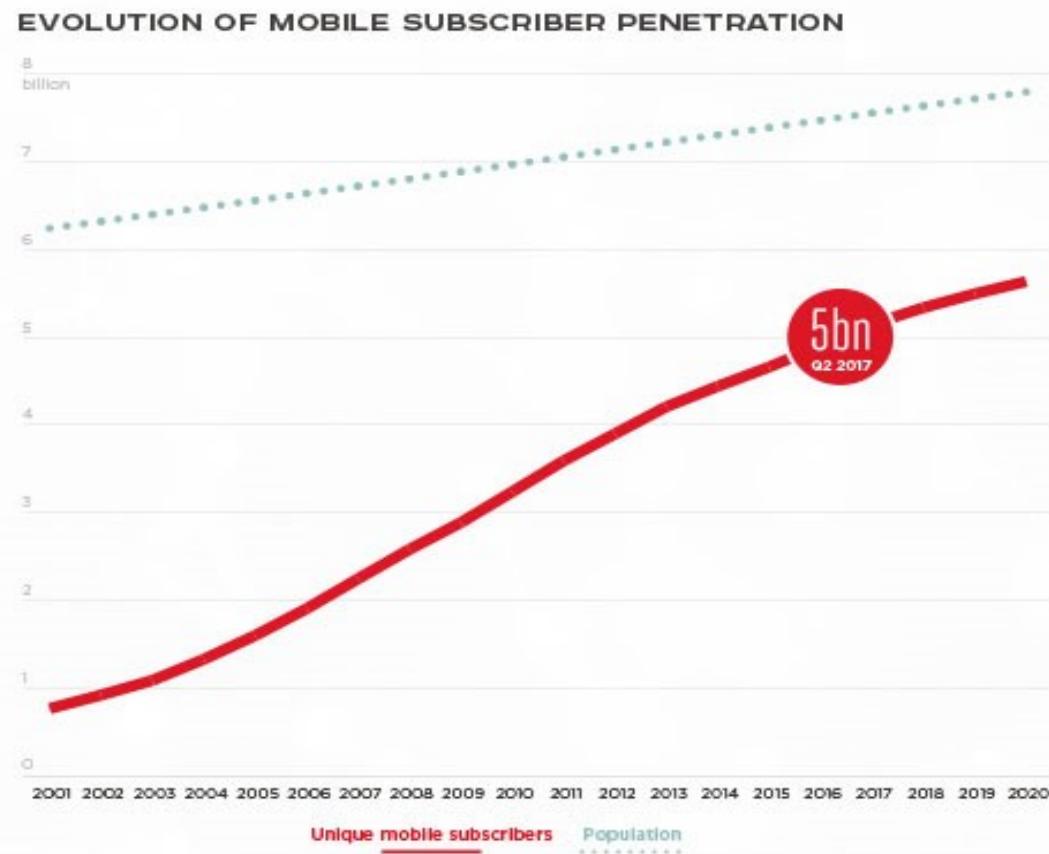


1 5 billion people now use mobile – the highest scale consumer tech worldwide

Key takeaways 4

Two thirds of the global population are now mobile subscribers; mobile has a greater reach than any other technology.

However, the rate of growth is slowing. It took four years to move from 4 billion to 5 billion; reaching 6 billion will take longer still.



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Trends in Mobile: Shopping



In stores, **82% of smartphone users** turn to their devices to help them **make a product decision**.

SOURCE: Google/Ipsos, "Consumers in the Micro-Moment" study, March 2015, United States. ThinkwithGoogle.com

91% growth in B2B researchers using smartphones throughout the path to purchase



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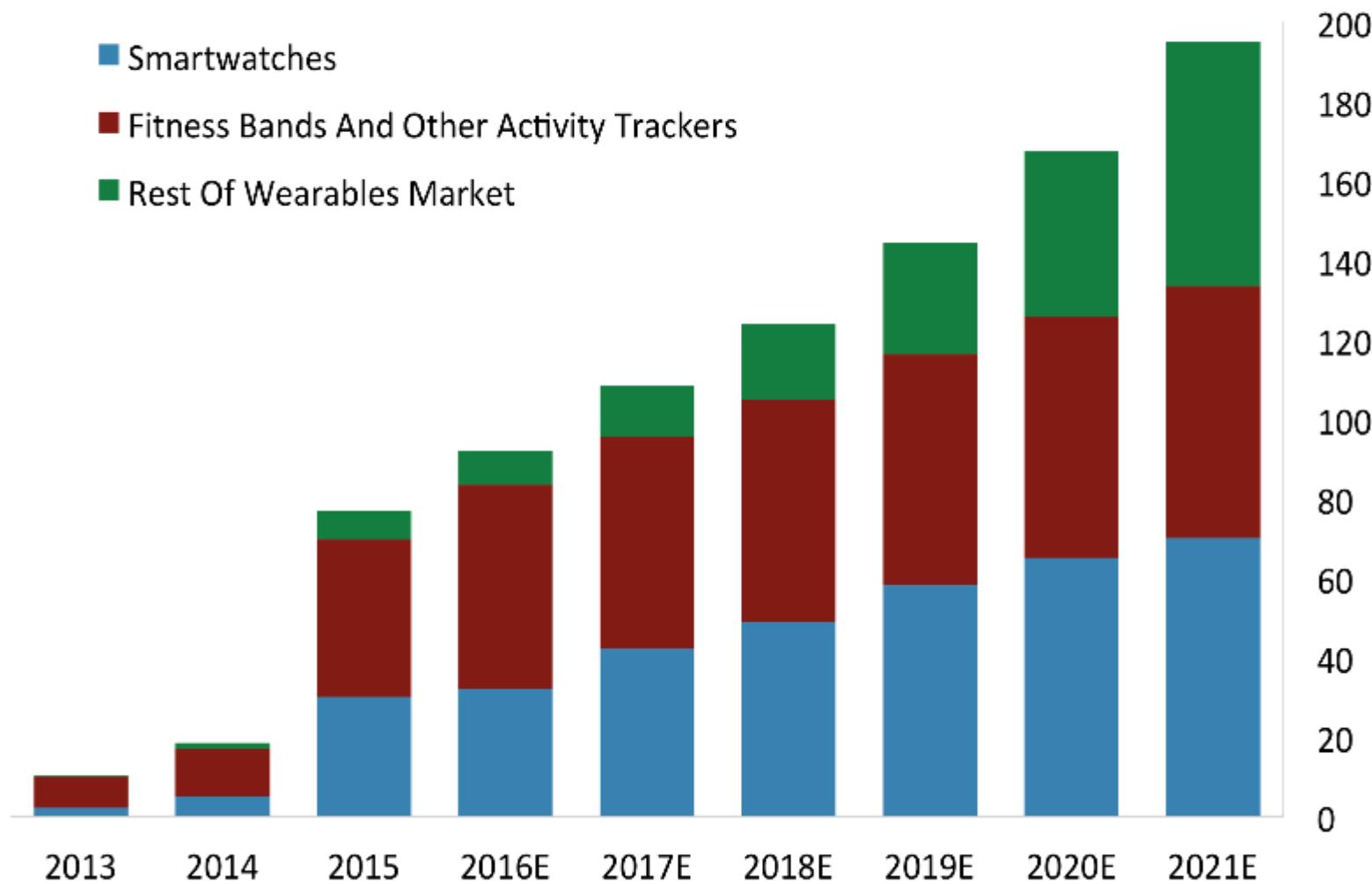
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Global Wearables Shipment Forecast, By Device

Millions



Source: IDC, BI Intelligence estimators

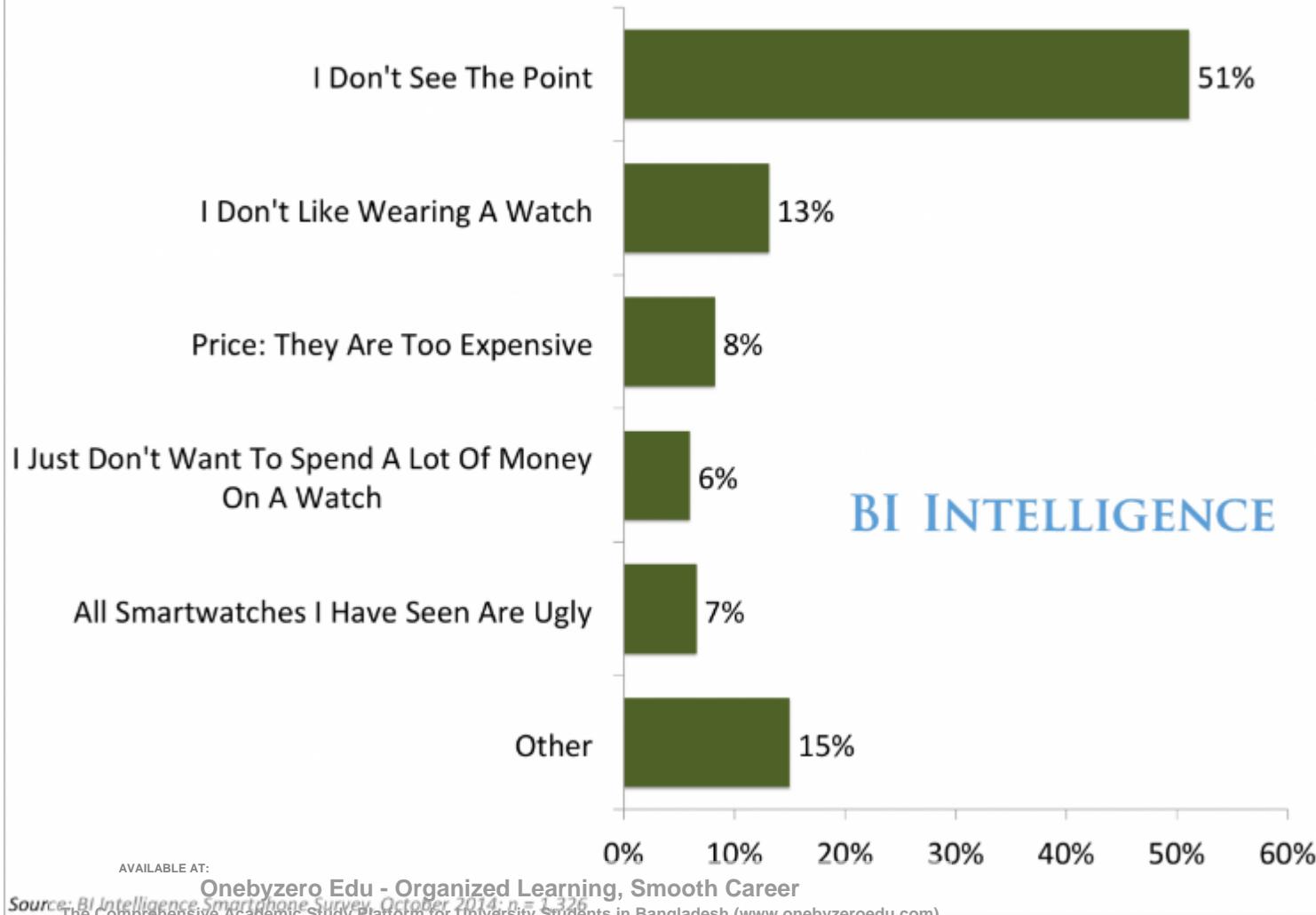
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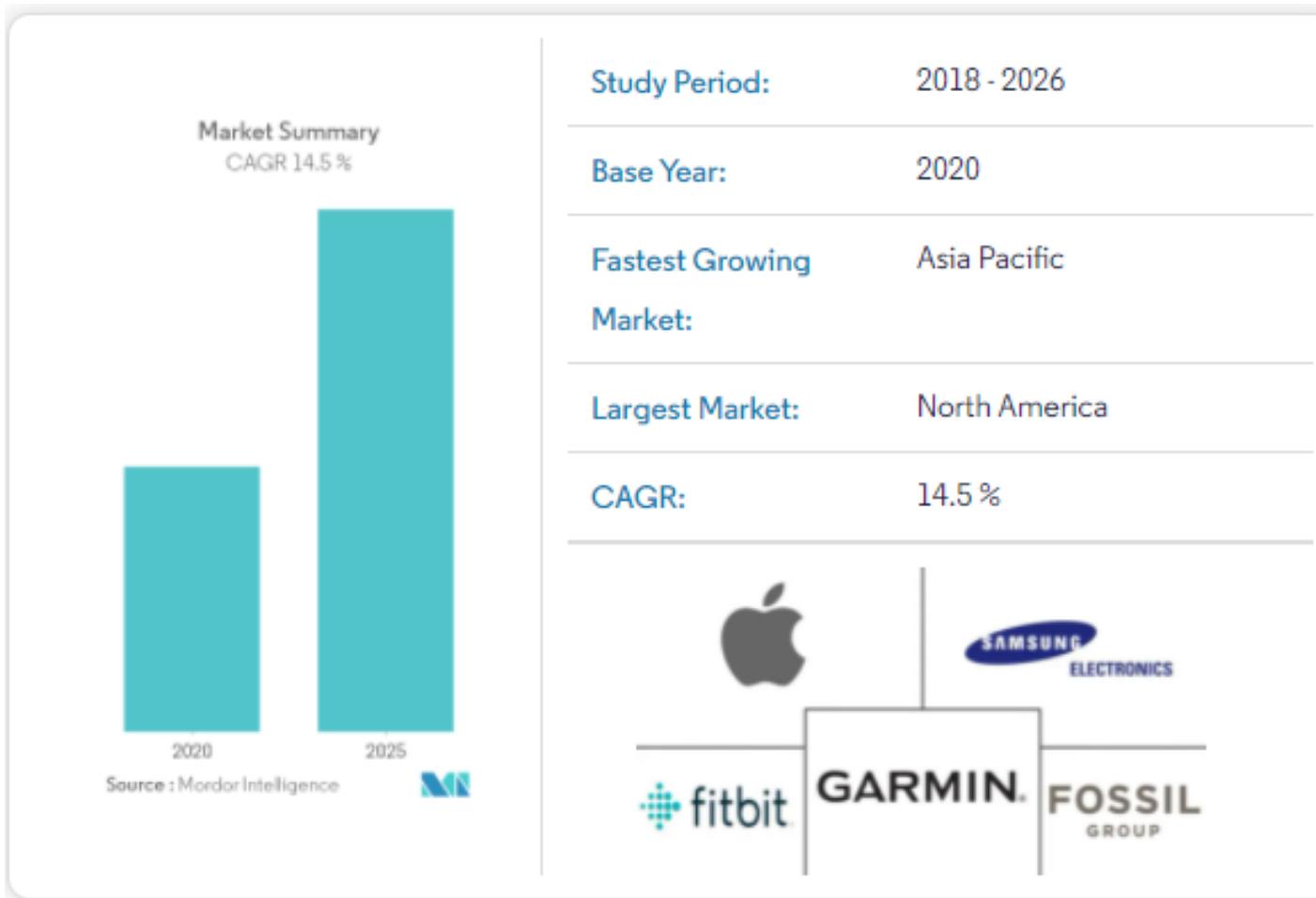
BI INTELLIGENCE

Trends in Mobile: Smart watches

Why Aren't You Interested In A Smartwatch?



Smartwatch Market Size



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Trends in Mobile: Healthcare

HEALTHCARE MARKET TRENDS

The web is crucial for healthcare

VIDEO INSIGHTS

Consumers are skipping the personal trainer and getting fit through YouTube videos.

Health and fitness channel **TONE IT UP** has over **20 MILLION VIDEO VIEWS**

Source: Youtube.com/user/Toneitup.com

SEARCH INSIGHTS

Health consumers buy more diet and fitness products in the Summer than any other season.

Season	Percentage
Summer	41%
Spring	29%
Winter	22%
Fall	8%

Source: Google/The Modifiers, Health Conscious Consumer Study, September 2013.

PATH TO PURCHASE

88% of those looking for health information start with **SEARCH ENGINES**.

Source: 2012 Google/Comperem Treatment Study

SEARCH TRENDS BY DEVICE

Year over year the number of consumers using mobile devices to stay healthy has doubled.

HEALTH CARE SERVICES

Device	Q4 2012	Q4 2013
Smartphone	29%	36%
Tablet	7%	8%
Desktop	64%	56%

NUTRITION & DIETING

Device	Q4 2012	Q4 2013
Smartphone	29%	37%
Tablet	9%	10%
Desktop	62%	53%

Source: Google Internal Data.

CONSUMER INSIGHTS

HOSPITAL ADMINISTRATORS

80% contact a vendor directly after an online search.

Source: Google and HIMSS Analytics, Hospital Decision Makers Study, May 2013

BABY BOOMERS

57% of BABY BOOMERS have searched for healthcare and wellness information online.

Source: Inside Look at Boomer Healthcare Consumers, 2010

WEIGHT LOSS

80% of those looking for weight loss, rated search as **EXTREMELY IMPORTANT** to their decision process.

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KEY INSIGHTS

When patients see a paid search ad, they take ACTION...

Action	Percentage
Conduct searches for more info	26%
Begin the research process	38%
Visit the website of treatment center that was advertised	39%
Consider a treatment center that was advertised	36%

Source: 2012 Google/Comperem Treatment Study

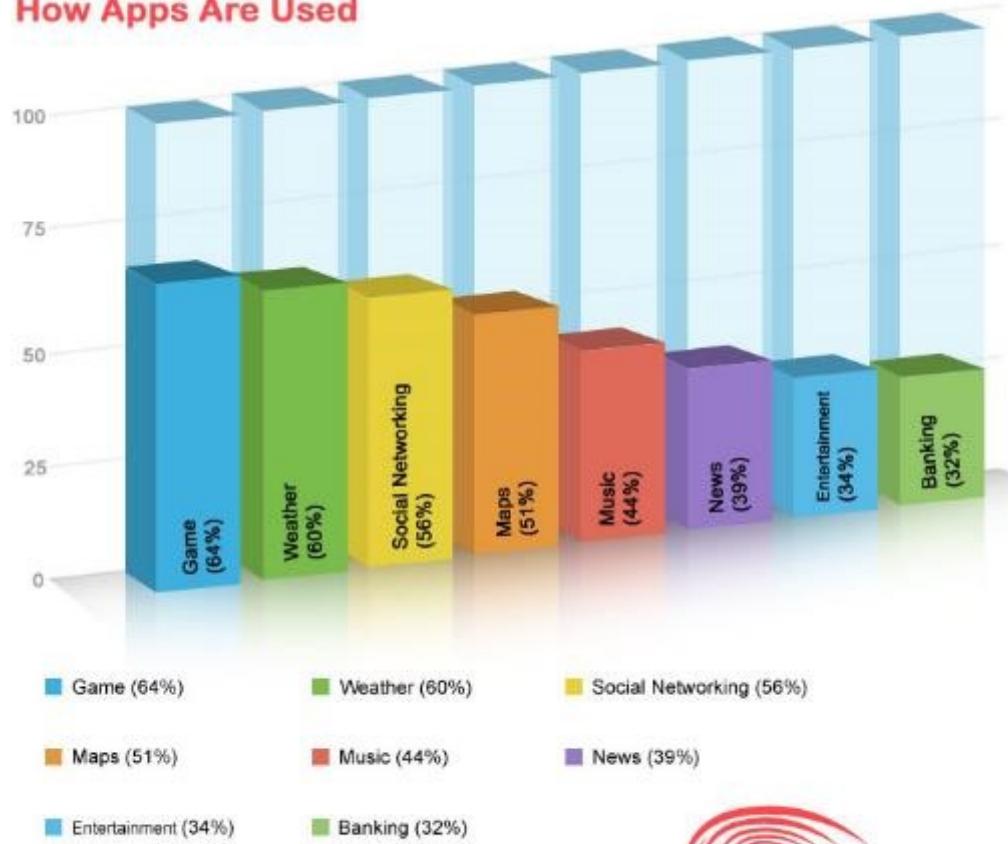
GOOGLE SOLUTIONS DRIVE RESULTS

Simple and easy to use

Google

Trends in Mobile: Apps

How Apps Are Used



Source: Nielsen

Website: www.crispycodes.com | Email: info@crispycodes.com

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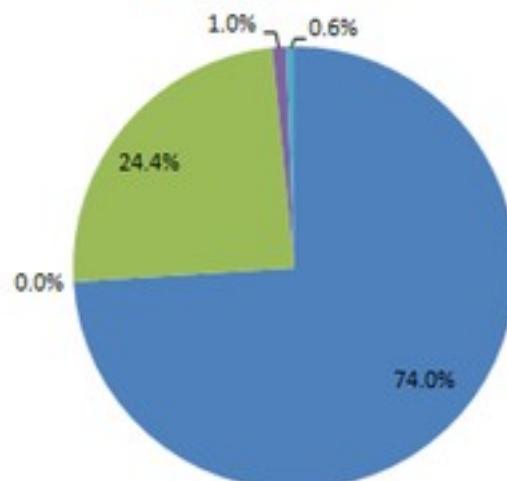
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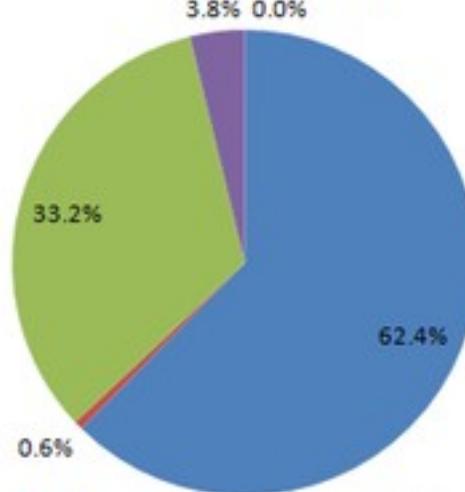
Trends in Mobile: Smartphone OS

Smartphone Operating System Market Share

China April 2015



USA April 2015



■ Android ■ BlackBerry ■ iOS ■ Windows ■ Other ■ Android ■ BlackBerry ■ iOS ■ Windows ■ Other

Market Realist

Source: Kantar World Panel

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Trends in Mobile: Apps

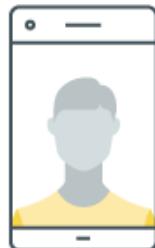


iOS App Statistics

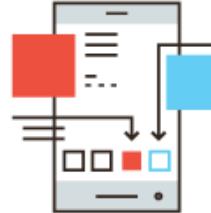
In addition to announcing iOS 9, the newest OS X, and a new streaming music service at their annual developer conference WWDC, Apple this week announced some pretty staggering statistics from the App Store. Here's a summary:



100 billion
apps downloaded
since 2008



119
apps downloaded
per iOS user



1.5 million
apps in the
App Store



850
apps downloaded
per second



AVAILABLE AT:

<http://www.macrumors.com/2015/06/08/app-store-surpasses-100-billion/>

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Trends in Mobile: Students



NEARLY ALL STUDENTS
TEXT EVERYDAY...

Send texts everyday

YES **94%** NO **06%**



...MUCH MORE THAN
MAKE CALLS EVERYDAY.

Make calls everyday

YES **73%** NO **27%**



TECH ADDICTION? MANY
STUDENTS EXPERIENCE IT.

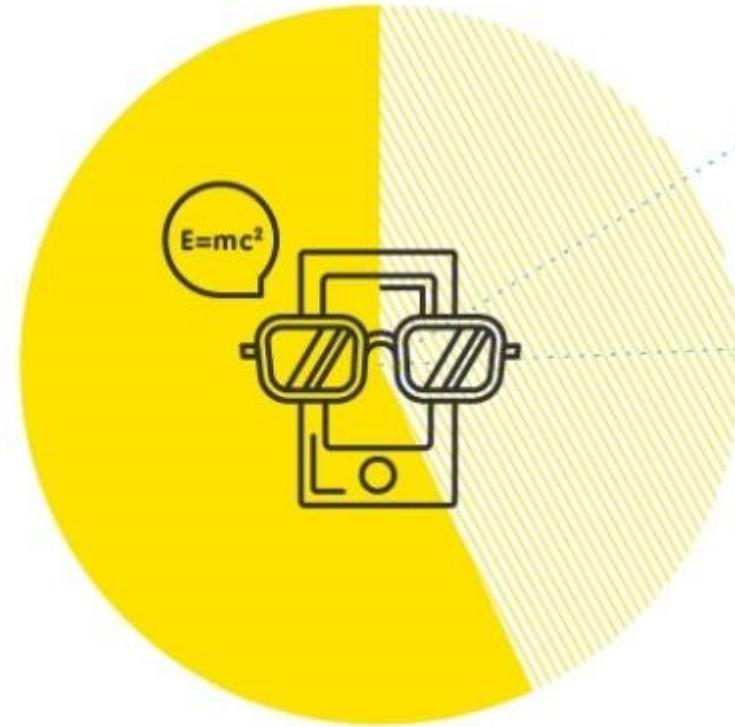
Sometimes feel 'addicted'
to phone

YES **60%** NO **40%**

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Trends in Mobile: Students



SMARTPHONE: **57%** BASIC: **43%**
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IPHONE AND ANDROID ARE NECK-AND-NECK FOR THE TOP SPOT

IPHONE	42%
ANDROID	43%
BLACKBERRY	12%
WINDOWS 7	02%

NEARLY ALL SMARTPHONE OWNERS USE THEM FOR SOCIAL NETWORKING...
Use phone for social networking:
YES 97% **NO 03%**



BUT LUCKILY, CHEATING ON A PHONE IS RARE

Has cheated on test with phone

YES 13% **NO 87%**