

CELL PHONE BASICS

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An International
Association of Technology
& Computer User Groups

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SUMMARY

Your smart Android or iPhone cell phone is actually 5+ separate radio transmitter-receivers in a very compact device. If you get a working understanding the petty details of these 5+ transmitter-receivers, you can make better use of your smart cell phone and save money.

TOPICS

- Two Types of Cell Phones
- SIM versus eSIM
- Basic Uses For a Smart Cell Phone
- 5+ Transmitter-receivers In A Smart Cell Phone
- Not Having a Data Plan
- Having a Data Plan But Using It Wisely

TWO TYPES OF CELL PHONES

- "iPhones.." from Apple
- Android phones from all other manufacturers

TWO TYPES OF CELL PHONES

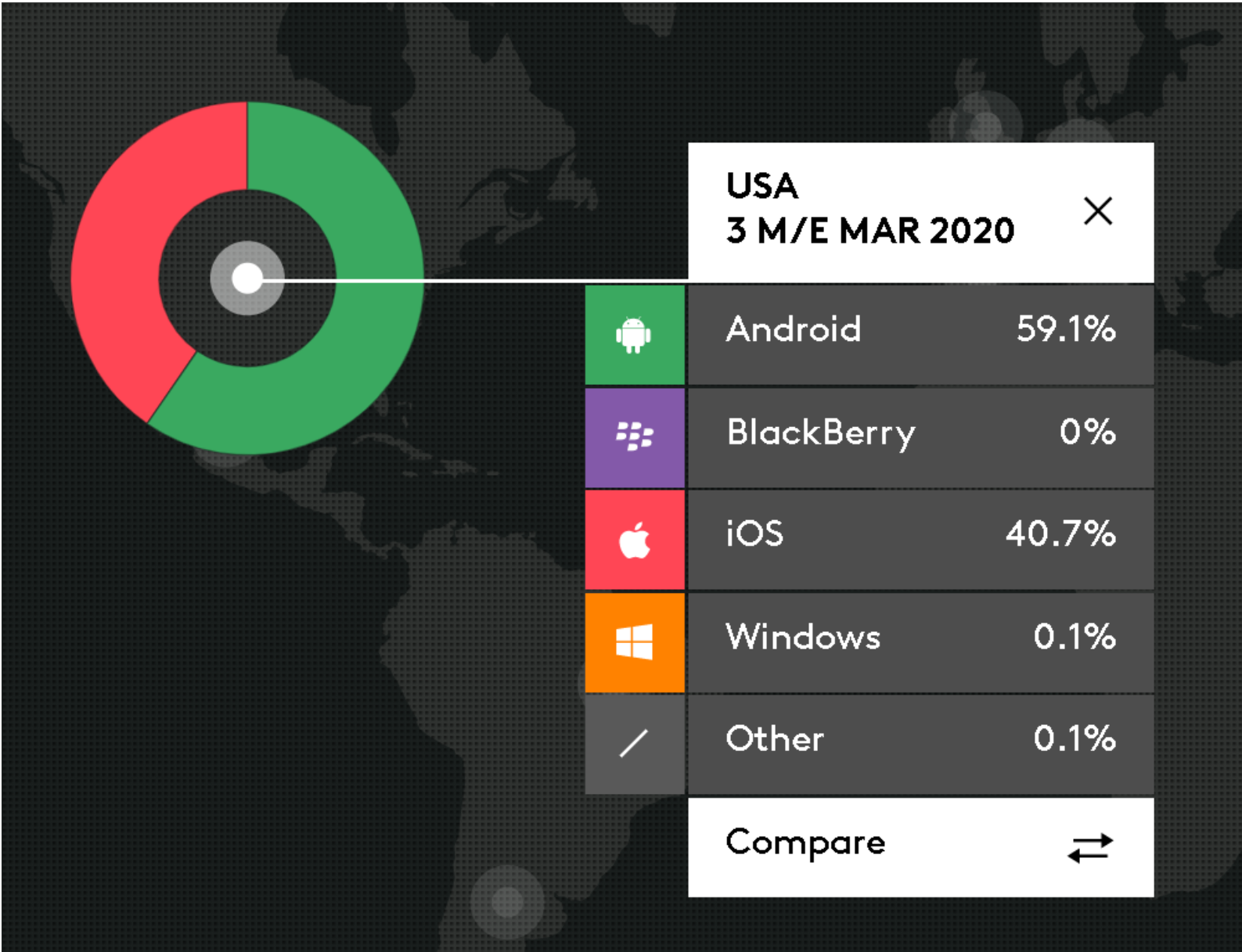
(continued)

- "iPhones" run Apple's iOS operating system
- "Android" phones run "Android" which is a "modified version of the Linux kernel and other open source software" as explained at [https://en.wikipedia.org/wiki/Android_\(operating_system\)](https://en.wikipedia.org/wiki/Android_(operating_system))

TWO TYPES OF CELL PHONES

(continued)

- As of March 2020 for the U.S.A.:
iPhones (running the iOS operating system) had about 40 percent of the usage share
AND
Android phones had about 60 percent of usage share:



USA
3 M/E MAR 2020



Android 59.1%



BlackBerry 0%



iOS 40.7%



Windows 0.1%



Other 0.1%

USA
3 M/E MAR 2020



Android

59.1%



BlackBerry

0%



iOS

40.7%








Windows

0.1%



Other

0.1%

USA		
3 M/E MAR 2020		
	Android	59.1%
	BlackBerry	0%
	iOS	40.7%
	Windows	0.1%
	Other	0.1%

TWO TYPES OF CELL PHONES

- This is "usage share".
Most statistics that you find will show "shipments per quarter or year" in terms of of "dollars" and they will show higher values for iPhones because iPhones average much higher in average price relative to Android cell phones.

TWO TYPES OF SMART CELL PHONES

- Source for the previous slides:
<https://www.kantarworldpanel.com/global/smartphone-os-market-share/>

TWO TYPES OF SMART CELL PHONES

- According to the previous source, the usage share of Android cell phones is much higher relative to iPhones outside of the U.S.A.

TWO TYPES OF SMART CELL PHONES

- Source for previous slides:
<https://www.kantarworldpanel.com/global/smartphone-os-market-share/>

SIM VERSUS eSIM

- SIM = "Subscriber Identity Module"
- eSIM = "embedded Subscriber Identity Module"

SIM VERSUS eSIM (continued)

- With the exception of really-old now-obsolete phones that were locked to run on Verizon's former "CDMA" system, all current cell phones have at least one SIM slot in them.

SIM VERSUS eSIM (continued)

- "CDMA"

= "Code-Division Multiple Access" =
former cell phone system that
Verizon utilized in in the United
States until 1 year ago

The Verizon cell phone carrier will
no longer support "CDMA" phones
at the end of the 2020 calendar year.



SIM VERSUS eSIM (continued)

- An eSIM module is actually a chip inside the cell phone that you or your cellular phone salesperson configures using either a special carrier-provided app or using the "Settings" function inside a cell phone:

SIM VERSUS eSIM (continued)

- To configure an eSIM inside an iPhone XS or higher, see [https://appletoolbox.com/how-to-use-dual-sim-and-esim-on-iphone-xr-and-xs/#How To Set-Up eSIM on Your iPhone](https://appletoolbox.com/how-to-use-dual-sim-and-esim-on-iphone-xr-and-xs/#How_To_Set_Up_eSIM_on_Your_iPhone)

SIM VERSUS eSIM (continued)

- Some Android cell phones have two SIM slots.

Android phone manufacturers call this "dual SIM" in their specifications.

SIM VERSUS eSIM (continued)

- Some cell phones will have both a SIM slot and an eSIM chip: one example is Apple's iPhone XS and higher models of iPhones. Apple refers to having both a SIM slot and an eSIM as being "dual SIM".

SIM VERSUS eSIM (continued)

- Three different sizes of "SIM" modules:
Most current models of cell phones have a "Nano SIM":
It is about the size of your smallest fingernail:



From left to right: Standard SIM, Micro SIM and Nano SIM. Picture adapted from [Wikipedia](#) (l

SIM Type	Alternative Name	Length (mm)	Width (mm)	Height (mm)
Standard SIM	2FF or "Mini SIM"	25.00	15.00	0.76
Micro SIM	3FF	15.00	12.00	0.76
Nano SIM	4FF	12.30	8.80	0.67

SIM VERSUS eSIM (continued)

- Source for the previous image:
<https://kenstechtips.com/index.php/smartphone-type-standard-sim-micro-sim-or-nano-sim>

SIM VERSUS eSIM (continued)

- According to

<https://support.apple.com/en-us/HT209044#:~:text=iPhone%20XS%2C%20iPhone%20XS%20Max,nano%2DSIM%20and%20an%20eSIM.&text=An%20eSIM%20is%20a%20digital,use%20a%20physical%20nano%2DSIM> :

iPhone XS, iPhone XS Max, iPhone XR, and later feature Dual SIM with a nano-SIM and an eSIM.¹ An eSIM is a digital SIM that allows you to activate a cellular plan from your carrier without having to use a physical nano-SIM.

SIM VERSUS eSIM (continued)

- See

<https://support.apple.com/en-us/HT202645>

for which model of iPhone has
which model of SIM card

5+ TRANSMITTER-RECEIVERS IN A SMART CELL PHONE

1. Cellular transceiver
2. Wi-Fi transceiver
3. Global Navigation Satellite System receiver (= GPS receiver)
4. Bluetooth transceiver
5. Near-field Communication transceiver (=NFC transceiver)

6+ TRANSMITTER-RECEIVERS IN A SMART CELL PHONE (continued)

6. FM radio receiver (some Androids)
7. "Magnetic Secure Transmission" transmitter (= "MST" transmitter in Samsung Androids only)
8. "IRDA" transmitter
(turns Android phone into a television remote device,
"IRDA" stands for "Infra Red Data Association")

6 TRANSMITTER-RECEIVERS IN A SMART CELL PHONE

- Any smart phone app that does not require an Internet connection for operation (i.e. that does not require a Wi-Fi connection or a data plan) still will require an Internet connection when you are installing an app (for the first time) or when you are upgrading an app

1. CELLULAR TRANSCEIVER

- Transmitter/receivers located at cell tower sites
- Digital signals on most phone calls route to the Public Switched Telephone Network (PSTN)
- Voice traffic for phone calls is mandatory
- Optional "Data Plan" traffic through cell towers usually costs extra

Cell phone

connects via radio waves to
cell tower (of carrier)

connects to

Base Station Controller ("BSC" of carrier)

connects to

Multiple Telephone Switching Office
("MTSO" of carrier)

connects to

Mobile Switching Center ("MSC" of carrier)

connects to

Public Switched Telephone Network (PSTN)

1. CELLULAR TRANSCEIVER (continued)

The next slide uses only the cell system acronyms to save on space:

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

connects to
"PSTN"

1. CELLULAR TRANSCEIVER

(continued)

- When a cell phone calls another cell phone that is using the same carrier, the call is routed between "Mobile Switching Centers" ("MSCs") that belong to the same carrier: the call is NOT routed through the "Public Switched Telephone Network":

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

connects to
"PSTN"

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

connects to
"PSTN"



1. CELLULAR TRANSCEIVER

(continued)

- When a cell phone calls a cell phone of another cell phone carrier or a land-line phone, the call is routed out through the "Public Switched Telephone Network":

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

connects to
"PSTN"

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

connects to
"PSTN"



2. Wi-Fi TRANSCEIVER

802.11n: both 2.45 GHz and 5.0 GHz radio bands

(802.11n = "Wi-Fi 4")

802.11ac: only on 5.0 GHz

(802.11ac = "Wi-Fi 5")

802.11ax: both 2.45 GHz and 5.0 GHz radio bands

(802.11ax = "Wi-Fi 6")

2. Wi-Fi TRANSCEIVER (continued)

- Used to give the phone Internet access for Internet functions
- Most phones can route voice calls over the Internet (instead of through the cell carrier's cell towers) if the Wi-Fi signal that they are connected to are fast enough

2. Wi-Fi TRANSCEIVER (continued)

- Can be used to tether "data plan" Internet access to other devices if "Personal Hotspot" is turned on
- Most map apps and navigation apps use Wi-Fi "triangulation" as part of "location services" to help locate where your phone is located

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER

- All 5 GNSS systems use "Low Earth Orbit" ("LEO") satellites:
 1. GPS = Global Positioning System (US)
 2. GLONASS = Global Navigation Satellite System (Soviet Union)
 3. Galileo (European Union)

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER (continued)

4. BeiDou Navigation Satellite System
(Peoples Republic of China)

5. QZSS = Quasi-Zenith Satellite System
(Japan only)

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER (continued)

- Iphones 6, 7, 8, 10, 11, etc. use the first 4 previously-mentioned GNSSs simultaneously and automatically
- Android phones can use all five of the previously-mentioned GNSSs simultaneously and automatically

3. GLOBAL NAVIGATION SATELLITE SYSTEMs (GNSS) RECEIVER

(continued)

- Most map apps for smart phones use the GNSS receiver as part of it's ability to locate where the phone is located:

See

<https://www.quora.com/Does-Google-Maps-use-GPS-as-well-as-GLONASS-in-Android-smartphones>

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER (continued)

- Specialized smart phone apps can use the GSP transmitter-receiver even if no data plan or Wi-Fi connection is available:

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER (continued)

- "MyGPSCoordinates" app
at
<https://itunes.apple.com/us/app/my-gps-coordinates/id945482414?mt=8>

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER (continued)

- "GPS Status" app
at
<https://itunes.apple.com/us/app/gps-status/id1254805862?mt=8>

3. GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS) RECEIVER (continued)

- To test a GPS-only app:
Turn off the data plan in "Settings".
Turn off the Wi-Fi connection in "Settings".
Run the GPS-only app and see if it gets a correct GPS fix on your location.

4. BLUETOOTH TRANSCEIVER

- According to <https://en.wikipedia.org/wiki/Bluetooth> **Bluetooth** is a wireless technology standard for exchanging data between fixed and mobile devices over short distances using short-wavelength UHF radio waves in the industrial, scientific and medical radio bands, from 2.400 to 2.485 GHz..

4. BLUETOOTH TRANSCEIVER

(continued)

- Note that Bluetooth runs at the same radio frequencies as microwave ovens, cordless phones, and legacy Wi-Fi systems.

4. BLUETOOTH TRANSCEIVER

(continued)

- Uses of Bluetooth transceiver inside smart cell phones:
 - Hands-free cell phone use in cars
 - "Personal Area Network" with computers, tablets, and printers, and
 - Micro-Location iBeacons
- Most Bluetooth apps in cell phones do not require a data plan or a Wi-Fi connection

4. BLUETOOTH TRANSCEIVER (continued)

- Uses of Bluetooth transceiver inside smart cell phones (continued):
Can be used to tether "data plan" Internet access to other devices if "Personal Hotspot" is turned on

5. NEAR-FIELD COMMUNICATION (NFC) TRANSCEIVER

- According to

https://en.wikipedia.org/wiki/Near-field_communication

NFC is a set of short-range wireless technologies, typically requiring a separation of 10 cm or less. NFC

operates at 13.56 MHz on ISO/IEC 18000-3 air interface and at rates

ranging from 106 kbit/s to 424 kbit/s.

(3 to 30 MHz is the "High Frequency"

"shortwave radio" range.)

5. NEAR-FIELD COMMUNICATION (NFC)

TRANSCEIVER (continued)

- To use NFC with "Android Pay" or "Apple Pay"

Start "Android Pay" in an Android phone or "Wallet" in an iPhone or the store-specific app.

Place the top of the smart cell phone within 1 1/2-inches of the point-of-sale terminal device.

Follow the instructions in the wallet app or the store-specific app to complete the transaction.

5. NEAR-FIELD COMMUNICATION (NFC) TRANSCIVER (continued)

- Most wallet apps or store-specific apps do not require a data plan or a Wi-Fi connection when you are making a purchase at a "point of sale". They only require a NFC radio-transmitter chip for you to make a purchase at a "point of sale". Many cheap Android phones do not have an NFC radio-transmitter chip.

5. NEAR-FIELD COMMUNICATION (NFC) TRANSCIVER (continued)

- iPhones prior to "iPhone 6" do not support "Apple Pay".

See

<https://www.macrumors.com/roundup/apple-pay/>

6. FM RADIO RECEIVER

- Even though most models of "iPhones" have an FM radio receiver chip inside of them, the Apple company has disabled all of them, despites appeals from the FCC and consumer advocacy groups. There are many conspiracy theories about why Apple is refusing to activate the FM radio receiver chips inside their iPhones.

6. FM RADIO RECEIVER (continued)

- Most apps that purport to be FM and/or AM radios inside smart phones are actually streaming the station from the station's Web site, requiring a data plan or a Wi-Fi connection

6. FM RADIO RECEIVER (continued)

- Some Android phones have FM receiver chips inside of them and some do not.

See

<https://nextradioapp.com/supported-devices/>

- Most Android phones made by "Blu" have a FM receiver chip inside them
- "Blu" brand phones are available at Walmart

6. FM RADIO RECEIVER (continued)

- The "NextRadio Free Live FM Radio" app is available at the "Play Store" of a Android phone but this app only works to turn your Android phone into an off-the-air FM radio if two conditions are met:

Condition 1:

You phone has a FM radio chip inside it and

Condition 2:

You have a wired headset plugged into the USB jack at the bottom of the phone since the headset servers as the required FM antenna

BASIC USES FOR A CELL PHONE

1. Telephone calls
2. Texting
3. Camera
4. Internet access
5. Digital wallet
6. Personal hotspot
7. Store and edit files and photos

BASIC USES FOR A CELL PHONE

- Details of
 1. Telephone calls
 - Route through Cellular Transmitter/Receiver when no Wi-fi is available
 - Route through your Wi-Fi connection if you allow it in settings AND when a fast-enough Wi-Fi connection is available

BASIC USES FOR A CELL PHONE

- Details of
2. Texting
"Short Message Service" (= "SMS")
Messages do not travel over the Public
Switched Telephone Network (PSTN)
160 characters per message
Route through the cellular
transmitter/receiver of your cell phone

BASIC USES FOR A CELL PHONE

- Details of
2. Texting (continued)

See

[https://www.twilio.com/docs/glossary/
what-sms-character-
limit#:~:text=The%20character%20li
mit%20for%20a,are%20limited%20t
o%2067%20characters.](https://www.twilio.com/docs/glossary/what-sms-character-limit#:~:text=The%20character%20limit%20for%20a,are%20limited%20to%2067%20characters.)

BASIC USES FOR A CELL PHONE

- Details of
2. Texting (continued)
Path of a text message from sender to recipient:

Cell phone

connects via radio waves to
cell tower (of carrier)

connects to

Base Station Controller ("BSC" of carrier)

connects to

Multiple Telephone Switching Office
("MTSO" of carrier)

connects to

Mobile Switching Center ("MSC" of carrier)

~~connects to~~

~~Public Switched Telephone Network (PSTN)~~

BASIC USES OF A CELL PHONE

(continued)

Details of

2. Texting (continued)

Path of a text message from sender to recipient:

The next slide uses only the cell system acronyms to save on space:

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

~~connects to~~
~~"PSTN"~~

BASIC USES OF A CELL PHONE (continued)

- Details of
2. Texting (continued)
Path of a text message from sender to recipient:
- When a cell phone sends a text message, they are routed to and between "Mobile Switching Centers" ("MSCs") that belong various cell phone carriers and the call is NOT routed through the "Public Switched Telephone Network":

Cell phone
connects to
cell tower
connects to
"BSC"

connects to
"MTSC"

connects to
"MSC"

~~connects to~~
~~"PSTN"~~

Cell phone
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connects to
"MTSC"

connects to
"MSC"

~~connects to~~
~~"PSTN"~~



BASIC USES FOR A CELL PHONE

- Details of
3. Camera(s)
Front-facing Camera
(for selfies and Zoom)
Rear Camera(s)
(sometimes called the "Main Camera")

BASIC USES OF A CELL PHONE

- Details of

4. Internet access

All current smart phones can act as "Internet-connected" computers with three ways to connect to the Internet:

"Data Plan" via Cellular Transceiver

or

"Wi-Fi" through "Wi-Fi Transceiver"

or

Wired "Ethernet" through an external adapter

BASIC USES FOR A CELL PHONE

- Details of
5. Digital wallets

See

http://aztcs.org/meeting_notes/winhardsig/cell-phones/cell-phone-wallet-apps.pdf

BASIC USES FOR A CELL PHONE

- Details of
6. Personal Hotspot:
If your cell phone has a data plan:
use another cell phone, tablet, or
computer to connect to your cell
phone's "Data plan"-provided Internet
connection by means of Wi-Fi,
Bluetooth, or a short cable

BASIC USES FOR A CELL PHONE

- Details of
6. Personal Hotspot: (continued)
A computer, another cell phone, or a tablet connects to your cell phone which then connects to the Internet through a data plan.
If a cell phone does not have a data plan, then "Personal Hotspot" will not work.

BASIC USES FOR A CELL PHONE

- Details of
6. Personal Hotspot: (continued)
See
[http://aztcs.org/meeting_notes/wi
nhardsig/cell-phones/cell-phone-
tethering.pdf](http://aztcs.org/meeting_notes/wi
nhardsig/cell-phones/cell-phone-
tethering.pdf)

BASIC USES FOR A CELL PHONE

- Details of
 7. Store and edit files and photos

INTERNET CONNECTION IS MANDATORY FOR APP INSTALLATION

- Any smart phone app that does not require an Internet connection for normal operations (i.e. that does not require a Wi-Fi connection or a data plan) still will require an Internet connection when you are installing an app (for the first time) or when you are upgrading an app

THREE WAYS TO CONNECT A SMART CELL PHONE TO THE INTERNET

- Wi-Fi "Wireless Access Point"
- Data Plan (from your cellular carrier)
- Ethernet Adapter (to wired Internet)
 - Lightning-to-Ethernet adapter
for an iPhone
 - USB-C to Ethernet adapter
or micro USB to Ethernet adapter for
an "Android" cell phone

THREE WAYS TO CONNECT A SMART CELL PHONE TO THE INTERNET

- Your cell phone has a built-in Cellular transmitter/receiver
- Your cell phone has a built-in Wi-Fi transmitter/receiver

THREE WAYS TO CONNECT A SMART CELL PHONE TO THE INTERNET

- If you wish to connect your cell phone to a wired Ethernet connection to a router or broadband modem:
An Ethernet adapter for a cell phone is an optional accessory that you have to buy

USE "SPEEDTEST.." TO DETERMINE IF YOU PHONE IS USING IT'S DATA PLAN OR YOUR HOME Wi-Fi

- When you are at home, your iPhone or Android phone will default to using your home Wi-Fi when it is fast and reliable enough. However, your iPhone or Android phone will use your cellular data plan instead if it detects that your home Wi-Fi is too slow or unstable.

USE "SPEEDTEST.." TO DETERMINE IF YOU PHONE IS USING IT'S DATA PLAN OR YOUR HOME Wi-Fi (continued)

- If you have a cellular data plan, make sure that it is turned off in "Settings". Then make sure that Wi-Fi is turned on in "Settings". Then use "Speedtest by Ookla" to determine your upload and download speeds.

USE "SPEEDTEST.." TO DETERMINE IF YOU PHONE IS USING IT'S DATA PLAN OR YOUR HOME Wi-Fi (continued)

- If you have a cellular data plan, make sure that it is turned on in "Settings". Then make sure that Wi-Fi is turned off in "Settings". Then use "Speedtest by Ookla" to determine your upload and download speeds.

USE "SPEEDTEST.." TO DETERMINE IF YOU PHONE IS USING IT'S DATA PLAN OR

YOUR HOME Wi-Fi (continued)

- If you have a cellular data plan, make sure that both Wi-Fi and "Cellular Data" are turned on in settings. Then use "Speedtest by Ookla" to determine your upload and download speeds. If your upload and download speeds indicate that you are using your cellular data plan, even when your home Wi-Fi is available, it usually means that you need to fix your home Wi-Fi.

APPENDIX 1: CELL PHONE GENERATIONS

- <https://encyclopedia2.thefreedictionary.com/cell+phone+generations>
- <http://net-informations.com/q/diff/generations.html>
- <https://www.pcmag.com/encyclopedia/term/cellular-generations>