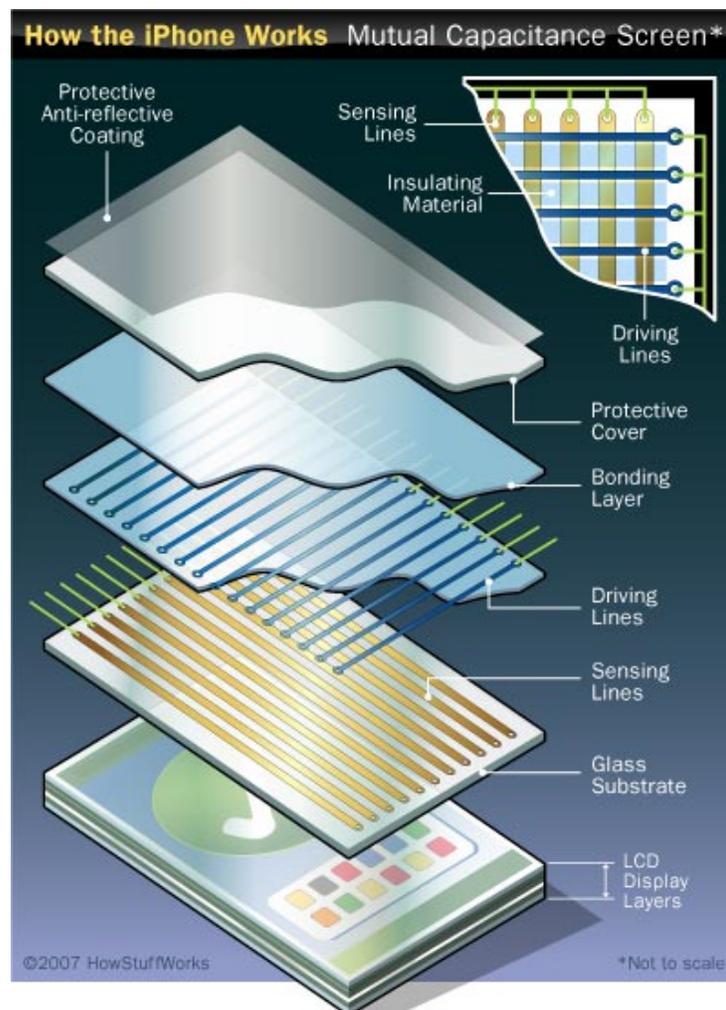


How the iPhone Works

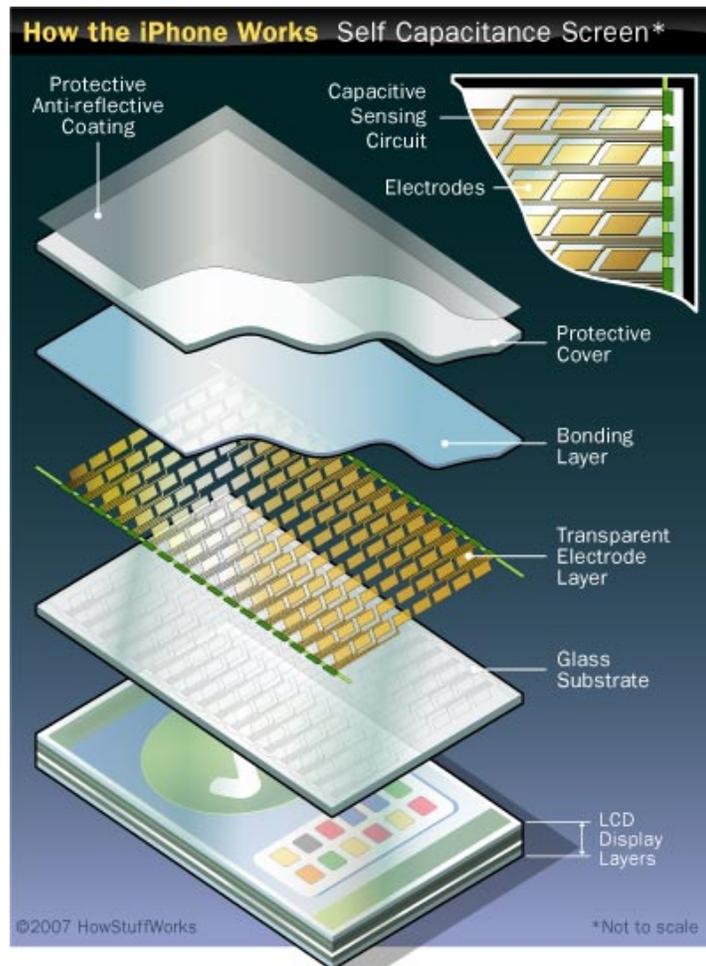
from <http://electronics.howstuffworks.com/iphone2.htm>

Multi-touch Systems

To allow people to use touch commands that require multiple fingers, the iPhone uses a new arrangement of existing technology. Its touch-sensitive screen includes a layer of [capacitive](#) material, just like many other touch-screens. However, the iPhone's capacitors are arranged according to a coordinate system. Its circuitry can sense changes at each point along the grid. In other words, every point on the grid generates its own signal when touched and relays that signal to the iPhone's processor. This allows the phone to determine the location and movement of simultaneous touches in multiple locations. Because of its reliance on this capacitive material, the iPhone works only if you touch it with your fingertip -- it won't work if you use a stylus or wear non-conductive gloves.



A mutual capacitance touch-screen contains a grid of sensing lines and driving lines to determine where the user is touching.



A self capacitance screen contains sensing circuits and electrodes to determine where a user is touching.

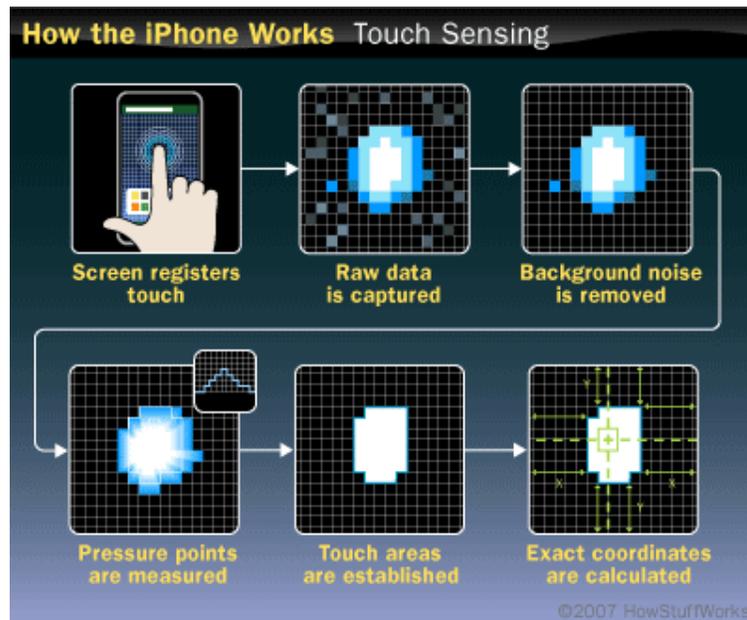
The iPhone's screen detects touch through one of two methods: Mutual capacitance or self capacitance. In **mutual capacitance**, the capacitive circuitry requires two distinct layers of material. One houses driving lines, which carry current, and the other houses sensing lines, which detect the current at nodes. **Self capacitance** uses one layer of individual electrodes connected with capacitance-sensing circuitry.

Both of these possible setups send touch data as [electrical](#) impulses. In the next section, we'll take a look at exactly what happens.

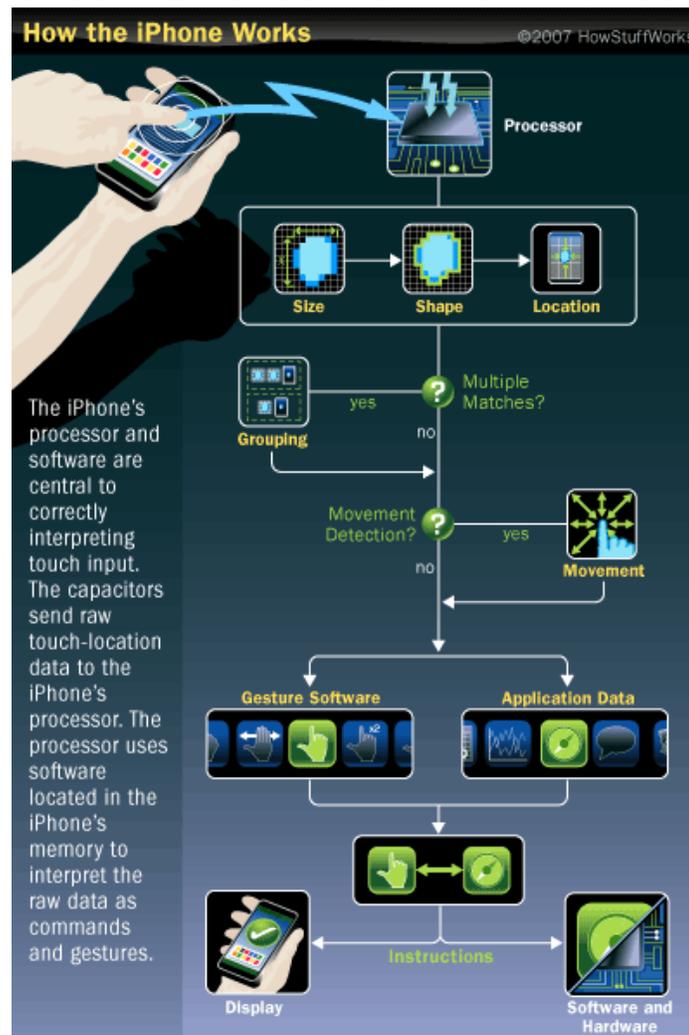
iPhone Processor

The iPhone's processor and [software](#) are central to correctly interpreting input from the touch-screen. The capacitive material sends raw touch-location data to the iPhone's [processor](#). The processor uses software located in the iPhone's memory to interpret the raw data as commands and **gestures**. Here's what happens:

1. Signals travel from the touch screen to the processor as electrical impulses.
2. The processor uses software to analyze the data and determine the **features** of each touch. This includes size, shape and location of the affected area on the screen. If necessary, the processor arranges touches with similar features into groups. If you move your finger, the processor calculates the difference between the starting point and ending point of your touch.



3. The processor uses its gesture-interpretation software to determine which gesture you made. It combines your physical movement with information about which application you were using and what the application was doing when you touched the screen.
4. The processor relays your instructions to the program in use. If necessary, it also sends commands to the iPhone's screen and other hardware. If the raw data doesn't match any applicable gestures or commands, the iPhone disregards it as an extraneous touch.



All these steps happen in an instant -- you see changes in the screen based on your input almost instantly. This process allows you to access and use all of the iPhone's applications with your fingers. We'll look at these programs and the iPhone's other features in more detail in the next section, as well as how the iPhone's cost measures up to its abilities.

iPhone Features

iPhone Specs

Apple is fairly secretive about the exact processors and circuitry found in the iPhone. Here's a glimpse of what it takes to keep the iPhone 3GS running:

- 3.5-inch, 163 ppi screen with a glass protective covering
- [Battery](#) with up to 10 hours of talk time on 2G networks, 5 hours on 3G, 6 hours of Internet use on WiFi, 7 hours of video playback, 24 hours of audio playback and 300 hours of standby time [source: [Apple](#)]
- Macintosh OS X operating system
- 3.2-megapixel camera capable of shooting video at 30 frames per second
- Ambient [light](#) sensor
- Accelerometer
- Radio transmitters for [Bluetooth](#), [WiFi](#) and [cellular](#) (3G, GSM and EDGE) signals
- Proximity sensor, which likely produces [near-infrared light](#) and measures its reflection from nearby objects
- 16 GB or 32 GB of storage space (older iPhones could store 8 GB or 16 GB of data)

Check out Apple's [lists of specs](#) for more.

The front surface of the Apple iPhone has only one button -- the Home button. Pressing the Home button takes you to the main screen of the iPhone's **graphical user interface**. There, you can choose from the device's four primary functions using icons at the bottom of the phone:

- **Phone:** 3G, [GSM](#) or EDGE cellular phone service as well as a visual voice mail menu
- **Mail:** POP and IMAP e-mail access, including in-line pictures, HTML capabilities and push e-mail from Yahoo mail
- **Web:** Safari Web browser
- **iPod:** Music and videos

You can open the iPhone's other applications from the upper portion of the Home screen. These include a calendar, calculator, notepad, and **widgets**, or mini-applications made specifically for the iPhone. Older iPhones include a 2.0-megapixel [camera](#) and software you can use to organize your pictures -- the iPhone 3GS ups the stakes with a 3.2-megapixel camera. You can also use an iPhone to check weather reports and [stock](#) quotes. Even though the iPhone doesn't support [Flash](#), which the YouTube site relies on, you can watch YouTube videos using the corresponding application. The keys and buttons you need to navigate each application appear only when you need them.

The shape of the screen changes when you need it to as well -- you can shift the perspective from vertical to horizontal by tilting the phone. An **accelerometer** inside the iPhone lets the operating system know to change the orientation of the image on the screen. This means that you can scroll through long lists of music files on a long, narrow screen, and you can watch movies in a widescreen format. You can learn more about accelerometers in [How the Nike + iPod Works](#) and [How the Wii Works](#).

The second generation of the iPhone introduced several new features. We'll take a closer look at those in the next section.

3G iPhone Applications and Problems



Andrew Ross/AFP/[Getty Images](#)

Customers in Hong Kong wait in line to buy the 3G iPhone.

In June 2008, Steve Jobs unveiled the 3G iPhone at a conference for application developers. Apple offers 8 GB and a 16 GB options. The new phone's appearance only changed a little bit -- the new model has a slightly sleeker design and its back isn't silver any more. Customers who buy the 16 GB model can choose between an iPhone with a black or white plastic back. The 8 GB model only comes in black.

Perhaps the biggest announcement -- apart from the fact that the phone could take advantage of 3G network technology -- was that the new iPhone has a [GPS](#) receiver. One of the challenges of GPS devices is that they tend to drain [batteries](#) pretty quickly. That's because the device is constantly receiving signals from [satellites](#) orbiting the Earth.

Apples to Apples

Why does Apple call the second generation of iPhones the 3G iPhone? It's because the new iPhone can take advantage of the 3G cellular network. So the phone is in its second generation, but the network is in its third. The United States has a fairly limited 3G network, so U.S. citizens might not be able to tap into the faster speeds even if they buy the 3G iPhone.

Another important addition to the iPhone was support for Microsoft Exchange. Microsoft Exchange support means users can now synchronize their iPhones with their Microsoft Outlook accounts. By adding this feature, the iPhone becomes more competitive with other enterprise [smartphones](#) -- the phones businesses use to keep executives and employees connected when out of the office.

When it released the original iPhone, Apple didn't support third-party applications, though that didn't stop developers from writing them. But with the original iPhone, in order to even run a non-Apple application, an iPhone owner had to first **jailbreak** his or her phone. Jailbreaking just means the owner could load and run third party applications. But it came with a risk -- if you tried to install official updates from Apple with a jailbroken phone, Apple could tell that some hanky panky was going on. But the 3G iPhone acts as an application platform, and Apple encourages developers to create content for it.

Trouble in the Background

Although Apple now encourages developers to create applications for the iPhone, the company still doesn't let any outside application access background processes. That means you have to run a program actively to take advantage of it. If you switch to a different program, all activity on the first program will stop. Apple may support third party background applications in the future.

The transfer to the 3G iPhone didn't go without a hitch. Instead of allowing customers to purchase phones and activate them at home, Apple wanted them to activate the phones inside the store. Unfortunately, Apple's systems suffered an overload, causing massive delays during the product launch. Most customers ended up having to activate at home anyway.

Some of the new applications take advantage of the iPhone's accelerometer feature. Games like Super MonkeyBall let the player control the game character by tilting the phone in different ways. Could the iPhone become the next portable gaming platform? That's precisely what Apple claimed at its Sept. 9, 2009, press event. That brings us up to the current generation iPhone: the 3GS.

The iPhone 3GS

App Controversy

To get an application into the iTunes App store, Apple must approve it first. Apple retains the right to deny any application that duplicates or damages the features of the iPhone. This has led to controversy -- in 2009, the FCC stepped in to investigate claims that Apple rejected Google Voice applications unfairly.

Apple unveiled the iPhone 3GS at the 2009 World Wide Developers Conference (WWDC). The S stands for "speed." According to Apple, the iPhone 3GS is up to twice as fast as the previous iPhone 3G model. That applies both to accessing the data network and launching [applications](#). In real-world tests, journalists found that the iPhone 3GS often was more effective at picking up 3G signals from the cell phone carrier.

But the iPhone 3GS isn't just faster than previous models. It also boasts some new features. Here's a rundown of what you can expect to find on the latest model of the iPhone:

- **More storage space:** There are two versions of the iPhone 3GS: 16 GB and 32 GB models. This doubles the capacity of older iPhone models. Both models are available in white or black.
- **Video camera:** Not only does the iPhone 3GS's camera capture larger photos (3.2 megapixels versus the iPhone 3G's 2.0 megapixel camera), it can record video at 30 frames per second, too. The camera can focus automatically or you can use the [touch-screen](#) to tell the camera where to focus the image. It also adjusts the image's white balance automatically.
- **Voice control:** While many other phones on the market have voice dialing features, the iPhone 3GS's voice control extends the functionality to other parts of the phone. Not only can you make calls by speaking into your phone, you can also control music playback and other functions.
- **Compass:** When paired with the accelerometer and [GPS receiver](#), the iPhone 3GS's compass helps keep iPhone owners from getting lost. It also allows app developers the opportunity to develop augmented reality applications.
- **Oleophobic screen:** One problem with touch-screens is that they tend to attract smudges. The iPhone 3GS has an oleophobic screen. An oleophobic material repels oils, keeping the screen relatively smudge-free.
- **Tethering:** If your cell phone carrier allows it, you can use the iPhone 3GS as a modem for your computer. Simply hook the iPhone 3GS to the computer using an Apple [USB](#) cord and you can surf the Web at 3G speeds. Some carriers don't allow tethering, including AT&T in the United States.

These features sound impressive, but many of them already exist on other [smartphones](#). We'll explore the iPhone's competition and its pros and cons in the next section.

iPhone Prices and Competition

Apple iPhone vs. Cisco iPhone

When Apple announced the iPhone in January 2007, it quickly got the attention of computer technology company Cisco. Cisco was already using the iPhone name on a range of [VoIP](#) products and services. Cisco filed a lawsuit, but the two companies eventually reached an agreement with undisclosed terms in February 2007. The agreement allows both companies to use the iPhone name.

The iPhone has gotten a lot of attention in the press, but other [phone](#) models already have similar features. Several phones now run on Android, the mobile operating system designed by Google. The Palm Pre is the first phone to use Palm's new OS called WebOS. Numerous [smartphones](#) have a built-in Opera Web browser designed for mobile devices. Although most other phones don't have completely virtual controls, some, like the Helio Ocean, have multiple physical [keyboards](#). You can slide the front portion of the Ocean vertically to access a number pad or horizontally to access a QWERTY keyboard. The orientation of the images on the screen changes depending on which keyboard you are using. Other phones, like the Samsung Instinct, the LG Prada and the HTC Touch phone, use touch-screens and virtual controls much the way the iPhone does.

In some cases, Apple's iPhone received more attention for what it couldn't do than its wide range of features. Until June 2009, the iPhone was incapable of using cut and paste. And then, on Sept. 25, 2009, Apple rolled out multimedia message (MMS) support to its users. You can find both of these features on other phones -- MMS is common even on regular cell phones. Why did it take so long for Apple to support these basic features? There's no clear answer, though one theory is that because iPhone owners utilize their data plans more than the average smartphone user they make a significant impact on their carrier's network. As the iPhone gets more features, it puts a heavier strain on the network. It's possible that Apple is working with its carriers to avoid overloading networks with increased traffic.

At its introduction, the iPhone's price was \$499 for 4 GB of storage space and \$599 for 8 GB. In September 2007, Apple announced that it was lowering the price of the 8 GB model to \$399 and that it would continue to sell the 4 GB model while supplies lasted. The 3G iPhone came with another drop in price: The 8 GB 3G iPhone became available for \$199. Apple was able to discount the phone because phone service providers like AT&T subsidized the hardware.

The introduction of the iPhone 3GS ushered in another price cut. Now the only model of the iPhone 3G available in Apple stores is the 8 GB black phone for \$99. The 16 GB iPhone 3GS is \$199 while the 32 GB model is \$299.

In the United States, the iPhone requires a two-year contract with AT&T, formerly known as Cingular. Unless you hack your iPhone and unlock it, it won't work at all without the AT&T plan. AT&T packages include a required data plan (\$30 per month as of September 2009) that you must subscribe to and can never remove even if you decide to just use the iPhone as a normal cell phone.

The first iPhone hit the U.S. market on June 29, 2007. In the days after the release, users and reviewers criticized some of the iPhone's features, including slow browsing speeds and difficulty using the virtual keyboard. Customers reported difficulties with the lengthy activation process and itemized paper billing statements that were hundreds of pages long. Consumer-rights advocates criticized the cost of the iPhone's battery replacement program. Early iPhone adopters were also angry at the dramatic price increase -- Apple responded by offering a \$100 store credit [source: [Apple](#)]. In spite of all these difficulties, Apple sold its millionth iPhone in September 2007.



The HTC Touch
Image courtesy
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