Touchscreen Technology
Touchscreen technology:
The world at your fingertips

What's the invisible technology essential to smartphones, tablets and other mobile devices that generated an estimated $16 billion in revenues in 2012?¹ The answer is touchscreen technology, and it transforms the world we live in with a swipe, a touch and a gesture. It's also sparked an explosive growth of the mobile device market. By 2018, the touchscreen industry is expected to be $32 billion.² And, according to the research firm IDTechEx, the touchscreen market is expected to triple by 2022.³ Considering a recent study shows that 72 percent of Americans are within five feet of their devices at any given moment, it's no wonder touchscreen technology is something we can no longer live without.⁴

In case you missed the headlines, in October of this year, Samsung® released a curved phone, aimed to enhance the touchscreen experience. The Galaxy Round® is the latest model that paves the way for bendable and unbreakable touchscreens, and provides more functionality than flat screen phones. The Galaxy Round has a horizontal curve that allows for a more comfortable grip, and includes a tilt function that allows users to check information such as missed calls and battery life, even when the home screen is off. In addition, users can scroll through media files by simply pressing the screen's right or left side.⁵ It's the latest and greatest in touchscreen technology, but in reality, it's a small taste of what is on the horizon.

Once a futuristic concept, touchscreen technology is found in everything from music players to printers, train ticket machines to supermarket self-checkouts. The ability to manipulate the world is just a finger touch away, and it's become so commonplace you may not even realize you’re using it. Game consoles, tablets, computers and smartphones are the most common devices that use touchscreen technology. But it is also used with voting machines, satellite navigation and at airports to check in travelers more efficiently. Think about the last time you went to a museum, you most likely used touchscreen computers to find out more about the displays. The interfaces that use touchscreen technology are abundant, and as

technology advances, more products are incorporating this efficient and user-friendly interface. It’s hard to argue that the impact is profound; the world is literally at our fingertips.

In fact, it’s transformed the way we live, work and learn. Think about chalkboards, for example. A large percent of the population probably remembers classrooms equipped with chalkboards and erasers. But today, many classrooms are equipped with whiteboards or a Smart Board® that is used when students aren’t working on tablets. In case you’ve never seen one, Smart Boards use interactive technology in combination with a computer, projector and whiteboard that allows users to manipulate content with the touch of a finger.

What makes the touchscreen concept so popular? Simply, touchscreen technology is instinctive and easy to learn, and it’s got a science fiction thrill to it. It’s not just convenience that has made it a mainstay in modern gadgetry, it’s exciting and comfortable. And, it’s growing every day in popularity. Gartner® predicts that in 2015 more than 50 percent of PCs purchased for users under the age of 15 will have touchscreens, up from fewer than two percent in 2009.6 In addition, touchscreen technology has just scratched the surface; the future is evolving beyond our wildest imaginations.

This Blue Paper® looks at the evolution of touchscreen technology, how it works and glances into the future. Believe it or not, despite the leaps and bounds it’s made and the impact it has on our daily lives, touchscreen technology is still in its infancy. The paper also looks at the pros and cons of touchscreen technology, and how it’s being used to improve the customer experience in a number of industries. Finally, the paper explores how a company might integrate touchscreen methods to enhance marketing. So get comfortable, you’re about to reach out and touch the future.

The evolution of touchscreen before the iPhone®

A common perception is that Apple® invented the touchscreen with the iPhone. In truth, Apple was an innovator of touchscreen technology, but hardly the inventor. Touchscreen technology was first introduced in 1965 by inventor E.A. Johnson at the Royal Radar Establishment in Malvern, United Kingdom.7 His work focused on the concept of capacitive touch, which is the exact concept used in

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many smartphones today. In 1967, he published the article “Touch Displays: A Programmed Man-Machine Interface” in the journal Ergonomics, and just like that, touchscreen concepts were born.

Figure 1. depicts the basic elements of a capacitive touchscreen. The panel uses an insulator, such as glass, that is coated with a transparent conductor such as indium tin oxide (ITO), which allows the human finger to act as the conductive. Early technology introduced by Johnson only allowed screens to process one touch, which differs from the “multi-touch” concepts used today. Nonetheless, his early touch interface was adopted by air traffic controllers in the UK, and remained in use until the late 1990s.

Figure 1. Capacitive touchscreen technology

During the 1970s, another form of touchscreen technology called resistive technology was developed, almost by accident. American inventor G. Samuel Hurst was working on another project when he came up with the idea to use electrically conductive paper for an experiment. During the process, he realized the same technology could be used for other purposes. He formed a venture called “Elographics,” and discovered that a touchscreen on a computer monitor was an ideal method of interaction.

Resistive touch technology responds to pressure rather than electrical conductivity. Unlike the capacitive screen, the resistive design is made of several layers and responds to pressure from a finger or stylus. The outer layer flexes under any touch, and is pushed back onto a layer behind it. This completes a circuit, telling the device which part of the screen is being pressed.

In the 1980s, multi-touch technologies appeared after the University of Toronto developed a tablet that could read multiple points of contact. Two years later, Bell Labs developed a touchscreen that changed images with more than one hand. Also during this decade, Bill Buxton, a computer scientist and pioneer of
human-computer interaction invented the multi-touch tablet using capacitive technology. Interestingly, today Buxton is a principal researcher for Microsoft® and continues to contribute to the evolution of touchscreen technology.

It was during the 1990s that touchscreen technology found its way into the hands of consumers. Thanks to the work of computer scientist Andrew Sears, who studied human-computer interaction, things that we take for granted like swiping, tapping and multi-touch interactions were discovered. Suddenly, screens became more receptive to touch and gestures, and as a result, innovation began to focus on using this concept in personal devices and cellphones.

As you may recall, it was during the 1990s that the first personal digital assistants (PDAs) were released. Hand-held devices like the Newton PDA and Palm Pilot® quickly became the latest “must-have” gadgets in the business world. PDA devices didn’t necessarily feature the finger-to-screen type of touchscreens that are used to today, but because consumers embraced the concept, technology leaders realized the market potential and innovation flourished.

The early part of the millennium can be characterized as the touchscreen explosion. Technology advancements and creative innovation brought multi-touch and gesture-based technology to the masses. The Nintendo DS® was released in 2004 as the first touchscreen, handheld gaming system, and it profoundly impacted the gaming industry. Of course, the pivotal moment in history is when Apple® released the iPhone in 2007 as the first product that operated solely on touchscreen technology. Shortly thereafter, consumers were introduced to the iPad® and iPod Touch® and competitors quickly followed suit. The touchscreen market had arrived, bringing with it new ideas and products that made consumers hungry for more.

The evolution of the touchscreen explosion is fascinating. If you’d like to learn more, the technology firm GUIFX® published a listing of touchscreens that changed the world. It highlights the products that were revolutionary from the 1970s until present day.

How does touchscreen technology work?

According to PC Magazine® a touchscreen is, “a display screen that is sensitive to the touch of a finger or stylus.” It’s widely used with ATM machines, retail point-of-sale terminals, car navigation systems, medical monitors and industrial control systems. According to Mary Bellis, inventor of the touchscreen, its impact has been profound: “It’s a display screen that is sensitive to the touch of a finger or stylus.”

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panels. It’s become one of the most widely used technologies, and it continues to evolve. But, how does it work, exactly? There are essentially four different types of systems that are used to recognize a person’s touch. These include resistive, capacitive, surface acoustic wave and infrared technologies. The following chart (Figure 2.) illustrates the basic differences between the technologies.

**Figure 2. Touchscreen Technology Explained**

<table>
<thead>
<tr>
<th>RESISTIVE</th>
<th>CAPACITIVE</th>
<th>SURFACE ACOUSTIC</th>
<th>INFRARED</th>
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</thead>
<tbody>
<tr>
<td>A resistive system consists of a normal glass panel that is covered with a conductive and a resistive metallic layer. In actuality, there are multiple layers that are separated by thin spacers.</td>
<td>In a capacitive system, a layer that stores the electrical charge is placed on the glass panel of a monitor. When a user touches the monitor with his or her finger, some of the charge is transferred to the user, so the charge on the capacitive layer decreases. This decrease is measured in circuits located at each corner of the monitor. The computer calculates where the touch event took place and relays that information to the software. Capacitive models are more expensive to produce and are most commonly found in the iPhone® and Android® models. The capacitive system is more accurate than a resistive touchscreen, and provides a clearer picture. Capacitive system transmits almost 90 percent of the light from the monitor whereas the resistive system only transmits about 75 percent.</td>
<td>Surface acoustic wave touchscreen systems are more complex and costly because they require more technology and sophisticated design. These systems use transducers and reflectors to measure changes in the reflection of ultrasonic waves when the screen is touched. In each acoustic wave touchscreen, there are two transducers, one receiving and one sending, which are placed along the x and y axes of a monitor’s glass plate. There are also reflectors placed on the glass that reflect an electrical signal sent from one transducer to the other. The receiving transducer is able to tell if the wave has been disturbed by a touch event at an instant, and can locate it accordingly. The wave setup has no metallic layers on the screen, and as a result, 100 percent of light is transferred through the glass to provide perfect image clarity. This makes the surface acoustic wave system best for displaying detailed graphics.</td>
<td></td>
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<tr>
<td>Resistive technology relies on pressure to be applied to the surface of the display, with a finger or stylus, which uses electrical circuits to tell the device where the user is touching.</td>
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<tr>
<td>Two devices that use resistive touchscreens are the HTC® Touch Diamond® and the Samsung Omnia®. A resistive system is cheaper to make, and it therefore more prevalent among low cost, low-feature phones and devices.</td>
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If you’re still confused about the difference between resistive, capacitive, surface acoustic and infrared touchscreens, you might consider watching a three-minute video produced by Virgin Mobile® or check out a handy infographic that clearly outlines the differences between the technologies. Figure 3. below also provides a snapshot of some of the differences between the touchscreen technologies.

**Figure 3. Summary of touchscreen technology options**

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Life with touchscreens

In 2010, the firm The Astonishing Tribe® (TAT®) released a video on YouTube® that depicted the future of touchscreen technology. The video shows how people might use touchscreen technology throughout their daily experiences in the year 2014. It gives the viewer a glimpse into how touchscreen technology can be used at home, work and in every day interactions. It begins with a man waking up, expanding his touchscreen alarm clock to read the news, followed by a woman brushing her teeth and using her mirror as a touchscreen interface to review her schedule and access headlines. In the workplace, you see employees using touchscreen technology on multiple interactive screens and desktop tables. It's a fascinating and accurate portrayal of how touchscreen technology is engrained into daily lives. As explained by TAT in the video precursor: “Capacitive screens have now become a commodity for touchscreen devices … imagination is the only thing stopping us. We will soon have dual screens, malleable screens, screens built into Wi-Fi connected mirrors, desks or backside of gadgets clothed with e-ink screens, tactile feedback, color screens with great contrast in sunlight, holographics/stereoscopic screens, or screens actually knowing where they are in relation to other screens thanks to ultrasonic emitters and microphones.”

Clearly, imagination is the only barrier to the future of touchscreen. So, let's take a look at some of the touchscreen technology that's developing in modern day homes.

At its research center, Microsoft created a live diorama centered on the future of touchscreen. Located within Microsoft's Envisioning center, at the Redmond, Washington campus, you can see a living room “of the future.” The room represents a high tech living space designed to make the future “easier and more enjoyable.” According to Steve Clayton, editor of Microsoft's blog Next, the room is like “a concept car that allows us to share what it might be like to experience future technologies with visitors, get their feedback, tweak, remix and discuss.”

So what’s in the room? Imagine a family wall that uses Microsoft's SmartGlass® technology that enables a family to post pictures, stay organized or connect remotely with other tablets or devices. The interactive wall uses voice automation as well as touchscreen capability, and is pitched as the replacement to using your refrigerator to communicate important information. In one scene, one of the family members holds up a piece of food to the touch-enabled kitchen wall and

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14 Ibid.
asks for recipe ideas. Much of what is featured in the room is a glimpse of what’s possible in the next five years, and how touchscreen technology will impact every aspect of our lives.

Soon you’ll see appliances incorporate touchscreen elements. Although the basic function of appliances won’t change, touchscreen technology may change how we operate and control them. Companies like Samsung® and LG® have started developing touchscreen displays on appliances that can interact with smartphones or tablets. In what LG describes as “Smart Home” technology, homeowners will be able to control appliances virtually using defined gestures.15 LG and others are using near-field communication (NFC), which means you can simply wave a smartphone over devices to connect them together. The goal, said LG North America President and CEO Wayne Park is to “make it so that consumers can engage with their smart home in a way that’s natural and automatic, rather than convoluted and anti-intuitive.”

Specifically, smart appliances will offer self-diagnosis capabilities, and send owners a message to their smartphone or device alerting the owner to any potential problems or malfunctions. Smart appliances will also share advice on how to improve efficiency or make life easier. The smart refrigerator, for example, will let you see what’s in your fridge to help plan shopping trips or tell you how you can maximize energy efficiency. Meanwhile, the smart oven will provide downloadable recipes or cooking methods based on your cooking habits and oven usage.

How about using your smartphone to vacuum? The new HOM-BOT® robot vacuum can be remote controlled by smartphones, and is equipped with an onboard camera to let you check the cleaning process remotely. Now imagine that all of your appliances are tied into a single platform for ease in control and monitoring, and you’ll have an idea of how touchscreen technology will fully integrate with appliances in the future.

**Touchscreen trends**

A technology that’s making headlines today is kikin®, the latest touchscreen search tool that will be released by Vodafone later this year.16 It’s an enhanced touch tool to help you find information on the Web. If you are reading an article, for example, and come across a phrase you want to know more about, with

Kikin all you need to do is touch the word, and a Web browser at the top of the page will give you access to everything you want to know about that keyword or phrase. It’s an easier way to access Web content without leaving your page.

Likewise, Nokia released a super sensitive, touchscreen technology with the Nokia Lumina® 820 that allows users to click their phone even if they are wearing gloves. Meanwhile, earlier this year Sony® rolled out the Xperia Sola® phone, which uses Floating touch™ technology. Floating touch is a new touch-sensor technology that lets users interact with a phone without even touching it. A finger hovers over the screen up to 20mm above the screen, which means you can hover over a link to pick it out, then touch the screen to select it. This technology is valuable with smaller Web links because it controls the user interface without ever touching it. Finally, as of 2012, all Samsung® phones are equipped with Swype® technology, which is gesture-based technology that identifies what you are typing before you are finished. Thanks to Swype, all you need to do is drag your finger around keys, and the technology makes intelligent guesses about the words you are using, and the more you use it, the better it gets at guessing.

Some claim the future of touchscreen technology will incorporate stylus use to a greater extent. When we think of touchscreen technology, we often think of human touch as the primary connector. However, in some cases, the use of a stylus is more appropriate and accurate. Not only does it give fingers a rest, but it also increases functionality. For example, with a stylus, users can incorporate handwriting into documents when needed. Or, by using a stylus, one can hover over email attachments and files to preview them as thumbnails, or circle pictures on the Web that can be cut and pasted into a document. Accordingly, a lot of innovation is focused on perfecting the use of the stylus for those that need more defined interaction.

**Touchscreens that touch back**

Another touch technology that’s evolving is haptics vibration. Haptics vibration simulates a sensation of touch when a touchscreen button has been pressed. For example, a phone would vibrate slightly in response to the user’s activation of an on-screen control. The resistive force that some “force feedback” joysticks and game steering wheels provide (for instance, think of the Wii®) is another form of haptic feedback.

Companies like Immersion® have introduced platforms that take haptics to the next level. Imagine strumming a guitar, and strumming actual strings, only you’re using a flat computer equipped with haptics technology. Or, imagine playing a game that allows you to choose a different weapon for each activity, and you can...
actually feel the difference in strength and precision. Immersion’s new platform MOTIV® technology provides touchback technology that opens up a whole new world for the user. Likewise, Microsoft Research in Asia introduced SlickFeel, a technology that makes an ordinary sheet of glass feel as if it has physical buttons or even a physical slider with varying levels of resistance. Such haptic feedback could help users find the right control on compact devices like smartphones, or enable the use of a touchscreen without looking at it; which would be handy for use in cars.

What about touchscreens that have buttons that magically appear during use? Tactus® Technology is developing a new interface that incorporates the use of buttons that appear on demand and allow users to push and type their fingers as they would with any physical button or keyboard. When the buttons are disabled, they disappear into the screen, becoming invisible and allowing the flat touchscreen to reappear. The Tactile Layer™ technology integrates with modern day touchscreen-based devices (e.g. smartphones, tablets, personal navigation systems, gaming devices, and more) and merely replaces the front layer of the existing display. If you want to learn more about this fascinating technology, Tactus published a useful whitepaper online titled “Taking Touch Screen Interfaces Into a New Dimension.”

Finally, imagine using 3D haptic technology to review a patient’s brain scan to help identify treatment options. Thanks to Microsoft, this is possible. While 3D haptic touch is expected to become valuable in the medical field, it’s easy to picture it being used in education, too. It could be a way to allow students to touch and feel materials that would be too dangerous or rare to handle in the real world. In the PC realm, some applications might include 3D modeling and visualization apps. The ability to provide realistic, 3D images that can be manipulated with the human hand is just another way that touchscreen might change the way we live, work and learn.

How to give customers a touching experience

Are you one of those shoppers that hate trying on clothes in confined dressing rooms? If so, then the future of touchscreen may improve your shopping experience. At the John Lewis® department store in London, shoppers no longer have to change clothes to try on new outfits. Instead, they can stand in front of a full-length digital mirror and use hand motions to swipe from one outfit to the next. With a quick touch, you can change the color of a dress you are trying

on, without removing your clothes. The technology, developed by Cisco Systems®, uses a 3D camera to capture a person’s shape in conjunction with touchscreen technology so that customers can “try on” outfits without visiting a dressing room. The mirrors are part of a pilot program designed to help launch the concept at other stores across the globe. Gartner® research shows that 85 percent of purchases will be influenced by some kind of digital experience in 2015 (up from 40 percent in 2012), so it’s not surprising that companies are adding more touchscreen features to products and services.19

Indeed, touchscreens are designed to make life easier, and companies are capitalizing on the opportunity. For example, companies like PepsiCo® and Royal Caribbean Cruises® now use tablets, digital signs, touchscreen kiosks and mobile applications to improve the customer experience. Likewise, in New York, Bloomingdale’s® display windows include several digital screens that enable customers walking by to try on high-end sunglasses. The interactive display regularly draws crowds which the company hopes will translate into increased sales.

If you’ve travelled to the Minneapolis airport recently, you probably noticed the abundance of touchscreen services and solutions. Delta®, for example, introduced the OTG Media Bar™, a virtual newsstand where customers have the option to rent an iPad, complete with content of their choice. The devices are available throughout the terminal, and customers can download publications, movies, music and apps to enjoy during their flight. Once the guest reaches their final destination, they return the iPad in a pre-paid postage box that’s received at the time of rental.20

Also, within the Minneapolis airport, there are four restaurants that let diners order dinner directly from their table. Tables are equipped with anchored iPads, which can also be used to surf the Internet, play games or check email. When customers are finished with their meal, all they need to do is swipe their credit card through the attached payment terminal on the iPad, and they are free to go. It’s a new, futuristic concept that customers praise, not only for the ease in ordering and paying for a meal, but for the fun and exciting atmosphere it helps create.21 It’s another way touchscreen is being used to enhance the customer experience by making it easier and faster to purchase and explore products.

19 Ibid.
Integrating touchscreen in your business

Although almost any business can benefit from the use of touchscreen technology, it’s most frequently used in retail, aviation, manufacturing, hospitals, and businesses related to healthcare. For hospitals and healthcare providers, touchscreen tablets provide moveable technology that is durable and easy to clean. Doctors use them to ensure safe health checks and examinations on site. In addition, information that is presented on screen helps medical staff walk through complex procedures. Portable touchscreen technology helps bring medical attention to far reaching and remote areas that are otherwise difficult to reach. Thanks to this type of technology, patients are able to get screened and monitored from home or remote areas that lack medical facilities.

According to the firm TechSling®, touchscreen technology speeds up tasks by as much as 20 percent. That is probably related to the fact that touchscreens provide instantaneous results with a mere touch of the finger. They also require less hand-eye coordination than computers or cell phones, allowing users to complete actions faster. Time savings is especially prevalent when customers use handy, portable kiosks to search product information, which is why they are becoming more common across a variety of industries, too. The transportation industry uses them to make it easier for customers to print tickets or boarding passes. Meanwhile, grocery stores are increasing the number of self-check-out options that use touchscreen registers. Some companies are also using touchscreen kiosks for recruiting purposes. Many stores offer the ability for potential employees to apply online using a touchscreen that collects job employment history and contact information. Likewise, in retail stores, touchscreen kiosks help customers find baby and wedding registries and provide the opportunity to order items for delivery immediately, without ever stepping into the store if you prefer.

Also, educational touchscreen devices are found in schools and other learning centers because of the ease in which they promote learning and training. Younger generations find it fun and intuitive, while corporations find it valuable for training new hires and skill-based training. In addition, this approach can help offset training costs associated with staff and curriculum materials.

You probably noticed the increased use of touchscreens at trade shows. It’s an effective way to showcase your product, draw a crowd and collect leads. However, depending on the type of touchscreen you acquire, you can spend anywhere from $1,500-$80,000 for a large-format, touch display. This is because like any product, you pay more for high-end services and features. The more expensive

touchscreen displays provide enhanced design and usability, clearer pictures and visuals, and increased touch accuracy. Experts caution that “you get what you pay for” when it comes to touchscreens, so it’s best to do your homework if you are considering making an investment. In addition, since touchscreen technology is a moving target, you’ll want to consider future needs and invest in something that will fit your needs in the future.

For this reason, a number of companies choose to rent touchscreen kiosks that can be customized based on their needs. Vernon Computer Source is just one of the many companies that customize touchscreens for trade shows, conventions, training and other purposes. In reality, there are dozens of organizations that can help customize touchscreen solutions for your business, it’s a thriving industry due to the expense associated with developing these tools in-house. Touchscreens can be customized to provide product information for customers, say in a business lobby or waiting area. Print features that are built into some models make it easy for customers to take the information they need with them. Renting touchscreen technologies is a cost effective way to obtain high quality, leading edge tools that can help customers shop or learn more about your product without breaking a budget.

Get ready to reach out and touch the future

In summary, what’s in store for the immediate future of touchscreen technology? As you’ve probably gathered, you should get used to hearing about things like sensitive touch, floating touch, the return of the stylus, projected touchscreens and more. New products are being released almost every day, and it’s nearly impossible to keep up. If you aren’t using touchscreen methods in your company, think about whether a touchscreen solution might help you improve the customer experience, bring products to new venues, or help attract and retain employees.

While these tools provide different features and methods, they share one critical commonality: They seek to make life easier. Moving forward, touchscreen technology promises to give customers and employees greater convenience while enhancing the way we market and sell products. So, get ready to touch the world, and along the way, make your customers and shareholders happy. That’s a touching view of the future.

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