

# THE NEXT MOBILE REVOLUTION

## Near Field Communication (NFC)

*The promises and pitfalls of a technology that will change your life*



**September 2011**

**MIT Enterprise Forum of the Northwest**

Seattle-based MITEF NW is one of 28 chapters of the MIT Enterprise Forum with headquarters in Cambridge, Mass. A global non-profit organization, it is dedicated to the advancement of technology entrepreneurs. MITEF NW's mission is to inspire, connect, and educate our region's entrepreneurial and technology business community. For more information, please visit us online at [www.mitwa.org](http://www.mitwa.org).

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# Introduction

Imagine a world where a tap of your mobile phone provides secure, keyless, and cardless access to your home, car, hotel room, workplace—even mass transit—automatically paying and checking you in as necessary.

Or maybe you wave your mobile device at a product or an advertisement to access more information, read reviews, and compare prices with other suppliers in your local area. Even walk through a museum or gallery and launch companion audio and video presentations to enhance your experience with a swipe of your phone, connecting the virtual world to your physical world.

How easy would it be to fill an e-shopping cart at your neighborhood market using your mobile phone, then tap your phone to pay without waiting in line? Or to walk into a store and be alerted that your favorite items are on sale, and that there are new items you may want to check out based on your previous purchases?

What if you could exchange business cards, photos, videos, or other information electronically, or connect to a new acquaintance on Facebook or Google+ with a simple tap of your mobile device?

If the widespread use of technology has been an impersonal and isolating development, how different is a world where technology moves with you—to make purchases, access transportation, provide identification, authorize entry to secured spaces, and generally streamline the mundane tasks of everyday life?

If you're a frequent traveler on Sound Transit or a Starbucks coffee drinker—or you've been one of the lucky few to test drive Angry Birds Magic—you've had a preview of what's possible.

Near Field Communication (NFC) has the potential to consolidate and replace a dizzying array of cards and devices, including credit and debit cards, retailer loyalty cards, keys, coupons and discount offers, credentials and other identification. It can add content and intelligence to ordinary objects, as well as create an enabling new world that simplifies the way you manage your daily activities in powerful and fundamental ways.

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This document is the result of background research and interviews conducted with technology experts, venture capitalists, entrepreneurs, as well as business and thought-leaders in the NFC space between June and August 2011 in preparation for an MIT Enterprise Forum held in Seattle, WA on September 28<sup>th</sup>, 2011. It is not intended as a comprehensive or authoritative treatise on the subject of NFC. Any errors are ours and not the responsibility of our speakers or interviewees.

# Technology

Near field communication (NFC) is a standards-based wireless technology that is typically implemented as a chip in a mobile phone or other mobile device, or in a card. It enables short-range communication between the NFC-enabled device and another NFC device, reader or tag—generally with just a wave or a tap of the device. As such, it can be used for an almost limitless range of applications, including mobile payments.

As a technology, NFC traces its roots back to work done by Sony and Phillips, which led to an accepted ISO standard for NFC in 2003. It is essentially an outgrowth of RFID (Radio Frequency IDentification) technology—the basis for various contactless payment applications, including payWave (Visa) and PayPass (MasterCard). It's also closely related to the technology used in Asia's FeliCa payment application.

The technology gained traction in 2004 when the NFC Forum was created to “advance the use of Near Field Communication technology by developing specifications, ensuring interoperability among devices and services, and educating the market about NFC technology.” The organization also offers a certification program for NFC-enabled device manufacturers to provide credibility and assurance that the manufacturer's device conforms to NFC Forum specifications.

The NFC Forum now includes more than 150 members, including such household names as American Express, AT&T, Ericsson, Google, Intel, LG, MasterCard, Motorola, Microsoft, Nokia, PayPal, Sony, and Visa. They work collaboratively to promote the use of NFC in mobile devices, consumer electronics, and tablets.

So, what is NFC and how is it different from other wireless technologies, such as Bluetooth and WiFi?

## Differentiating Characteristics

NFC is a two-way, peer-to-peer wireless technology that differs from most wireless technologies in a number of important ways, including the following:

- **Limited range** NFC is inherently short range, unlike other wireless technologies. From a practical perspective, it can share data and power over a distance of approximately four centimeters, or a little more than one and a half inches.
- **Speed** NFC is typically slower than alternative technologies, such as Bluetooth and WiFi.
- **Power consumption** NFC requires less power than most other wireless technologies.
- **Simplicity** NFC-enabled devices don't require a set-up or pairing process to work with each other, unlike Bluetooth or WiFi. In fact, NFC can be used to establish the connection between such devices and then hand it off for longer-range communication.

- **Active or passive** NFC features can be used by active, powered systems such as cell phones, or can be passive sticker-type labels similar to RFID tags.
- **Security** In large part, NFC's security features derive from the fact that NFC-enabled devices are extremely short range. Mobile phones, tablets, or other devices must be in close physical proximity to communicate using NFC. For additional security, communications can be encrypted—and in applications where security is important, many already are—although the NFC specification does not require encryption.

## Advantages

According to the NFC Forum, NFC offers a number of important advantages. It is simple and intuitive, and inherently application-agnostic, so it's versatile enough to be used in a broad range of industries and applications. It's also sufficiently flexible to work with existing and legacy technologies, such as contactless cards.

The technology itself is open and standards based, facilitating interoperability. Because its range is severely limited, it offers security advantages over other wireless technologies—especially when combined with certain built-in security capabilities.

Finally, it can be used to set up or enable other wireless devices that would otherwise require more complex processes, including Bluetooth and WiFi.

NFC-enabled devices are commonly, but not necessarily, mobile phones. When NFC is implemented in a smartphone or other device containing memory and a processor, the potential sophistication of its NFC-enabled applications increases as a result.

# Ecosystem

The ecosystem for NFC is a complex one—particularly when it comes to phone-based financial transactions—and involves collaboration among a range of research and manufacturing organizations, telecoms, merchants and other consumer-facing businesses, financial institutions, and consumers.

Such collaboration, including an open, standards-based foundation, is viewed by most as a critical success factor for NFC, especially in the mobile payments / ecommerce sector. Sybase President Marty Beard summed it up this way: *“For mobile commerce to take off, industry stakeholders must harmonize their efforts in the same way that led to proliferation of SMS and MMS technologies.”*

The NFC Forum fosters the open concept from a technology standpoint, including with its PlugFest events which allow companies to anonymously test the compatibility and interoperability of their NFC-based products with those of other NFC developers.

All told, nearly a decade of cross-industry effort has gone into the development of NFC technology and the underlying business concepts to support its commercialization. Early on, disagreements arose over which players in the ecosystem— phone carriers, banks, and / or credit card companies, for example—should profit from mobile payments applications. Today, Google and Isis are exploring revenue options that are not based on taking a cut of the underlying financial transaction, such as making money from coupons and advertising.

The concept of integrating new technology with legacy systems is another important aspect of ecosystem collaboration. Companies such as Sequent Software aim to support NFC services without requiring major changes to existing payment infrastructures.

# Applications

The average American has between four and five credit cards according to most surveys. Census data puts the number at closer to 10 per household. But that's only an average.

As much as 10 percent of the U.S. population has 10 or more credit cards. Then add in merchant credit cards, bank cards, loyalty and affinity cards, gas cards, and airline and other travel rewards cards. And what about insurance cards and healthcare cards, plus all the identification and building access cards we are now required to carry? Many of these cards also come with passwords, PIN numbers, or security codes that you need to remember.

Confusing?

Enter NFC with its promise to consolidate all the contents of our wallets—and so much more.

The true possibilities of NFC—which extend far beyond mobile payments—are only beginning to attract the public's attention in the United States, but NFC-enabled phones and other devices are more commonplace in Japan and parts of Europe. The Japanese use NFC-enabled devices on their daily commute for transit schedules, tickets, and payments, as well as an e-wallet for convenience store shopping near transit stations. NFC is also embedded in remote controls for Japanese televisions, allowing viewers to access program information, download coupons, and pay for pay-per-view programming.

You'll find a general overview of the major applications for NFC, arranged by category, in the following paragraphs. You can also view videos of NFC use cases in action posted by members of the NFC Forum by visiting the NFC Forum's YouTube channel. However, they only touch the surface of what may be possible with NFC when creative minds and a more accommodating infrastructure combine.

To test the boundaries of innovation in the NFC space, the NFC Forum holds a global competition each year for researchers and commercial product developers. The NFC Forum website provides a list of recent competitors and winners, and describes their applications. The website also references more than 100 NFC pilot projects that have been undertaken worldwide.

## Mobile Payments and eCommerce

Many consider mobile payments as the killer app that will take NFC into the mainstream. In fact, according to a survey conducted by MasterCard, nearly two out of three people surveyed are open to the idea of using their mobile phones to make payments. NFC's inherent short range and security features make it a preferred technology for these types of financial transactions.

Mobile payments have certainly gained more attention and a greater investment from major players than any other NFC application.



In May 2011 at a press conference in New York City, Google unveiled its mobile payments service Google Wallet. According to Stephanie Tilenius, Google's Vice President of Commerce, *"Your phone will be your wallet. Just tap, pay, and save."* Designed for an open ecosystem, Google Wallet will run as an Android app on NFC-enabled mobile phones and support both the Google Prepaid Card and Citi® PayPass™-eligible MasterCard® credit cards.

U.S. wireless giants AT&T Mobility, T-Mobile USA, and Verizon Wireless joined forces as Isis, with a charter to create a mobile commerce platform based on NFC technology. In July 2011, Isis announced relationships with the four major payment networks in the U.S. According to Isis CEO Michael Abbott, *"By working with the nation's payment networks—Visa, MasterCard, Discover, and American Express—we significantly advance the vision of an open and secure platform that provides banks and merchants with a new and highly relevant way to connect with consumers."* The network is slated to launch in initial markets including Austin, Texas and Salt Lake City, Utah in the first half of 2012.

In July 2011, PayPal announced its own NFC-enabled payment solution. According to Laura Chambers, Senior Director, PayPal Mobile, this phone-to-phone solution is an *"NFC-enabled Android widget that lets people pay and get paid in a matter of seconds by simply tapping together two Samsung Nexus S phones."*

Many of the major credit card companies are also working on their own digital wallets, including Visa and American Express.

Additional NFC-payment variations are under development—for restaurants, for example, where customers don't want to surrender their mobile phones to their servers to pay for meals. These tap-to-pay applications allow customers to pay at their tables and download discounts and coupons. The concept applies to other sectors of the hospitality industry as well.

Although large-scale mobile payment implementations garner the most attention, mobile payments aren't the only commerce-related application for NFC. There are NFC-enabled implementations for loyalty cards, discounts, coupons, and e-shopping carts, as well as smart tags for product information, pricing, and comparison shopping. NFC-based applications can also deliver customer-specific advertisements and offers to shoppers. For mobile payment retailers, such non-payment applications can generate additional revenues and provide their customers with added value.

## Travel and Transportation

If you've used local transportation in the Seattle metropolitan area or the greater Puget Sound region, you may have paid for your bus, rail, train, or ferry trip using an NFC-enabled ORCA card (One Regional Card for All). It is the payment mode of choice for passengers using Sound Transit, King County Metro Transit, Community Transit, Everett Transit, Kitsap Transit, Pierce Transit, and the Washington State Ferries.

For longer-distance travel, you might soon use an airline's NFC application to reduce the stress and hassle of travel. You'll be able to select and purchase your ticket, check yourself and your baggage in, pass security checkpoints, and even board the plane.

Air France became the first airline to test NFC stickers for flight information and boarding passes in 2009, with its Pass and Fly program. Currently, SAS issues contactless stickers to its EuroBonus gold members. The stickers transmit membership numbers and call up flight information, as well as streamline check-in and boarding procedures. According to SAS' SmartPass Service Manager Kristine Mayer, *"When the NFC mobile market is ready, it is a natural step that SAS Smart Pass is integrated in the mobile."*

The concept of using NFC for faster check-in is equally applicable to the rental car and the hotel / hospitality sectors as well.

NFC applications can also deliver maps, schedules, and other travel-related content.

## Gaming and Other Entertainment

Angry Birds fanatics are eagerly awaiting the NFC-enabled Angry Birds Magic. This new version of the wildly successful phone-based game uses NFC to unlock advanced levels of the game. Fruit Ninja takes another approach to NFC gaming: Tap to get an extra blade rather than an extra level. NFC can also be used to initiate two-player gaming.

Like movies? One day soon, you'll be able to use NFC to purchase tickets for movies or other events, such as concerts, museum showings, and theater performances. Swipe an NFC tag to see the movie's trailer or launch an audio or video clip.

The British Museum in London, UK is using NFC to replace headsets for guided tours. According to the museum's Marketing Manager, NFC *"has the potential to change how we interact with our visitors. By simply touching tags located throughout both our venues, visitors can delve deeper into London's story in an immediate and engaging way."*

## Secure Identity and Authentication

How does any person—or any entity—know that you are you, either online or in the physical world? User names and passwords, student IDs, employee IDs, government IDs, drivers' licenses, healthcare cards, insurance cards ... the list of personal credentials to support your identity goes on and on.

Many believe that the smartphone (or other similar mobile device) will be *the* secure hub to manage all aspects of a person's identity, and NFC may play an important role in that. In fact, over time, identity and credential management may rival mobile payments as the killer app for NFC, and become a significant revenue source for a company able to position itself to claim leadership in this space.

## Access / Keyless Entry

An extension of NFC's identity capabilities, NFC-enabled tags and readers offer the potential to consolidate and replace the handful of keys and access cards most Americans carry with them throughout the day.

NFC credentials can provide for keyless access to homes, offices, and other commercial buildings, cars, parking garages, as well as hotel and motel rooms to name just a few. Most colleges and universities, and many corporations already use NFC-capable readers to control access to secure buildings.

## Social Networking

Likes, friending, location-based check-ins, profile exchanges, and other social networking activities—once exclusive to the web—are moving to the physical world via NFC, along with tap-to-share features for business cards, photos, videos, music, and other data. NFC applications for social media engagement have the potential to drive significant demand for NFC-enabled devices.

Foursquare added an NFC tap-in feature in its 3.0 upgrade earlier this year. Foursquare and Google combined to test the new capability at the Google I/O Conference in San Francisco this spring. Attendees tapped NFC-equipped devices to tags located around the conference center to check in and request Google I/O badges.

Japan's largest social network, Mixi, provides its users with NFC-powered features to share their physical locations with friends in real time, as well as share websites and NFC-tagged real-world objects.

NFriendConnector, originally developed in 2009 at a German university, allows Facebook users who meet in the physical world to exchange profiles through NFC-enabled mobile phones and automatically generate status updates.

## Bluetooth and WiFi Connections

NFC devices do not require pairing or configuration processes to communicate unlike Bluetooth and WiFi. As a result, NFC can dramatically simplify both Bluetooth and WiFi communications. Tap two NFC-enabled devices for instant Bluetooth pairing. To configure a WiFi network, tap an NFC-enabled device to an NFC-enabled router.

After the handover from NFC to Bluetooth or WiFi, the devices can move beyond NFC range without losing contact and data transfers at faster Bluetooth or WiFi speeds.

## Smart Objects and Content Delivery

Finally, while it may not be getting much attention yet, some see NFC's ability to connect people to information—in what has been referred to as an ability to hyperlink the physical world—as its true killer app.

NFC stickers can add content and intelligence to a virtually limitless range of physical locations and commonplace items, such as posters, advertisements, coupons, gifts, products, and pharmaceuticals to name just a few. There's even an application to read NFC tags on gravestones, providing the human story of the deceased.

Google is providing NFC-enabled window stickers to local businesses in test cities as part of the rollout for its Google Places and Hotpot local recommendation services.

French retailers use NFC smart tags to provide product information, pricing, and ingredient lists to visually impaired and physically handicapped customers.

This use of NFC holds broad promise for the delivery of healthcare. Smart tags can identify physical items such as rooms, beds and medications. NFC can also deliver secure content, including personal healthcare data, patient history, remote monitoring data, diagnostic tools, and treatment recommendations.

One NFC application connects to a post-surgery kit that allows doctors to remotely monitor progress and check for signs of complications. As a result, patients can return home sooner. Another application links the NFC device to a diagnostic sensor that enables self-testing for a range of conditions and diseases, including pregnancy, drug allergies, and AIDS. Home healthcare workers use NFC-enabled mobile phones to track the date and time of visits and record the services provided.

# Challenges to Adoption and Potential Opportunities for Innovation

Despite the promise of NFC technology and the burgeoning interest, there are hurdles to widespread adoption that must be overcome before the technology is integrated into everyday life. Among them are security and privacy issues, consumer apathy or ignorance about the technology and its potential benefits, an underdeveloped infrastructure, and a lack of coordination among all the players in the ecosystem.

These areas also represent opportunities for entrepreneurs who can leverage their expertise to move adoption forward.

## Security and Privacy Concerns

Not surprisingly, security and loss / theft of the device are top concerns for consumers. According to data compiled by Compete earlier this year, people who were not inclined to use their phones for mobile payments cited security issues (56%) and loss of their phones leading to unauthorized access to their bank accounts (52%) as major reasons why they wouldn't.

Such concerns are not unique to NFC applications—and the fact that NFC technology requires devices to be within a few centimeters to transmit data is a definite advantage in terms of security. The close proximity limits the opportunity for data theft, eavesdropping, and hacking. The use of encryption, PIN numbers, and designs that isolate sensitive information from the device's operating system can provide additional security.

NFC payment options afford another security advantage in that consumers aren't required to surrender credit or debit cards to a server or other salesperson for payment, which can often involve taking the card out of sight or into another room for processing.

However, critics claim that NFC, like other competing technologies, still has security vulnerabilities that must be addressed, including signal jamming, spyware, and malware.

The possibility of loss or theft of a mobile phone or other NFC device is a very real concern. Suppose you accidentally leave your phone in a public place, or someone steals it. What are the protections to ensure that this unscrupulous person cannot access your bank accounts, home, hotel room, or workplace? A variety of solutions are being considered and, in some cases developed, which include coding, encryption, and password-protected devices. Remote locking capabilities and remote data wipes are other examples.

Privacy advocates have also expressed concern about the amount of personal data that would be available to carriers when personal information, such as bank account numbers and shopping habits, are transferred to smartphones. Adequate safeguards and boundaries with regard to acquiring, sharing, selling, and protecting data are still being drawn for other technologies, and NFC will be subject to the same concerns and potential solutions.

## Consumer Adoption

Early adopters may try anything, but mainstream consumers need a compelling use case to drive their adoption.

When it comes to the general public, some express concern that mobile payments may simply be a solution in search of a problem. Others refer to it as a solution in search of a value proposition. For many people, they argue, removing a credit card or contactless card from a wallet to pay for a purchase is not a major inconvenience. In addition, mobile wallets may never completely replace a physical wallet, which consumers use for more than payment cards—driver’s licenses and plain old cash, for example. So how can you make customers’ payment experiences significantly better?

Retailers see benefits and cost savings from moving customers through their stores faster and more efficiently—or getting additional value from their customer loyalty programs. But they still need to convince consumers that NFC technology offers something more convenient and faster than our engrained credit card and cash payments systems—or other, non-NFC implementations such as Starbucks’ 2D barcode.

Most retailers have investments in existing automated systems that they and their customers currently use, and there is understandable concern that the transition from these legacy systems may be frustratingly long and difficult.

There are also competitors to NFC vying for merchant and customer acceptance. For example, Starbucks’ 2D barcode-based mobile application allows customers to make purchases at the company’s nearly 7,000 retail locations. Square’s mobile application for Android and iOS, including a free reader and new Card Case and Square Register features, currently competes with NFC-based mobile payment applications. The challenge for NFC is to ensure that the experience is markedly faster and easier than that afforded by other technologies.

## Infrastructure Development

Mobile payments may very well be the killer app to drive adoption of NFC, but it requires a supporting infrastructure that has not fully developed in the United States.

The lack of infrastructure resulted in a chicken and egg scenario – merchants were reluctant to invest in upgrading their terminals for NFC when there weren’t payment-enabled devices available in the market, and consumers had little reason to buy NFC phones if there weren’t places to use them.

Starbucks is a case in point. Although the company signed a deal to bring NFC payments to its UK locations and has expressed continued interest in NFC in the U.S., it chose a 2D barcode implementation for its U.S. locations. Chuck Davidson, responsible for Starbucks' innovation strategy, has been quoted as saying that the company is *"unwilling to wait for the NFC infrastructure in the U.S. to reach critical mass"* and will remain committed to its current platform *"until a meaningful number of our customers have NFC-enabled mobiles."*

Only a small number of the mobile phones and smartphones currently on the market have NFC capabilities, although predictions for growth are significant. Google estimated that half of all smartphones will have NFC by 2014. Juniper Research forecasts that one in five new mobile phones will have NFC by 2013 and that 300 million smartphones will be NFC-equipped by 2014, half of them in North America alone. However, recent history suggests that NFC may not be introduced to the marketplace as fast as evangelists for the technology expect. And one major player, Apple, remains silent on the issue. Although the rumor machine has alternately embraced both outcomes, many analysts currently predict that Apple will delay inclusion of NFC technology in its popular iPhone until NFC hits critical mass.

As a result, some entrepreneurs in the NFC space have elected a no-phone-needed approach that is not dependent on smartphone market penetration. Seattle-based Iota demonstrated its NFC-enabled TAPP™ device at CTIA Wireless 2011 earlier this year. According to Iota, TAPP has the *"guts of a cell phone, the brains of a computer, the power of NFC, and the secure identity of a smart card in a small package."* It is a secure identity device that holds and uses *"distinct mobile, social, financial, shopping, health, and government credentials, sharing only required elements for each transaction."* TAPP connects via cellular network and communicates with smart objects via NFC and Bluetooth.

When it comes to actually making purchases, there are relatively few point-of-sale (POS) terminals in retail stores—although that too is changing over time.

It is estimated that there are currently only 200,000 retail locations with NFC-enabled POS systems, compared to the millions of sites it will take for widespread adoption. However, that number is set to grow dramatically over the next few years. ABI Research reports that eight to five percent of point-of-sale terminals will be NFC-enabled for payments by 2016.

VeriFone, a global leader in secure electronic payment technologies, has committed to including NFC as a standard feature on all of its new POS terminals. Google has announced that its Mobile Wallet service is or will be available at hundreds of thousands of merchant locations, including such major retailers as Bloomingdales, Radio Shack, Jamba Juice, Macys, Walgreens, Toys R Us, Sunoco, The Container Store, and CVS Pharmacy.

According to some, the biggest obstacle to the emergence of NFC at the retail level may very well be merchant resistance—both in terms of complexity (if adding NFC means supporting multiple payment systems) and potential costs. As a result, the deployment of NFC systems that also support contactless cards and other legacy systems is a vital element in the transition. Ensuring that the new systems won't dramatically increase transaction costs for merchants is another important success factor for adoption.

## Industry Collaboration

Widespread adoption of NFC as a basis for mobile payments requires collaboration throughout a particularly complicated ecosystem.

In February 2011, Sybase 365 polled attendees at the GSMA Mobile World Congress and found that a majority believe mobile-proximity payments using NFC technology is still at least two years away. The main obstacle cited by respondents is the still undeveloped ecosystem among all the players, including mobile device manufacturers, carriers, retailers, standards and platform developers, and banks.



# Closing Remarks

Any fundamental change requires a compelling story, especially when that change impacts habitual behaviors and entrenched process and technologies.

The final months of 2011 and early 2012 may very well see the start of a fundamental change in the commercialization of NFC technology, when many if not most new smartphones are NFC-equipped, and the NFC investments of major companies such as Google, PayPal, and the wireless companies and payment networks involved in the Isis joint-venture come to fruition.

However, it has been predicted before, and the widespread adoption of NFC has yet to materialize in the United States. At the very least, it has been slower than many had anticipated—especially with regard to large-scale commercial and consumer-facing implementations.

Researchers and smaller entrepreneurial companies aren't waiting for large-scale infrastructures to develop or for that one killer, mass-market application to drive demand. Instead, they are innovating in the NFC space based on a range of mobile phone and non-phone devices, and looking beyond replacing existing applications to envision completely new uses for NFC.

Entrepreneurs, intrapreneurs, and innovators see opportunity in reimagining what is possible in an NFC world.

# Appendices

**Appendix 1:** Glossary

**Appendix 2:** MIT Enterprise Forum Moderator and Panelists

**Appendix 3:** Interviewees

**Appendix 4:** Resources

**Appendix 5:** Acknowledgements

## Glossary

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Angry Birds	Mobile phone game application that uses embedded NFC technology to unlock additional levels of play when tapped to another NFC device.
Barcode	<p>Machine-readable representation of data using vertical lines, typically affixed to item labels for automated data entry at point-of-sale.</p> <p>A barcode of vertical lines is known as a linear, 1D, or one-dimensional barcode.</p> <p>Codes comprised of a grid are called 2D barcodes or QR codes.</p>
Bluetooth	<p>Proprietary open wireless technology standard used for exchanging data between equipped devices, including phone or headset links.</p> <p>Range is five to 100 meters depending on the class, with a quasi optical wireless path required. Maximum data rate is 2.1 Mbit / sec. for the current 4.0 specification.</p>
Bluetooth Low Energy	Low-energy consumption version of the 4.0 Bluetooth standard. Range is up to 50 meters and data rate up to 260 Kbit / sec. for the current 4.0 specification.
Cryptography	Science and technique of encoding information. This is especially relevant to the electronic transfer of funds.
Data Rates	<p>Rate at which data can be transmitted from one enabled device to another. Maximums for selected wireless communications are:</p> <p>Bluetooth: 2.1 Mbit / sec.</p> <p>Bluetooth Low Energy: 260 kbit / sec.</p> <p>NFC: 424 kbit / sec.</p> <p>WiFi: 54 Mbit / sec.</p>
eCommerce	The term can encompass the entire commerce cycle of developing, marketing, servicing, selling, and buying products and services over the internet. A more limited definition refers only to the buying and selling of products and services over the internet.

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Electronic Business Card	Electronic file that carries information similar to a paper business card. More interactive and dynamic content may also be included than can be placed on a paper card. A paper business card may contain a QR code for instant online access to the corresponding electronic business card.
Electronic Money	Electronic system that allows the flow of currency via purely electronic means. Different embodiments of this concept include centralized, decentralized, and offline systems.
Keycard	Credit card-sized device that can be used to access physical areas when used with compatible receptors. Keycards may have patterns of holes, a barcode, or a magnetic strip that contains the information to unlock the receptor. An electronic, RFID-type keycard is correctly called a proximity card.
NFC (Near Field Communication)	Short-range (4-20 cm) communication technology useful for secure exchanges of information. NFC elements are compatible with some existing RFID infrastructure.
NDEF (NFC Data Exchange Format)	Standardized format for transmission of information via NFC peer-to-peer connections.
NFC Forum	Organization dedicated to advancing NFC technology through common specifications and standards ( <a href="http://www.nfc-forum.org">www.nfc-forum.org</a> ).
NFC Tags	Physical tags that typically contain 1 kB of information and can be formed into labels, keycards, and bracelets. These passive electronic elements (similar to some RFID tags) can have their data accessed by the tap of an NFC device.
NFC World Congress	Event that promotes NFC technology and interoperability, first of which was held September 19-21, 2011 in Nice, France.
ORCA Card (One Regional Card for All)	Credit card-sized NFC RFID (ISO / IEC 14443) passive electronic device used for payment on mass transit assets in the Puget Sound area of Washington State. Cards can make payment for bus, train, and ferry travel.
Pairing	Establishment of a radio frequency connection between two compatible devices. Bluetooth can require up to six seconds to pair while NFC pairing can be completed in 0.1 second. If both Bluetooth and NFC are present in the same device, NFC can be used to expedite Bluetooth pairing.

Proximity Card	Contactless, passive RFID, credit card-sized device that can be used to access physical areas or payment systems when placed in close proximity to compatible receptors.
QR Code (Quick Response Code)	Also called a 2D (two-dimensional) bar code, these printed grid-type patterns hold more information than a 1D barcode. Current smartphone applications (e.g. RED LASER) use the phone's camera to capture and read the QR code, and can link the user to a corresponding internet web page.
Radio Frequencies	Different devices use different frequencies:  Bluetooth from 2400 to 2480 MHz  Bluetooth Low Energy is same as Bluetooth (2400-2480 MHz)  NFC is 13.56 MHz  RFID varies between different standards and countries  WiFi is 2.4 and 5 GHz
RFID (Radio-Frequency Identification)	Physical tags with embedded microchips. A passive RFID tag requires the RFID tag reader to be within a few centimeters to provide power via induction. An active RFID tag contains a small battery and can have a range of 10 meters. Options for tags include up to 1 Mb of memory and the ability to erase and rewrite data. Due to there being no global RFID standards, RFID tags from different manufacturers and countries have different communication, programming protocols, and frequencies.  Some passive RFID infrastructures (13.56 MHz ISO / IEC 18000-3) can be utilized by NFC-enabled systems to allow payment, keyless access, etc. For example, the Washington State ORCA card is both passive RFID and NFC.
Standards	NFC is an open platform technology standardized in ECMA-340 and ISO/IEC 18092.
UI / UX	User interface / user experience.
VPN	Virtual Private Network.

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## WiFi

Wireless system for the transmission of data at 2.4 and 5 GHz, typically to and from computers. Due to the single WiFi standard (IEEE 802.11), any WiFi device is potentially compatible with any other WiFi device worldwide. Range of communication from a hot spot is up to 20 meters indoors with a typical maximum data rate of 54 Mbit / sec.

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# MIT Enterprise Forum Moderator and Panelists

## Moderator

### David Brudnicki, CTO, Sequent Software, Inc.



David (also known as "DB") has been at the forefront of mobile products and technology for over 20 years. He has been critical in Sequent's emergence as the pragmatic and elegant leading solution in NFC payments. He is co-author of five patents related to mobile messaging and communications, and is a recognized business and technology visionary in the mobile applications and services space.

David has led advanced technology and product development teams at AT&T Wireless Services, including music, imaging, location-based-services, messaging, and mobile-commerce products. He has also held various technology and leadership roles at Sprint, Prime Computer, and Dow Jones & Company. David is an expert in user interface and industrial design, as well as software architecture. He is also a decorated veteran of the United States Coast Guard.

## Panelists

### Kelly Franznick, Founder & CEO, Blink Interactive



As the CEO of Seattle-based user experience research and design firm Blink Interactive, Kelly manages company strategy and engagements with clients that range from start-ups all the way to Fortune 500 companies.

Prior to starting Blink in 2000, Kelly led user-centered design projects at E-Lab (acquired by Sapien Corporation), Lexant, and Immersant.

Kelly has a Bachelor of Science in Design from Arizona State University's Design School where he studied industrial design and human factors. He also holds a Master of Design degree, specializing in Human-centered Design, from the Institute of Design in Chicago.

## **Aaron Roberts, Founder & CEO, QThru**



A passionate entrepreneur who enjoys building culture-shaping services with technology, Aaron has 19 years of experience in the technology industry focusing on mobile, VOIP, and image processing / tools.

He founded QThru, a service that is shaping the way people shop and pay for goods by providing shopping and self-checkout using a smartphone from a brick-and-mortar store.

Prior to QThru, Aaron worked as a Senior Software Development Manager at Research In Motion where he helped grow RIM's prosumer email service division from a few hundred thousand to over 30 million subscribers. He was the brainchild behind the BlackBerry Management Center, a lightweight cloud-based management suite designed to simplify the grouping and management of BlackBerry devices for small IT Infrastructures.

When he is not building companies, Aaron is an avid maker, inventor, and science fiction fan.

## **Jaymee Johnson, Head of Marketing, Isis**



A joint-venture between AT&T Mobility, T-Mobile USA, and Verizon Wireless, Isis is chartered with building a nationwide mobile commerce platform that will transform the way consumers shop, pay, and save. In this role, Jaymee is responsible for both consumer and business, including merchant, issuer, and acquirer marketing.

Before joining Isis, Jaymee spent six years with T-Mobile USA where he most recently served as Director of Strategic Development and Investments. While at T-Mobile, Jaymee was a member of the core team that developed and incubated the Isis business model. He had previously served in related business development and marketing roles. Jaymee began his career at aQuantive in the early days of online advertising, serving in analytical and product management roles within both Avenue A (now Razorfish) and Atlas (now Microsoft).

Jaymee is a graduate of the Massachusetts Institute of Technology, where he received an undergraduate degree in Mechanical Engineering. He also holds an MBA from the Sloan School of Management at MIT. Outside of work, Jaymee enjoys spending time outdoors in the Pacific Northwest with his family.



## Russ Stromberg, CEO, Iota



Iota is a Seattle-based company that is bringing the power of national voice and text to Android-based touch screen tablets and other mobile Internet devices. Iota's core product, FLEX, is a wearable GSM phone device that connects tablets and other devices via Bluetooth to GSM networks around the world, including AT&T and T-Mobile.

Russ founded Iota after 15 years in the wireless industry, most recently as a leader at T-Mobile in engineering and product development.

## Interviewees

<b>Name</b>	<b>Affiliation</b>	<b>Website</b>
Brian Brooke	Research, Policy, Business Development Manager Sound Transit	<a href="http://www.soundtransit.org">www.soundtransit.org</a>
David Brudnicki	CTO Sequent Software, Inc.	<a href="http://www.sequentsw.com">www.sequentsw.com</a>
Sheena Chandock	Managing Director Lucid Communications	<a href="http://www.thelucidway.com/">www.thelucidway.com/</a>
Leigh Anne Duncan	Mobile Manager Alaska Airlines	<a href="http://www.alaskaair.com">www.alaskaair.com</a>
Kelly Franznick	Founder & CEO Blink Interactive	<a href="http://www.blinkux.com">www.blinkux.com</a>
Fred Hennige	Senior Architect, Mobile Division Alaska Airlines	<a href="http://www.alaskaair.com">www.alaskaair.com</a>
Andy Hickl	President ARO	<a href="http://www.aro.com">www.aro.com</a>
Chris Jeffries	Development Manager Sound Transit	<a href="http://www.soundtransit.org/">www.soundtransit.org/</a>
Jaymee Johnson	Head of Marketing Isis	<a href="http://www.paywithisis.com">www.paywithisis.com</a>
Kevin Keating	Managing Director Lucid Communications	<a href="http://www.thelucidway.com/">www.thelucidway.com/</a>
Joe O'Neill	President Tiger Mountain Group	<a href="http://www.tigermountaingroup.com">www.tigermountaingroup.com</a>
Aaron Roberts	Founder & CEO QThru	<a href="http://www.qthru.com">www.qthru.com</a>
Pat Santos	Attorney Lee & Hayes, PLLC	<a href="http://www.leehayes.com">www.leehayes.com</a>
Chetan Sharma	Founder & President Chetan Sharma Consulting	<a href="http://www.chetansharma.com/">www.chetansharma.com/</a>
Russ Stromberg	Founder & CEO Iota	<a href="http://www.iotadeveloper.com">www.iotadeveloper.com</a>
David Talach	Vice President, Global Product Marketing VeriFone	<a href="http://www.verifone.com">www.verifone.com</a>

# Acknowledgements

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## Resources

Background research was conducted using the following resources and websites of companies offering products or services in the NFC space.

All Things D	<a href="http://www.allthingsd.com">www.allthingsd.com</a>
Computerworld	<a href="http://www.computerworld.com">www.computerworld.com</a>
Mashable	<a href="http://www.mashable.com">www.mashable.com</a>
Mobile Payments Today	<a href="http://www.mobilepaymentstoday.com">www.mobilepaymentstoday.com</a>
Mobile Tech News	<a href="http://www.mobiletechnews.com">www.mobiletechnews.com</a>
Near Field Communications: a technology primer	Chris Foresman <a href="http://arstechnica.com/gadgets/guides/2011/02/near-field-communications-a-technology-primer.ars">http://arstechnica.com/gadgets/guides/2011/02/near-field-communications-a-technology-primer.ars</a>
NFC Forum	<a href="http://www.nfc-forum.org">www.nfc-forum.org</a>
NFC Data	<a href="http://www.nfcdata.com/blog">www.nfcdata.com/blog</a>
NFC News	<a href="http://www.nfcnews.com">www.nfcnews.com</a>
NFC Times	<a href="http://www.nfctimes.com">www.nfctimes.com</a>
NFC World	<a href="http://www.nfcworld.com">www.nfcworld.com</a>
ReadWriteWeb Blog	<a href="http://www.readwriteweb.com">www.readwriteweb.com</a>
RFID Journal	<a href="http://www.rfidjournal.com">www.rfidjournal.com</a>
Security in Near Field Communication (NFC)	Ernst Haselsteiner and Klemens Breitfuß <a href="http://events.iaik.tugraz.at/RFIDSec06/Program/papers/002%20-%20Security%20in%20NFC.pdf">http://events.iaik.tugraz.at/RFIDSec06/Program/papers/002%20-%20Security%20in%20NFC.pdf</a>
Wikipedia	<a href="http://en.wikipedia.org/wiki/Near_field_communication">http://en.wikipedia.org/wiki/Near_field_communication</a>