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Connectivity and Continuity: New Fronts in the Platform War

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Abstract:

Device interconnectivity in video conferencing, telephony, texting, file sharing, and application handoff has become a critical battleground for tech giants. This panel compared approaches to device connectivity and application continuity, reviewed current solutions, and shared projections for the future of connectivity. Apple, Microsoft, and Google are predictably focusing on connectivity across devices and applications rather than across platforms. Given the scope of impact of these innovations, tech giants will be under increasing pressure to architect a world wherein devices and platforms are secondary to what users want to achieve via technology. Participants examined competing approaches to connectivity and continuity, explored emergent issues for research and practice, and discussed the social and business impacts of these technologies.

Keywords: Continuity, Unified Communication, Application Handoff, Device Integration, Device Convergence, Connectivity

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1 Introduction

Smartphones and tablets are replacing notebooks and desktops as computing devices of choice in many corporate environments and homes. Device interconnectivity in video conferencing, telephony, texting, file sharing, and application handoff—an ocean of transformational innovations—has become a critical battleground for tech giants Apple, Microsoft, and Google. In this panel, we distinguish between approaches to device connectivity and application continuity, review current solutions, discuss potential research, and share projections for the future of connectivity.

The technology giants are in a pitched battle for primacy in a new cloud ecosystem that promises fluid device-independent and application-agnostic communication and workflows. Apple's continuity framework enables seamless transition among devices and applications. Microsoft's unified communication solution integrates disparate technologies at the enterprise level. The Google Now initiative anticipates and provides information for specific contexts and enables application handoff between shared devices.

The big three are predictably focusing on connectivity and continuity among devices and applications rather than across platforms. For instance, Apple has not released an iMessage client for the Windows platform, and Microsoft's Lync is clearly not optimized for iOS. Nonetheless, the boundaries between platforms are becoming increasingly permeable. For instance, iPhone users can access Google Now via the Google iOS app. Given the scope and impact of these innovations, tech giants will be under increasing pressure to adopt open standards and break down the proprietary silos that isolate devices and platforms.

2 Organization of the Panel

Panelists were experienced technologists representing two large corporations, one mid-sized company, and a university. The panel focused on exchanging ideas among panelists and audience members on connectivity and continuity technologies. The panel addressed issues encountered by users who attempt to communicate and work seamlessly across myriad computing and telephony devices. The topics that panelists addressed included the current state of connectivity and continuity, platform idiosyncrasies, business and social impacts, and potential research.

Panelists represented a diversity of experience and perspectives and brought those lenses to bear on discussions of Apple's Continuity initiative; Microsoft's unified communication platform; the Google Now initiative; enterprise, managerial, research, and social issues; and the future trajectory of connectivity.

3 Overview of the Technologies

3.1 Unified Communications

Unified communications (UC) integrates telephony, conferencing, instant messaging, and clients (Elliot & Blood, 2015). Large UC vendors include Cisco (Cisco Jabber), Microsoft (Microsoft Lync, now Skype for Business), Mitel, and AVAYA. UC is a collaborative technology that allows users to easily engage in a multitude of communications activities (e.g., phone conversations, email, instant messaging or chatting, and real-time audio and video conferencing) using one common interface. Most importantly, one can perform such activities regardless of the physical location or device being used by any party engaged in the communication. Furthermore, UC makes it possible for users to effortlessly switch between communication channels. For example, something as simple as a click of button can instantly switch a conversation from instant messaging to a telephone call. This feature allows users to choose the medium that is most appropriate for the task at hand.

Other UC features include shared user profiles and presence management. Shared user profiles provide instant access to contact information. Presence management, often cited as among the most beneficial aspects of UC, provides real-time information about users' availability and status. In most UC products, multiple user-status options are available that help facilitate the right time or method for a conversation. UC allows users to self-identify as busy, in a meeting, not available, or away. When one sets their status to "not available", the system blocks chat messages and automatically routes voice calls to voicemail. The away status indicates that a user has not been active in the UC environment for some time. A user can also identify the type of technology they are using. For example, a user can set the status to "mobile" to indicate that they are using a smartphone. The type of technology one uses often impacts the type of

tasks that one might attempt because some tasks are difficult on a smartphone but easily accomplished on a personal computer.

Organizations have begun to use platforms for much more than to simply support internal communication and collaboration, such as to improve business-partner communications and enhance customer support and customer service. For example, UC's integration into the contact center (i.e., call center) space is creating a precedence in the way that support calls are handled. Not only does UC allow agents to handoff a chat conversation to a senior agent without the caller being aware that the handoff has taken place, it also allows agents to see what the caller is typing before they hit the submit button, which allows agents to gain a better understanding of the mindset of the caller in order to provide more targeted assistance. UC technology is evolving quickly and shifting the experience of both working in teams and providing customer service.

3.1.1 Greatest Promise

Increased productivity from improved communication and collaboration is the greatest promise of UC. Moreover, UC has become a mobile tool that one can leverage from mobile devices, which provides users with the flexibility to participate in various communication venues (conference calls, video chat, etc.) and engage in real-time synchronous knowledge sharing regardless of geographical location or device they use.

3.1.2 Challenges/Obstacles

Previous research has demonstrated that increased usage of UC tools enhance productivity. However, there are risks associated with the use of these tools. One risk is user perception of mental overload that results from an increased number of interruptions and increased demand to engage in multitasking. One must also consider cultural differences. This factor includes sensitivity to message content and to message frequency and timing. Laws and regulations are another consideration. For example, some countries limit the use of various UC features, such as prohibiting the recording of video conferences. Finally, one must address geopolitical concerns and considerations given that UC platforms and tools are often hosted in several different countries.

3.2 Apple Continuity

At its 2014 Developer Conference, Apple coined the term "Apple Continuity" and announced that it would center its go-forward strategy on providing a seamless and continuous experience as users move from one device to another. Specifically, continuity focuses on five features: voice, text messaging, file sharing, application handoff, and, most recently, instant hotspot. For example, a phone call received on the iPhone will also ring on an iPad and Macbook, and, if answered on one device (such as the Macbook), one can easily transfer it to another device (such as the iPhone). The same goes for text messaging. A text message received on an iPhone will also appear on the user's other Apple devices. This feature provides added convenience: the user can easily switch to a device with a larger keyboard to respond to the text message. Airdrop allows one to share files with any Bluetooth-enabled Mac device that might be in range. Application handoff allows a user to start using an application on one device and switch to another device while maintaining user status in the original application. For example, a user who opens the popular AirBnB app on an iPhone and then searches for and chooses a lodging accommodation can easily switch to a MacBook to complete the reservation. Apple's iCloud is the thread that ties together these technologies. For continuity to work, one must be signed into the same iCloud account on all devices, have Bluetooth enabled on all devices, and ensure that all devices are connected to the same wireless network.

3.2.1 Greatest Promise

Pervasive or ubiquitous computing, the vision and greatest promise of Apple Continuity, envisions a world in which omnipresent computing devices are seamlessly connected and always available. Apple's continuity framework is an evolutionary step in the direction of users interacting with computing devices anywhere and everywhere at any time on any device.

Convenience and increased productivity are probably the greatest benefits for the user. Basically, continuity improves device usability and promotes device freedom. Before continuity, many tasks were relegated to a specific device, and transferring tasks between devices, if possible, was cumbersome.

With continuity, it does not matter on which device one begins a task because one can easily switch to a different device and pick up where they left off. This ability to seamlessly move between devices increases personal productivity as one can complete tasks more efficiently. Devices that had been underused now have new life. For example, an iPad one used solely as a video-player changes into a heavily used communications device. The promise of continuity is a more natural way to interact with and use our computing and communications devices.

3.2.2 Challenges/Obstacles

The greatest challenge for Apple's Continuity initiative at the current time is technical immaturity. Reliability in particular has been an issue, which Apple acknowledges. On its support site, Apple has stated that "Occasionally when you use Continuity with your iPhone, iPad, iPod touch, or Mac, you might find that a phone call doesn't transfer to your other devices. You might not see the Handoff app icons where they should be. Or Instant Hotspot might not share the Internet with your other devices" (Apple, 2014). Continuity is also not supported on many older devices such as the original iPad or even the iPad 2. Backwards compatibility will continue to be an issue, similar to what has been experienced with the release of operating system upgrades.

The next greatest challenge is usability. Currently, setting up continuity between devices is a complex and multi-step process that can be intimidating to novice (and even advanced) users. In addition to obtaining an AppleID and properly setting up an iCloud account, there are at least five other settings on each device that one must correctly enable. Further, once continuity is working, navigation is a bit complicated as each feature has a different method of user interaction. For example, handing off a phone call works between a Macbook and an iPhone but not the other way around. More consistency is needed before more users will adopt the initiative.

Finally, privacy and security issues can easily become major obstacles. The greatest concerns center on a fear of Apple's intrusiveness. The continuity framework is specifically designed to work only on Apple devices and only if one maintains a presence in the Apple iCloud. This restriction achieves two things: it provides Apple with a wealth of data about its users and it confines continuity users' purchases to Apple products. The major risk to Apple is driving users away because they become frustrated with Apple's progress in maturing its continuity framework or with Apple's proprietary approach; users will especially grow frustrated if competitors are successful at achieving the vision of ubiquitous computing before Apple does.

3.3 Google Now

Google's approach to connectivity and continuity is all about information. The tagline for the Google Now service is delivering the "right information at the right time". To ensure connectivity and continuity, Google Now supports a variety of platforms ranging from PCs (e.g., Chrome browser and Chrome operating system) to mobile devices (e.g., Android and iOS smartphones).

Google Now works by displaying a series of cards, or snippets of information, that it believes the user might find pertinent. For example, if traveling to Dallas, Google Now displays a card containing current weather information for Dallas. While back at the office at 4 p.m. on a Friday afternoon, Google Now displays a card containing the current estimated time for the drive home. Displayed cards are consistent across all platforms: a user sees the same traffic card in a Chrome browser as in a Google iOS app. By offering a consistent look and feel, Google Now provides what it refers to as connectivity without user barriers. Further, as the cards are tied to a single Google account, Google Now essentially offers a continuous experience for the user.

Providing relevant, accurate, and timely information relies on how much Google users are willing to share with the service. Fortunately, Google Now users are able to select how much or how little information they want to share, although the more a user shares, the better the experience. For example, if a user provides both a home address and a work address, Google Now will send push notifications when traffic between these two locations begins to build. Or, if a user allows access to their Gmail or Google Calendar, Google Now will automatically provide directions (and tell you when you need to leave) to any appointments, parties, or meetings noted in the calendar or contained in an email.

3.3.1 Greatest Promise

It almost goes without saying that Google's service offerings are already well known and widely popular—Google Now simply leverages user information with Google's massive network of data to offer a connected experience across the Google platform. If Google can produce exactly the information we need when we need it, Google Now will become extremely popular.

3.3.2 Challenges/Obstacles

Because Google Now relies on personal information, both privacy and security present major challenges. To take full advantage of the Google Now service, users have to trust Google with personal information including search and location histories. As an example, Google Now requests location information and, if allowed, will track and store a map of everywhere a user has been. It remains to be seen how many people value privacy over conveniently provided information such as traffic and weather reports. Google's other challenge is accepting its business model. Google offers free services, but it makes a profit from data sharing and targeted advertising. Many users are uncomfortable with having their information used in this way—a challenge that Google must face if it wants the Google Now platform to excel.

To a far lesser degree, Google Now also faces challenges with platform boundaries. Incorporating Google Now into Google-owned platforms such as Android or Chrome is easy, and Google has seamlessly incorporated Google Now into the structure of these platforms. Playing by the rules of other manufacturers (such as Apple on iOS), however, presents its own challenges. Google apps running on iOS only operate when they have been explicitly opened; Google cannot integrate its functionality in the core of iOS as it does in the Android OS, which is inconvenient for the user. For example, Google Now has no access to Apple's Siri, so the only way users can activate voice commands that work in a Google app is to open the Google app. In response, Google has implemented some clever workarounds. For example, the Google app, which includes Google Now, does not only include its own virtual search assistant but also creates links between any other Google app installed on the phone (i.e., the maps link will take the user to Google Maps instead of the default Apple Maps). Google will have to continue to work creatively to offer a continuous experience as users cross into other vendor platforms.

3.4 State of Connectivity and Continuity in Industry

From a technical standpoint, multiprotocol label switching (MPLS) and VPN connectivity technologies dominate the industry standard for connectivity, but companies are slowly moving to more cellular and Wi-Fi platforms. These wireless platforms are what provide the "always-on" connectivity that users desire and are propelling forward the unified communications and the Internet of things (IoT). IoT is the concept that any powered device can be connected to the Internet (Morgan, 2014). Projections moving forward are grand. UC- and IoT-based industries are expected to grow dramatically by the end of the decade. According to market research, the UC market will reach US\$75.81 billion (an increase of 16.3%) by 2020 (Grand View Research, 2015) and the number of IoT devices will rise from 10 billion to more than 34 billion (Greenough, 2015). Of course, IoT and UC platforms are based on cloud technology. As such, cloud technology provides business with a virtual seamless continuity strategy for voice, text, data, application, and document sharing.

3.4.1 Greatest Promise

The rising landscape of UC and the IoT environment is one that will allow users to remain connected 24/7 and access enterprise resources at any time; as such, they will facilitate optimal business continuity. Employees will be able to work anytime, anywhere, and on any device (be it their own device or a company-owned device). Further, UC enables employees and customers to collaborate and communicate seamlessly regardless of any individual's location or communications platform. Perhaps the greatest promise of the seamlessly interconnected environment will be its positive impact on business processes and business relationships. UC represents multiple channels of communications through which users have the ability to choose the communications channel based on their needs, which not only enhances the customer experience but also deepens the relationship between the customer and the business. The "always-on" access to business resources provides the leverage needed to improve business processes such that one does not only meet customer expectations but exceeds them.

3.4.2 Challenges/Obstacles

Security is obviously a huge challenge and obstacle for the enterprise. Organizations need to create and implement new security measures, guidelines, and enforcement mechanisms in order to prevent unauthorized access and manipulation of UC tools and IoT devices. Providing security at this level is a major obstacle. Multiple layers of security will be necessary, and the security focus will need to shift to securing individual roaming devices as opposed to securing a group or network of devices located at fixed locations. Other challenges arise with securing wireless devices because many have limited CPU and memory capabilities. Further, securing mobile apps often slows processing time and the time it takes to interconnect with an enterprise app. Ensuring that security features remain “turned on” will be an ongoing challenge as users discover disabling those features might significantly increase device performance. We are entering uncharted waters with this new age of always-on and always-connected devices. We not only need to become proficient at projecting potential security vulnerabilities but also be able to identify them as they occur and act immediately. Addressing the security obstacle will be paramount to the success of connectivity and continuity.

3.5 Summary

With the proliferation of computing devices and the ever-expanding robustness of the Internet, many believe the next step in the evolution of computing technology will be seamless interconnectivity that results in an uninterrupted and continuous experience for users as they move between devices. The panel discussion reviewed different approaches to connectivity and continuity. Table 1 summarizes the main points that the panelists presented in relation to unified communications, Apple’s Continuity Framework, the Google Now initiative, and their potential impacts on the enterprise.

Table 1. Summary of Continuity and Connectivity Technology Promises and Challenges

Technology	Greatest promise	Greatest obstacles/challenges
Unified communications	Increased productivity.	User perception of mental overload, cultural insensitivity, and security vulnerabilities.
Apple Continuity	More natural and productive way to interact with and use computing devices.	Technical immaturity, complex usability, and sole focus on the Apple ecosystem.
Google Now	Immediate access to relevant information.	User concerns for personal privacy violations and cross-platform integration.
Impact on the enterprise	Always-on (24/7) connectivity, which affords opportunities for greater productivity, more efficient business processes, and improved business relationships.	Security: the need for new approaches to identifying vulnerabilities, creating security action plans, and remediating threats.

4 Panelists Commentary

In the course of panel discussions, participants examined competing approaches to connectivity and continuity, explored emergent issues for research and practice, and discussed social and business impacts of these technologies. They explored four areas in detail: platform exclusivity, implications for security risks, current state and future directions of application handoff, and the performance of the three major players in this space (i.e., Microsoft, Apple, and Google).

4.1 Platform Consideration

Currently, the initiatives that promote device interconnectivity and continuity are based on competing ideologies and provide solutions primarily focused on a single platform. For example, Apple’s continuity only works with Apple devices. Microsoft’s unified communication offering (now called Skype for Business) heavily relies on the integration of Microsoft’s software products and the use of many proprietary protocols including Skype. Google Now is integrated into the Google Android OS and works as an add-on in other platforms. This issue resonates with the long standing problem in the IT industry: proprietariness versus openness. Table 2 presents panelists’ responses to the issues of continuity and connectivity in and across platforms.

Table 2. Opinion of Panelists - Continuity and Connectivity Within or Across Platforms

Panelist / technology	Commentary
Joy Fluker / Unified communications	UC represents continuity and connectivity both in and across platforms. In fact, UC's success results from the integration of many different communications mediums. Over time, UC has evolved from integrating voice with other communication technologies such as instant messaging (IM, or chat) to incorporating collaborative communications tools such as video conferencing. Further, UC has expanded its reach from traditional computing devices to include mobile devices. Major limitations have been vendor restrictions in support of various types or brands of devices, mostly audio and video devices. Functionality can also be limited when a service is not supported by the UC vendor or not enabled by a system administrator.
Meg Murray / Apple Continuity	Apple's continuity strategy focuses exclusively on Apple. In some ways, this makes sense. Technically, cross-platform integration is more complex. As a continuity strategy is first initiated, getting it right within one's own ecosystem is probably a necessary precursor to extending one's reach. The risk with this strategy is platform lock-in. For users to enjoy the benefits of continuity, they must become and remain Apple centric, which actually further segments the computing technology landscape by generating a deviation from a path to true computing ubiquity. As Ars Technica, a leading provider of technology advice, has noted: "For those of us who prefer to live in between ecosystems, continuity takes today's vendor lock-in problems and makes them even worse" (Cunningham, 2014).
Zach Bailes / Google Now	For continuity to truly work, it must be both in and across platforms. Google Now performs best in the Google network but does provide offerings that span multiple platforms. The main issue with Google Now continuity is that it works best in an all-Google environment where it is integrated into the Android OS (the latest version is referred to as Google on Tap). On other platforms, Google Now is an add-on. Further, increased functionality of Google Now will depend on its providing integration capability with third-party apps. While Google has been reaching out in this arena, some have complained that Google maintains strict control over which "cards" it shows users. For continuity to truly catch on, it has to be seamless. If barriers to entry exists, users will not embrace the concept.

4.2 Security

Security is a major issue in today's interconnected world. As the number and types of devices connected to the Internet increase, so will the security challenges. In fact, technology progression often lags when unexpected security vulnerabilities and threats arise. Continuity and connectivity are built on the exchange of data and facilitated through centralization via the cloud, which has implications for privacy and security. As we indicate earlier, security and privacy may be the biggest obstacles to device interconnectivity. Table 3 presents panelists' comments on security issues.

4.3 Application Handoff

The idea behind continuity extends beyond device connectivity—it also includes continuous access to information. Application handoff refers to transferring activities among multiple devices associated with the same user. Basically, handoff allows users to start an application on one device and continue using that application on another device and pick up where they left off. For example, a user can start typing a long email on their phone and switch to their PC to finish it as if they had not changed devices. Handoff support in a browser allows a user to open a webpage on one device and then switch to another device where the webpage will open in the same scroll position as where it was on the original device. For the end user, juggling the use of a multitude of devices, application handoff adds another dimension of convenience and efficiency. Table 4 presents panelists' comments the current and future state of application handoff in their respective technologies.

Table 3. Opinions of Panelists: Security Issues

Panelist / technology	Commentary
Joy Fluker / Unified communications	<p>Security in the UC environment is definitely a matter of concern, especially for global organizations. Many larger organizations have functionality restrictions in different geographical regions based on security and privacy laws. For example, some countries do not allow voice communication across borders. Therefore, if the voice system is not located in the country, the voice communication via the UC platform is forbidden. What this translates into is that users in one country may not be able to use some of the features included in a UC solution. Other types of barriers also exist. The use of video often creates interesting security and privacy issues. In some countries, the use of video is not allowed in certain situations. For example, there are laws that state that a user in one country cannot be allowed to see the office/home setting of a user in another country while one is working. In some countries, it is considered a breach of privacy if the spouse of a worker is in the view of the camera while a video conference is taking place. In this same scenario, it is considered a security breach if the non-employee can see the office setting of other video conference participants.</p> <p>With the growth of UC solutions, vendors have continued to look for ways to better secure communications channels. As early as 2009, industry leaders in the UC space announced they would leverage security focused capabilities from outside companies such as IBM and ISS that have strong security solutions. These companies are better equipped to proactively prevent attacks such as denial or interruption of service, VoIP phishing, eavesdropping, malware, and various other threats. By engaging third-party solutions, UC vendors are able to meet the security needs of their customers via enhanced protection and increased support for remediating security issues.</p>
Meg Murray / Apple Continuity	<p>Real and perceived issues of security and privacy related to Apple continuity arise from the fact that continuity requires one to use the iCloud and a single AppleID. Apple touts that it maintains privacy because devices hand off data to each other rather than a centralized system handling it. They state that security is afforded because the AppleID is only used to identify which devices belong to a user; it is the hardware that has access to the data (unless of course, one stores their data in the cloud). Further, Apple notes that most syncing is enabled over Bluetooth so that devices must be physically close to each other for sharing to occur. Albeit, for the user, there are other considerations. For example, to maintain continuity, Apple has to maintain information about a user's state. It does this by automatically and "silently" uploading a text document to the cloud. Depending on what a user might be doing, there is the potential for exposure of sensitive personal information. And, even though syncing is done when devices are in close proximity, the data, at least for now, makes the trip via the cloud. Apple remarks that continuity is a user's choice: it does not have to be turned on. The tradeoff for the user will be accepting a security and privacy risk in exchange for added convenience. If Apple heeds the call for better security, risks will go down and the use of continuity features will go up.</p>
Zach Bailes / Google Now	<p>I believe security is the major issue with connectivity and continuity. In order for devices to be connected, you have to trust the entity in the middle. In the case of Google Now, that entity is Google. Google already has a populist reputation for hoarding data about its users and a reputation for invading user privacy. Many people worry about their information being stored in the cloud. Even though they may not realize they already have information exposed on the Web or in the cloud, there is an inherent worry about entrusting a Web-based service with continually uploading data about your location or the minute details of your communication behaviors. User desire and need for personal security and privacy is the major barrier for connectivity and continuity.</p>
Demetrius Fluker / Impact on the enterprise	<p>In today's enterprise, having insecure applications and poorly built services readily translates into a negative impact on company financials. Breaches will always happen, but they are likely to become even more prevalent as the tools and techniques used to exploit vulnerabilities gain a kind of normalcy in the world of hackers. A strong cybersecurity program will become one of an organization's greatest assets and the role of cybersecurity professionals will take on more importance. In order for connectivity and continuity to enjoy widespread acceptance, potential security threats, vulnerabilities, and risks must be assessed and strategies for remediation identified.</p>

Table 4. Opinions of Panelists: The State of Application Handoff

Panelist / technology	Commentary
Joy Fluker / Unified communications	At the current time, application handoff is not really a focal point of unified communications. What is prevalent is device handoff. UC enables various forms of communication to be transferred seamlessly between devices or communications services. While not yet actively being discussed, it is quite possible that application handoff will be included as a feature in the future.
Meg Murray / Apple Continuity	<p>Application handoff will be big. Right now, however, handoff is a newly introduced feature and interest has yet to take off. Handoff faces several challenges. For one, it relies heavily on the use of the cloud to track and transfer data between devices. There are also issues with data synchronization, duplication, and versioning. However, as discussed before, one of the major issues will be convincing software developers to provide cross-platform support. For example, what incentive is there for Microsoft to enable handoff for the Office suite of applications to support Apple devices?</p> <p>Apple views handoff as the way of the future. Most core Apple apps, such as Safari, Maps, Calendar, and Reminders are handoff enabled. Apple has also provided a continuity development framework that supports handoff in third-party websites and apps. For example, handoff is supported in such well-known apps as AirBnb, <i>The New York Times</i>, and Babble. It is starting to appear in other apps as well, such as photo editors, calculators, to-do lists, and cooking apps. For true continuity and computing ubiquity to be achieved, handoff will eventually have to be a feature included in most apps.</p>
Zach Bailes / Google Now	Experimentation with application handoff has been occurring for a while, but mainstream implementation is just beginning to happen. However, for application handoff to truly work, it must be seamless for the end user, which means that, if a user has to make a concerted effort to make handoff happen, it no longer achieves its goal. For example, Google Docs users expect to find a document left unfinished in the same state when they return to work on it. These users do not worry about having to save a file to a hard drive or upload it to the cloud—they know that their file is saved and accessible. For application handoff to work, it must be this seamless.
Demetrius Fluker / Impact on the enterprise	The current reality in industry is that some amount of confusion will occur regarding handoff due to the sheer size of many applications in use today. While it might be practical for handoff to be incorporated as a feature in a single-user application, it is much more difficult to achieve in a multi-user enterprise software solution. It will require synchronization of user status tracking and data sharing. Right now, that is primarily achieved by retaining user state when users log out of a program so that, when they login again, they can resume their work. True application handoff between devices, particularly for users' own devices (i.e., BYODs) will be challenging for the enterprise especially if there is a need to support data exchange between personal clouds, enterprise clouds, and the public cloud.

4.4 Technology Companies Apple, Google and Microsoft

Increased usability and functionality is a major driver in the technology market space. Historically, there has been a race to be first to market to offer innovative solutions. First movers often gain an advantage over their competition: that is, they gain increased market share and increased visibility, a better reputation, and the ability to exert control over the technology's progression. In the case of connectivity and continuity, first-mover advantage affords the opportunity to define standards for cross-platform integration. There is much at stake for Apple, Google, and Microsoft as they strive to maintain their status and technological dominance. The next evolution of technology will be built on the integration of computing devices, and the technology company that masters this well will be the benefactor of eminence. Table 5 presents panelists' comments on "what's at stake" for these technology giants.

Table 5. Opinion of Panelists: What's at Stake for the Major Players?

Panelist / technology	Commentary
Joy Fluker / Unified communications	Based on reports from large research organizations such as Gartner (Eliot & Blood, 2015), the projection is that the UC technology vendor with the strongest customer focus will win. This will be the UC solution that supports communication between in-house employees and communication with external customers, which means the platform will have to incorporate additional connectivity tools, some of which will be outside the purview of the vendor. These tools must be multi-functional to address a wide range of needs that span the entire organization from the contact center to the back office. Further, the UC platform that expands its offerings to include integration with resources such as knowledge management will rise ahead of its competitors. At the current time, Microsoft is sitting at the cusp of becoming the leader in the UC marketplace. Many see their acquisition of Skype as a strategic move that has given them access to a broader spectrum of users. Microsoft is now poised to take a UC mindset from the office to the home.
Meg Murray / Apple Continuity	It seems the major IT vendors are in a race to be “king of the mountain”. Even Samsung has entered the fray with Samsung Flow, an initiative to provide continuity between Samsung devices. However, right now, no one wants to invite others to play in their “sandbox”. I believe that, once the first partnership becomes a reality, the floodgates will open. I do not believe there will ever be a crowned “king”, but I do believe that, at some point, there will be convergence and that cross-platform solutions will become the norm.
Zach Bailes / Google Now	It is difficult to pick a winner because the tech giants are taking very different approaches to connectivity and continuity. Apple is focused on selling devices—the connectivity they have enabled between their own devices encourages customers to stay in the Apple ecosystem. Google’s mission is to collect data useful for trend analyses, which they achieve by offering free services to users. They also make their services available across platforms—someone can be both an iPhone user and a Google user. Microsoft seems to be making great strides to improve connectivity in the workplace. Offerings such as Office 365, Sharepoint, and Skype for Business facilitate real-time collaboration among team members. It seems that, as the major players compete for leadership position, the end user is in the position to be the winner as these companies vie for their business.
Demetrius Fluker / Impact on the enterprise	There is a lot at stake here, with many of the issues centered on security. Continuity and connectivity open up many risks for the enterprise. Examples include theft of intellectual property, seizure of private data, the creation and distribution of malware on enterprise infrastructure, and the illegal posting of restricted business information on the Web. The economic impact of cyberattacks tends to increase over time. The real challenge for the enterprise will be to understand and appropriately assess the costs of these risks and to develop strategies to stop or prevent them. A security breach attributed to a continuity strategy of any of the big three players will certainly damper their progress and reputation. The company that gets out in front of the security vulnerabilities will be the big winner.

4.5 The Future

Technology is always in a state of flux; it constantly progresses and evolves. Many theorize that this next wave of technological innovation will be revolutionary. Much of this revolution is precipitated by a growing number of varying types of computing and other devices interconnected via the Internet. This territory is new and one that will emerge as technical possibilities become reality. Table 6 presents panelists’ vision of the future.

Table 6. Opinion of Panelists: Vision for the Future

Panelist / technology	Commentary
Joy Fluker / Unified communications	I believe we will soon see universal UC tools that enable more organizations and more people to connect with the right technology at the right time. This is the future. Many of the issues faced today that result from a plethora of devices and platforms will one day be eliminated as we move towards universal standards for interconnectivity. UC has already shown that it has the potential to reduce cultural barriers and facilitate team collaboration regardless of where team members may be located. Most importantly, connectivity and continuity enhances the ability to share data and information—necessary precursors to knowledge exchange. The concern, however, is how a reliance on technology to facilitate communications will impact face-to-face interactions.
Meg Murray / Apple Continuity	Apple's view of the future is one where billions of people hold Apple devices that seamlessly interact with each other. That may not happen but Apple is definitely onto something—users are ready for a continuous experience as they move from device to device. Continuity is in the early stages of development and implementation, but it will continue to evolve and mature. As it does, we will begin to witness innovative uses that have yet to be imagined. Continuity will impact our daily lives—both at work and at home. The possibilities are endless as we move further along the man-machine continuum.
Zach Bailes / Google Now	Google Now is going to become even more accessible and more powerful. For example, Google is extending its reach by supporting more devices. Android Auto is placing Android OS in the consoles of vehicles and Android Wear is bringing Google Now to a variety of wearable devices. Google is also enhancing support for third-party services such as generating cards from Spotify and Uber. Because Google Now is an extension of Google Search and heavily integrated into the Android OS, I see Google investing even more into its Google Now initiative, which would make it even more attractive and useful for the user.
Demetrius Fluker / Impact on the enterprise	Enterprise connectivity will continue to shift to a more mobile and redundant platform in the form of UC, IoT, cloud storage, and wireless access—both cellular and Wi-Fi. The introduction of cellular G5 and wireless carrier network optimizations will significantly increase network speed for enterprise users. Continuity and connectivity will allow on-demand connectivity enhancing the ability to complete tasks and increase worker productivity. On the other hand, it will also tax the communications network. Securing the devices and data across the wireless network will remain a significant challenge for corporations. Successful companies will be those that have a plan that addresses transformation, implementation, and management of the transition to ubiquitous computing in the enterprise.

5 Discussion and Conclusion

Interest in connectivity and continuity, among technology companies and end users alike, is growing as an interconnected ecosystem that comprises a multitude of devices becomes reality. Unified communications and the Internet of things are examples of such connectivity initiatives. Continuity of user experience, however, is the ultimate goal. Apple, Microsoft, and Google are predictably focusing on connectivity across devices and applications in their own environments. The differing approaches these companies take are impactful. Microsoft is focused on facilitating collaborative communications. Apple is focused on providing a seamless user experience across devices. Google is focused on providing the right information at the right time. Going forward, however, connectivity and continuity across platforms will be key points of differentiation among these players. Given the scope of impact of these innovations, tech giants will be under increasing pressure to architect a world wherein devices and platforms are secondary to what users want to achieve via technology.

Decades-old waves of technology-driven change are cresting in the form of accelerated digitization sweeping across industries and reshaping how digital technologies impact society, work, and home. The rush toward digitization is driving the emergence and evolution of ICT technologies and digital services that enmesh people in networks of interconnected physical objects, virtual processes, and communications channels. However, value derived from digitization will only be realized through the strategic convergence of people, processes, and devices. We need to take care to coordinate and align these elements to optimize person-to-person, person-to-object, and object-to-object communication (Domingo, 2012).

Innovation diffusion theory (Rogers, 2010) posits that technological innovation creates uncertainty about expected consequences that is resolved only when potential adopters think they have enough information to reduce the vagueness. While digitization is a known phenomenon, the expanse of what is being digitized is new. Much of the uncertainty surrounding the interconnectedness of devices centers on the displacement of people in the decision making process. More and more decision making is facilitated or driven by some form of sensor-enabled monitoring, which creates a more intimate and bi-directional relationship between people and machines. Currently, the focus is on how connectivity and continuity can be used to improve current business processes; what has not been explored is the real likelihood of “more radical, emergent, unpredictable, and user-led innovation in the future” (BCS, 2013. p. 2). Technological innovations often catalyze revolutionary change. The intended and unintended impacts and consequences of the always-on, always-connected digital society cannot be fully predicted, but the time is right to begin the discussion.

There is considerable hype in the trade press about digital transformation, the Internet of things, and unified communications and collaboration. However, we have little empirical research on connectivity and continuity. Both practitioners and scholars must build a better understanding of factors that contribute to and hinder the successful adoption of these transformational innovations. The benefit for the enterprise is touted to be increased productivity, stronger customer relationships, and a better decision making ability; major challenges include amplified threats to security and privacy. However, other dynamics appear to be at play as technological change drives cultural change. As leading digital transformation researcher Marc Carrell-Billiard notes, “[f]inding ways to help people across [the] digital divide and the culture shock that rapid change brings is going to be just as important as the technology we use to get there” (Miller, 2016). Research opportunities abound to investigate the transformation occurring as a result of device connectivity and application continuity. We need to understand the effects on organizations and business processes and on individual users and societies. As we note above, we must explore the consequences of displacing face-to-face interaction with communication via UC&C channels, how employees deal with mental overload resulting from increased multitasking, and how “always-on” access affects our culture.

Connectivity and continuity innovations are changing how we interact with each other and our computing devices and foreshadowing a world in which omnipresent devices are seamlessly linked and always available. The primary obstacle to universal connectivity and continuity is competition—pockets of devices bound to proprietary platforms separated by chasms of compatibility. Profound digital transformation will occur when the pressure to bridge the chasms—and profits associated with doing so—surpasses the drive to bind consumers to families of devices in corporate ecosystems.

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