

Enterprise Mobility¹

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1 Mobilising Interaction

1.1 From Telegraph to Mobile

The past 150 years signify unprecedented development in the ways organizations organize distributed activities. The invention of scientific management at the end of the 19th Century along with technological innovations such as the telegraph, filing cabinets, and printers suddenly made it possible to manage large-scale organizational activities distributed across continents much more efficiently and effectively (Yates, 1989). A variety of physical information management technologies played an increasingly critical role, but with the birth of the business computer in Post-War 1950s marked the beginning of an era of rapid acceleration in the importance of complex digital information management for business across all sectors (Caminer et al., 1998). During the next thirty years, mainframe computers formed the backbone of organizational information management. The 1980s gave birth to the networked personal computer allowing further distribution of computing power (Hinds and Kiesler, 2002). Fast forward to the present and we witness the pulverization of computing access with myriads of mobile phones, digital recording devices, contact-less sensors, etc (Yoo, 2010). Portable-, handheld-, and embedded client technologies are interconnected through personal-, local-, and global digital networks. The combination of powerful client technologies connected through high-speed networks to a variety of cloud services provides a powerful digital infrastructure the consequences of which we have yet to fully grasp (Tilson et al., 2010).

1.2 Predictions

We tend to be rather poor at understanding the technological development when it is right underneath our noses. Several prominent predictions of the impact of information technology turned out to be off the mark (Sørensen, 2011, p.20ff). IBM's Chairman Thomas Watson

¹ Sørensen, C. (Forthcoming): Enterprise Mobility. To appear as Chapter 60 in **The Computing Handbook Set – Information Systems and Information Technology**, ed. H. Topi, vol. 2. CRC Press.

famously remarked in 1943 “I think there is a world market for maybe five computers”. Digital Equipment Corporation co-founder Ken Olsen stated in 1977 “there is no reason for any individual to have a computer in his home”. Even Bill Gates’ proposition in the late 1980s that “Microsoft was founded with a vision of a computer on every desk, and in every home” now seems to greatly undershoot a reality littered with computation. Xerox Lab’s Mark Weiser came close when he in 1991 stated that “The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it” and thus defined the foundation for ubiquitous information technology. Harold S. Osborne already in 1954 famously predicted a device similar to a mobile phone with a unique ID given each person at birth and following him or her until death.

1.3 Researching Mobile Information Technology Practices

A variety of research has been conducted into mobile information technology practices and this section briefly classifies the research into the four categories of studies into: 1) the mobile phone applied in a general social context; 2) broad ranges of mobile- and ubiquitous information technology used in a social context; 3) the mobile phone used to support work activities; and 4) broad ranges of mobile- and ubiquitous information technology used for the purpose of work. The last category is labeled ‘enterprise mobility’ and the focus of the remainder of the chapter but before leaping onto this important subject, the following will briefly discuss all four categories of mobile information technology research.

1.3.1 The Mobile Phone in Society

It is not strange that a significant research effort has been put into understanding the role of one single technology – the mobile phone – in society. There are currently billions of mobile phones in use across the Globe and its use crosses geographical, social, religious and income barriers. This has led to a number of books and articles within the field engaged in the social study of mobile communications. While significant and important, it is essential to note that this research field is mainly interested in studying social phenomena and seems less interested in understanding technological diversity. Good examples of this line of research are, for example: Agar’s (2003) account of the history of the mobile phone; Baron’s (2008) work on the co-evolution of technological practices and language; and a large body of work exploring the new communicative practices and changes on social rituals emerging from mobile phone use by researchers such as Ling (2004; 2008), Harper (2005), Licoppe and colleagues (2001; 2004; 2006), Fortunati (2002; 2005), and Katz & Aakhus (2002), to name a few. The general and widespread global diffusion of mobile phone communication has been explored by Castells (2007) and Funk (2004). Some research has also explored regional characteristics, for example in: Japan (Ito et al., 2005), The Asia-Pacific region (Rao and Mendoza, 2004; Pertierra, 2007; Hjorth, 2009), and in developing countries in general (Horst and Miller, 2006; Donner, 2008).

1.3.2 Mobile- and Ubiquitous Information Technology in Society

Despite the immense global success of the mobile phone, there are good reasons for studying technological properties in use more broadly beyond this one incarnation. Mobile- and ubiquitous technologies are used in conjunction with the mobile phone, and the mobile phone is integrating a number of previously distinct technologies. This shapes everyday life by what Yoo (2010) characterizes as “experiential computing”, which is the everyday experiences with a range of technologies embedding computational abilities, such as; mobile phones, iPods, digital

cameras, GPS navigators, digital photo frames, smart toasters, intelligent ovens, in-car entertainment systems etc. Relatively little research beyond specific studies into the human-computer interaction aspects have been conducted within this area, which can be characterized as the social study of ubiquitous computing. Good examples of such research is the work on design, intimacy, and environment as digital technologies disappear into everyday life by authors, such as Weiser (1991), Norman (1988; 1993; 1999), Dourish (2001), Mitchell (1995; 2003), and McCullough (2004). Researchers have also studied changes in influence and power distribution as the result of mobile- and ubiquitous technologies, for example, the consumer impact of RFID technology (Albrecht and McIntyre, 2006), and wearable computing for citizen activism (Mann and Niedzviecki, 2002).

1.3.3 The Mobile Phone at Work

There is a relatively small body of research specifically focused on the organisational use of the mobile phone at work, which is striking when considering the organizational proliferation of this technology. It is, however, often difficult to specifically isolate the mobile phone at work since it will often be an element in a larger portfolio of mobile- and ubiquitous technologies now when the mobile phone is less associated with the isolated connectivity of voice calls and SMS messaging. The social study of the mobile phone at work has research a diversity of issues, such as: The role of the mobile phone in maintaining ongoing social contact whilst at work (Wajcman et al., 2008); the intensification of work (Bittman et al., 2009); work-life boundary maintenance (Golden and Geisler, 2007; Wajcman et al., 2008); and the organizational use of mobile email (Mazmanian et al., 2006; Straus et al., 2010). Although not research-based, Kellaway's (2005) amusing fictional account of mobile email forms a highly informative image into contemporary organizational life with mobile email.

1.3.4 Mobile- and Ubiquitous Information Technology at Work = Enterprise Mobility

The emergent organizational use of a range of diverse mobile- and ubiquitous technologies led Lyytinen & Yoo (2002b) call for more research into this subject. This call has largely been ignored across the Information Systems field the passing decade (Sørensen, 2011). While a significant amount of research has explored how individual users in a social context use the mobile phone, there is little research exploring the organizational use of more complex portfolios of mobile- and ubiquitous technology (Sørensen, 2011). Some research, however, does explore the issue of enterprise mobility. A number of edited collection broadly explores mobile- and ubiquitous technologies at work and mobile working (Andriessen and Vartiainen, 2005; Sørensen et al., 2005; Basole, 2008; Hislop, 2008; Kourouthanassis and Giaglis, 2008). A range of books aimed at practitioners engaged in implementing enterprise mobility within their organization, e.g., (Lattanzi et al., 2006; McGuire, 2007; Darden, 2009; Reid, 2010; Sathyan et al., 2012).

This chapter reports on such research into enterprise mobility. It focuses on the mobilization of interaction at work through the application of mobile- and ubiquitous information technology. The aim is to provide a conceptual map of the core challenges the mobilization of interaction pose to individuals, teams and organizations. The chapter argues that the mobilization of interaction at work challenges existing arrangements and that the complex human-technology relationship must be more closely considered in order to understand how to manage unintended consequences.

1.4 The Mobile Enterprise

Organizations have rapidly adopted a range of mobile- and ubiquitous information technologies to support instant connectivity, access to corporate infrastructures and for a range of other purposes. The first bulky mobile phones from the 1980s have been replaced with smartphones and tablets offering fast Internet access. Tiny microchips and associated sensor technologies can be used to track objects, vehicles, and people, using for example, Radio Frequency Identification (RFID), Near Field Communication (NFC) and the Global Positioning System (GPS). A great variety of portable- and embedded devices beyond the ordinary mobile phone serve a range of purposes. These arrangements move far beyond establishing connectivity between people or granting access to information services. The technology also serves a variety of purposes implemented through machine-to-machine (M2M) connections.

Organizations, of course, constantly consider how emerging information technology can offer new possibilities, but equally, some technologies become important because they represent solutions to existing problems. This two-way bind of problems and solutions interacting through a mesh of technological and organizational arrangements is as old as information technology itself (Yates, 1989). Since the birth of the mainframe, organizations have engaged in an increasingly complex arrangement of locally and globally distributed activities (Urry, 2003). This has made it possible to geographically shift activities depending on changing needs, available skills and cost levels, for example, extensively separating the design and production of goods and services. Apple's iPhone is designed in California and manufactured in China with components gathered from further distant countries. Its applications are downloaded from globally distributed server farms and are globally sourced from hundreds of thousands of small and large programming outfits. After-sales support is located wherever is most appropriate for the time of the day or the nature of the customer-inquiry.

2 Capabilities and Performances

In order to understand this development in general, and the organizational consequences of mobile- and ubiquitous information technology in particular, it can be helpful simply to consider the organizational application of mobile- and ubiquitous information technology as the technology performances carried out in the meeting of technological capabilities (see Figure 1) and the requirements of organizational activities. The diversity of capabilities is illustrated below in Figure 1 and Figure 2 subsequently illustrates the relationships between capabilities, work requirements and technology performances.

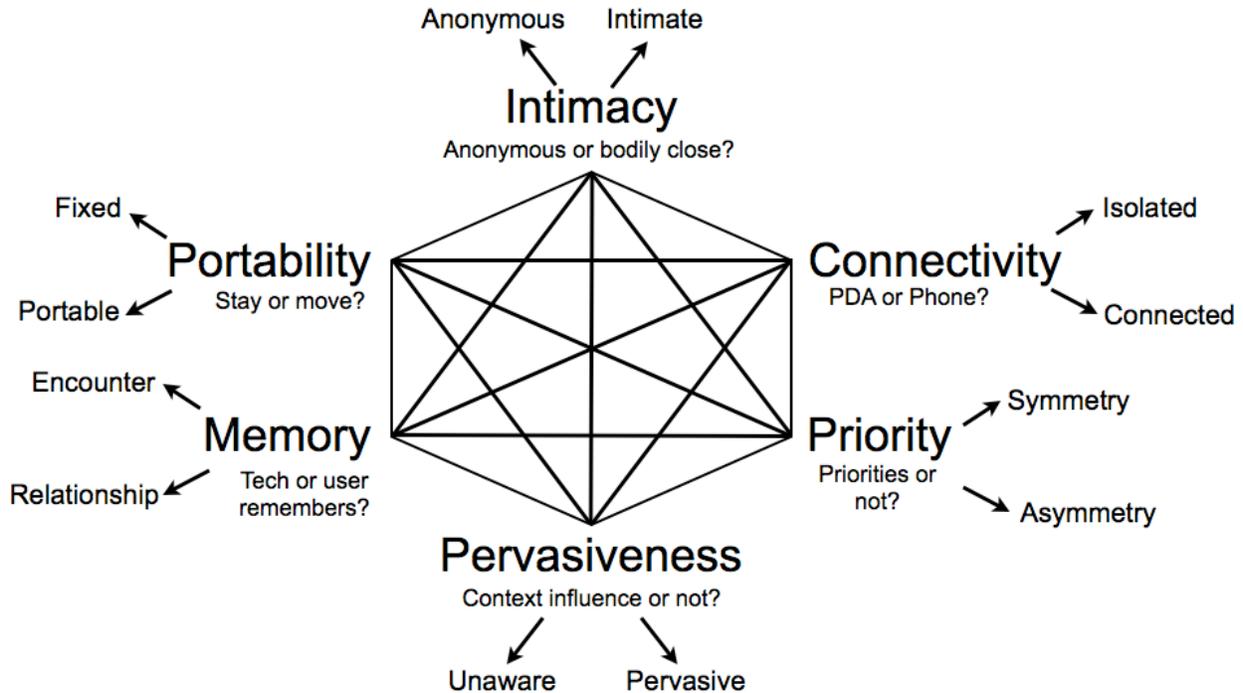


Figure 1: Overview of the six enterprise mobility capabilities.

2.1 Mobile Capabilities

Let us first consider six categories of capabilities, or affordances, specifically important for the understanding of the unique characteristics of mobile- and ubiquitous technology at work.

2.1.1 Connectivity

The technological development has since the era of the telegraph signaled a process of radically increased connectivity, from the first transatlantic telegraph cable in 1866, over Bell's telephone patent in 1878 leading to ubiquity of telephones and subsequently fax machines, to Martin Cooper's first call on a handheld mobile phone in 1973 heralding the age of the mobile phone. Rapid development of cellular telecommunications networks followed from the first fully automated (1G) analogue mobile network in Japan in 1979, over 2G networks from 1991, high data capacity (3G) networks from 2001, and to the emerging 4G networks. All of this has led to cheap global connectivity where in 2003 mobile phone subscriptions first exceeded fixed-line subscriptions. 2012 saw more mobile connected devices than people on Earth, and it is estimated that 16 billion mobile devices will be interconnected in 2016 (Cisco, 2012).

2.1.2 Portability

The miniaturization of information technology has during the past decades produced increasingly portable, yet powerful, computational devices. This portability of the computing device forges closer relationships between the technology and the geographical movement of users, objects, and vehicles. Computation is not restricted to specific locations, but can follow organizational processes and members. The term 'mobile technology' most frequently refers to the combination of a portable client connected to a network, for example the mobile phone used for calls and SMS messages. However, in the context of this chapter, mobile technology much broader refers to technologies that can combine any of the six types of capabilities listed in Figure 1:

Portability, connectivity, intimacy, pervasiveness, memory, and priority.

2.1.3 Intimacy

One of the key assumptions is that the closer a technology is situated to the human body, the more critical the user-technology relationship becomes. The mainframe may be important, but the personal computer is highly personal, yet not as critical as the mobile phone, which takes up a position on par with keys and credit cards (Chipchase et al., 2004). The user may consider mobile- and ubiquitous technology as intimate since it is bodily close and continuously follow the user. However, in terms of technological capabilities, intimacy is in this chapter denoting the ability of the technology to explicitly support an intimate user-relationship, for example, by recording user behavior and modeling user preferences. If the technology continuously records and models user behaviour and –preferences, it can directly support the forging of intimacy.

Capabilities rendering the user known through monitoring, modeling and interaction signify technologized intimacy, for example, the close proximity to the human body of the client-parts of the technology, and the ongoing technology relationship fostered by the user. When combined with connectivity, the intimacy can relate to the identifiability of the user through the close physical proximity with technology.

2.1.4 Pervasiveness

Pervasiveness here signify a computer's capability of relating directly to its environment (Lyytinen and Yoo, 2002a). A pervasive washing machine sensor can allow for the control of soap according to how dirty the water is. A GPS navigator keeps track of a vehicle's location through awareness of its location in relation to geo-stationary satellites. The much-used term ubiquitous computing is then defined as the combination of portability and pervasiveness with the combined ability to both sense the environment and be carried through it (Lyytinen and Yoo, 2002a).

2.1.5 Memory

The technological capability of remembering supports a fundamental distinction between technology merely treating the user-relationship as separate and unrelated encounters, as opposed to technological capabilities enabling user-interaction forming an ongoing relationship in which the technology can record activities and subsequently react upon these. When the technology does not support memory of an ongoing process, then the user is solely responsible for constructing and maintaining memory of the process. When the technology explicitly maintains memory of aspects of the process, then the technology can support by managing aspects of the process complexity (Carstensen and Sørensen, 1996). Technology-based memory is generally a prerequisite for comprehensive support of complex decision processes (Mathiassen and Sørensen, 2008).

2.1.6 Priority

In a similar manner to information technology supporting the remembering aspects of the interaction, it can also support the prioritization of interaction. While the user of course continually engage in assessments and prioritization when for example looking at a phone when called, then some of the prioritization can also be supported explicitly by the technology. This can be implemented in the form of a variety of notification- and filtering capabilities supporting rules stipulating how the interaction should unfold or directly supporting human choices through

providing additional information about the interaction. Such prioritization explicitly treats the interaction as asymmetrical, where as an absence of priorities implies the assumption of interaction symmetry. Mobile- and ubiquitous technology can directly support the prioritization of interaction through various filtering- and awareness mechanisms, for example, by directly excluding or including specific interaction depending on information about content, caller identity etc (Oard, 1997; Ljungberg, 1999; Sørensen, 2010). The technological capability of supporting interaction prioritization relates directly to research into user-awareness (Heath and Luff, 2000), interruptions (McFarlane, 1998; Rennecker and Godwin, 2005; Wiberg and Whittaker, 2005) and information overload (Hiltz and Turoff, 1985; Schultze and Vandenbosch, 1998; Eppler and Mengis, 2004; Iastrebova, 2006; Harper, 2010).

2.2 The Complexity of Technology Performances

Enterprise mobility is, in short, the organizational application of complex combinations of the six capabilities discussed above embedded in mobile- and ubiquitous information technology. This application is governed by the emerging characteristics of the work situations the users find themselves in (see Figure 2). These situations are often conflicting and contradictory, and therefore calling for a combination of planned and emerging usage of the technology (Sørensen, 2011). Some activities are characterized by a very high degree of individual discretion regarding what needs to be done and how precisely this must be accomplished. Other activities are governed by next to no rules and procedures and thereby requiring extensive discretion on the part of the individual. A majority of activities share characteristics from both and will require some discretion, and therefore also require both planned- and emergent technology performances.

The complexity emerging when specific combinations of mobile information technology capabilities within a specific portfolio are evoked cannot easily be characterized in terms of straightforward linear causality between the aim of the activity and an associated performance. Rather, the negotiations of contradicting requirements emerging from the situation can lead to the user engaging different actions with the technology depending on the specific situation, the mood of the user and a range of other aspects. As an example, the decision by an individual of whether or no to answer a call on their mobile phone is not necessarily straightforward and will depend on a range of factors, for example, who the caller is (if this can be ascertained a priori), what the recipient is currently doing, what he or she guesses the caller wishes to discuss, etc. A straightforward mapping can only be made between a set of technology performances by the user against a discrete set of situations if any possible individual discretion has been removed from the work conducted. Emerging aspects of work will in most cases make it necessary for the user to engage in emerging technology performances taking the specific situation into consideration (Sørensen, 2011).

3 Cultivating Fluidity and Boundaries at Work

The organizational impact of mobile- and ubiquitous information technology is difficult to document precisely given that the technology is applied in a great variety of roles, spanning work with very little individual discretion to work relying on extensive individual discretion. Within field force automation it may be complicated, yet doable, to assess the benefits of increase use of mobile- and ubiquitous information technology as the work process can be codified and

measured against a computer-calculated ideal process. The technology performances will in this case be treated similarly to the steps in an automated manufacturing process where the components are expected to behave in a certain manner at a certain point in time.

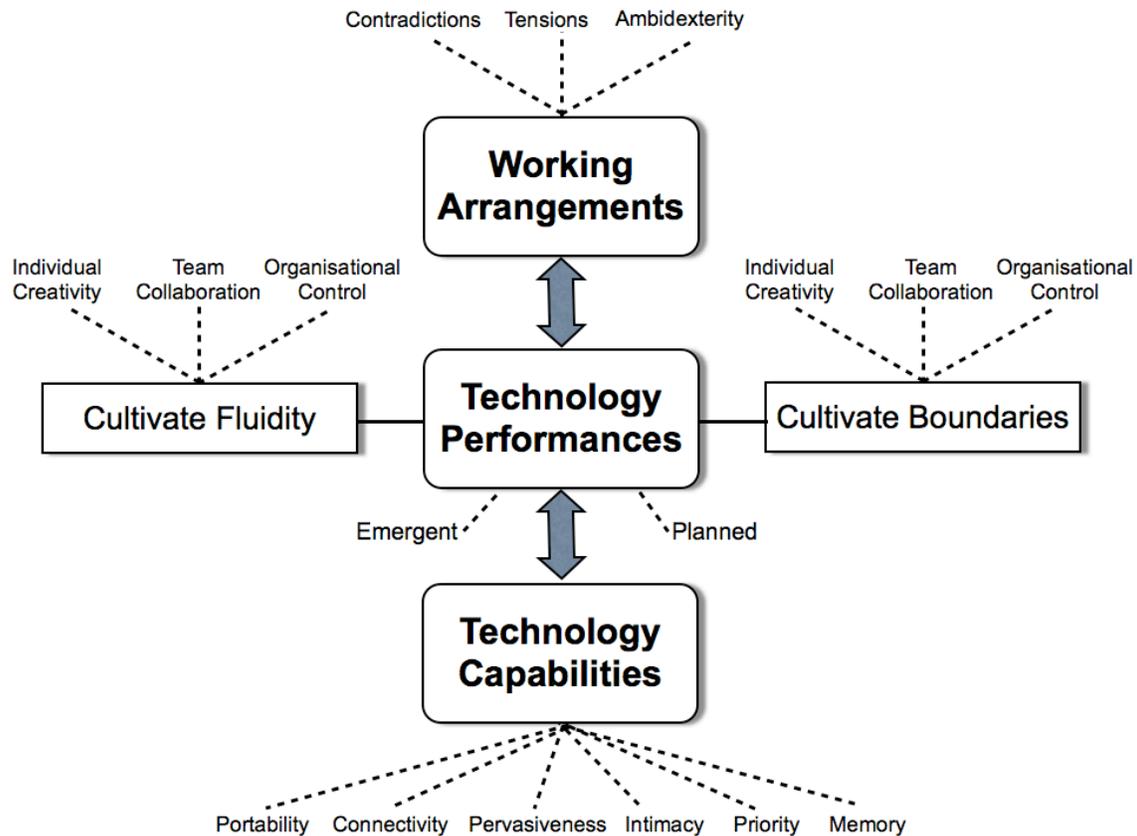


Figure 2: The cultivation of interactional fluidity and boundaries through emergent and planned technology performances when the contingencies of work meet technology capabilities.

At the other end of the discretion spectrum top executives or highly independent professionals are expected to largely govern their own activities and make choices they deem appropriate according to the specific situation. For this type of work it can be almost impossible to devise simple measures for process quality, and simply measuring the outcome does relatively little to factor out the importance of particular technology performances. However, most work will be characterized by being governed by some organizational rules, while retaining some degree of discretion. Furthermore, it is often far from trivial from a distance to ascertain to what extent work can be conducted without discretionary decisions as unanticipated exceptions can call for emerging technology performances.

3.1 Anytime/Anywhere or Sometime/Somewhere?

The ability to engage in mobile technology performances anytime, anywhere and with anyone is an often-cited practical implication of the application of mobile- and ubiquitous information technology. Whilst this can technically be correct, then such focus emphasizes the technological opportunities in Figure 2 over the organizational opportunities and constraints. Whilst a mobile phone allows for interaction with virtually anyone on Earth, this does not reflect any

organizational reality. Work is always situated in some context where certain issues, people, contexts, and time slots have more importance over others. Possessing a colleagues' mobile phone number does not necessarily mean that the person can be called at any time. When combining the technological opportunities with the organizational realities, then the technology performances are conducted as complex arrangements where interaction occurs sometimes, somewhere, and with someone (Wiberg and Ljungberg, 2001). The everyday mobile technology performances are ones hovering between being anytime and the sometime, and for the participants, this is in itself often a subject of negotiation.

3.2 Distance and Movement Matter

Olson & Olson (2000) argues that despite serious attempts to completely alleviate the importance of distance in collaboration, then distance still matters. Collaboration across distances imposes a separate set of issues that must be overcome, even if the technology at the same time does facilitate highly distributed work (Olson and Olson, 2000; Dubé and Robey, 2009). In the use of networked personal computers, distance both matters as a barrier for interpersonal collaboration, and at the same time matters as it also directly facilitates remote collaboration.

It can similarly be argued that the use of mobile- and ubiquitous technology suddenly both makes the physical location of the user less and more important before – *movement matters* when mobile- and ubiquitous technology is deployed in an organization (Sørensen et al., 2012). The technology performances will frequently relate to human movement and therefore create a whole new set of issues related directly to the negotiation of interaction in movement. We can hardly assume that this does not create new challenges for the participants – especially if the movement cannot be made subject of collective inquiry. The opening questions of; “Where are you?” and “do I disturb?” directly relate to matters of distance and movement.

However, for the organization movement also matters when mobile technology helps loosen constraints for its members' locations and movements. When organizational members by circumstances are forced to work at their workstation, their movement is mostly a matter of ensuring sufficient number of working hours and to arrange around this constraint. When they are able to work from a range of locations whilst moving, their location and movement are no longer merely issues of personal preference. They become important operational, tactical and even strategic concerns. Sales organizations with travelling salespeople have of course known this for a long time. However, mobile technology performances make it possible to engage in more fine-grained decisions regarding the distribution of work across time and location.

In the traditional workplace roles could relatively easily be identifying those that required other arrangements that stationary working with no movement and being co-located with everyone else in a fixed office or by a machine (see Figure 3). In the mobile enterprise, roles are open for more flexible assignments. Some work may at times need to be organized as locally mobile within a specific location. At other times, work may require as arranged as remotely distributed from other colleagues, yet fixed at a desk. Yet at other times, work may need to be organized as mobile working, i.e., both remotely located and mobile.

	Mobile	<p>Local Working</p> <p>Medical professionals</p>	<p>Mobile Working</p> <p>Repair engineers</p>
Movement		<p>Stationary Working</p> <p>Trad. office workers</p>	<p>Remote Working</p> <p>Virtual teams / teleworkers</p>
	Stationary	Co-located	Remote
		Place	

Figure 3: Separating remote distribution and movement, four analytical categories of working emerge: stationary-, remote-, local-, and mobile working. Adapted from (Sørensen et al., 2012).

3.3 Balancing Fluidity and Boundaries

As discussed above, mobile technology performances represent choices regarding the unfolding of activities and interactions across time and locations. With the networked personal computer, distance took on new meanings, and with mobile information technology so does movement. The performances are localized individual or collective judgments regarding the combination of technological possibilities when faced with a possibly contradicting organizational reality. The performances can in these situations result in the removing of existing boundaries for interaction – establishing more fluid interaction. The use of mobile email is a good example to the extent that members of the organization choose to use email as a horizontal means of communication transcending previous lines of reporting and responsibility. However, mobile technology performances can also establish new or reinforce existing boundaries for interaction (See Figure 2). Not only can mobile performances set people free from their desks so they can move where it makes most sense to them, to the teams they work in, or to the organization as a whole. The performances can also bring organizational routines, procedures and infrastructure along and through intimacy and pervasiveness support that specific procedures are enforced or that certain lines of command obeyed. It is, in other words, not a simple matter to ascertain what outcomes mobile performances can entail as mobile technology performances contain the inherent duality of both contributing to increased fluidity and boundaries in decision processes.

The following discusses the cultivation of fluidity and boundaries through mobile performances at three different levels of analysis: 1) individuals creatively seeking fluid performances by balancing availability and engaging boundaries for interaction, such as turning off the phone; 2) teams seeking to engage in transparent collaboration by balancing fluid internal team interaction with boundaries for how they interact with others outside the team; and 3) organizations seeking to cultivate interactional boundaries within the organization and at its boundaries

3.3.1 Individual Creativity

The performance can support individuals in engaging in fluid working practices with few boundaries hindering interaction if this is deemed suitable and with the individual cultivation of barriers for interaction when needed, for example, through filters blocking out requests. The extensive use of mobile information technology over years renders the individual a highly experienced professional in engaging in such cultivation, within the technological constraints. For example, usage throughout a 40-hour working week will within five years have accumulated the 10,000 hours of practice cited as necessary for true expertise within a domain (Simon and Chase, 1973; Ericsson et al., 1993; Gladwell, 2008; Sørensen, 2011). We have found a number of very good examples of such expertise in creative cultivation of mobile performances in our studies (Sørensen, 2011, p.77-100).

The Japanese CEO Hiro, for example, engages in highly complex performances when moving freely around Tokyo to get inspiration for new mobile services his small company possibly could build and launch (Kakihara and Sørensen, 2004). Hiro conducts “innovation by walking around” and extensively relies on advanced filtering features implemented on his mobile phone. This results in a number of profiles emitting different noises depending on the caller or the mobile email sender. He prefers most interaction to be channeled to mobile email so he can quickly scan the requests and prioritize which ones he acts upon when. This transforms synchronous and asynchronous interaction into the asynchronous email, which allows Hiro to constantly filter and monitor incoming interaction. In this way, immediate requests can be prioritized before acted upon, and Hiro also argues that he in reality in this way uses the asynchronous mobile email as an almost synchronous technology as he constantly checks email. The arrangement, however, provides him with a slight buffer allowing instant prioritization – a task more difficult with truly synchronous interaction. He also relies significantly on a stationary administrator as a means of managing his availability and interaction requests.

The London black cab driver Ray also engages extensively in the cultivation of fluid interaction (Elaluf-Calderwood and Sørensen, 2008). His extensive training and experience in navigating the streets of Central London without other navigational support than his memory allows him to define his own rhythm of working. He can independently choose where he places the cab in order to maximize his income and as such he is a stationary, yet mobile, example of the direct importance of discretionary choices concerning location and movement. He receives some jobs from colleagues via mobile phone when a sudden demand appears, and others centrally dispatched from a computer cab system. However, most jobs appear when customers in the street hail his cab or when he is at the front of a taxi rank.

For the Middle-Eastern foreign exchange trader, Khalid, the day-job consists of office-based trading, but outside normal working hours he engages in mobile trading using a mobile phone and a specialized mobile device providing market information (Sørensen and Al-Taitoon, 2008). Here, the balancing of home- and working life is a major aspect of the balancing of fluidity and boundaries.

Common for these three examples is the extensive reliance on movement as a means of doing the work. For the CEO and the cab driver, the movement is in effect an integral part of the work, whereas for the trader, movement is an essential aspect of striking some balance between work and family requirements. When engaged in mobile working all three are largely either independent or largely able to shape their own work. They can over time cultivate a sense of

rhythms of working and of interaction supporting the cultivation of fluid working and the management of interruptions (Sørensen and Pica, 2005; Sørensen, 2011, p.94-100).

3.3.2 Team Collaboration

For teams engaged in collaboration and in the coordination of mutual interdependencies, the ability to obtain fluid and transparent negotiation of these interdependencies is a key concern. It is obviously both pregnant with opportunities and fraught with problems to obtain such fluidity when team members are both scattered and moving rather than when everyone is situated within the same office space.

For the police officers John and Mary, their interaction is largely conducted within their patrol vehicle, where they have continuous contact with the control room through a in-car terminal and radio system (Sørensen and Pica, 2005). When out of the vehicle and engaged in an incident they rely heavily on the flexible means of a shoulder-mounted radio as a constant connection to the control room and to each other. The in-car system represents complex interaction boundaries between teams as it streamlines the co-ordination of officers accepting to attend incidents. The team of two officers constantly cultivates the rhythms of working both establishing fluid activities and cultivating interactional boundaries. In doing so they rely extensively on a wide range of the technological capabilities discussed previously.

For Simon, a security guard doing rounds on industrial estates in Manchester, the coordination of work with the control room consists of little individual discretion (Kietzmann, 2008). His activities are almost automatically directed by a system whereby he swipes a RFID-reader mobile phone over an embedded RFID chip and the system informs him via SMS where to go next. Collaboration is here entirely codified through a specific set of stipulated performances.

One of the important aspects of managing the negotiation of mutual interdependencies is formed by decisions regarding interaction priority. If all interaction is prioritized equally then the associated interactional symmetry will rely on the individual member to manually prioritize interaction. In both the cases above, systems embed capabilities supporting prioritization of interaction to facilitate more effective collaboration. Mobile technology performances also challenge traditional notions of individual versus collective working as the extensive use of mobile interaction can support the individualization of highly interdependent activities (Barley and Kunda, 2004; Felstead et al., 2005; Sørensen, 2011).

3.3.3 Organizational Control

From the perspective chosen here, an organization can be viewed as a specific arrangement of boundaries for interaction and facilitators for fluid interaction. Organizations will, from this perspective, spend considerable effort cultivating internal boundaries so they facilitate desirable fluid interaction and limits undesirable interaction. Similarly, much effort will be invested in cultivating the organizational boundary enabling some and hindering other forms of interaction.

For the restaurant supply delivery driver Jason, work is regularly challenging organizational arrangements (Boateng, 2010). When delivering goods to a restaurant he has, against procedure, provided the owners with his private mobile phone number instead of forcing customers to contact the call centre who thereafter would contact Jason. He will also, for practical purposes at times neglect procedures of not waiting in case a customer is not present at the restaurant. Such arrangements are obviously both efficient and desirable from Jason's perspective, yet ineffective

from an organizational perspective. If and when Jason leaves his job, customers will be frustrated as they no longer can use the established fluid arrangement of just calling Jason's mobile. Also circumventing the call centre results in order discrepancies not always being properly logged within the system. However, in the tension between centrally fixed boundaries and Jason's circumvention of these boundaries, Jason manages to carve out a little extra discretion for himself.

The hospital nurse Yin, who is further educating herself to a new role along with 15 other colleagues within the British Health Service, is caught up in a clash of arrangements of organizational fluidity and boundaries between the local hospital where she spends most of her time, and the central London-based organization responsible for her further education, which she attends one week in six (Wiredu and Sørensen, 2006). Conflicting local and remote requirements cannot be reconsolidated through the use of mobile technology performances. The remote organization desires intense documentation of the remote work-integrated learning process. The local hospital does not see the importance of this documentation and establishes strict boundaries for interaction, for example by not allowing her to use mobile technology in normal working hours. The end result is that the technology performances are abandoned for documentation purposes and the London-based learning team instead relies on Yin's movement to resolve the issue. Every six weeks for a year she attends one-week sessions in London and these sessions are deemed sufficient as means of documenting her learning. In this example, the organizational constraints and boundaries lead to human movement directly replacing mobile technology performances.

Table 1 summarizes the enterprise mobility capabilities discussed above and illustrates the diversity of capabilities across cases.

Name	Job	Technology	Enterprise Mobility Capability					
			Port.	Conn.	Intim.	Perva.	Memo.	Prior.
Hiro	CEO	Mobile phone	Yes	Yes	Yes	No	Yes	Yes
Ray	Cabbie	Computer-cab syst.	No	Yes	Yes	Some	No	Some
Ray	Cabbie	Mobile Phone	Yes	Yes	No	No	No	No
Khalid	Trader	Terminal	Yes	Yes	Yes	No	Yes	Yes
John & Mary	Police	Mobile Data Terminal	No	Yes	Yes	No	Yes	Yes
John & Mary	Police	Personal radio	Yes	Yes	No	No	No	No
Simon	Security	RFID phone	Yes	Yes	Yes	Yes	Yes	Yes
Jason	Driver	Mobile Phone	Yes	Yes	No	No	No	No
Yin	Nurse	Handheld Assistant	Yes	No	No	No	No	No

Table 1: Illustration of the diversity of capabilities across the example cases discussed in this section.

3.4 Enterprise Mobility and Organizational Complexity

Mobile technology performances can serve organizational purposes by providing both direct remote observation and indirect remote control. Such attempts can at the same time be subjected to a variety of counter-activities to serve individual- or team-purposes. For the organization, mobile technology performances both represent new opportunities for re-engineering of traditional boundaries in order to obtain more effective decision flows, but they also represent challenges as ineffective boundaries can lead to sub-optimal interactional boundaries and much misdirected or wasted effort. For the Middle-Eastern bank engaging in mobile foreign exchange trading after normal working hours, mobile technology performances represent the only viable solution to the problem that the bank wished to engage in 24-hr trading without maintaining a

trading floor around the clock. The solution of shifting trading across the globe following the sun was not feasible. Neither was home-based trading fixing traders by their personal computer all evening and night. However, although mobile trading clearly resulted in stress on the traders home life/work life balance, it at least represented a solution acceptable to both the bank and the traders.

Establishing much tighter and more interactive connections between individual workers and portable technology connected to communication networks allow both for the contradicting purposes of: 1) tightening centralized control and codification of the work process; and 2) providing increased decentralization and individual discretion through extensive access to the necessary corporate information. This development resembles the distinction between the use of information technology for either codifying or informing work discussed in the 1970' and 1980s when IT was introduced in a range of sectors (Zuboff, 1988). However, this time it is personal as the technology is not an organizational anonymous entity but linked directly to individuals. The role of enterprise mobility and mobile technology performances can be viewed as one means of supporting organizational paradoxes.

Organizations experience the difficulties of balancing a variety of concerns, for example; balancing long-term exploration of opportunities with short-term exploitation of current abilities; being flexible and agile whilst securing stable structures for decision making, or balancing concerns for internal and external focus (Quinn and Rohrbaugh, 1983; Birkinshaw and Gibson, 2004; O'Reilly III and Tushman, 2004). The ability of an organization to be ambidextrous has been forwarded as a solution to managing organizational paradoxes where the organization needs to follow two seemingly contradicting logics. However, it has been argued that altering structural arrangements is not a long-term solution to this problem. Instead, the balancing of contradicting concerns must be delegated to individuals in the organization who then can make discretionary decisions depending on the actual situation and thereby enable contextual ambidexterity (Birkinshaw and Gibson, 2004). Enterprise mobility can serve as one of the means supporting organizations in achieving such contextual ambidexterity since it can ensure a much more consistent and comprehensive individual access to both the necessary information, access to the appropriate colleagues, while simultaneously support the detailed implementation of organizational procedures and control arrangements (Sørensen, 2011, p.49-52, p. 158-167).

4 Enterprise Mobility Research Challenges

The research field studying enterprise mobility is still in its relative infancy despite the practical importance of the technology in many organizations. As an illustrative example, despite a prominent call for action to researchers in 2002 for the Information Systems field to investigate the organizational use of mobile- and ubiquitous information technology (Lyytinen and Yoo, 2002b), a decade later, only less than 4% of all papers in the top-8 journals even remotely explored the subject (Sørensen, 2011, p.9).

4.1 Individual Intimacy and Organizational Trust

One of the primary challenges of understanding both opportunities and challenges in the organizational use of mobile- and ubiquitous information technology relates directly to the increased intimacy and pervasiveness offered by the technological capabilities. The technology affords intense investigation into individual micro-patterns of behavior, thus making highly

intimate aspects of everyday working life susceptible to intense scrutiny. It also affords the close and intimate connectivity between the work environment and technological properties, enabling the codification, mapping, monitoring and calculation at an immense scale. Google's effort to map street views led to significant debate over privacy when the passing Google car has caught people on the images, but the combination of intimacy and pervasiveness will require a significant shift in our understanding of the complex relationships between technological opportunities and prevailing opinions of individual privacy. The success of advanced enterprise mobility capabilities will rely even more critically on interpersonal- and organizational trust than other technological innovations in the enterprise, precisely because enterprise mobility connects technology and person even tighter than previous information technologies. The workers could quite literally end up having everywhere to go and nowhere to hide.

4.2 Optimizing Knowledge Supply-Chains

From a broader organizational perspective of understanding the bigger picture, one of the significant challenges is to understand how to more flexibly manage the opportunities of fluidity and boundaries. Considering the advantages gained by computerizing the manufacturing supply-chain, then enterprise mobility represents the challenge of understanding how computerization of the knowledge- or service supply-chain through mobile information technology can lead to advances. However, while the nuts and bolts of highly distributed manufacturing processes do not care much about what is written about them in various databases, then humans very much do. One of the challenges in this is to understand the balancing of individual privacy concerns with the organizational advantages of large-scale real-time big-data analysis. As technology and its application advances, increasing amounts of highly detailed data is collected concerning organizational and inter-organizational processes and their outcomes (Benkler, 2006; Kallinikos, 2006; Ayres, 2007; The Economist, 2010). Such data represents the opportunity for the organization to flexibly define its internal and external behavior depending on the emerging contingencies and thereby achieve contextual ambidexterity. For individuals, teams and organizations, the challenge is to understand how to flexibly configure portfolios of technological capabilities to support the balancing of interactional fluidity and -boundaries as this increasingly is up for negotiation and not pre-determined by the physical arrangement of workstations, offices, and buildings.

4.3 Rapid Technological Developments

It is a key concern to explain how enterprise mobility is not only similar to, but also differs from other organizational technologies. It is clearly feasible to look at traditional implementation and work effectiveness issues with this particular technological intervention as with other technologies. However, the key challenge is to identify issues of particular importance for mobile- and ubiquitous information technology. As an example, the closer relationship and instant feedback loops between the user and the technology can perhaps create new types of dependencies (Mazmanian et al., 2005). Unpacking how the constantly changing technological opportunities and ongoing changes in working practices interrelate is a core concern and must relate directly to a theoretical understanding of essential changes in technological opportunities. As an example, the recent development of mobile smartphone and tablet application stores has significantly shifted the opportunities for organizations to more easily deploy complex mobile technology using worker self-service and relying on consumerized solutions. The unpacking of how rapidly changing technological circumstances and changing organizational practices

interrelate is a complex endeavor but necessary for the further understanding of enterprise mobility. The cases above illustrate complex use of a variety of the technological capabilities presented in Figure 1 of: Portability, connectivity, intimacy, pervasiveness, memory, and priority. The mere fact that the technology reaches widely from the user's hand over the built environment to global infrastructures makes the dynamics even further complex.

4.4 Paradoxical Technology Relationships

Much research of socio-technical phenomena tends to adopt the assumption that the user-technology relationships are straightforward, stable, and predictable. However, this is a questionable assumption, especially when the technology in question assumes a highly intimate relationship with the user (Arnold, 2003). For enterprise mobility, the user-technology relationship is highly interactive, rely on close physical proximity and constant connectivity, and the performance relating a user's goal and a specific technical capability cannot be described as linear and simple. Assuming that the user is bestowed some degree of individual discretion then the technology will often allow the same operation to be conducted applying different technology performances by selecting from a portfolio of opportunities. Furthermore, situational richness will likely imply that the user is not able to act as simply mapping discrete goals and technological opportunities. Rather, a range of concerns may concurrently compete as triggers of specific intent. When a person receives a mobile email, the decisions regarding what to do will be informed by a range of situational factors. Also, the outcome itself of the technology performances can influence future situations. The constant checking of mobile email and instant replies also creates the need to further check and manages the environmental expectations of continuing to constantly reply to emails. This signals paradoxical technology relationships where the technology concurrently both: Fulfils and creates needs; simultaneously is public and private; supports mobility, yet enables a constantly fixed point of contact; bestows the user with competence, yet also renders the user incompetent (Mick and Fournier, 1998; Jarvenpaa and Lang, 2005). Whilst other technological innovations also may display such characteristics, mobile- and ubiquitous information technology will further challenge the notion of simple linear relationships between situations, technological capabilities and technology performances. Research into mobile- and ubiquitous technologies must seek to identify and explain the specific socio-technical complexities emerging when the technology is adapted and shaped by individuals, teams and organizations. This chapter has sought to identify some of the unique aspects, for example in terms of the importance of human movement. The chapter has also explored the organizational use of mobile- and ubiquitous technologies beyond a simple logic of straightforward relationships between what the technology can offer and how it is used. This relates directly to the emerging notion of complex relationships between user-behavior and available portfolios of organizational information services (Mathiassen and Sørensen, 2008). A promising research approach can be the detailed mapping of micro-coordination practices (Ling, 2004; Licoppe, 2010) using novel techniques seeking to uncover hidden patterns in complex non-linear phenomena (Gaskin et al., 2010, www.orgdna.net).

5 Summary

Enterprise mobility – the organizational application of mobile- and ubiquitous information technology is a significant, yet under researched, area of computing. This is despite a significant practical relevance of the subject. The challenges for practitioners and academics alike are to

understand the specific opportunities and challenges imposed by this technological development and the associated organizational practices. This chapter has argued that the core challenges relate directly to the ability of the technology to intimately relate to and interact with the user, to manage, prioritize and remember ongoing interaction processes with the immediate environment, while connecting through personal-, local-, and global communication networks. It is argued that these capabilities in non-linear ways relate to user goals through planned and emergent technology performances. Such novel technology performances, it is argued, can intentionally or unintentionally challenge existing interactional boundaries at the individual-, team- and organizational level. For the individual, mobile technology performances can both facilitate new interactional practices and require the creative management of these opportunities to establish fluid working. For the team, the effective and transparent negotiation of highly distributed interdependencies also requires careful balancing of instant fluid access with boundaries for interaction. At the organizational level, fluid decision processes must be balanced with the cultivation of internal and external interactional boundaries. The introduction of mobile- and ubiquitous technologies can mark a way of rendering: 1) the individual more available while in charge of his or her own work; 2) teams more effective; and 3) organizations more flexible, yet better controlled. Such arrangements can be viewed as incremental changes to existing arrangements. However, the significant potential of enterprise mobility is of course to allow for new business models and disruptive organizational arrangements, for example challenging assumptions about organizational membership, and individual flexibility at work (Barley and Kunda, 2004).

Typically, an unintentional effect is increased interactional fluidity where individuals suddenly are given opportunities for more flexible and fluid access to information resources or colleagues. This can in turn result in both increased effectiveness if it allows for more meaningful connections, but also, as the examples demonstrate, tensions between individual and organizational concerns. It is, therefore, essential that individuals-, teams- and organizations constantly cultivate the balance between technology performances increasing fluid organizational arrangements with those establishing interactional boundaries. Such efforts requires significant improvements in our understanding of the complex and paradoxical relationships between the constantly developing diversity of technological capabilities and changing organizational practices.

6 Defining Terms

1G = First-generation analogue cellular telecommunications networks

2G = Second-generation cellular telecommunications networks, which were digital

3G = Third-generation cellular telecommunications networks offering increased data transmission rates

4G = Fourth-generation cellular telecommunications networks with even faster data transmission rates

RFID = Radio-frequency identification

NFC = Near field communication

GPS = Global positioning system

M2M = Machine-to-machine

Cellular telecommunications network = Radio network that uses the geographical partitioning into cells as a means of reusing frequency bands

7 References

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8 Further Information

Mobility@lse: <http://mobility.lse.ac.uk>

Enterprise Mobility Forum: <http://theemf.org>

Mobile Enterprise Magazine: <http://www.mobileenterprisemag.com>

Enterprise Mobility Exchange Network: <http://www.enterprisemobilityexchange.com>