11 ASSESSING THE MOBILE–STATIONARY DIVIDE IN UBIQUITOUS TRANSPORT SYSTEMS

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Abstract *Many transport organizations seek to develop seamlessly integrated computing environments. A central problem in attempts to realize such* ***ubiquitous transport systems*** *is the divide that exists between stationary transport management systems and mobile applications such as embedded vehicle sensor networks and in-vehicle services for message handling. Originating from different innovation regimes, these technologies are heterogeneous in that they rely on different technological platforms and knowledge bases, as well as the institutionalized settings from which they have emerged. This paper assesses how the mobile–stationary divide plays out in practical efforts to develop ubiquitous transport systems in road haulage firms. This assessment is conducted through a multiple-case study that identifies socio-technical challenges associated with this divide. Building on this assessment, the paper contributes a set of implications for enterprise-wide ubiquitous computing environments where coordination of diverse sets of mobile units is central to organizational performance. On a general level, these implications are important for any organization attempting to integrate mobile and stationary information systems.*

1 INTRODUCTION

Facilitated by improved mobile and wireless communication services and continuing miniaturization of computing devices, the emergence of ubiquitous computing has enabled distributed computing capabilities with which highly mobile organizations can address core information processing problems and opportunities (Lyytinen and Yoo 2002; March et al. 2000). In particular, the promises of ubiquitous computing technologies are attractive to organizations in which coordination of diverse sets of mobile units is central to organizational performance.

As an example of such organizations, the typical road haulage firm coordinates a workforce mainly consisting of drivers who are geographically distributed and constantly moving, providing timely pickup and delivery of goods. Plagued by low margins and intensive competition, road haulage firms have implemented a wide variety of distributed IT support tools to conduct their day-to-day business (Lindgren and Henfridsson 2003). Such IT support includes services that offer dispatchers overviews of their mobile resources by positioning individual trucks, drivers route calculation services to minimize time and fuel expenditures of assignments, and managers vehicle performance recording services are maintained for accurately following the mobile workflow (see Akinci et al. 2003; Giannopoulos 2004; Roy 2001).

While such technology investments promise to redefine the ways business can be organized and conducted, evident in these investments is also the desire to integrate people and the systems they use. In Andersson and Lindgren (under review) the term ubiquitous transport systems (UTS) is used to discuss seamlessly integrated computing environments applicable to the transport industry. Attempting to understand infrastructure capabilities of such distributed and heterogeneous computing environments (see March et al. 2000), they present typical service requirements in the Swedish road haulage sector. In the quest of a "total solution" to the service requirements of road haulage firms, however, a central problem is the mobile–stationary divide. The mobile–stationary divide refers to the set of socio-technical problems associated with the integration of stationary office systems (transport order and cargo planning systems) and mobile applications (embedded vehicle sensor networks and in-vehicle telecommunication services for order management and message handling).

Overcoming the mobile–stationary divide is vital for transport organizations seeking to interconnect various technological, social, and organizational elements into an assemblage that enables physical and social mobility of computing and communication services (see Lyytinen and Yoo 2002). Realizing the vision of UTS involves dwelling with the multitude of applications emerging in the road haulage business. Indeed, as noted in the literature, a significant challenge is to create, integrate, and maintain heterogeneous computing resources as effective components of well-functioning architectures (Lyytinen and Yoo 2002; Sambamurthy and Zmud 2000). An important first step is thus to explore organizational efforts to develop integrated computational solutions (involving heterogeneous, geographically distributed computing resources) spanning far beyond the stationary parts of transport organizations.

In this paper, we present a multiple-case study that assesses the mobile–stationary divide in practical efforts to implement UTS in road haulage firms. The study is part of an ongoing action research project (see Baskerville and Wood-Harper 1996) involving academics at the Viktoria Institute, road haulage industry representatives, a number of road haulage firms, and system vendors. Contributing to the early stage of the ubiquitous computing research tradition in the field of information systems, this paper reports an assessment of organizational attempts to bridge the mobile–stationary divide.

Discussing socio-technical challenges associated with such attempts, the paper contributes a set of implications for enterprise-wide ubiquitous computing environments where coordination of diverse sets of mobile units is central to organizational performance.

2 THE MOBILE–STATIONARY DIVIDE IN UBIQUITOUS TRANSPORT SYSTEMS

A ubiquitous computing environment can be described as "a heterogeneous assemblage of interconnected technological and organizational elements, which enables the physical and social mobility of computing and communication services between organizational actors both within and across organizational borders" (Lyytinen and Yoo 2002, p. 378). One central issue in developing and using ubiquitous computing environments in organizations is to handle its inherent heterogeneity. Manifested in new requirements on the construction of ubiquitous enterprise architectures (Lyytinen and Yoo 2002), the heterogeneity of such architectures typically follows from the challenges surrounding attempts to interconnect technologies belonging to different innovation regimes. Indeed, innovation regimes, such as technological platforms and knowledge bases, as well as institutionalized settings in which technological innovations emerge (Godoe 2000), are vital in understanding and handling heterogeneity.

In utilizing technologies originating from different innovation regimes, organizations face organizational, social, and technological challenges. At the organizational level, there are challenges related to the managerial rationale for designing and evolving their IT activities in response to the imperatives of changing business and technological environments that need to be tackled (Sambamurthy and Zmud 2000). Indeed, the organizing logic must be adapted to the heterogeneous assemblage of interconnected social and technical elements of ubiquitous computing environments. Moreover, in weaving together technologies originating from different innovation regimes, ubiquitous computing environments promise to involve redefinitions of social action as well as new social behavior (Jessup and Robey 2002). In particular, the seamlessness sought over multiple contexts not only triggers such social changes but it also occasions new socio-technical design challenges (Henfridsson and Lindgren 2005). Finally, there exist a number of technical challenges associated with heterogeneous and distributed computing environments (Lyytinen and Yoo 2002; March et al. 2000). For example, realizing interoperability between different innovation regimes typically requires software components that can work as gateways between different standard sets (Hanseth 2001).

In the transport industry, two broad categories of innovation regimes can be distinguished (see Andersson and Lindgren, in review). The first regime relates to the mobile side of transport organizations, that is, the set of technologies and corresponding knowledge bases surrounding the vehicles and their drivers in daily work practice. These technologies include both vehicular systems (e.g., embedded vehicle sensor systems) and driver-centric computing systems (e.g., in-vehicle services for order management and message handling). The second regime relates to the stationary side of transport organizations, that is, the set of office systems and corresponding knowledge bases associated with controlling and coordinating transport assignments and mobile resources. These technologies include systems for transport order management and cargo planning, resource coordination, and route calculation.

Belonging to different innovation regimes, the alignment of mobile and stationary technologies in transport organizations is difficult to achieve. While such integration is central to realizing the vision of UTS (as seamlessly integrated computing environments applicable to the transport industry), the divide existing between these innovation regimes also appears in their deployment in user organizations. In line with Andersson and Lindgren, we here refer to this divide as the mobile–stationary divide, highlighting the set of organizational, social, and technical problems related to integration of stationary office information systems and mobile applications. Viewing this literature review as a backdrop and context for the research problem, we here present a multiple-case study of the ways in which the mobile–stationary divide plays out in practical attempts to realize the vision of UTS. Whereas this divide and its associated challenges can be traced in the literature, there exist few, if any, studies that seek to explore these and their mutual interdependencies in greater depth.

3 RESEARCH METHOD

3.1 Research Design and Sites

The research presented here is part of an ongoing action research project (see Baskerville and Wood-Harper 1996) called "Value-Creating IT Support for Road Haulage Firms" in which researchers from the Viktoria Institute, system vendors, and road haulage representatives collaborate. Our previous work reports socio-technical problems related to the capability of the underlying technical infrastructures to support services required in road haulage firms (Andersson and Lindgren, in review). This paper assesses the nature of the mobile–stationary divide through a multiple-case study (Yin 1994), covering organizations that try to address issues pertaining to this divide. We used our prior study as input for case selection (applicability to the research themes), purpose (elaboration of early results), and analysis (themes used to structure analysis of new data).

In our research design, we were specifically interested in cases where attempts to integrate mobile and stationary systems were evident. Finding such cases in the Swedish transport context has proven to be a challenging task, due to the low market penetration of technology specifically designed for road haulage. In order to acquire a sample of such cases, we approached six major system vendors actively involved in the action research project for recommendations of user organizations of interest. Guided by our action research agenda, the proposed cases were then evaluated using the service requirements previously reported on and a set of criteria. From this process, six cases were selected to be included in the study (see Table 1).

Table 1. Case Overview

Organization	Size	Ownership	Systems		Transports
			Mobile	**Stationary**	
A	325	Independent	CoDriver	SAdata	Bulk, foods, oil, goods
B	300	Member owned	Barkfors	TDXlog	Goods
C	100	Independent	Dynafleet	Transport 2000	Foods, goods
D	40	Independent	FAS	In-house system	Foods, goods
E	300	Member owned	Hogia Innovation	Hogia Mobilast	Waste, foods
F	11	Independent	Transics	TUF 2000	Chemicals

3.2 Data Collection and Analysis

This study includes six data sources. These are interviews with system users, documents produced by users in daily practice, notes from user observations, system vendor documentation, notes from vendor interviews, and observation notes from vendor demonstrations. To cover experiences of technology use, where applicable, we interviewed individuals involved in three different levels of work (dispatchers, drivers, and managers) in each of the six organizations, focusing on socio-technical impacts. Questions concerned the user's experience of interaction with the technology and social effects on work practice. The resulting 15 semi-structured interviews, lasting between 1 and 2 hours, were recorded and later transcribed. While these interviews provide the bulk of the empirical data, supplementary data was also gathered. Where needed to resolve ambiguity emerging in these interviews, short observations of systems in use were made. For example, a driver using an in-vehicle order management system would be observed and field notes taken. Further information includes documents from vendors and user organizations describing systems and intended use.

As previously mentioned, early results from the same project were used to direct our attention on emerging themes and issues. While not explicitly following the grounded theory approach (Strauss and Corbin 1990), the overall process exhibits similarities in that the initial research was conducted in an open-ended manner, while this subsequent stage is more directly concerned with emerging themes from the initial stage.

The analysis was performed iteratively and concepts were discovered, defined, and refined. Statements formed candidate concepts, verified or modified by similar occurrences elsewhere in the data. When all empirical data had been analyzed in this fashion, a second iteration was performed, this time to test the relations between the candidates and further refine them. From this process, a set of concepts emerged. This set was compared to the prior three categories to test the viability both of the prior categories themselves and of the newly formed set of concepts. Finally, the categories and the concepts were used to elicit a number of socio-technical challenges associated with practical efforts to overcome the mobile–stationary divide.

4 FINDINGS

On the basis of our multiple-case study, this section outlines key categories and concepts related to the mobile–stationary divide. In addition, it presents socio-technical challenges surrounding attempts to realize UTS in the six investigated road haulage firms. Table 2 summarizes these findings and associates each concept with the case organizations in which they were evident.

Table 2. Mobile–Stationary Divide: Categories, Concepts, and Socio-Technical Challenges

Categories	Concepts	Socio-Technical Challenges
Mobile resource evaluation	• Driver control (A, C) • Resource consuming control (A, D, E) • Ambiguous context interpretation (D)	• Digital traces in mobile resource management
Transport data management	• Workflow transparency (E, D, C, B) • Manual manipulation elimination (C, B, F) • Process control (B, E) • Task reallocation (A) • Transparency enabled empowerment (B)	• Organizational work-flow configuration in distributed environ-ments
Dispatcher-driver communication	• One way communication (A, C) • Communication confidence (C, D) • Delivery apprehension (D, F) • Sensemaking difficulties (C)	• Time independence in *ad hoc* communication

4.1 Mobile Resource Evaluation

Mobile resource evaluation concerns the ability of the stationary part of the organization to accurately follow the mobile workflow using system support. Concepts found in the analysis are driver control, resource consuming control, and ambiguous context interpretation.

Driver control refers to the ability of the stationary personnel to assess the compliance of the mobile workforce with organizational policies such as speed limits, drive time legislation, and other vehicle-related metrics. Controlling the mobile workforce from a central location was largely viewed as difficult. Some case organizations (A and C) aimed to measure and control technical and human components through embedded vehicle systems. An illustrative example is systems that constantly remind drivers to use efficient driving styles. As illustrated by a dispatcher from case organization A, experiences pertaining to use of such technology were positive.

> *Before we got this system, you didn't really know about these things. Well, you knew that a certain driver drove too fast, but did it really have that much effect on fuel consumption? Now you get a really good view of the costs of driving too fast, and when you get that, it is easier to tackle the problem.*

Resource consuming control concerns the balance between invested resources and outcomes of follow-up activities. While embedded vehicle systems generated huge sets of data describing performance down to individual driver and vehicle levels, however, many managers found that the time invested in assessing newly available metrics mitigated the potential benefits. Although satisfied with the increased level of detail provided, a dispatcher from case organization A commented,

> *I work more now, since I've got access to more information. With this system I get information on each driver or truck. The time I invest, that's probably the main difference. On the other hand, the analyses are better, more reliable. Earlier, I had nothing to work with, so yes, I work more with this now.*

However, there were also concerns that decisions would be taken on false grounds. For example, concentrating on fuel consumption as a variable could prove incorrect as many other factors have to be considered such as the conditions in which a particular driver operates and the load factor and cargo weight of the assignments carried out. Such a detailed analysis was not available in the systems studied. As asserted by the manager of case organization D, it was not deemed feasible to perform it manually due to the complexity and time involved.

> *Well, we have made some remarks, but we have not taken it very far actually. There are lots of things beyond their [the drivers] control that influence their driving. For example, we have a number of trucks involved in high security assignments where you can't stop. They have to follow the convoy and they can't deviate. There are also other things that are more important. If you choose a smaller non-toll road you might save money while the fuel consump-*

tion goes up. So it's not that easy. If you want that kind of analysis, it takes a lot more time and that's something that I don't have.

While the positive consequences illustrate opportunities to follow the workflow of multiple mobile resources, the challenges involved in resource management of mobile resources are evident. The digital trace of mobile work created in systems was at worst found incomplete and/or inconsistent with the context in which the mobile resources operate and at best resource consuming in terms of analysis and use.

4.2 Transport Data Management

Transport data management refers to the ability of the systems to rationalize the process of continually documenting and analyzing transport assignments. Analyzing the empirical data, we found five interrelated concepts: workflow transparency, manual manipulation elimination, process control, task reallocation, and transparency-enabled empowerment.

Workflow transparency concerns effects of horizontal information sharing. Generally, an individual dispatcher is responsible for managing and reporting on the workflow of a certain group of vehicles. By granting dispatchers access to each others' system views, the introduction of transport management support created a workflow transparency. A dispatcher from case organization B explained,

If I get a booking and enter it into the system, I don't have to be there personally if that customer calls and wants to know something. All information is there. It becomes an asset for everyone. I think that is good.

The reoccurring task of responding to customer information needs become less dependent on individual dispatcher availability as individual knowledge was in a sense transferred to the traffic controller collective.

Manual manipulation elimination refers to the ability of the systems to seamlessly integrate the process of transport data management. With separate stationary transport data systems and mobile order systems, information transfer was conducted manually. As noted by several respondents, this manual information input was regarded a problem with important implications. Primarily, manual handling of information transfer was time consuming. Also, the risk of information corruption increased with the number of manual replications and/or modifications performed. As recognized by the manager of case organization C, stationary users of integrated systems saw these problems with manual input eliminated in that the need for manual information transfer was minimized.

If you had an assignment in the transport management system, you had to enter it once more into Dynafleet before you could send it to the driver. Now it's sent immediately. It saves a lot of time.

Process control concerns the ability of the systems to trace transactions performed. Before the introduction of mobile order systems, paper documents pertaining to goods delivered or picked up were handled by drivers. This fragmented manual process made follow-up an arduous process. Resulting from integrated mobile and stationary systems, case organizations B and E experienced positive effects of an unbroken chain of computerized information exchange. This made possible automated repositories, easily scanned in search for anomalies. Respondents at the managerial level with access to such records experienced greater possibilities to follow up transactions in less time than before, as noted by the manager of case organization E.

> *Now I can use the system to follow a vehicle thoroughly. I can go back months. Before [the introduction of the system] I had no idea. It's a lot easier to get statistics. I can accomplish in 10 minutes what used to take 2 hours.*

Many drivers asserted that mobile order systems changed their work designation. As a driver from case organization A commented, they now had to perform work previously related to the stationary workforce.

> *It all started when we got mobile phones, which was all right. Then we got an order system and had to manage all order documentation ourselves. And now this! [Referring to the in-vehicle order management system.] Some feel that we get more and more of the paper work. On the other hand, we don't have to wait for them [the dispatchers] to sort the order receipts out before leaving. Now, when you have loaded, you do it yourself on the mobile terminal when you want to.*

While this indicates that such a task reallocation was unwelcome and regarded as an additional burden, it also rendered drivers the opportunity to manage their workflow themselves.

Transparency-enabled empowerment concerns the potential of technology to alter the power balance through making information globally available. In umbrella organizations consisting of independent road haulers, increased information access was viewed as potentially disruptive by the stationary part of the organization. As they previously were the sole owners of searchable and detailed information pertaining to revenue on assignment level, they now feared that drivers would question the authority of the dispatchers, demanding access to the most profitable assignments while shunning those less lucrative. The manager of case organization B was acutely aware of such potential effects.

> *They get a lot more information now, so hopefully it has become easier for the haulers to follow up so they get paid for their assignments. They might also get an idea of what assignments are better to take than others. All are not equally profitable. This is for good and for worse, because if you discover that some assignments yield little in return, you won't take those assignments.*

Since the stationary organization has other priorities than optimizing the revenue of individual member road haulers, this was seen as potentially disruptive to the current way of managing mobile resources.

In sum, the positive and negative consequences related to seamless transport data management support showed a clear organizational impact. Indeed, the introduction of technology highlights a challenge of work flow management in distributed environments. The integration of mobile and stationary computing resources entails a previously unavailable transparency as well as a redistribution of tasks and responsibilities among actor groups who see new threats and opportunities arise.

4.3 Dispatcher-Driver Communication

Dispatcher–driver communication concerns the ability of the systems to rationalize the communication between stationary and mobile actors. Such system support includes messaging services for reducing redundant verbal communication between dispatchers and drivers. Our empirical analysis generated four interrelated concepts: one-way communication, communication confidence, delivery apprehension, and sensemaking difficulties.

While messaging services imply two-way communication between drivers and dispatchers, actual usage indicated a different mode of interaction. Dispatchers posted textual messages to drivers, thereby gaining the benefit of a one-way communication channel. Drivers were by comparison passive recipients, probably at least partly attributed to mobile device manipulation difficulties. Still, as noted by the dispatcher of case organization A, this time independent communication was regarded as beneficial and time saving in dispatcher–driver communication.

> *If I call someone [a driver] and the phone is busy, I just send a message "call me" and in a short while I'll get a call. It could be something concerning vehicle maintenance or that the driver needs to contact someone or something similar. I find that very good. And what's really good is that even if the driver is not at work, you can send a message in the evening, and then the following morning when he logs on he'll get it.*

Furthermore, the introduction of messaging systems linking mobile and office workers offered the possibility to track communication history. This brought a greater sense of communication confidence in that both drivers and dispatchers experienced that conversations were subject to fewer interpretational disputes and less frustration later. A driver from case organization A explained,

> *This gives us drivers a sort of protection. Because if we have sent a message, they [the dispatchers] have got the time it was sent and everything on the computer. It is stored there, so there can't be any unnecessary arguments.*

Despite these positive and intended consequences, we also discovered a type of delivery apprehension relating to the reliability of current mobile–stationary communication technologies. As illustrated by the manager of case organization C, senders were not confident that messages actually reached the recipients in time.

The way drivers and dispatchers interact is different now. Sometimes, when there is a lot of communication going on, the drivers have felt that they were not getting answers fast enough. They then wonder if their messages have been read at all. This can be especially frustrating when waiting for a return load.

Indeed, technical problems related to the underlying information transfer protocols (most notably GSM/SMS) rendered a new and unwelcome uncertainty. In some cases, this caused senders to confirm the reception of textual messages by phone, thereby eliminating the time saving benefits sought, if not making communication even more resource demanding. A dispatcher of case organization D commented,

It sometimes happens that they [the drivers] get important messages much later than they should have. If you take for granted that they arrived in due time, things go wrong and you have to correct them later. So the only way to know is to call them.

Sensemaking difficulties relate to the inability of the systems to comprehensibly embody communication practices between mobile and stationary actors. While the case organizations introduced communication systems to minimize communication ambiguity, sensemaking limitations to structured and formalized communication were evident. Taking for granted *ad hoc* information that does not fit the format of systems messaging or relying solely on textual messaging was regarded a dangerous approach, as the recipient's interpretation could not be confirmed as is the case with synchronous verbal conversation. The manager of case organization C exemplified,

They would send a message, "Load eight pallets there and five there." But with this system you can't add, "You must put those pallets in front because..." The misunderstandings can be very costly, if you don't communicate properly. It [the system] must never replace talking.

Summarizing the positive and negative consequences of mobile–stationary communication technologies, we identified a clear effect on the communication patterns between dispatchers and drivers. While several respondents appreciated the time independence in *ad hoc* communication created by technology, users also experienced a diminished control of the communication process. The cooperative effort involved in constructing the meaning of conversation became subject to limitations imposed by the communication systems. Such sensemaking efforts are challenging in attempts to reduce temporal dependence in communication between stationary and mobile actors in road haulage firms.

5 DISCUSSION

Following the ongoing diffusion of mobile and wireless communication services in our everyday life, ubiquitous computing environments have emerged as a vital area of research in information systems. As indicated in recent research, its implications span multiple levels of analysis and call for new research approaches (Lyytinen and Yoo 2002). Indeed, the heterogeneous and distributed nature of these computing environments requires both technology-intense (March et al. 2000) and socially informed (Jessup and Robey 2002) research. In fact, most ubiquitous computing research issues can be productively approached with research efforts that tackle the intertwining of social and technical elements playing out in attempts to design, implement, and use seamless services (Lyytinen and Yoo 2002).

In view of the socio-technical challenges of ubiquitous computing, this paper sets out to explore the mobile–stationary divide in UTS. This divide plays out as the set of socio-technical problems surrounding the integration of stationary office systems and mobile applications required for ubiquitous transport services. A central problem associated with such integration is the heterogeneity inherent in this type of attempt. Belonging to different innovation regimes (Godoe 2000), attempts to interconnect technologies with heterogeneous platforms, knowledge bases, and institutionalized settings are difficult. We have identified three socio-technical challenges associated with the mobile–stationary divide: digital traces in mobile resource management, organizational workflow configuration in distributed environments, and time independence in *ad hoc* communication. These challenges have implications for enterprise-wide ubiquitous computing environments where coordination of diverse sets of mobile units is central to organizational performance.

At the organizational level, attempts by road haulage firms to realize seamlessly integrated computing support caused new workflow configurations that changed organizational structure. The information transparency created by such integrated solutions rendered changes in the relation between the mobile and stationary workforces. As an example, mobile workers found themselves in a position where they performed tasks previously attributed to the stationary personnel. Moreover, in a situation where independent drivers were confronted with detailed information on the financial viability of individual assignments, stationary personnel saw their authority to coordinate and control the way in which transport assignments were allocated undermined. This example suggests that organizations have to adapt their organizing logic to the structural changes imposed by interconnected organizational and technical elements of heterogeneous and distributed computing environments (see Lyytinen and Yoo 2002; Sambamurthy and Zmud 2000).

At the social level, the desire of road haulage firms to rationalize mobile–stationary communication by employing new technology occasioned both positive and negative effects on communication patterns. The independence of time in *ad hoc* communication was widely recognized as beneficial. While establishing this independence, however, the cooperative effort involved in constructing the meaning of conversation became subject to limitations imposed by the communication systems. Users viewed the diminished opportunities for individual interpretation as helpful, but simultaneously noticed new issues of uncertainty related to their common understanding of mobile work. Indeed, such sensemaking difficulties had direct consequences for mobile work practice as well as social interaction. Left unattended, these adverse effects of efforts to achieve time independent communication are likely to impede the development of skills and organizational commitment on behalf of the mobile workers (see Jessup and Robey 2002).

At the technology level, there are several unresolved issues regarding development of ubiquitous computing architectures with the capacity to meet the service requirements of transport organizations. In filtering and combining information from both mobile and stationary sources lies the potential of increased understanding of the organization (see Jessup and Robey 2002). However, our case organizations were largely unsuccessful in their attempts to utilize the digital trace of mobile work created in systems as it was found incomplete and/or inconsistent with the context in which the mobile resources operate. According to our respondents, a contributing factor here was that the knowledge bases of mobile and stationary system vendors, including their understanding of mobile and stationary work practice, differed. This suggests that the development of architectures with the capability to facilitate mobile resource evaluation will be complex due to the diverse technological regimes involved (see Godoe 2000). In the context of the transport business, the heterogeneous assemblage of embedded vehicle systems and stationary systems requires a common platform of protocols and data standards to ensure interoperability of systems and to enable the integration of distributed technologies (see Lyytinen and Yoo 2002; March et al. 2000).

6 CONCLUSION

A central problem in attempts to develop seamlessly integrated computing environments for transport organizations is the existing divide between mobile and stationary systems. This paper has reported an assessment of how the mobile–stationary divide plays out in organizational efforts to realize such computing environments. On the basis of this assessment, we have also discussed implications for development of enterprise-wide ubiquitous architectures including distributed technical, social, and organizational elements. Indeed, these implications are important for any organization attempting to integrate mobile and stationary information systems.

An important task for researchers and practitioners is to assist transport organizations in their efforts to overcome the mobile–stationary divide. However, realizing the vision of UTS requires a thorough understanding of the nature of the multitude of both mobile and stationary technologies in the transport business. We have observed intricate organizational effects created by such technology. Further work is needed to uncover the underlying reasons for the adverse effects described. This includes shedding light on the relationship between key actors involved in development of the required computing components of UTS. As our findings indicate, seamlessly integrated ubiquitous computing environments are going to be the result of the combined efforts of a diverse set of innovation regimes.

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