TIME-CRITICAL INFORMATION SERVICES
Analysis and Workshop Findings on Technology, Organizational, and Policy Dimensions to Emergency Response and Related E-Governmental Services

ABSTRACT
This paper discusses a general framework for understanding and researching end-to-end performance of inter-organizational e-governmental services and reports the findings from an expert workshop held at the National Center for Digital Government. The focus of this paper is on time-critical information services (TCIS) – the medical necessity to deliver emergency services as rapidly as possible coupled with the dependence of these services upon accurate and timely information from multiple organizations. The authors outline a TCIS model and then discuss an invitational workshop that allowed for expert (academic and practitioner) input and feedback on the TCIS dimensions and the best means for understanding their occurrence in on-the-ground emergency services. Workshop participants analyzed TCIS from a socio-technical perspective and provided conceptual, practitioner and methodological critiques and suggestions. Overall, participants found the concept of TCIS to be a valid model for understanding, researching, and developing e-government systems within the specific context of emergency response as well as within the broader context of time-critical services to the public. Workshop recommendations focused on the need to closely assess inter-agency and inter-organizational information exchanges along and between three levels: technical, organizational, and governance. The paper concludes with a discussion about future research directions based on the analytical framework and workshop findings.

Keywords
e-government, emergency medical services and response, performance evaluation, time-critical information services

1. INTRODUCTION
This paper provides an overview of time-critical information services (TCIS), with specific reference to its use in emergency response and related e-governmental services. The paper is composed of three parts. The first part provides a preliminary review of the concepts and methods relating to the TCIS concept, including recent work by the authors on the concept. The second part contains a summary of the expert workshop that was conducted to explore the concept of TCIS. The final part provides a summary and direction based on these two activities.

2. TIME-CRITICAL INFORMATION SERVICES
This section examines the concepts and methods relating to the TCIS, placing the research within the context of e-government. The interaction between technology, the people and organizations, and the policies governing organizations and their usage of information technology (IT) is then explained. Our recent work on the concept is then presented.

2.1 Taking Just-in-Time to e-Government
From an e-government perspective, contemporary Emergency Medical Services (EMS) systems such as 9-1-1 are emblematic of what could be considered a “time-critical information service”. The time-critical element refers to the medical necessity to deliver emergency services in as rapid a time period as possible, executed through a chain of dispatchers and responders. The information-critical element refers to the fact that this service has become highly dependent upon information—from the nature and location of the incident, to the medical needs of the patient that should be attended to at the awaiting hospital (Arens and Rosenbloom, 2002; Hale, 1997; Turoff et al., 2004). Moreover, both time and information service elements are fundamentally organizational issues: effective and timely service depends upon all participating organizations working cooperatively and utilizing information technology effectively (Mayer-Schonberger, 2003). In particular, wireless carriers, emergency dispatch center administrators (e.g., Public Safety Answering Points), law enforcement, fire and EMS officials, and state and local political leaders need to cooperate to deliver an integrated set of 9-1-1 services (Jackson, 2002; Lambert, 2000; Potts, 2000).
Of course, time efficiency and effectiveness are not new concepts to business, computer, and information professionals. Concepts such as Just-in-Time (JIT) and Business Process Reengineering (BPR) have become central to private sector business operations and information technology planning. These concepts, and others like them, coincide with the notion of improving the integrated delivery of business related processes and services using information technology. Real-time, information rich, computer aided processes to reduce costs and increase efficiencies in the value chain are driven by the private sector axiom that “time is money”.

While private sector oriented information systems have focused on the critical role of information technology in achieving JIT delivery and improved value chain management, our thesis is that similar attention is needed to those public sector services that are also highly time and information dependent. EMS represents an illustrative application domain of JIT in public services, where in this case “time is lives”.

Transportation research, specifically Intelligent Transportation Systems (ITS) research, has looked at how IT can create efficiencies (i.e., time and cost savings) in transportation related public services (Horan, 2004). However, to date, limited research has been done to understand how IT can enhance time-critical functions for public services (such as EMS) that are information intensive. Further, we have found a paucity of e-government research that investigates time-critical dimensions to those public services that depend on multiple cooperating organizations.

2.2 The Need for a Socio-Technical Approach

Before launching into specific dimensions of our model, it is perhaps useful to explain the socio-technical orientation of our research. Important dimensions related to performance improvement (including time related dimensions) are the overarching organizational, institutional, and technical systems that interact with each other (Fountain, 2001). Improving timeliness and overall performance means looking at the supporting technology and how it interacts with the people and organizations using them, as well as the policies governing organizations and their usage of IT.

In her private sector (business) research, Markus (2004) explains the need for more integration between IT development and organizational change management; a need that she has termed “technochange.” Markus states, “Technochange situations call for big improvements in organizational performance. These improvements cannot happen unless tasks, jobs, and organizational processes all change along with IT (p. 7).” Similarly, but from a public sector research perspective, Fountain (2001) explains the need for coordination between inter-organizational networks of people, organizations, and policies to gain a better understanding about how they interact with IT. Fountain’s Technology Enactment Framework provides a set of guiding propositions that explain the interactions between objective information technologies, organizational forms, and institutional arrangements. These interactions influence the design, perceptions, and uses of information technologies.

A socio-technical approach must be holistic, addressing the entire system. Fountain (2004) explains that for a large socio-technical system, the mere accumulation of more sophisticated technology and specialists is insufficient. In order for agencies to develop new, integrated e-government programs, they must first examine the entire existing socio-technical system to assess their organizations’ readiness to integrate digital government – from technical, managerial, and political perspectives.

Time-critical public service systems (such as EMS) are large, complex, and often dynamic, and thus need to be investigated from such a perspective. Sussman (2002) and colleagues speak of “Complex, Large-Scale, Integrated, Open Systems” (CLIOS). A significant aspect of their analysis is examining the nesting of technological systems within institutional processes and linkages. To restate in the domain of e-government, a CLIOS (such as EMS) includes a technical system that is nested in a social and institutional system. The degree and nature of these linkages are complex, and in this sense complex includes dynamic, emerging, and not fully predictable elements. Moreover, their (CLIOS) approach suggests the utility of portraying a complex system as an important conceptual step toward understanding how the system operates and evolves. Included in this portrayal is the need to examine links across the various institutions, including their complex inter-organizational socio-technical permutations.

While there is a need to understand how a complex inter-organizational system operates and interacts with its various parts, there is also a need to understand the best methodological approaches for examining this phenomenon. The primary purpose of the time-critical information services symposium is to better understand the socio-technical nature of such systems as well as the best methodological approaches for examining them. The motivation for this inquiry is that a grounded conceptualization will provide a means to analyze and improve time-critical services to the public. More specifically, it is aimed to understand the impact that timely information can have on governmental processes, service performance, and on the general public welfare. The conceptual emphasis is on the interplay between information, information technologies, the organizational network charged with delivering EMS, and the policies that govern EMS agencies and service provision. It is structured as an inter-disciplinary investigation at the interface between information science and organizational science, focusing on the information and organizational processes involved in time-critical information services.

This research builds on an initial investigation of EMS conducted under sponsorship from the Minnesota Department of Transportation and extends the analysis to additional regions so as to inform national e-government, highway safety, healthcare, and emergency management policies.


2.3 Our Conceptual Model

For the last three years the authors have examined time-critical information services within the context of rural emergency response (Horan and Schooley, 2005b). Our analysis has led us to identify several features that we think are important for understanding end-to-end performance in time-critical information services. We provide a preliminary conceptual illustration in Figure 1. Based on this preliminary analysis there are several components that would enter into a conceptual model for time-critical information services, both in regard to EMS specifically and other public services generally. These components include: 1) the time and information critical elements of the service, 2) inter-organizational linkages that include both qualitative organizational elements as well as “hard” information flow elements, 3) end-to-end elements that consider performance metrics within and across the process flow, and 4) context variation elements such as normal versus peak conditions (in terms of service demand). We summarize this preliminary conceptual model below, then describe the symposium topics, discussion, and findings, and finally discuss future research directions.

![Figure 1. Illustration of TCIS Concepts](image)

2.3.1 Time-Criticality

The first concept focuses on the time-criticality of the governmental services and improvements therein. In the case of EMS, time is measured in minutes and seconds and these differences can have a pronounced impact on the health condition and survivability of patients. As illustrated by the top row of Figure 1, a point of departure for examining EMS is the linear sequence of events. The “end-to-end” EMS service typically begins with a consumer action (placing the call), involves the private sector (the cellular service provider) delivering the call, the public sector (PSAP or state police) receiving and dispatching the call, the private and/or public sector (an ambulance service or fire/police) providing first response, transport and health care services, and finally, either a public or private sector hospital delivering additional health care services. It is this end-to-end process that needs to be made efficient. The business sector has integrated end-to-end time-critical concepts such as Business Process Reengineering (BPR), Just-in-Time (JIT) information systems, and Supply Chain Management (SCM) into day-to-day operations.

This leads to the notion of how organizations create processes and cultures that recognize and embrace time-criticality and improvements therein. That is, it is plausible that organizations can to a greater or lesser extent embrace the concept of ‘time-criticality’ in their processes, procedures, and preferences.

2.3.2 Information Exchange

Even in the early days of the 9-1-1 system, information was important. Conveying voice information on location and the nature of an emergency proved valuable to response agencies to help prepare for the unique circumstances of each individual emergency incident. As this information becomes digitized, more information can be made available to responders. The second concept focuses on the dynamics surrounding the exchange and sharing of information throughout the end-to-end time-critical process. One of the key problems of governmental services is that information travels serially and sequentially, from one processing unit to the next, often with time-consuming feedback loops when incomplete or inaccurate information is detected. In the case of EMS, information mistakes can be tragic, as when an ambulance is unable to find the victim due to inaccurate location information about the scene of the accident. Further, new technologies, such as computer-aided dispatch, can establish technical inter-organizational linkages, but do not ensure a comprehensive linkage between organizations to accommodate the dynamic human response elements inherent in responding to unexpected events (Turoff, 2002).

In our research, we found that while the service hand-offs were incrementally improving the time and information flows, what was missing was an integrated “organizational awareness” between organizations on how they were to inter-operate (Horan and Schooley, 2005a). The software can only go so far without the “org-ware”—that is, integrating organizational policies across the service (see Figure 1, second row from the top).

2.3.3 Inter-organizational Systems (IOS)

A time-critical information service is typically inter-organizational in nature – there is a hand off from one agency to another, or if within an agency, across the functions of an agency. The design of an information system for a service delivery system is as much of an inter-organizational phenomenon as it is a technical undertaking. Businesses have extended the aforementioned BPR concept to include a network of organizations, across value chains, to improve business processes with partners, vendors, suppliers, distributors, and sales channels. The key lesson from two decades of BPR experience, however, is that BPR necessitates organizational understanding and change (Hammer, 1997). This private sector concept of the need for organizational change, induced by information technology implementation, has
recently been expanded into public sector e-government research (Scholl, 2004).

This third concept focuses in on the formal and informal organizational relationships, as well as how they affect and are affected by information exchange strategies. New technologies can be developed and implemented to enhance organizational performance, but this raises the question about how well these technologies and systems affect the inter-organizational linkages and relationships.

2.3.4 End-to-End Performance

For time-critical information services, end-to-end performance is what matters to an injured citizen (see Figure 1, third row from the top). For example, it makes little difference for an operator to dispatch quickly if the ambulance takes a very long time to arrive and/or goes to the wrong location. The critical descriptor here is “end-to-end”. Measuring effectiveness across organizations (end-to-end performance) is essential to understanding how public services are delivered to the public, the level of service (timeliness, quality) with which they are delivered, and how the network can be improved to deliver better services in an information-critical and time-critical manner. The challenge is how to implement this “end-to-end” concept within and across emergency provider organizations.

While information systems are often implemented to address separate silos of a governmental process, the end-to-end nature of time-critical information services facilitates or at least allows for information systems that can report on overall system performance. The real challenge then becomes working across very different organizational cultures—for example, departments of transportation, law enforcement, and fire/ambulance response—to achieve a holistic understanding of the total service performance. The concept of “end-to-end” highlights this aspect of e-government service delivery.

2.3.5 Normal and Extreme Events

The end-to-end performance of a time-critical service is not only a function of system processes but also a function of exogenous occurrences that tend to pressure or stress service delivery. Extreme events, such as storms, natural disasters, or terrorist attacks provide obvious examples of situations that could cause a range of system failures including overload or even collapse. This raises research issues about how information systems could be used to enhance the ability of first responders (e.g., EMS) to ramp-up service capabilities rapidly and effectively despite these exogenous occurrences.

Research focused solely on a system’s normal behavior cannot fully characterize the full range of possible system dynamics. Fedorowicz, Gogan, and Ray (2003) explain that an inter-organizational “ecology”, or dynamic inter-organizational information sharing system, must examine “punctuating events, processes of co-evolution, and other dynamics that are not often captured in research studies (p. 2782).” Thus, from a research perspective, extreme events provide unique opportunities to examine the systems, including the functioning of cooperative organizations under “extreme accident” conditions, such as system overload or collapse. From a systems performance perspective, dealing with crises or extreme events can be a pivotal test of the overall system management capability (Horan and Sparrow, 2004).

3. WORKSHOP STRUCTURE

The TCIS Workshop was structured to provide an opportunity for expert (academic and practitioner) input and feedback on the TCIS dimensions outlined above and the best means for understanding their occurrence in on-the-ground services in the EMS area. The workshop featured experienced academics, researchers, and practitioners and was conducted in April 2005 at Harvard University in cooperation with the National Center for Digital Government. Additional co-sponsorship was provided by the State and Local Policy Program, Humphrey Institute, University of Minnesota in collaboration with the ITS Institute, University of Minnesota.

The first level of discussion was at the overall conceptual level, for as Shanks, Tansley and Weber (2003), note: “Perhaps the best way IS [Information Systems] professionals can facilitate the validation of conceptual models is to generate high-quality conceptual models at the outset” (p.89). Moreover, attributes outlined by these authors, in particular the extent to which they are accurate and complete, in addition to high-level conceptual development with both stakeholder and empirical validation was followed in this exploratory examination and workshop.

3.1 Conceptual Overview and Discussion

Dr. Horan opened the symposium with an overview of the workshop objectives and agenda. He first described the topic, time-critical information services as an emerging concept that combines the e-governmental aspects of service delivery, but does so under time constraints. He introduced the conceptual framework that had guided his team’s research on the topic (see Figure 1). This conceptualization stressed four dimensions: 1) time-criticality; 2) information exchange; 3) inter-organizational systems performance; and 4) normal and extreme events. Dr. Horan then reviewed the substantive focus on EMS as an exemplar of time-critical information services, making note of the longer response times and higher fatality rates in rural areas. He then laid out the objectives of the symposium, in terms of reviewing, discussing, and critiquing both the concepts of time-critical information specifically in EMS as well as more broadly in e-governmental research.

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Jane Fountain, Associate Professor of Public Policy, Harvard University, and Director of the National Center for Digital Government, provided a broad policy and conceptual introduction and a review. Dr. Fountain focused much of her comments on the distribution of power within and across government agencies, as well as how time-critical information services, and emergency medical services, relate to cyberinfrastructure concepts. Fountain mentioned The Atkins Report, which describes a
“cyberinfrastructure” where databases and centers communicate with one another. Sensors, tools, and information systems are used to provide performance information to an organization, inter-organizationally, and across a network. She related the cyberinfrastructure discussion to EMS, where such technologies could have a strong impact on the service. Dr. Fountain then turned her attention to the concept of governance. Though technologies could provide an important impact on a government service, she noted that EMS demonstrates a need for strong governance. This is due to the lack of shared, or network, accountability for service outcomes. Dr. Fountain suggested that a model be used to demonstrate extreme, or stress situation cases, focusing on who is in charge of the incident (and thus document that there is no end-to-end accountability). Dr. Fountain described how commercial bases are often not built for the reasons in which they were designed. She also mentioned that tools built for end-to-end usage, rather than one “leg” of a service, are critical.

Joe Sussman, Professor at the Massachusetts Institute of Technology, performs work that involves planning, investment analysis, operations, management, design, and maintenance work of Complex, Large-Scale, Integrated, Open Systems (CLIOS). Dr. Sussman has applied CLIOS to many applications, both within the United States and abroad. He has had significant involvement in the Intelligent Transportation Systems (ITS), where he has assisted in building the U.S. national program. In his presentation, Dr. Sussman gave two examples that he believed were appropriate for making a comparison to systems that supply emergency medical services. The first example was that of the transportation and environment system in Mexico City, Mexico. In explaining how the CLIOS process was used in this case, he stated that it exhibits features of nested complexity and evaluative complexity. The second example was that of transporting spent nuclear fuel from many nuclear power plants within the United States to a central site in Yucca Mountain, Nevada. Dr. Sussman noted that this case also demonstrated the complexities that were observed in the Mexico City case. Principally, ITS involve the surface transportation systems’ use of established technologies in the areas of communications, control, electronics, and computer hardware and software. Some key ideas that these cases and ITS bring to EMS, according to Sussman, are the way that organizations will interact with one another and the changes that must be made to the institutions.

3.2 Methods and Impacts
This section of the workshop turned to the state of practice for a “grounded” perspective on how time-critical information services are being realized within the context of EMS. The presenters addressed both rural and urban perspectives, including the role that technological improvements have played in enhancing performance and related organizational and policy challenges to achieving service improvements. The workshop provided an opportunity to obtain feedback about “on-the-ground” challenges to innovative technology use. Speakers during this session included David Aylward, Director of ComCARE, and Dr. Lynne Markus, Professor at Bentley College.

The ComCARE Alliance is an organization whose mission is to improve emergency response through the innovative use of information technology. The ComCARE Alliance is a seven year old national coalition of 100 organizations that represent nurses, doctors, emergency medical technicians, wireless companies, public safety and health officials, transportation companies, automobile companies and safety groups, and others who are working to educate the public and policymakers. These groups are ultimately responsible for the 7,000 9-1-1 systems nationwide, as well as related emergency communications systems. Mr. Aylward, Director of ComCARE, began his presentation by stating that emergency response has missed the information revolution, leaving all groups (such as emergency medical technicians, nurses, doctors, wireless companies, and public health and safety groups) within the system disconnected. Mr. Aylward believes that the use of voice alone is not sufficient for emergency response crews and a perfect device or system that can be put in place to provide all of the voice and data information needs does not yet exist. He pointed out that automobile crashes are only a small part of emergency management and would therefore be insufficient to drive changes. Rather, he argues that the underlying medical condition of the patient is paramount. Mr. Aylward believes that in order to improve EMS, several items must be examined: facilitation services research, metrics collection, and a roll-over system for 9-1-1 calls. Facilitation services, as described by Mr. Aylward, consist of security, rights management, and directory services. With regards to metrics, he concluded that knowledge needs to be measured, since FARS data is insufficient. He observes that the lack of a roll-over system for 9-1-1 calls creates a stressful situation for small 3-person PSAPs.

Lynne Markus, a Professor at Bentley College, discussed her research on inter-organizational systems and its implications for time-critical information services generally and emergency response services, specifically. She noted that while most of her research has been in the private sector, such as enterprise business systems, the lessons apply to the public sector to a large extent. She outlined three major spheres in which this research has occurred: 1) adoption of technology, 2) how innovation of technology is used, and 3) the outcomes. These three spheres capture the sequence of activities and processes that occur when new systems are introduced. As TCIS is outcome based, Dr. Markus highlighted two possible outcomes – (1) service provisions, such as quality and cost and decision making (how the knowledge will be used) and (2) information processing, which includes such things as administration costs, errors in handling information, and delays. The issue of outcomes raises several questions: What role does IT play in these outcomes? How will technology be used (rather than concerned with the technology itself)?

A key point raised by Dr. Markus is the distribution of cost and benefits across systems that are implementing systems: Who pays for the information and how do they benefit? Her research has found this to be a particularly important, yet vexing, issue in inter-organizational systems. If there is not a mutuality of benefits to costs, then participation can be uneven and that is quite problematic for an inter-organizational system like emergency response systems. From an academic perspective, the research
issue is how to analyze the distribution of costs and benefits across participants. From a policy or practical perspective, the issue is how to accommodate a diverse arrangement that can ensure a mutuality of costs and benefits.

Finally, Dr. Markus concurred with others, who had noted the need to look at multiple levels of inter-organizational systems. It is one level (and an important level) to look at service cooperation, but to fully understand that level, one needs to also look at the overall institutional architecture.

3.3 Case Applications in the United States

Policy plays a critical role in the development and implementation of e-government generally, and EMS specifically. This section of the workshop addressed TCIS within the policy context, both locally as well as nationally. The moderated discussion was aimed at better understanding the context in which TCIS operate and to understand the role policy plays in shaping and influencing the design and deployment of TCIS. Both EMS policy and e-government policy contexts are relevant to this discussion. Presenters during this session of the conference included Kevin McGinnis, an EMS system builder, Barbara Pletz, EMS Director of San Mateo County, and Bradley Estochen, Engineer and Project Manager for the Minnesota Department of Transportation. This analysis was used to inform the analytical framework for time-critical e-government services in consideration of the conceptual, methodological, and practical dimensions.

Kevin McGinnis began studying EMS systems in 1974, and has been an EMS system builder ever since. His experience in EMS is extensive and includes working as a paramedic, an EMS trainer, a regional EMS coordinator, a hospital emergency department director, Maine's state EMS director for 10 years, an EMS system consultant, serving the NHTSA conducting statewide EMS evaluations, a Program Advisor for the National Association of State EMS Directors, a director of a hospital-based ambulance system, and serving as the Maine EMS trauma system development coordinator. Mr. McGinnis discussed the state of rural emergency response as virtually unchanged over the last 30 years, involving voice communications and manual (as well as some automated) data collection. He presented arguments for the need to integrate data communications into the EMS system, particularly for rural areas where emergency response times can be over an hour. For example, data communications could be used for EMS technicians to communicate with physicians in a life threatening situation when out in a rural area. Currently, data communications are not prevalent in rural EMS and there is much work still to be done. He discussed how interdisciplinary operations, or operations involving multiple agencies and organizations, cease in major events (such as 9/11). Mr. McGinnis discussed how emergency technicians do not want a lot of information pushed to them, that they have high-stress jobs, and do not want to become overwhelmed by excessive data feeds (and information overload). Technicians work in highly dynamic environments where every emergency situation differs. This environment is better suited to having access to a variety of information that they could pull when they need it. Mr. McGinnis provided a preliminary display of what he believes to be an effective user interface for EMS personnel. This hypothetical user interface would provide quick links to real-time information as needed by technicians, such as hospital emergency room wait times, number of available beds, types of physicians on duty at awaiting hospitals, availability of medications, and so forth. Such a user interface does not yet exist, nor does the underlying information system to support it.

Barbara Pletz has been the San Mateo County EMS Program Administrator since 1988. She is a registered nurse with over 30 years of California EMS experience. She is an active participant at the state level on various EMS committees and is former president of the EMS Administrators' Association of California where she served as its legislative chair for six years. Ms. Pletz described how San Mateo County uses EMS response time data. She explained that this data is used to determine how their overall system is performing and to determine the level of service that their sub-contracted service providers are delivering. Since the county sub-contracts EMS to American Medical Response (AMR), they closely track and observe performance data to ensure that the ambulance service meets performance benchmarks set forth in their contract. Ms. Pletz provided a specific example of how the data was used. Ambulance response times were increasing in one particular region (the area is divided into 5 regions). An inquiry into why response times were increasing revealed that AMR had reduced staffing levels in that region, which had negatively impacted their ability to respond in a timely manner. According to agreements set forth in their contract, AMR was fined by San Mateo County and AMR staffing levels were subsequently increased. According to contract, AMR reports quarterly on data related to responses, transports, costs, revenue, earnings, average patient charge, and collection rates. In addition, AMR is subject to additional audits by the county. Any incident responses that do not meet the time frame benchmarks indicated in the contract must be tagged with a reason why. Reasons include: bad address, change in priority level, traffic, weather conditions, cancelled call, and others.

Currently, real-time performance information is not collected. Performance is monitored on a quarterly basis. Ms. Pletz discussed some of the lessons they have learned through implementing technology in the field to enhance EMS. She described the county’s attempt to implement hand-held computers to enter and communicate emergency incident data in the field. She explained that the implementation failed. However, a significant amount of electronic data is used to augment voice. This data is entered into on-board PC's (first responders) and laptops (ambulances) and transmitted over the web via wireless transmission. A single electronic patient record is created at the time of a CAD dispatch. Some of the CAD data is included along with first responder and ambulance paramedic patient care record data and emergency department outcome data (with working diagnosis and disposition). The data is available for managers to query, slice, and create reports. Ms. Pletz explained how much of their system-wide success has not come due to specific technologies, but due to standardization. Performance tracking beyond the initial EMS response is limited. The number of patient diversion hours is tracked and shared with other hospitals and is currently the only method to monitor individual hospital performance.
Bradley Estochen is an engineer and project manager in the Minnesota Department of Transportation’s Intelligent Transportation System department. In his presentation, Mr. Estochen reported on the many ways that the General Motors OnStar system is impacting emergency services. He described OnStar as a vehicle safety and security system that effectively provides emergency assistance. Mr. Estochen stated that there are plans to standardize the OnStar system in 2006 vehicles. In the event of an automobile accident, the OnStar system shares information such as the location of the vehicle, the final resting position, the time of the accident, how the report was initiated (such as air bag deployment), and the type of vehicle. However, no personal information is shared by the OnStar system. Mr. Estochen stated that one concern that emergency service personnel believe they face, as a result of systems such as OnStar, is the risk of homeostasis (where risk-takers feel a greater sense of security due to the monitors and may take even greater risks). In his duties as the Mayday Field Operation Test program manager, Mr. Estochen works with the United States Department of Transportation, the Mayo Clinic, OnStar, 9-1-1 service providers, and technology consultants. He stated that the Mayo Clinic has a desire to improve the outcome for patients involved in vehicle accidents. Mr. Estochen briefly explained the value of the Condition Acquisition and Reporting System (CARS), whose features allow transportation personnel to enter, display, and disseminate travel, road, weather, and traffic information. However, he noted that the CARS, while currently available in ten states, is being adopted slowly.

3.4 Research Needs and Policy Implications

This fourth session consisted of an interactive discussion among workshop participants focusing on the research and policy directions suggested by prior case and research presentations and workshop participants focusing on the research and policy implications. This segment of the workshop was moderated by Lee Munnich, a Senior Fellow at the University of Minnesota. It provided the invited speakers a chance to offer additional commentary and it gave the workshop participants the opportunity to provide relevant feedback based on their expertise and professional experience. The following paragraphs provide some highlights of this insightful discussion.

Dr. Fountain made two points, one regarding the role of people and the other regarding issues of legality. First, she pointed out that in building the systems that support EMS, the people that have to work with these systems (the users) need to be considered, as well as the patients (the customers). Second, the legal obligations associated with the private systems, such as OnStar, need to be examined within the context of the legal obligations of the larger public service (EMS)

The costs associated with any type of public EMS system are of vital concern. Mr. Alyward’s comments stressed that designing and building information systems that are affordable to all local EMS systems and agencies must be considered. He added that there are many examples of the exorbitant costs associated with not doing this. Mr. Alyward also added that the commercial world is building technical devices to access a distributed service based network that would accomplish these goals. There is currently a business plan for the integration of these systems into emergency services.

Dr. Sussman mentioned the importance of maintaining archival data. He felt that this type of data would be useful for strategic planning. Ms. Flaherty, a NHTSA Program Analyst, cautioned that the mission of business is different than the mission of healthcare. She suggested that those working with EMS systems should exercise care when applying business models to EMS. Adding to the discussion of legal issues, Mr. McGinnis stated that the use of information from vehicle recorders has legal implications. He also offered that time criticality must be weighed against service outcome. Dr. Markus mentioned the value of creating a web-based forum for local EMS agencies to share their information technology and business model implementation experiences with other agencies nationwide.

Sheila Madhani, a program officer for the Institute of Medicine (IOM), National Academies of Sciences, mentioned that she is currently involved in a major study with “The Future of Emergency Care in the United States Health System”. She discussed that the scale of analysis is broad, with the focus of the study extending beyond pre-hospital care and into post-arrival at a hospital, pediatric emergency care, and rehabilitation. Final reports are being compiled and are due in April 2006. Madhani mentioned that pre-hospital care is only one portion of the emergency care system and that it has been valuable for the IOM to look at pre and post hospital care at multiple levels, including policy and technology, such as is the case with TCIS.

4. CONCLUSION

In sum, participants found the concept of time-critical information services to be a valid model for understanding, researching, and developing e-government systems within the specific context of emergency response as well as within the broader context of time-critical services to the public. Some participants noted that as a general conceptualization the model seemed vague and that the case studies were crucial to providing insight and ‘grounding’ to the concepts. Discussions about the three levels of relationships—technical, organizational, and governance—were particularly instructive to tying operational examples to TCIS concepts. Further, the general view from participants was that the inter-organizational and “end-to-end” issues and concepts were the most practical and useful. Understanding outcomes from the ‘end’ is what carries significant value in terms of lives saved from more timely services, etc. Moreover, there was recognition that while both upstream and downstream activities mattered, performance in the hospital, once the accident victim arrived, was a critical aspect of the service that should be examined in the future.

Participants agreed that both quantitative and qualitative measures are valuable for evaluating TCIS dimensions. Note was made of the importance of visually-based systems, such as had been demonstrated through the Arena demonstration. Another point was made about the possibility of considering perspective-based metrics, such as from the consumer, organizational, and user perspectives. Further, there is the looming question of the
distribution of costs and benefits, especially about how it related to who will be paying and who will be benefiting. There was endorsement about the need for grounded case studies to improve understanding of these issues. Finally, the concept of evaluative complexity seemed to capture many of these issues.

Participants argued that substantial institutional fragmentation exists, making inter-organizational cooperation difficult. However, there was a strong sentiment that existing institutional fragmentation should not be treated as a given. The governance dimension precisely points at the need to consider policy level actions that could be taken at the local, regional, and national levels. One issue regarding policy is the apparent lack of competition to drive system improvements and the possible use of this, or related mechanisms, needed to inspire innovation.

Participants noted that there had been a general movement toward trying to utilize performance metrics in government, and to some extent, in e-government. In thinking about performance, participants advocated keeping the perceptions of the customer in mind. Moreover, the metrics should not just be oriented around the status quo, but to keep in mind a vision of the possible, not just existing conditions. A global view of high performance could be devised to help drive system change and improvement.

Participants described the need to identify IT solutions that could be appreciated and used at the “end user” level and within work systems. While most of the discussion had focused on the service level implications of performance metrics, participants also noted that performance metrics could be used to drive governance as well as analysis. Operational tests could also provide insight into business models for inter-organizational performance as well as technical aspects.

Returning to the simulation, the visual nature of it suggests alternative scenarios can be developed to better understand what is possible and to generate consensus around such changes. As one participant noted, “people don’t know what they don’t have”. When asked the question: “How can TCIS advance our understanding of e-governmental services and contribute to the well being of citizens?” participants noted the importance of having a dynamic interaction between general models of e-government, such as those suggested by TCIS, and grounded case study examples. Also, a number of social issues could be more fully examined; for example, the privacy tradeoffs (and regulations such as HIPAA) that could be involved in providing more health information electronically.

A key to understanding the needs of the many users of a complex inter-organizational public service is to understand the context of the existing system. This conference highlighted the need to understand the context of inter-organizational information exchange from three levels: technological, organizational, and policy. Several inter-organizational e-government researchers have also recently confirmed the value of understanding public systems from multiple perspectives (see Dawes and Prefontaine, 2003; Scholl, 2005; Williams and Fedorowicz, 2005). Thus, one of the next steps for the authors is to examine information hand-offs from one emergency response organization to another across different deployments in the U.S. through a grounded case study approach. The goal would be to understand the operational system, and then to understand the context of information hand-offs from technological, organizational, and policy perspectives. Such context will provide a way to understand how performance information is acquired and shared across organizations, the barriers and synergies to sharing such information, and the requirements for overcoming barriers to include performance information tracking in an “end-to-end” system design.

Within the United States, work is currently underway within the Department of Transportation (DOT) at a national level to develop the next generation 9-1-1 (NG 9-1-1) system that integrates voice, video, and data. However, research conducted by the authors has shown that there exists a challenge to ensure that adequate information related to the end-to-end system performance is captured. Knowledge of the performance across the system will be of paramount importance not only to each of the stakeholders, but also to the organizational elements that are responsible for facilitating the service level agreements between the service providers. From this perspective, therefore, the authors plan to develop a framework for incorporating performance information into the Intelligent Transportation Systems (ITS) architecture as well as the NG 9-1-1 systems architecture and preliminary concept of operations (CONOPS) proposed by the U.S. DOT for EMS. The framework will then be applied to the ITS architecture and CONOPS document for NG 9-1-1 systems. The authors intend to provide a set of recommendations for incorporation into these systems.

5. FUTURE DIRECTIONS
Subsequent to the research symposium, we have had additional discussions and interactions with the participants including responding to a Request for Information (RFI) from the National Highway Traffic Safety Administration (NHTSA) on Next Generation 9-1-1 Systems. These interactions have further confirmed the value of continuing research efforts to expand the TCIS model. As such, our future research falls into two primary areas. The first is in regards to understanding the needs of the users of TCIS systems from multiple dimensions. The second is in response to the need for a national model for building performance into EMS systems.

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7. REFERENCES


