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Proceedings

Implications of the New Digital Economy on Transportation: Developing Research and Data Needs

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Prepared by
Center for Transportation Analysis
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831-6206
managed by
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Implications of the New Digital Economy on Transportation: Developing Research and Data Needs

1. Workshop Objective

The objective of the workshop was to stimulate the process of developing an "e-sensible" transportation system by convening stakeholders to identify research and data needs to develop a better understanding of the impacts of e-commerce on transportation. The product of this workshop will serve as a starting point for the development of a five-year strategic plan that identifies data and research needs, and outlines future steps.

In the keynote address, Administrator Coyner of the Research and Special Programs Administration at U.S. Department of Transportation (USDOT) urged that the development of this plan take into account the different design life cycles between transportation systems (measured in terms of "glacial time") and information technologies (measured in terms of "internet time").

2. Background

The new digital economy is becoming an increasingly major element of our societal landscape. Perhaps the most prominent aspect of the new digital economy is e-commerce. The U.S. Census reported that U.S. retail e-commerce sales reached $5.5 billion during the second quarter of the year 2000, an increase of 5.3 percent from

the first quarter. Furthermore, a significant portion of the U.S. economic gains during the past decade have been widely attributed to increased productivity spurred by the Internet and information technology. Changes being brought about by the new digital economy have been compared to those from the industrial revolution.

This globally connected, digitally supported economy is changing transportation in at least two major ways: (1) changes in freight demand and movements, and (2) changes in personal travel demand and travel patterns. These changes could in turn lead to safety, environmental and equity implications, and to a transformation of land-use patterns. There is considerable speculation about e-commerce's impact on transportation. Some foresee that e-commerce will have substantial impacts, far beyond the more obvious impacts on the freight industry. However, little is known about specifically *how* and to *what extent* e-commerce will influence or interact with transportation.

Although e-business accounts for less than 1 percent of total retail sales today, the digital economy is evolving rapidly and is going to impact transportation possibly more than any other revolution in the past. To harness the economic potential of digital technologies, it is important to encourage the development of a transportation system that will promote, and not constrain, the growth of electronic commerce. It is also important to avoid the possible negative effects on society from these changes in transportation patterns. Thus, it is crucial to develop a comprehensive understanding, and a quantitative estimate, of these possible impacts. The time to do so is now so that the process of developing an "e-sensible" transportation system can begin, not at

the *glacial* speed that plagues some transportation projects, but at the *Internet* speed at which the most dynamic parts of our economy are changing.

3. Workshop Structure

A Workshop on *Implications of the New Digital Economy on Transportation: Developing Research and Data Needs* was held at the National Academy of Sciences in Washington, DC, September 14 and 15, 2000. Researchers and representatives of federal and local governments and the private sector gathered to identify research and data needs to develop a better understanding of the impact of the digital economy on transportation.

Dr. R. G. Gilliland, an Associate Laboratory Director of Oak Ridge National Laboratory (ORNL) welcomed the workshop participants and introduced the keynote speaker, Administrator Kelley Coyner of the Research and Special Programs Administration of the US DOT. Administrator Coyner challenged the participants with four crucial questions (see Box 1).

Challenges Identified by
Kelley Coyner, Administrator
Research and Special Program Administration
U.S. Department of Transportation

Q1. What impacts will e-commerce have on transportation logistics?

Q2. What changes should take place in transportation systems to facilitate economic growth by taking advantage of e-commerce?

Q3. What opportunities will e-commerce provide to design transportation systems?

Q4. How are e-commerce benefits distributed and how can we make sure all have an opportunity to benefit?

After the address by Administrator Coyner, the workshop participants were briefed on recent activities on e-commerce and transportation, and on potential issues identified by different groups, including a number of standing committees of the Transportation Research Board (TRB). A resource paper authored by researchers at the Center for Transportation Analysis, ORNL helped set the stage for discussions at the workshop by identifying potential changes in transportation that might result from the new digital economy and by suggesting some of the potential impacts of these changes.

Workshop participants were divided into two breakout groups. The objectives of the breakout groups were to:

- identify issues related to implications of the digital economy on transportation and build a consensus on the more important of these issues, and
- develop a preliminary five-year road-map of how to acquire a more comprehensive understanding, and quantitative estimates, of the impacts of e-commerce on transportation.

The road-map comprises of an identification of stakeholders, processes, research plans, data needs, governments' roles, and potential public and private partnerships.

The second keynote speaker, Deputy Secretary of Transportation Mort Downey, addressed the group at the conclusion of the workshop. His address

emphasized the importance of cyberspace to government policy, and the dramatic changes e-commerce will increasingly have on transportation.

4. Summaries of Issues Identified in the Workshop

Given the fact that the digital economy is developing very rapidly and that digital economy-induced changes to transportation services have already occurred, the workshop participants were steered by four major questions:

- What impacts will the digital economy bring to transportation?
- How can we identify and measure such impacts on transportation?
- What changes should take place in the transportation system to facilitate economic growth?
- How can the transportation sector get the most out of the digital revolution?

Discussions at the workshop formed the basic idea that the digital economy will induce two types of changes in our transportation system: (1) changes in transportation **demand**, and (2) changes in transportation **supply**. These changes will in turn bring about social, energy, environmental, safety, and economic impacts (Figure 1).

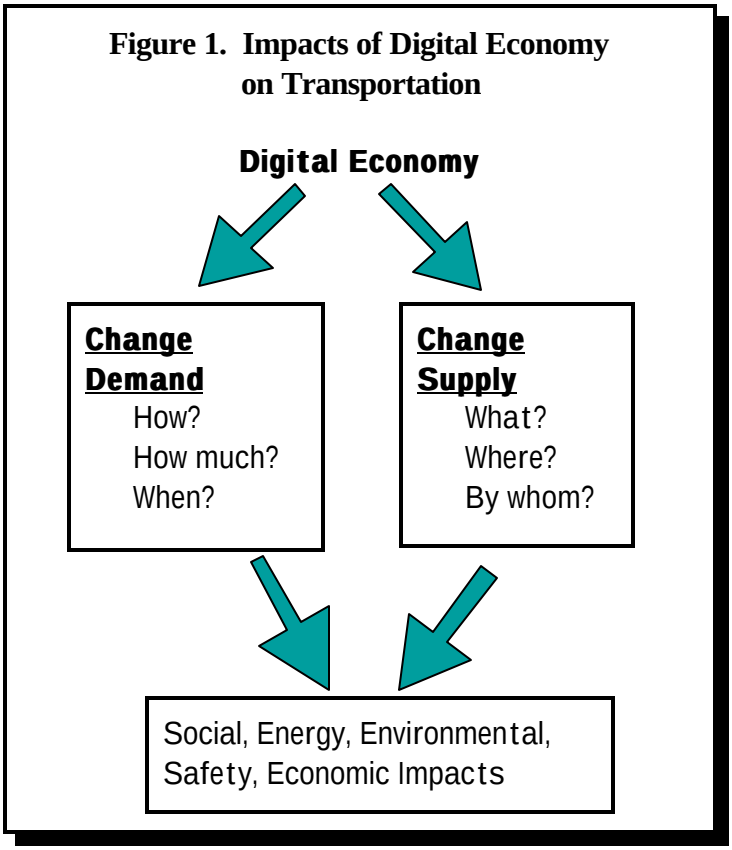

Figure 1. Impacts of Digital Economy on Transportation

4.1 Changes in Freight Transportation Demand

Recent advances in electronic commerce are creating unprecedented interactions between suppliers and customers around the globe. The comparatively low cost and instant access to information about new products and markets via cyberspace are leading to a tremendous increase in freight activity, both in terms of tons and value transported. On the other hand, accurate and timely information on suppliers, markets, and their transportation requirements brought about by the digital revolution makes

supply chain networks (chains of relationships that integrate and organize the movement of goods between suppliers , manufacturers, distributors, retailers and consumers) more efficient and more profitable than ever before. Conceivably, this efficiency gain in the movement of goods that result from more efficient supply chain networks might offset the increased demand for freight transportation.

Issues in Understanding the Change in Freight Demand

1. *Changes in freight demand.*
   - How will the digital economy reshape trade and hence change the demand for freight transportation?
   - What will be the net change in aggregate vehicle miles of travel, and in concomitant consumption of fuel and emissions of pollutants?
2. *Patterns and characteristics of freight flow.*

   It is foreseen that the efficiency and other changes induced by the digital economy will significantly change the ways in which goods are moved, both domestically and globally.
   - How will the patterns and characteristics of freight movements change as a result of the digital economy?
   - How will the intermediate assembly and distribution of goods change among manufacturers?
   - Has the view of reliability of transportation services changed?
   - What are the implications in designing the future transportation systems?

3. *Impact of the digital economy on the supply chain(s) of key industries.* Unquestionably, the digital economy will expedite the exchange of information among suppliers, all the way through to their customers, creating new and more efficient supply chain networks.
   - What are the changes in the supply chain(s) of key industries?
   - What will be their implications for transportation?
4. *Impact of the digital economy on inventory flow through the supply/demand chain.*
   - What will be the nature of goods being transported with respect to quantity, extent of processing, and ownership?
   - Will increased in-transit visibility change behavior?
   - What are the important performance metrics and how should they be measured?
     - Profitability
     - Reliability
     - Efficiency
   - Will transportation purchasing become monopolistic?
5. *Impacts on communities as a result of the concentration of local deliveries.*
6. *Strategies to facilitate efficient and safe local deliveries.*

4.2 Changes in Personal Transportation Demand

Just as the digital revolution is making its presence felt in freight transportation through the evolution of supply chain networks, so will this same revolution make its presence felt on personal travel through changes in households' daily and weekly travel activity patterns.

The digital revolution influences personal travel behavior and lifestyles in at least three different ways. First, goods and services can be purchased on-line, minimizing many discretionary trips to grocery stores, the post office, book stores, banks, etc. Second, the digital revolution provides an alternative entertainment medium, reducing the desire to visit friends, or to go to movie theaters and concert halls. Finally, many workers are adopting flexible work schedules or locations by working at home or at tele-work centers, changing both the frequency and location of the daily commute. This revolution will potentially affect both trip frequencies as well as trip lengths. However, the overall impacts on personal travel demand are unknown.

<u>Issues in Understanding Change in Personal Travel Demand</u>

1. *Impact of the digital economy on people's travel patterns.*
   - How will time, space, purpose, and mode distribution change?
   - How will users' expectations change and what will influence them?
   - Has retail purchasing changed and what has been the impact on transportation patterns?

- What are the size and nature of companies involved in the digital economy?
- How will the use of digital technologies evolve? What will be the impact of this evolution on the demand for transportation services?
- What will be the extent to which ready access to the latest information on transportation services (e.g., discounted air, rail, and cruise ship fares) encourage trip-making (e.g., long-distance non-work travel) that would not have taken place otherwise?

2. *The extent to which the digital economy deters travel.*
   - Will the ability to work at home catch on in much greater numbers than at the present?
   - Will audiovisual home entertainment technology reduce the number of out-of-home entertainment trips?
   - Will on-line shopping grow sufficiently to generate a sizeable at-home grocery and durable product delivery industry?
3. *The combined transportation implications of these changes.*

4.3 Changes in Transportation Supply and Related Issues

Issues in understanding the changes in transportation supply include:

1. *Impact of the digital economy on the planning, development, and management of the transportation infrastructure.*
   - What is the digital economy's impact on supply chains?

- What might the digital economy enable in the designing and building of the transportation infrastructure and processes?
- Has transportation network "throughput" changed?
- How have digital economy providers invested, deployed and utilized technology within the transportation network?

2. *Impact of the digital economy on transportation modal choices.*
3. *Technology-induced changes in the decision-making process.*
   - How should public investment decisions be made under high uncertainty?
   - What is the potential for demand-responsive systems?
   - Is the nature of the supply chains changing in terms of visibility, and how are participants performing risk management?
4. *Has infrastructure investment risk changed with the digital economy?*
   - What criteria should guide transportation infrastructure investments?
   - What are the human capital skill requirements to support, and take advantage of, the digital revolution?
5. *Operational efficiency of the overall transportation network induced by the digital revolution.*
6. *Shifts and/or concentrations in nodes and corridors.*
7. *Digital economy-induced changes in industry structure.*

4.4 Institutional Challenges and Issues

Issues in understanding the institutional challenges include:

1. *Impact of the digital economy on institutional roles and responsibilities in transportation.*
   - Will government actions provide incentives or disincentives to enhance the digital economy?
   - How will the digital economy impact transportation operations?
   - How should access be provided across transportation activities?
   - Has transportation oversight affected the use of the digital economy?
2. *The implications of the digital economy for standards and standards development in transportation.*
   - How should transportation providers interface?
   - Have regulatory and process issues posed obstacles to effective global transportation?
3. *Changing missions of traditional transportation organizations.*
   - What will be the changes in transportation that will warrant changes in regulations?
   - Under the premise of seamless transportation across modes, what should be the institutional structure of government agencies?
   - What will be the human resource requirements for transportation professionals?
4. *Regional and national issues in a decentralized planning context.*

5. *Implications of new data forms (e.g., transaction-based data) for transportation planning.*

5. Research Needs

To address the issues identified above, the workshop participants identified and provided many research needs. Recognizing that there would be resource constraints to any research program, they prioritized these needs and recommended the more important ones:

1. Estimate the Impact of the Digital Economy on Freight Transportation Demand
2. Estimate the Impact of the Digital Economy on Overall Transportation Demand
3. Re-engineer the Nation's Transportation System to Meet Future Transportation Needs and to Foster Economic Development
4. Understand Changes in Supply Chain Visibility, In-Transit Visibility and Inventory Management
5. Create Digital Opportunities to Improve Energy Efficiency, Environmental Sustainability, and Transportation Safety
6. Develop Methodology to Estimate the Digital Economy-Induced Impacts on Energy, Environment, and Safety
7. Assess the Digital Divide
8. Estimate the Digital Economy's Impacts on Land Use Patterns

9. Estimate the Impact of Digital Economy Induced Transportation on Economic Growth
10. Create Digital Opportunities for Transit

These research needs are discussed in more detail below.

5.1 Estimate the Impact of the Digital Economy on Freight Transportation Demand

A distinctive element of the digital economy is its ability to expedite information exchange and improve information accessibility on supplies, manufacturers, shippers, carriers, products, markets, and customers. This element will in turn lead to a number of changes and revolutions in freight transportation operations. One example of such changes is that freight logistics and supply chain management will respond to this element, leading to potential improvements in freight movement efficiency. Another example of such changes is that the digital economy potentially encourages more convenient, on-line shopping and increases demand on, and patterns of, freight transportation. However, it is unclear how these changes will counteract each other, and what the net impact on freight transportation will be.

This proposed research will identify the digital economy-induced changes in, and estimate the net impacts on, freight transportation.

1. Estimate freight movements, **without** the digital economy, in terms of value, tons and miles.
   - What types of goods are moved from where to where?

- How are the goods moved?
- How much of the goods are moved by which modes?
- How much and what kinds of goods are handled at the intermodal connectors?
- When are the goods moved?
- The extent of home-based freight demand.

2. Estimate freight movements, **with** the digital economy, in terms of value, tons and miles
3. Estimate the "delta" changes in the network demand, by mode
   - How does the digital economy impact transportation modal choices?
   - Will increasing transportation demand lower the transportation costs? Will lower transportation costs induce further increase in freight demand?
   - Will the efficiency gained in supply chains as a result of the digital revolution offset the increased demand in freight transportation?
4. If the net impact of the digital economy on freight demand is real, evaluate the current capacities on, and the spatial distribution of, roadways, waterways, air, rail, intermodal terminals, and connectors in meeting the changing demand.

5.2 Estimate the Impact of the Digital Economy on Overall Transportation Demand

It is foreseeable that the digital economy will alter personal travel patterns by allowing consumers to shop more products or services on-line, and reducing travel

needed to go to grocery stores, banks, book stores, etc. Also, the digital economy provides the opportunity for tele-commuting, reducing and changing the traditional daily commutes. It has been suggested that time saved from the less frequent visits to the grocery stores and banks might induce more discretionary travel. It is unclear how the digital economy will alter trip frequency, and trip *temporal* and *spatial* distributions by mode and purpose. Furthermore, changes in the ways in which freight transportation and passenger transportation interact are unclear.

This proposed research will identify the digital economy-induced changes in, and estimate the net impacts on, passenger transportation. Moreover, this proposed research will evaluate the net impact of the digital economy on the overall transportation demand by combining changes in freight transportation demand and changes in passenger transportation demand.

1. Identify and quantify digital economy-induced changes in people's travel patterns.
   - The extent to which on-line shopping and on-line services minimize discretionary travel.
   - The extent to which ready access to information on transportation services encourages travel (e.g., does knowing discount fares encourage more leisure travel?).
   - The extent to which tele-working alters commute patterns.
   - The net impact on trip frequency, trip distribution by time of day, by mode, and by trip purpose.

2. Estimate the "delta" changes in network demand.
3. Combine changes in freight demand and changes in passenger demand and determine whether the net impact of the digital economy on transportation demand is significant.

5.3 Re-Engineer the Nation's Transportation System to Meet Future Transportation Needs and to Foster Economic Development

Should the previous two research projects conclude that current transportation capacities can not meet the changing demands for transportation, this proposed research will:

- develop guidelines for managing the current systems to maximize efficiency,
- develop guidelines for designing future transportation systems, with respect to roadways, waterways, air, rail, intermodal terminals, and connectors to meet future demands, and to foster economic developments.

5.4 Understand Changes in Supply Chain Visibility, In-Transit Visibility and Inventory Management

More accurate and more up-to-date information on the availability (and latest price) of goods is changing the way businesses handle their inventories. Many companies are moving towards "just-in-time" delivery mode. In this mode a supplier or its freight carrier is required to deliver goods directly to the customer within a short period of time. This can be a period of days or even hours. The product supplied

may come from supplier owned or leased warehousing, or even directly from the supplier's manufacturing plant. The companies receiving the goods are substituting more demanding transportation requirements for savings in their inventory holding costs. In some cases access to near real time information on the location of in-transit vehicles and their cargos is an additional facet of this IT revolution in supply chain management. The more both suppliers and their potential customers know about available product inventories, including in-transit inventories, the more effectively, in theory, demands for goods can be met. Research is needed to improve government as well as private sector understanding of the how these IT advances create e-business options for reducing the total logistics costs of goods acquisition. From the government perspective, understanding which sectors of the economy are most likely to benefit from new information technologies can lead to better assistance to companies seeking to trade in the rapidly evolving, and highly competitive, global marketplace. Understanding how these e-business logistics are changing is also important to government's efforts to ensure fair business practices, with both suppliers and their customers increasingly sharing information, some of it proprietary, about their operations.

Besides the implications for business economics, these developments also have implications for both the volume and pattern of goods movements. Will shorter delivery schedules mean greater reliance on truck transportation, and therefore the need for greater investments in our highway system? How will fuel consumption in the freight sector be impacted? At the level of the individual firm there are also some important research and development issues to be faced. For example, to what extent

can traffic routing and fleet management software be developed to minimize miles traveled and costs incurred? How flexible can a company afford to be in its contracting for product deliveries on the basis of least offered price? How reliable are such e-business dealings in terms of actual on time physical product deliveries, and how can firms as well as governments develop measures that will help them identify best freight practices?

5.5 Create Digital Opportunities to Improve Energy Efficiency, Environmental Sustainability, and Transportation Safety

It has been widely recognized that many of the public sector's procedures move at "glacial" speed while information technologies advance at *Internet* speed. It is also recognized that there are ample opportunities where digital technologies can help the transportation sector to improve energy efficiency, environmental sustainability and transportation safety. Fortunately, some public sector procedures are relatively nimble and can be implemented almost immediately to leverage the benefits afforded by digital technologies. On the other hand, many of the glacial-speed public sector processes need to be initiated almost immediately in order to capitalize, in the near future, on the potential benefits afforded by digital technologies. That said, the challenge then becomes how to create digital opportunities by properly aligning public sector processes, some nimble and some not-so-nimble, to take advantage of digital technologies to maximize energy efficiency, maintain environmental quality and improve transportation safety.

The proposed research would create digital opportunities by undertaking the following tasks:

1. Identify digital opportunities.

   Convene a panel of visionary IT and transportation experts to develop applications where transportation energy efficiency, environmental quality and transportation safety can be achieved through IT. Digital technologies will be aligned with potential public sector implementations, with respect to the speed and the extent to which these opportunities can be adapted, as necessary, and implemented. One such opportunity for improving the efficiency of the transportation sector is developing seamless operations in border-crossings by expediting information flow. The effort required to implement this opportunity appears to be modest when compared to other applications such as populating the nation's entire vehicle stock with efficiency-inducing devices. This border-crossing application will reduce vehicle idle time at border-crossings, thereby significantly reducing fuel consumed and pollutants emitted, and improving safety and operations at the border-crossing sites.
2. Estimate the cost-benefit ratio of each identified opportunity.
3. Explore and foster cost-sharing partnerships with other agencies and private-sector shareholders.

   An example of possible partnerships in the board-crossing application is DOE, DOT, IRS, EPA and the United States Customs Services.
4. Implement qualified digital opportunities.

Depending on the nature of the opportunity, this task could include conducting feasibility studies, developing rapid prototyping projects, formulating programs or policies, etc.

5.6 Develop Methodology to Estimate the Digital Economy-Induced Impacts on Energy, Environment, and Safety

The changing demands on freight and passenger transportation might lead to undesirable impacts on our society in the form of reduced energy efficiency, environmental quality and highway safety. For example, the change in demand for freight transportation has a number of safety implications. First, freight traffic will likely increase, subjecting the public to more trucks on the roads. Research suggests that a greater percentage of trucks in traffic will have a profoundly adverse impact on highway safety. Another safety impact of increasing freight transportation demand is the increasing population of commercial drivers, surfacing issues such as driving hours of service compliance.

On the other hand, if part of the digital economy affects transportation in a way that certain trips can be completely avoided (such as electronic delivery of software, music, or documents), then the question arises as to the extent to which this *decreased* demand for freight transportation will counterbalance the *increased* demand for freight transportation spurred by other parts of the digital economy.

Although the monetary value of B2C transactions is less substantial than B2B, B2C has very different safety implications than B2B. For example, to what extent will

the digital economy expand the final "delivery" points of goods beyond central business districts and retail centers into urban and residential areas? How will B2C impact bicycle and pedestrian safety in urban and residential areas? How should residential streets and local roads be modified to handle the potentially greater volume of trucks?

From the energy and environment perspectives, faster and guaranteed on-time delivery may also mean more vehicle miles of travel (VMT) by vehicles carrying lower payloads. More VMT may mean more pollutants emitted. It has been speculated recently that about half of the trucks on our highways are traveling empty. Many others, especially within urban areas, are carrying only partial loads. Will more complete information lead eventually to more efficient utilization of transportation assets? Will the ability to use real time in-vehicle communications in conjunction with real time data on vehicle stock availability and the latest customer demands allow significant savings in vehicle fleet utilization costs? And will such savings be gained in part from, or at the expense of, additional vehicle miles of travel and fuel use? The solution to these problems is likely to be found in better use of the Internet itself, including the data and technology necessary to track inventory levels, to locate and re-schedule vehicle assets, and to allocate manpower to better match customer needs. We should expect this real time data to become better used as we adapt to life with the Internet. For example, we should be able to retrieve information on the most fuel-efficient forms of transportation for specific movement needs.

To strategically plan a future transportation system which will not be impacted by these undesirable impacts, this proposed research will carefully identify, and develop methodologies to estimate, the size of these impacts.

5.7 Assess the Digital Divide

The digital economy, especially the exponential growth in B2B and B2C e-commerce, offers the potential of bringing goods and services to economically depressed locations, and to disabled and elderly people who are confronted with numerous barriers in transportation systems that limit their mobility and access to goods and services. How can the government encourage the use of Internet-based transportation information and services in economically depressed locations and among disabled people and aging population? What should be the federal, state and local governments' roles in the provision of local community information networks and how will these impact transportation services needs? How should these services be provided to minimize the digital divide?

The digital economy also has the potential to create a growing divide between those with information and those without access to it. Groups in society that are susceptible to being left behind by the digital technology revolution are those traditionally faced with such situations—areas with larger population of low income and poorly educated families, as well as the elderly, minority groups and those with disabilities. Possible benefits from the digital revolution include the opportunity to link people in these groups more closely with the rest of the community, where ever they

live (suburbs, remote rural locations, or resource poor neighborhoods). The Internet is a great "leveler": we all look alike in cyberspace (Nie, 2000). Failure to keep pace with developments in information technology will cause individuals, companies, and also nations to lag behind their neighbors. As Mitchell (1995) points out, Nations' that seek to grow economically will have to invest in costly information networks along with investment in ports and shipping fleets, railroad networks, and highway systems and will have to find innovative ways to finance their development and improvement. The different possible answers to these issues may have profoundly different social consequences, leading to potentially contentious policy debates.

This proposed research will develop ways to assess the potential extent of the digital divide, and recommend strategies to prevent or at least reduce it.

5.8 Estimate the Digital Economy's Impacts on Land Use Patterns

The digital economy encourages new relationships between the economics of production, distribution and warehousing. These relationships in turn will alter the geography of business, which in turn will alter the needs for new roads, new transit services and new freight pick-up and delivery services. A key question for regional planners is whether the digital economy will encourage or discourage the geographic expansion of our cities. As companies begin to generate a higher percentage of their sales via cyberspace they are going to become increasingly "location-neutral." Will this encourage a further spread of office activity, warehousing, and other activities into the suburbs?

Residential neighborhoods might also change. Neighborhoods traversed by large numbers of just-in-time, small package delivery trucks might call for changes in street layouts and increasingly strict controls over freight traffic. It is currently unclear what significant growth in such to-the-home goods delivery services (see Harker and Goulias, 1999) will do to residential preferences. The nature of retail locations might also change, with significant implications for one of the fastest growing areas of trip making in recent years, that of shopping. Will the large, multi-purpose shopping malls of today remain as popular in the future? Or, will home delivery or direct-to-the-customer wholesale activity make them less common? Will the "brick and mortar" establishments begin to feel threatened?

This research will project the digital economy-induced changes in urban land use patterns and in the relationship between residential areas and local concentrations of delivery and pickup facilities; and the changing patterns around ports and intermodal terminals. Also, this proposed research will project the digital economy-induced changes in the relationship between rural and urban communities, and the impact of this changing relationship on rural economic growth. Finally, this research will evaluate the associated implications on transportation planning.

5.9 Estimate the Impact of Digital Economy Induced Transportation on Economic Growth

Economic growth and transportation are vitally linked. One cannot be sustained without the other. Transportation breeds economic growth, economic growth demands additional transportation, and the cycle continues. Therefore, it is crucial to

understand the intricate relationship between transportation and economic growth so that this cycle remains strong and vital. Conceivably, the digital economy will spur unprecedented requirements, both with respect to capabilities and assets, on transportation.

In order to pro-actively and strategically plan the future transportation systems, this proposed research will estimate the impact of digital economy induced transportation on economic growth.

5.10 Create Digital Opportunities for Transit

The digital economy will bring both opportunities and challenges to public transit. Intelligent transportation systems that use digital technologies provide transit agencies with opportunities to improve their operations, service delivery, and ridership. However, the digital economy might also affect the demand for transit in other ways. For example, increased geographical dispersion and decentralization of activities could likely be the consequences of the digital economy. Digital communications might lead to significant changes in daily work practices, with a large percentage of population tele-working from home. One consequence of this scenario might be urban sprawl and decreased demand for transit, because proximity to work place would be an even less important factor in residential location. Furthermore, digital communication connections will increasingly affect the central-gathering-place role which cities and urban areas have traditionally played. Some of the major issues that will require

investigation in order to better define and plan public transportation in the emerging digital economy are:

1. Identify how digital technologies can improve transit operations.
   - What are the benefits, costs, reliability, and issues in deploying intelligent transportation system (ITS) technologies?
   - To what extent have transit ITS technologies improved service and increased ridership?
   - What are some "best-practices" in the use of digital technologies in transit operations?
2. Assess the impact of technology on daily life and businesses.
   - What is the nature of demand for transit in the digital economy?
   - What is the market demand for transit services in the digital economy?
   - How are individuals daily activity patterns changing as a result of the digital economy, and what are the potential implications for transit services?
   - What is the impact of the digital economy on residential choice and population density, and their implications for transit?
   - What is the impact on the mobility needs of our aging population, and the role of transit in meeting those needs?
1. Identify techniques that have to be developed to model the interactions between land uses, and transportation demand and supply in the digital information age.
   - What modeling methods need to be developed?

- What are their data and information requirements?

2. Assess the role and potential for transit services to narrow the gap of the digital divide.

6. Data Needs

Ideally, data needs should be aligned with the research for which data are needed. Thus, all of the aforementioned research needs should have specific plans to meet their data requirements. Nonetheless, the workshop participants recommend the following fundamental data-related actions. The workshop urged that any data collection effort should leverage, to the greatest extent possible, on non-transportation surveys.

1. More resources should be devoted to design careful plans to collect more meaningful information on the entire transportation network, including data on multimodal freight movements, such as *what* and *how much* (in terms of tons and values) is moving from *where* to *where by what modes*; the extent of "door-to-door" transportation, and home-based freight trip rates.

2. Develop benchmarks for changes in transportation demand and supply that are spurred by the digital economy (in tons, values, and passengers).

3. The digital economy will conceivably alter the more traditional supply chains by significantly altering business interactions between carriers and

customers. It is, therefore, essential to develop a strategy that achieves better alignment of customer and carrier data and that addresses privacy and security concerns.

4. Measure e-commerce induced transportation changes on economic growth and productivity.

7. Data Opportunities and Issues

The digital technologies offer unprecedented opportunities in new data and new tools for collecting data. Along with these opportunities arise concerns such as the positive and negative impacts of new data forms (e.g., transactions-based data), and the coordinated access and use of data from public and private sources.

Furthermore, with data that were inaccessible in the past becoming available, the opportunity presents itself to define measures of transportation system performance that can more meaningfully evaluate the nation's transportation system.

8. Next Steps

To maintain the momentum created by this workshop and to ensure that the workshop's recommendations are carefully considered, the participants recommended that a task force with greater stakeholder involvement be convened to further refine and prioritize research needs. This task force should be charged with the tasks of: evaluating potential benefits of the proposed research programs from the perspectives of cost and practicality; implementing research programs by forging funding partnerships from agencies such as DOT, DOE, EPA, AASHTO, State Departments of Transportation, and the private sector; and evaluating research program results.

Keynote Address

Mort Downey, Deputy Secretary of Transportation

Thank you, Dr. Walton (Michael Walton, Chair of the workshop, Department of Civil Engineering faculty at the University of Texas, Austin), and good afternoon.

Today's "Dot-conomy"—based on real-time transactions and door-to-door overnight delivery—is a major driving force behind America's economic prosperity and it's here to stay, according to a recent White House report. (Source: Digital Economy 2000, the Commerce Department's third annual report on the information technology revolution and its impact on the economy, June 2000.)

Yes, E-commerce is booming. The U.S. Census reported that U.S. retail e-commerce sales reached $5.5 billion during the second quarter of this year, an increase of 5.3 percent from the first quarter.

Allen Greenspan and others have also informed us that a large share of U.S. economic gains of the past decade have been due to increased productivity spurred by the Internet and information technology. For consumers—at least those who have access to the Internet—electronic commerce usually means greater choice, faster service, and lower prices. For the nation, the digital age means more jobs, higher growth, lower inflation, and tremendous new investment that will strengthen our economy for the long term.

And, if you surf the Net, you can't help but notice the wealth of information that's available on-line—from medicine to mechanics—it's all there. One downside is that you can't get away with telling your spouse that you didn't have time to shop for an anniversary gift or card!

But, along with the positives there are unknowns and issues that need to be considered as we move further into the digital age.

In terms of transportation, the shipment volumes sent by air or truck are likely to grow. Pressures for infrastructure investment to build more runways or expand the highway network could be substantial.

How will this new electronic economy change the way we move goods, and what are the potential environmental impacts? What is government's underlying role with regard to the Internet and the digital economy? These are all good questions that deserve some exploration because the issues are so important to current and future generations.

Transportation is a key link in the E-commerce chain, and I believe that one of government's important roles is to gather data about potential impact so that we can better prepare for future investment in and planning for public infrastructure.

Government's Role in Cyberspace

President Clinton and Vice President Gore believe that government's role is to create an environment in which everyone can benefit from the Internet and E-commerce. One of government's most important roles is to ensure access for all Americans, and Vice President Gore has been leading that charge as we wire all schools and libraries in every community. And, thanks to the Vice President and to state and local school districts who took initiative, 63 percent of classrooms and 95 percent of schools are connected to the Internet.

The administration's budget for FY 2001 reflects a targeted approach to create digital inclusion. Our Technology Opportunities Program and proposed Connecting American Families program for home Internet access reflect our concerns that there is a role for the Federal government—providing grant funding to local groups, coming up with local solutions from non-profits, local governments and other organizations. And, we pass on the information about what those grantees learn to others.

We have also asked for money to spur broadband deployment and to fund community technology centers. We are meeting with mixed reviews so far in the appropriations process.

While E-commerce has become an important daily force in our domestic economy, the global telecommunications landscape is still somewhat fragmented. Fewer than 6 percent of Internet users currently reside in developing countries, which

account for 84 percent of the world's population (Source: Futurist, September). As more of the world's economic activity takes place digitally, the developing world is trying to catch up. Lack of telecommunications infrastructure is a serious barrier to the growth of the Internet and communications systems. Innovations such as mobile phones that provide Internet access where wired services are unavailable are helping to overcome the technological obstacles, but there are also political, business, cultural, and legal obstacles.

President Clinton and Vice President Gore view the digital divide, and digital inclusion, as more than a domestic issue and have been working to close the global digital divide.

During the G-8 Economic Summit this past July, President Clinton and industrialized world leaders committed to forming a Digital Opportunity Task Force to help coordinate government efforts to increase access to the Internet and electronic commerce. The Overseas Private Investment Corporation will have a new $200 million line of credit to support e-commerce and Digital Divide projects in developing countries. The Federal Communications Commission has been working with countries like Ghana, South Africa, Peru, Jamaica and Argentina to strengthen regulatory bodies that will pave the way for development of a telecommunications infrastructure in those regions.

The private sector, including companies like America Online, Cisco Systems, foundations and universities, are teaming up to contribute to projects aimed at closing the digital divide.

The legal status of and confidence in Internet transactions has also been an issue. Last June, President Clinton signed the "Electronic Signatures in Global and National Commerce Act. The Act provides a domestic and global uniform commercial legal framework that recognizes, facilitates, and enforces electronic transactions worldwide. The new law provides business with a predictable, technology-neutral legal environment while protecting consumers.

While we hear a lot about B2B (Business to Business) and B2C (Business to Consumer) activity on the Internet, we've also been working to strengthen the G2C (Government to Citizen) connections via the Internet.

This Administration has made E-Government a high priority of every agency in the federal government today. We are continuously looking for ways to use the Internet to provide useful information to citizens; to deliver service more efficiently; and to offer more opportunity for citizens to interact with government.

Last week, for example, we at DOT released our new, 5-year Strategic Plan which includes input received from citizens and DOT stakeholders on-line. A few years ago, DOT began putting proposed regulations on-line for access, then added the

opportunity for on-line comment filing. Recently, we reached a milestone when the 1 millionth page of material was added to our electronic docket file.

E-Commerce's Impact on the Business of Transportation

Many in the transportation community can envision a future in which technology makes it possible for the customer to track products or goods from the point of origin, on the ship, to the dock, to the train or truck, and to the final destination. We see a future where you can interact at any time, from anywhere, with the government at all levels—federal, state, local—to get information about transportation. The research community has played and should continue to play an important role in achieving this vision.

The Department of Transportation is strongly encouraging the transportation industry to find ways to use technology to make transportation intermodal and truly seamless as well as safer. We believe that together—with technological and human innovation—we can create a transportation system that will meet the demands of this new century.

Businesses are increasingly using the Internet to improve efficiency, and this has had a real impact on the transportation sector. Firms are moving their supply networks and sales channels on-line and participating in the on-line marketplaces. Freight companies are teaming up with software developers.

As more and more countries get connected, we'll see even more growth. Global electronic commerce could be worth $7 trillion to the global economy by 2004 (Source: White House Website document, source quoted: Industry Standard, Feb. 21, 2000).

According to a recent Volpe white paper, logistics expenditures have been cut in half as a result of incorporating information technology—declining to 10.5 percent in 1996 from 20 percent of GDP in 1960. Companies have re-engineered the supply-chain process to achieve just-in-time (JIT) inventory-control that cuts costs and increases speed and asset productivity.

Transportation is no longer the industry we have known in the past. Andy Grove of Intel said last year that: In five years, all companies will be Internet companies or they won't be companies at all. We see this in the news as FedEx and UPS team up with software companies like Oracle and Sun Microsystems to create more efficient shipping and logistics networks.

There is debate about whether rail will lose out to trucking and aviation in the digital economy, but I think it's too early to say for sure. The rail industry is beginning to set up new exchanges and to offer new tracking capabilities. Burlington Northern Sante Fe is leading the pack in electronic commerce, having developed an integrated, totally electronic exchange of information that makes shipment management more efficient. And, recently six North American railroads joined forces to create an open electronic exchange—a one-stop cyber shopping site linking buyers and sellers.

Amtrak is also pursuing a strong presence in the mail and small package delivery market, often in partnership with both major truck lines land the Class I freight railroads whose track it uses.

Time will tell whether all of this effort will be enough to improve rail service and win back shippers from the highway.

Conclusion

The forces that elevated the Web to the center stage of the global commercial transactions have been enabled by powerful communication and information networks. We have only begun to understand the transportation and economic impacts of the immense capabilities offered by the new IT systems and the Web.

E-commerce growth and prosperity are closely tied to the viability of the nation's domestic transportation network. We need to develop a better understanding of how e-commerce is impacting transportation demand, highway capacity, urban bottlenecks, intermodal market share, and the environment.

The "point and click" world of Web commerce has not eliminated the need for infrastructure. Some of the early e-tailers didn't fully comprehend the fact that you still need a safe and reliable transportation system to deliver the goods. (Remember the disappointed kids and frustrated parents last year when a dot.com couldn't deliver thousands of holiday toys on time?)

It's apparent that the United States will rely increasingly on technology—including information technology—to make transportation safer and more efficient. And government will continue to have a role in making these systems—information and transportation—safe, efficient and accessible for all Americans.

Keynote Remarks

Kelley S. Coyner, Administrator of Research Special Program Administration, USDOT

Thank you, Dr. Gilliland. On behalf of Secretary Slater and Deputy Secretary Downey, I am pleased to represent the Department and be a part of this important Workshop to discuss how transportation leaders can identify and develop the research and data needs to better assess impacts of the digital economy on our transportation system.

I thank Dr. (Mike) Walton, our Chair, for his leadership and vision to plan this very timely workshop. Mike, I know you live and work in my birth state of Texas and we Texans…. To Gil (Dr. Gilliland) and the Oak Ridge National Laboratory, to Tom Palmerlee and the Transportation Research Board, I thank you for your partnership to co-sponsor this workshop: the "Implications of the New Digital Economy on Transportation: Developing Research and Data Needs." I also thank the Academy for hosting us today. I especially want to thank Suzanne Schneider of the Academy for her work to facilitate Department of Transportation participation; my participation today and that of our Deputy Secretary, Mort Downey, tomorrow afternoon.

This two-day workshop brings us together-- stakeholders and experts from the public and private sectors of our transportation system. We welcome our Colleagues from the Federal government, our university partners, and our industry friends.

The Department is represented by several of our organizations:

1. from the Office of Intermodalism - Rich Biter
2. from the Research and Special Programs Administration - Edward Brigham of my staff,
3. from the Office of Secretary of Transportation/Policy Office – Jeanne O'Leary,
4. from the Federal Highway Administration – Scott Green,
5. from Federal Motor Carrier Safety – Doug McKelvey,
6. from BTS - Susan Lapham and Deborah Jones.

I have come this morning with a startling revelation, something no one in this room knows. I went to elementary school with Jeff Bezos… founder of Amazon.Com. We were in different grades – I sixth and he fourth and we both battled with the same terminal connected by modem to a mainframe in our math class. We learned "basic" and tried to teach it to our teachers. And that is as close as our lives intersected. He founded Amazon.Com and well, I didn't. I did not learn this until I read about our common heritage in the Washington Post.

What distinguished me and Jeff Bezos is the same thing that we determine your success in divining the implications of the new digital economy on transportation? Bezos and others like him are careful students… moment to moment. They have applied technology in ways that can revolutionize far more than the way we shop. They have connected consumers and businesses, they have mined data and exploited it, they have reshaped logistics …. Not just in one way but in many ways. How should you proceed to respond to research and harness digital commerce and communication to operate our transportation system - One that not only facilitates the economic growth fueled by Internet commerce, but one that in the making benefits from the Internet

economy and one that better serves the business and private citizens because of its own use of E-Commerce?

As you meet today and tomorrow to frame a research plan and to identify data needs, be certain to explore the following:

- What impact has E-commerce had transportation and logistics and what will it?
- What changes need to occur in transportation and logistics to facilitate E-commerce?
- What opportunities does E-commerce/Internet pose for the way we design, build and operate the transportation system?
- How are the benefits of E-commerce distributed and how can we ensure that all benefit?
- What impact has E-commerce had on transportation and logistics and what will it?

Anecdotal evidence points to stresses on the transportation infrastructure – congestion in Northern California is restricting FedEx air traffic, freight movement through the Chicago rail corridor causes nightmares for some of our industry partners, the New York air traffic corridors and other parts of the country experienced domestic passenger carrier hublocks due to the bad weather and the increased volume of summer travelers, and at our borders we have seen truck gridlock.

We know that patterns are changing as a result of electronic commerce. We see reductions in product cycle time, increases in business to business transactions, IT-driven improvements in productivity and the need for a more skilled workforce

Over the past few years we have seen the number of Internet users worldwide grow 50-fold from fewer than 5 million in 1993 to about 250 million today. These 250 million users are expected to grow by another 40 percent to 350 million in the next three or four years.

It is estimated that by 2003, the volume of web-based purchases will have grown more than ten-fold.

What do we do with this information? While we know as Secretary Slater says we cannot download an Omaha Steak or a LandsEnd sweater, does this explosion in on line purchase necessarily mean greater demand for transportation or does it mean a change in the nature of the demand? What do collaborative supply chains portend for transportation networks? What is the relationship between increase electronic communication and travel?

These are hotly contested issues. They are key to answering my second broad question.

- **What changes need to occur in transportation and logistics to facilitate E-commerce?**
- And you are not alone in looking at them.
  - The Department of Transportation and the Council on Competitiveness have been working to frame some of these issues. This week representatives of UPS, FedEx, U.S. Customs, and major carriers met to tease out some of these questions. We identified as key issues:
    - standard setting and interoperability,
    - early markers or leading indicators for transportation needs versus lagging indicators such as congestion.

  - We discussed how data might be mined to provide such indicators without impinging on proprietary data.
  - We expect to share a report on our discussions at Secretary Slater's International Transportation Summit in a few weeks.
- **What opportunities and challenges does E-commerce/Internet pose for the way we design, build and operate the transportation system?**
  - E-commerce is giving consumers greater choice, whether that means finding the product they want -- new or used – from a particular location, on the way to a location, or in production at one of many factories, or the ability to specify exactly what they want and having it built. Both private and public providers of transportation infrastructure and services have the chance to gain greater data about pricing, terms, margins -- it all will be out there on the Web. What should they do with that? Are they, particularly governmental agencies prepared to take advantage?
  - Can E-commerce models solve issues that increasingly challenge us? For example, could an E-Commerce site bring passengers together with transportation for those without vehicles or those who are physically unable to drive? What are the data, technical, and social prerequisites for success?
  - How can the Internet change the way we design, build, maintain, and operate our transportation systems? What have Internet reservation systems meant with respect to data that airlines have on load factors? There is some evidence to suggest that disintermediation has actually given airlines less sense of the total system loads and thus less ability to plan their individual air traffic operations. I raise this example because while you may find that E-commerce affords a great deal more data, I

encourage you to examine how who has access to that data shapes the operation of the transportation system.

  - Does the Internet afford new ways to design and build transportation infrastructure?
  - What does E-commerce mean in terms of the security of transportation systems and privacy of individual consumer information? The transparency provided by the Internet compounds issues we are already sensitive to in the Intelligent Transportation Systems.
  - As well as the information network capacity. Is the Web eliminating many trips or is it in fact creating new bottlenecks and capacity shortages in the domestic transportation network?
  - Do we have measurable data on the impact of e-commerce on our highways, airways, railways and waterways?
- **How are the benefits of E-commerce distributed and how can we ensure that all benefit?**
  - Much has been written on the digital divide particularly as it pertains to technology skills and Internet access. If we value access for all to mobility and economic opportunity, then we need to understand the implications of the digital divide for provision of transportation and employment within the transportation sector. What can we learn about this?
  - What are effective ways to bridge the digital divide in access to transportation and transportation employment? Are there best practices? What inhibits success?

Within TRB, others are charged with looking at transportation education and workforce needs. As you look at E-commerce, I encourage you to engage other relevant committees particularly in this area. And to look at private and public sector efforts to understand skill gaps and address them.

Our task in this workshop is to identify and reach consensus on these potential issues in order to develop a five-year roadmap to acquire a comprehensive understanding, and present quantitative estimates of the impacts of e-commerce on transportation. But do not rest there. In order for your work to benefit the transportation system, you must structure it so that it is collaborative with other efforts and so that you provide feedback to all levels of government and business as you go along. Every time I give a speech I try to think what can I say that the audience will remember. Hopefully it will not just that I went to the same elementary school as Jeff Bezos. I hope that you in research endeavors will take into account that you have the opportunity to combine data and analysis with imagination to do more than respond to E-commerce but to use E-commerce to enhance our world through transportation.

I envy you the opportunity you have in your work. And, I caution you as well. If you just research to confirm our current view of transportation you are missing the power of the Internet…. It is like the educator who employs the Internet to provide more drills and does not see the Internet as a way to improve teaching.

I wish you well and I look forward to keeping up with your progress.

Program

Workshop on
Implications of the New Digital Economy on Transportation:
Developing Research and Data Needs

September 14 and 15, 2000
National Academy of Sciences
2101 Constitution Avenue, Washington, D.C.
Welcome and Plenary Sessions in the Lecture Room. Breakouts in Rooms 250 and 280
Workshop Chair: C. Michael Walton, University of Texas-Austin

Thursday, September 14, 2000

7:30 - 8:00 am **Breakfast**

8:00 - 8:15 am **Welcome and Introduction of Keynote Speaker**
R.G. Gilliland, Associate Director, Oak Ridge National Laboratory

8:15 - 8:45 am **Keynote Address**
Kelley Coyner, Administrator, Research and Special Programs Administration, US DOT

8:45 - 10:00 am **Reviewing Recent Activities and Research**

Presentations

Measuring E-Business	T. Mesenbourg Assistant Director for Economic Programs Bureau of the Census
E-commerce and the Freight Industry	J. Barnehama President, Netshipping.com
The Digital Economy - *Changing the Shape of Transportation*	Frank Southworth Oak Ridge National Laboratory
Summary of TRB Executive Committee Meeting's *Discussions on E-Commerce*	G. Giuliano University of S. California

10:00 - 10:30 am **Break**

10:30 - 11:45 am **TRB Standing Committee Reports on Potential E-commerce Issues**

Moderator Christina S. Casgar, Chair of TRB Multimodal Freight Section (A1B00)

- A1B02 Freight Transp. Planning & Logistics — Christina S. Casgar
  A1B07 Urban Freight Transportation
- A1B05 Intermodal Freight Transport — William J. DeWitt
- A1B08 Ports & Channels — Theodore Prince
- A1B09 Freight Transportation Data — Lance R. Grenzeback
- A5003 Information Systems & Technology — Jeffrey Western
- A5006 International Trade and Transportation — Frank Southworth
- A5016 National Transportation Data Requirements — Alan E. Pisarski

11:45 am - 12:00 pm **Objectives of the Breakout Sessions** — C. Michael Walton

12:30 - 2:00 pm	**Breakout Session 1: Identification of Issues** (including a working lunch)	***Rooms 250 & 280***
	Breakout Group A: Leader Genevieve Giuliano, University of Southern CA	***Room 250***
	Breakout Group B: Leader Theodore Prince, Trangistics LLC	***Room 280***
2:00 - 2:30 pm	**Break**	
2:30 - 4:00 pm	**Breakout Session 2: Setting Priorities**	
4:00 - 5:00 pm	**Plenary Session 1: Interim Reports on Issues**	
	Breakout Group A Breakout Group B	
5:00 - 6:30 pm	**Reception**	***Rotunda***

Friday, September 15, 2000

8:00 - 8:30 am	**Breakfast**	***Breakout Rooms 250 & 280***
8:30 - 10:00 am	**Breakout Session 3: Building Consensus on Research Framework and Data Needs**	
10:00 - 10:30am	**Break**	
10:30 - 11:30 am	**Breakout Session 4: Outlining Next Steps**	
11:30 - 12:15 pm	**Lunch**	***Lecture Room Anteroom***
12:30 – 1:00 am	**Plenary Session 2:** Mortimer L. Downey, Deputy Secretary of Transportation *Understanding the Impact on the Digital Economy on Transportation*	
1:00 - 2:30 pm	**Summary Reports of Breakout Sessions** Breakout Group A Breakout Group B	
	1. Synthesis of Key Issues, Research and Data Needs	
	2. Processes and Next Steps	
	Respondents Panel Chair, Robert B. Shelton, Oak Ridge National Laboratory Arnold F. Wellman, Vice President, United Parcel Service * John Reeve, President, Reeve and Associates Richard Biter, Office of Intermodalism, U.S. DOT	
	Open Discussion	
2:30 - 2:45 pm	**Next Steps and Adjourn**	C. Michael Walton

* Invited

List of Participants

Oak Ridge National Laboratory
and
Transportation Research Board

Workshop on
Implications of the New Digital Economy on Transportation: Developing Research and Data Needs

National Academy of Sciences
2101 Constitution Avenue, Washington, D.C.

September 14-15, 2000

PARTICIPANTS

TRB * OAK RIDGE WORKSHOP ON
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DEVELOPING RESEARCH AND DATA NEEDS

The National Academies
2101 Constitution Avenue, NW, Washington, D.C.

September 14 and 15, 2000

Joe Barnehama
NETSHIPPING.COM, Inc.
1020 Madison Avenue
N.Y., NY 10021
212 717-8400
212 202 7912 FAX
e-mail: joelb@netshipping.com

Douglas Bauer
Executive Director, CETSEO
National Research Council
The National Academies
2101 Constitution Avenue, NW (HA280)
Washington, DC 20418
202 334-2400
202 334-3373 FAX
e-mail: dbauer@nas.edu

Richard Biter
Office of Intermodalism
400 7th Street SW, Room 10126, S-3
Washington, DC 20590
202 366-5781
202 366-0263 FAX
e-mail: richard.biter@ost.dot.gov

Joedy Cambridge
Senior Program Officer
Transportation Research Board & Marine Board, NRC
2101 Constitution Ave., NW (GR-326)
Washington, DC 20418
202 334-3205, 202 334-2003
202 334-2030 FAX
e-mail: jcambrid@nas.edu

Christina S. Casgar
Executive Director
Foundation of Intermodal Research & Education
7501 Greenway Center Drive, S-720
Greenbelt, MD 20770-6705
301 982-3400 Fax: 301 982-4815
e-mail: tina.casgar@intermodal.org

Eileen Collins
National Science Foundation
Division of Science Research Studies
4201 Wilson Blvd., Room 965
Arlington, VA 22230
703 292-7768
703 292-9091 FAX
e-mail: ecollins@nsf.gov

Kelley S. Coyner
Administrator
Research & Special Programs Administration
Department of Transportation
400 7th Street, SW., DRP-1
Washington, DC 20590
202 366-4433
202 366-3666 FAX
e-mail: kelley.coyner@rspa.dot.gov

William J. DeWitt
Teaching Professor & Exec. Dir., QUEST Program
University of Maryland
3411 Van Munching Hall
College Park, MD 20742-1815
301 405-0351
301 864-6777 (home office)
301 864-6668 (home FAX)
e-mail: wdewitt@rhsmith.umd.edu

Mortimer L. Downey
Deputy Secretary
U.S. Department of Transportation
Office of the Secretary
400 Seventh Street, SW. Room 10200
Washington, DC 20590
202 366-2222 Fax: 202 366-3937

Barbara M. Fraumeni
Chief Economist
Bureau of Economic Analysis
1441 L Street NW
Washington, DC 20230
202 606-9603
202 606-5311 FAX
e-mail: barbara.fraumeni@bes.doc.gov

Gil Gilliland
Oak Ridge National Laboratory
P. O. Box 2008, MS-6248
Oak Ridge, TN 37831-6248
865 574-9920
865 576-6118 FAX
e-mail: gillilandrg@ornl.gov

Genevieve Giuliano
Professor
School of Policy, Planning & Development
University of Southern California
Ralph & Goldy Lewis Hall
650 Childs Way
Los Angeles, CA 90089-0626
213 740-3956
213 740-6170 FAX
e-mail: giuliano@rcf-fs.usc.edu

Barry J. Glick
Principal
Carillon Ventures, LLC
2111 Wilson Blvd., Suite 700
Arlington, VA 22201
703 812-9164
703 351-9292 FAX
email: barry@carillon.com

Scott Greene
Office of Policy & Program Development
Federal Railroad Administration, RRP-13
400 7th Street, SW., Mail Stop 15
Washington, DC 20590
202 493-6408
202 493-6401 FAX
e-mail: scottgreene@fra.dot.gov

Lance Grenzeback
Senior Vice President
Cambridge Systematics, Inc.
150 Cambridge Park Drive, 4000
Cambridge, MA 02140
617 354-0167
617 354-1542 FAX
e-mail: lrg@camsys.com

Pat S. Hu
Director, Center for Transportation Analysis
Oak Ridge National Laboratory
P.O. Box 2008
Building 3156 MS-6073
Oak Ridge, TN 37831-6073
865 574-5284
865 574-3851 FAX
e-mail: hups@ornl.gov

Deborah Johnson
Maritime Transportation Program Mgr.
Bureau of Transportation Statistics, U.S. DOT
Office of Transportation Studies
400 Seventh St., SW.
Washington, DC 20590
202 366-8578
202366-3640 FAX
e-mail: deborah.johnson@bts.gov

Ed Kashuba
Chief, National Data Management
Federal Highway Administration HPPI-40
U.S. Department of Transportation
400 7th Street, SW., HPM-40
Washington, DC 20590
202 366-0160
202 366-7742 FAX
e-mail: ekashuba@fhwa.dot.gov

Elaine King
Sr. Program Officer
Transportation Research Board, NRC
The National Academies
2101 Constitution Avenue, NW , GR-326
Washington, DC 20418
202 334-3206
202 334-2030 FAX
e-mail: eking@nas.edu

Janet Kraus
Vice President
Mundle & Associates
1520 Locust Street, Suite 801
Philadelphia, PA 19102
215 731-9350
215 731-9354 FAX
e-mail: mundle@aol.com

Susan Lapham
Associate Director, Office of Statistical Programs
Bureau of Transportation Statistics
U.S. Department of Transportation
400 Seventh Street SW, Room 3430
Washington, DC 20590
202 366-9913
202 366-3640 FAX
e-mail: susan.lapham@bts.gov

Russ Lee
Director, Center for Energy & Environmental Analysis
Oak Ridge National Laboratory
P.O. Box 2008
Building 4500N, MS-6205
Oak Ridge, TN 37831-6205
865 576-6818
865 574-8272 FAX
e-mail: leerm@ornl.gov

Steve Lee
Department of Energy EE-3
Office of Energy Efficiency
1000 Independence Avenue, SW
Washington, DC 20585
202 586-0836
202 586-2056 FAX
e-mail: steven.lee@ee.doe.gov

Stephen C. Lockwood
Vice President
Parsons Brinckerhoff
3200 Tower Oaks Blvd.
Rockville, MD 20852
301 816-1848

Gary Maring
Director, Office of Freight Mgmt. & Operations
FHWA (HOFM-1), Room 3401
400 7th Street, SW.
HOFM, Room 3401
Washington, DC 20590
202 366-5018
202 366-3302 FAX
e-mail: gary.maring@fhwa.dot.gov

Tomas Mesenbourg
Assistant Director for Economic Programs
U.S. Bureau of Census
Room 2069-3
Washington, DC 20233
301 457-2932
301 457-3767 FAX
e-mail: thomas.l.mesenbourg.jr@census.gov

David Miller
Assistant Vice President
Parsons-Brinckerhoff
1528 Walnut St., Suite 400
Philadelphia, PA 10102-3604
215 790-2322
215 735-1462 FAX
e-mail: millerd@pbworld.com

Michael P. Onder
ITS Program Manager for CVO/Freight
U.S. DOT ITS Joint Program Office
400 Seventh St., SW, HOIT-1
Washington, DC 20590
202 366-0263 Fax: 202 366-3302
email: michael.onder@fhwa.dot.gov

Tom Palmerlee
Senior Program Officer
Transportation Research Board, NRC
The National Academies
2101 Constitution Avenue, NW
Washington, DC 20418
202 334-2907
202 334-2003 FAX
e-mail: palmerl@nas.edu

Rekha Pillai
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831
865 576-8048
865 574-3895 FAX
e-mail: pillairs@ornl.gov

Alan Pisarski
Consultant
6501 Waterway
Falls Church, VA 22044-1328
703 941-4257
703 941-5086 FAX
e-mail: pisarski@ix.netcom.com

Theodore Prince
Trangistics, LLC
9011 Arboretum Parkway, Suite 150
Richmond, VA 23236-3476
804 754-2291
804 754-2292 FAX
e-mail: tedprince@aol.com

John Reeve
President
Reeve & Associates
79 Wharf Lane
Yarmouth Port, MA 02675
508 362-9156
508 362-7992 FAX
e-mail: reeve@mediaone.net

Daniel Roth
FreightDesk.Com
4920 Norfolk Avenue
Bethesda, MD 20814
301 215-9512
301 215-6764 FAX
e-mail: droth@freightdesk.com

Rolf Schmitt
Transportation Specialist
Federal Highway Administration HOST-1
400 7th Street, SW., Suite 3404
Washington, DC 20590
202 366-9258
202 366-8712 FAX
e-mail: rolf.schmitt@bts.gov

Suzanne Schneider
Assistant Director
Transportation Research Board, NRC
2101 Constitution Avenue, NW, GR-324-C
Washington, DC 20418
202 334-2959
202 334-2920 FAX
e-mail: sschneid@nas.edu

Isaac Shafran
Senior Vice President
Louis Berger International, Inc.
1819 H Street NW, Suite 900
Washington, DC 20006
202 331-7775
202 293-0787 FAX
e-mail: ishafran@louisberger.com

Bob Shelton
Director, Energy Division
Oak Ridge National Laboratory
P.O. Box 2008
Building 4500N, MS-6187
Oak Ridge, TN 37831-6187
865 576-8176
865 574-7671 FAX
e-mail: sheltonrb@ornl.gov

Frank Southworth
Center for Transportation Analysis
Oak Ridge National Laboratory
P.O. Box 2008
Building 4500N, MS-6206
Oak Ridge, TN 37831-6206
865 576-8153
865 574-3895 FAX
e-mail: southworthf@ornl.gov

C. Michael Walton
E.H. Cockrell Centennial Chair in Engineering
University of Texas at Austin
Department of Civil Engineering
E. Cockrell Jr. Hall 6.3
Austin, Texas 78712-1076
512 471-1414
512 471-4995 FAX
e-mail: cmwalton@mail.utexas.edu

Arnold F. Wellman, Jr.
Vice President/Corporate Public Affairs
United Parcel Service
316 Pennsylvania Avenue SE, Suite 300
Washington, DC 20003
202 675-4251
202 675-3384
e-mail: awellman@ups.com

Jeffrey Western
Deputy Director
Bureau of Automation Services
Wisconsin DOT
4802 Sheboygan Ave., Room 201B
P.O. Box 7982
Madison, Wisconsin 53707-7982
608 264-8712
608 266-1515 FAX
e-mail: jeffrey.western@dot.state.wi.us

Frank Wilner
Editor
Traffic World Magazine
1230 National Press Bldg.
Washington, D.C. 20045
202 661-3371
202 661-3383 FAX
e-mail: frank_wilner@trafficworld.com

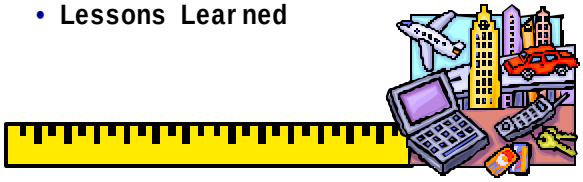
Measuring Electronic Business

Briefing for the Digital Economy Workshop

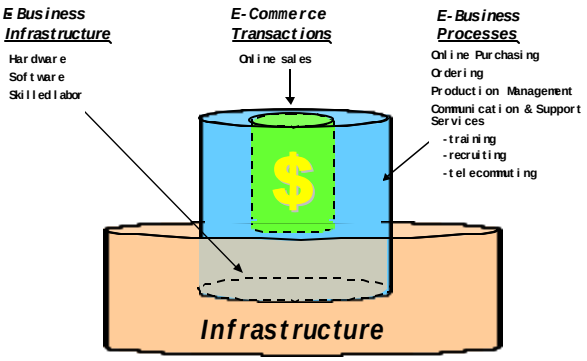
Presented by Tom Mesenbourg
tmesenbo@census.gov

Measuring E-Business

- E-Business Framework & Definitions
- E-Business Measurement Activities
  - FY 2000
  - FY 2001
- Lessons Learned



E-Economy Measurement Framework



E-Business Infrastructure Definition

E-business infrastructure is the share of total economic infrastructure used to support e-business processes and conduct e-commerce transactions.

Underlying Concepts
E-Business Infrastructure

- *Broadly defined to include expenditures for:*
  - Hardware
  - Application Software
  - Telecommunications
  - Purchased support services
  - Support services provided by the firm

Electronic Business Definition

Electronic business is any process that a business organization conducts over computer-mediated network channels.

Underlying Concepts
E-Business Processes

- Some examples include:
  - online purchasing
  - vendor managed inventory
  - production design, scheduling & control
  - online sales
  - payment processing
  - online logistics
  - customer management & support
  - employee training
  - recruiting
  - telecommuting

Underlying Concepts
E-Business Processes *(continued)*

- E-business processes of interest because
  - change the ways organizations operate and conduct business
  - lower transaction costs, improve efficiency
  - change relationships with suppliers and customers
  - change industry structure
  - affect economic measures

Electronic Commerce Definition

Electronic commerce is any transaction conducted over computer-mediated network channels that transfers ownership of, or rights to use goods or services.

Underlying Concepts
E-Commerce Transactions

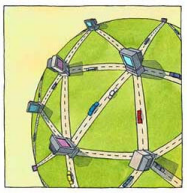
- Transaction is an event; won't measure all transactions
- E-commerce transactions occur within selected e-business processes
- Agreement between buyer and seller to transfer ownership or rights to use goods or services occurs over computer-mediated networks.

Underlying Concepts
E-Commerce Transactions *(continued)*

- Electronic agreement is the trigger for an e-commerce transaction, not the payment.
- Commitment and payment often occur concurrently for B2C transactions.
- Payment generally lags commitment in B2B transactions.
- Will not measure zero priced transactions

Computer-Mediated Networks Definition

Computer-mediated networks are electronically linked devices that communicate interactively over network channels.



Underlying Concepts
Computer-Mediated Networks

- *Electronic devices communicating interactively with other electronic devices, for example:*
  - computers
  - personal digital assistants
  - webTV
  - internet-enabled cellular phones
  - interactive telephone systems
- *Minimal human intervention*
- *Networks include internet, intranets, extranets, EDI networks, and telecommunication networks. Networks may be either open or closed.*

E-Business Measurement Activities
FY 2000

- Developed e-business framework and definitions
- Released first official measures of e-commerce retail sales
- Initiated e-business research activities

E-Business Measurement Activities
FY 2000

- Monthly Retail Survey
  - Internet sales collected starting October 1999
  - Quarterly data releases
  - First official measure of Holiday 1999 retail sales released March 2000
  - First quarter 2000 released 5/31/00
  - Second quarter 2000 released 8/31/00

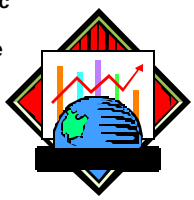
Estimated Quarterly U.S. Retail Sales: Total and E-Commerce

Period	Retail Sales		E-commerce as a Percent of Total Sales	Quarter-to-Quarter Percent Change	
	Total	E-commerce		Total Sales	E-Commerce
4th Quarter 1999	821,351	5,198	0.63	8.5	(NA)
1st Quarter 2000 r	747,934	5,240	0.70	-8.9	0.8
2nd Quarter 2000 p	815,685	5,518	0.68	9.1	5.3

E-Business Measurement Activities FY 2000 Research

Pembroke Consulting (Dr. Adam Fein)

- Documents evolving supply chain
- Implications for economic statistics programs
- Recommendations will be implemented in 2002 Economic Census



E-Business Measurement Activities FY 2001

FY 2001 E-business Budget Initiative ($8.5 million) provides:

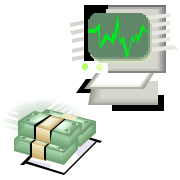
- E-commerce measures for most economic sectors:
  - manufacturing
  - retail & wholesale trade
  - services (+350 industries)
  - food services & accommodations
- Baseline measures of e-business process usage for manufacturing
- New surveys & expanded use of e-business methods by BOC

Census Bureau FY 2001 Survey Measures

- 1999 Annual Wholesale Trade Survey
  - E-commerce sales data for 1999 & 1998
  - E-business purchases indicator
- 1999 Annual Services Survey
  - E-commerce sales for 1999 & 1998
  - Product data for selected industries
- 1999 Accommodations & Food Services
  - E-commerce sales for 1999 & 1998

Census Bureau FY 2001 Survey Measures

- 1999 Annual Retail Trade Survey
  - For all industries:
    -
    -
  - Additional info for non-store retailers, computer & office supply stores:
    -
    -
    -



Census Bureau FY 2001 Survey Measures

- 1999 Annual Survey of Manufactures Supplement
  - Supplement to Plant Manager June 2000
  - E-commerce shipments as a percent of total
  - E-purchases as a percent of total purchases
  - Information on e-business process use -- now & future
  - Information on integration with suppliers & customers

E-Business Measurement Activities New Programs in FY 2001 Budget Initiative

- New surveys of electronic marketplaces and supply chain organizations
- E-commerce questions on Sept. 2001 Current Population Survey supplement
- Develop e-business infrastructure measures
- Electronic reporting capability expanded
  - Internet reporting for 5 million businesses in 2002 Economic Census; filing of export documents
- Establish customer relationship management group to work with largest U.S. companies

Lessons Learned

- Definitions and concepts are important
  - more examples the better
  - expect the unexpected
  - technical jargon vs. language clear to non-technicians

Lessons Learned (continued)

- Distinction between e-commerce transactions, e-business processes, and the e-business infrastructure not obvious
- Computer-mediated networks -- term not widely understood
  - extranets unfamiliar to some respondents
  - some firms question why we include EDI

Lessons Learned (continued)

- Measures can be problematic
  - e-commerce measures for services tougher
  - e-business processes measurement challenges
    - little experience
    - processes vary by sector
    - use measure straightforward
    - process impact/effects complicated
  - infrastructure measures -- just getting started

Lessons Learned (continued)

- Statistical unit/survey instruments place significant constraints on what you can collect
  - accountants not familiar with processes
  - records may not be available (ex. EDI sales)
  - infrastructure measures more likely available for company, not establishment
  - longstanding reporting arrangements can complicate delivery of targeted surveys

Lessons Learned (continued)

- NAICS 2002 does good job of identifying e-businesses, but won't fully describe what they are doing
- Start modestly, leverage existing resources
  - can do something with existing instruments
  - expansion will require additional resources
- Don't expect lots of feedback on measurement priorities or measures
  - rapid changes occurring
  - no definitive source of expertise

Questions and Answers

tmesenbo@census.gov

The Digital Economy: Changing the Shape of Transportation

Frank Southworth
Oak Ridge National Laboratory

Prepared for the Workshop on Implications of
the New Digital Economy on Transportation,
September 14-15, 2000
National Academy of Sciences, Washington D.C.

The Issue:

The Digital Economy is already with us, and developing very rapidly.

Changes to transportation services have already occurred.

Q1. How Can We Identify and Measure Such Impacts on Transportation?

Q2. How Can The Transportation Sector Get The Most Out of The Digital Revolution?

Areas of The Digital Economy Affecting Transportation:

- **Business-to-Business E-Commerce**
- **Business-to-Customer E-Commerce**
- **Consumer-to-Consumer E-Commerce**
- **Person-to-Person Interactions**

VERY rapid growth expected over next 5 years:

Some recent estimates:

> Possibly $ 1 trillion in business-to-business transactions today, growing to as high as $ 4.8 trillion by 2003

> Projected $8 billion business-to-customer industry (46% of Internet users made their first on-line purchase in second half of 1999)

> Customer- to- customer e-commerce --"virtual garage sales" (Ebay in 1999: 196.4 million items, worth $2.8 billion)

Rapid Growth In Internet Use Is Expected:

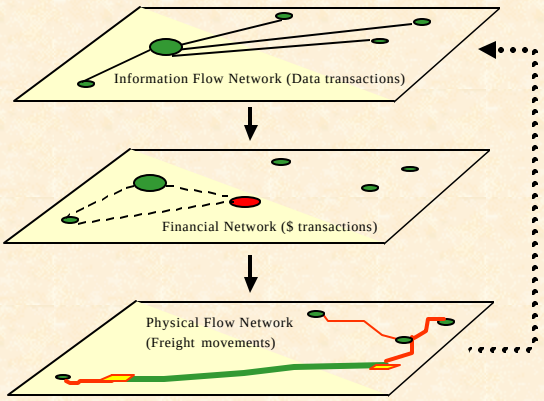
> Jan. 1999 ----- 182 million Internet users.
By 2005 ---> 766 million (?), 1 billion (?),..

> In the US: By 2005 ---> 7 out of every 10 adults on Internet regularly (Average U.S. Internet user is currently on-line > 12 hours /week: by 2005 ???)

> Abroad:By 2005---> 5 out of 10 adults using Internet regularly in W. Europe and Asia-Pacific Region

Potential Changes in Freight Transportation

- **Major Impacts on Supply Chain Networks:**
  - **changing business alliances**
  - **vertical integration**
  - **door-to-door INTERMODAL transportation**
  - **more informed, and more global trade**
  - **transportation vs. other logistic costs**
  - **lower unit transport costs (?)**



Potential Changes in Passenger Travel

- **Changes in Household Travel Activity Patterns**
  - **Continued erosion of the traditional 9-to-5 workday / school day (?)**
  - **"Virtual Accessibility" vs. Travel**
- **Equity Issues**
  - **Is there a growing "Digital Divide" ?**

The Digital Economy's Effects on Transportation: A look at Seven Issues:

1. **Cost**
2. **Safety**
3. **Security**
4. **Energy & Environment**
5. **Land Use**
6. **Equity**
7. **Planning**

SUMMARY:

- **Cyber-Space is evolving rapidly, more so than than any of the previous transportation impacting revolutions**
- **A great deal of UNCERTAINTY exists over the digital economy's likely impacts on transportation.**
- **Significant R&D activity is needed if we are to make the most of the opportunities offered by the digital revolution.**

Data Needs include:

> Data on the volume of digital commerce

> Data on the responses of freight shippers, carriers and brokers (inc. 3PLs)

> Data on the responses of individuals/households

> Data on the evolution of Information Technologies

HOW Collected? -- On-line surveys, CATI surveys, Panels...

Summary

E-Commerce and Transportation

June 2000 "Red Meat Session"

TRB Executive Committee Meeting

Genevieve Giuliano
School of Policy, Planning and Development
University of Southern California

E-Commerce and Transport: Basic Factors

- Information Technology revolution
  - declining costs of access to information, processing information ö use information to reduce costs, increase productivity
- Reduced information costs = reduced transaction costs
- IT allows a new round of "gains from trade"
  - comparative advantage
  - globalization
- IT as enabling, not deterministic

IT, Globalization and Commerce

- Comparative advantage
  - exploit economies worldwide
  - global networks
- Competition
  - deflationary pressure
  - rapid change
  - consolidation/fragmentation
  - consumer "pull"

The "e" in e-Commerce

- Restructures the buyer - seller relationship
  - customization
  - buyer - portal - e-retailer - distributor - manufacturer
- New technology ö new products, processes, linkages ö 2PLs, 3PLs, exchanges, VSPs, etc.
- Supply chain efficiency as response to competitive constraints on prices
  - most rapid growth in B2B commerce
  - reduced inventory strategies

The Synergistic Role of Transport

- Globalization as dependent on efficient transport as IT
- Distributed production, out-sourcing, just-in-time delivery
- Trends in air passenger transport, air freight, ground freight

Issues: Freight Transport Industry

- Consolidation
  - potential benefits of consolidation
  - longer term impacts on prices, barriers to entry
- Emergence of intermodal firms?
- Labor issues
  - labor supply
  - work rules

Issues: Transportation Facilities

- Intermodal connections
  - nodes as bottlenecks
  - how to integrate operation of different modes
- What is the source of system inefficiencies?
- Congestion and importance of reliability
- How to plan for highly uncertain future?
- What is a flexible system?
  - IT, pricing, multi-functions
- Economic obsolescence vs infrastructure life

Issues: People

- The 7/24 world of the new economy
  - social and cultural constraints
  - household activity patterns
  - your supply chain constraint is my quality of life issue
- People are not packages
  - no system optimization
- IT gives more choices ö behavior less predictable

Issues: Complement vs Substitute

- Globalization = more interaction = more transport of goods and people
- Supply chain efficiency may reduce transport input per unit output, but more output
- Conversion of hard goods to virtual goods
- Telecommuting, remote offices, mobile offices

Issues: Spatial Structure

- What do changes in workplace imply?
- Amenity-driven location decisions
- Flexible firms, rapid change suggest more "footloose" activities
- What social changes are taking place, and what do they imply?
  - Shopping patterns, recreation

Issues: Institutions

- Disconnect between transportation system users (mostly private) and suppliers (mostly public)
  - profit motive/survival provides clear objective function
  - serving diverse public is fuzzy and subject to change
  - transport system as exogenous

Issues: Institutions

- Mismatch between institutional decision-making (glacial speed) and rate of change in economy (internet speed)
  - complexity of planning process
  - modal divisions
  - politics
  - opportunities
- Predatory competition among regions (not new)
  - can we prevent inefficient investments?

DRAFT WHITE PAPER

Potential Effects of the Digital Economy on Transportation

Michael Hilliard
Frank Southworth
Rekha Pillai
David Middendorf

Center for Transportation Analysis
Oak Ridge National Laboratory

July 2000

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
managed by
UT-BATTELLE, LLC
for the
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under contract DE-AC05-00OR22725

1. Purpose of this Paper

The driving force behind the nation's economic growth over the last 10 years has been the increased productivity of the workforce, and this increased productivity relied heavily on the structural and procedural changes made possible by the digital economy. It is not yet easy to quantify and predict the growth and changes in demands that will be placed on the transportation system because of the globally connected, digitally supported economy, but we must begin to try to envision this future. Historically, decades were required to implement substantial changes to transportation systems' infrastructures and policies. However, the digital economy is changing dramatically on a monthly basis. The transportation system must adapt quickly to continue keeping pace with the dramatic economic growth fueled by the digital economy. It is imperative that the increasing demands on transportation systems be met rapidly and reliably. This will require transportation systems to continuously adapt to customers' changing demands to avoid creating a transportation-based bottleneck that might slow the growth of electronic commerce. We also must avoid negative effects to society and the environment from changes in transportation patterns. It is imperative that we begin research that will help determine transportation policy and investment decisions on local, regional, national, and global scales in the near future.

We begin the formulation of a research agenda by discussing the primary attributes of the digital economy that affect the transportation sector, and we provide initial estimates of the current scale and growth rates of these electronic exchanges. These new ways of doing business change the demand and growth pattern for transportation; therefore, we must review the current and potential changes in freight and passenger transportation likely to result from the changes in demand. In turn, these changes in transportation patterns affect society in numerous ways. This paper considers the changes in terms of six topics: cost, safety, security, energy and environment, land use, and equity. Issues identified under these topics also challenge the transportation planning process. Many of these issues overlap or require similar data and models, suggesting an integrated research approach. We offer this set of issues as the starting point for a discussion of that integrated research agenda.

2. Attributes of the Digital Economy that Affect Transportation

The entry cost for worldwide marketing has become affordable to the smallest company (or individual). For the cost of space on a Web server and some design effort, a company can advertise its product to the world. This global marketplace can be divided into three roles.

1. Business-to-business is by far the largest component of the digital marketplace: estimates range from less than $0.1 trillion to as much as $1.0 trillion in transactions in 1998, forecast to rise to $4.8 trillion dollars or higher by as early as 2003 (FHWA, 2000; Southworth, 2000). In numerous industries, on-line bidding provides competitive markets between small and large suppliers on a worldwide basis.
2. The business-to-customer role is well publicized by the "dot coms" of the world, but it is actually just beginning to take hold. Approximately 47% of the individuals with home access to the Internet have made at least one purchase; 46% of them made their first on-line purchase in the last six months of 1999 (Nie, 2000). This segment could grow to $80 billion in transactions per year (Southworth, 2000). We can anticipate significant growth spurts in this area as Europe, Japan, and China expand the connectivity for their populations. Easier interfaces with e-commerce sites (particularly the use of voice recognition software in countries with character-based languages, such as Japan and China, where the keyboard is a particularly difficult interface) may provide a sudden expansion of the marketplace.
3. The consumer-to-consumer role, a trend toward globalization or at least nationalization of the classic garage sale/classifieds, could have an interesting effect on reuse of items and on the need for transportation of purchased items. For example, Ebay, the largest online auction service, listed 129.6 million items ranging from personal used items and collectibles to automobiles, to artwork, and facilitated gross merchandise sales of $2.8 billion in 1999 (Ebay annual report).

The digital economy is one of the empowering technologies changing current methods of manufacturing (US DOC, 1999). It provides the information flow that allows companies to manage supply chains, to develop lean manufacturing processes, and to coordinate global logistics. Information-based employees are able to work from any location, avoiding a commute to a central location and being accessible to employers at any time. Using the Internet, buyers and sellers are confronted with a new and sometimes bewildering collection of options. Goods that can be digitized (documents, photographs, software, music, newspapers, books, etc.) can be distributed directly over the network without any physical movement. Many services that used to require a physical presence, such as banking and insurance, can now be provided electronically. As users gain trust in the technology, the variety of on-line services will grow rapidly. How this growth will affect personal travel (working, shopping, playing) remains to be seen. As for freight transportation, most goods still must be transported physically, and the interface between the electronic marketplace and the world of logistics is a new challenge for many companies. While technology is already speeding up some of the "paperwork" associated with transactions (even international transactions), the desire by all of the companies involved for rapid and reliable door-to-door visibility of cargo raises difficult issues. The government's role will be to encourage and monitor fair business practices and to facilitate the development of policies, procedures, and standards for interaction.

3. Potential Changes in Transportation Sector

3.1 Freight Movement

The Internet both facilitates and encourages interaction, and the more human beings interact, the more business they do and the more freight they are likely to generate. Recent advances in electronic commerce are creating interactions between suppliers and customers around the globe. The comparatively low cost of acquiring knowledge about new products and markets via cyberspace is leading to a global commerce revolution that brings with it new types of business

competition and new types of business arrangements. Patterns of domestic and international trade are changing in response to these developments, putting new demands on the nation's freight transportation system. The geography, and therefore the economics, of freight movement must change as a result. On the one hand, additional freight activity, measured in both ton-miles and dollar-miles transported, is likely to result from buyers finding more cost- effective suppliers outside their own regions or countries. On the other hand, better (more accurate, more timely) information on suppliers, markets, and their transportation requirements can lead to more efficient use of transportation assets. In some cases, transportation can be avoided completely, as in the electronic delivery of software, music, or documents. How these and other competing forces play themselves out will become a major determinant of freight traffic growth over the next two decades.

Recent estimates are that as much as 90% of electronic commerce by value and by volume takes the form of business-to-business transactions. The major effect of the digital revolution on this business-to-business commerce is the establishment of new and more profitable *supply chain networks*—chains of relationships that integrate and organize the movement of goods among suppliers, manufacturers, distributors, retailers, and consumers (Handfield and Nichols, 1999; National Research Council, 2000). At each transition in the process, the companies involved must trade off the cost of transportation against the cost of materials, manufacturing, and inventory. Where this tradeoff favors maintaining smaller inventories, at the expense of necessarily more reliable just-in-time transportation, a greater demand for smaller, more frequent deliveries may occur within the transportation system. This demand in turn suggests increases in aggregate vehicle miles of travel (with concomitant fuel consumption and emissions production). These e-commerce–induced changes are already interacting with other changes occurring in production as well as distribution. Many per-unit distribution costs have been lowered in recent years as a result of technological advances in line haul shipping and cargo handling, as well as of the advances taking place in cyberspace. The spread of the digital economy acts as both a catalyst for and a component of these other advances in economic production. An important key to future reductions in freight logistics costs may be new sorts of business alliances that are encouraged by the economies to be

gained by sharing certain types of business information within (appropriately brokered and patrolled) sections of cyberspace. How will these new Internet/intranet–connected e-partnerships reshape trade and hence the demands for freight transportation a decade or more from now? Recent developments include vertical integration of transportation providers, increasingly through the use of third-party logistics companies. The goal of this integration is to provide seamless door-to-door pickup and delivery services, often involving two or more modes of transportation. Perhaps the earliest success story of this type has been the small package delivery industry. Issues to be resolved within the transportation industry itself include finding the most economical means of moving goods within better-planned but also rapidly evolving product supply chains. Keys to success are likely to include better use of intermodal transportation options—use that allows carriers to realize the maximum benefits of using each mode in its most economical context. Modern real-time information systems can play an important role here by reducing both the transaction costs and the scheduling delays that are all too frequent at intermodal transfer points. These delays are an especially acute problem when freight has to cross national boundaries. At such boundaries (notably at seaports, airports and border crossings), freight is subjected to tariffs and to safety, security, environmental, and other inspections. Government faces a challenge in this area to facilitate the rapid throughput of freight by using the latest information technologies to carry out its public obligations without imposing additional costs on the private sector (Kopicki, 1998; OECD, 1998).

Some significant changes in supply chain networks are also occurring as a result of the steady growth in business-to-customer commerce. This is an area we can also expect to grow significantly over the next decade, as individuals become more comfortable with the idea of paying for as well as ordering goods and services over the Internet. The bulk of business-to-customer transactions on the Internet last year were for smaller items (books, CDs, etc.) that can be shipped by small-parcel carrier and by premium delivery service to meet time-sensitive demands. Similarly, customer-to-customer direct commerce, while small by comparison, also seems likely to reinforce this trend toward more transportation-intensive forms of small-parcel delivery. This trend raises

environmental as well as safety issues as pickup and delivery trucks become more common visitors to residential or mixed-land-use neighborhoods.

3.2 Passenger Movements

Just as the digital revolution is making its presence felt in freight transportation through the evolution of supply chain networks, so will its presence be felt in personal travel through changes in the household's daily and weekly travel activity pattern. Many people expect the digital revolution to change lifestyles in significant ways. One change that may occur is use of the Internet to purchase goods and services. Another is its use as an entertainment medium. A third is the use of in-home computers or telework centers to change both the frequency and location of the daily commute. While the American public has shown considerable tolerance of increasingly heavy rush-hour traffic within our largest cities, it has yet to decide what to do with the new set of travel/no-travel options offered by shopping, playing, and working in cyberspace.

The next few years of Internet use may prove crucial to just how household travel patterns evolve and eventually settle down to the new reality of a cyber-connected society. Both trip frequencies and trip lengths are likely to be affected. So may choices of travel mode and trip purpose. For example, will ready access to the latest information on discounted air, rail, and cruise ship fares increase the volume of long-distance non-work travel? Or will it simply make such travel more cost-effective for passengers? Will the ability to work at home catch on in much greater numbers than at the present? Will audiovisual home entertainment technology reduce the number of out-of-home entertainment trips? Will on-line shopping grow sufficiently to generate a sizeable at-home grocery and durable product delivery industry? How will families who take advantage of cyberspace to reduce their otherwise necessary travel activity use this freed-up time on other activities? Will they, for example, engage in more discretionary forms of travel involving different modes and different traveling arrangements? Once the notion is relaxed of a traditional family unit, acting around a fixed 9-to-5 workday and similar schoolday schedule, the opportunities for new

types of travel patterns to emerge multiply rapidly. If children in the near future carry watch-sized or palm-sized, Internet-connected computers with them, how will this technology affect parental monitoring, family interaction, and joint activity planning; how will those changes in turn affect trip scheduling and trip chaining?

A second important aspect of this evolution is access to the Internet itself. There is legitimate concern at present about equity of access to the Internet. Certain groups within our society are currently outside its direct influence, including the poor, many elderly and disabled persons, and many persons with limited education. On the other hand, possible benefits from the digital revolution include the opportunity to link people in the suburbs, in remote rural locations, or in resource-poor neighborhoods into common on-line communities. Initial surveys indicate that the Internet can serve as a great leveler by providing access to information on all facets of life. Opportunities in the transportation sector include on-line ordering to allow consolidated scheduling of pickup and delivery services to remote and low-density locations. These services could include demand-responsive public transit and third-party vanpools, as well as otherwise uneconomical grocery and durable product delivery services. Can new and more flexible forms of demand-responsive transit service evolve to fulfill the mobility needs of would-be non-drivers?

4. Issues

4.1 Cost

Internet technologies help deliver transportation-based information universally and economically and enable a potentially exponential growth of benefits to users of the U.S. transportation system. Innovative strategies are needed to finance the development and improvement of transportation infrastructures and services both nationally and globally, and without bias regarding transport mode or geographical boundaries. A goal of Internet/intranet/extranet technologies is the concept of "an open virtual organization." Transportation will be an integral part of these virtual organizations, along with marketing, sales, accounting, purchasing, order filling, and manufacturing. Transportation systems software needs the capability to capture the flow of information, material, and people that can be used by organizations to better manage their supply chains. A major challenge that an "open virtual organization" faces is determining total supply-chain costs. As an integral part of such organizations, transportation will have a major adverse impact on the bottom line if it is not managed efficiently.

The introduction of a myriad of e-commerce innovations into the freight transportation system can be expected to reduce the unit costs of transportation. These e-commerce innovations will be equivalent, in price, to technological improvements in freight transportation itself. They will enable the transport of a quantity of freight the same distance at a lower unit cost—or a longer distance at the same cost— than under the older technology. The changes in final delivered costs will in turn change the relative as well as absolute costs of goods produced in different locations. These changes will in turn create the potential to induce changes in the levels of production at these different and competing locations. Some of these changes are likely to come about because the Internet or its successors provide greater visibility, on a global scale, of a company's, a region's, or a country's natural advantages in the trading of specific commodities.

Issues:

· How does the transportation system add value to the supply chain, and who benefits from this value and what level? Where should one invest next to improve value?

· How do we get government to be more responsive to state, local, and individual transportation needs so that all parties understand the benefits of a strategy and its execution?

· How can a decision-making environment be created that moves organizations from "partnership-based decision making" toward "cross-enterprise decision making" where decisions are made to optimize benefits for all parties across the virtual organization?

· What quantitative models are necessary to capture and evaluate "inter-enterprise" strategies for decision making in the new environment?

4.2 Safety

The greatest and most obvious impact the new digital economy will have on the U.S. transportation system is the change in *demand* for freight transportation and, to a lesser extent, the change in passenger transportation patterns. The change in demand for freight transportation has a number of safety implications. First, freight traffic will likely increase, subjecting the public to more trucks on the roads. Research suggests that a greater percentage of trucks in traffic will have a profoundly adverse impact on highway safety. On the other hand, if part of the effect of the digital economy is that certain trips can be completely avoided (as a result of electronic delivery of software, music, or documents, for example), then the question is the extent to which this *decreased* demand for freight transportation will counterbalance the *increased* demand for freight transportation spurred by other parts of the digital economy.

Second, although the monetary value of business-to-customer transactions is less substantial than that of business-to-business transactions, business-to-customer interaction has very different safety implications. For example, to what extent will the digital economy expand the final "delivery" points of goods beyond central business districts and retail centers into urban and residential areas? How will business-to-customer interactions impact bicycle and pedestrian safety in urban and residential areas? How should residential streets and local roads be modified to handle the potentially greater volume of trucks?

Issues:

· If increased demand for freight transportation leads to increased demand for intermodal facilities (e.g., airports, sea ports), are some facilities more susceptible to unsafe operating conditions than others? How should these facilities be identified? What actions should be implemented to prepare these facilities?

· If increased demand for freight transportation results in increased demand for on-time delivery, is our nation's truck-stop infrastructure capable of handling these increased truck volumes? Are the hours-of-service regulations resilient enough to accommodate increased demand for on-time delivery?

· Would an increased demand for freight transportation subject our residential streets and local roads to greater traffic hazards? What are these traffic hazards? What actions and policies should be implemented to mitigate these hazards?

4.3 Security

As the effects of computer viruses and other hacker activities make front page news, the U.S. population learns what industry and government analysts have known for years—a threat to

our computing systems is a threat to our economy. As we use the digital economy to increase our productivity, we also create new points of vulnerability; but if we design systems to be robust, we can also develop tools that help us recover from attacks or natural disasters. The major physical points of transportation system vulnerability, which are linked to digital communication and computing, include centralized control centers (air traffic control, railroad dispatching centers, highway traffic control centers, fleet operations centers), airports, and seaports. International trade routes may be particularly vulnerable in the United States because 25 seaports handle 97% of the containerized shipping and 90% of the air cargo moves through 15 airports (Southworth, 1997).

The other area of vulnerability is in the communication systems used by industry and government to relay orders, schedules, and shipping directions to other companies and customers within supply chain networks. There is a paradox associated with e-commerce: to be efficient the systems must be publicly accessible, based on industry standards, and integrated across the supply chain; but this accessibility provides entry points for threats, the standards provide well-known points of weakness, and the integration allows an attack or failure in one system to shut down an entire network of systems. The move to lower on-hand inventories increases the effect of a disruption because raw material and critical components would run out within a few days. To design systems that meet the needs of supply chains but maintain adequate security is a major challenge.

When we consider the national defense component of security, we note that our military forces are affected by changes in transportation patterns. With the decrease in forces located overseas, and the increased demands on the military to respond to a wide range of crises, small to medium-sized deployments are occurring regularly. Major deployments (such as Desert Storm) require significant use of commercial transportation assets. Commercial rail cars, cargo ships, cargo aircraft and passenger aircraft are required to move the forces overseas. The increasing emphasis on lean logistics in the commercial world and the high utilization rates for trucks and rail cars create a situation in which a surge of demand by the military will quickly be felt in the commercial world in

the form of delays and lack of transportation support. Many carriers are under contracts with the Department of Defense and must provide the assets in time of crisis. Others feel obligated to support the national interest. This lack of surge capability without cutting into the economic vitality of the nation is a concern at the highest levels of the military (Brown et al., 2000).

Some of the advances of the digital economy, however, enable a more rapid recovery from such disasters or attacks by providing the capability to reroute traffic more easily to restore safe and efficient operation and the capability to track shipments and vehicles to provide real-time status updates. Business, the transportation industry, and the government will have to work closely together to assess risks, develop means to mitigate the risks, and be prepared to recover from cyber-attacks. The President's Commission on Critical Infrastructure Protection has made some initial efforts in this direction (Southworth, 1997).

Issues:

· How do we develop control systems that are able to interact with an open-architecture network but are secure from malicious threats?

· How do we develop redundancy into control systems so that the loss of any single component of the system does not compromise the entire system?

· How can we use the technologies being developed for commercial practices to detect and recover from natural disasters or terrorist/hacker events?

· What are the major sets of requirements for military transportation, and how would a major deployment affect the commercial world? Are there actions we can take now to mitigate these effects?

4.4 Energy and Environment

What does this rapid increase in e-commerce mean for energy consumption? While energy savings per se do not drive companies to use the Internet, lower costs and higher profits do. One way to obtain lower costs in the highly competitive freight transportation industry is to cut fuel costs. The challenge facing freight carriers is to make the correct trade-off between speed and reliability of service, on the one hand, and the operating costs, including fuel costs, of providing speed and reliability on the other. The difficulty in forecasting the future energy demands from the transportation sector results from the logistical complexities involved in these competing forces.

Faster today usually means less fuel-efficient. Faster and guaranteed (on-time delivery) can also mean more vehicle miles of travel by vehicles carrying lower payloads. Many vehicles, especially within urban areas, are carrying only partial loads. Will more complete information lead eventually to more efficient use of transportation assets? Will the ability to use real-time in-vehicle communication in conjunction with real-time data on stock availability and the latest customer demands allow significant savings in vehicle fleet utilization costs? And will such savings be gained in part from, or at the expense of, additional vehicle miles of travel and fuel use? The solution to these problems is likely to be found in better use of the Internet itself, including the data and technology necessary to track inventory levels, to locate and reschedule vehicle assets, and to allocate manpower to better match customer needs. We should expect more effective use of these real-time data as we adapt to life with the Internet. For example, we should be able to retrieve information on the most fuel-efficient forms of transportation for specific movement needs.

The digital economy could also affect future traffic volumes and patterns by acting as a substitute for travel, notably as an alternative to the daily two-way commute. A recent estimate of the telecommuting market in the United States put it as high as 50 million persons by 2030. In the mid-1990s, it was probably around 2 million workers, and not all of those telecommuted on a full-time, five-day-a-week basis (see US DOT, 1993; US DOE, 1994). How telecommuting, as well

as teleshopping, telebanking and teleconferencing, affects energy consumption will depend not only on actual market penetration rates, but also on how telecommuters change their other travel habits and how they subsequently view the importance of travel distances in choosing houses, as well as workplaces. Will less frequent but longer commutes compensate for currently shorter but more-frequent home-to-work round trips? Will telework centers emerge in the suburbs? The limited success of telework centers should not as yet be considered the final story (remembering the initially slow progress of mobile phones into the marketplace). The emergence of networked work centers in major airports is an indication that the concept of supporting telecommuting with shared resources is viable. Each of these trends would seem to support rather than counteract urban sprawl (see Section 3.9) and hence the potential for counter-balancing increases in the length of trips. Romm et al. (1999) provide a good review of these trends and their possible effects on energy usage.

The digital economy's linkage to both passenger and goods movements offers the best means yet for understanding how different types of transport services affect our environment. A dream of many transport economists is the ability to internalize in an accurate and equitable manner the external costs of transportation. These "externalities" include air, noise, and groundwater pollution; fossil fuel consumption; and aspects of both passenger and cargo safety. Real-time in-vehicle and along-the-highway traffic monitoring devices now promise a future in which detailed spatial and temporal data on traffic movements both within and between cities are plentiful. The availability of this intelligent transportation system technology is a major reason for increased interest in travel pricing mechanisms as a means of capturing these travel externalities. Having travelers pay their true costs of driving on publicly funded roads has some theoretical merit. Possibilities include travel fees based on point (e.g., toll plaza), area, distance, duration, and time of day, as well as parking fees based on time of arrival and departure, and duration (see May, 1994). How dynamic fees might alter travel patterns is currently little understood. Before these payment schemes can be introduced within the United States, however, issues of equity in the access to road space will need to be addressed. At least a better understanding of the damage done to highways by heavy truck

transportation ought to be possible, leading to better maintenance planning. Of value to the truckers themselves will be accurate, up-to-date information on the location and severity of traffic bottlenecks, notably time-consuming, accident-induced traffic congestion.

Issues:

- What are the relationships between telecommuting and energy usage?

- How can the federal government identify and then encourage the use of energy-efficient modes of just-in-time goods delivery service?

- How will we manage and protect the sensor data gathered as they become more personal or sensitive (individual travel activity, toll payments, commercial activity)?

- Can demand-based tolls significantly affect traffic patterns?

4.5 Land Use

How will the digital economy change our cities 20 or more years from now? E-commerce encourages new relationships between the economics of production, distribution, and warehousing. These relationships in turn will alter the geography of business, which in turn will alter the needs for new roads, new transit services, and new freight pick-up and delivery services. A key question for regional planners is whether the digital economy will encourage or discourage the geographic expansion of our cities. As companies begin to generate a higher percentage of their sales via cyber-space they will become increasingly "location-neutral." Will this encourage a further spread of office activity, warehousing, and other activities into the suburbs?

It has been speculated, for example, that one of the economies to be gained from real-time information technology will be the elimination of small branch offices and stores. Cyber-banking, for example, might lead to the elimination of many local banks, and reductions in the number of local

retail outlets and overall retail floor space are both possible outcomes of e-retailing. Walk-in traffic may be of much less significance than it is today.

Residential neighborhoods may also change. Neighborhoods crossed by large numbers of just-in-time, small package delivery trucks may induce changes in street layouts and increasingly strict controls over the local movements of freight vehicles. It is currently unclear what significant growth in such to-the-home goods delivery services (see Marker and Goulias, 1999) will do to residential preferences. The nature of retail locations may also change, with significant implications for one of the fastest growing areas of trip-making in recent years—shopping. Will the large, multi-purpose shopping malls of today remain as popular in 20 or 30 years time, or will home delivery or direct-to-the-customer wholesale warehouse pickup make them less common (remember how uncommon they were only 40 years ago). The "brick and mortar" establishments are beginning to feel a threat. During the 1999 Christmas season, the St. Louis Galleria attempted to prohibit any in-store "signs, insignias, decals or other advertising or display devices which promote and encourage the purchase of merchandise via e-commerce" in its 170 retail tenants (WSJ, Nov 24, 1999).

Some changes in the functional relationships between urban and rural communities can also be expected. What closer cyber-ties between central versus peripheral communities will mean for urban expansion needs to be explored. Over the past 200 years, proximity first to a river crossing, then to a railroad, and subsequently to an interstate highway interchange played a major role in the economic prosperity of rural communities. In contrast, the information superhighway may prove less discriminating in its effects on place. Accessibility is now determined in part on the basis of Internet connectivity. With greater access to global market information, some rurally based companies may be able to increase their customer bases. This may lead to an increase in rural truck traffic. Alternatively, many "rural businesses" may simply refer to rurally located employees making cyber-deals that cause goods to be manufactured in and transported between urban locations.

Issues:

· Will the digital economy support urban sprawl, be neutral to sprawl, or encourage a return to more compact cities?

· How will e-commerce affect specific types of business location decisions, notably site agglomeration versus site dispersion?

· How will telecommuting affect residential location decisions?

· How will cyber-interaction between rural and urban residents affect rural community growth?

· How will the digital economy affect daily travel activity patterns, notably working (telecommuting, teleconferencing), shopping (teleshopping), educational (distance-based learning), and social/recreational (e-mail, real-time audio-video communication) interactions?

4.6 Equity

Digital technologies have the potential to make access to transportation services more equitable. On the other hand, they also have the potential to create a growing divide between those with information and those without access to it. Groups in society that are susceptible to being left behind by the digital technology revolution are those traditionally faced with such situations—areas with larger populations of low-income and poorly educated families, as well as the elderly, minority groups, and those with disabilities. Possible benefits from the digital revolution include the opportunity to link people in these groups more closely with the rest of the community, wherever they live: in suburbs, in remote rural locations, or in resource poor neighborhoods (Wolpert, 1996). The Internet can be a great "leveler"—we all look alike in cyberspace (Nie, 2000). However,

failure to keep pace with developments in information technology will cause individuals, companies, and nations to lag behind their neighbors. As Mitchell (1995) points out, nations that seek to grow economically will have to invest in costly information networks along with ports and shipping fleets, railroad networks, and highway systems.

One approach to the network availability problem is bottom-up or grass-roots provision of local community networks, that is, information networks available to the public via computer equipment placed in publicly accessible buildings such as civic centers and libraries (Campbell, 1995; Parker, 1996). This approach has the potential to lead to a relatively new form of land use developed specifically to support information technology applications—community technology centers or "telecenters." The latest equipment could be accessed at such centers by small businesses, telecommuters, government service providers, and educational institutions. Rural communities that cannot justify expenditures on high-speed highway access would be able to justify high-volume "information highway" access. The various urban and rural communities within a state would be tied more closely together. This approach has the potential to improve the accessibility of services in rural areas. Potential benefits within the transportation arena include faster emergency vehicle response times, coordinated goods delivery, and rural transit schedules. Digital technology tools will be especially valuable in bringing dispersed communities closer together, providing increased access and providing information-based services to maintain and improve the nation's competitive advantages. The digital economy, especially the exponential growth in business-to-business and business-to-customer e-commerce, offers the potential to bring goods and services to economically depressed locations and to disabled and elderly people whose access to good and services is limited by barriers in the transportation system (Penney and Associates, 1996).

Issues:

· How can governments ensure Internet access for all groups in our society?

· How can the government encourage the use of Internet-based transportation information and services in economically depressed locations?

· What should federal, state, and local governments' roles be in the provision of local community information networks, and how will these affect needs for transportation services?

4.7 Planning

A rapid evolution to a digital economy is likely to challenge the traditional transportation planning process. Both the nature of planning solutions and the methods used for reaching those solutions will most likely change. Currently, a lack of consistent data hampers attempts to inject the effects of e-commerce into projections of future demands for transportation (Pedersen, 2000). The data available to the planning process are certain to change and grow considerably.

As regionally based intelligent transportation system (ITS) architectures begin to monitor traffic within our largest cities, comprehensive, minute-by-minute data on highway-specific traffic volumes and speeds will be available to planners for the first time. A better-informed short-range as well as longer-range planning process ought to result. The movements of trucks, as well as automobiles, within these traffic streams will have significant implications for infrastructure planning for highways, airports, and other publicly financed transportation systems. ITS-based traffic control strategies offer the opportunity for planners to enter a more informed and more interactive mode of doing business, in which short-term traffic control experiments can be monitored and adapted before becoming part of longer-range plans.

Wider and easier access to planning documents through the Internet will also allow for more public participation in and comment on the planning process. As a result, transportation specialists will need to learn to respond to this new form (and probably increased volume) of public input into the decision-making process. With advocacy groups likely to play a big role on the Internet, these inputs to the planning process are also likely to be multi-modal as well as multipurpose in nature. Transportation planners are likely to be challenged to provide interactive, "what-if" planning demonstrations of their proposals in ways that make their interpretation accessible to wide audiences. Parts of these audiences will have their own information-gathering capabilities, which they may use to evaluate a proposed plan. Better-informed planning decisions should result. Better-informed and information technology– savvy planners will be needed to apply the process. In the future, the ability to synthesize large volumes of information from diverse sources is likely to be a key talent for a successful planning career.

Issues:

· What techniques for expanding the transportation system's capacity best fit the demands of the digital economy? What roles does each of the modes have in this economy?

· How can we reengineer the transportation planning process into a faster and more flexible process to better match the pace of change in the digital economy?

· What new requirements will transportation planners have for tools to manage the improvement and expansion of transportation infrastructure in a multi-modal environment?

· What training will transportation planners need in order to operate effectively within a more interactive, more Internet-accessible planning environment?

· How will governments manage and protect the large volume of electronic data they gather as the data become more personal or sensitive (individual travel activity patterns, toll payments, commercial activity, etc.)?

5. Summary

The information technology community is fond of measuring time in "Internet years" to highlight the rapid changes in technology affecting the global network. How long is an Internet year? That depends on when you ask the question. A quick search of the Web produced several estimates. The estimates from 1999 ranged from 6 months to 3 months. The estimates from early 2000 ranged from 50 days to 32 days. When we consider that changes to transportation infrastructure require decades of planning and construction, it is clear that the two technologies are operating on vastly different time scales. However, the digital economy has inextricably linked the futures of the two technologies. The transportation sector must begin to envision the future, to forecast demands, and to plan for the necessary long-range changes. The issues we have derived are some of the important questions to be answered. Addressing each of these issues will require a research plan to gather data, develop analysis tools, model the systems undergoing change, and identify government efforts that can support the changes. Many of the tasks are clearly multidisciplinary, requiring expertise from the social sciences, information sciences, mathematics, engineering, and transportation modeling. The problems are not one-dimensional, and the effective solutions certainly will not be.

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