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The Dynamic Relationship

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Executive Summary

The search for solutions to urban road congestion frequently leads to promoting telecommunications as trip substitution:

- Letting employees work at home instead of commuting, which is called telecommuting.
- Shopping on the Internet, that is, teleshopping.
- Distance learning, which means taking classes via videoconferencing or the World Wide Web.

However, the story of telecom and transport is much more complex than trip substitution. Telecom includes the Internet, cell phones, the exchange of data between machines, and much more. For example, the automobile industry is now moving to use the Internet to communicate vehicle maintenance status automatically and make it available online. Within a decade or so, the World Wide Web will likely be available everywhere through voice command. Full-time, high bandwidth connections mean that television will be delivered via the Internet.

Telecom impacts on transportation can be broadly categorized as (a) changes in the characteristics of transportation demand (including travel volume, trip timing, destinations, routing, and mode), and (b) changes in the quality of the performance and user characteristics of transportation itself (including safety, speed, and reliability).

For transportation policy analysts, telecom as a substitute for travel is typically the most interesting aspect of telecom-transport interactions. Five different mechanisms at work are:

- Letting people achieve much of the purpose for going to a place without actually having to go there. Telecommuting, teleshopping, and distance learning are prime examples.
- Calling ahead to a potential travel destination to find out if the trip is really worth making.
- The ability to weigh travel conditions against trip purpose. The Internet already displays video of freeway traffic in Seattle, Portland, and elsewhere.
- The revision or elimination of costly passenger and freight trips. Improvements in truck dispatching and the routing of sales personnel are examples.
- Changing lifestyle patterns, such as surfing the Internet instead of going out to see a movie.

Yet overall, telecom applications are unlikely to reduce congestion overall, due to:

- The limited potential for worker telecommuting days compared to the magnitude of traffic.
- Continuing success of place-based businesses, which can use technology to attract customer visits in competition with teleservices.
- Further dispersion of homes, organizations, and consumer activities, which telecom supports.
- Telecom making people aware of attractive new destinations, and thus providing more invitations and motivations to travel.
- General economic stimulation from telecom growth that causes travel consumption to grow.

Telecommuting should now be placed in the broader context of teleworking, which encompasses the activities and travel patterns of field workers, the home-based self-employed, and suburban branch workers of downtown firms. Statistics Canada reports that teleworking in that country grew from 600,000 workers in 1993 to a million workers in 1997. A U.S. survey commissioned by the International Telework Association and Council indicates that 19.6 million workers, about 10 percent of adults, telecommuted in 1999.

While teleworking changes the location of workers, teleservices change the location of customers. Teleservices refer to all the ways that telecom applications are now changing the locations, activities, and travel patterns of consumers and business customers. This includes electronic commerce (e-commerce), prominent examples being online shopping from home computers, kiosks in malls, and cell phones that connect to Amazon.com and TicketMaster.

The impact of e-commerce on the amount of travel for store shopping is still unclear because of technological developments and entrepreneurial business initiatives yet to unfold. For example, if body imaging and custom clothing manufacture arises, a physical infrastructure of relatively small neighborhood clothing stores may arise as locations for body scanning and final product try-on and acceptance, challenging the travel reductions achieved via e-commerce.

While online shopping by consumers has caught the attention of popular media, the much bigger story in e-commerce is business-to-business (b-to-b) transactions, approximately 10 times the volume of business-to-consumer spending. Managing flows of raw materials, components, and finished goods requires telecom-dependent logistics processes, which in turn yields these results:

- More online and telephone ordering by households and businesses creates more diverse sources of product supply and more package delivery.
- Telecom and computers enable tight management of the flow of goods from factories to point of consumption, even while in motion aboard airplanes, trains, and trucks.
- Computerized logistics means that expanded varieties of goods are in trucks, warehouses, and stores everywhere.
- Emphasis on fast, guaranteed delivery leads to more trucks carrying only partial loads.

Finally, across both freight and passenger transport, telecom can modify the length, timing, routing, and mode (car versus transit) of travel through Intelligent Transportation Systems (ITS), the integrated application of computers and telecom to road transportation by cars, buses, and trucks. ITS includes the following:

- Surveillance and dispatch systems that improve incident response and clear problems sooner. Accidents and breakdowns are the source of 60 percent of traffic congestion.
- Electronic signs that strategically advise drivers of alternate routes, point to the nearest available parking, or display the exact time until "next bus" arrivals at transit stops.
- Fast, automatic, electronic fee collection at parking facilities, on toll bridges and freeways.
- Cable TV channels and Web sites that provide electronic maps showing bus location and video of freeway congestion areas.

According to the U.S. Department of Transportation, ITS spending is 10 times more effective in providing road capacity than spending on road building. For example, freeway management systems such as ramp metering have reduced crashes by nearly 50 percent while allowing 22 percent more traffic flow at speeds 13 to 48 percent faster than prior congested conditions.

In response to the findings in this paper, civic leadership needs to pay constant attention to the challenges and opportunities that telecom presents to transportation. Regional Transportation Planning Organizations (RTPOs), such as TransLink in Lower Mainland British Columbia and Puget Sound Regional Council, need to show much more consideration of the telecom applications that are likely to influence future mobility in Cascadia.

Recommendations

- RTPOs need to implement new methodologies that acknowledge the uncertainty and risk in future projections of transport demand and traffic congestion.
- ITS investments deserve more emphasis in public transportation budgets to improve performance from existing road infrastructure.
- State and provincial governments should better inform public and private organizations on the opportunities for teleworking and other telesubstitution for travel.
- There should be a new regional research and education forum for teaching civic leadership how the development and deployment of telecom applications can yield more mobility.

Introduction

This report presents new findings about the impact of telecom (the commonly used short form of the word telecommunications) on transportation, including travel substitution, travel stimulation, and travel modification. More generally, it is a survey and analysis of how telecom affects movement of people and goods. The report also discusses how telecom tends to modify the location of homes, businesses, and other generators of activity in the Cascadia corridor (British Columbia, Washington and Oregon). Telecom helps alter the pattern and density of land use as well as the origins and destinations of trips, all of which influences the volume, timing, mode, and other characteristics of travel.[1]

Overall, the net effect of the changes that expanding telecom brings to travel patterns is very complex, and not predictably a cause of reduced overall travel demand. While some aspects of telecom are causing people to travel less, other characteristics cause them to travel more. Travel patterns are modified as well. The steady growth in both telecommunications and travel demand over the past few decades makes it clear there is no reason to even assume the overall effect of telecommunication is a net reduction in trip making. As futurist Paul Saffo writes, "The more we communicate electronically, the more we desire to meet face to face ...I looked at the last 100 years of travel and communications statistics, and it's clear: Both go up in tandem."[2]

But there are steps we can take to maximize the role telecom can play in improving transportation. Telecommuting from home as a way to reduce rush hour commuting to offices – what most people think of as telecom's main impact on transportation – is an overinflated hope for traffic reduction, even while growing as a tool for greater organizational performance. The broader scope of telecom substitution for trips of all purposes needs to be considered. But the best potential lies in the technology of Intelligent Transportation Systems – telecom applications that improve the performance of the roads and vehicles that move people and goods.

Telecom, New Player in Transportation

Telecom commonly means the point-to-point communications found in telephone calls and fax transmissions. But today it also refers to the ubiquitous and rapidly growing public Internet connecting millions of computers to provide electronic mail, World Wide Web browsing, and other services, and to the Internet's private cousins, the organizational intranets that are accessible only by designated employees and sometimes by customers. Telecom can also mean the exchange of data between machines, such as the systems that control the red and green lights for freeway ramp metering, or the Global Positioning System (GPS) that uses satellite signals to tell a special radio receiver exactly where it is located on planet Earth.

In time, the Internet will very likely become the technological underpinning for virtually all telecom, including voice telephone service and improved forms of broadcast radio and television, as well as electronic mail, information retrieval, and videoconferencing. Over the next decade the Internet will become an even more ubiquitous technology, connecting most people, many kinds of information, and many objects. The World Wide Web grows by over two million pages per day.[3]

The Internet now operates over both wires and radio signals. Cars, appliances, cameras, sensors, and other machines increasingly will use the Internet automatically to manage and maintain themselves and to help the lives of people. This technology will offer new versions of television, radio, photography, film and music distribution, telephones, live event coverage, and e-mail. Nano-technology[4] may even allow for the distribution of small manufactured goods using what can be described as object printers. Previously unimaginable new forms of entertainment and education will also come via the Internet.

The automobile industry is now moving to include Internet connectivity in vehicles, and the cellular telephone industry is introducing Web browsing in hand-held devices. Both cars and the mobile devices will be aware of their geographic location through the use of GPS technology. Within a decade or so, the World Wide Web will likely be available everywhere through voice command. At the same time, the effect of cell phones, electronic maps, and other telecommunications devices on a motorist's ability to drive safely have become a challenge to law enforcement and a growing political concern.[5]

The Motor Vehicle: Still Dominant in Transportation

Since World War II, automobiles and trucks have emerged as the dominant mode of transportation in the Cascadia Corridor and North America generally. For example, the latest commodity flow survey for Washington State (1993) shows that trucks carry 73 percent of the value of freight originating in the state and 72 percent of its weight as a modal share.[6] Cars and buses provide about 88 percent of passenger miles in comparison to planes and trains, even including long distance air travel.[7] Rubber-tired vehicle modes are likely to remain dominant for reasons we will link to telecom later in this report.

Over the past 50 years, this dominance has spurred land use development patterns and densities oriented to cars and trucks. Typical parking and road access features acknowledge that most people arrive and leave by car, and that most goods move by truck. In a city like Seattle, about one quarter of developed land is in public rights of way for automobiles.[8] Examples of vehicle-oriented development include the shopping centers, strip malls, industrial parks, warehouse centers, and office campuses dispersed widely over metropolitan areas such as Lower Mainland BC, Bellingham, central Puget Sound, Portland-Vancouver, Salem, and Eugene, and the urbanizing areas in between.

Public investment in highway and road infrastructure and supporting systems has not been sufficient to keep up with growth in peak-period vehicle traffic. Roads that are free flowing when most people are at home or at work experience congestion during periods of peak traffic associated with weekday commuting, popular weekend shopping hours, and scheduled sports and entertainment events. A startling fact is that some 60 percent of congestion is attributed to accidents and incidents.[9] As with network flows generally, congestion is most associated with a limited number of bottlenecks that constrict vehicle flow, such as tunnels, bridges, major intersections, international boundary crossings, ferry ramps, and approaches to major trip destinations like central business districts, shopping malls, stadiums, and airports. In the case of many bottlenecks, the situation is one of overwhelming peak period demand a decade or more after the facility was designed and built. Sometimes the initial design was inadequate because of under funding or other reasons.

Relating Telecom to Transportation

Some transportation planners would like the public to believe that telecom itself is a mode of travel for going places, but this is a serious error. Telecommunications, like transportation, affects location and movement through applications of technology to the needs of people and organizations. However, treating telecom as a mode of transportation -- an alternative to the modes of bus and car -- emphasizes how one reaches a distant place, which obscures the critical distinctions between being in proximity to a destination as a result of travel, and communicating with a destination. A list of distinctions between the advantages of face-to-face presence (transportation) and remote interaction (telecom) is presented in Table 1. (Some of the academic research in this area goes under the label media choice, referring to communications choices such as meeting, phoning, or writing).[10]

Moreover, not all applications of telecom particularly bear on transportation. Many telephone conversations, faxes, e-mails, and Internet sessions do not impact transportation in any way. Still, many uses of telecom do bear on transportation, and those – in the complex interaction of movement of people and goods and movement of information via telecom – are what concern us here. Telecom, we will see, can act to increase, decrease or otherwise modify personal travel.

Telecommuting and certain kinds of Intelligent Transportation Systems (ITS) are two of the most prominent telecom applications.

Telecommuting, of course, means employees working at home -- or close to home in a neighborhood center -- instead of commuting to an office. Later in this report we will examine the potential of telecommuting as an option to vehicle travel that could ease traffic congestion. While telecommuting is the most common telecom application that bears on travel demand, direct commuting to work accounts for only one trip segment in five,[12] and there are other telecom applications that influence the need for travel. We will consider these other applications, in particular, teleworking (an expansion of telecommuting to all of telecom's influences on work location), teleservices (applications that influence customer locations), and electronic commerce generally.

ITS encompasses all of the applications of computers and telecom to road transportation by cars, buses, and trucks.

Telecom impacts on transportation can be broadly categorized as (a) changes in the characteristics of transportation demand (including volume, timing, destinations, routing, and mode), and (b) changes in the quality of the performance and user characteristics of transportation itself

Table 1: Distinctions between Remote Interaction and Face-To-Face Interaction

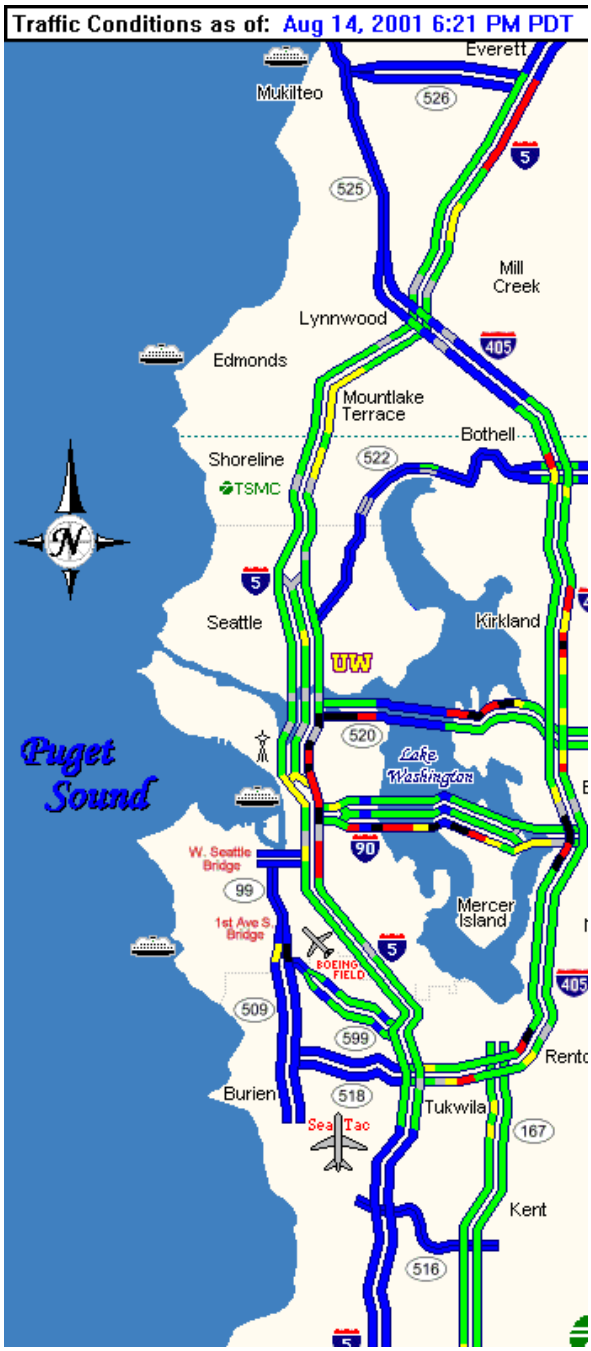
Distinction category	Example
Focus of attention	Meeting creates more focus than a telephone conference.
Concern and commitment	Making a trip shows more caring than a phone call.
Sensory input	Wider range of senses employed in visiting than by phoning.
Information bandwidth	More information is available in a visit than through e-mail.
Mixed media issues	Attending a meeting by speakerphone is a different experience than sitting at the table, which means that mixing the two modes is an issue in critical meetings.
Personal skills	Some people are better at video presentation and some are better in person.
Power and status	Making people visit instead of letting them call is symbol of power and status.
Peripheral opportunities	On a visit one can do many additional things, unlike with a phone call.
Flexibility opportunity	Being on the scene usually allows more flexible response than a telecom interaction.
Confidentiality	Face-to-face conversation is more secure than using telecom.
Unique proximity value	Saying you've been there has different value than saying you watched on TV.
Value of the journey	Sometimes what happens on the trip to get there has value apart from the reaching the destination

Source: Niles, 1997[11]

(including safety, speed, and reliability). Telecommuting bears mostly on demand and ITS generally bears on transportation performance. Some telecom applications do both. For example, traffic reporting such as the Seattle area system of live freeway videos and maps on the Internet (Figure 1) are today used by some workers to decide when and by what route to go home. Videos and color-coded maps influence the departure time for these people to leave to get on the freeway, the route they take, and even if they go at all. And, by influencing these choices, the freeway traffic reporting system reduces trip time and makes the transportation system work better.

Computerized dispatching that optimizes routing for a large fleet of delivery or home service trucks, such as the fleets of FedEx or Sears, is another example of an ITS application that influences both transportation demand and performance. By minimizing the driving distances of these trucks, the system creates more space on the road for other vehicles. Congestion will be marginally eased to the same degree as when a commuter leaves her car at home and takes the bus.

Figure 1: Real Time Traffic on the Internet



Telecom for Trip Substitution

For transportation policy analysts, telesubstitution – the use of telecom as a substitute for travel -- is typically the most interesting aspect of telecom-transport interactions. There are at least five different mechanisms at work in travel substitution:[13]

Equivalent functionality

The main method of trip elimination is that telecom lets people achieve much of the purpose for going to a place without actually having to go there. Sufficient functionality is achieved from a distance by telecom allowing observation, transactions, communications, and information exchange. Instead of driving to work, a worker stays home and telecommutes. Instead of registering for university classes on the campus, a student registers over the telephone. Instead of driving to the grocery store, one orders from Albertsons.com, although in this case a truck trip from the grocery warehouse to the buyer's home replaces a car trip from the home to the grocery store. However, as emphasized earlier, not all characteristics of physical presence can be duplicated with remote telecom access.

Pre-travel or even in-route validation of trip purpose

In addition to providing opportunities for telesubstitution, telecom also lets people call ahead to find out if the trip is worth making. Calling ahead to confirm that a scheduled meeting is still occurring is one example. Another example: instead of driving around to a variety of stores looking for a particular item to purchase, a shopper phones to a number of stores until the item is located, and then drives to one store directly. This telesubstitution effect can be a variation of telecom that changes the length of trips.

Knowledge of travel conditions weighed against trip purpose

Accurate, up-to-date knowledge of weather or traffic congestion at the destination or on the journey can cause trips to be canceled as with perhaps teleconferencing or other telesubstitution used instead of face-to-face presence. Joining a meeting by telephone may be inferior to attending in person, but it may be much better if the only freeway leading to the site of the meeting is blocked by an accident. This effect is closely related to changing the timing or route of a trip.

Process reengineering

Beyond decision-making by individuals, telecom allows the revision of organizational operations to eliminate passenger and freight trips that raise costs unnecessarily. For example, small computers in delivery trucks can keep track of the truck's location via GPS satellite tracking, and can also know the location of new pick-up points (including pick-up cancellations) in real time. This allows the delivery company to calculate pick-up sequences and best routes that allow more stops with less driving by each truck.

Another example: instead of a soft drink delivery truck driving to a heavily used Coke machine once every two days to fill it up (whether needed or not), wireless radio status reporting on the contents of the machine allows the bottler to visit as needed, which results in one visit every 3.3 days. A third example: the reconfiguration of telemarketing call centers to be larger and more centralized, or smaller and more dispersed, or virtual through individuals working at home. In the Seattle area, home workers are used by Holland America Line Westours, for example.

Travel behavior is more often an emergent phenomenon in process reengineering, rather than a sought after goal. In other words, time savings, dollar-cost savings, quality improvements, or more responsiveness to customers are the main goals typically sought in process reengineering, but not minimization of vehicle mileage. If transportation costs and delays are not seen as a business problem or opportunity, then change in travel behavior – reduction of driving, for example -- is going to be incidental, rather than the focus of change. For example, if the effectiveness of an industrial selling process is judged to be higher when a sales representative visits potential buyers in person, then there will be little corporate interest in saving vehicle mileage by designing a telephone sales process.

Changing lifestyle patterns

Going beyond direct functional substitution, a fifth potential source of travel saving comes from telecom providing opportunities to change leisure, recreational, and personal activity toward patterns that generate fewer trips. An example is members of a household more frequently staying home to surf the Internet rather than going out to see a movie at the cinema.

Travel Stimulation and Modification

It is a false assumption, however, that telecom only works to reduce the need to travel. Trip stimulation and modification through telecom are as likely as outright travel substitution, it turns out. Travel stimulation and modification occur several ways:

More invitations to travel

Telecom can very simply and directly cause new trips to happen by conveying messages to potential travelers about necessary or desirable trip destinations. For example, the boss calls to have a worker come in on Saturday. Or, a fax describes and invites people to a special event. In fact, the earliest known example of telephone usage was a stimulant to physical movement: Alexander Graham Bell's first words over his newly invented telephone in 1876 were to his assistant, "Watson, come here, I need you!"

Broader focus of attention

Aside from direct invitations, telecom can simply create a wider field of attention, leading to awareness of new places to visit and people to meet.

Economic stimulation

Telecom also has broad effects on movement and location that increase transportation demand. This happens because telecom usage supports and spurs economic growth and consumption.

Changes in origins and destinations

Telecom changes travel destinations both directly in the short run, and indirectly in the long run. Directly, one can hear about new opportunities on a last minute basis. For example, driving down the highway in an unfamiliar location, one typically uses signs or printed material to determine where to stop for gasoline or a meal. This method of choosing destinations will be augmented within the next decade. Entrepreneurs are building the wireless Internet where messages will be received on location-aware portable handsets and in moving vehicles. Internet-delivered messages will be the equivalent of signs along the roads. For example, Mr. Jones cruising in his Web-enabled car along I-5 between Marysville and Mt. Vernon becomes hungry, and enters that fact into his specialized, wireless Web browser. Various restaurants ahead of him from Mt. Vernon, Bellingham, Ferndale, Blaine, and White Rock could be put into a position to bid for his business by messaging back with seating availability and delicious specials ready to eat.

Telecom-enabled destinations

Many new kinds of work and leisure destinations are telecom-enabled: big box retail, sports bars, call centers, and suburban office parks. To the degree that these new kinds of locations tend to locate in dispersed, auto-dependent locations, new travel destinations will be generated.

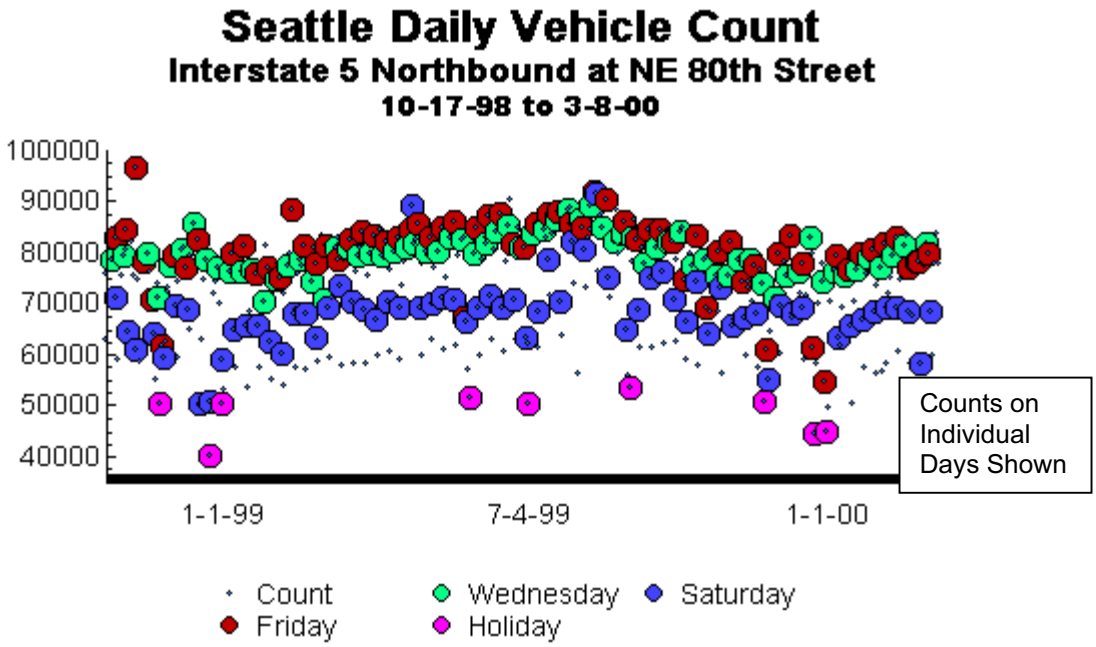
Trip length modification

Telecom can make trips longer as well as shorter. For example, an online information system could be designed to describe the nearest place to purchase a needed item, so users can avoid driving to a familiar place that is farther away. In the longer term, telecom supports residential sprawl with its longer trip patterns, because people can telecommute or operate a home-based business, instead of commuting daily to a distant central office during peak traffic periods. Long distance commuting is reduced in frequency per month, or made more flexible in hour of the day timing.

Trip timing modification

Telecom can also cause trips to be made at different times, perhaps avoiding peak periods. Telecommuters and other home workers with flexible schedules have more opportunity to do some necessary errands during off-peak periods, and stay put at home during the morning and evening rush. On the other hand, just-in-time delivery services like Federal Express, which are very much enabled by the technology and last-minute habits of the information age, generate vehicle traffic in evening rush hour to meet the deadlines that are part of their pledge of rapid service.

Figure 2: Seattle Traffic Volume Not Lower on Friday



Source: WashDOT Sensors, Compiled by U of Washington

Trip routing modification

Telecom can cause the route of a trip to change. Good information about traffic conditions generated by Web sites like the Seattle area Smart Trek freeway traffic maps (http://www.wsdot.wa.gov/PugetSoundTraffic/cameras)can be the motivation for staying off of a crowded corridor in peak, or for driving into a corridor that would typically be avoided in the absence of information that now reveals the traffic is free-flowing.

Trip mode modification

Telecom can cause the mode of travel to change. An information system that provides accurate, real-time information on the exact time when a bus will arrive at a nearby stop, or a real time dispatching system that enables small buses to make front door pick-ups, could cause more people to ride the bus rather than use private automobiles.

Teleworking in the broadest sense, however, is likely to diminish mass transit and ridesharing appeal relative to private vehicle modes. This decline in appeal comes from changes in economic structure, business processes, and land use that are moving the North American economy in the direction of more temporary employment, just-in-time travel, and geographic dispersion.

Overall Impact of Telecom on Travel

As we shall see in the next section, the observation that a growing number of workers telecommute and in this way eliminate some commuting journeys cannot be generalized into a finding that telecom as a whole reduces net travel. The few available quantitative studies that look at regional or national telecom and travel behavior are unclear in their overall implications.[14] As pointed out by Patricia Mokhtarian in a review of research for the Transportation Research Board, "[R]esearchers have pointed out that the substitution effect is more likely to be short-term and direct and to occur within the boundaries of the process being studied, whereas the complementarity [stimulation] effect is more likely to be long-term and indirect and to occur outside the scope of the studied process." [15]

Authorities in Seattle and other Cascadia regional cities monitor traffic volumes on key highways with sensors. When data from these sensors happen to be posted to the Internet, any

researcher can explore trends. That teleworking is making urban traffic lighter on Friday, for example, has been suggested. This claim can be investigated for various road segments around Seattle. Figure 2 (page 10) illustrates that for one northbound segment of I-5 in Seattle, daily traffic volumes on Friday exceed the volumes seen on Wednesday, Saturday, and holidays, perhaps because of people leaving for the weekend. Many segments would need analysis to show conclusive results on changed travel patterns.

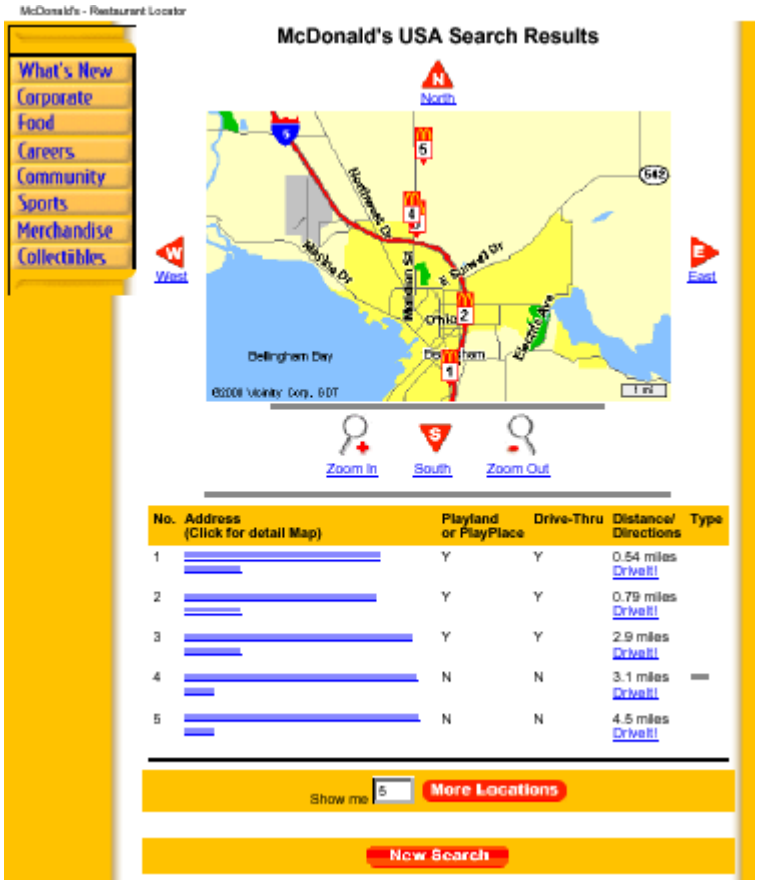
A Closer Look at Telecommuting

When most people think of telecom as a way of reducing travel, they think of telecommuting. In fact, the word "telecommuting" -- meaning the use of telecom to avoid or reduce commuting to work -- is frequently confused with "telecommunicating" or even "telecommunications," both meaning any use of telecommunications for any purpose.

For example, the purpose of telecom for McDonald's -- largely TV advertising, but some Internet services -- is to influence more people to come to their ubiquitous restaurant locations more often. The Web site http://www.mcdonalds.com includes a restaurant location finder (Figure 3) and Vicinity.com has announced a service that enables a Palm VII handheld wireless Web terminal to retrieve the location of the nearest McDonald's and other brand-name locations.[16]

Since the American economy in the new millennium now includes many categories of workers who do not engage in a daily commute to a fixed location, the phenomenon of telecommuting must be placed in a broader context of teleworking. Teleworking means all changes in the location of workers caused by telecom. Teleworking affects the location and movement of all workers, all day, and encompasses the activities of field workers, the home-based self-employed, and workers in suburban branches of downtown firms. Table 2 describes the many varieties of teleworking.

Figure 3: McDonald's Web Site is Geared To Customers Finding Out Where to Eat



Over a decade of experience reveals that allowing or specifying more flexibility in work locations benefits both organizational and individual performance. Some of these benefits, as documented by the Washington State University Energy Program, are listed in Table 3.

There are many examples of productive telecommuting in Cascadia -- Washington, Oregon, and British Columbia organizations with successful telecommuting experiences that have been documented and published. A list culled from several sources is provided in Table 4. See pages 12 and 13 for tables 2 through 4.

Table 2: Categories of Teleworking

• Typical, part-time home telecommuter: Employee regularly stays at home and works instead of commuting to an available office within daily driving range. Frequency can vary from occasionally to three-quarter time, with two days per week a typical frequency.
• Full-time, less-typical home telecommuter: Employee routinely works from an at-home office or workstation within the same metropolitan area as the normal office and travels only once per week or less to the normal office.
• Telecenter/branch telecommuter: Full-time employee works part-time for reasons of convenience and travel-saving at a different facility provided by the employer, but retains a desk in the normal office.
• Telecenter/branch worker: Full-time employee reassigned to working regularly and routinely from a remote telecenter or branch office somewhere else in the metropolitan area, the normal office being eliminated, downsized, or shared.
• Virtual office worker: Employee provided with home or portable office equipment and has her normal office taken away because the vast majority (typically 80% or more) of work time is in the field. May have a shared office space in the employer's building.
• Long-distance telecommuter: Would have a company office with the rest of work group if one were located nearby, but instead is allowed to work from a distant residential location because employer wishes to retain him. May report to a more convenient branch office, work from a home office, or do both.
• Mobile professional: Has a normal office to which he or she can officially report to work but allowed to work as needed with location independence because of extensive travel requirements inherent in job responsibilities. Includes traveling sales people, field auditors, trainers, and maintenance technicians.
• Independent homeworker: Self-employed professional or business owner who could have an office outside of the home but who choose instead to work routinely from an office at home.
• Remote regional field worker: Employee assigned to cover a geographic area that is remote from the main office, so is required to work from home, a branch office, a rented office, or some combination.
• Decentralized work group: All of the employees in an office-based work group reassigned and now reporting to another employer-provided facility in a different part of the metropolitan area from the normal office.
• Remote branch/back office: Rather than expand staff and space at the normal office, the employer establishes a new office in a remote location. The employer transfers existing employees to live and work in the new location or else hires new people who live nearby.

Source: Adapted from John Niles, *Beyond Telecommuting,*[20] Exhibit 1-6, page 1-8

Table 3: Benefits of Telecommuting

Organizational performance benefits
• Greater employee productivity and work quality
• Increased ability to attract and keep valued employees
• Improved employee morale and job satisfaction
• Increased access to labor markets of disabled, part-time, and semi-retired workers
• Less sick leave and reduced absenteeism
• Reduced office and parking space needs
• Increased ability to meet air quality or transportation mandates
Personal benefits to employees
• Improved work environment
• Improved morale
• Greater job satisfaction and sense of accomplishment
• Greater responsibility and feeling of trust
• More lifestyle flexibility
• Less commuting time and stress
• Lower commuting costs

Source: "Everything You Need to Know About Telework," a brochure from Cooperative Extension, Washington State University Energy Program, 1997.

Table 4: Employers Offering Telecommuting in Cascadia

Davis Wright Tremaine LLP
Hewlett-Packard (branches in Bellevue and Lake Stevens, WA)
ConneXt
Active Voice
Holland America Line Westours Inc.
Washington Dental Service
Electronic Data Systems' Seattle Solution Center
Washington Mutual
Fred Hutchinson Cancer Research Center
AirTouch Cellular
City of Redmond, Washington
DDB Seattle
In Focus Systems Inc
City of Portland
Oregon State Government
Kaiser Permanente
University of British Columbia Real Estate Division
Government of British Columbia
Oracle Canada
District of Pitt Meadows, British Columbia

Source: Washington State University Extension Service, Oregon Energy Office, and Canadian Telework Association[21]

Teleworking is complex, changing in character, and growing. Statistics Canada reports that teleworking in that country grew from 600,000 workers in 1993 to a million workers in 1997.[17] A U.S. nationwide survey commissioned by the International Telework Association and Council indicates that telecommuting from home as of 1999 is at 19.6 million workers, about 10 percent of adults. According to another survey, about 27 percent of American households have members doing some work from home, including after hours.[18] In Washington State, a survey of 450 businesses conducted in 1999 found 34 percent offering telecommuting as an option.

On the other hand, working from home by wage and salaried workers has apparently reached a market share plateau. For the U.S. as a whole, according to the Current Population Survey of the Census Bureau, the percentage of such workers at home fell from 14.7 percent in 1991 to 13.7 percent in 1997.[19]

But in Seattle, both Boeing and Microsoft have resisted work-at-home telecommuting. For these and other companies there are many understandable, documented reasons telecommuting is limited in its application. Most basic, supervisors and managers would simply prefer to have their employees working close by in the office instead of remotely in their homes, to feel better able to manage their work. Telecommuting advocates consider this preference a failure of management technique. A more objective view would be that management's perceived costs of changing work processes and culture to support telecommuting locations in remote places are judged to exceed the perceived benefits.

As an illustration of corporate attitudes in a high-tech, traffic-clogged region that might be expected to embrace telecommuting, consider a recent informal survey of about 50 multimedia industry firms in the San Francisco Bay Area. A researcher looking for case examples of telecommuting practice instead found near universal reluctance to implement telecommuting. Even the Sierra Club and the Metropolitan Transportation Commission (the regions' metropolitan planning organization) do not support telecommuting for their employees.[22]

There are strong telecommuting promotion programs carried out by government agencies in Washington and Oregon, with resource-sharing cooperation between the two states and with the analogous program in Arizona. Organizational managers seeking how-to guidance for establishing or expanding telecommuting can find detailed case study material on the World Wide Web.[23] The Washington State University telework assistance program has distributed about 2,200 packets of printed case study materials to organizations. In November 2000, the Washington State Telework Coalition released a report with recommendations for the expansion of teleworking in the state.[24]

Telecommuting, Traffic Volume, and Congestion

Teleworking and teleservices are going to increase in the years ahead, and will let many workers and customers avoid traffic congestion. Yet, they are unlikely to reduce congestion overall. Worldwide academic research findings and observation of daily urban life support this view.[25]

Conventional wisdom constantly informs us that telecommuting has the potential to reduce urban traffic congestion. For example, Microsoft executive Steve Ballmer remarked to an assembly of his customers in 1998: "The whole notion of how computer technology can let people work in different places, in virtual teams, at different times and in different ways, is ... fundamentally important to the State of Washington government, as it tries to think out and plan for economic growth and development and traffic here in the Greater Seattle area. I do admit it's very close to home. It used to take me seven minutes to get to my house in the evening; it now takes me 37 [minutes]. I hope telecommuting very much helps with this problem."[26]

And Cathy Cole, executive director of Seattle's Commuter Challenge, which promotes commute reduction to King County employers, proclaims, "One of the most overlooked tools for reducing traffic congestion in our area is having people work from home -- telecommute."[27]

Despite such hopeful enthusiasm, researchers who have looked carefully at telecommuting are very cautious about the potential for congestion reduction. This caution can be counterintuitive, because staying home to telecommute for a day does eliminate the commuting travel that would have occurred otherwise. Survey evidence indicates that telecommuters do not drive extra miles to lunch or shopping on telecommuting days. Also, their cars are not taken over by other household members on telecommuting days.[28] This is very good news.

However, the potential of telecommuting to reduce urban traffic is lessened by three circumstances: first, the potential amount of workers' telecommuting days compared to the magnitude and sources of urban traffic volumes; second, latent demand for new road capacity; and third, the relationship between telecommuting and land use "sprawl."

On the first point, the problem is this: Less than half of rush hour traffic is people going straight to work. And at most, only about half of the commuting work force has jobs in which telecommuting is a reasonable option, if their management is willing. In fact, an upper bound on management acceptance of telecommuting can be placed at around 50 percent. Then, experience shows that telecommuters who engage in the practice stay home about two days per week, that is, about 40 percent of workdays. Multiplying the four fractions together yields a combined impact on rush hour traffic of five percent. This amounts to just a few years growth in traffic for an economically healthy metropolitan area. A more detailed calculation by the U.S. Department of Transportation in 1992 projected a ten-year cumulative reduction in vehicle miles traveled of at most 1.4 percent. Since 1992 urban traffic has continued to grow despite steady growth in work-at-home telecommuting.

The second caveat about the potential of telecommuting relates to traffic dynamics. There is consistent evidence that latent travel demand will cause some additional travelers to move onto urban freeways as additional telecommuters stay home. This is illustrated by how quickly new road capacity is filled in urban areas. The expanded I-90 bridge over Lake Washington is an example in the Cascadia region. The overall take back from latent demand is estimated around 50 percent by researchers at Oak Ridge National Laboratory.[29] For every two telecommuters who stay home, one space on the road will be taken by a new road commuter who switches from arterials to the freeway, from rapid transit to private vehicle, or from going in before rush to going in during the peak. Transportation analyst Anthony Downs calls this the "triple convergence."[30]

A final point of caution about telecommuting and travel savings relates to residential location preference and dispersion. There is limited but consistent evidence that telecommuters are more likely than non-telecommuters to live farther from the office. Living in Bellingham and having a job in downtown Seattle is made more tolerable when one has to commute to work only two days per week. This means that the mileage saved by avoidance of commuting on some days is partially taken back on commuting days by a longer commute, and also by a more mileage-intensive mode of living in non-work activities. This is an expression of the land-use and travel relationship that links suburban and small-city living to higher level of driving than big-city living, where distances to shopping and services are shorter and transit services more plentiful.

None of this evidence takes away from the fact that individual people who choose on a Tuesday to stay home and telecommute are going to avoid traffic congestion on that particular day.

Table 5: U.S. Internet Household Users and Consumer Goods Purchased Online

Year	Households (millions)	% of Total Households	Consumer Goods Purchases ($millions)
1996	6.5	6.6	$750
1997	14.5	14.5	$1,500
1998	24.4	24.2	$3,700
1999	28.0	27.6	$6,100
2000	32.0	31.4	$10,000
2001	35.3 (Estimated)	34.4 (Estimated)	
2002	44.0 " "	42.7 " "	

Source: http://www.emarketer.com/estats

Teleservices

As indicated above, teleworking means all the ways that telecom applications are changing the locations, activities, and travel patterns of workers. In contrast, teleservices mean all the ways that telecom applications, including use of the Internet for electronic commerce (e-commerce in short), are now changing the locations, activities, and travel patterns of consumers and business customers of goods and services. E-commerce includes such phenomena as online shopping from home computers, kiosks in malls, or cell phones that connect to Amazon.com and TicketMaster. First, we will look at consumer use of the Internet for shopping, and then the much larger business-to-business e-commerce.[31]

Business response to the advent of consumer use of the World Wide Web in the mid-1990s led to exponential growth in retail shopping via personal computers, and seemingly long-term acceptance of online buying as an alternative to in-store shopping. Despite the economic downturn that began in late 2000 and deflated some high-flying Internet shopping companies, the dotcom sector is here to stay.

Table 5 shows one estimate of the growth in Internet users, with about 30 percent of U.S. households online in late 1999. Table 5 also estimates consumer online purchases for each year 1995-2000, illustrating an exponential growth curve that stood at $3.7 billion for 1998. The volume of Internet shopping is still very small in comparison to $2 trillion dollars of annual retail spending, but is approaching 10 percent of catalog shopping volume where people order by mail or phone. One research firm estimates that online shopping will account for 6 percent of all U.S. retail sales by 2003.[32]

The leading items purchased via electronic shopping are computer hardware and software, books, recorded music, home electronics, videos, travel services, event tickets, gifts and flowers, and (mostly casual) clothing. Groceries, furniture, and automobile sales are just beginning. Of the top Internet retailers, most do not have stores, such as Amazon, Dell Computer, Egghead Software, and CDNow. Bookseller Barnes & Noble is a major exception, although it is running stores and its Web site as separate operations. Major catalog retailers like L.L. Bean have launched Web sites, and so have many store retailers like Wal-Mart and Nordstrom, although many efforts are still preliminary.

The Internet brings impressive new capabilities to the shopper: worldwide searches for product availability and the best price, access to specialized niche providers around the world, communications with other buyers of the same product for information and troubleshooting, electronic auctions, instant aggregation of independent buyers to obtain quantity discount, easy input for custom configurations, instant voice access to sales assistance personnel, and tracking of delivery status, to name just a few of the exist-

ing and emerging capabilities. Photo-like screen resolutions for product images, rapid access speeds, and always-on shopping are becoming increasingly available.

Businesses have generally separated electronic shopping from in-store shopping; different organizations do them, even within the same company. The gap will likely be eliminated as successful retailers merge online and in-store services, in what may come to be known as "clicks and mortar," a phrase coined by David Pottruck, co-CEO of stock brokerage Charles Schwab.[33] When both worlds are merged in a particular retail enterprise, customers will be able to order electronically at home or in the store, be able to receive goods by delivery at home or in person within the store, and be able to return unwanted goods at the store or by mail.

Existing and new shopping malls have already begun to establish themselves as entertainment destinations in order to draw shoppers who could otherwise buy mall goods online. Whatever quality and speed of computer access the average consumer has at home in the year 2010, a large retail institution surrounded by free parking may well be able to provide a better electronic alternative (bigger screen, faster access to virtual reality environments, food and drinks, a comfortable couch, instant delivery of goods instead of next day) for the consumer who wants to leave home for his or her online shopping.

Three broad patterns of behavior in electronic shopping with travel implications are apparent:[34]

Online research and ordering, but travel for fulfillment

People use the Internet to research what they want to buy and to learn the location and offerings of a store or service facility (such as a restaurant or wristwatch repair shop). Then they travel in the usual way to complete the purchase. This process may or may not include ordering the item (such as a pizza or item of furniture) in advance of their arrival at the store or service facility. Some retail firms and shopping malls, such as Circuit City and Office Depot, are building Web sites to give consumers access to their computerized inventories in stores to facilitate efficient shopping and store visits.[35] A trip may occur immediately after the online shopping, or may occur some days later when something that was ordered remotely is available for pick up, installation, or other order fulfillment. The travel effects of this pattern are mixed. Trip making may be reduced because electronic research is substituted for in-store browsing at multiple locations. Or online research may lead to more travel because shoppers become more aware of widely scattered consumption opportunities.

Online ordering with commercial delivery by truck

Increasingly, consumers are able to order an item through the Internet or through a telephone call, and then have the item delivered. Next day delivery is often possible. This sequence is the typical process in electronic shopping and is analogous to ordering through a mail order catalog. UPS and Federal Express are both engaged in business initiatives that provide delivery services for Internet retailers. The travel effect of this pattern seemingly includes one or more fewer store visits, but it may be that consumer research ahead of the purchase transaction (such as visiting several home electronics store to check prices and compare the performance of multiple television sets) leads to just as much or more consumer travel. Furthermore, the home delivery scenario includes more truck activity on the streets near people's homes. More just-in-time package delivery by competitive systems of partially-loaded trucks (from FedEx, United Parcel, and the Post Office as well as OfficeMax, Sears, and Albertsons.com, to name just a few) may not prove to be inherently more travel-efficient than shoppers driving to stores and bringing home what they want.

Online ordering and electronic delivery

Certain items and services can be delivered electronically through the Internet or cable TV; for example, computer software, the new electronic books that load into hand-held readers, greeting cards delivered to ultimate recipients via e-mail, pay-per-view movies, and postage from the Post Office. Services that can be delivered electronically include travel arrangements, counseling, resume and other document preparation, and banking. In general, electronic ordering and delivery naturally yield the most direct travel savings.

Electronic shopping is nowhere near its technological limits. It would appear that there are many years of growth in consumer utilization ahead, although the impact on the amount of travel for store shopping is still quite unclear because of technological developments and entrepreneurial business initiatives yet to unfold.

It is probable that the entire physical structure of the retail system will evolve in response to the capabilities of the Internet and the attraction of sellers, purchasers, and entrepreneurs to the Internet. For example, if online ordering and home delivery becomes increasingly popular, physical stores may respond by becoming larger (or smaller), and more numerous (or less). For example, large chain bookstores, and Amazon.com, the electronic bookstore, have clearly made small independent bookstores less viable, and many have disappeared. As a speculative example of structural change, if body imaging and custom clothing manufacture arises, a physical infrastructure of relatively small neighborhood clothing stores may arise as locations for body scanning and final product try-on and acceptance to take place. All developments like these are likely to incrementally modify consumer travel patterns for shopping.

The analysts closest to the Internet and retail industries are generally unprepared and unwilling to forecast the evolution of electronic shopping beyond five to 10 years in the future. To avoid misdirecting transportation resources, government-led planning processes will need to be aware of a range of potential changes coming from the growth of the Internet economy, and conversant with alternative scenarios for what electronic shopping is likely to mean for the interaction of consumer and retail industry behavior.

Business-to-Business Electronic Commerce and Logistics

While Amazon.com and online shopping by consumers has caught the attention of popular media, the much bigger story in electronic commerce is business-to-business (b-to-b) transactions. Forrester Research forecasts that b-to-b sales of products and services online will grow from $131 billion in 1999 to $1.5 trillion in 2003, approximately ten times the forecast for business-to-consumer spending.[36] The flavor of leading edge, b-to-b electronic commerce is captured in this summary from Canada of how Wal-Mart operates throughout North America:

> "At Wal-Mart, an Electronic Data Interchange network links retail stores, redistribution centers, suppliers and manufacturers with transportation industries. All information (sales history, number of items in transit) is digitized and maintained in a common database, to which floor retail staff ('associates') have access through a bar code scanner and display read-out. The floor-level associate responsible for a given section, such as household wares, places the order. The order is then transmitted through the common network directly to suppliers, redistribution centres and transport firms. The supplier who receives the order ships it to the redistribution centre, where the goods are transferred from the supplier-delivery loading dock to the retail-store shipment dock, with minimal (24-48 hours) trans-shipment time to the retail store.

Table 6: 1994 shares of truck traffic in the Puget Sound Region

Long haul (>250 miles) trucks to or from points in the region	9.5%.
Short haul (<250 miles) trucks to or from points in the region	29.0%
Local delivery trucks	48.5%
Through trucks	13.0%

Source: Quick Response Freight Manual[39]

> The result: 97 per cent of Wal-Mart's goods never pass through a warehouse, and Wal-Mart can pay suppliers directly through customer sales."[37]

An important part of the transportation impact of b-to-b electronic commerce lies in what transportation policy analysts call "freight mobility," now increasingly subsumed by a process that professionals in business call "logistics." The Council of Logistics Management defines logistics as "...the process of planning, implementing and controlling the efficient flow and storage of raw materials, in-process inventory, finished goods, services and related information from point of origin to point of consumption." Logistics is very dependent on information flows, and information flows require telecom. This thought is captured in the observation first made by Federal Express that moving information that describes the movement of a package is as important as the movement of the package itself.[38]

Logistics and the freight movement that goes with it is a complex area of transportation, for which comprehensive descriptive information is not generally available for the Cascadia region or anywhere else. Lack of data is especially apparent with respect to intraurban delivery, such as trucks moving containers from the docks to local warehouses, or making package deliveries from airports and warehouses to business and residential locations.

Because of how Cascadia is geographically situated on the edge of the continent, and encompassing the northernmost area of urbanization, practically all of the trucks moving in the region have either picked up their cargo in the region, or are on their way to a delivery in the region. Unlike an interior continental region like Illinois, there are very few trucks simply passing through. Major high volume pick up and delivery points in Cascadia exist at the marine ports and at airports. The three major urban centers of the region, Vancouver-Surrey, Seattle-Tacoma, and Portland-Vancouver, are each served by both international airports and container ports, and are Cascadia's main centers of production, consumption, and distribution. Thus, these three regions are the origin, destination, or simply the areas of in-region delivery activity of most trucks that move in Cascadia.

This distribution of activity is illustrated by a 1994 estimate of how truck traffic is classified in just the Puget Sound Region of Washington State, seen in Table 6. Just 13 percent of truck traffic is classified as "through trucks " in the Everett-to-Tacoma part of Cascadia. This traffic must include those trucks on Seattle-area freeways that are moving between Vancouver, BC and points south of Tacoma, or east of Snoqualmie Pass, which is another case of traffic to or from points in Cascadia. What is very striking is the large proportion of trucks – almost half -- engaged in local urban delivery.

Telecommunication technology is increasingly used by the private sector in keeping track of cargo containers, packages, and trucks. Tracking technology in some ways compensates for the delays that trucks increasingly face in the congested, urban areas of the Cascadia Corridor.

A review of literature describing logistics and the role of telecom reveals a basic finding:

the growth in the global economy (with corresponding import and export of goods overseas) plus the rise of e-commerce will cause a growing number of frequent truck deliveries to more separate locations.[40] E-commerce, to repeat, includes business-to-consumer, like Amazon.com, but also encompasses business-to-business, such as the millions of dollars racked up daily in online equipment sales by Cisco Systems. B-to-b exceeds b-to-c by a factor of 10.

Other considerations in the relationship between telecom and logistics:

- More online and telephone ordering by households and businesses of all sizes will lead to more diverse sources of product supply and more package delivery to the separate locations of households and businesses. The limited coverage and long-distance focus of railroads means that trucks will carry much of the new volume, even while railroads are moving greater numbers of containers from Cascadia seaports to inland locations.

- Very tight management of the flow of goods from factories to point of consumption can happen by telecom and computers, to the point that inventories can be managed even while in motion aboard airplanes and trucks. A growing trend in warehousing is cross-docking,[41] where goods arrive on one loading dock by truck, are quickly sorted, and within hours are directed to another dock where a second truck waits to take them away. The equivalent process in manufacturing where there is more delivery activity and smaller inventories is called just-in-time supply.

- Because of consumer and business demand for variety and options in products, and the ability of computers and electronic data flows to keep track of a larger number of separate items, there are more and more kinds of separate goods (known as stock keeping units or SKUs) in trucks, warehouses, and stores everywhere. A counterbalance to this trend influencing truck movement is the fact that the movement of documents, recorded music and video, software, and other physical objects containing only information, is destined to fall off as pure electronic delivery grows along with the growth of the Internet.

- Warehouses are often becoming more active as sorting and distribution centers, with trucks coming and going with more frequency. Large multi-acre locations where goods can be moved from dock to dock quickly and trucks can get in and out without facing frequent congestion become a much-sought resource. Such facilities of course are more compatible with low-density suburban areas than with high-density central cities.

- Using computers and telecom to manage complexity, the package delivery industry -- including FedEx, Airborne, the US and Canadian postal services, and UPS -- is now able to offer many grades of guaranteed delivery speed. Service grades include first day morning, first day afternoon, second day, and three day, which leads to more and more truck delivery runs by these competitors throughout the business day, and even on weekends.

- The emphasis on fast, guaranteed times of delivery is leading to more dispatch of trucks carrying only partial loads, instead of waiting for enough cargo to fill a truck up. More trucks are needed with partial loads than if full loads are moved.

- At the same time, the Internet is facilitating the creation of new transportation capacity brokerages that potentially create the opportunity for the efficient, online selling and buying of available capacity on trucks that would otherwise move out with only partial loads.[42]

- The need for speedy deliveries and for guaranteed delivery times will create more pressure for nighttime deliveries, when personal automobile traffic is less of a constraint on urban truck movement. On the other hand, increasing nighttime truck traffic in some North American jurisdictions has caused a political call for regulatory restrictions, since people who live near places where trucks deliver and move about do not like their sleep interrupted by the noise of trucks.[43]

Intelligent Transportation Systems (ITS)

Whereas teleworking and teleservices are about the location of workers and customers, ITS – computer- and telecom-based capabilities that improve the road system's performance– directly changes the characteristics of vehicle travel.

ITS is an underutilized transportation resource all over North America, but one that Cascadia is well positioned to exploit, since strong ITS deployment – called Smart Trek – has already begun in the Seattle area. According to the U.S. Department of Transportation, ITS spending is 10 times more effective in providing road capacity than spending on road building. ITS helps drivers to share the road more efficiently, thus moving more quickly and more safely over existing roads. For example, traffic monitoring and traffic signal control systems on existing arterials can improve traffic flow from 8 to 25 percent. Freeway management systems, such as ramp metering, have reduced crashes by nearly 50 percent while handling 22 percent more traffic at speeds 13 to 48 percent faster than pre-existing congested conditions.[44]

There are several immediate ITS applications that could be developed and implemented to better transportation in the Cascadia Corridor.

For better public transportation services, these telecommunications applications could be implemented:

- Electronic signs at key urban transit centers and bus stops that display the exact time until various "next bus" arrivals.

- Inexpensive, pager-like devices included with annual bus passes that tell bus riders how many minutes until their bus arrives at their stop. Such a service would improve perceptions of safety of single riders during late night in downtowns, and is also useful for suburban riders to gauge the best starting time for the walk on a cold, rainy morning to their bus stop.

- Cable TV channels and Web sites that indicate on maps the exact location of suburban buses, as a way of marketing capacity to occasional users.

- More demand-responsive, route-deviation protocols for buses in suburban areas to pick up and deliver people closer to their destinations.

- Subsidized installation of ITS in-vehicle equipment, and computer-based coordination systems, as an inducement for regular SOV commuters to accept carpool riders.[45]

For managing vehicle traffic, these ITS applications would be useful:

- Electronic signs signaling lower speed limits on freeways as volumes build or weather deteriorates to smooth out flows and reduce the onset of incident-caused congestion.

- Electronic signs combined with weigh-in-motion on freeway exit ramps alerting trucks to slow down based on their axles, weight, and speed. This is on-the-shelf, proven technology that saves lives and reduces incidents. Corporate sponsorships could cover the cost.

- Automatic, electronic fee collection at entrances to key parking facilities such as GM Place, Seattle Center, Safeco Field, Tacoma Dome, and the Rose Garden to cut down on congestion during events.

- Electronic tracking systems that inform drivers of the location and number of available spaces in parking facilities in urban centers, like the real-time monitoring of 29 parking garages deployed in Cologne, Germany and available for inspection on the Web at http://www.koelnverkehr.de/park/park100.htm.

- Electronic signs that advise drivers of other routes, such as I-5 versus I-205 in Portland, I-5 versus SR-99 through downtown Seattle, and Highways 99 versus 91 across the Fraser River in British Columbia.

- Surveillance and dispatch systems that improve incident response and clear problems sooner. Incidents are the source of 60 percent of traffic congestion. Incident management systems have been found to reduce travel time by 10 to 45 percent.[46]

For providing travelers with useful information, these telecom applications are helpful:

- Much wider road network coverage in the video pictures and electronic maps displayed by State/Provincial Departments/Ministries of Transportation on the Internet.

- Kiosks displaying traffic conditions in the corridors of office buildings and other places available for viewing by homeward bound commuters, especially those with the option to stay later. This is already in place at some Microsoft buildings.

- Electronic signs in congested areas pointing the way to nearest available parking.

- In-car devices that warn drivers of congestion ahead. These devices need to be much easier to comprehend than the pager watches tested in Smart Trek.

- Use of cellular data feeds from moving cars and buses to provide better data on traffic conditions on arterials in the region.

Again, an important issue is the impact of wireless telecommunications on driver attention to the requirements of driving. Peter Holland, president and CEO of InfoMove, a Kirkland, Washington company that is developing ITS in-car systems, presents another take on safety when he notes "What will really move the masses to adopt these technologies is safety-oriented concerns." These include being warned of traffic slowdowns ahead on the freeway, and automatically and quickly summoning help to an exact location if necessary.[47]

Land Use and Mode Choice

Telecom is likely to be a growing force for the further dispersion of homes, organizations, and consumer activities. This is bad news for advocates of transit-oriented development.

A number of observations support the notion that telecom incorporates an inherent bias toward suburban dispersal.

- Telecommuters tend to live farther away from work than non-telecommuters.

- Wireless phones make commuting more tolerable, reducing the "friction of distance."

- Intelligent Transportation Systems increase effective road capacity and speed traffic along, which is especially helpful to drivers in the automobile-oriented suburbs.

- Telecom and computers facilitate larger stores: control of larger inventory, easier price changing, and faster checkout. These benefits allow stores with walls to compete with the prices and variety found in online stores. Larger stores fit better into suburban areas.

- New office construction in suburban office parks permits easier telecom wiring than using rehabilitated or recycled space in the central city.

- Wireless voice and data services work better in low-rise, moderate-density environments than in high-rise, high-density environments.

- Electronic networks motivate long-distance travel and "just-in-time" logistics, establishing a predilection to locate closer to airports.

Telecom, overall, is also likely to be a force for increasing the demand for anywhere, anytime, personal mobility (that is, cars). Telecom stimulates a propensity to take advantage of a wide variety of dispersed destinations where there is economic or social opportunity if one can get there. As described in a previous section, telecom-enabled logistics stimulates frequent movement of partially full trucks delivering packages sent the day before or even more recently. So too does telecom lead to a just-in-time, do-it-now world, running on "Internet time."

Table 7 (page 24) provides a list of the mechanisms by which telecom promotes the use of automobiles. Transportation planners frequently focus on how sprawling land use forces people to use cars. In fact, the influence may work just as strongly in the reverse direction: the requirement to move about in private automobiles creates a demand for land uses with parking lots, drive-by and drive-through services, and freeway access from all directions.

This is bad news for conventional public transportation. However, there are some ways in which telecom makes mass transit perform better and attract more customers, as shown in Table 8 (page 25).

Transportation planning carried out by Regional Transportation Planning Organizations – RTPOs such as TransLink in Lower Mainland British Columbia, Puget Sound Regional Council, and Portland Metro – is based on a foundation of professional, mathematical methodology atop hidden, structural assumptions about land use, organizational behavior, and consumer choices going out 30 years in the future. The published plans to date indicate little consideration of the potential telecom applications that are going to be part of shaping the coming decades in Cascadia. In fact, the mathematical methodology of transportation modeling makes consideration of the complex and uncertain impacts of telecommunications difficult.[48]

Nevertheless, with the mathematical calculations in place, transportation planners in urban Cascadia have advised their political leadership toward implementing a public policy that tries to divert the ongoing evolution of automobile-oriented, telecom-influenced development. The means of this good-hearted attempt at diversion are significant public capital investments for transit infrastructure construction and for subsidizing supportive land use near transit stations. Examples are SkyTrain in Vancouver, Link Light Rail in Seattle, and MAX Light Rail in Portland. The burden on these supposedly long-lasting investments is that they would have to change driving, recreation, and shopping behavior massively in order to be cost effective.[49] However, the direction of change required can run counter to the influence of telecommunications. With regard to infrastructure permanency, the miles of electrified intraurban and interurban trolley track removed from service in the U.S. since 1920 exceeds the Interstate Highway mileage that has been constructed through the present day.[50]

Table 7: Ways in Which Telecom Promotes Automobiles over Mass Transit

• Telecom creates awareness of people, places, and events in locations dispersed throughout a metropolitan area, and diverse destinations with diverse timing are often most easily, quickly, and inexpensively reached by automobile. Also, for reaching more distant locations that become known through telecom, airports are usually more easily accessible by car than by other transportation modes.
• Mobile telecom creates new demands for last-minute changes in timing and destinations. Cars are superior to transit for spur of the moment, multi-stop, flexible trips.
• To the degree that automobiles are perceived by consumers to be a pleasant, superior way to travel, telecom in the form of ITS and Internet-monitored maintenance adds (and will add in the future) to the functionality of cars.
• Modern logistics functionality -- frequent, small shipments on demand, including more home delivery -- is enabled by telecom and fulfilled with the use of trucks as a preferred mode of freight transport.
• Telecom drives and facilitates increasingly large scale in retail stores, because of the technological ability to manage inventory and move customers through checkout lines quickly. Big stores require large trade areas and expansive parking lots to attract a sufficient number of customers. These dispersed customers will generally arrive in private vehicles that make shopping with friends and taking goods home easy.
• Telecom is a leading source of productivity and wealth in the economy, and wealth leads to a preference for automobile transport over public transit.
• Telecom creates the need for quiet, private space in which to converse on the telephone. Cars provide that space very well, while allowing the primary function of transportation to be served at the same time.
• Telecommuting and work-at-home creates a travel demand profile that is non-routine, off-peak, and less amenable to transit use than to private vehicle use.
• Business sales force and field worker productivity is highly telecom-enabled and requires a flexible mobility to reach dispersed locations that is better provided by cars than by transit.
• The network economy requires speed and versatility; cars are the fastest, most flexible way to go places.
• Telecom stimulates a part-time, self-employed work force without fixed transportation patterns.
• The telecom-enabled global economy requires more evening and night shift workers to serve 24-hour per day demands, and this requires off-peak commuting that is best served by cars.

Source: Global Telematics

Conclusions

We have seen that the relationship between telecom and transportation is a complicated and rapidly changing issue.[51] Civic leadership needs to pay constant, objective attention so it can help society to take advantage of new opportunities, maximize the potential of telecom applications that bring improvements in transportation, and not waste resources pursuing policies that have a negative or insignificant impact on the important problems of transportation.

Table 8: How Telecom Can Make Public Transit Easier and More Convenient

• Debit card, credit card, or smart card fare payments for riding on mass transit.
• Real-time countdown timers displaying the minutes and seconds until a mass transit vehicle departs a particular stop. Timers are implemented where the SeaBus Ferries depart across Burrard Inlet in the Vancouver, BC region.
• Dispatching and coordination of on-demand, door-to-door transit services, known as dial-a-ride or para-taxi. An example is private sector airport shuttle vans.
• Emergency panic buttons that summon help for customers who perceive themselves in danger at bus stops and on transit vehicles. These are found at bus stops on the campus of University of Washington in Seattle.
• Real-time information over the phone or on the Internet describing which among many to take, where to transfer to reach an unfamiliar destination, and when your bus will arrive.
• Bus drivers using special radio devices to change traffic signals preemptively to green, know which bus stops to skip, and when to deviate from congested routes to move faster.
• Riding transit as a passenger provides a safer environment than driving for use of cell phones and Web browsers.
• Telecom-based educational and communications services on mass transit vehicles as part of service to customers – distance learning, online shopping, sending messages.
• Closed circuit video surveillance cameras to provide security in park and ride lots and transit stops.
• Telephone- or Internet-coordinated ridesharing and vanpooling, including instant, one-time arrangements.
• Traffic forecasts for daily commuters that indicate when mass transit is a faster mode than driving alone.
• Provision of special electronic pager devices to frequent customers that let them know when their bus is getting close.

Source: Global Telematics

While there are many personal and economic benefits to be achieved through telecommuting and associated work behavior changes, research fails to support some of the popular conclusions that are reached about benefits of telecommuting on travel demand. Like high capacity mass transit, telecommuting lets thousands of rush hour travelers stay out of road congestion, but a variety of limits and dynamic considerations about human and organizational behavior will likely cause traffic congestion to continue.

There is little evidence that telecommunications applied to the activities that cause people to travel generally is going to result in a reduced number of vehicle trips and vehicle miles traveled in the foreseeable future, and much theoretical justification exists for thinking that telecom will stimulate more vehicle movement.

Telecom use in the form of Intelligent Transportation Systems (ITS) brings improvements to the movement of people, goods and services. ITS in some ways, like freeway ramp metering, reduces congestion, and in other ways, like warning travelers of blockage locations, makes congestion more avoidable or tolerable.

With telecommunications, as is the case with all applications of technology, the law of unintended consequences applies. Some will be positive, and some will be negative or create their own complications. Growing wireless telecommunications capability – cell phones, Internet, and other technology – inside of private automobiles and delivery trucks is a wild card that needs to be monitored closely.

Recommendations

- In light of telecom-facilitated changes in human and organizational behavior, the task of Regional Transportation Planning Organizations (RTPOs) in planning for continuing passenger and freight mobility is difficult. New methodologies that acknowledge a higher degree of uncertainty and risk are needed. Cascadia RTPOs have a strong professional reputation, and could lead the way for North America in changing how planning is done. In light of the complexity and opportunity that wireless telecom, the Internet, ever-more powerful computers, and ITS bring to the future, political leadership should encourage their RTPOs to develop planning techniques that yield a more flexible, robust response to market-driven and technology-driven forces.[52]

- More emphasis should be placed on ITS investments in public transportation budgets to gain more performance from existing road infrastructure. An explicit examination of the cost-benefit returns in reprogramming public resources from building concrete and steel infrastructure to installing more ITS applications should be pursued.

- The potential of ITS – in particular adaptive cruise control that provides for automatic braking and lane keeping to make passenger automobile travel along freeways take on the characteristics of train travel – should be carefully considered in the competitive analysis phase of planning for capital expenditures in intercity passenger rail.

- Given that vehicle breakdowns and accidents cause approximately 60 percent of urban traffic congestion, the implementation of ITS systems that would inhibit such incidents, or that would hasten vehicle detection and clearance by authorities, should be emphasized.

- Transportation planning authorities should make effort to use the existing vehicle tracking capabilities of private truck fleet operators as a source of data to monitor and report the performance of the road system in moving all types of cars, buses, and trucks.

- Enhanced educational efforts should be pursued by state and provincial governments to inform public and private organizations on the opportunities for enhanced performance through teleworking from home.

- A research-based, knowledge-building, idea-sharing Cascadia Transportation Forum along the entire Eugene-to-Vancouver corridor offers hope for a more productive understanding of the logistics, consumerism, and congestion dynamics, powered by telecommunications, that characterize the economy of Cascadia today. This Forum could lead to leveraging innovative, comprehensive non-capital solutions as suggested in the Cascadia Transportation Project Phase I Report. Smarter investment in the multi-jurisdictional Region could lead to a better mixture of transport and telecom supporting the social and economic desires for proximity, transactions, and relationships.

- The recommended Forum should establish a step-by-step method of learning how the process of telecom applications development and deployment can be changed to yield a higher level of mobility improvement than would otherwise occur. Measurement of trip-volume impacts should be built into the process, based upon a foundation of learning how particular technologies affect particular trip types in particular organizational and customer circumstances.[53]

Recommendations of topics for further research that would lead to better public and private policy include:

- The effect of telecom applications, including the Internet, on modes of personal mobility, namely individualized transport in private vehicles versus mass transit.

- Media choice – business preferences for face-to-face versus telecom.

- Why major employers like Boeing and Microsoft do not embrace teleworking for their office workers to the same degree as Hewlett-Packard and IBM do with similar jobs.

- More emphasis on measuring the travel reduction implications of particular telecom applications, including electronic service delivery by organizations, which face parking and other transportation difficulties.

- Evaluation of State of Oregon's program of tax credits to spur telecommuting[54] to determine if adoption of other jurisdictions is warranted.

- Detection and measurement of changes in traffic volumes and patterns that can be linked to teleworking and teleservices, along the lines of Figure 2 earlier.

Final Word

Telecommunications and transportation "deliver" distant locations to us in very different ways. The relationships with distant places that each technology offers are quite distinct. Because of the differences in how they span distance, telecommunications should be considered less as a replacement for transportation and more as a way of adding quality to transportation and to the experience we have at a travel destination. Telecom lets us make sure that the time and dollar resources that will necessarily be consumed in travel are well spent. Telecom helps us decide where, when, and how to go.[55] The value of a transportation system that lets us go when and where we want to go is not diminished as telecom becomes more pervasive and powerful, but rather is enhanced.

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About John Niles

John S. Niles is a senior fellow at the Discovery Institute and owner and president of Global Telematics, a policy research and management consulting firm based in Seattle. He works with innovators from business and government on regional telecommunications strategy, public transportation revitalization, and economic development planning.

He has led projects that linked telecommunications development to public policy in Idaho, Washington, Oregon, Montana, California, Minnesota, and Kentucky, as well as in the federal government. He is the principal author of the landmark study for the U.S. Department of Energy, *Beyond Telecommuting: A New Paradigm for the Effect of Telecommunications on Travel* (1994).

As a management consultant, Mr. Niles has been on the development and start-up teams of eight successful business or community service enterprises. He has provided advice and counsel to business and government leaders in North America, Asia, Australia, and Europe. He is a leading interpreter of how advanced telecommunications changes the way people live, work and move around. Mr. Niles has written 25 published articles and several books, including co-authorship of *The New Management: Line Executive and Staff Professional in Future Firm* (McGraw Hill, 1976). His views have been quoted in many publications, including the *New York Times*, *Christian Science Monitor*, *Los Angeles Times*, and *Washington Post*. He has also appeared on the PBS show "Nightly Business Report" and on National Public Radio's "Morning Edition," and spoken at forums such as the Annual Pacific Telecommunications Conference, and the National League of Cities Annual Congress.

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He began his independent consulting career as a member of the start-up team of Control Data Corporation's Local Government Information Network (LOGIN), 1979-1984, based originally on the CYBERNET and TECHNOTEC mainframe computer technology of CDC, and lately migrated to the World Wide Web.

Earlier in Mr. Niles' career, he served as a project manager in the first District of Columbia home rule government of Mayor Walter Washington (1974-78), and before that as a U.S. Naval Officer in Patrol Squadron 26 (VP-26), 1971-74.

He earned his bachelors degree in mathematics at Massachusetts Institute of Technology (1968), and a master of science in industrial administration at Carnegie Mellon University (1970). John Niles grew up in Detroit, Michigan and attended Cass Technical High School, graduating in 1964.

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