The Case for Smarter Transportation

IBM

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Transportation is the circulatory system of our economy. Though many people take it for granted, every day the world relies on a complex network of transportation systems to move people, food and the products that sustain civilization. Airplanes, trains, ships, cars, buses, trucks and bicycles navigate myriad routes to reach their destinations. Even if you don't leave your home, your life is still influenced by this massive system: virtually every tangible good—food, clothing, medicine, fuel, and electronics—has been transported into your world from somewhere else.

Transportation is the circulatory system of our economy.

Collectively, these systems facilitate the full range of human activity, from commerce to education to recreation. This crucial transportation circulatory system consists of:

- *Vehicles*, *aircraft*, *trains and ships* that move people and cargo from one place to another.
- *Infrastructure* that makes it possible for movement to take place (such as roads, rail lines and bridges).
- *Terminals* where journeys begin and end, where passengers transfer from one mode of transportation to another and where freight is organized and assembled (for example, stations, car parks, airports and seaports).

The types of vehicles, infrastructure and terminals are different from system to system, and from era to era. But the basic dynamics of transportation remain. And as we consider the future of our current transportation systems, we find ourselves at a crossroads.

Globalization, population growth and rampant urbanization are conspiring to overwhelm transportation systems around the world, many of which were built to accommodate a fraction of their current load. Over the last 50 years, international trade in manufactured goods grew 100-fold. In 1950, there were 83 cities of a million people or more. Today, there are 476[1], and more than half of the world's population lives in urban areas.[2] And demands on the world's transportation infrastructure are expected to increase at double the rate of population growth.[3]

The negative effects of these overburdened systems in mature markets are not hard to quantify:

- Almost one-quarter of U.S. scheduled flights in 2008 were delayed;[4]
- Traffic congestion costs the European Union more than one percent of gross domestic product (GDP)—or over 100 billion Euros per year;[5]
- Less than half of container vessels arrive in port on schedule;[6]
- Twenty percent of CO^2 emissions are the byproduct of transportation;[7]
- U.S. drivers wasted 4.2 billion hours, 2.8 billion gallons of fuel and $87.2 billion due to traffic congestion in 2007.[8]

These trends are inefficient and unsustainable. They're also incredibly expensive. They jeopardize the growth of businesses, cities, countries and entire regions, constricting economies and wasting money.

That's why operators around the world are gearing up for major infrastructure projects to break the logjams. It's estimated that in the next 20 years up to $30 trillion will be spent on transportation infrastructure.[9] And emerging economies are heavily investing in transportation to serve the needs of their swelling populations and to support economic development.

But we're going to need far more than just new infrastructure to solve these problems, because the cost of maintaining our existing roads, rails, equipment and terminals is already straining government budgets and corporate balance sheets.

Fortunately, *we are on the verge of a transformative change* for the world's transportation systems. For the first time, we can measure, monitor and manage transportation operations in real time.

We find ourselves on the verge of a transformative change for the world's transportation systems.

But to build truly smarter transportation systems, we will also need to:

- Increase the capacity of existing transportation networks by accurately predicting demand and better aligning capacity for both passenger and freight carriers.
- Build an enduring economic and political case for change using more complete information about costs, pricing and demand.
- Create new business models to attract private and public investment.
- Develop advanced traffic control systems for air, land and sea; design intelligent vehicles, aircraft and trains that act as nodes on an integrated network.
- Empower customers with information about their transportation choices.
- Reduce energy use and harmful emissions, while assuring safety.

In short, we will need smarter transportation.

The important work toward this transformation has already begun. And as each element of digital infrastructure is applied to our roads, railways, ships and aircraft, we move one step closer to a more effective global transportation system for the 21st century.

Catalysts for Smarter Transportation

We see three key catalysts that are increasing the pressure on transportation systems and ratcheting up the urgency for improvement. They are each fueled by the unrelenting demand for faster, cheaper and better transportation options brought about by population growth, urbanization and globalization. And though these catalysts may carry different weight between developed and emerging regions, and between different modes of transportation, they are virtually universal.

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1. **The need for new, more sustainable public and commercial revenue models.** As older transportation infrastructure deteriorates, traditional revenue models—such as tax revenue for public transport and roads, passenger fares on commercial carriers and fees for freight—are no longer sufficient to cover costs or generate adequate profits. The systems need fixing, and some projects require massive infrastructure overhaul, costing billions. But few are willing or able to pay for it.

   For these reasons, *we need to do more with less*. The prices and taxes we pay must reflect the true costs (construction, operation, fuel, environmental impact and safety) so that customer demand, and therefore public and private investment, will gravitate to the most efficient modes of transportation.

2. **Global and regional competition.** To be competitive, both private operators and governments must provide efficient, convenient transportation services. A city's prospects for future growth depend on competing for corporate and residential tax revenue. Businesses locate in cities that provide easy access to goods, services and employees. Residents count transportation high among quality-of-life criteria. And commercial carriers face increased competition within and between modes of transportation. For example, on some short routes, high speed rail has taken majority market share from airlines.

3. **Greenhouse gas emissions and energy consumption.** In some countries, the transportation sector accounts for nearly one-third of all greenhouse gas emissions.[10] As lawmakers take aim at reducing carbon emissions and energy use, and as fuel costs increase, public and commercial transportation providers need to increase throughput while reducing environmental impact. This will certainly require more efficient vehicles, but it will also require advanced road, rail, sea and air traffic management systems, fewer delays and better alignment of capacity with demand.

Our Approach to Smarter Transportation

By marrying digital technology with physical infrastructure, we can collect and analyze historic and real-time data about how transportation networks are used. We can use analytics to predict demand and balance capacity within and throughout modes of transport. We can model future demand, capacity, cost and impacts. And we can use data to build defensible cases for change; change that is economically palatable and profitable; change that requires less investment than simply building more roads, bridges, airports and rails.

This is our approach to smarter transportation. It is an approach that begins with creating a strategic transportation vision, identifying and coalescing key stakeholders and aligning with the overarching goals of the region or business. It relies heavily on data, and as such requires standards for the exchange of information among systems, yielding a detailed understanding of current cost and asset utilization and how demand patterns can be expected to change in the future.

This strategic approach often will not be accomplished through a single master plan, centralized control or government mandate. In many cases it will be accomplished by independent parties acting in their own best interest to serve customers and constituents, reduce costs and prosper. And the solutions that are employed will address four strategic imperatives in parallel:

1. **Predict demand and optimize capacity, assets and infrastructure.** Current transportation systems experience both congestion and under-utilization because demand is not accurately predicted, capacity is poorly managed and loads are not balanced. This wastes money and time and degrades service. Transportation providers need deeper insights and predictive models for demand throughout the network. Some are already collecting and analyzing historic and real-time data from digital devices to see patterns based on recurring factors such as location, time and date, unplanned factors such as weather and intentional actions such as price changes and promotions. The sources of this information include sensors on vehicles and infrastructure, video monitoring, GPS data, mobile phone signals, satellite images, air traffic control data, reservation systems, smart fare cards and more.

   Armed with this holistic view of demand, managers can employ advanced traffic management systems for land, sea and air which allow operators to model and manage optimal routes, schedules and capacity in real time.

The sharing of data can also enable compelling new sources of revenue and innovative business models. In the commercial arena, there is the potential for a new transportation service industry: Integrated Travel Providers that can own and operate multiple modes of transportation and offer end-to-end travel services; Mobility Service Providers that aggregate information about all modes of travel and serve them up to customers on mobile devices, making it possible for travelers to shop, purchase and execute their travel with continuous information updates; and Lead Logistics Providers, independent parties who aggregate and coordinate end-to-end shipping, providing freight customers with self-service tools and a single contract.

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Data driven traffic management also provides new opportunities for revenue generation. Road congestion charging has shown great promise in both reducing traffic and raising money. And usage-based tax models such as road-user charging based on miles driven, zone entry charges, or tolls can replace gas tax revenues while helping shape behavior.

In 2005, Stockholm's city center was buckling under the weight of nearly half a million commuter vehicles every weekday. Commute times were rapidly rising. And city residents were concerned about the environmental impact of gridlocked car traffic.

The Swedish National Road Administration worked with IBM® to implement a road charging system to reduce congestion and encourage use of public transit and green cars. Congestion was reduced so much that bus timetables had to be changed to reflect faster transit times. And the citizens of Stockholm voted to make the system permanent.

The program reduced downtown traffic by 18 percent, reduced CO^2 emissions by 14 percent in the city center and increased public transportation ridership by 80,000 passengers per day. Inner-city retailers saw a six percent boost in business. What's more, estimated revenue of €84 million is channeled back into improving public transportation.

Researchers at KTH Royal Institute of Technology in Sweden are gathering real-time information from the Global Positioning System devices in nearly 1,500 taxi cabs in Stockholm and will soon expand to gather data from delivery trucks, traffic sensors, transit systems, pollution monitors and weather information. The data will be processed using IBM streaming analytics software, giving city managers and travelers real-time information on traffic flow, travel times and the best commuting options.

For example, a resident could send a text message listing their location and desired destination. The technology would instantly process the real-time traffic, rail and weather information and provide anticipated travel times via car and public transportation, giving the individual an accurate and instant view of the fastest way to get to his or her destination.

Also see: Singapore Land Transport Authority

In a smarter transportation system, travelers and freight customers are empowered with information and tools to determine for themselves the best way to move from origin to destination, throughout all modes of transportation, with due consideration to cost, time, convenience and environmental impact.

2. **Improve the end-to-end experience for travelers and freight customers.** In a smarter transportation system, *travelers and freight customers are empowered* with information and tools to determine for themselves the best way to move from origin to destination, across all modes of transportation, with due consideration to cost, time, convenience and environmental impact. These tools can also simplify supply chain planning, pricing and execution for freight customers, provide information about alternate routes and schedules and enable real-time alerts, promotions, and information about connecting carriers.

   Other smarter transportation capabilities can impact the customer experience as well: advanced traffic management can reduce delays; better planning of routes and schedules can improve on-time performance; and self-service technology can reduce lines and help make air and rail terminals more efficient and convenient.

   When Air Canada wanted to extend self service beyond the airport by integrating mobility into its self-service portfolio, the airline saw the opportunity to introduce a new class of services that makes the most of the "always on" nature of mobile devices and creates a dialogue with customers.

   Air Canada engaged IBM to develop applications for the Apple iPhone, iPod Touch and BlackBerry that allow passengers to download electronic boarding passes, check in, get flight status, book rental cars and more. There were

more than 30,000 downloads of the app in 64 countries in the first six days, with a 60 percent increase in mobile check-ins. Ninety-three percent of Air Canada passengers say self service has improved their travel experience. The app saves 80 percent of the per-check-in cost compared to counter check-in. The project won the Canadian New Media Award for Best Mobile App of 2009.

Also see: Amsterdam Schiphol Airport Baggage Handling

3. **Increase operational efficiency while reducing environmental impact.** The inefficiencies of today's transportation systems can translate into deteriorating service, excess cost, energy use and environmental impact. And in urban areas we are reaching the limits of how much land can be dedicated to new roads, rails and terminals.

   Transportation systems are tremendously asset-intensive and use large amounts of energy. Smarter systems optimize existing assets and infrastructure, minimizing the need for increased investment. They save money and time by knowing the location, status and availability of all equipment and assets. They can shift from scheduled to predictive maintenance which improves up time and equipment life. *Energy use, carbon emissions and cost can be reduced* by monitoring vehicles in real time and by better planning of supply chains and parts inventories. Crew planning tools ensure personnel with the necessary skills are available where and when they are needed. Cargo loading can be accelerated and the number of trips required can be reduced using analytic tools. And the financial impact of different operational choices can be modeled to make the most of revenue and cost.

   China Ocean Shipping Company (COSCO) is China's largest shipping conglomerate, operating in more than 1,500 ports in 160 countries. COSCO needed to make the most of its distribution resources to strengthen its competitive position. Fundamental to this goal was preparing for growth in the area of logistics services, without affecting service levels. When COSCO pursued this path by acquiring other logistics service providers, it inherited redundant facilities and shipping routes, causing inefficiencies.

In order to provide a truly interconnected service, COSCO implemented a supply chain optimization solution that provided data-driven recommendations for the five major logistic areas: product development; sourcing; production; warehousing; and distribution.

The solution streamlined COSCO's distribution network, reducing the number of distribution centers by 60 percent with no degradation of service. Logistics costs were reduced by 23 percent through leaner inventory management, efficient loading and optimized route planning. Their CO^2 emissions fell by 15 percent, along with a 25 percent reduction in fuel costs. The transformation of COSCO's supply chain not only benefited the company's bottom line, but also allowed COSCO to use environmentally sustainable practices supporting its obligations as a member of the United Nation's Global Compact and making it possible for the organization to meet its own internal corporate social responsibility expectations.

4. **Assure safety and security.** Paramount to the success of any transportation system is safety and security, which cannot be compromised. Fortunately, a smarter system can improve safety and security even as costs are reduced. *Sensors provide data to enable a shift from scheduled to "predictive" maintenance* and can monitor the condition of equipment and infrastructure in real time, avoiding impending failures. Video cameras can constantly scan rail lines, airports and roadways while analytic tools identify risks. Advanced traffic management systems can reduce congestion and accidents.

   Also, a smarter transportation system can improve security by detecting and evaluating threats through analysis of passenger information, electronic surveillance and biometric identification and by ensuring that passenger and cargo data is only accessible to authorized personnel.

   The border agency for one of the world's most heavily travelled nations was formed to strengthen border protection without impeding the progress of lawful travelers. The agency has more than 25,000 staff throughout 135 countries.

Using advanced analytics implemented and supported by IBM, the agency initiated a program to integrate advance passenger information, biometrics and data sharing between stakeholders including airlines, immigration, police and customs. The strategy, known as Advanced Passenger Processing, makes it possible for the agency to move their border controls as far as possible from their national frontier by checking visitors in advance of their arrival at the border.

It works like this: A near real-time risk assessment is performed while the traveler is in transit, by comparing information from travel documents and carrier reservation systems to the latest watch lists looking for a match. This enhances security and speeds up processing for the vast majority of visitors and citizens. The assessment identifies matches with a high degree of accuracy. Matches are passed on for human validation to determine whether a match should be regarded as a genuine risk and thus become a "hit" and potential "alert." Alerts are passed on to the appropriate border control agency for action. The goal is to clear low risk passengers as early as possible in the travel process, so that the agency can focus their attention on those that generate a hit.

By mid-2009, after nearly four years of operation in a number of ports-of-entry and for selected transportation carriers, the project has handled more than 106 million passenger movements per annum. It has greatly assisted a number of counter-terrorism operations and led to more than 1,900 arrests for crimes including murder, rape and assault.

Conclusion

Transportation systems are complex. But they are not more complex than many of the other systems that IBM has worked to transform by collecting data, analyzing it and making smarter decisions. Global financial markets have reaped the rewards of these efficiencies. So have hospitals, global retailers and government agencies.

Smarter transportation can drive economic vitality and improve our quality of life.

Smarter transportation can drive economic vitality and improve our quality of life. It can be more efficient, provide better service to customers and constituents, protect the environment and help assure our safety and security. That's why IBM is working with some of the most advanced operators of transportation networks in the world, from municipal governments to railway operators to airlines. We have the technology today to start giving travelers and customers what they really want—smooth seamless door-to-door transportation. Let's build smarter transportation for the 21st century.

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