A SMARTER TRANSPORTATION SYSTEM FOR THE 21ST CENTURY

A Frost & Sullivan White Paper
INTRODUCTION

Globalization, for better or worse, is a dominant feature of our world. As barriers between continents, countries and cities have diminished, and a surging population has urbanized, economic growth and prosperity have become inextricably linked to accessibility; accessibility to markets, to production materials, to services, to food and to culture, which are all preconditions for human survival. The increasing density of urban living, however, can slow the movement of people as well as goods; therefore, accessibility is dependent on an efficient and intricate global network of air, rail, road, and water links between and within our population centers of cities and megacities.

This paper finds that our aging transportation system is threatening to restrain globalization as current systems are struggling to meet the needs of this highly urbanized planet in which the business of moving goods and people from one place to another typically generates toxic byproducts and lost productivity. Ground-breaking innovations in transportation technology are difficult for the current system to accommodate, and the system itself has yet to evolve to meet the changed set of fundamental needs and demands placed on it. Whereas the system has not yet completely gridlocked, we clearly need something that is smarter, more efficient, and better than what we have now.

We think the answer is a new ecosystem that marries information technology to the global air, rail, road, and water transportation networks.

A 20TH CENTURY TRANSPORTATION SYSTEM IN A 21ST CENTURY WORLD

When the current transportation system was developed over the course of the first half of the 20th century, the world was characterized by a population that was still mostly rural but moving into a period of more intense urbanization. Transportation systems were developed in isolation for a particular city or country; however, as can be seen in Figure 1 below, the effects of our current global transportation network have drastically changed since this time. The diagram created for the World Bank highlights population clusters of 50,000 people or more and looks at their travel time to major cities. Darker areas of the map indicate the remote, relatively sparsely populated places of the world; however, the dominant, brighter areas of the map indicate closer proximity to cities where transportation systems have been modified to provide higher accessibility levels. Also plotted on the map are blue lines that represent the many shipping lanes connecting coastal agglomerations.
Figure 1: An Urbanized, Interconnected World

Figure 1 also shows an important trend in population growth from the beginning of this millennium as the lighter areas highlight high population density. According to the recent UN World Urbanization Prospects report\(^1\), only 13 percent of the world’s population lived in cities in 1900, which grew to 29 percent in 1950, and was estimated at 49 percent in 2005. Not only are we migrating to the cities, but our cities are getting bigger and more numerous. In 1950, there were 83 urban areas with more than 1 million people living in them. Today, in 2010, there are 476 of these spread around the world\(^2\). Cities and megacities are the organs of the global economy, and intercity travel and transport is the lifeblood.

In parallel with this global urbanization trend and need for long-distance transportation networks, a complementary trend toward “suburbanization” was beginning, wherein urban centers grew outward into suburbs, and further still into exurbs. In this modern topology, ring roads encapsulate the urban areas, and highways and commuter rail systems provide connectivity between the cities and their suburbs and exurbs. A web of streets, roads, and highways are woven into all cities of any size, while most large cities also have some sort of commuter system of trains and streetcars flowing above and under the ground.

Intercity travel was also becoming increasingly common. Urban centers are the nexus nodes binding the world together. Global economic command centers, such as Tokyo, New York, Los Angeles, London, Chicago, Paris, Mexico City, Hong Kong, and Buenos Aires, constitute a substantial portion of national economies. People, goods, services, and information continually flow between urban centers, forming the foundation of global society. The system of aircraft, cars and trucks, trains, and ships interconnecting urban centers forms the large, complex, and increasingly congested global transportation system that we have in the 21st century.
Key technical achievements have been fundamental in helping to achieve today’s globalization levels and have laid the foundation for an ecosystem that allows the seamless movement of large volumes of goods around the world. The 1960s kick-started this technological burst with the ISO container, which streamlined the rapid global shipping of goods, and the Boeing 747, which streamlined the rapid movement of people and talent around the world. Since that time, advances in information and communications technology have helped to drive globalization even further.

The majority of today’s transportation systems are a by-product of systems that were designed and established in the 20th century. However, our increasing demands are pushing them past their intended capacity and operational life span. In recent years, we have seen the start of new transportation systems being developed, which require massive infrastructure works and are inherently dependent on information and communication. These systems, however, require significant planning, funding, governmental backing, and construction activities as they are being designed for decades’ worth of use. It is crucial for the transportation industry to understand why our transportation needs are changing in order to best design and implement new systems so they are robust and flexible enough to take us into the 22nd century.

THE DRIVERS THAT ARE PUSHING THE NEED TO CHANGE OUR CURRENT TRANSPORTATION ECOSYSTEM

We believe there are four fundamental factors that underlie the need to change the transportation ecosystem: a rapid population expansion, hyper-urbanization, globalization, and pervasive information and communications technology.

1. A Rapid Population Expansion
One of the most well-recognized root causes of transportation system congestion is the relentless growth of world population. At the dawn of the 20th century, when many of the current transportation systems were being planned, the global population was approximately 1.6 billion. In 1950, it was roughly 2.5 billion, and by then end of the 20th century, it was 6 billion strong. As we closed out the first decade of the 21st century, the global population was estimated at almost 6.8 billion. While the number of people has increased an average of 1.5 percent per year over the past 60 years, and is expected to average 1.0 percent over the next 20 years, demand on the transportation systems is expected to increase at double that rate over the same period.

2. Hyper-Urbanization
The complexities involved in meeting the transportation requirements of high-density cities, as well as newer forms of community arrangements, drive the need for a next-generation transportation ecosystem. Considering the physical growth restrictions cities across the world have, we find that urbanization is moving in two ways: the formation of “Mega Cities” and the appearance of “compound communities.”

By 2020, it is expected that developing economies will lead the way in forming Mega Cities to accommodate their rapid population expansion. We already see that the boundaries of Johannesburg and Pretoria in South Africa are merging into a Mega City that is commonly
known as “Jo-Toria.” Current transport infrastructures anchored primarily by roadways are largely inadequate to effectively move people and things around these Mega Cities.

Considering another example, it is expected that planning in densely populated cities such as Sao Paulo, Brazil, and Chennai, India, will evolve to develop compound communities. Here, offices and homes will move adjacent to one another to form areas where people live and work in small compounds. The short-distance travel and transportation needs of these community compounds will be based in personal mobility, as well as the transportation of goods within them (e.g., food), which are not readily accommodated by current transportation systems.

3. Globalization
In the often-cited Thomas L. Friedman concept of a "flattened" world, the blurred national borders impacting trade, outsourcing, supply-chains, and politics have, for both better and worse, changed the world. The impact of globalization on transportation has been to increase the traffic across all types of transport between urban centers, and charged demands for increased speed, security, and reliability. The next evolution of the transportation ecosystem must deliver something from point A to point B, with a high level of service, regardless of the distance traveled, the borders crossed, or the number of steps in between.

4. Pervasive Information and Communications Technology
Although the basic modes of transportation technology – road, rail, air, water – have evolved, the rapid spread of information and communications technologies into every facet of life is driving change in the global transportation ecosystem. Sensors and microchips are pervasive across the system. Transmitting the data that they gather to processing and analysis points can enhance the capabilities of the current system, as well as lay the digital foundation for new infrastructures. From infotainment, tracking, and telematics applications for vehicles, to real-time scheduling and notification for air travelers, to security monitoring and threat detection for shipping containers, information and communications technology is a strong catalyst in an evolving transportation ecosystem.

Transportation systems of the future must adequately account for the macro changes that we are seeing in these four core areas, at the same time as minimizing the inefficiencies that we can see in today’s systems.

THE CONSEQUENCES AND COSTS OF AN INEFFECTIVE TRANSPORTATION ECOSYSTEM
The consequences of inefficiencies in the transportation ecosystem resonate on a personal level. The hour-and-a-half it takes to go 10 miles in a morning commute; the late shipment from the supplier on the other side of the world delaying the production run; the permanent brown haze coloring the skylines of our cities. We know that our transportation systems cannot deliver to our expectations. On a broader scale, the costs
of an inefficient system are more subtle, but may be more critical. We can seek to understand the impact of inefficient transportation systems by assessing two categories: the economic impacts and the environmental impacts.

**Economic Impacts**

One glaring illustration of the impact of an inefficient system is the economic cost due to transportation congestion. Sitting in traffic, for instance, is a drain on the economy. U.S. road congestion in 2007 wasted approximately 2.8 billion gallons of fuel, and more than 4.2 billion hours of lost productivity, for a combined cost of $87.2 billion. These costs are not only found in road traffic congestion, as air traffic congestion in an inefficient transportation system also has substantial economic costs. In 1998, a study done for NASA forecast that the cumulative effect of air traffic congestion would burden the U.S. air travel industry with $53 billion in increased operating costs and $46 billion in lost airline output by 2010.

On other measures, the inability of the current transportation system to keep up with demand slows the global supply chain. Container ports present glaring examples of these inefficiencies. In 2003, the U.S. Chamber of Commerce forecast that every major container port on the U.S. Eastern seaboard would triple the volume in containers handled by 2020, while some on the Western seaboard would quadruple in volume. In the first quarter of 2007, APL, the global transportation and logistics company, stated that globally only 46 percent of container vessels arrived into port on schedule. In Europe, this figure fell to only 30 percent of vessels being on time, while in its largest port of Rotterdam, the figure was only marginally better at 35 percent on time. The global economic recession of 2008-2009 did relieve some of the congestion in container ports, but as the economy improves, congestion will return.

**Environmental Impacts**

There are a number of environmental impacts from the current transportation system, and one of the most obvious is CO2 emissions. The U.S. Environmental Protection Agency estimates that transportation is the second-largest source of CO2 emissions in the U.S., accounting for almost one-third of all CO2 emissions, and the OECD estimates that the figure is 20 percent on a global basis. Of this, the overwhelming majority is due to road transportation, with aviation placing a distant second.

Urban heat islands, a phenomenon in which metropolitan areas tend to be significantly warmer than surrounding rural areas, are strongly linked to the use of concrete and asphalt in buildings and road surfaces, as well as waste heat from automobiles (anthropogenic heat) and air pollution. For instance, the city of Chicago draws attention to the contributions of transportation and the urban heat island effect in its Chicago Climate Action Plan. Apart from changing the microclimate in a city, urban heat islands can also trap pollutants in an inversion effect, threatening inhabitants' health.

There is also a strong link between the economic and environmental impacts of congestion in the transportation system. The brown haze obscuring the skyline of Hong Kong is becoming a permanent feature in the city of 7 million. Research by the University of Hong
Kong’s Department of Community Medicine estimates that air pollution, caused in large part by ships and vehicle traffic, cost the city’s economy $HK 1.8 billion in 2009 in air pollution illnesses and lost productivity\(^\text{11}\). Other work by the Civic Exchange, a Hong Kong-based economic think tank, suggests that half a million people, a substantial portion of its professional class, will leave the city because of this air pollution\(^\text{12}\).

**THE NEXT REVOLUTION FOR TRANSPORTATION – A SMARTER TRANSPORTATION ECOSYSTEM**

As the paper has highlighted, current transportation systems are nearing their capacity limits, and a better system must be developed to adequately manage our interconnected world.

Future transportation must be “smart” in that it needs to be able to not only react quickly to the demands placed on it, but also anticipate them. This new system should address four main challenges that are emerging from the current system, as shown in Figure 2.

**Figure 2: Challenges for a Smarter System**

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<tr>
<th>Mitigating Congestion and Planning Capacity</th>
<th>Empowering Transportation System Users</th>
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<tbody>
<tr>
<td>The smarter system must be able to meet a growing and dynamic demand for transportation and provide for efficiency, consistency, and profitability to its users.</td>
<td>The smarter system must be able to deliver choices to its users, with an array of options that cater to different users segments, reflecting the needs of the segments.</td>
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<tr>
<th>Ensuring Safety and Security</th>
<th>Eco-Efficiency</th>
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<td>The smarter system must be safe for all users, including passengers and freight customers, and must minimize exposures to risks while protecting the integrity of users’ information and interests.</td>
<td>The smarter system must respect the environment, limiting or inhibiting adverse impacts on it, while also using natural resources efficiently.</td>
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The better, smarter transportation system we envision addresses these challenges to make transportation efficient, reliable, safe, and eco-conscious. Because transportation is so integral to our economic well-being, as well as lives, the 21st century system has to be a tool to generate wealth. The new system will require a committed effort with much investment and time devoted to its development in order for the return on investment to be positive. We believe that by viewing the new transportation system holistically, as an eco-system of constituent parts, the synergies derived from this new eco-system will net a positive return to the world. To guide this vision we need to create a roadmap from our current outmoded system, to the better, more intelligent or so to say, “smarter,” transportation eco-system.
A ROADMAP FOR A 21ST CENTURY TRANSPORTATION ECOSYSTEM

Given the adverse impacts that result from an outmoded transportation system, planners and strategists in all segments of the transportation ecosystem are creating more intelligent systems as a means to mitigate these problems and increase the value the system can bring. In order to implement any transportation system, there are two elements that need to be considered: the requirements for its physical infrastructure and those for its digital infrastructure.

The actual requirements of the physical infrastructure for transportation systems can be easily visualized and mapped as it is made up of elements such as:

- Vehicles that move goods from one place to another, for example cars, boats, rail cars
- Pathways and infrastructure that allow movement to take place, for example roads, rail lines, shipping lanes
- Terminals or endpoints where journeys begin and end, where passengers transfer from one mode of transportation to another, and where goods are tracked, organized, and assembled, for example stations, car parks, airports, and ports.

The complexity that comes with the design of physical infrastructure is that in most cases, many compromises have to be made to integrate a transportation network around existing structures. For example, there are more logistical problems implementing a new rail line across the city of New York compared to a new city such as Dubai, or a new eco town development. New cities have the capacity to plan themselves around transport routes and can even build overhead rail tracks so the road is free from public transportation and congestion, but older cities, such as London, do not have this flexibility. For instance, Crossrail in London is a new rail line that by 2011 will directly connect the most eastern and western outskirts of the capital. However, once it reaches the city of London, the whole line will have to go underground as there is physically not enough space for it on the surface. The construction efforts of tunneling are significantly more costly and complex than laying overground lines, but it is the only solution that will provide an efficient and fast rail connection.

The key turning point for when any transportation system becomes “smart” is when digital infrastructure is overlaid to interconnect and “fill in” the downfalls that the physical infrastructure cannot avoid. As a simple example, we know that poorly designed roads cause traffic bottlenecks, but by overlaying simple digital intelligence and systems, like traffic lights, traffic flow can be improved. Taken to a scenario in the 21st century, the physical infrastructure of automatic number plate recognition (ANPR) cameras mounted on overhead gantries for toll roads provides for the digital infrastructure of data collection, analysis, and dissemination to charge the account of an Electronic Toll Collect user.

The 21st century smarter system digital infrastructure is based on overlaying IT and Communications hardware and software at critical points in a transportation ecosystem.
This enables the collection and conveyance of information to operators and users. Elements of the digital infrastructure would include sensors and instruments placed in the physical infrastructure endpoints, pathways, and stations. Following the pathways at times, and using established communications networks at other times, the data to and from the sensors and instruments would move to central processing hubs where analysis tools can monitor, predict, and advise operators and users on actions to take regarding conditions prevailing in the physical infrastructure. Note that some actions can be taken automatically, whereas others may require human intervention.

In the smarter transportation eco-system, the physical and digital networks are interconnected to enable rapid sharing of data, control access as appropriate, and allow for feedback loops so the eco-system constantly modifies its behavior. The deeper the network penetrates into the components of the smarter system, and the wider the scope of the interconnection between components, the better it can address the users’ imperatives.

Today, we are at a point where advancements in physical and digital infrastructure can work hand in hand, placing us in a prime position to develop smart, intelligent, and forward thinking transportation solutions.

**SMARTER TRANSPORTATION SYSTEMS IN OPERATION TODAY**

When looking at the vast network of transportation systems in operation today, we can see that there are many examples across road, rail, air and sea where smart initiatives have been implemented, bringing together physical and digital infrastructure to provide intelligent networks. Our analysis has identified four challenges that smart transportation systems should address:

- Predicting demand and optimizing capacity, assets and infrastructure,
- Improving the end-to-end transportation experience,
- Improving operational efficiency while reducing environmental impact, and
- Assuring safety and security.

These imperatives are explained in more detail below, along with examples of how today's transportation industry is starting to address these with various smarter transportation solutions.

**Predicting Demand and Optimizing Assets and Infrastructure**

A major challenge raised by the current transportation system is that parts of the system experience capacity overloads and high levels of congestion, as the demand placed on assets and infrastructure are not accurately predicted and planned. Transportation system managers, operators, and service providers need to gain deeper insights into the usage of their transportation systems, therefore, one imperative that would be addressed by a smarter transportation eco-system is to enable system managers to accurately and reliably understand and model demand across the transportation network.

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It is possible to analyze historic data to uncover traffic patterns based on recurring factors such as location and time or season, as well as unplanned factors such as natural disasters, or episodic events like airline seat sales or special promotions. Armed with a holistic view of demand, system managers would be able to model scenarios and better plan routes, schedules, and maintenance on the system by optimizing assets, infrastructure, and capacity. Further, a smarter transportation eco-system would give managers the power to create dynamic multimodal plans and models, and execute real-time operations based on real-time data, which may not fall into plans based on historic patterns.

Perhaps one of the most widely publicized changes to road travel in the 21st century has been the advent of congestion charging, low emission zones, and road tolling networks. With the combined aim of moving traffic away from heavily congested city zones and roads, and reducing vehicle emissions, schemes that have been widely adopted by governments received positive feedback from users and have been successful in reducing traffic volumes and moving passengers toward mass transit solutions.

**Case Study: Congestion Charging in the City of Stockholm**

Stockholm is an interesting case for Congestion Charging, as the aim of the scheme was not only to reduce the 450,000 cars that traveled through Stockholm on a daily basis, but also to better manage the flow of traffic in and around the complex network of islands, bridges and small access roads of the city during peak hours. The trial that began in July 2006 is still in operation today, and as announced during the ITS Conference in September 2009, the city has seen CO2 emissions reduced by between 14-18 percent and the number of passengers using public transport increased by 60,000 passengers per day.

Figure 3 below highlights the business benefits that have been seen as a result of the scheme, which clearly highlights how the city’s assets have been optimized through the use of the Congestion Charging scheme.

**Figure 3: Business Benefits Seen from the Stockholm Congestion Charging Scheme, 2008**

- 20 – 25% reduction in overall traffic volume in central Stockholm
- Significant reduction in economic costs associated with traffic congestion
- Generation of an estimated €84M that can be channeled into further reducing congestion – making the initiative virtually self-sustaining
- Improved climate for commercial transport and logistics
- Improved air quality
- Improved response time for emergency vehicles

Source: IBM On Demand / Frost & Sullivan
IBM was responsible for the design and development of the system, which was developed using SAP and WebSphere software. Flexibility for payment methods allows travelers to have the fees automatically withdrawn from their bank account and to allow citizens to view their account information online and pay or dispute fees. This self-service solution has allowed the city to better manage their resources and focus on other transport planning areas.

Case Study: Singapore Land Transport Authority
Public transportation requirements in Singapore are immense, with nearly 3 million people riding the bus and 1.6 million people riding the train every day. Coupled with an expected population increase of 50 percent over the next 10 years, Singapore’s Land Transport Authority (LTA) decided it needed to develop a new fare processing system that would allow any card issuer to issue cards for any part of Singapore’s public transport system. The LTA wanted to understand the demands placed on the entire transport network in order to configure the most convenient routes, schedules and fares so that public transport would be seen as more attractive for passengers.

Since the implementation of the new Symphony for e-Payment (SeP) system has been implemented, the Singapore LTA has seen an 80 percent reduction in revenue leakage from “lost” transactions that were previously due to systems issues, a 2 percent reduction in the overall lifecycle cost of the fare processing system, and, most impressively, a doubling of performance capacity to the current level of 20 million fares per day.

The new system also allows the Singapore LTA to review the overall commuter base of Singapore and create profiles on routes that are commonly taken, main connection bases, and analyze how patterns change over time. With this insight into the demand on the transportation network, the LTA is able to further enhance the performance and, in turn, the attractiveness of public transport for residents of Singapore.

Improving the End-to-End Transportation Experience
A second challenge flowing from the current transportation system is that its users and customers often are presented with a limited range of choices for moving their goods or themselves from point to point. For instance, flight delays due to poor capacity planning or weather delays routinely strand passengers in airports, leaving them angry and dissatisfied with the airlines. As a result, system operators can lose customer loyalty and suffer from weakened brands.

A smarter transportation system could help transportation system operators and service providers differentiate their customer service offerings from their competitors. It would give them a wider range of options to present to their customers and help them to improve their customers’ end-to-end transportation experience. In addition to more choice for their customers, smarter systems would also improve the customer experience by reducing delays in the system because demand is accurately predicted.
The customer experience would also be improved as customer needs and preferences are anticipated and incorporated into individual customer travel or transport plans. This could extend into the journey itself, so that individual needs could be addressed throughout the course of the journey. Also, the smarter system’s ability to connect adjacent service providers allows them to collaborate to make a movement between providers seamless during a complex journey.

With better experiences, they gain more loyal customers who become advocates for the brand, which can increase their revenue and market share on the top line, as well as improving bottom-line results, reducing cost by optimizing capacity across adjacent providers.

Case Study: Air Canada
In 2009, Air Canada showed itself to be a pioneer in integrating digital infrastructure within their transportation system to greatly enhance customer’s end-to-end experience. The company was recognized for its achievements in customer service at the 2009 Canadian New Media Awards and received the prestigious award of Best Mobile Application for its free app for the Apple iPhone and iPod touch for travelers to access their travel information. As of December 2009, Apple proudly boasted of having more than 100,000 apps, however, Air Canada has been the first North American airline to use this popular form of information dissemination and interaction platform with passengers to its advantage.

As explained by Air Canada’s Executive Vice President and Chief Commercial Officer Ben Smith, the app is the next stage of development in their existing real-time information service for passengers that are on the move. The app enables passengers to use their iPhone or iPod to check in, retrieve electronic boarding cards, track flight information, and obtain personalized itinerary details.

The app itself was developed as a native application rather than a Web-based application. As Air Canada wanted the priority to be on customer experience, the development team focused on the system architecture and user interface design, which has been successful as it has received a 4.5 out of 5 star rating on Apple’s App Store.

Case Study: Baggage Handling System at Amsterdam’s Schiphol Airport
Amsterdam’s Schiphol airport serves the third-largest international air travel market in the world and is one of Europe's largest airports with more than 40 million passengers per year and with approximately 40 percent of these passengers transferring between flights. Schiphol airport has been planning for expected future growth in passenger numbers, and to achieve this, a new baggage hall is being built with a state-of-the-art baggage management system.

As any small delay or failure in the system would cause significant passenger discomfort, the priority of the baggage system is that it is robust and fail-safe. The system itself uses RFID and robot handling, and enables the airport to control and track each bag using state-of-
the-art high availability techniques, analytics and software. This helps to monitor baggage handling performance, quickly resolve issues, and identify areas for further improvement.

The benefits that Schiphol airport will see with their new baggage management system will not only be monetary (in terms of lost baggage costs), but also with customer satisfaction. Improving speed, efficiency and reliability of baggage handling will reduce passenger transfer times and the time passengers need to wait in waiting halls and baggage reclaim areas.

**Improving Operational Efficiency While Reducing Environmental Impact**

Today, the current transportation system can be highly inefficient, and in a cost-conscious environment, inefficiencies translate into lost revenue and market share. As well, climate change and negative environmental impacts have become persistently linked to transportation. A smarter transportation eco-system has to not only improve operational efficiency across the eco-system, but it must also have a reduced environmental impact compared to the current system.

An important aspect to operational efficiency in a smarter transportation system is to increase and extend network capacity using current infrastructure and assets without increasing capital expenditure. One way to do this in a smarter, interconnected eco-system is to collaborate with adjacent service and infrastructure providers. By easily and seamlessly sharing assets across systems, routes can be planned as if there were only one large system. Better operational efficiency also increases an operator’s ability to deal with irregular operations across the transportation network.

Using asset tracking technology in a smarter system, time and costs are saved by knowing the location, status and availability of the assets in the system. Low-cost routes can be planned and updated on a regular basis with data gathered across the eco-system. Over time, this data also helps to model the financial impact of business decisions, streamline planning, and monitor performance to maximize revenue, margins, and cash flow.

A more efficient transportation system can also translate into reducing total resource use and CO2 and other pollution emissions. Least-emission routing can also be modeled in a smarter system, with a goal of moving freight or people using modes that emit minimal amounts of pollutants and greenhouse cases. In addition, distribution centers could be consolidated to lower overall emissions, and vehicle idling in traffic along distribution routes could also be controlled to minimize emissions.

**Case Study: COSCO**

An illustration of the ability of a more intelligent system to improve operational efficiency while reducing environmental impact can be seen with the China Ocean Shipping Company (COSCO). COSCO is one of China’s largest shipping conglomerates, owning or operating fleets of more than 800 modern merchant vessels with a total capacity of more than 500 million dead weight tons, a shipping volume of more than 400 million tons, and operating in more than 1,500 ports in 160 countries and territories globally.
With this global coverage, huge network of distribution channels and continued boom in shipping demand, COSCO found the need to optimize the development of its distribution center resources to strengthen its global competitiveness. Fundamental to its optimization initiative was the goal of not affecting service levels while also preparing for future business growth in the areas of higher value logistics services, such as warehousing, supply chain management and port services. COSCO strengthened its business growth through acquiring other logistics service providers, however, as a consequence, the company inherited redundant facilities and shipping routes, which caused inefficiencies in areas such as inventory management. In order to provide a truly interconnected and global service, a smarter transportation system was required.

COSCO implemented a supply chain optimization solution based on algorithms to provide data-driven management recommendations for the five major logistic areas of product development, sourcing, production, warehousing, and distribution. By taking this approach, COSCO aimed to streamline the number and placement of facilities in its distribution network, enabling more efficient and sustainable logistics processes.

Through the application of the solution, and as a result of analysis and action on the recommendations from the solution supplier, COSCO was able to implement a range of operational efficiency and environmental impact reduction initiatives, highlighted in Figure 4 below.

Figure 4: COSCO’s Operational Efficiency and Environmental Impact Benefits

This transformation of COSCO’s global supply chain not only benefited the company’s bottom line but also allowed COSCO to put into motion environmentally sustainable practices. As a member of the United Nation’s Global Compact, this application of a smarter transportation solution supports the membership obligations and helps the company adhere to its own Corporate Social Responsibility achievements.
Assure Safety and Security

Paramount to the success of a smarter transportation eco-system is safety and security. These are two concerns that cannot be compromised, and a smarter system can actually help improve these factors across the system.

Safety can be enhanced when real-time data is flowing into analysis engines. Regular maintenance schedules can be implemented from components on individual vehicles to large sections of the infrastructure. Furthermore, warnings or failures at any part of the system can be detected and addressed rapidly. Passenger and freight safety can be protected because operators of smart systems are able to predict and avoid vehicle failure, and can reduce accidents and congestion by balancing traffic across routes or modes.

Security is a growing concern for transportation systems, particularly in the post-9/11 world. Infrastructure and vehicles are highly exposed to risk because they often span large distances in environments that are difficult to control. A smarter system can enhance detection of security threats through monitoring (e.g., surveillance or location/status tracking), can assist threat evaluation, and enable rapid response to threats. Informational security can also be addressed through a smarter system. Advances in communications network security can be applied to transportation networks so that network, passenger, and freight information is only accessible to authorized personnel.

Case Study – Smarter Food Tracking

A clear impact that our interconnected world has had on our every day lives is the vast array of food that is available in our supermarket shelves. Take, for example, the U.K., which has variable climate; it is possible at any time of the year to find strawberries that may have been imported from Egypt and grapes that may have come from South Africa. The logistical operations involved in the food industry are vast, spanning continents not just countries, utilizing road, rail, sea and air networks, and requiring high levels of safety and security to track and protect the quality and integrity of goods that are being distributed.

One country that has taken heavy measures to track food is Norway, wherein an RFID “tag” developed by IBM is applied to beef or chicken at the time it is butchered and shrink wrapped, and the temperature and humidity of the conditions it travels in throughout its supply chain is monitored. When food arrives at a supermarket the tag is scanned and the recipient informed if it has been kept within the required tolerances during transit.

This system is expected to be a government requirement for all food sold in Norway by 2010 and was driven by consumer pressure for this high regulation to maintain high levels of food safety during transit. In reality, any industry, like pharmaceuticals, that requires temperature and/or humidity integrity to be maintained can benefit from the system.

Security during transit is also another key aspect that smarter transportation systems must manage, as was seen by the case in January 2010, where banana containers that were shipped to Lidl supermarkets in Madrid were found to be hiding cocaine. Chips and tags have successfully been used to assure security on transit.
Case Study – Wireless Condition-Based Monitoring in the Rail Industry

In development by IBM for the rail industry is a system of wireless sensors attached to the rolling stock called MOTES, which can communicate with each other and with a control center using a mesh network. The sensors monitor the condition and location of the equipment. This system has been successfully trialed in the rail industry to provide a smarter way to track and monitor rolling stock. The current method to track rolling stock is through the use of passive RFID tags that are attached to the rolling stock. When the rolling stock passes a wayside reader, it is identified and noted. One key limitation of the current system is that if a rail car does not move past a reader, it is not tracked. Also, high infrastructure costs due to the thousands of miles of track where a wayside reader is required, as well as replacement costs for equipment due to the harsh operating environment, are seen.

The MOTE sensors are likewise attached to the rolling stock but differ from RFID technology in that they can collect and transmit information using a variety of communication networks, thereby removing the need for thousands of wayside readers. In addition to location, MOTES can also record and transmit other important information, such as the condition or temperature of key components. Rail operators are able to readily identify the location and condition of rolling stock, enabling better asset utilization and predictive maintenance.

Another interesting development in the rail industry is the trialing of IBM’s first-of-a-kind project to provide a safer working environment in train yards. In FOAK projects, IBM researchers join with clients to test new technologies on real business problems. Train yards are very complex industrialized and dangerous workplaces, with many tracks and many trains going back and forth. Workers have frequently suffered loss of limb or even life if they happen to be in the wrong place at the wrong time. Using digital video surveillance, sensors, and RFID technology, IBM is developing a system to monitor train yards and track the location of workers to identify potential safety breaches. Video technology can also be used to supplement or replace the physical inspection of locomotives, rail cars, and fixed equipment. It is also possible to leverage technology to test rail tracks themselves to sense wear and tear. Advanced analytic systems aggregate data from multiple sources to identify and mitigate risks and to alert operators.

CONCLUSIONS ABOUT THE SMARTER TRANSPORTATION ECO-SYSTEM

The world marches on, and the essential human activity of transportation will continue regardless of the state of the world’s transportation systems. We believe the current systems served their purposes well, but they are in need of an update to accommodate the needs of the new millennium. A rapidly expanding population that is becoming highly urbanized, the relentless tide of globalization, and the pervasive presence of technology are all driving the need for change in our transportation systems.

In order to meet the challenges of congestion, to empower consumers and customers, to ensure the safety and security of them and their cargo, and to maintain efficient and eco-
sensitive operations, a smarter and better system is needed. We are at the point where we can build a next-generation transportation eco-system that meets these challenges. The system uses the existing physical infrastructure as a foundation and overlays it with a digital infrastructure of IT and communications hardware and software to add dynamic intelligence to transportation.

This smarter system protects the quality of life and enables transportation system operators to create and capture value from the system. It allows operators to predict the demands placed on the systems and to optimize assets and infrastructure to accommodate these demands. In turn, this can improve the operational efficiency and life span of the systems, while mitigating the environmental impact caused by inefficiencies. By giving more power to the users of the system, the traveler and end-user experience is improved, while the safety and security is enhanced throughout the system.

It may seem a daunting task to overhaul the massively complex global transportation eco-system, but incremental steps have already been taken. The development of congestion charging road systems in Stockholm, and Singapore’s Land Transit Authority’s scheme to optimize transit routes for commuters in the city-state, demonstrate that a smarter system can meet capacity demands that change on a frequent, sometimes hourly, basis – and do it efficiently, consistently, and profitably. In another example, the shipping and logistics giant COSCO was able to use an intelligent system of supply chain management and asset tracking to streamline its operations and reduce its CO2 emissions. The gain in efficiency was coupled with lower fuel and operations costs, stronger competitive differentiation, and its high level of service was uncompromised.

For the users of the fledgling smarter transportation system, early implementations also demonstrate that such a system is better. Air Canada’s real-time flight information system and Schiphol airport’s smart baggage handling system are improving the end-to-end customer experience in the often hectic world of air travel. The Norwegian example of using RFID tags to track food from “farm to fork” helps ensure the safety and integrity of the nation’s food supply. Similarly, cutting-edge applications of RFID, sensors and digital video surveillance in the rail industry are paving the way for increased operator safety and better risk management in rail transportation systems.

The case studies portrayed in this paper highlight the fact that a smarter system can be a vastly better system. With both Greenfield opportunities and retrofit projects, the marriage of the physical transportation infrastructure with a modern digital infrastructure lays the foundation for the smarter transportation system. The roadmap for such a system is emerging, and it is up to transportation system owners and operators, governments, service providers, and the users themselves to follow it.
ENDNOTES

1 World Urbanization Prospects: The 2005 Revision, Population Division, Department of Economic and Social Affairs, United Nations.

2 City Population at http://www.citypopulation.de/world/Agglomerations.html


8 “Human-Related Sources and Sinks of Carbon Dioxide,”
http://epa.gov//climatechange/emissions/co2_human.html


10 http://www.chicagoclimateaction.org/

11 Hedley Environmental Index, School of Public Health, University of Hong Kong.
http://hedley.index.sph.hku/aboutUs.php

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