

Insight Report

Connected World Transforming Travel, Transportation and Supply Chains

In collaboration with The Boston Consulting Group

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Preface

How will people travel and how will goods be transported in the year 2025? Will driverless cars be a main mode of transportation in the megacity of the future, directed by traffic command centres? Will unmanned drones deliver our packages? Which single mode or combination of transport modes will dominate our lives? How will holographic telepresence influence communication and future travel?

The answers lie in hyperconnectivity – the interconnectedness of everyone and everything, which is becoming the reality of how individuals, society and nations interact. Hyperconnectivity is a major driver of innovation, specifically in travel and transportation, which can be made more seamless, more efficient, more comfortable and more eco-friendly by 2025.

Connected World: Transforming Travel, Transportation and Supply Chains is a cross-industry joint effort of over 50 leading companies from the travel, transportation and information and communications technology (ICT) industries to explore the future of travel and transportation by 2025. The project outlined scenarios for which to prepare, and identified four cross-industry solutions that stand out for their societal benefits and potential business opportunities. Those key solutions include a game changer for using intermodal travel, a future traffic management system for megacities, a new answer for visa, airport-security and border-control processes, and logistics optimization. While technology per se is not the principle hurdle to the development of this solution, successful implementation depends on addressing institutional barriers such as legal frameworks and regulatory constraints, and on establishing new collaborative models between businesses and governments.

To work towards the solutions and achieve realization, further conceptual detailing and regional dialogue with industry stakeholders and policy-makers will be the key objectives for the project in 2013. Information on project progress can be found on the Connected World website at <http://www.weforum.org/issues/connected-world-transforming-travel-transportation-and-supply-chains>.

From Pain Points to Opportunities in a Hyperconnected World



Pain Points of the Current Travel and Transportation System

Today's travel and transportation environment is clearly overburdened (see Figure 1). Congestion plagues every major city. The average speed of vehicles in the centre of London is 14 km/h during rush hour.¹ Moscow's traffic moves slowly at 6 km/h on average.² A traffic jam stretching for 190 kilometres is not unusual for São Paulo.³ At airports and borders, travellers increasingly face a number of frustrations, including tedious security controls and long waits at baggage check-in or drop-off. The Fukushima disaster in March 2011, which caused a partial breakdown in supply chains, demonstrated the vulnerability of global logistics.

Disjointed travel and transportation networks are further strained by national and regional regulations and standards — partly outdated air traffic management at the national level, and different train track sizes between neighbouring countries are examples of the incongruity.

An estimated US\$ 4 trillion will be required annually from now until 2025 to meet the staggering global demand for infrastructure.⁴ With government investment falling in the OECD (Organisation for Economic Cooperation and Development) countries due to deficit and public debt concerns, smart solutions in terms of using new technologies and innovative business models are needed to bridge the investment gap.

Additional Challenges for Travel and Transportation

Perhaps the most important development on the horizon is global population growth. By 2025, an additional 1 billion people will inhabit the earth, with 87% of this growth originating in Asia and Africa.⁵ Two important megatrends follow from this expansion.

The first megatrend is the *Great Economic Shift*, a radical change in the socio-economic makeup of the global population. Indeed, half of the world's population will move into the middle class by 2030, a megatrend that will influence all types of middle-class expectations pertaining to mobility. Automobile ownership, a singular feature of middle-class aspiration, provides an example. Car ownership may be stagnating in developed countries, but the number of cars worldwide is projected to swell by 60% by 2025, leading to roughly 1.6 billion cars on the streets.⁶

Figure 1: Most Congested Cities and Typical Frustrations of International Air Travellers

Source: Frustration Rising: IBM 2011 Commuter Pain Survey. 2011. IBM; Navigating the Airport of Tomorrow. 2011. Amadeus, Travel Tech Consulting.

Most Congested Cities Worldwide (Commuter Pain Index 2011)

- 1

Mexico City, Mexico
- 2

Shenzhen, China
- 3

Beijing, China
- 4

Nairobi, Kenya
- 5

Johannesburg, South Africa
- 6

Bangalore, India
- 7

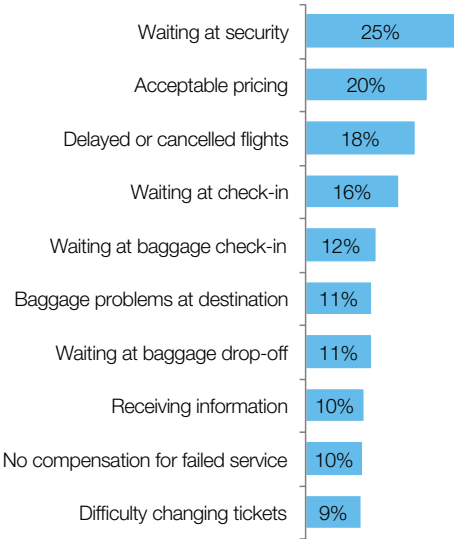
New Delhi, India
- 8

Moscow, Russian Federation
- 9

Milan, Italy
- 10

Singapore

Problems Air Travellers Experience (in %)

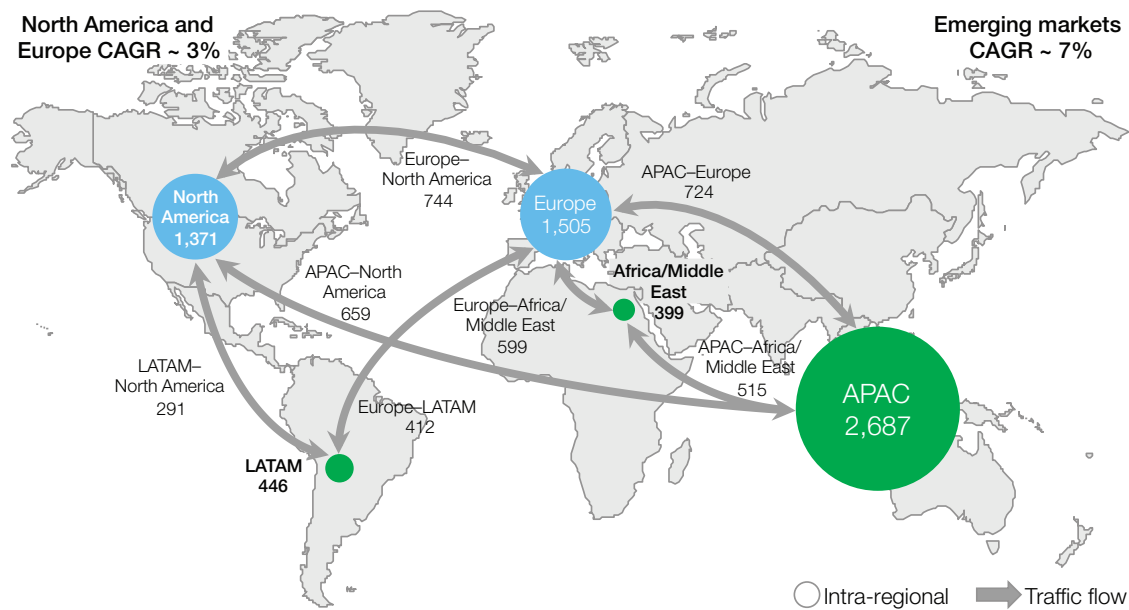


Civil aviation, another middle-class manifestation, is anticipated to at least double from 2012 to 2025, with Asia expected to become one of the most important domestic and international air transport markets (see Figure 2).⁷ The estimated increases in logistics are

equally staggering. Freight transportation, measured in freight ton kilometres (ftk), is forecast to increase by 60% between 2010 and 2025, reaching up to 31.1 trillion ftk.^{8,9}

Figure 2: Global Passenger Air Traffic Forecast 2025

Source: Airbus; Global Market Forecast. 2011.



The second key megatrend is the *Great Urban Shift*. By 2025, nearly half of the world's population will live in cities of more than 1 million inhabitants. In addition, the total number of megacities – with more than 10 million inhabitants – is projected to increase from 23 in 2011 to 37 by 2025 (see Figure 3), with nine new megacities emerging in Asia alone.¹⁰

Another development to consider is *Global Ageing*. Individuals aged 55 or older will account for 20% of world population (or 1.6 billion out of 8 billion) in 2025. This “silver segment” is even expected to reach 35% in G7 countries by 2025,¹¹ a situation that will call for age-appropriate mobility solutions.

Figure 3: Megacities with > 10 Million People, 2011 and 2025

Source: UN “World Urbanization Prospects: The 2011 Revision,” 2011

Megacities with > 10 million people, 2011 and 2025

Megacities	Size 2025	Continent
Tokyo (Japan)	38.7	Asia
Delhi (India)	32.9	Asia
Shanghai (China)	28.4	Asia
Mumbai (India)	26.6	Asia
Mexico City (Mexico)	24.6	North America
New York (USA)	23.6	North America
São Paulo (Brazil)	23.2	Latin America
Dhaka (Bangladesh)	22.9	Asia
Beijing (China)	22.6	Asia
Karachi (Pakistan)	20.2	Asia
Lagos (Nigeria)	18.9	Africa
Kolkata (India)	18.7	Asia
Manila (Philippines)	16.3	Asia
Los Angeles (USA)	15.7	North America
Shenzhen (China)	15.5	Asia
Buenos Aires (Argentina)	15.5	Latin America
Guangzhou (China)	15.5	Asia
Istanbul (Turkey)	14.9	Europe
Cairo (Egypt)	14.7	Africa

Megacities	Size 2025	Continent
Kinshasa (DR Congo)	14.5	Africa
Rio de Janeiro (Brazil)	13.6	Latin America
Chongqing (China)	13.6	Asia
Bangalore (India)	13.2	Asia
Jakarta (Indonesia)	12.8	Asia
Chennai (India)	12.8	Asia
Wuhan (China)	12.7	Asia
Moscow (Russia)	12.6	Europe
Paris (France)	12.2	Europe
Osaka-Kobe (Japan)	12.0	Asia
Tianjin (China)	11.9	Asia
Hyderabad (India)	11.6	Asia
Lima (Peru)	11.5	Latin America
Chicago (USA)	11.4	North America
Bogotá (Colombia)	11.4	Latin America
Bangkok (Thailand)	11.2	Asia
Lahore (Pakistan)	11.2	Asia
London (UK)	10.3	Europe

Existing megacities (2011)

New megacities (2025)



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Hyperconnectivity – the Disrupting Power

What do these megatrends mean for hyperconnectivity? How can hyperconnectivity in turn be leveraged to create further integration of travel and transportation solutions?

Certainly, the world's interconnectedness is only becoming stronger: global mobile phone subscriptions are projected to soar from 5.6 billion in 2012 to 7.6 billion by 2017, driven by the growth of the middle class in emerging markets, where only 39% of the population currently owns a mobile phone (see Figure 4). Web-enabled smartphones, moreover, will comprise two-thirds of market shipments by 2017, soon making any mobile phone other than a smartphone seem anachronistic.¹²

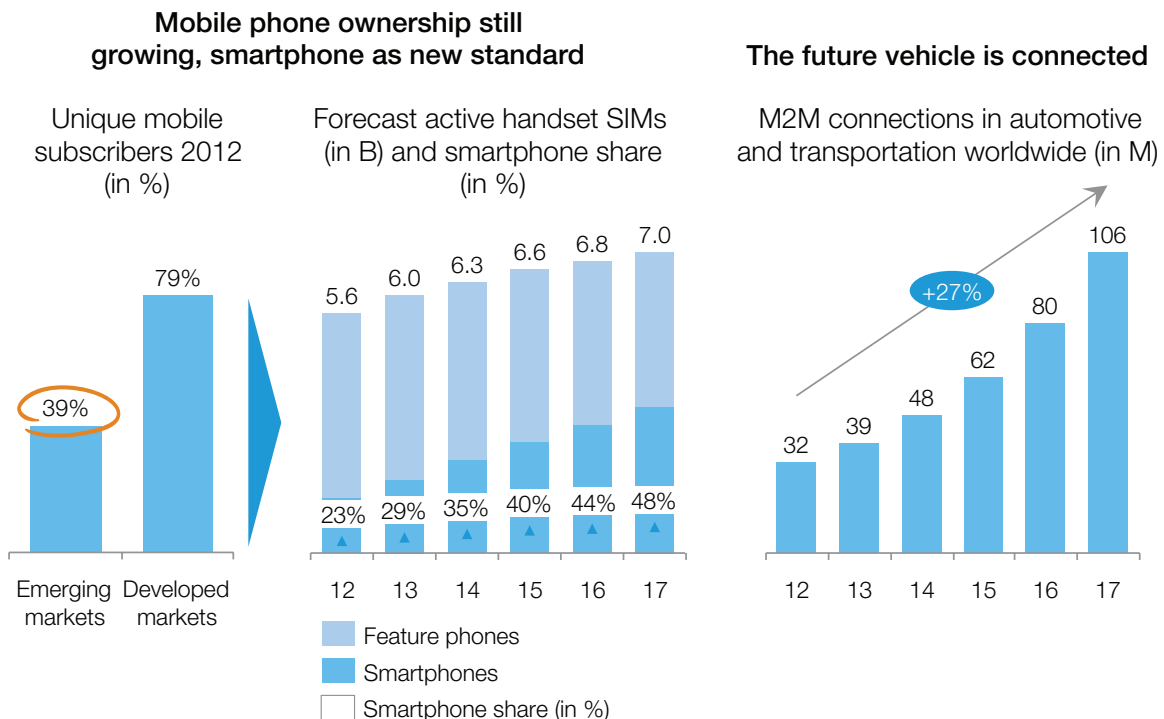
At the same time, machine-to-machine (M2M) connections in automotive and transportation will triple between 2012 and 2017 (see Figure 4). According to a recent Groupe Spéciale Mobile Association (GSMA) study, by 2025, 90% of all newly sold cars will be able to communicate with other cars and infrastructure; this represents a market opportunity of roughly US\$ 22 billion.¹³ In fact, the tagging of vehicles, containers and products with radio frequency identification (RFID) – to easily pinpoint and verify them real-time, enabling more transparent supply chains – is projected to increase exponentially, from roughly 15 million tags in 2012 to over 250 million tags in 2025.¹⁴

Such growing connectivity has the power to dramatically change the world. Although true hyperconnectivity may face daunting challenges in areas such as cyber-security and data privacy, there are tremendous market opportunities for businesses agile enough to offer the right solutions. The data deluge, for instance, is creating a sector of big-data analytics that uses algorithms to find predictive patterns in large datasets; that predictive power can be harnessed to manage traffic flow in megacities, among other applications. The massive growth in smartphones and accompanying location-based apps is creating new tools to travel conveniently from A to B. Consumers will increasingly seek more customized and seamless solutions to their transportation and connectivity needs in one single mobile device. Sensors in vehicles will enable traffic steering and prevent collisions, among other advantages. The travel, transportation and communications sectors will in sum benefit.

Hyperconnectivity also offers opportunities in the profound growth of electronic and mobile commerce, as consumers migrate from bricks-and-mortar retail shopping to online purchasing. The latter activity is forecast to capture a 30% share of the US retail market by 2025.¹⁵ This will radically change how goods are sourced, purchased and transported, thereby affecting urban infrastructure and requiring new solutions for city logistics.

Figure 4: Mobile Connectivity Growth – Smartphones and M2M Connections in Automotive and Transportation

Source: Groupe Spéciale Mobile Association (GSMA); Analysys Mason; Secured by Design Ltd. 2012



The Connected World Project – Leveraging Hyperconnectivity for Integrated Travel and Transportation Solutions

Given the middle-class aspirations linked to mobility that are identified in the *Great Economic Shift* megatrend, the future travel and transportation environment will need to handle a greater volume of people and goods more quickly and more efficiently than ever. It must also tackle a new era of expectations of comfort, safety and eco-friendliness.

Hyperconnectivity will be a key enabler in the coming years. The World Economic Forum, in collaboration with by The Boston Consulting Group, launched the Connected World: Transforming Travel, Transportation and Supply Chains project in March 2012 to identify integrated travel and transportation solutions. The

project has gathered more than 50 senior executives across the transportation, travel, tourism and logistics industries, senior executives from the ICT sectors, and leading academic experts to identify megatrends and potential game-changing events that will affect travel and transportation in the next 10 to 15 years.

Four distinct scenarios were developed to frame potential developments for 2025. These scenarios are visionary outlooks that consider global megatrends and market-shaping macroeconomic parameters. They should inspire preparation for the future by developing the right solutions that will reshape travel and transportation based on consumer needs and technological innovations.

Each scenario offers a radically different inflection of parameters, thereby presenting very dissimilar challenges for travel and transportation. The four scenarios are described in detail in the following section, offering an imagined view of how particular challenges in each might be addressed.



Travel and Transportation 2025 – Four Scenarios, Imagined



Scenario Overview

Making a prediction is always tricky, but as management expert Peter Drucker once observed, “The best way to predict the future is to create it”.¹⁶ A good first step, therefore, seemingly would be to imagine the possible futures that might occur. Each of the following four travel and transportation scenarios do just that:

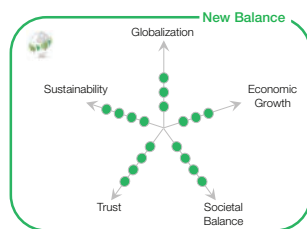
- New Balance: A New (Green) Rhythm to Life
- Maximized Growth: Faster, Higher, Further
- Mind the Gap: A View of the 80/20 Split
- Local Is King: The Odegards’ Little Farm

Each reflects different socio-political, economic and environmental parameters that will affect travel, transportation and supply chains, and ultimately how people live and work. Each scenario has distinguishing dimensions: globalization, economic growth, societal balance, trust and sustainability (see Figure 5).

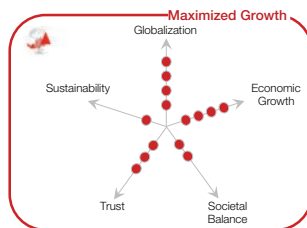
These scenarios are purposely kept extreme and provocative to provide a wide spectrum of possible futures. They do not, of course, suggest certainty of occurrence. It is far more likely that the various scenarios will materialize in different regions, probably at the same time and with different levels of intensity. Nations, organizations and people will most likely develop varying strategies to either counter or adapt to these developments.

Figure 5: Four Scenarios

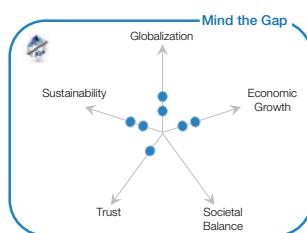
Source: World Economic Forum/The Boston Consulting Group analysis



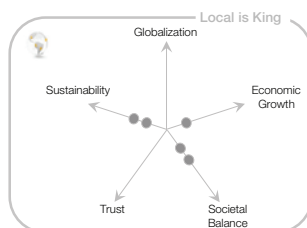
The **New Balance** scenario is characterized by a society that has adopted a healthy style of life where sustainable consumption is the new mantra and countries interact with each other more openly, in ways that decrease restrictions across borders. Information and communications technology (ICT) will support consumers and industry to make choices based on carbon footprints and environmental impact and enable shared transport solutions. Public transport and e-mobility solutions will be pushed and highly developed through respective investments. Business travel in particular will be complemented by communication solutions that provide telework and telepresence to limit the environmental impact.



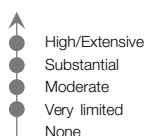
The key elements of the **Maximized Growth** scenario are globalization and economic growth. Environmental concerns are sacrificed for profits. Ownership of personal vehicles will remain the predominant mode of local transport. Ever-increasing traffic in megacities and on highways will be one of the main challenges in this scenario. Massive investment in streets and road traffic management will be needed. To bridge longer distances efficiently, new high-speed train connections and airports will be built. The role of ICT is to maximize speed, efficiency and throughput of the travel and transportation systems. This also applies to high-speed access to the cloud in all means of transportation. Telework and telepresence are used mostly to address concerns about time efficiency.



The **Mind the Gap** scenario is characterized by split societies and markets. The rich can afford the latest technologies, drive luxurious cars and travel in private jets. They live in gated neighbourhoods with excellent infrastructure and special transit highways and thoroughfares. The less wealthy will mostly depend on relatively simple public and shared transport solutions and live in areas with ageing infrastructure. They use ICT solutions that support cost-effective transport and accommodation. New options, however, might eventually include virtual reality experiences, which might become a popular substitute for real holiday trips.



Finally, in the **Local Is King** scenario, the world has been shaken by massive cyberattacks, a growing number of regional conflicts and fear of pandemics. Nations wall off and reimplement barriers for travel and trade. There is a strong focus on local products and services. Surveillance of individuals and goods will be pervasive to ensure national security and health. Gone is the open Internet, which has been replaced by more secure local networks, and social networking will be closely monitored to avoid terrorism and social unrest. General population trust levels are so low that e-commerce is mostly limited to local suppliers and networks. The net effect of these measures is a stagnant economy.



The following stories imagine and illustrate the different scenarios for the year 2025.



New Balance: A New (Green) Rhythm to Life

Antonio Chirillo is a professional saxophonist and recording artist based in Rio de Janeiro, Brazil. Today, at 60, he records and plays when he wants to – and he is called frequently. As he sleeps, his phone quietly buzzes, his e-mail box instructing him to join a studio rehearsal with the multi-Grammy award-winning singer Dianne James in New York. When Antonio wakes up, he checks his e-mail, and the news puts an extra lift in his step. A gig with Dianne James – he starts preparing to go.

Like many megacity residents of this New Balance world, Antonio does not own a car – the result of extensive taxing of car ownership, congestion charges within cities, escalating fuel prices to reflect the societal costs of carbon emissions, and fundamental changes in societal values regarding personalized transport. Indeed, a green revolution took place during the second decade of the 21st century. It happened in part because a number of dramatic natural disasters galvanized public opinion about the need for laws and regulations addressing climate change. A new green outlook has also emerged from a growing and better- educated middle class, which now aspires to a healthier and greener lifestyle where cars, for instance, are no longer status symbols. Over the past decade, Brazil experienced a sustained drive to rebalance the country's transport matrix towards sustainable modes. This has made public and shared transportation the dominant means of transportation in a city like Rio.

Antonio's smartphone buzzes again – this time it's his **IPITA**, or **integrated proactive intermodal travel assistant**, reserving all the means of transportation he will need for his imminent trip for the rehearsal. A swarm car, a driverless e-vehicle representing the state-of-the-art mode of individual public transport in Rio, has been scheduled to pick him up. Just before his swarm car arrives at the flat, it stops at *Patisserie*, Antonio's favourite pastry shop, where a barista in charge of to-go orders places a chocolate croissant and cappuccino on a rack designed for that purpose, billing the order to Antonio's account. The car is soon waiting at the curb with his light breakfast and music tuned to his favourite satellite jazz station. The swarm car then heads to the closest metro station several kilometres from Antonio's house and drops him off just in front of the station.

Rio's public transport system has been optimized across many different transport modes, a legacy from the city's infrastructure investments for events like the World Cup and Olympics. Antonio can therefore select from an array of services provided by RioTrans, Rio's premier **integrated intermodal mobility provider**, which offers various aligned transport choices – from the metro and e-buses to swarm cars and real-time automobile- and bicycle-sharing. Access to these different modes is gained through a simple fingerprint, and fees are electronically charged to a single account. Because the travel assistant software knows where Antonio is at all times, it can suggest when and where the best transport options are available to him, using real-time traffic data.

Figure 6: New Balance Scenario Characteristics

New Balance
Scenario triggers <ul style="list-style-type: none"> — Green revolution — Natural disasters attributed to environmental pollution in former years
Socio-political boundaries <ul style="list-style-type: none"> — Highly democratic — Liberalized travel and trade — Large educated middle class, Gini coefficient* ~ 35 or lower — Consumers favour green, healthy lifestyle — Extensive environmental policies
Economic environment <ul style="list-style-type: none"> — GDP growth 1-2% p.a. in mature, 4-5% in emerging markets — Labour productivity increase ~ 1% p.a. in mature, ~ 4% in emerging markets — Stable, moderately positive consumer confidence
Business drivers <ul style="list-style-type: none"> — Drastically increasing carbon taxes cut demand for oil with prices falling as low as US\$ 50/barrel in 2025 – yet still increasing overall energy cost — High investment in public transport and green technologies — Highly connected society, ICT partly substituting daily commute and business travel
* Gini coefficient <p>Represents a measure of the inequality of income distribution. Can vary between 0 (perfect equality) and 100 (maximal inequality).</p>

As Antonio arrives at one of the biggest metro hubs of the city, his travel assistant guides him safely through the labyrinthine station to a connecting train. During the trip, the travel assistant projects icons onto Antonio's contact lenses' display; the images appear unobtrusively in his field of view, and the train takes him to the other end of the city to his studio. It is a sunny day and he still has plenty of time. The personal assistant knows that Antonio loves to cycle when it's sunny, so, while he is still on the metro, it checks the weather and suggests that Antonio switch his swarm car reservation to a pedal electric cycle (pedelec). "It seems to know more about what I like than my wife does," Antonio sometimes jokes. Pedelecs are free of energy tax and offer the cheapest public transport option. His pedelec, ready to ride in front of the station, takes him along the beach to his final destination, the brand new RioJazz record studio.

As soon as he is at the studio, Antonio's band mate, Buddy, dials in from Tokyo to the **holographic communication platform**. A hologram projects not just Buddy but his entire drum kit.

"Hey," Buddy says, "I think I figured out what to do with our song." And sitting down at his drums, Buddy begins a beautiful percussive structure in 6/8 time that Antonio can hear clear as a bell. Antonio opens his saxophone case and listens for a few bars, then adds a few new phrases of his own to the piece they've both been working on. They're a world apart and smiling at each other.

"You've got it!" Antonio exclaims.

"No," Buddy shouts, smiling. "You've got it."

Just then, the legendary singer Dianne James appears on the holo-stage. "Good morning from New York, gentlemen. Are we ready to start?"





Maximized Growth: Faster, Higher, Further

If you're in business – and in this scenario you are – the trend towards growth has reached a free-market apotheosis. You live in a hyperglobalized world in which business, society and national government structures are as seamless as possible, all serving economic progress. Towards that end, travel and trade restrictions have been lifted, making borders almost meaningless. So long, passport! Hello **ACIS** or **fully automated check-in, security and border control/smart visa**. Because you're a frequent traveller, with your biometric and visa information fully registered in the global transport database, you have extra time for the small things – like breakfast – during which you read a newspaper op-ed from your smartphone: "Societies turn individualistic, career- and status-oriented." That's about right, you think to yourself in the elevator, leaving your bags in the lobby of your flat from where, thanks to the **TATLO** or **tracking- and transparency-based logistics optimizer**, they will be forwarded to your hotel room in Dubai. The taxi to the airport provides you with full onboard connectivity – a **mobile living room and virtual office** system – and it contains a 3D-screen with gesture and voice control, your privacy ensured by a shielded taxi cabin. Once registered by fingerprint, you can easily access your cloud and click through the latest office e-mails, or proceed to watch your favourite movie.

And you might need a movie. Growth has hit your megacity with a vengeance, causing massive traffic jams. But in life, as you well know, there are always trade-offs for everything, and one can always count on human ingenuity to solve problems. Just so, the city's **COMET** or **condition-based megacity traffic management** command centre routes your car, along with tens of thousands of others, to maximize flow patterns, steering you ahead of schedule around a massive construction project for a high-speed train (one of many such projects trying to catch up to demand).

At the airport, you pass the crowded red-and-yellow security check points and stroll through the airport's nearly empty "green" line, which designates your risk class, with confirmed visa and, voilà, you're through security. Before you know it, you're sitting in your plane, airborne. You've got some work to do, of course – the plane's in-seat **mobile living room and virtual office** system has already loaded multimedia dossiers of the business clients you'll be meeting in Dubai. You watch and comment to them in the mini-holo-cabin of your business-class seat during your flight, and Skype with your family at home. The step-change in satellite deployment of recent years – and what this has enabled, including free on-board Wi-Fi – are things you now take for granted.

Figure 7: Maximized Growth Scenario Characteristics

Maximized Growth
Scenario triggers <ul style="list-style-type: none"> — Ongoing global growth — Ever-increasing trade volumes
Socio-political boundaries <ul style="list-style-type: none"> — Moderate democracy with economic/capitalistic orientation — Liberalized travel and trade, highly globalized — High education levels — Slightly growing middle class, Gini coefficient ~ 40 — Consumers favour efficiency, wealth, status, individualism — Significant pollution and few environmental policies
Economic environment <ul style="list-style-type: none"> — GDP growth > 3% p.a. in mature, > 8% in emerging markets — Labour productivity increase ~ 2% p.a. in mature, ~ 8% in emerging markets — High consumer confidence
Business drivers <ul style="list-style-type: none"> — High demand drives oil price up to US\$ 200/barrel in 2025 — Investment in efficient infrastructure and automation — Huge improvements in fuel efficiency and traffic automation mobilize society — Highly connected, ICT mostly complementing travel, huge rise of machine-to-machine communication

Later in Dubai, after your business is finished, you're invited to a tour of the new airport control tower – just before it officially opens. From this height it seems as if a new order is about to begin, an order as breath-taking as the office towers in the distance that seem to leap from the desert into the sky, an order long in the planning, whereby a kingdom of oil is about to become a kingdom of the air.

"Welcome to the busiest shipping hub in the world," your tour guide, Mansour, says, "where almost everything stops first, ever so briefly, on the sands in Dubai, before going somewhere else." It's a good line, you think, and Dubai World Central has the numbers to back it up – over 120 million passengers and 12 million tons of freight each year,¹⁷ 50% larger than Heathrow, 2 billion people living within a four-hour flight radius.¹⁸ Below, the lights of Airport City stretch into the distance, an entire city of one million people built around the biggest airport in the world. Something about the place reflects the new growth era: the timely, efficient, seamless global movement of goods and people.





Mind the Gap: A View of the 80/20 Split

Brian Hedges, a private security pilot, is flying his **logistics heli-drone** over New Delhi. The view is crisp and sweeping, and from this vantage point, an ocean and a continent away in Colorado Springs, USA, he can see the full effects of life in a society split between the top 20% and everybody else. The political realities of that split, of course, had long been in the making and could be characterized as a gradual shift of power towards the best educated and most successful. Those in power have furthered their own interests in a variety of ways, including where and for whom large infrastructure projects were built.

In an autocracy, the top 20% benefited first from these projects, with high-speed rail lines that few of the poor could afford, and “premier” driving lanes on the new Ring Roads around Delhi. While the poorer 80% received promises of more work to benefit them, a heli-drone pilot like Hedges can plainly see the real effects of such an autocratic system taking shape on the ground. A haze of tyre fires rises above the district of South Patel Nagar, an area of the city that local police officials have basically ceded to crime gangs. Police won’t even enter that zone.

Hedges’ drone follows the new subway line running west along the newly opened extension of National Highway 10, one of the super highways that have the new “premier” driving lanes running alongside the old Rohtak Road. The extension leads to the gated community of Qubulpur Heights, about 50 kilometres west of Delhi on the way to Rohtak. Flying above Qubulpur, its walls and gates gleam in the afternoon sun. Such places, isolated from the rest of the megacity that Delhi has become, have their own private branch lines of medium- and high-speed trains feeding directly into all major lines, and they have their own private air- and heliports.

Drone pilot Hedges is working for a security vendor in the service of Qubulpur’s municipal command centre; he is ordered to visually track a limousine caravan of college students on their way to a graduation party in Kamla Nagar, Delhi.

The command centre knows where the limousine is – its satellite tracking has ensured that – and the limousine company’s **preventive vehicle maintenance and safety system** is fully engaged. That system, which has become almost mandatory for anyone doing business with elite communities like Qubulpur, offers anti-collision protection and advanced safety functions against theft and robbery. It is also capable of forecasting future material failures. “One would hate to imagine a breakdown somewhere near Bahadurgarh,” the limousine company owner says pointedly to potential customers, about an infamous no-man’s-land “beyond the fence”, the phrase that Qubulpur Heights residents use to describe any place outside the safe confines of their compounds.

Figure 8: Mind the Gap Scenario Characteristics

Mind the Gap
Scenario triggers <ul style="list-style-type: none"> — Political system favouring elites — Former rapidly developing economies take global lead
Socio-political boundaries <ul style="list-style-type: none"> — Autocratic system, safety measures stabilizing the system — Society split in rich, educated 20% and poor 80%, with a missing middle class; Gini coefficient > 45 — Wealthy consumers seek comfort, status and safety, the poor seek low-cost goods and services — Pollution in poor areas
Economic environment <ul style="list-style-type: none"> — GDP growth 1% p.a. in mature, 2-3% in emerging markets — Stagnation of labour productivity — Social classes stuck, reflected by split consumer confidence
Business drivers <ul style="list-style-type: none"> — Oil price slowly rising to US\$ 180/barrel in 2025 — Low infrastructure, investments, mostly only on behalf of the upper class — Innovations focus on comfort and safety for wealthier population — Basic Internet and virtual reality for all, newest technologies reserved for the rich

The Old Rohtak Road looks like any freeway in North America or Europe, but has people sleeping near it, their campfires glowing at night, and has traffic stalled, very often, for 10 kilometres or more at a stretch. Alongside the Old Road, Hedges spots the limo caravan. The **COMET** or **condition-based megacity traffic management system** has identified the caravan as a privileged premium subscriber and routed them into a separate lane walled off by concrete pylons. They speed by the stalled traffic on their way to Kamla Nagar. Inside the limo, the students are waving to everyone they pass on the Old Rohtak Road. On the other side of the pylons, a family sits in traffic in a shared car, using a simple version of an **IPITA** to access public transport options – real-time rideshare websites, coordinating via social media networks to travel in groups economically. It's a scene in which new-tech mobility meets old-tech traffic jam, the family and their co-passenger watching a limousine speed by, college students waving. A boy in the stalled car asks his father, "Daddy, why do those people get to travel in that empty lane?"





Local Is King: The Odegaaards' Little Farm

Lewis Odeggaard stood with his wife, Ellen, in their kitchen, holding an envelope in his hand. It was from his daughter, LuLu, who was at sleep-away camp outside Pittsburgh, USA.

"Aren't you going to open it?" Ellen said.

The Odeggaards had cancelled their vacation to Italy and had instead sent LuLu to her grandfather's farm in western Pennsylvania. Lewis had broken the news to his sister, Ruth, who lived in Quercianella, a tiny resort town near the port city of Livorno, using the neighbour's secure Internet system, one that required a biometric verification from both parties before Lewis's e-mail could be received. He had typed his message, placed his index finger on the scanner, and pressed "Send". Ruth had communicated with her brother on a shopping trip to Livorno, finding a place with a bio-secure network; she had got her finger scanned and then learnt the disappointing news. "Local business is booming," Lewis had written, "more than we can handle, actually, which is good, but our trip will have to wait." It was a slow but safe method of communication, in a world that had begun to see, despite occasional disappointments, the advantages of doing things a little more slowly and safely – and more locally.

Long ago, back in 2012, there had been a lot of public discussion about hypercentralization, hyperconnectivity and increased globalization. A small but vocal group, the Black Swans, who took their name from a popular book of the time, argued that hypercentralization had made economies increasingly vulnerable to catastrophic events.

They claimed that, rather than remain vulnerable, economies and political systems should decentralize and become small, autonomous units. They used Switzerland's highly decentralized political system of 26 cantons as an example of a purposefully constructed structure that was robust and resilient, even in a catastrophe. But their call for the orderly decentralization of the global economy had been largely ignored. Then came a wave of cyberattacks, the likes of which had never been seen before. The impact on public opinion and public policy was great. The fear of further catastrophic events became a global concern and hung over the markets, bringing economies almost to a standstill. Companies and countries unplugged from the open Internet and life became smaller and more localized – not as the Black Swans had proposed, but by default. People began to experience and, in some sense, appreciate the societal benefits of decentralized systems. Communities began working together, and people began to rely upon their own communities. The Odeggaards' vertical farm, for example, was part of a tight-knit community economy.

International travel was still possible – the Odeggaards had fully intended to go to Italy – but was cumbersome and very expensive. **ACIS or fully automated check-in, security and border control/ smart visa** systems had been implemented, easing the frequent security and ID checks at airports, train stations and borders. But the mood had shifted, and safety and security was a primary – and constant – concern, affecting travel on every level. This new, widespread focus on risk and security led to a new generation of safety features in automobiles. **Vehicle operator and passenger health analytics**, for instance, now performed health status and virus checks before anyone entered a vehicle.

Figure 9: Local Is King Scenario Characteristics

Local Is King
Scenario triggers <ul style="list-style-type: none"> — Cybercrime — Regional conflicts, pandemics
Socio-political boundaries <ul style="list-style-type: none"> — Local/national orientation — Protectionism, including travel and trade barriers — Relatively balanced society but stagnating education levels and lower purchase power — Consumers seek safety and traditional lifestyle — Moderate environmental policies
Economic environment <ul style="list-style-type: none"> — Recession, with stagnating or slightly declining GDP — Decrease in labour productivity — Dampened consumer confidence
Business drivers <ul style="list-style-type: none"> — Oil price around US\$ 160/barrel in 2025 — Infrastructure investments cut — Less innovative culture — Stagnation or decrease in connectivity — Small, secure networks replace Internet, access with biometric identification

On the macro-level, against the backdrop of chronic economic stagnation, the government had launched many new initiatives to stimulate growth within restricted and localized markets. This had been the impetus behind the movement to reclaim and repurpose empty office structures that became the kind of “green building” in which the Odegaards now lived and worked – “green” as in high-rise, vertical farming. Under a federal make-work programme, dozens of vacant commercial office buildings had been retrofitted. All the apparatus of the former occupants – in the Odegaards’ case, a once-thriving Internet financial trading company – had been ripped out, discarded and replaced with dirt, many tens of thousands of cubic metres of it (or its hydroponic equivalent) to create vertical farming buildings.

The Odegaards were part of a local collective of vertical farmers who, as part of a deal with the government, were allowed to live in the building they farmed and sell produce via local retailers and public markets. For the sake of consumer protection, all products needed to undergo intensive checks. International products utilized new radio frequency identification (RFID) tagging technology, storing information about country of origin, date of expiration, nutrition and health facts, all enabled by the **TATLO** - the tracking- and transparency-based logistics optimizer system, which functioned as an additional level of security to ensure the safety of the food supply.

“Well, aren’t you going to open it?” Ellen asked again, pointing to the envelope.

With his thumb, Lewis pried the letter open and read it aloud:

*Dear Mommy and Daddy,
I hope you are well and that you got the water pumps fixed. Grandpa says “hello”. After our trip to the airport – I thought I would die of boredom, all those security check points – I wanted to e-mail you right away, but Grandpa said he’s not part of my local Internet system. He’s not part of any system. He pointed to the rain falling from the sky and said, “That’s my system”. He handed me this paper and a pencil and told me to use the post office. I’m writing this to see if he is pulling my leg again. I’m writing also to tell you how much I love being on the farm. Grandpa calls his a “real farm”, and calls ours a “funny farm”. I know you are working harder than ever and are busy, so I don’t mind not going to visit auntie this year. I love going places with you, but I had forgotten how beautiful it is to just stay where you are. Just between us, are we farmers or “funny farmers”? Just wondering. Love, LuLu.*

Lewis looked up from the letter. “She’s learned how to use ironic quotation marks.”

“Good,” Ellen answered. “In this world, it’ll come in handy.”





Outlook – How Information and Communication Technologies Will Change Our World

Computing



In 1965, Gordon E. Moore predicted that the number of transistors in an integrated circuit would double every two years.¹⁹ Moore's law and its continuations are expected to remain effective in coming years, when the further miniaturization of components, as well as the development of new technologies (e.g. quantum computers^{20,21}) will drive the **growth of processing power** to more than 128 times its current values.²²



In addition, the ways data are stored and analysed will change dramatically by 2025. Instead of maintaining large computing units on site, **cloud computing** will be the standard method to access processing power, storage capacity and software on demand. By 2025, the volume of data stored is set to reach 100 zettabytes – equivalent to 36 billion years of high-definition video footage.²³



The upcoming increase in computers' processing power will change the modes of data processing and analysis. IBM envisions that by 2017, computers will be able to analyse images in a way that is not very different from the way humans do.²⁴ **Big data in-memory databases**, enabling real-time processing and **analytics** of huge unstructured datasets, will become mainstream and enable processes like real-time traffic control.

Connectivity



The speed of both **mobile and fixed-line connectivity** is expected to reach new magnitudes by 2025. 1 Gbit/s fixed-line speed will be available for most offices and households in developed markets and rapidly developing economies, while 5G mobile connectivity will provide a dense net with connection speeds of more than 100 Mbit/s to users of mobile devices.^{25,26}



Small and energy-saving modules for **machine-to-machine communication** will be incorporated in all kinds of vehicles, infrastructure and devices. Together with big data analytics, these modules will enable smart traffic control to establish the new levels of safety and convenience car users demand.²⁷

Display



Augmented reality (AR) will become an integral part of life and is expected to reach mainstream levels within the next 10 years.²⁸ Technologies like windshield displays, data glasses or micro-lens displays will further push AR applications. The new connection speeds will enable new forms of **virtual reality** or VR and holographic communication through **3D and holographic displays**.

Assistance



Virtual personal assistants will be ubiquitous by 2025. They will learn and adapt to their users' preferences, constantly analysing the environment to autonomously make suitable suggestions, for instance, regarding plans for travel or vacation. The individualized assistant will respond to language and gesture control and will communicate accordingly. In the 2025 physical world, **robotics** are expected to assist seniors with adequate care and medical diagnoses.^{29,30}

Identification



Technological advances in error-free scans of fingerprints, irises or faces will lead to an expansion of **biometric identification**. Stored biometric data can be used as a digital identity, simplifying authentication in e-commerce or security and border control. Together with advances in **scanning technology** (for liquids, laptops etc.), a complete walk-through with luggage at airport security and "smart borders" is within reach.³¹

Mobile payment/ticketing



The adoption of mobile payment standards and near field communication (NFC) with smartphones, will allow **contactless payment** support mobile ticketing.

Printing technology



By 2025, printing will have moved from ink on paper to multiple substances in 3D. **3D printers** will not only be affordable and easy to use, they will be able to print complex products from a variety of different substrates. When taking a car to the garage for repairs, for instance, the mechanic might be able to print some of the spare parts to fix it.



Printed electronics, such as radio frequency identification (RFID) chips, will aid logistics and information transfer in general. RFID chips printed on each carton of milk, for example, will inform consumers about the manufacturing process and the delivery cold chain. In coming years, the market for such printed electronics and components is expected to grow by 58% annually.³²

Connected Travel and Transportation: Key Solutions



Addressing the changing needs of customers and technological progress, especially in the field of connectivity, will be crucial in the next 10-15 years, and will require novel solutions. The implications of each 2025 scenario therefore have been analysed to identify the best answers to future demand and challenges. The Connected World project participants discussed more than 100 potential solutions, selecting 12 for further investigation based on their cross-industry impact, strong ICT component, and potential to significantly shape the future of travel and transportation. The 12 solutions fall under the main categories of information/navigation/steering, communication, new forms of mobility and safety/security (see Figure 10).

Information/navigation/steering solutions offer the greatest opportunities for all stakeholders in the travel and transportation network. They seem best able to transform a perceived challenge such as data deluge into an opportunity of big data analytics. In the case of IPITA, the aggregating, processing and analysing of vast amounts of real-time data increase the transparency and efficiency of transport flows across different transport modes. TATLO uses growing connectivity to increase the transparency and efficiency of supply chains, and COMET uses the predictive power of big data analytics to optimize traffic flows in megacities based on targets such as air quality.

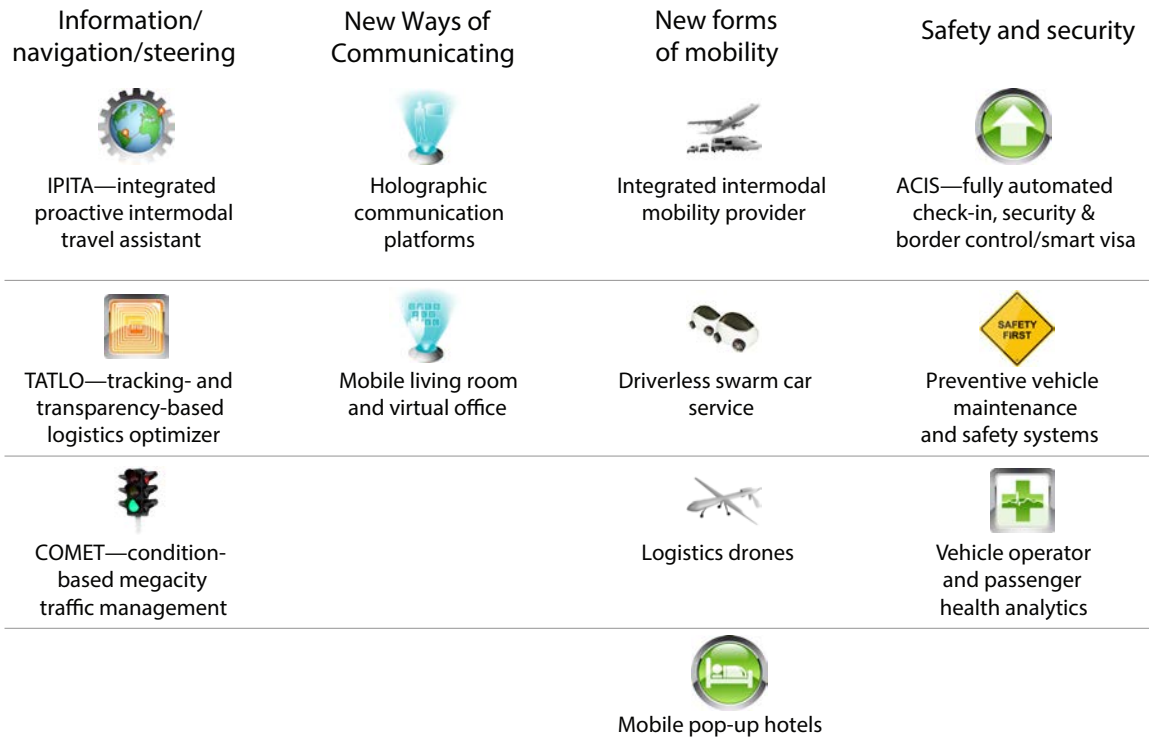
New Ways of Communicating come in two shapes.. Sophisticated holographic communication platforms provide a potential substitute for business travel and physical meetings. Meanwhile, the mobile living room and virtual office complements travel and commuting by offering high-speed access, in all kinds of vehicles, to media and applications in the Internet cloud; it uses voice/gesture steering and simpler holographic displays.

New forms of mobility represent existing means of transportation such as the integrated intermodal mobility provider, which offers from one source a variety of mobility services like car-sharing, train and flight connections, and pedelec/bicycle-sharing. But this solution also could represent new physical forms of mobility, such as swarm cars, logistics drones or mobile pop-up hotels.

Safety and security solutions like ACIS aim to enhance visa, check-in and security processes, while increasing the reliability of personal authentication and security scanning. These solutions will serve at airports and borders, where some systems are already being tested, but will also be deployed in a wider array of travel platforms, such as train stations, hotels and conference centres. Preventive vehicle maintenance and safety systems, on the other hand, will process data collected from the vehicle, the environment and the driver to anticipate maintenance, and even to avoid collisions. Vehicle operator and health analytics will check the health of both driver and passengers, and provide remote emergency services through telemedicine.

Figure 10: Connected World Solutions for Travel and Transportation by 2025

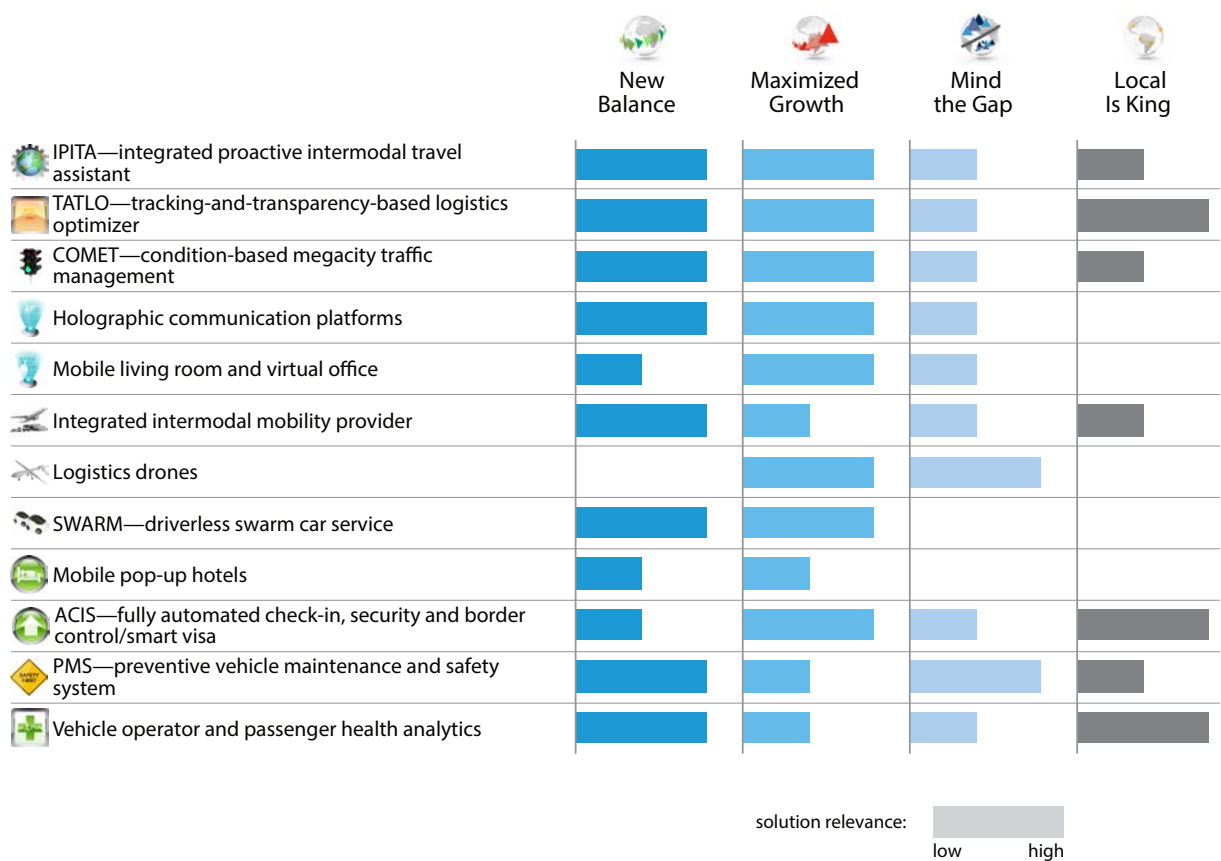
Source: World Economic Forum/The Boston Consulting Group analysis



Some solutions like IPITA will be highly relevant and applicable, regardless of which future scenario materializes. The others will be more suited to specific challenges within each scenario — for example, driverless swarm cars will be particularly appropriate for the New Balance and Maximized Growth scenarios (see Figure 11).

Figure 11: Relevance of Solutions to the Scenarios

Source: World Economic Forum/The Boston Consulting Group analysis

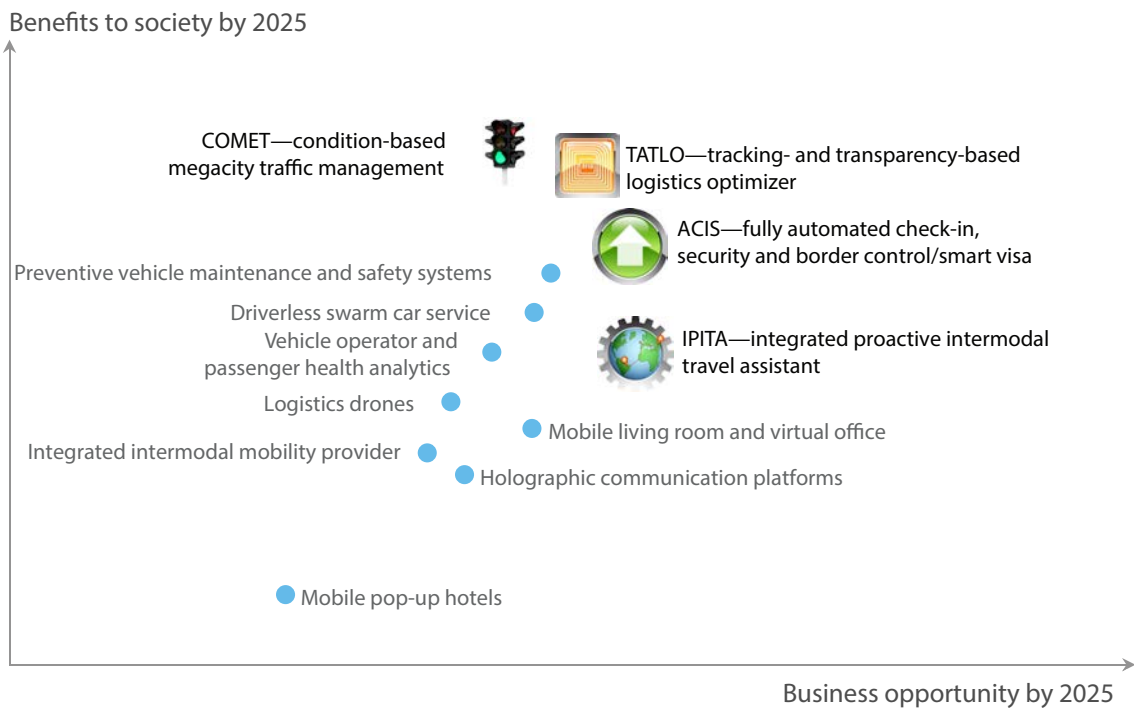


The 12 solutions were evaluated for their value to business and society by 2025, and their impact (see Figure 12). Of the 12 solutions, IPITA, TATLO, COMET and ACIS are most likely to provide robust business opportunities and societal benefits

across the transportation, travel and supply chain industries. These four solutions are explored in greater detail later in this section; the eight other solutions are described briefly in the Appendix.

Figure 12: Evaluation of Connected World Solutions

Source: World Economic Forum/The Boston Consulting Group analysis





IPITA – Integrated Proactive Intermodal Travel Assistant

Finding and making connections among different modes of travel – seamlessly – remains a challenge. No solution exists today at a national or international level that combines real-time data on available connections for all traditional modes of travel (cars, public transport, trains and planes), let alone emerging models of shared transportation for cars, bicycles, pedelegs and accommodation.

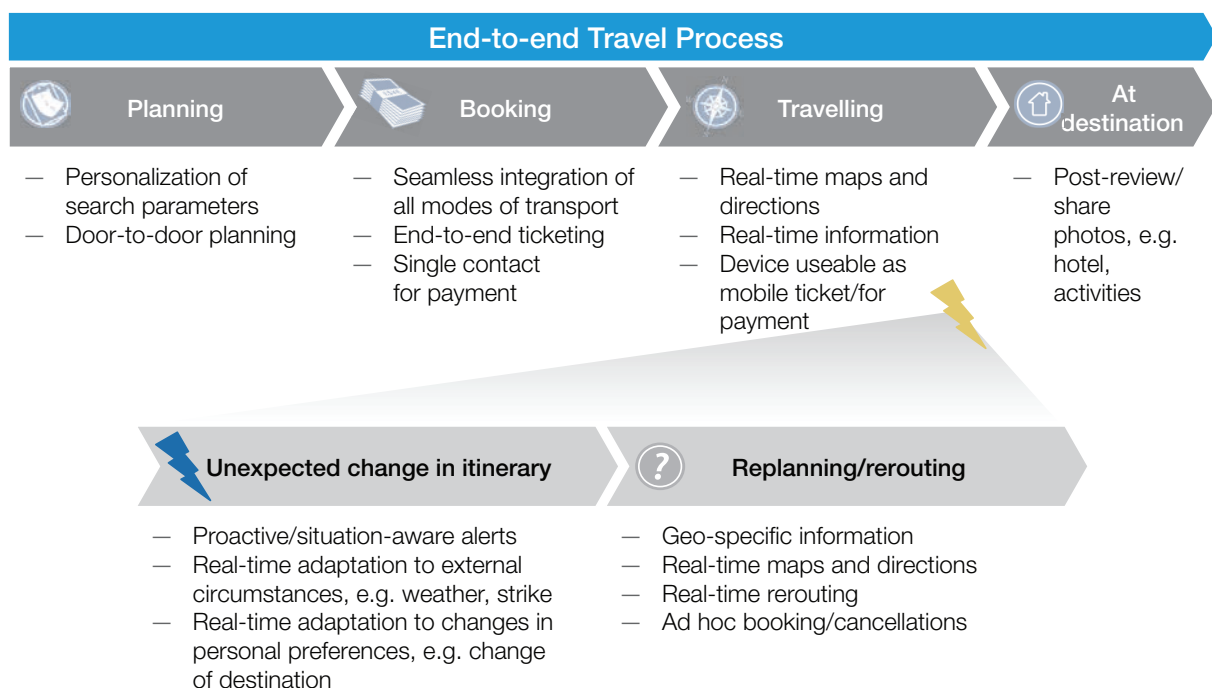
IPITA is the solution that aims to optimize intermodal travel planning, booking and navigation, using real-time maps and geo-specific information (see Figure 13). Interfaces to the traffic management systems for road, rail and air ensure the latest traffic information and predictions. Any changes and disruptions to travel plans – such as scheduling delays, congestion or weather problems – will be detected quickly. Given travel requirements and constraints, IPITA is also a platform from which alternative modes of travel or real-time rerouting, rebooking and re-ticketing

can be suggested. All of this will be provided by a single, seamless interface that includes one mobile ticket across all modes of travel.

The user interface will provide steering by natural language and gestures, and data glasses or even contact lenses as displays. IPITA will leverage comprehensive real-time information, optimized to personal needs (e.g. travel time, budget limits, environmental impact, available work time, favoured means of transportation and social media ratings). Big data analytics and artificial intelligence will make powerful end-user support for travel and transportation possible.

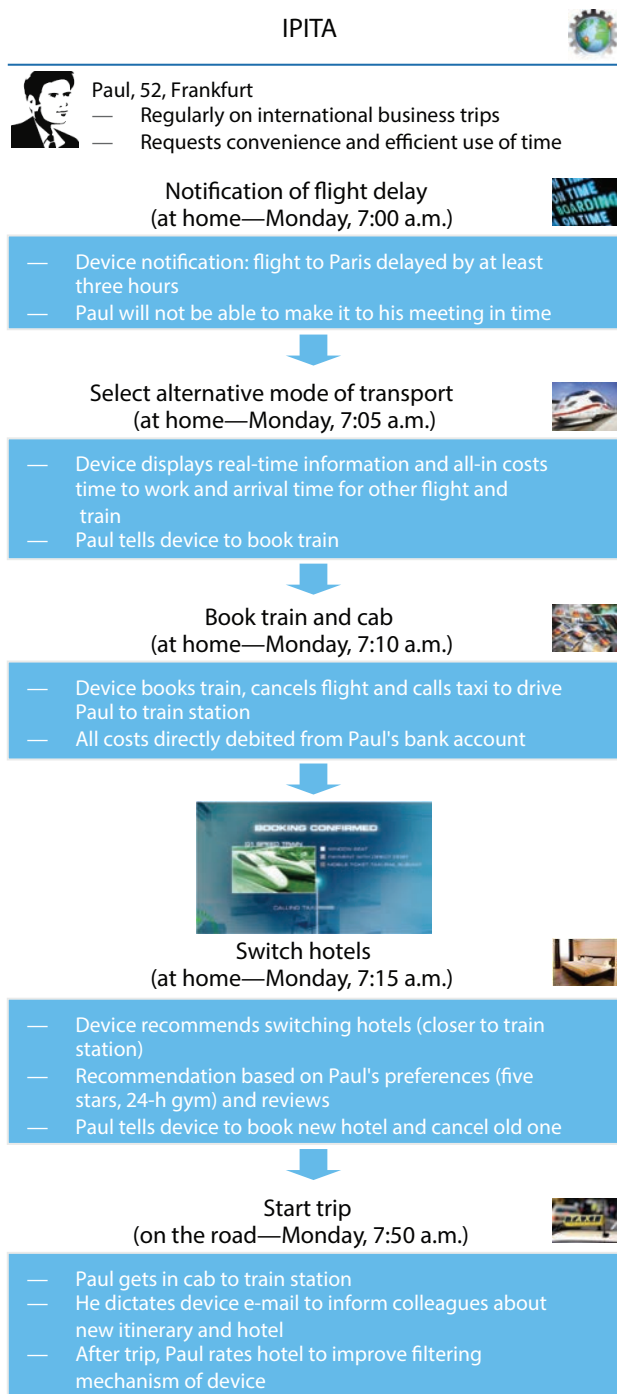
Figure 13: IPITA – Functionalities

Source: World Economic Forum/The Boston Consulting Group analysis



An example of a user journey (see Figure 14) illustrating some of IPITA's functions during a business trip can be viewed at <http://youtu.be/4KGNjAS7VvQ>.

Figure 14: IPITA – User Journey



Industry Impact

Today's complex mixture of transportation and accommodation options, along with shared-usage models and related support for pedestrian navigation, suggest a network building on coherent, real-time, end-user information. Achieving this coherence will allow end users to navigate unfamiliar streets with immediate, hitherto unavailable "local knowledge". By reducing the complexity of coordination, users will possess real-time scheduling data and can calculate travel times and costs more easily, using a single ticket for the different travel modes. IPITA may thus encourage people to switch from personal transportation by car to shared-usage or public transport.

To make IPITA a reality, all travel and transportation players must be connected on IPITA and visible to end users. The greater transparency of rates, scheduling and other factors will heighten the competition among players in the sector. This, in turn, will lead to pricing pressure on comparable services, although it will be offset by other capabilities. Indeed, IPITA represents the chance to market new, differentiated and premium services, which will be rated by credible testing authorities or social peer groups.

Navigation systems offered by automotive manufacturers face increased competition. The trend to "bring your own device" exerts pressure on both costs and the need to integrate today's onboard navigation directly with smartphones. Original equipment manufacturers (OEMs) will have to decide whether they should launch their own external IPITA or focus on gaining end-user revenue by integrating others' IPITA functions into car displays/audio systems.

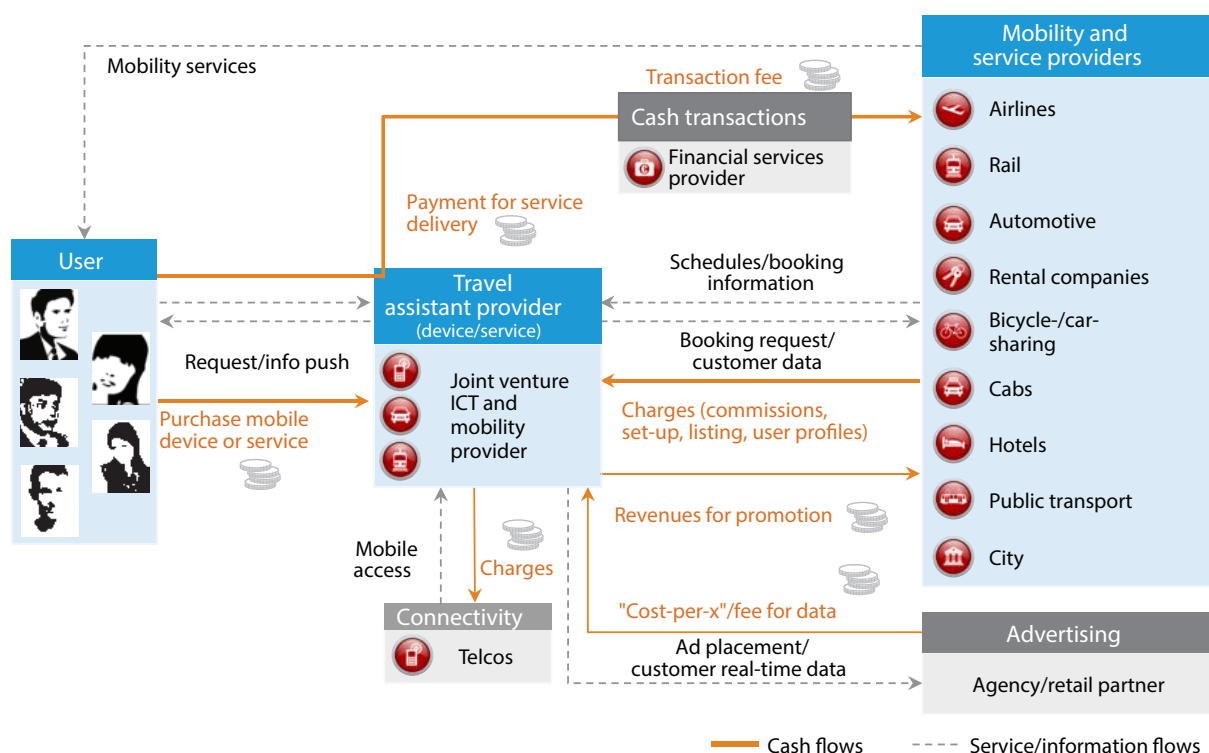
Automotive OEMs, public transport companies, railways and airlines may be tempted to launch this solution. But the most probable candidates for IPITA deployment are global ICT players. They can leverage their ability to programme and run complex, multinational information technology (IT) projects, while providing a neutral environment to host such a platform. Joint ventures between mobility providers at the national and international levels could also be viable (see Figure 15).

IPITA will provide ample scope for retail offers through location-based services. This will likely contribute to significant business opportunities and revenue beyond the booking of pure travel services.

While many different business models are possible, it seems likely that free or subsidized versions featuring basic IPITA functions will emerge initially. Once critical mass is reached, subsequent IPITA versions will likely be monetized.

Figure 15: IPITA: Exemplary Cooperation and Business Model

Source: World Economic Forum/The Boston Consulting Group analysis



Implementation Challenges

- The IPITA solution requires cross-industry cooperation of various players.
- Only a few transport companies today are willing and able to provide up-to-date scheduling and real-time traffic data that others can process on a platform. A legal framework may be needed to oblige all players to provide scheduling and real-time traffic data in a standardized format.
- As most road traffic management is operated at the city level, negotiations are required to access up-to-date traffic information and predictions of a city's critical mass.
- A fair business model must be defined to incentivize all players to provide their data and allow real-time rebooking and re-ticketing.
- International regulatory intervention will be needed to reduce data-roaming charges.
- IPITA's need for continuous information about end-user preferences in order to offer customized travel and retail offers, may raise concerns about data ownership and privacy.

Overcoming these challenges could lead to the rapid deployment of IPITA solutions that compete in the market over user friendliness or such value-added features as automatic rebooking after a change of travel plans.

Initial Concepts and Implementation

Today, the market for this kind of service is just emerging. Currently only an incomplete patchwork of capabilities is available that hardly resembles the projected intelligent solution of 2025 – a device that contains a plethora of travel and transportation data from all mobility players.

A few Internet start-ups have initiated proposals for IPITA-like intermodal connections, and leading business travel providers currently offer certain itinerary management and rebooking services. But end users are still obliged to connect to different providers and pay separately for hotels, flights, trains and other services.

Nevertheless, some progress is being made.

In the automotive sector, first-mover OEMs have launched intermodal travel planners that either are built into the car's infotainment systems (e.g. Audi's intermodal route planner) or are smartphone apps (e.g. Daimler's moovel app). Should smartphone apps for car sharing gain traction, more OEMs might be attracted to IPITA solutions.

Google, for its part, already has several components in place (see Figure 16). Google Transit was integrated into Google Maps in 2007 to support travel planning, a feature that Google has extended to several hundred cities. The service allows the user to compare train and public-transport information to travelling by car. Google Now is an intelligent personal assistant for smartphones with a natural language interface. It automatically provides real-time information predicting what the end user needs to know, based on movement and search habits. Travel planning is currently supported by providing real-time traffic conditions and alternate routes, by suggesting which trains or buses are next when coming close to the station, and by displaying upcoming flight status and traffic information. Another potential development is Google Glass, Google's new eyewear. It provides user interaction via an integrated hands-free display, and is slated to enter the mass market in a couple of years.

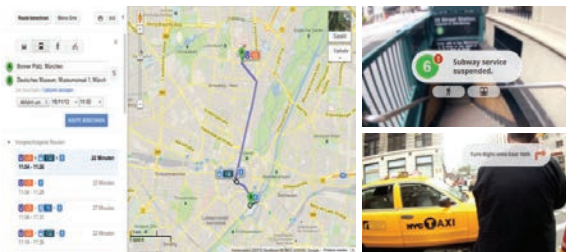
In-Time (see Figure 16) is a European Union (EU) pilot project co-funded by the European Competitiveness and Innovation Programme (CIP) to develop an IT-based, multimodal, real-time travel system built on the so-called Common Agreed Interface between cities and service providers. Designed and installed as public-source software, this interface has been running in six European cities since 2012. The ongoing pilot project provides pre- and on-trip information for the optimization of multimodal routes, as well as data for the cities' central traffic management centres. In-Time also explored the regulatory environment needed to provide

intermodal real-time traffic and travel information. The project results, which also will help to define Pan-European standardization of the interface between operators and service providers, were submitted in March 2012 to the follow-up "Co-Cities" CIP project, which will run until April 2014. Within Co-Cities, a full "feedback loop" from end users or travellers to the cities' traffic management authorities will be developed and installed; respective smartphone apps are already available. For more information, see <http://www.in-time-project.eu/en/welcome.htm> and <http://co-cities.eu/>.

Figure 16: Exemplary Projects on Intermodal Travel Planners

Source: Google; European Union

Google provides several components towards an intelligent travel assistant



Mode and route selection

- Google Transit (integrated in Google Maps)
 - Comparison of car, rail, public transport, bicycle, pedestrian routes, estimation of costs
- Google Now
 - Smartphone assistant predicting what user wants to know (habits, location)
 - Provision of real-time traffic information
- Google Glass
 - Device with small display mounted on a pair of glasses and voice control
 - Navigation, location-based services, payment, communication

IN TIME aims for pan-European multimodal real-time travel info



Sample scenario

- Pilot project funded by European Competitiveness and Innovation Programme
- Pilot started in 2009 (duration: three years) in six European cities
- Objectives of the project
 - Setting regulatory environment
 - Reducing energy consumption of single traveller by changing travel behaviour
 - Attaining internationally standardized interfaces
 - Providing real-time traffic information



COMET – Condition-based Megacity Traffic Management

Condition-based megacity traffic management (COMET) systems use real-time information collected from vehicles, infrastructure and people for active traffic management through routing and dynamic tolling. In so doing, they ensure traffic flow, air quality, access rights, safety and security.

Both the scope and capabilities of traffic management envisioned for 2025 far exceed anything that currently exists. In full realization, COMET (see Figure 17) would enable real-time traffic monitoring

and communication between all automobiles and a city's traffic management system, using road system sensors, cameras and wireless communications. Real-time data analytics would predict traffic congestion before it occurs. Intelligent steering or routing methods would include adjustable speed limits, dynamic tolling, traffic congestion rerouting or access restriction, and real-time parking-spot management. Preselected parameters for CO₂ or fine dust would also help to limit environmental pollution.

Figure 17: COMET – Functionalities

Source: World Economic Forum/The Boston Consulting Group analysis

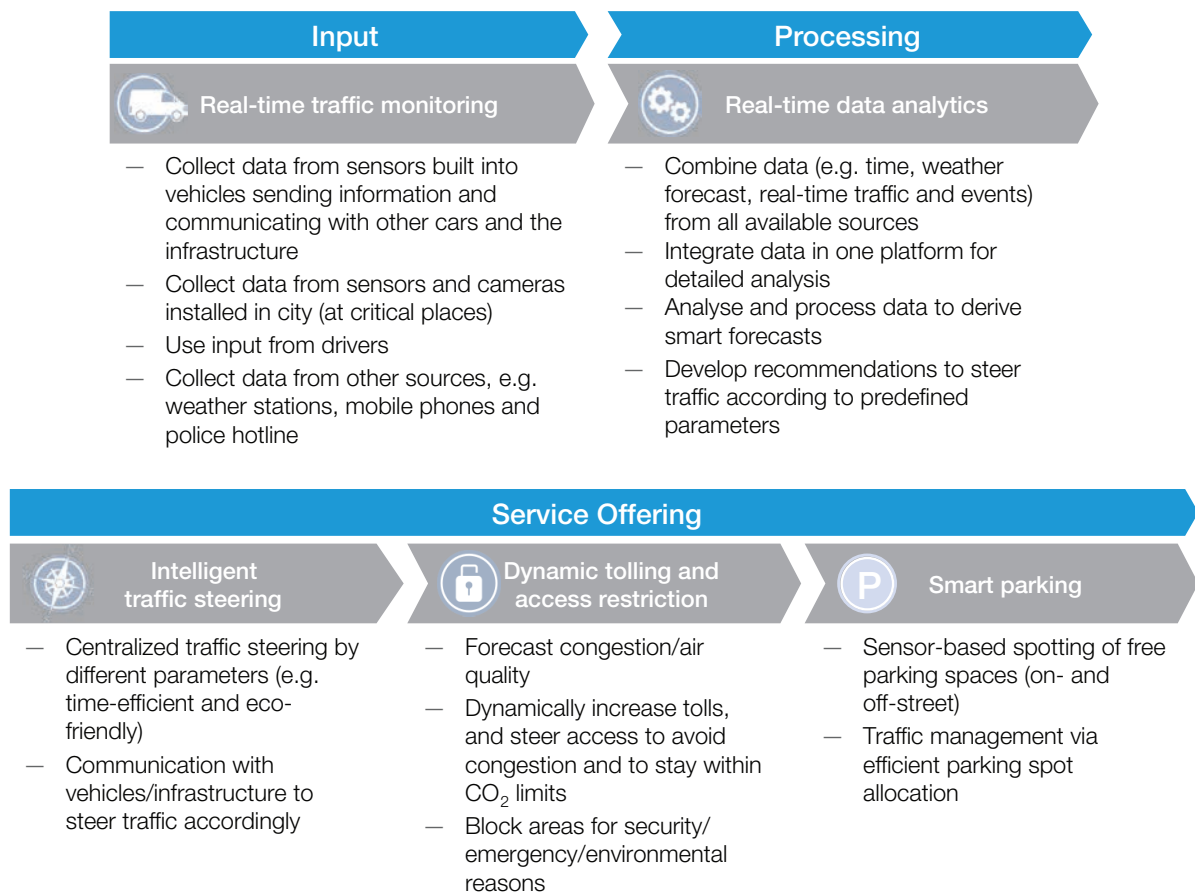
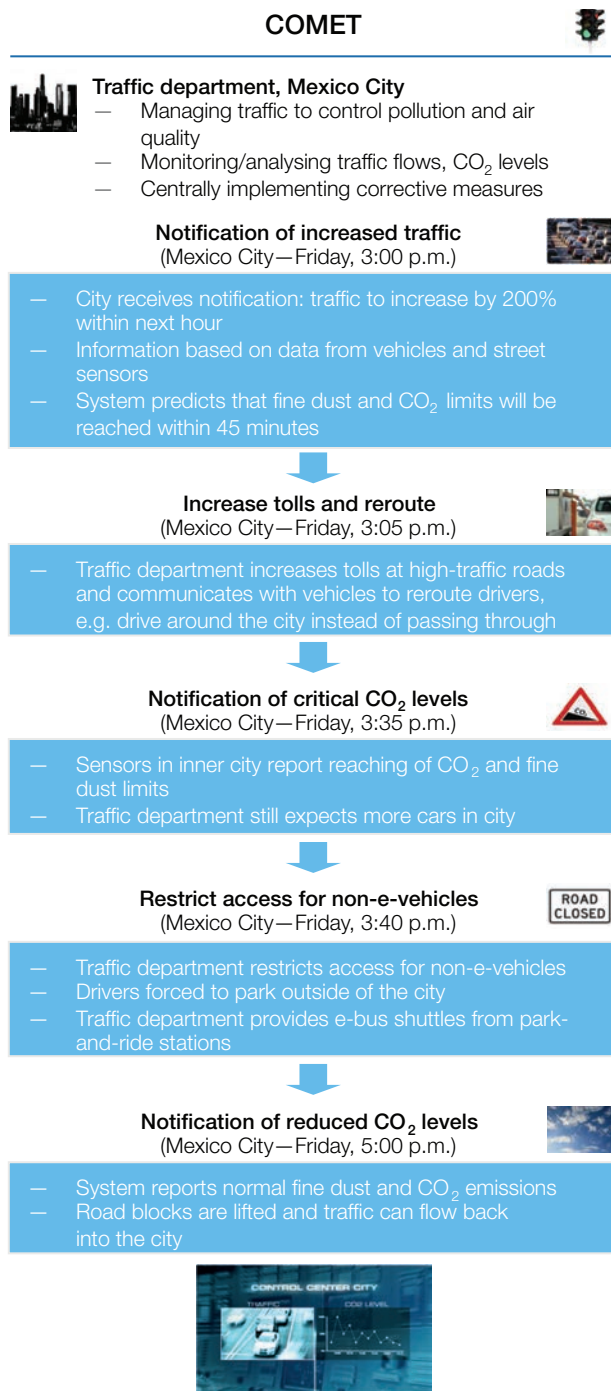


Figure 18 shows an exemplary user journey, in which a megacity's traffic management system reduces congestion and CO₂ emissions by dynamically imposing tolls and traffic rerouting, and by restricting city access to non-electric vehicles once emission limits have been reached. Using COMET, the megacity in the example provides additional public transport for passengers at park-and-ride stations. A video illustrating the solution and this specific user journey can be viewed at <http://youtu.be/Meh359r014>.

Figure 18: COMET – User Journey



Industry Impact

COMET will affect the transport industry, as vehicles will need to provide key traffic data via sensors, as well as communicate with each other and the infrastructure.

Automotive manufacturers need to integrate their vehicles' navigation systems and voice controls so that drivers can easily interact with the central traffic management system. Integrated payment and authorization mechanisms for road tolls, congestion charges, etc., will be other differentiators.

Logistics companies have more control over reaching final destination on time by taking, for a fee, priority lanes for urgent deliveries.

Public transport will play an important role, providing as-needed carrier capacity to alleviate congestion and mitigate critical levels of pollution.

Infrastructure companies will be crucial to this solution as they likely will construct, and possibly even operate and manage the toll system, with some participation from governments through public-private partnerships or other innovative financing and management arrangements.

ICT providers, on the other hand, might diversify horizontally and participate in a new market of traffic management operators in partnership with local authorities. The ICT sector is well suited to offer big data analytics that will enable the deployment of COMET.

Implementation Challenges

- The most critical challenge is probably the availability of funds for infrastructure, e.g. for dynamic signage, toll systems and the back-end IT platform.
- To ensure interoperability, data formats and communication protocols between vehicles, infrastructure and central traffic management must be standardized.
- To allow for comprehensive information exchange, cars must be equipped with the necessary communication components. Public authorities may need to implement directives to encourage adoption.
- A legal framework is required to define COMET functions, such as dynamic public-road intervention, restriction of roads and dynamic tolling.

Initial Concepts and Implementation

Aspects of centralized traffic management are emerging in some major cities. One example is the futuristic system rolled out three years ago in Rio de Janeiro, Brazil (see Figure 19), which incorporated a command centre that integrates multiple aspects of city management, emergency response, road traffic and

public-transport management. For its part, Langfang in China (see Figure 19) recently installed a new intelligent transportation system that relies on video surveillance and dynamic traffic lights to enforce traffic laws and alleviate congestion. These two implementations are exemplary for a global market for smart traffic systems that should reach about US\$ 12 billion by 2025, according to current research.³³

Figure 19: COMET – Functionalities

Source: Smarter Cities, IBM (Rio de Janeiro); Huawei (Langfang)

Intelligent operation centre in Rio de Janeiro, Brazil



Operation centre in Rio de Janeiro

- Implemented by the city of Rio de Janeiro
- 600 employees monitor the city 24/7, 300 screens with real-time data on traffic, weather, police and medical services
- Systemic integration of different data-generating and city management systems
- Early detection and prevention of traffic jams with more than 400 cameras

Intelligent transportation system in Langfang, China



Langfang traffic management centre

- Traffic surveillance system includes 178 cameras
- Traffic management via traffic signal control
- Detection of traffic violations
- Reduced peak-hour congestion by about 30%, from 1 hour to 40 minutes



ACIS – Fully Automated Check-in, Security and Border Control/ Smart Visa

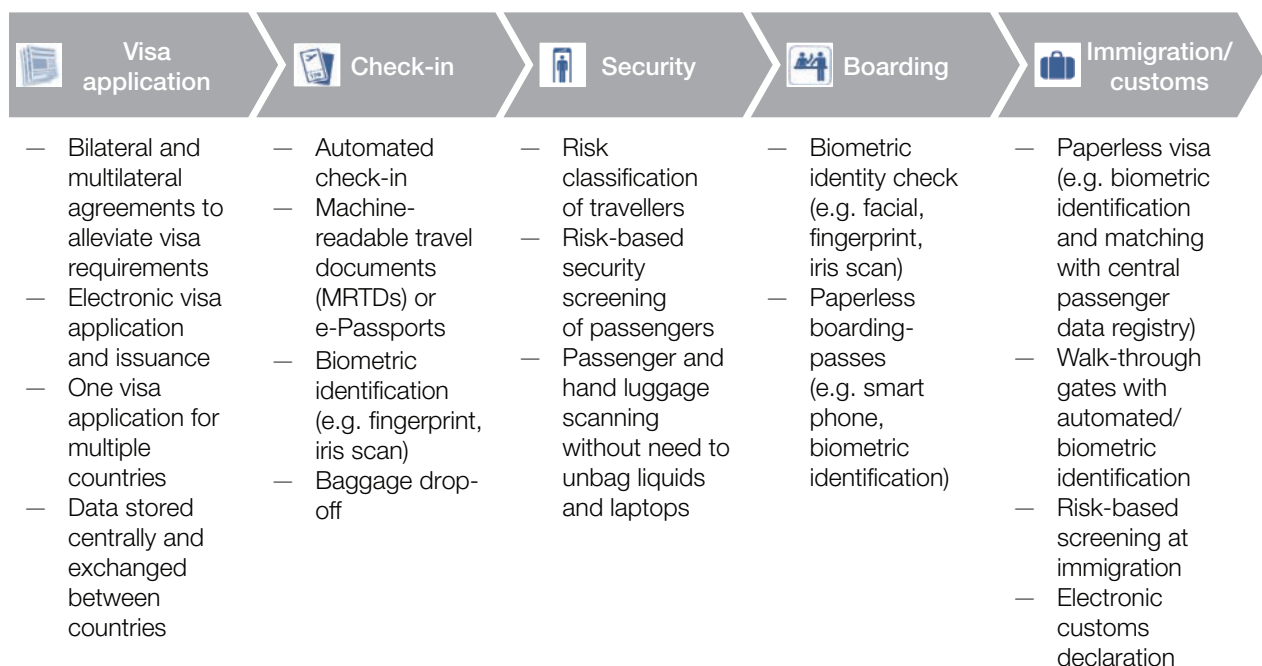
Efficient, seamless and secure travel, without queuing at consular services, security check points or borders may soon become a reality. Travellers will benefit from a host of solutions, including e-passports, smart visas and automated kiosks for biometric identification that uses face, fingerprint, iris or voice ID to enable faster processing than traditional travel documents. Other solutions, such as intelligent risk-class allocation, luggage walk-

through scanning and behaviour checks will expedite travel processes and allow a greater focus on high-risk individuals.

Figure 20 shows the functionalities of ACIS, from electronic-visa application to check-in, security screening, lounge access and boarding, all the way to immigration and e-customs.

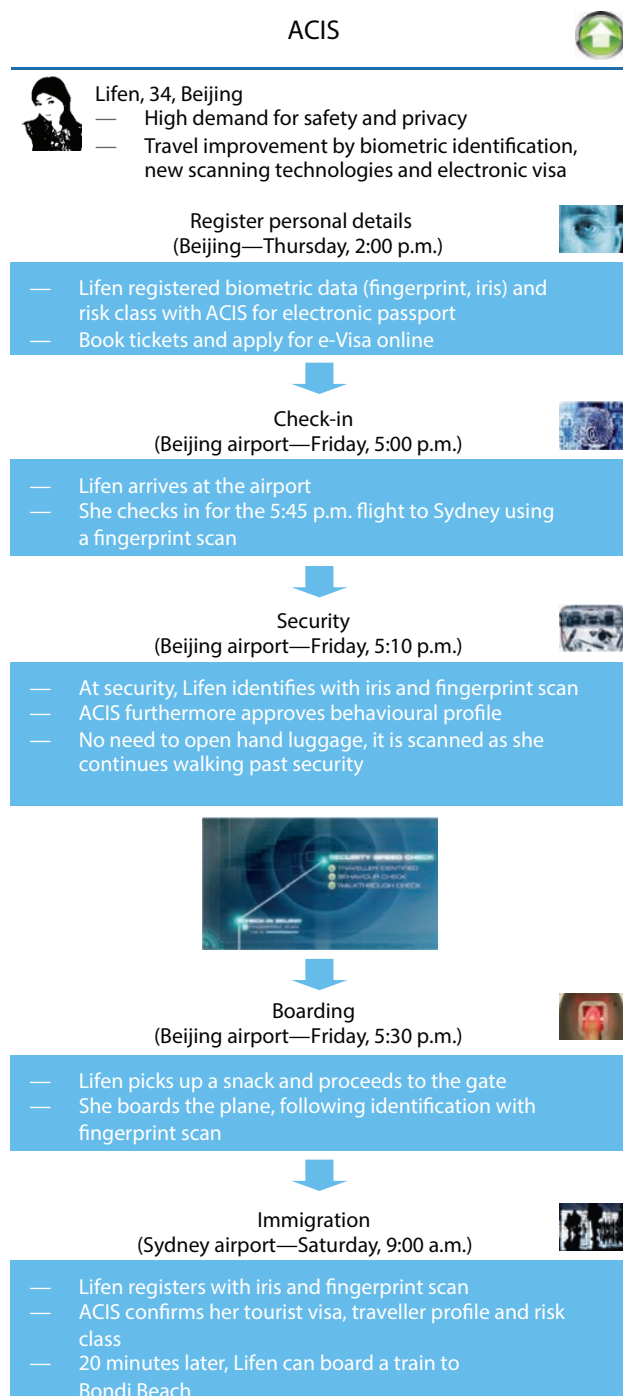
Figure 20: ACIS – Functionalities

Source: World Economic Forum/The Boston Consulting Group analysis



An illustration of a typical user journey is provided below (see Figure 21). A video illustrating the ACIS solution can be viewed at <http://youtu.be/hRyv0aLgsxw>.

Figure 21: ACIS – User Journey



Industry Impact

Airports will require substantial funds for the new security infrastructure, but they can benefit from process improvements leading to optimized passenger throughput and costs. Accelerated security procedures will increase the attractiveness of air travel and customers may spend more time shopping at the airport. Airlines will benefit greatly, without substantial investment, although some limited outlay might be required to facilitate new modes of passport/customs clearance.

Because ACIS will make it easier, it is likely that international travel will grow. The hotel industry, in particular, is expected to benefit from an increase in international guests. Biometric identification, check-in and walk-through security may also gain long-term importance for hotel check-ins, or for efficient passage in other travel hubs, such as train and subway stations.

Governments will benefit from the greater numbers of travellers and tourists. Automation also will lead to lower costs in border control services.

Implementation will directly affect security manufacturers, which will provide the scanning and surveillance hardware, and software companies, which will provide the solutions to handle large volumes of complex data efficiently and securely.

Implementation Challenges

- A significant prerequisite is the installation of a legal framework to support the new risk-based security and border processes.
- For customers, the benefits must clearly outweigh the perceived risks in making personal information available to multiple databases across governments. Rules must be laid down and communicated about the types of personal data that can be used, their storage, and sharing and transfer.
- Biometric identification requires registration of every citizen's information. If some countries choose not to use biometric passports or IDs, this will become a hurdle for full ACIS deployment.
- Behaviour-based scanning will require high predictability and low failure rates to gain public acceptance.
- Governments need to establish bilateral and multilateral agreements on electronic visas and the associated data exchange; this will involve security and immigration agencies, and collaboration with the private sector.
- Countries or airports with budgetary constraints may not be able to deploy this solution. In this case, new partnership models will have to be developed (e.g., with private security companies that set up and manage ACIS security equipment for the airport or country) with fees collected from the traveller.
- Cyber resilience will always be crucial to maintain consumer confidence in a stable and trusted system.

Initial Concepts and Implementation

At present, the deployment of fully automated systems is limited. Dubai International Airport has one of the most advanced automated immigration checking, with the first biometric iris recognition terminals launched in end-2012. But fully automated security check-in at the airport is still years away. The International Air Transport Association (IATA) has developed a concept that combines elements of risk-based security with the enhanced detection capability of advanced screening technologies (see Figure 22). Several individual components are being tried at selected airports, and the first integrated pilot projects are planned for 2014. Further information about IATA's check point of the future can be found on the IATA website at www.iata.org/whatwedo/security/Pages/checkpoint-future.aspx.

Figure 22: First Pilots on Automated Check-in, Security and Border Control in Aviation

Source: Checkpoint of the Future Executive Summary, IATA

IATA check point of the future



IATA check point of the future 2020 blueprint

- Use of "scanning tunnels" equipped with an array of eye- and face-scanners and advanced scanning technology (e.g., x-ray machines and metal and liquid detectors)
- Risk assessment and risk-based screening of passenger and cabin baggage allows efficient use of resources
- Advanced scanning technologies make process more convenient for passenger (no need to remove liquids, laptops, jacket, shoes, etc.)



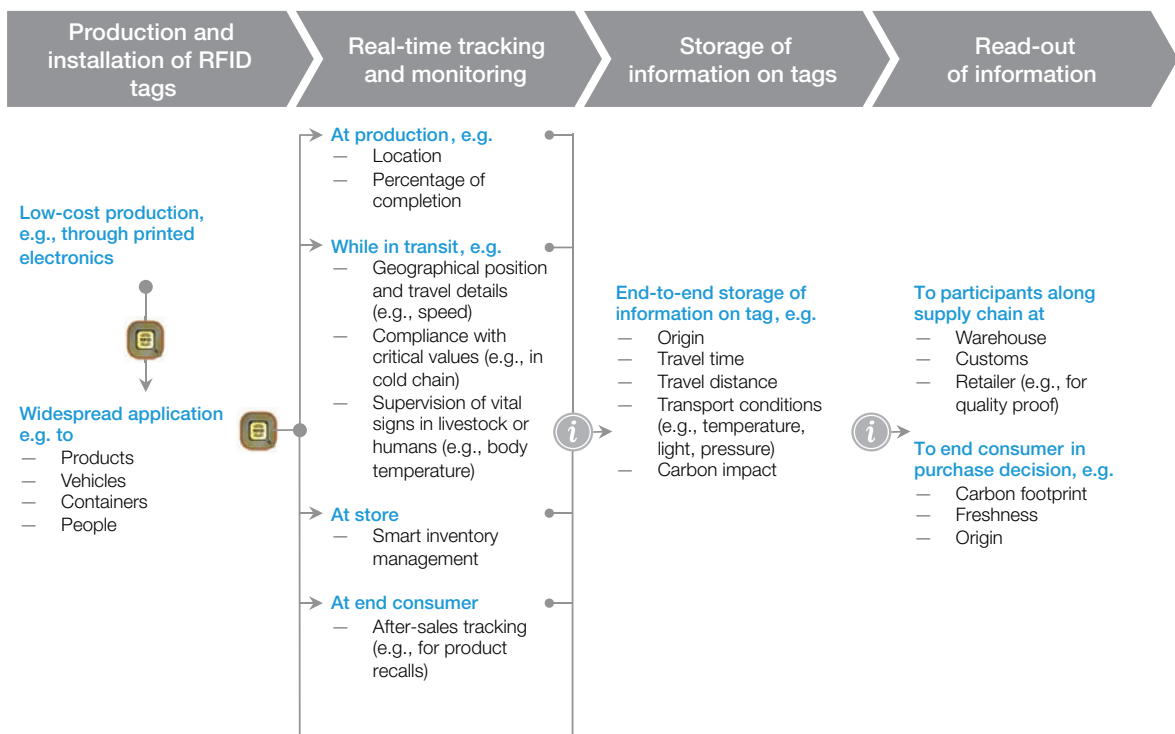
TATLO – Tracking- and Transparency-based Logistics Optimizer

Logistics and supply-chain efficiencies remain a last-mile challenge for global businesses. The Connected World project suggests a real-time monitoring and tracking system that uses widespread low-cost printed electronic chips (e.g., RFID chips) to “tag” all items with real-time accessible product information. This solution could become, like the now omnipresent and revolutionary bar code, one little thing that makes a big difference in 2025. Logistics and supply chains will become far more transparent, with each chip and the underlying ICT platform enabling the tracking of an individual product’s location and characteristics such as age, origin, transport route, nutrition values, temperature and storage, and even carbon footprint (see Figure 23). Along the supply chain, different players will insert and extract information, which will require system integration and open data availability among the various players, including government. Indeed, as RFIDs become integral to a global economy, transparent information will help consumers to make informed purchases. It will also nudge manufacturers towards making greener products and will expedite product recalls using after-sales tracking.



Figure 23: Printed RFID Tags as Low-cost Means to Achieve Fully Transparent Supply Chain

Source: World Economic Forum/The Boston Consulting Group analysis



An illustration of a typical user journey is depicted in Figure 24; a video showing this user journey can be viewed at http://youtu.be/L_PAyvuHII.

Figure 24: TATLO – User Journey



Industry Impact

Real-time tracking applications that use identification tags on single products will benefit numerous industries.

The whole supply chain can be tracked, from producer to logistics provider to wholesaler and retailer to the end consumer. The latter will be able to select the freshest product based on its origin, nutrition value and carbon footprint. For their part, companies can learn more about end consumer behaviour, and differentiate themselves by products and services.

Car, train and airplane manufacturers will use tagging to track vehicle parts and manage inventory competently. Airlines, rail service providers and hotels will tag luggage to improve control and service. And the hospitality industry will eventually tag products to restock used items more efficiently.

Implementation Challenges

- Cross-industry cooperation, and cross-industry standardization are needed to enable end-to-end tracking and transparency in the global supply chain.
- Secure data transmission protocols are required across nations and industries.
- Creating the necessary IT platforms and processes will require initial investment from industry stakeholders.
- Tagging, measuring and storage of data, and reading of RFID tags will be additional costs.
- Lower costs for RFID tags and their potential recycling – especially of more sophisticated tags – will determine if TATLO covers simple supermarket products by 2025.
- Consumer privacy concerns need to be addressed because products will be traceable after a purchase. Integrating RFID tags into products to improve the understanding of consumer behaviour must avoid invasion of consumer privacy.

Initial Concepts and Implementation

Several companies have already entered the market, providing RFID-based, real-time monitoring and tracking systems across the supply chain. The implementation challenges mentioned earlier, however, have hindered the use of this solution for mass-market products.

CHEP, an Australian provider of pallet and container pooling services, provides distinctive levels of connectivity for a range of industries. The RFID-enabled container (see Figure 25) provides a wide range of tracking benefits, especially a real-time view for every participant in the supply chain, of the location and

status of the product and the container. This visibility is crucial for food safety, inventory management, operational efficiency and continuous cost improvements. The agriculture industry exemplifies the incremental value of this visibility – dairy producers, for instance, can respond to stringent food-safety regulations by capturing, recording and transmitting critical supply-chain data, while receiving real-time notifications of quality control and temperature of the products to ensure the cold chain.

The Supply Chain Carbon Council has developed a reference model for using RFID-based carbon labels to reduce emissions by creating transparency for consumers, who can scan the labels with NFC smartphones that link to a central product database.

Figure 25: First Solutions for RFID-based Tracking and Transparency

Source: CHEP. www.chep.com; Supply Chain Carbon Council. www.escinst.org; NXP Semiconductors



CHEP – container tracking using RFID

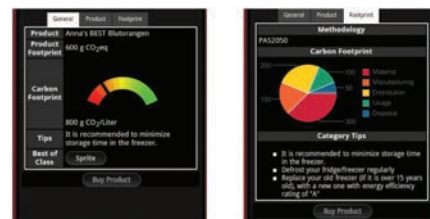


Containers labelled for tracking

- Pooled containers provide distinctive levels of connectivity for a range of industries, including automotive, aerospace, chemical, consumer goods, fresh food and manufacturing
- Real-time view into the location and status of the customer's products, including quality control measures
- Key for food safety, inventory management, operational efficiency and continuous cost improvements



Supply Chain Carbon Council – RFID-based carbon labels



Detailed carbon footprint information via smartphone app

- Partnership between global players from technology and strategic advice sectors, with the mission to reduce carbon emissions
- Accurately track emissions through the supply chain at individual product level
- Storage of product's environmental impact data on RFID-based carbon label
- Consumer scans label with near field communication (NFC) mobile phone, which communicates with central product database

The Way Forward – Overcoming Implementation Challenges



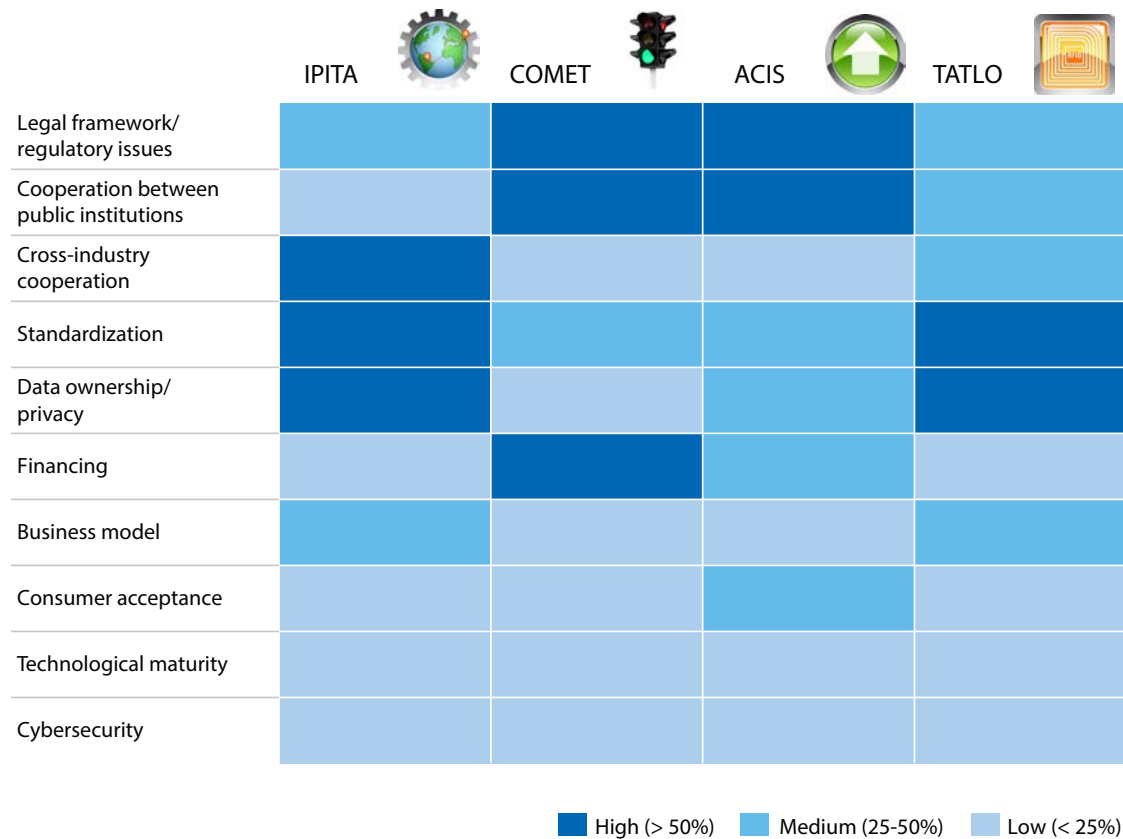
It is one thing to identify solutions for travel and transportation, and quite another to determine how to deploy them. Keeping that in mind, a first view has been developed on the challenges to be addressed for successful implementation. The hurdles are related

mainly to legal frameworks, cooperation between industry and public agencies, standardization, data ownership and financing; technological maturity and cybersecurity are not considered real hindrances (see Figure 26).

Figure 26: Heat Map of Realization Challenges

Note: Percentage of respondents listing challenge among top 3 challenges for respective solution

Source: Evaluation by project participants and further experts (35 responses). World Economic Forum/The Boston Consulting Group



Detailed work in 2013 will provide a more granular implementation framework for the private and public sectors. Some key considerations will include:

- Business opportunities. Identify areas that offer high benefits and potential quick wins (e.g. which industries and applications should be prioritized).
- Stakeholder benefits. Define the value-add for each stakeholder group and the business model that will best incentivize all players.
- Quantification of financial effects. Assess investments and operational costs versus revenue benefits.
- Funding solutions. Identify suitable financing/business models and partnerships to fund necessary infrastructure.
- Operation models. Discuss different models – for example, should a solution's owner operate or outsource?
- Essential partnerships. Evaluate different partnership options, including cross-industry cooperation and public-private partnerships.

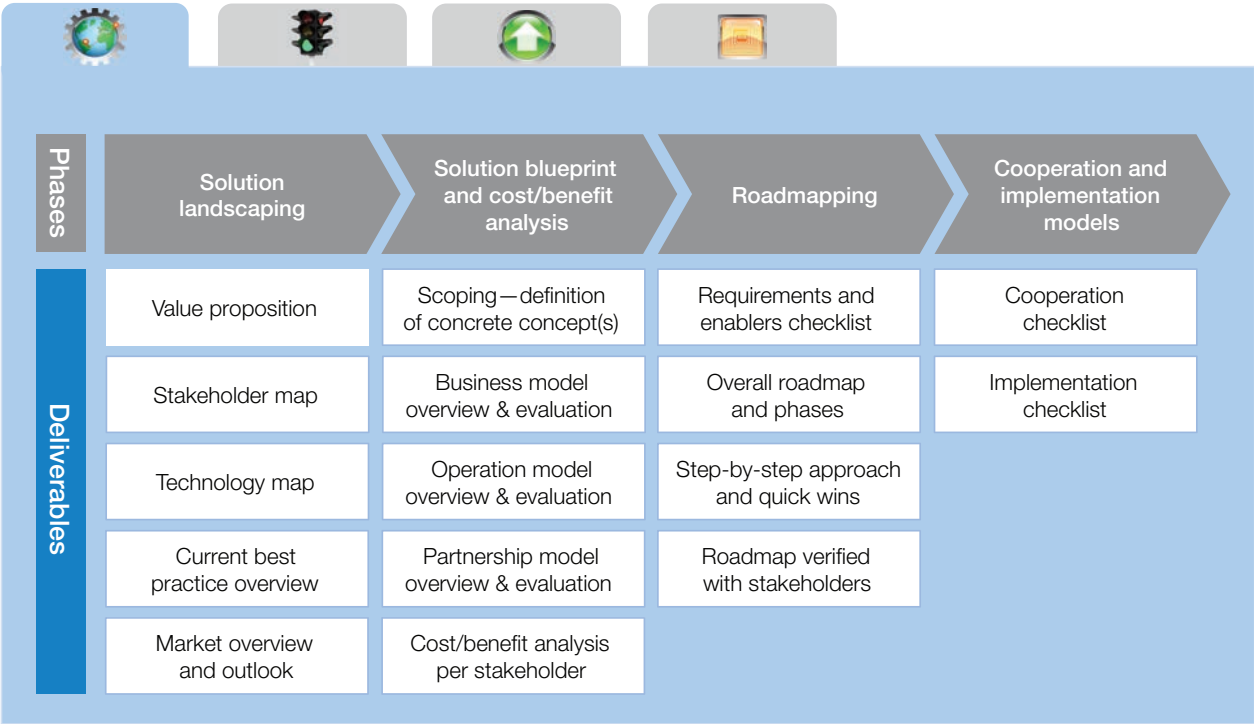
All solutions will require an overarching understanding of the following areas:

- Standards required (national, regional or global) – the alignment of data fields, formats and data exchange among industry players, business to government, and government institutions at an international level.
- Legal frameworks needed – for example, to allow intervention in road traffic or new airport security procedures.
- Data privacy and data-usage regulation – defining registration, usage and protection of personal data.
- Security systems protection – setting up stringent measures against cyber attacks.

The Connected World project's main goal in 2013 will be to create a roadmap for step-by-step implementation, and build a discussion on cooperation and implementation models for each of the four solutions.

Figure 27: Connected World Project – Approach for Second Project Year (2013)

Source: World Economic Forum/The Boston Consulting Group analysis



A number of regional workshops will facilitate the dialogue between industry players and public authorities on developing enablers and on addressing challenges in that specific region. Areas of specific focus will include the need for principle-based use of big data analytics, and stronger transparency and accountability norms. The observations gathered will be shared in the Forum's Hyperconnected World initiative as a way to be distributed across a wider domain of issues.

A specific focus on the urban environment will leverage the expertise in the Future of Urban Development initiative, and will integrate the findings in the regional workshops and solution development.



Appendix



Further Solutions

The remaining solution areas include: new ways of communicating, new forms of mobility, and safety and security. Selected solution ideas are described within each area

New Ways of Communicating

A new generation of holography could pose a disruptive set of questions for global business in 2025: As real-time, 3D communication becomes commonplace, will it become a substitute for business travel? Will the reasons for business travel change completely, or will virtual holo-meetings merely complement the way business is currently conducted? Will onboard connectivity while travelling, e.g., the mobile living room and virtual office, make people even more mobile as they gain convenient access to the cloud for private or business purposes?



Holographic Communication Platforms

Business has long recognized the value proposition in holographic telepresence. In 2009, while on a stage in Bangalore, India, Cisco Chief Executive Officer John Chambers discussed the state of holographic meetings with Cisco's Marthin De Beer and Charles Stucki, who at the time were both in San José in the USA. De Beer and Stucki seemed to be standing alongside Chambers, their 3D likenesses clearly rendered – no jerky movement, no awkward pauses; just three guys conversing casually in front of an audience. "I can see that you both have shaved since the last time I saw you," Chambers joked. Stucki smiled modestly and later, after his talk, appeared to throw a beach ball into the audience. The point behind the banter, of course, was much more serious: the barriers of distance – from Bangalore to San José – were falling. Real-time business meetings using holographic platforms across great distances had become a reality. So what is in store for the Connected World of 2025?

In part, it will consist of rapid deployment of holography to meetings across the world. Current holo-platforms allow 3D rendering of manufacturing designs – a jet engine can hover in 3D above a boardroom table, for instance. Future holo-platforms will include holo-meeting rooms at companies and travel hubs, such as airports, train stations and hotels. Eventually holographic telework centres will also be deployed in local neighbourhoods, representing the Internet café of the future. With advanced features, such as virtual handshakes through "surface feel", already being tested, the business deal of 2025 could be sealed in a holo-room. Holo-meetings could significantly reduce the amount of business travel by 2025. This, in turn, would lead to savings in costs and time, a reduction in greenhouse gas emissions, and other environmental benefits.



Mobile Living Room and Virtual Office

This solution is the logical next step in high-speed connectivity for passengers while travelling – and will enable the latest wireless access technologies to use personal cloud services and infotainment services seamlessly. 5G will provide high-speed connectivity in cars and trains, while devices and battery consumption will shrink significantly. Advanced satellite broadband will enable continuous speeds of up to 100 Mbit/s during flights and trips anywhere in the world. End users will be able to interact with different media by holographic gesture control – imagine having a 3D-enabled Kinect gaming device with gesture control to entertain children on a long drive. The systems will automatically adapt to end-user preferences once logged in with a biometric user ID.

New Forms of Mobility

Integrating all forms of mobility into a single provider could be key to seamless services. While the new intermodal provider may use existing means of travel and transportation, totally new shapes of mobility are expected to emerge. Driverless swarm cars, for instance, could become a personal solution for public transport in cities. Unmanned drones could provide long-distance or megacity courier services, and mobile pop-up hotels could emerge as a customized and flexible base for accommodation.



Integrated Intermodal Mobility Provider

One company providing all means of passenger travel seamlessly, whether air, bus, car, bicycle or train? This could be part of a complete travel experience by 2025. Biometric identification via iris or fingerprint scanning could eliminate even the physical ticket, so no boarding pass to pocket, misplace or lose. Travellers become their own boarding pass – from hotel to metro or taxi to plane. The integrated intermodal mobility provider will enable access to different forms of transport, charged to a single account. Deutsche Bahn of Germany is an early mover in the passenger transport market, offering train, car and bicycle sharing, and cooperating closely with German air carrier Lufthansa to enhance passenger convenience on flights within Germany. Public transport and automotive companies are likely to follow. Parts of this integrated mobility portfolio may also be provided by incorporating partners and alliances to offer one seamless service to the end user.



Driverless Swarm Car Service

Two main ideas prevail about the driverless swarm car. The first vision is of a car that can operate without a driver – the autonomous car, as demonstrated recently by Google in partnership with several OEMs. Getting the expensive prototypes affordably to market, of course, is a hurdle that one industry observer describes as being "the size of the Grand Canyon".

The second view seems to take a conceptual leap and recognizes, for instance, that hundreds of millions of other cars are out on the road. Wouldn't it be better to find a way to get them all to work together? "Fully autonomous vehicles tend to be completely independent of what everyone else is doing," says Tim Edwards, lead engineer for the Motor Industry Research Association (MIRA), an industry research facility in Warwickshire, England. "We want cars that are working together in unison effectively."³⁴ That's the idea behind MIRA's Network Assisted Vehicle, or NAV – a vehicle that can be programmed to follow a specific route or be controlled remotely by a wireless network. In contrast to autonomous vehicles, NAVs would communicate with one another and be linked with a condition-based megacity traffic management system that could direct them in large groups or swarms.

A fleet of driverless swarm cars could provide individual public transport for cities and optimize traffic flow. Intelligent demand predictions would steer cars to where they are needed, with idle time used for last-mile logistics services or at wireless charging stations. Registered users will access a swarm car with their biometric IDs, and the service will be charged to their account. Using personal profiles, swarm car providers will accommodate specific car requests and provide customized in-car options, such as music or videos, all based on end-user preferences. Several major automakers, including Audi, Volkswagen, Volvo and Nissan, have invested in researching autonomous driving. Google is experimenting jointly with several OEMs and has received authorization to drive autonomous vehicles on public streets

in Nevada and California – as long as a “driver” is in the car to intervene, if necessary. Research institutes like the Massachusetts Institute of Technology and the German Research Centre for Artificial Intelligence are pushing further into the future, exploring the concept of foldable swarm cars.

Whatever shape emerges, foldable or otherwise, a swarm car fleet will require multiple cooperation arrangements, especially between car manufacturers and infrastructure. That is already happening, according to MIRA's Edwards: “We are actually working with some of the infrastructure suppliers to work out what that strategy might be in the future.”³⁵ The rollout of swarm or autonomous cars is still on the horizon, however, although not as far out as it seems. “In 10 years, we'll have the technology for autonomous vehicles well in hand,”³⁶ Nady Boules, director of General Motors' Electrical & Controls Integration Lab, observed recently. Sergey Brin, co-founder of Google, estimates that five more years will be enough to reach maturity.³⁷ But this may be too optimistic. Regulators and insurers are balking over issues of liability in collisions with driverless cars, for instance. The legal framework over such cases is still unmade. Indeed, determining who is at fault when driverless cars collide will be tricky for regulators, swarm car providers and automobile manufacturers over the next few years.



Logistics Drones

“It will soon be technically feasible, if culturally unimaginable, to deploy passenger and cargo planes with empty cockpits,” wrote Nick Paumgarten in a May 2012 issue of *The New Yorker*. Under discussion was the ongoing revolution in unmanned aerial vehicles (UAVs) or drones. We seem to know a great deal about them, especially how more than 7,000 UAVs deployed by the United States' military have transformed military tactical and strategic operations. But this same transformative technology, according to many observers, will also reshape civilian travel and transportation by 2025.

Automated aviation has, of course, improved by leaps and bounds, and already the private drone industry has deployed long-range reconnaissance UAVs for livestock monitoring, pipeline security, border patrol, crop monitoring and geomagnetic surveying for oil, gas and mineral exploration, as well as for search-and-rescue operations and scientific research.

Drone applications in the transport space are moving slowly – or very quickly, depending upon the perspective – with military applications again leading the way. Between November 2011 and July 2012, an unmanned freight-carrying helicopter, the Kaman (K-Max Unmanned Aircraft System), in a joint venture with Lockheed Martin, had flown more than 525 hours and lifted more than 1.6 million pounds (about 725,750 kg) of cargo to remote battle positions in Afghanistan. This sort of testing may be the first step in a worldwide scenario of drones. Some logistics drones may monitor traffic or control air traffic; smaller commercial heli-drones may make deliveries within congested megacities. Chris Anderson, who recently left his job as editor-in-chief of *Wired* magazine to enter the drone market, recently wrote: “The private drone industry is like Apple in 1984.”³⁸ While it may be too early to see unmanned FedEx planes flying overhead, the Federal Aviation Administration of the USA is likely to open up domestic airspace to large drones by 2015,³⁹ and expects 10,000 unmanned commercial aircraft to be flying in American skies by 2017.



Mobile Pop-up Hotels

Mobile pop-up hotels offer quick, temporary accommodation, often in remote or exotic locations, or at events that require temporary lodging for large numbers of people. They may be built from prefabricated modules plugged together on site or from collapsible structures such as tents, or may be fully mobile, built and stacked onto large transport vehicles. Pop-ups provide accommodation for seasonal or unique events, such as fairs and conferences or outdoor music festivals. The UK start-up, Snoozebox, is one of the first companies to offer luxury short-term accommodation at seasonal hot spots. In 2025, pop-up hotels will be set up within a few hours, will provide luxury features like balconies or jacuzzis and will be highly automated.

Safety and Security

Big data analytics seem most applicable to the individual consumer in vehicle maintenance, safety systems and health analytics. These new solutions have already begun to emerge, but the jump to what lies in store for 2025 is big.



Preventive Vehicle Maintenance and Safety Systems

Remember when mechanics used to open up the hood and poke around to find the problem with the car? Today, many car models have smart ignition keys that contain technical information on wear and tear, so that the diagnosis starts at an office desk, rather like a meeting with an accountant. The ignition key is plugged into a computer and a clean-cut technician analyses the car's systems; not a speck of grease anywhere. By 2025, of course, that will have changed. Preventive vehicle maintenance systems will remotely analyse a car's performance as it is driven, using big data analytics to predict repairs needed before something happens on the road. Onboard weather information will help to forecast driving conditions and, if something does happen, navigation assistance will help to locate the nearest petrol station or repair shop.

Today, new models provide safety features like active cruise control, active braking and traction control systems, and blind-spot detection. But by 2025, optimized safety equipment will include sensors that communicate between different cars, thereby helping to predict and perhaps prevent a collision. On the road, attention can be devoted to other things while driving – when in platooning mode. Here, vehicles fall into a platoon led by a vehicle with a professional driver, and automatically adjust distance and speed. Initial platooning systems have been tested already, for instance by the EU-funded SARTRE project involving Volvo and other companies. Insurance companies have already begun linking safe, real-time driving patterns to lowered insurance rates, and this practice will become more widespread, reinforcing safety on the road.



Vehicle Operator and Passenger Health Analytics

Improved safety will include vehicle operator and passenger health analytics, the continuous remote monitoring of the health and well-being of everyone in the car, including system checks and warnings if the driver is intoxicated or sleepy. Health analytics will use sensors, cameras and interactive textiles, and will have a wide application beyond the automotive sector. They can be used to monitor the health status of passengers in different modes of travel, and trigger necessary action – insulin adaptation for diabetes patients, for instance, or video links to a telemedicine call centre in an emergency. Health analytics will also help to curtail the spread of contagious diseases by providing quick checks of passengers at travel hubs.

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Advisory Board

Thomas Enders, Chief Executive Officer, EADS, Netherlands
Rupert Stadler, Chairman of the Board of Management, AUDI, Germany
Ken Hu, Deputy Chairman, Huawei Technologies, People's Republic of China

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United Parcel Service
VDA (German association of the automotive industry)
Volkswagen
AB Volvo
WPP

Project Team

Thea Chiesa, Director, Head of Aviation, Travel and Tourism Industries, World Economic Forum, Switzerland
Philipp Saylor, Senior Community Manager, Automotive Industry, World Economic Forum, Switzerland
Mark Maczat, Project Leader, The Boston Consulting Group, Germany

Project Directors

John Moavenzadeh, Senior Director, Head of Mobility Industries, World Economic Forum, USA
Antonella Mei-Pochtler, Senior Partner and Managing Director, The Boston Consulting Group, Austria
Michael Rüssmann, Partner and Managing Director, The Boston Consulting Group, Germany
Nikolaus Lang, Partner and Managing Director, The Boston Consulting Group, Germany

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World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744

contact@weforum.org
www.weforum.org