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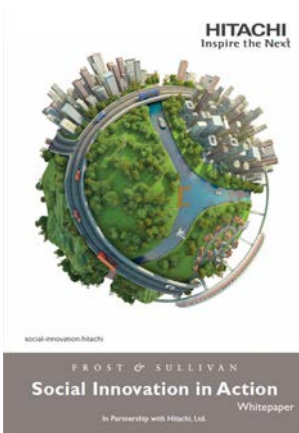
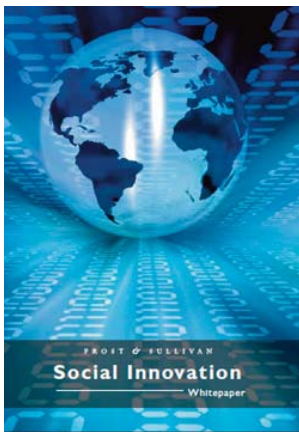
# Social Innovation in Transport and Mobility Whitepaper

In Partnership with Hitachi, Ltd.  
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THE FUTURE IS OPEN TO SUGGESTIONS

Hitachi Social Innovation



Contents

**Introduction** .....2  
 Social Innovation: The Need for Global Change.....2  
 Transport & Mobility: The Need for Innovation .....3  
**Mega Trends & Future of Mobility Vision**.....4  
 Introduction & Future of Mobility Vision .....4  
 Urbanisation.....4  
 Technology: Connectivity & Convergence.....5  
 Social Changes & Preferences.....5  
 Smart Governance: Public Policy enabling Social Innovation .....6  
**Defining Social Innovation in Transportation & Mobility**.....8  
 The need for Intervention and Social Innovation.....9  
 Social Innovation in Action - Today .....9  
 Journey Planning .....9  
 On-Demand Transport .....10  
 Electric Mobility.....11  
 Traffic Management.....12  
 Growth in Rail.....12  
 Social Innovation in the Future .....14  
**Quantifying the Opportunity**.....15  
**Hitachi’s Unique Contribution**.....18  
 Social Innovation in Transportation & Mobility at Hitachi .....18  
 Hitachi’s role in Connecting Mobility .....19  
 Hitachi High Speed & Advanced Rail Rolling Stock .....21  
 Customer Centric Vision to Improve Mobility .....22  
**Conclusion**.....23  
 Cross-Sector Convergence in Social Innovation .....25

Social Innovation Whitepapers

Hitachi has partnered with Frost & Sullivan to produce research studies on Social Innovation. Our previous Social Innovation Whitepapers define what Social Innovation is and the key Mega Trends globally which define our future societies.

Access our Website at <http://www.hitachi.eu/en/sib/whitepapers/> to download the Whitepapers in full.

“How will we empower our increasingly urbanised global population with door-to-door, multi-modal transport solutions that will be affordable for all our citizens?”

## Introduction

### Social Innovation: The Need for Global Change

The world is changing fast. The Transport and Mobility sector is a perfect example of an area riddled with challenges brought about by the complexities of the modern world, but ripe for innovation for the betterment of society, businesses, and individuals.

In Transport and Mobility, the question is how will we empower our increasingly urbanised global population with door-to-door, multi-modal transport solutions that will be affordable for all our citizens. And furthermore, how can we deploy innovation to solve the growing challenges of congestion, emissions, safety, convenience and comfort?

In our previous Whitepapers (<http://www.hitachi.eu/en/sib/whitepapers/>), we defined Social Innovation as “the deployment of technology and new business models to bring about real positive change to the lives of individuals and societies, creating shared value.”

By starting from the most critical global mega trends (Urbanisation; Smart is the New Green; Future of Energy; Future of Mobility; and Health, Wellness & Wellbeing), we identified the key element of convergence as absolutely critical to the delivery of Social Innovation. That means convergence of technologies, industries, products and business models, including finance.

Looking closely at the sectors that Frost & Sullivan define as having the greatest need for Social Innovation (Energy, Water, Transportation, Healthcare, Manufacturing, Construction and Natural Resources), we also identified that Social Innovation will represent a market opportunity of \$2 trillion by 2020.

In this Whitepaper we will highlight the specific mega trends impacting the future of mobility, and define what Social Innovation can deliver to the transportation market. We will take a deep dive into the challenges and opportunities for Social Innovation in Transport and Mobility, as well as quantifying the relevant opportunities and their impact from our extensive research in this market.

We will also introduce Hitachi and its Social Innovation Business and show how the company has become a visionary global player with a thought leading position in the sphere of Social Innovation, as well as sharing some examples of ground-breaking projects being delivered around the world in the crucial areas of rail, V2X communication, traffic management and Electric Vehicle (EV) charging, and IT enabled services.

We outline how Hitachi is building for the future using technology led solutions in an efficient, integrated way. This Whitepaper is supplemented by the findings and strategic discussions of the Social Innovation Forum, hosted in London on June 17th 2015 and co-hosted by Hitachi and Frost & Sullivan.

“Congestion already stifles the global economy an estimated 2% of GDP per year, and air pollution causes in excess of 7 million deaths per year”

“IT integration capability is set to positively impact the rail, traffic management, and EV charging sectors in particular”

### Transport & Mobility: The Need for Innovation

The global transportation market is experiencing a period of disruption. In light of several converging mega trends, a combination of new technology and society led innovation is transforming mobility products and services, and delivering a fundamental change in consumer expectations in the process. This is resulting in new business models based around mobility-as-a-service, providing a combination of on-demand transport solutions predicated around how to get from A to B most effectively - a new paradigm of technology led Mobility Integration.

However, in a world set to increase from 50% to 60% urbanised by 2025, further innovation is required. Congestion already stifles the global economy an estimated 2% of GDP per year, and air pollution causes in excess of 7 million deaths per year as a result of air pollution exposure. As the need for urban mobility increases, smarter and more society oriented innovation is required to overcome these increasing challenges of congestion and air quality, to facilitate continued economic growth and improve people's quality of life.

The good news is that the building blocks and the roadmap are already in place in many cities and countries, owing to strong collaboration between visionary thinking companies and public sector bodies alike. A global push to increase sustainability and accessibility has led to improving mass transit, new business models surrounding the use of cars, and the ability to adapt mobility services based on the local environment quickly and scalably through leveraging new technology.

Furthermore, companies such as Hitachi are moving towards delivering innovation to their customers and society as a whole, to mitigate some of the global transportation challenges, and in turn improve Quality of Life; a trend commonly referred to as Business to Society (B2S). This IT integration capability is set to positively impact the rail, traffic management, and EV charging sectors in particular.

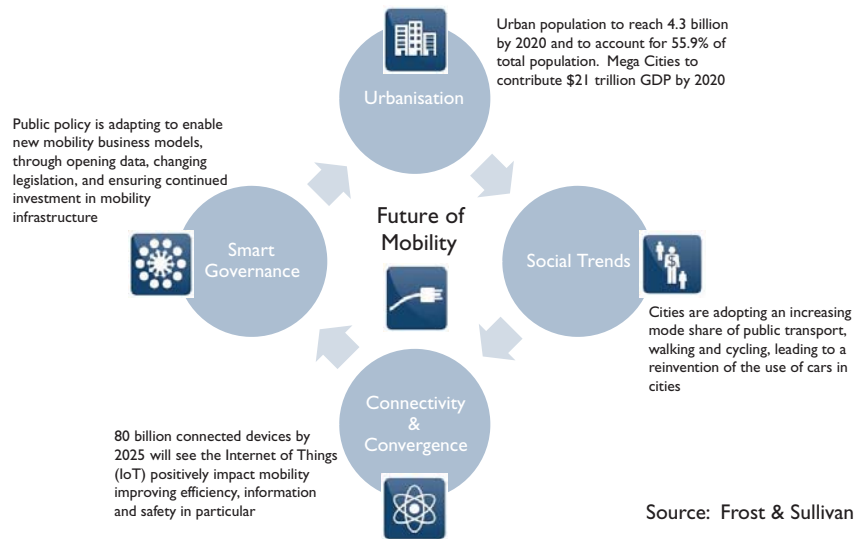
## Mega Trends & Future of Mobility Vision

### Introduction & Future of Mobility Vision

The future of mobility is set to become far more integrated and seamless, providing customers with a range of travel options, as opposed to the provision of largely individual modes of transport we see today. We are already witnessing new mobility business models like car-sharing, cycle hire, and on-demand transport applications increase the convenience and utilisation of mobility, and positively influence behaviour change towards a more sustainable urban mobility.

This vision is being realised by a convergence of four main mega trends that are being continually tracked by Frost & Sullivan research teams – urbanisation leading to an increasing population density and potential for new mobility business models, social preference changes, rapidly advancing technological developments revolutionising mobility, and smart governance to enable the legislative framework for social innovation in transport to flourish.

### Mega Trends Driving Social Innovation in Transport & Mobility



### Urbanisation

This is essential to truly mitigate the challenges faced by congestion and pollution in urban areas, but also to overcome poor connectivity and information on transportation that customers experience today. If the urban proportion of the global population grows to over 60% by 2025 as predicted– a radical step change in our mobility networks to a more integrated network will be required. Already congestion is estimated to cost 2% of GDP in lost productivity – an equivalent to \$1.5 Trillion, and will increase exponentially if left unabated by 2025, owing to the population growth alone. Likewise, the 7 million deaths per year caused by air pollution will increase if the continued growth of mobility demand

However, this same challenge borne by urbanisation is also starting to provide a huge opportunity for innovation in transportation solutions. As population density increases, so does the viability for mass transit and shared mobility solutions, thus operators are able to schedule profitable transit routes, and service providers obtain a sufficient level of members to sustain their business by maximising utilisation – demonstrated effectively in car-sharing or ridesharing for example.

### **Technology: Connectivity & Convergence**

Technology has been a key enabler of all new mobility business models, as well as driving considerable change within the automotive and transportation sectors. For example, the penetration of smartphones, connected devices and infrastructure has led to a world of potential exploitation of Big Data, improving mobility in the process. With a forecast 80 billion connected devices by 2025, the Internet of Things (IoT) phenomenon is expected to positively impact all aspects of our transportation network.

This has already started to improve the customer experience, for example with new application-based services to hail rides, taxis, and to check real time status of our trains, but importantly also to

provide operators the insight they need to improve their business, whether obtaining people's perceptions via social media, load levels on the road or rail, and through smart train signalling and traffic management systems that vastly improve efficiency and safety. Technology is penetrating all forms of mobility, and the next wave of development will move towards more automation in the network, and connecting vehicles to infrastructure and devices. Again, the operational benefit from this will be met with customer experience improvements – for example to allow the status of your travel to communicate with your onward journey, interchange, and perhaps more quirky – to connect with your kitchen and to provide your dinner in the evening, in the advent of open APIs.

Regarded by many as the most transformative force in transportation – connectivity has the potential to positively impact our lives, as well as our commutes, by linking up a seamless vision of connected living.

### **Social Changes & Preferences**

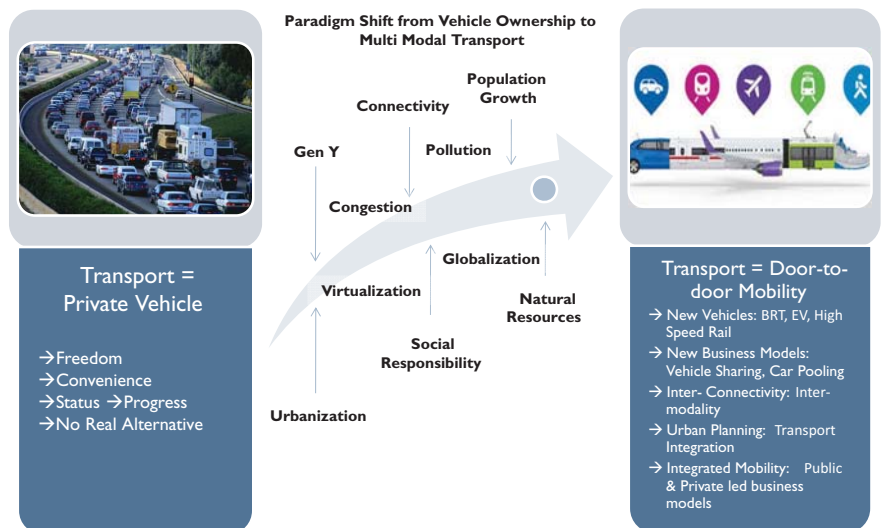
Furthermore, the way we view transportation is continually evolving. The proportion of mass transit in several mega cities now exceeds that of private transportation, owing to significant transit infrastructure development and a shift in mindset and acceptance of such solutions. In London for example, just 34% of trips are made by private car, with the remainder by public transport, walking or cycling. We've seen declining applications for driving licenses amongst 16-29 year olds in particular over the last decade in the UK (9%), France (4%), and Germany (14%) for example.

Clearly, the role and perception of the automobile in our lives continues to evolve. With increasing population density and connected lifestyles, we're witnessing a new wave of products and services improving the efficiency of the transportation network, and facilitating seamless integration of several services to make it easier for people to move around, which is changing the way that people use and view cars in their household, and which this Whitepaper will further document. This trend is commonly referred to as Mobility - a mixture of products, concepts, services, partnerships, and digitally enabled platforms that improve a city's transportation offering - a trend that is disrupting the sector, and leading to every provider looking to capitalise on this opportunity and analyse any potential threats to their business.

As a result, we are seeing a changing mindset from private car usage as the only and aspirational option, to a more integrated door-to-door consideration of mobility using whichever method is most efficient.

**Paradigm Shift from Vehicle Ownership to Vehicle Usage**

Changing demographics and advancing technology are delivering a shifting mindset in mobility, from private vehicles as the **only** form of mobility, to multi modal as the **preferred** option of mobility



Source: Frost & Sullivan

**Smart Governance: Public Policy enabling Social Innovation**

To fully enable Social Innovation and many of the aforementioned opportunities, public policy will have an increasing role to play to ensure the efficient and structured delivery of these new business models. The most common initiatives being pursued by smart cities and governments to achieve this include opening a city's vast data resources to private developers to ensure innovative business models and transport solutions can be offered and integrated into the city, as well as a reallocation of road space to prioritise public transport and cycling.

“We are moving to a world with a more sustainable multi modal environment reliant on mass transit for the majority of travel, and complementary mobility services for the remainder”

Where required, there is now the potential and political will to implement restrictive zones, such as congestion charging or low emission zones, to curtail congestion and pollution respectively and provide a revenue stream to invest in more sustainable modes of transport, as it works in London for example (where all revenues from the congestion charging scheme are reinvested in the public transit network by law).

London also has an exemplary open data policy, allowing the private sector to innovate on the vast data resources available through the London data store public resource. Transport is a key component of this, and at the Social Innovation Forum in London the Mayor's Advisor for Business & Science, Joe Mitton, presented how already this enables over 35,000 visits per month from over 450 applications such as CityMapper. Working with industry to create opportunities, and how data can support SMEs and citizen participation were also showcased as best practice.

Perhaps the most crucial aspect requiring political involvement is the investment in infrastructure, to underpin long-term economic growth of a country, especially such as high-speed rail. Frost & Sullivan research shows there will be an average 6% annual growth in high-speed rail track globally to 2020 owing to the significant economic and regenerative benefits it can bring. This transit orientated development will create a network of high-speed rail and transportation hubs, where areas are gentrified, redeveloped, and witness an increasing demand for housing and services, as the area becomes increasingly attractive for investment and to commuters through reduced journey times. This also extends to the retail environment of the station, which can be a vital component of funding some of the infrastructure. In times of austerity, such new ways of delivering and financing this will emerge, from Public Private Partnerships (PPP), to leveraging retail and sponsorship opportunities within public services, as we also see in Paris for example (e.g. the Velib cycle hire scheme funded by advertising firm JC Decaux).

In reality, the most successful cities will be those that ensure an integrated approach to all of these options, and thus facilitating new mobility business models that positively improve the lives of their residents. To achieve this, we are seeing more city, regional, national and international authorities collaborate to deliver an overarching integrated approach to transportation provision, such as delivering high-speed rail networks that will eventually connect whole continents rather than countries, and unlock considerable economic potential in the process.

In conclusion, a combination of urbanisation, technology-led solutions, and changing public policy / social preferences amongst the population has the potential to deliver a paradigm shift in mobility. We are moving away from the perception and development of cities around a single mode of transport – public or private, to a world with a more sustainable multi modal environment reliant on mass transit for the majority of travel, and complementary mobility services for the remainder.



### Defining Social Innovation in Transportation & Mobility

Frost & Sullivan previously defined Social Innovation as being about bringing innovation to deliver life-changing outcomes for society and individuals, requiring the convergence of technologies, industries, products, and business models. Whilst technology is impacting and disrupting all sectors, one of the key industry applications set to realise and enable Social Innovation is transportation, due to the converging mega trends outlined above and the considerable efficiency gains that can be realised as a result.

Thus, our definition can be directly applicable to the transportation sector; by leveraging technology in transportation networks to improve the travel experience for individuals, and collaboration to deliver collective benefits to communities and the wider society. This could take the form of mitigating the negative externalities of congestion or pollution, or targeting latent demand for mobility with new products and services, all of which have the potential to provide behaviour change when adopted on a mass scale.

There is considerable overlap with the opportunity areas of Intelligent Mobility, such as traffic management systems, connected cars, communication of transportation with infrastructure and associated dynamic rerouting, scheduling and operational information, and a move towards automated mobility. However, the key differentiator is the resulting social benefit and improvement to the users and communities, which is at the core of Social Innovation and indeed the focal point and intention of the business model, rather than just a positive outcome.

### Social Innovation in Transport & Mobility

Technology led innovation in transportation can improve quality of life, by reducing congestion and pollution, fuel savings and journey times; connected vehicles, trains, and services can deliver this Social Innovation



Source: Frost & Sullivan

“Social Innovation is essential for cities and companies that want to truly deliver an integrated mobility ecosystem of tomorrow”

### The need for Intervention and Social Innovation

Social Innovation is essential for cities and companies that want to truly deliver an integrated mobility ecosystem of tomorrow, by understanding the challenges faced by transportation at present, and offering incremental and radical innovation to solve these. The areas most likely to benefit the most from this innovation include congestion and air pollution caused by transport, journey time reliability, information on transport, connectivity - both internet related and transport accessibility related, infrastructure, and security – both physical and cyber related.

By understanding these challenges and the need for intervention, the same principles can then be applied to specific modes of transport, either individually or collectively, to solve societal challenges with innovation. This can either be a specific solution to improve the service of the road or rail for example, or a solution that targets one or several challenges whether specific to one mode of transport or several. All of these areas looked at individually will deliver incremental benefits to their respective cities and countries, but if considered cumulatively, there is an extrapolated opportunity to realise through enabling Social Innovation in transportation.

### Social Innovation in Action - Today

There are several areas where we already see Social Innovation improving transportation, across various modes and of differing scales.

#### Journey Planning

The first area to highlight is Journey Planning with real time information – transport is immensely habitual; one of the main reasons people use a consistent mode of transport is their familiarity with the service. When considering this with the private car, the flexibility and freedom provided to travel to any destination made it the most viable choice.

However, a key potential to overcome this habitual decision making is with reliable real time journey planning information, to educate users on the potential travel modes available as well as to give reliable route information, and amendments where accidents or disruption occurs. Already, we have seen a significant rise of journey planners available with varying business models, one of the largest being Israeli start-up Moovit, which has already gained over 20 million users, and sends notifications to the users smartphone in times of disruption. Given the service is available in 600 cities already, there is the potential to provide a reliable and familiar service to consumers globally, and thus allowing familiarity with transportation to remain, albeit encouraging a more multi-modal lifestyle where consumers know their various travel options.

“The opportunity to plan, book, and pay for travel when delivered on a multi-modal scale, empowers the user with choice as to the best mode for them based on price, journey time, or emissions”

One step further than just planning a journey is to book, pay, and potentially expense the service if you are travelling in the course of business. The opportunity to plan, book, and pay for travel when delivered on a multi-modal scale, empowers the user with choice as to the best mode for them based on price, journey time, or emissions for example and at the same time fosters a better understanding of the available mobility options with related pricing. Thus, innovating to integrate all of these different mobility services, provides a social improvement by increasing consumer awareness and confidence in the transportation network, and encourages the use of more sustainable modes of transport such as public transport which in turn reduces congestion and pollution.

This is a far more complex solution to deliver than only looking at the journey planning/information, as it requires integration to several systems such as ticketing, validation and billing, and also due to the varying providers and regulations in each country making it very hard to scale on a global level. One of the key enablers for this level of multi-modality is smart ticketing and/or contactless payment for transportation. A range of providers from several sectors including rail and public transport, car companies, service providers and technology providers see this as a lucrative opportunity and are heavily investing to deliver this, such as Moovel from Daimler for example, available in Germany already and looking to expand internationally to deliver this service.

Being able to access transportation seamlessly with a smart or credit card and without the need to purchase a ticket with cash, firstly saves time for the user and increases their confidence in the service, but also then allows them to be linked to several other services within the city, including non-transport. The key pioneer of this was the Octopus card in Hong Kong, allowing payment for public transport initially, and subsequently used to pay for retail goods and serve as validation of the user (in schools to register attendance for example). This now processes over 13 million transactions per day, almost double that of the city's population.

#### **On-Demand Transport**

This technology advancement is progressing to road based services as well. What is commonly referred to as on-demand transport is attracting new use cases for the car as a driver or a passenger. Being able to rent a self-driven car in a carsharing fleet now allows for instant access to one-way journeys from companies like DriveNow and car2go, or for longer round-trip journeys from companies like Zipcar; already over 5 million customers use these kind of services globally and they are forecast to grow to over 26 million by 2020 according to our latest analysis.

This is considered to be Social Innovation owing to each company developing a unique car access business model, and realising societal benefits from reduced car ownership and resulting congestion/pollution; recent surveys show that one car-sharing vehicle has the potential to remove up to 17 privately owned cars from the road. This is not all negative to car companies though, it is a realisation of the trend of declining car ownership in cities, and responding with innovative business models to remain relevant in the future of urban mobility. Furthermore, the replacement rates of these vehicles are much more frequent (averaging one year, owing to remarketing and the nature of the fleet deals), giving car companies a great opportunity to test/promote new products, and engage with a typically younger demographic who could be their future customers.

Customers can also hail a taxi or private hire service from one of the multiple applications available to request a cab, see the progress of the driver, plan their route before entering the car and pay for the journey upon completion with their smartphone. Companies such as DidiTaxi in China already have over 100 million users who do just that. Consumers benefit from an enhanced user experience, and the drivers reduce the time spent searching for a fare, which averages 33% of their mileage; thus reducing cost, congestion and emissions.

In a similar regard we have seen a sharp rise in the market for smart parking solutions, both by installing sensors in the infrastructure, and by linking supply and demand through mobile applications using peer to peer solutions. Given the fact that around 30% of congestion is estimated to be searching for a parking space at any time in a city, navigating drivers to a secured space which is paid for in advance, both improves confidence from the user, and reduces congestion, a true Social Innovation. Already the smart parking market is worth \$14 billion in 2014, and is forecast to grow to \$56 billion by 2025 from our latest research. This has a particular opportunity for innovation at rail stations and transportation hubs to maximise utilisation and leverage dynamic pricing where feasible.

#### Electric Mobility

With the continued development of electric vehicles, a truly collaborative mobility ecosystem has emerged consisting of charging station manufacturers, utility providers, parking companies, vehicle manufacturers and systems integrators in particular. With various business models involved, such as leasing the car and battery, subscription based or pay-per-use charging access, and vehicle to grid communication and energy storage, this provides a potentially lucrative market as electrification grows. Our forecast shows the number of electric vehicles will grow from 190,000 in 2014 to over 1.5m by 2020, which will increase the attractiveness of this market, and is already encouraging collaboration across the public and private sectors.

“A truly collaborative mobility ecosystem has emerged consisting of charging station manufacturers, utility providers, parking companies, vehicle manufacturers and systems integrators”

“The length of high-speed rail track is forecast to grow from 50,000 km to over 90,000km by 2020”

“As the rail market continues to grow, so does the potential for new technology enabled applications within the infrastructure”

The social benefit occurs mainly by reduced emissions, but also through a more balanced power use where cars can supplement the grid at times of peak energy demand.

#### Traffic Management

There is also an increasing opportunity to improve the traffic management systems of cities in particular, to achieve several of the intervention areas requiring Social Innovation. This is most commonly delivered through connected traffic signalling systems, ramp metering, CCTV, and inductive loops, but is quickly becoming reliant on probe based and crowd-sourced data from road users to deliver a more cost effective and reliable overview of traffic conditions, enabling dynamic re-routing where required. Waze for example has over 50 million users of the crowd sourced mobile navigation service, which collects user data to test speeds and congestion levels, and analyse this for the benefit of other users, thus giving accurate journey time information and re-routing where necessary, reducing journey times and congestion/pollution in particular.

Within public transport, on the roads we've witnessed a progression in recent years from solutions such as bus prioritisation at signalling to GPS enabled next bus stop notification to improve passenger comfort and understanding, cashless/ticketless buses to reduce loading time, and automatic passenger counts to understand utilisation levels.

#### Growth in Rail

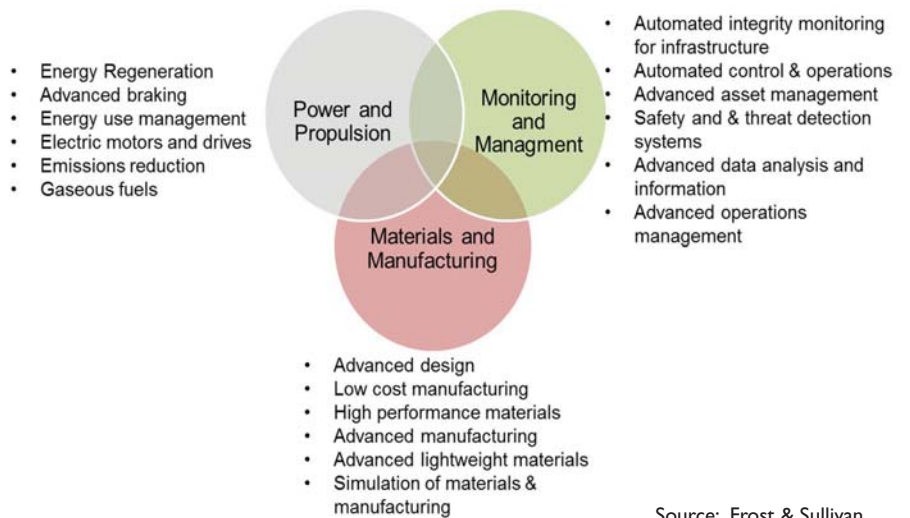
Specific to rail, a vast increase in the infotainment available on board has led to an increased productivity and comfort levels during travel, with 8.15 % of trains now wifi enabled and forecast to rise to 17.74% by 2020 in Europe. Furthermore, the length of high-speed rail track is forecast to grow from 50,000 km to over 90,000km by 2020 with particular growth in China, and overall rail passenger kilometres are forecast to grow from 3.2bn to 4.7bn by 2020. Given the rapid growth in both patronage and considerable investment required in new rolling stock, several rolling stock companies are innovating on their business model to provide trains as a service, inclusive of maintenance and engineering capability, for the duration of a contract and to an agreed service level agreement. Not only does this expand the scope and revenue potential of operators, it increases trust, longevity and fosters collaboration between manufacturers and operators.

As the rail market continues to grow, so does the potential for new technology enabled applications within the infrastructure. For example, communications based train control systems (CBTC) have the capability to double throughput and closeness of train departures, and offer significant power savings. This poses a great opportunity for replacing and upgrading legacy infrastructure to improve communications on all railways.

As rail and urban transit systems upgrade their infrastructure, there is a need for capacity to meet increasing demand and economic efficiency. Demand for rail and urban transit services, both passengers and freight, is set to grow due to a range of factors such as increasing urbanisation, congestion in other transport modes and the need to reduce carbon footprint. To build new transport infrastructure is hugely expensive and takes many years, particularly in developed economies, so infrastructure managers are increasingly looking towards upgrading the technology utilized to increase capacity from existing infrastructure. For example, running more trains at higher speeds with reduced headways. The need to achieve better value for money means a significant movement away from custom, proprietary designs, and towards the use of modularized, standardized components, connected together using standard network technology and provided with any relevant power supply.

The three priority growth areas in the global rail and urban transit industry are Power and Propulsion, Monitoring and Management, Materials and Manufacturing. All three areas have heavy data requirements and are expected to generate sufficient information to fit within Big Data definitions. Functionalities within Monitoring and Management are expected to see considerable developments by 2020. Finally, rail safety is a critical component of the goal to achieve automation in operations and asset management.

**Three priority Growth Areas in Global Rail Industry**



With over 80 billion devices expected to be connected to the internet in 2020, passengers are demanding changes in architecture that borrow heavily from other industries, products, and technologies. The rail sector is expected to witness tremendous innovation, resulting in new applications, business models, and opportunities.

### Social Innovation in the Future

As many of the above business models become more fully established and deployed on a mass scale, Social Innovation provides the opportunity to connect several of the initiatives to improve society and quality of life at a greater rate. Perhaps the most prominent opportunity area is exploitation of the mobility-as-a-service business models, to deliver a user-centric approach to providing tailored mobility solutions that are most efficient and seamless. This provides the opportunity to learn from customer travel behaviour to understand likely congestion and journey times based on historical journeys and advise on best travel options based on pre-time information, or prescriptive analytics. This can be used as part of a holistic booking platform where customers pay per use or on a subscription basis.

To enable this, the rise of connectivity and the IoT will improve communication between transportation and infrastructure. Whether trains to management systems, or increasingly cars to cars / grid / infrastructure, a smart city's transportation will be fully integrated and managed centrally. The rise in potential for mobility-as-a-service and a multi modal city then becomes evident.

As well as changing preferences from consumers towards access to mobility services over ownership of mobility products, companies are also likely to change their perceptions to a more managed mobility system for their employees. This will build on some of the mobility budget schemes available in countries such as the Netherlands to give employers a full understanding of their employee mobility spend and requirements, and allow better management of the employees travel, perhaps by incentivising sustainable modes or promoting certain modes such as rail through providing enhanced information and ticketing products/smartcards.

A great example of the trend towards integration can be seen in Japan, where national government has been leading a programme of revitalisation of the economy, through large investment in infrastructure. As an example, the country is currently looking ahead to the Tokyo 2020 Olympic Games and developing integrated transportation solutions to connect trains, buses, trams and taxis to deliver convenience, efficiency, safety and reduced emissions. In one of the world's biggest mega cities, with an aging population and an expected large influx of visitors, this is a perfect example of Social Innovation in action.

“The rise of connectivity and the IoT will improve communication between transportation and infrastructure”

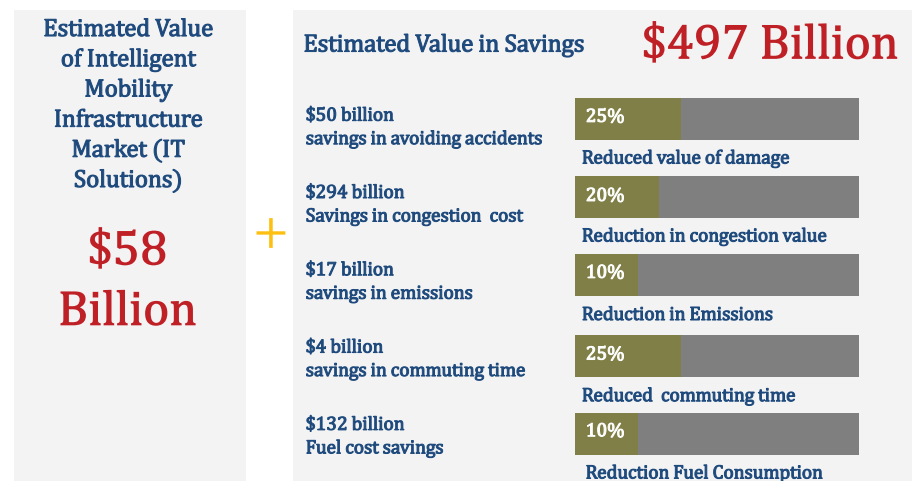
### Quantifying the Opportunity

In considering the monetary and societal benefit that can be derived from Social Innovation Business models, Frost & Sullivan have considered three main areas of infrastructure and service revenue opportunities, benefits to customers and society, and incremental revenue borne by increased mobility. Whilst presented as individual areas of benefit, in reality the three are interlinked; for example IT solutions that deliver social benefit, and in turn facilitate increased throughput on the transport network.

The first area of consideration within Social Innovation is the investment required to connect transportation networks. Connecting infrastructure and the vehicles that travel on them is a key enabler to realise most of the connected, automated new business models outlined above. Through a series of expert interviews with IT and systems integration organisations, it is estimated that an additional 3-4% of the value of transport infrastructure investments would be required to fully enable this opportunity area. With global transportation infrastructure reported to be worth \$33 Trillion between 2010-2030, this would require a further 3.5% spend, or \$57.8 Billion opportunity each year.

However when considering the social improvements that can be realised by this IT investment coupled with more Business to Society focused business models, the opportunity is ten times as great. This could total \$497 billion when collectively quantifying improvements in congestion, emissions and safety on the transportation network; thus the total Social Innovation in Transport & Mobility opportunity could be worth in excess of \$555 billion per year if its full potential were to be realised.

#### Social Innovation in Transport & Mobility – The Value at Stake



**= \$555 Billion value at stake**

Source: Frost & Sullivan

“The total Social Innovation in Transport & Mobility opportunity could be worth in excess of \$555 billion per year”



These social impact benefits can derive from mitigating 3 main externalities, congestion, pollution, and road traffic accidents. Frost & Sullivan estimate the potential for Social Innovation Businesses to reduce traffic congestion by 20% owing to traffic flow optimisation through intelligent traffic management systems, and increasing vehicle to vehicle communications. It is estimated that congestion stifles the economy of 2% of GDP per year (source: OECD), a total of \$1.47 Trillion. Achieving a reduction of this amount by 20% through Social Innovation Business models can therefore contribute \$293 billion in added value to the global economy.

Linked to this is the resulting reduction in journey times. With reduced congestion coupled with new business models such as group rapid transit, and encouraging higher occupancy within transit, could have the ability to reduce journey times by 25%. Reducing the average global commute time of 39 minutes each way per day, applied to the average hourly global wage of \$9.25 (source: UN International Labour Organisation) has the potential to achieve an additional \$5 billion in productive time, when just applied to commuting alone. This is crucial to increase productive time and also the time that we spend with friends and family, thus improving society.

In turn through more optimised traffic and travel speeds, and improving efficiency of transport (both in terms of energy consumption and optimised utilisation) has the potential to reduce emissions by 10%. In 2014 there were 32 gigatonnes of CO<sub>2</sub> emissions globally, with 14% of this attributed to transportation (source: International Energy Agency). Reducing the transport proportion of emissions by 10% has the potential to reduce 448 million tonnes of CO<sub>2</sub> annually across the transport network, with the potential to deliver \$17 billion of savings when applied to the average

carbon tonne price of \$37 (source: costofcarbon.org). As with the journey time example, whilst monetising the benefit is possible, the real social benefit of realising this reduction is a positive impact on people's health and even the potential to reduce the 7 million deaths per year owing to poor air quality.

Furthermore, as we see a further automation and intelligent driving potential on the roads in particular, this has the capability to reduce fuel consumption by 10%. With a billion cars now on the road, this would have the potential to reduce spending on fuel by \$132 billion per year, assuming each car travels 10k km per year consuming 0.12 litres of fuel per km and at a cost of \$1.10 per litre. This is real saving to consumers and businesses that can be reinvested into the local economy and thus improving society.

“More automated and Intelligent Mobility has the potential to reduce accidents by a total of 25% by 2030”

Social Innovation also has the potential to reduce accidents. The move towards more automated and Intelligent Mobility has the potential to reduce accidents by a total of 25% by 2030, through a combination of incident management and collision avoidance. Each road traffic accident causes \$3,000 of damage and repair costs (UK Department for Transport - DfT), without even considering the costs of injuries to passengers. Each year, 7% of the cars on the road are involved in an accident (DfT) leading to damage to the car or third parties. With a billion cars on the road globally, if we take the DfT statistic for UK and use a similar parallel elsewhere, around 66 million crashes per year could be reduced by 25%, thus saving \$50 billion in costs. Again, what is far more powerful is to consider the social benefit of reducing injury and ultimately deaths caused in transportation owing to Social Innovation Business models that reduce accidents.

Finally, whilst we've looked at the IT innovation and social benefits that could accrue, Social Innovation in transport could also deliver incremental revenue to transportation providers and cities. If journey experience is improved and society benefits as we have outlined, then this is likely to lead to an increased demand for mobility for business and commercial purposes alike. For example we have already seen case studies such as new high speed rail lines increasing travel demand overall, not as a substitute from other modes of transport but real new demand for mobility – such as the High Speed 1 (Class 395) link in UK between Kent and London, using Hitachi trains. Overall rail travel in the region has increased by a third between 2009-15, most of which is attributed to the high speed service. Whilst not monetised in this analysis, the social benefit is clear in enabling increased accessibility and true mobility for society as a result of Social Innovation in Transport.

Thus, the Social Innovation in Transport opportunity as a whole can be attributed to infrastructure, savings, and incremental revenue borne by transportation, with a minimum potential of \$555 billion per year based on the assumptions shown above. To deliver and enable this potential requires a combination of three main actions – behaviour change by users, smart policy and governance, and private sector investment. Consumer mindsets are likely to be influenced by a combination of journey improvements, social improvements, and possibly with policy intervention to pump prime the market in some cases, as we've seen with electric vehicles for example. Governments are beginning to realise the potential of mitigating externalities through implementing technology enabled innovation in transport, to improve the lives of their residents and foster economic growth. With these market and political headwinds, private sector investors and innovation companies are increasingly willing to invest in the kinds of business models that deliver Social Innovation, such as Hitachi for example.

## Hitachi's Unique Contribution

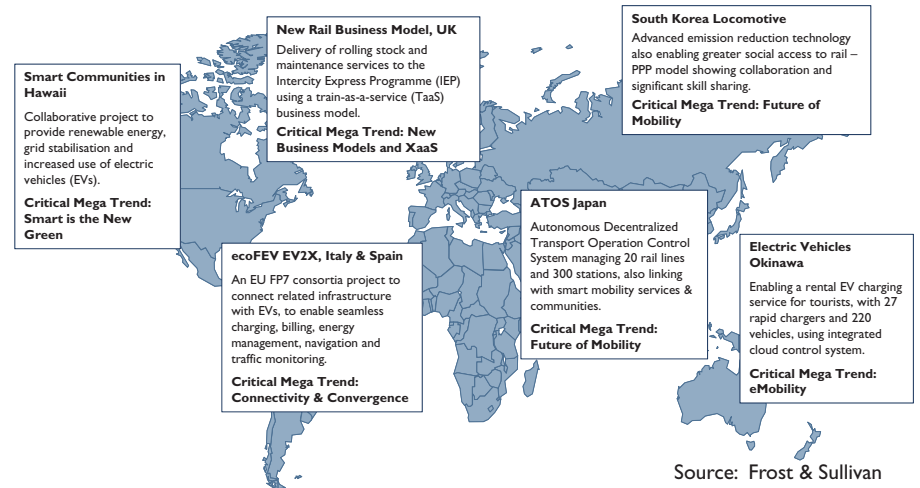
### Social Innovation in Transportation & Mobility at Hitachi

Hitachi – a global pioneer of Social Innovation as a value proposition for over 100 years – has Social Innovation Business at the centre of its mission, values and vision.

Whilst remaining a successful global rail rolling stock manufacturer and service provider, Hitachi has uniquely also diversified to deliver highly sophisticated IT systems integration services for the wider transportation market, with an initial focus on traffic management systems and Electric Vehicle charging, and with the capability to generate and analyse Big Data in transportation, connecting vehicles and infrastructure autonomously for example.

### Hitachi Social Innovation Projects: Examples of Convergence, Collaboration and Societal Impact for Transport and Mobility

“Hitachi’s goal related to Social Innovation is to help people travel in greater safety and comfort within cities, between cities, and between the various countries and regions in the world”



Specific to transportation, Hitachi's goal related to Social Innovation is to help people travel in greater safety and comfort within cities, between cities, and between the various countries and regions in the world. Hitachi provides advanced rail solutions for rolling stock design and manufacture, operations management, monitoring and control, information service, and maintenance. They're also developing EV-related technologies and integration within car electronics, toward the realization of a more environmentally-conscious mode of transportation, and are increasing their presence in the management and control of roads and airports. As a general mobility systems integrator, Hitachi constantly seeks to refine technologies related to the transportation infrastructure, ranging from railways to automobiles.

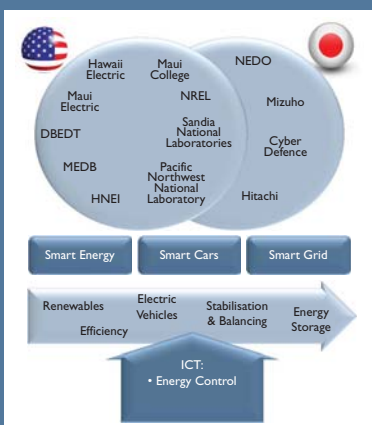
**1. Hitachi Live Example:**  
*“JUMPSmartMaui initiative creates smart communities in Hawaii”*

The JUMPSmartMaui initiative addresses the need to tackle Hawaii’s high dependence on oil for energy and transportation. The State has relied on fossil fuels for over 90% of its energy and transport and has increasingly suffered from rising prices.

Through the collaboration of multiple stakeholders, the initiative focuses on energy and transportation infrastructure and the application of autonomous, decentralised IT systems for energy control.

JUMPSmartMaui will deliver 25% renewable energy by 2020 and 40% by 2030, as well as maximising electric vehicle (EV) penetration, stabilising grid infrastructure and improving community ICT and mobility to enhance the quality of life of residents.

**Customer Benefit:** Improving quality of life by connecting transportation with renewable energy



This is one of the unique characteristics of Hitachi’s Social Innovation in Transportation & Mobility business model – the link between both public and private transportation. Several companies prioritise one or the other without the realisation that actually the two forms of transport are already connected by customers travelling to/from rail stations, and this collaboration can continue if connectivity between vehicles and other modes of transport is enabled. For example, drivers may be able to receive messages of disruption to their train service or at their station before their car journey to the station with automatically programmed alternate routing and ticketing, through the systems being developed by Hitachi’s team. More importantly, as the whole journey becomes connected, there is a greater potential for integrated mobility and fostering a multi modal transport network.

**Hitachi’s role in Connecting Mobility**

Early examples of a connected mobility ecosystem is the ability to book electric vehicle charging stations in advance, owing to the development with Hitachi charging solutions. This includes the information systems that enhance convenience for users (navigation and billing), and the infrastructure such as quick charging systems and storage battery control. This has already been demonstrated in Okinawa for example, where Hitachi technologies are enabling over 220 EVs to be rented to tourists through the Advanced Energy Company. Their wider involvement in electronic toll collection (ETC), supervisory image processing on roads and infrastructure controls, provides a much wider network beyond the railways to enable Hitachi to build an increasing footprint within an Intelligent Mobility ecosystem.

One of the key opportunities to enable Social Innovation in Transportation is through connecting public and private transport, through increased connectivity that allow communication between vehicles (V2V), and from vehicles to infrastructure (V2I). To deliver the wider societal benefits of reducing congestion, pollution and improving the economic viability of cities, there needs to be a more compelling reason to switch from using private to public transport, and indeed to choose an alternatively powered vehicle. This is currently somewhat precluded by the lack of information, price of the services, and relative user experience of either.

Communication systems between vehicles and infrastructure providers have the potential to revolutionise the transport sector. While “connected cars” (ie, vehicles enabled to communicate with infrastructure through embedded devices) have existed for several years, communication and cooperation between vehicles and connected transport-related infrastructures (such as traffic lights, parking lots, etc.) is a relatively new phenomenon.

By installing “V2X” communications (vehicle-to-vehicle and vehicle-to-infrastructure communications—basically a variant of WiFi) in vehicles, carmakers can interact directly with other vehicles and provide advanced applications by exploiting real-time data from vehicles and infrastructure. These systems can be used to improve road safety, traffic efficiency and passenger comfort. A cooperative connected car, for example, would receive not just information about a hazard detected by its own sensors (through a sound or vibration, which is more likely to catch the driver's attention than a road sign), but also through alerts from a vehicle further along the road. V2X communications can also help to provide more real-time information about traffic hold-ups.

Hitachi is working very keenly as part of a consortium to deliver this, initially with pilots for Full Electric Vehicles, as demonstrated in their role in the EU project eco-FEV. This includes the invention of an electro-mobility platform that combines information from full electric vehicle (FEVs) related infrastructure systems, with intelligent telematics services to enhance the FEV reliability. What this could provide is the capability to combine infrastructure to deliver efficient electric mobility, by extending and connecting already existing technical applications to make them more reliable, and also testing new standards and technology.

*“The heart of our eCo-FEV concept is the connection of multiple infrastructure systems relevant to Fully Electric Vehicles. We are convinced that electric mobility will play an important role in the future Smart Mobility and we believe that the eCo-FEV system will have a significant impact on the social, economic and environmental welfare of citizens, when implemented in Europe and elsewhere.” – Max Lenardi, Research and Development Laboratory Manager and Senior Research Engineer at Hitachi Europe*

Another key opportunity from this kind of connected mobility ecosystem is to better manage and re-route customers at times of disruption. Deeper than this, by having a detailed understanding of the customer requirements and behaviours on the transport network, enables service providers to both predict capacity, and automatically reschedule alternatives at peak times or unexpected events. This opportunity to increase the intelligence within the transport system is very much being explored by Hitachi from several perspectives, including related to rail, road, and communicating with a cities core transportation planning functions. This will enable Hitachi to provide information on the status of the transit network on a multi modal basis and enable key interventions to be actioned much quicker than at present.

## 2. Hitachi Live Example: “Eco Friendly Locomotive for Korea”

Hitachi plays a critical role in meeting mobility demand through bringing collaborative solutions to local railways such as the Nooriro project in South Korea.

Hitachi has worked collaboratively with Korea Rail to create a connecting transport system between base cities and multiple short distance transportation markets. The result shows the advantages that can be gained in a public private partnership (PPP) financing model – particularly the collaboration and societal impact leading to the redistribution of skills where customer and provider are learning from one another. A critical offshoot of the partnership between Hitachi and Korea Rail is the upskilling of the Korea Rail team through Hitachi engineers. The partnership has enabled the exchange of advanced skills as well as improved mobility for the South Korean community.

Nooriro has not only had a positive impact on emissions expected from electrification but has increased the comfort level of the commute whilst providing greater facilities for the elderly, the disabled and families travelling with infants. The advanced technology has also decreased the average maintenance work by 1.3 persons per train and is projected to sustain or improve that position over the next 30 years of operation.

**Customer Benefit:** Connected and integrated transportation with reduced emissions, as well as local employment and advanced skills development.

## Hitachi High Speed & Advanced Rail Rolling Stock

And, most importantly, Hitachi has continued to expand and successfully implement its core products in more markets – high-speed and advanced rail rolling stock. Having won high profile contracts in the UK for High Speed 1 (Class 395) to provide trains for the UK’s first domestic high-speed rail franchise, Hitachi Rail is manufacturing the new Class 800/801 series trains which will run on the Great Western and East Coast main lines for the government’s flagship £5.7 billion InterCity Express Programme from 2017 and 2018 respectively. This will see 122 new trains delivered on these respective lines, inclusive of 27.5 years maintenance and service delivery. The new trains will save on average 12% energy and carbon per passenger per journey compared to other electric rolling stock. These contracts will underpin the next generation of rail rolling stock in the UK, improving the commutes of millions of passengers and efficiency for operators.

Already, the HSI railway, using Hitachi Class 395 - or Javelin trains - has led to a 33% passenger increase on the Southeastern trains network, and has cut journey times between Kent and London to under 20 minutes to Ebbsfleet, and under 40 minutes to Ashford. At the Social Innovation Forum, Alistair Dormer, Global CEO of Hitachi’s Rail Systems Business stated that this is a life changing event for commuters from Kent to London, and what this means is that people can use time more effectively, for example allowing them to have breakfast at home with their children in the mornings, a true Social Innovation from the perspective of improving Quality of Life.

Furthermore, to improve train maintenance and service delivery at its flagship train maintenance centre in Ashford and on other fleets in future, Hitachi Rail is planning to utilise effective on-board and real-time data management solutions, which will allow the centralised and condition-based management of inspections and faults, and therefore the advance planning of necessary repairs. The system will also be able to log the distance travelled of each vehicle. This condition-based regime will draw on a wealth of data to enable pre-emptive maintenance, optimised planning of inspections and long term trend analysis to underpin Continuous Improvement. This will represent true rail prognostics in action, improving work efficiency, and maximising fleet reliability and availability for the operators and the travelling public.

It is for this reason that Hitachi Rail has developed standardised product platforms as follows: AT100 metro, AT200 commuter, AT300 Intercity and AT400 high speed. This allows Hitachi Rail to use its flexible trains to respond to customer requirements. Examples of this approach are the Class 395 ‘Javelin’ trains (above) and the IEP fleet, as well as the commuter trains which Hitachi Rail is producing to run on Abellio’s ScotRail network.

Another perfect showcase of this Social Innovation is Japan's Autonomous Decentralised Transport Operation Control System, or ATOS - a system built by Hitachi with JR East. ATOS is a huge system that manages 20 train lines and about 300 stations. It is the "Autonomous Decentralized" aspect that makes it unique. Subsystems at individual stations function autonomously, so the response is quick, and risks are localized.

That means that even if a system failure occurs at one station, operations can continue at the next station on the line. The system can also be extended gradually without having to interrupt the operation of the system as a whole. The system is demonstrating even further growth, transcending optimization as a simple operating system through harmonized links with smart mobility services, in-station services and the regional community.

Hitachi is actively seeking to establish and enhance this "Autonomous Decentralized" system approach to areas beyond transportation, in the fields of social infrastructure such as energy, intelligent water, health care in particular. Its goal is to achieve overall optimization in all infrastructure-related systems – a true Social Innovation for multiple industry sectors.

This increasing autonomous decentralisation gives rise to greatly improved services at rail stations, both from an operational perspective in understanding train and passenger capacity to improve scheduling and safety management, and from a passenger perspective, by improving services and journeys and stations. This increasing system of systems deployment between the train and the station allows for controlling the respective train/station services over apps, and connecting people within, creating a community based around rail stations. As a result, the train is very much at the core of a smart city landscape, and the increasing technology is creating a community around rail stations, with access to several services. With an ageing population in particular, this mixed land use and one stop shop approach to both mobility and services at rail station hubs is a core opportunity that Hitachi is helping to enable.

#### **Customer Centric Vision to Improve Mobility**

As well as the maintenance and train operations, Hitachi's focus on the customer is paramount, with the range of passenger information services available to improve the service and administrative efficiency for railway businesses, including on board information systems, seat reservations, advertisement management, and smartcard management. Therefore, in addition to eco-friendly efficient and reliable trains, Hitachi's Social Innovation strategy clearly includes a customer centric vision for making transportation more comfortable and enjoyable for passengers, underpinned by its statement:

“Hitachi is actively seeking to establish and enhance an “Autonomous Decentralized” system approach to areas beyond transportation, in the fields of social infrastructure such as energy, intelligent water and healthcare”

### 3. Hitachi Live Example:

*“Hitachi brings the service based Train concept to drive business model innovation in the rail industry”*

Hitachi has won a landmark project in the UK to deliver rolling stock and maintenance services to the Intercity Express Programme (IEP) for 27.5 years. The vision is to transform a rolling stock business into a solution business with a new business model. The concept is built around a service-based model whereby Hitachi maintains ownership of the rolling stock. The contract is a pay for use scheme where the client pays for on-time delivery of passengers for the life of the contract, thereby changing traditional fixed costs to a variable cost model and massively diminishing upfront investment.

The project includes a total of 866 railway cars (electric and bi-mode) using proven technology and local design. Leveraging Hitachi’s traffic management and train control systems, the train-as-a-service (TaaS) model will deliver increased capacity, reliability and redundancy; faster & seamless journeys; an enhanced passenger environment; less energy use and track damage; greater safety; and TSI (and RGS) compliance.

To drive its UK and international rail business, Hitachi is also building a new factory in the UK that will open in 2015 for manufacture, assembly and testing facilities with increasing scope including R&D. It will create 730 new jobs

**Customer Benefit:** Delivery of high quality, safe, comfortable and convenient rail travel with enhanced energy efficiency and a customer-centric business model.

*As a total system integrator of mobility, from railways to automobiles, we will support the future of transportation infrastructure in order to make the movement of people “safer” and “more comfortable,” as well as to build “more eco-friendly” cities*

This unique combination of transport solutions, railway maintenance, passenger information services and road based traffic management, tolling, and EV charging provides a leading range of solutions with the ability to already enable several multi-modal Social Innovation Bbusiness models of the future. Looking further forward, Hitachi’s recognition solutions in finger vein and location based services will enable great potential for exploitation in the transportation market, for validation and payment in particular.

It is clear that Hitachi is planning and capable of expanding its mobility portfolio to provide market leading solutions for automotive and transportation providers in particular, as well as improving the customer experience and ultimately the quality of life in the process.

### Conclusion

Social Innovation in Transport & Mobility is set to deliver a more seamless, connected and integrated mobility network, owing to an increasing innovation towards Intelligent Mobility. In turn, this provides several social benefits, as consumers and businesses better understand their options and begin to be offered a more user friendly and user centric mobility experience. Ultimately, this continued connectivity and technology will positively impact our lives and societal change as well as our commute, as mobility becomes easier to understand and enjoyable, allowing time to be spent more productively for business or social purposes and less stressful or confusing.

There are several requirements to achieve such potential, most notably transparency in data and solutions, especially where commercial conflicts may arise. In these instances the government may be required to set the framework for Social Innovation in transport locally.

Several benefits can accrue from Social Innovation in Transport & Mobility, most notably:

- Economic – to reduce costs to users and improve economic growth; reduced congestion and improved employment
- Social – improved accessibility through transportation and to improve journey times by 25%
- Environmental – to reduce emissions by up to 10%



Hitachi is already underway in delivering this vision of Social Innovation in Transport & Mobility, delivering life changing solutions to rail customers in particular, and expanding its focus to also prioritise IT integration services as part of its business offering, especially traffic management and electric vehicle charging systems. This combined expertise in rail and road based solutions allows Hitachi to facilitate the communication and autonomous interaction between both modes. This can increase the intelligence and potential of road and rail services for operators, and create a community based around rail stations by improving the user experience with access to several complementary services, such as retail and logistics.

Companies that adopt such visionary thinking with Social Innovation at their core are set to realise multiple benefits, notably with expanding value chain opportunities. As transport solutions start to attract interest from several industry sectors such as IT and energy management, there is potential to deliver seamless propositions for new mobility services with a network of partners. The most successful mobility business models of tomorrow will be built upon the partnerships that are made today given the time to scale and first mover advantage.

There is also notable creation of shared value from adopting Social Innovation Businesses, based on values that deliver real change to the customer rather than attracting purely on price or customer service. The kinds of solutions that mitigate the intervention areas outlined can benefit individuals' lives and organisations' long term prosperity, by removing some of the societal constraints that exist within transportation today.

The future of Social Innovation will see a mass adoption of new mobility business models, in a world where public transport is the dominant mode of transport and private transport is purely complementary in urban areas for specific use cases; thus several solutions such as carsharing, ridesharing and on-demand micro transit will emerge. This will ultimately bring a more complex but more efficient transportation ecosystem, where customers better understand their transport options and operators better understand their customers. This may require significant incentives and policy involvement in the short term favouring sustainable mobility, especially with regards to automated mobility business models, but also to ensure that the impacts of the solutions being considered and developed are practical and beneficial to the cities in which they're deployed.

“Individual elements such as energy, retail, security, entertainment and healthcare are increasingly coming together – with transportation – to enhance people’s lives and improve sustainability in communities”

Overall, Social Innovation in Transport & Mobility has the potential to enable a \$58bn per year market for connected infrastructure in transportation solutions, but more importantly nearly ten times this amount in social benefits. Over \$497bn per year in social benefits could be realised in reduced congestion, pollution and accidents caused by transport globally. This cumulative \$555bn per year is set to deliver life changing benefits to both users and non-users of the transport network by improving the journey experience and connecting people within a smart community, to improve the society in which people live.

Companies like Hitachi are set to benefit from enabling the core requirements for Social Innovation in Transportation & Mobility – changing behaviour and patterns from the transport users, fostering smart policies and governance, and delivering private sector investment in technology and infrastructure. It is these technological advances in particular that enable Hitachi to deliver Social Innovation in transport, through utilising the technology to improve society and quality of life.

#### Cross-Sector Convergence in Social Innovation

In this Whitepaper we have delved deeply into the challenges faced by society and the benefits that can be delivered through Social Innovation in Transport and Mobility. At Frost & Sullivan we believe that transportation is one of the most compelling areas for Social Innovation Business. It is a truly global phenomenon, with many different regional opportunities to make a real difference to people’s lives, whether it’s bringing personal mobility to parts of the world where infrastructure is limited, to drive economic growth around transport hubs such as train stations, or to enhance the comfort and convenience of commuters in the world’s major cities.

We have also identified that in a world driven by connectivity and convergence, true Social Innovation in Transport and Mobility is an enabler of a better future. A future where individual elements such as energy, retail, security, entertainment and healthcare are increasingly coming together – with transportation – to enhance people’s lives and improve sustainability in communities.

In our next 2 Whitepapers on Social Innovation we will be continuing the theme of drilling more deeply into critical industry sectors (Energy and Healthcare), while maintaining the crucial themes of connectivity, convergence and cross-sector impact of Social Innovation to bring real improvements to infrastructure and to society.

### ABOUT FROST & SULLIVAN

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### ABOUT HITACHI, LTD.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges with our talented team and proven experience in global markets. The company's consolidated revenues for fiscal 2014 (ended March 31, 2015) totaled 9,761 billion yen (\$81.3 billion). Hitachi is focusing more than ever on the Social Innovation Business, which includes power & infrastructure systems, information & telecommunication systems, construction machinery, high functional materials & components, automotive systems, healthcare and others. For more information on Hitachi, please visit the company's website at <http://www.hitachi.com>.

Social Innovation microsite:

[social-innovation.hitachi](http://social-innovation.hitachi)

Social Innovation blog:

[www.hitachi.eu/social\\_innovation](http://www.hitachi.eu/social_innovation)

Twitter: Global - [@HitachiGlobal](https://twitter.com/HitachiGlobal) Europe - [@HitachiEurope](https://twitter.com/HitachiEurope)

Hitachi Brand Channel:

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