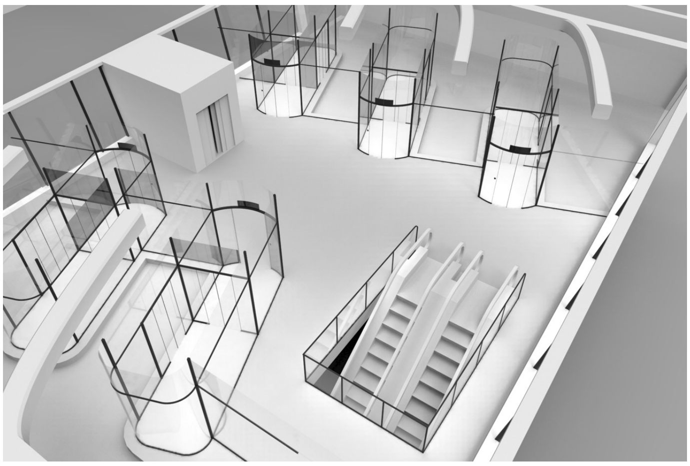
GENERAL TRANSPORT SYSTEM
FOUNDATION

Exploring a General Transport System (GTS)

ACRONYM: **NET**

Abstract

Transportation suffers from inherent shortcomings. We propose a novel General Transport System (GTS). GTS will revolutionise transportation by an overhead "monorail" system with automated, multi-purpose cabins hanging from magnetically levitated and propelled drive sleds. Research in transportation focuses on vehicle design, fuels and operations, GTS also focuses on infrastructure. Movement of cabins will be automated. Cabins will travel individually at reduced speed in urban areas, and in platoons at speeds up to 240 kph over long distances. Platooning can also increase the capacity up to subway levels. Switching will be done using a new electromagnetic technology with no moving parts, direct contact or friction. This proposal is about the necessary new components and sub-systems.



Terminal study by design student Joakim Gustafsson

Conventional transport systems (CTS) depend on friction between wheels and ground, causing wear on both wheels and track. GTS eliminates this by magnetic traction, levitation and track switching, all operated using a standard drive sled. The revolutionary drive sled is the heart of the GTS system and it carries a magnetic lead screw type propulsion, switching and coupling to the cabin. Different types of cabins may be suspended from the drive sleds and may be designed for both person and goods transport. Another aspect is that GTS allows for urban low speed operation of individual cabins and intercity operation of platoons of cabins. On local suburban and urban journeys, the passenger flexibility of the car will be retained but the parking problem will be solved as each cabin will transfer to the next fare when vacated. Cabins can accommodate passengers and their bicycles, baby carriages, wheelchairs or luggage. Traffic jams are avoided by platooning cabins at either the urban speed (<60 kph), or the regional speed (<120 kph), and applying automated logistics. High speed platoons travel at <240 kph over long distances. Platoons do not stop at intermediate stations as the High Speed Trains (HST) do, but continue at full speed, while a cabin, requiring stop, separates from the platoon and stops. GTS travel time over the full distance is reduced compared to the HST. In contrast with all current systems, and other frontier concepts, GTS passengers will travel the whole urban, interregional and long distance journey without need to change vehicle, a fact that reduces travel time even more.

The proposal is utterly complex, engaging some 30 researchers in five countries. Thus we need to divide the full project in two applications in a way that they will be both independent and interdependent.

Interdisciplinary studies will compare both CTS and frontier technologies with GTS. The result will be an extensive logistic, environmental, social and sustainable analysis and a financial estimate of the total costs for GTS. This will be performed in this application by acronym **NET**. Two interesting case studies, in London and Uppsala, will probably reveal advanced benefits by GTS.

Advanced electric, magnetic and operational experiments, laboratory test of a demonstrator, and a full-scale cabin model will be performed together as a unique design in a twin application by acronym **MAG**.

Section 1 **Functionality of GTS**

Introduction

This proposal addresses the topic FETOPEN-01-2016-2017: FET – Open research and innovation actions (RIA). A **General Transport System** (GTS) challenges Conventional Transport Systems (CTS) and other frontier proposals, not only on land, but also on short sea and air links. Providing a general functionality, as opposed to fragmentation with multiple transfers, is essential. This great challenge is met in four major stages. The current proposal concerns only the first stage arriving at a Proof-of-Principles, see below:

Proof-of-Principles project
General Functionality
Analyses, Communications
late 2017-2019

Proof-of-Concept, Prototype
Continued analyses,
Communications
2020-2021

Small-scale pilot plants
Standard and License
structure
2022-2023

Large-scale pionnering
experiences and start of
commercial exploitation
2024-

New great paradigms of transport have been introduced once or twice every century since the industrial revolution, steam propulsion, railways, automobiles, diesel engines, electric propulsion and air transport. Since the global jet-plane network developed in the 1960's no groundbreaking new technology has been developed, even though important, but incremental changes have refined century old technologies. Physical mobility technology is surprisingly stagnant while information technology (IT) is leaping forward rapidly.

We think a unique new technology may develop long before 2050, and that one of the enablers is electro-magnetic propulsion, braking, switching and platooning for non-stop mobility, independent of weather and friction.

It may be harder to explain GTS adequately than actually to develop it. For us in the consortium it is easy because we have been living with the developing concept for years and decades. Others can get confused by GTS because they are so accustomed to conventional transport technology and functionality in everyday life so our unique solutions seem impossible or obsolete. This means that communication activities will be crucial to ensure a successful realization of GTS. GTS will be surprising and challenging for the population at large.

Our concept is far-reaching, comprising collaboration between technological invention, physical design, logistics, ecological analyses, social behaviour science and financial analyses. The framework of the call does not permit all these matters to be fully developed in one project so our subject is split into two separate but interrelated proposals – while each proposal remains independently viable.

This application (acronym NET) addresses the perception, functionality, sustainabilty, costs and impacts of GTS in society and in the human mindset. It can be performed separately but converges perfectly with the sister application (acronym MAG) in terms of the technology of GTS, invention and design, if both are accepted. If only one proposal is accepted we will try hard to get the other proposal financed in another way.

Our GTS concept fulfils the requirements of "FET gatekeepers" abundantly. It is difficult to imagine a more revolutionary change in transport technology and function. Automated driving, electrification of cars and roads, or vacuum tube solutions, are in fact incremental in comparison with fully-fledged GTS. Conventional transport technologies are outdated by their dependence on friction and fragmented service.

1.1 Long-term vision, targeted breakthrough and specific objectives

The *long-term vision* is to replace all road, rail, short air and ferry transport by a universally applicable transport system that includes local, regional and long-distance high-speed lines in one service. The same vehicle will transport passengers and palleted goods from start to goal without transfer – just like the car. The only way to seriously compete with the car is to exploit this formidable advantage to the limit.

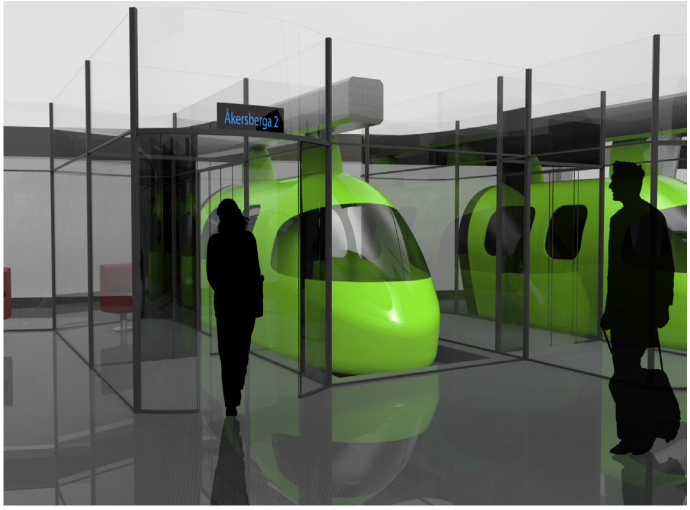
Most proposals to develop ground transportation depend inherently on wheels rolling on roads and railways. The disruptive GTS concept employs electro-magnetic levitated propulsion, free from wear of wheels or bearings. Other advantages include freedom from the conventional fragmentation of journeys and also from the hazardous function of ground transportation. Roads carrying mixed traffic effectively limit the density and connectivity of urban living. Over 50 percent of land area in cities is dedicated to roads and parking, and yet cities are still congested and overloaded.

A completely new infrastructure is proposed, replacing incrementally new vehicles using roads and rails. Van-like, light cabins are suspended under drive sleds, running electro-MAGnetically and in platoons at speed inside slender guideways; platooning renders a capacity like a subway train, while simultaneously allowing for velocities like a high-speed train. Cabins are automatically and seamlessly directed from many small stations through a NETwork of local, regional and high-speed inter-city lines to other small stations. Travellers board and disembark at stations of their choice.

The cabins have an optimum volume for both private and public travel (5-12 pax), with bicycles, baby carriages, wheel chairs and most luggage. For long distance journeys, facilities like WC, kitchenette and beds are provided. Cabins may alternatively be built for carrying small self driving vehicles, palleted goods or be van-like electric vehicles themselves (dual-mode). The first and last miles are thus covered and as such GTS is comparable to the private car without the burden of owning a vehicle. GTS is available, for everyone 60/24/7 without the need of a driving licence.

Notably GTS enables a great mobility for disabled persons. It uses only a small amount of electric energy, which may be harvested as part of the GTS infrastructure (photovoltaic cells etc). It produces no exhaust gas and makes almost no noise. The capacity is superior to most conventional modes of transport. Furthermore the effective travel times become much shorter for most journeys. It is a ground-breaking, and ground-saving, novelty. Making room for public ground space to be enjoyed for cycling, meetings, playing and recreation means that GTS will enhance the development of liveable and creative cities. GTS will give towns and landscapes the functional beauty of sustainable connectivity. The visual intrusion will then be accepted. Where it is relevant, the guideway may be placed under ground, in buildings or even over rooftops.

Five hundred years ago Erasmus van Rotterdam travelled Europe on horseback and by boat from Rotterdam to Gouda, Leuven, Brussels, Cambrai, Basel, Venice, Rome, Paris, London, Oxford, Cambridge..., suffering unthinkable hardships for days and weeks. In less than 50 years we will be able to reach Erasmus's Europe in few hours by GTS: for example non-stop from la Place Luxembourg in Brussels to his birthplace at Wyde Kerkstraat in Rotterdam in less than one hour, to his printer, Johann Froben's printing works in Basel in two hours, and to his patron, Sir William Blount's estate in Greenwich, London in one hour and 45 minutes. To make these journeys from origin to destination by any available means of transport today will take more than twice the time and is unlikely to use sustainable energy! Imagine that travel time is no longer lost time, because GTS offers enough room for rest, reading and doing something else than just travelling as there is no need to concentrate on driving the vehicle.



Terminal study by design student Joakim Gustafsson

Our *targeted scientific breakthrough* is a **Proof-of-Principles** for a human, sustainable and efficient general transport system (GTS). This target can also be conceived as an order for the physical realization of these functions and objectives. The electro-magnetic propulsion, track switch and levitation, coupled with the vehicle control system, forms the technical core for realizing the general functionality, which will change the conditions for mobility completely. The order for the general functionality covers full accessibility for all people and transporters, regardless of age and ability, around the clock (60/24/7). The order also covers all human and sustainable qualities declared by the United Nations. The sum of these advanced, combined, and fully integrated attributes characterizes the *Excellence of Function* in our project.

The project has the following *specific objectives* to be achieved within the duration of the project:

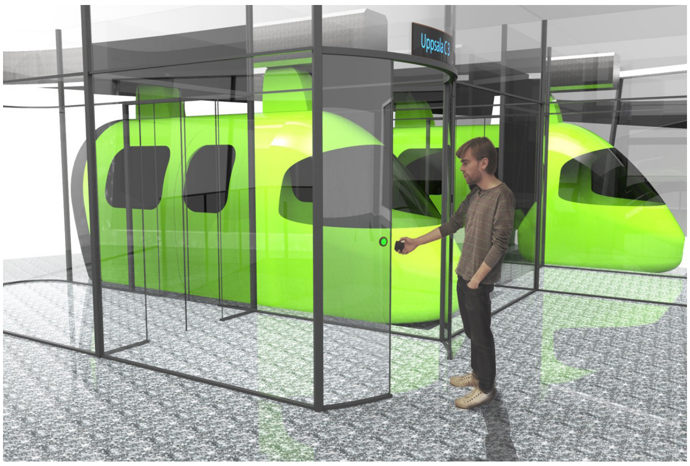
1. Adapt generic simulation models to reflect the functionality of GTS (speed levels, hierarchy, platooning)
2. Assess impact of GTS on logistic and operational analysis factors;
3. Assess impact of GTS on sustainable and social factors;
4. Assess impact of GTS on costs;
5. Conclude the impact of all multiple factors at explored sites (Uppsala, London...);
6. Disseminate, exploit and communicate the findings.

See more on how to achieve these specific objects in 1.3 Research methodologies.

1.1.1 General functionality, logistics, sustainabiity, social cost benefit analyses

The *General Functionality* is a completely new concept. Conventional transport systems suffer from fragmentation of journeys. We are so used to these shortcomings that we take them for granted.

You need a driving licence for driving a car and you will need this as long as ther is no “driverless” automatic system on the roads. There are also multiple disturbances on the roads: bad road surface, rain, snow, slippery conditions, friction dependence, traffic lights, intersecting traffic lanes, etc. Cycling and walking are promoted but unfortunately very risky due to the many intersections with car-lanes. Accidents and casualties are numerous, both with people, animals and objects. Parking is a constant growing problem that is expensive considering the very limited usage of cars. Multimodality between conventional modes is favoured but this locks vehicles for indefinite times and is actually an incremental method. Cars are used for 8 out of 10 trips in developed countries and the number is growing in developing countries. Despite the shortcomings of private car travel it is obviously chosen most frequently, probably due to its comfort and convenience compared to public transport. Public transport shares many shortcomings of road transport with private cars, but it has many more drawbacks. It runs on timetables, and the service is often infrequent causing waiting times to connecting departures. Buses and local trains are often overcrowded in peak hours. Ticketing is a ridiculously inconvenient problem worldwide. Public trips are delayed by frequent stops, where few travellers, or none, will board or disembark. Most transit service is impossible for disabled persons. Entering with wheel chairs, baby carriages or bicycles is often impossible or forbidden.



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GTS solves all these problems and many more by a **general functionality**. The guideways run safely, silently and freely up in the air. Your chosen journey goes nonstop from start to end; thus the fragmentation between public transport and private travel is removed. As GTS is completely automated, the service is available at all times. The cabin provides comfortable accomodation for wheel chairs, baby carriages, bicycles and all luggage. The travel time is generally half of the time spent on current public transport, or even by car. Ticketing is easy by smart-phone applications and check-in-and-out-gates. You can enter special cabins with your compact electric car or you may rent or enter your private dual-mode cabin, made especially for automated driving. GTS presents a number of **logistical and control challenges:**

- The same system will operate inside cities at medium speed, regional at high speed and intercity at express speed. This is a challenge for propulsion, braking and suspension and also for safe control combined with high capacity;
- Emergency braking poses different requirements at different speed levels;
- Emergency braking must be independent of power and communication;
- Platoon formation and splitting requires precise control during temporarily unsafe distances between vehicles;
- Vehicle movements between different speed areas involve re-grouping in vehicle platoons;
- Assignment of destinations to vehicles in order to maximize platoon length;
- Trade-off between ridesharing and passenger waiting-times;
- The network of stations and terminals between local, regional and intercity zones. The functional specification will specify how these challenges can be met so that:
- All guide-ways offer a greater capacity than one road lane;
- Passengers travel non-stop without transfer delays through local, regional and long-distance sections;
- Service level of the complete trip is superior to that of competing modes;
- Use of private cars will be reduced, freeing urban land for more attractive use.

GTS provides a set of technological and operational concepts for reducing the complexity of the existing road and rail transport logistics, and increasing the efficiency and capacity of transport. These novel concepts will eliminate the management of some complex operations that are required for CTS. This project will evaluate the impact of GTS in improving the logistics efficiency and capacity in comparison to existing road and rail transport systems. We will develop and investigate mathematical performance measures and operational research methodologies. Some of the standardized performance indicators, which are currently used to measure the technical performance of freight and passenger transport, will be investigated.

The **EU policy for Transport**[1] is set within this broad context. Since GTS is a long-term project, the European Commission's forward planning is relevant for signalling future expectations and opportunities. The 2011 White Paper Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system[2] sets out:

> *'… 40 concrete initiatives for the next decade to build a competitive transport system that will increase mobility, remove major barriers in key areas and fuel growth and employment. At the same time, the proposals will dramatically reduce Europe's dependence on imported oil and cut carbon emissions in transport by 60% by 2050.'*

Key goals for 2050 relevant for GTS include:

- a 50% shift of medium distance passenger and freight journeys from road to rail and waterborne transport;
- the phasing-out of conventionally-fuelled cars in cities; and
- CO_2-free city logistics in major urban centres by 2030.
- EU transport policy has long focused on connectivity, especially for the functioning of the single market, and it remains hugely important. There is now a particular focus on bringing innovation into the long distance networks. For rail, the industry-led Joint Undertaking for rail research Shift2Rail[3] is worth noting for its focus systems[4] on accelerating the integration of new and advanced technologies into innovative rail. Alongside this EU Policy, the EU adopted the sustainable development agenda, including 17goals, and the global agreement on climate; GTS delivers a considerable contribution to several of these goals.

1 Very comprehensively set out on the Commission's website http://ec.europa.eu/transport/index_en.htm

2 http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm

3 http://www.shift2rail.org/

4 The European Rail Research Advisory Council is also highly influential http://www.errac.org/

GTS ZERO VISION

When considering the final impact of GTS we will take into consideration how we manage to fulfil our GTS zero ambition compared to all conventional transport systems:

- Zero casualties
- Zero emissions
- Zero fossil energy usage
- Zero congestion
- Zero transfers during a journey
- Zero delays during a journey.

0%

Costs and benefits for the GTS system will be assessed by using a Cost-Benefit Analysis method (CBA). CBA is used in the public sector to evaluate a project, with costs and benefits quantified in money terms over the entire life time of the project. The Benefits of the CBA will include monetary values on Travel Time Savings, Traffic Safety Impacts and on Environmental Impacts (direct effects; and indirect effects; i.e. energy consumption also at the building phase.

It is well known that benefits are often assessed too optimistically while the costs are often are considerably underestimated. This does not need to be true, if carried out with the similar straight-forward method (CBA) that was used for the PRT-studies in the EU-project EDICT. PRT is the urban/local part of the GTS-system. Comparing the 'before' study of PRT in Cardiff with the 'after' PRT study at London Heathrow, the postulated travel times were said to be reduced by 50 %: These times have been more than fulfilled and waiting times were also reduced down to less than 1 minute, as forecast. As for capital costs, they were estimated 15 years ago in both Britain and Sweden for PRT-projects. After correction for inflation they compare quite well with today's real life costs both in Britain and in South Korea. The cost overrun is only 17 %; one reason (in Korea) was higher costs due to building the system to be earthquake safe.

The total costs of GTS include the construction of guideways, control system, terminals and vehicles. These costs will be depreciated over 40 years for infrastructure and a shorter time for vehicles. Demand for GTS trips will depend on the total transport demand in a certain region and on the level of competition with existing modes. The concept of generalized cost will be used, with the weighted travel time components for walk, wait, transfer and in-vehicle travel times and fares with GTS and with other modes and on the perceived value of time. The total demand can be determined from existing traffic models (if available) or it can be estimated from population, economic activities in zones around the new track using evidence-based elasticity models. Mode share models will be used to estimate the modal split. These models will be also used in WP5. Such models are available. Sensitivity analyses will be carried out to test the robustness of the net present values. User acceptance will be analysed by a focus group survey.

1.2 Novelty, non-incrementality, plausibility and foundational character

GTS combines its technological breakthrough with a general functionality, a feature that other systems do not offer. In that respect GTS is ahead of both Conventional Transport Systems (CTS) and other frontier technologies. So it is **not an incremental** change, it is a **novelty**.

The GTS functionality is plausible since it is based on proven technologies from previous developments such as:

- Linear electromagnetic propulsion and braking proven in PRT systems (Vectus PRT)
- Control system for PRT certified by the Swedish Railway Board
- Platooning at speed demonstrated by ARAMIS
- Generic simulation modelling developed by LogistikCentrum and the University of Southhampton

The Introduction of GTS is **plausible** because the proposal for breaking the detrimental effects of conventional transport is on the table. However, due to blind spots to some extent caused by vested interests, decision-makers avoid the deeper analysis of reasons for the failings. Our site-partner, the municipality of Uppsala, understands this dilemma and they are open for trying a new path for technological and functional development, which makes GTS plausible. As can be seen in e.g. table 1.2a below GTS differs from other alternatives in three major aspects: Magnetic switching, platooning (and dual mode) in one combination. Road and rail require large areas of land, often in conflict with other purposes and needs. A mainly elevated structure avoids these problems. Technologies may prove successful and, combined with the physical fact and hard-to-solve problem with autonomous vehicles, walking people and animals don't run any risk of serious injury or fatalities.

Table1.2a GTS compared to conventional (CTS) and frontier alternatives

Type	**Functionality**					
	Public/Private	Automation	Access	Restrictions	Distances	Dual mode
CTS						
Road/Car	Private, mostly	No	Driving license	Barriers at grade	All	No
Rail/Train	Public	Partly	Time table	Barriers at grade	Network	No
Road/Bus	Public	No	Time table	Barriers at grade	Network	No
Frontier						
Electric car	Private, mostly	No	Driving license	Barriers at grade	Short	No
Self-drive car	Private, mostly	Semi	Driving license	Barriers at grade	All?	No
Driverless car	Paratransit/taxi	Full	24/7	Barriers at grade	All?	No
PRT guideway	Private/Public	Full	24/7	Functional limits	Short	No
SkyTran	Private	Full	24/7	Functional limits	All lines	No
Hyperloop	Public ?	Full	Time table ?	Functional limits ?	Lines ?	? N/A
Transrapid	Public	Full	Time table	Functional limits	Lines	No
GTS	**Both**	**Full**	**60/24/7 full access**	**Few restrictions**	**All NETwork**	**Yes**

GTS is in an early stage and carries a high risk because of its visionary character. If, however, our exploration of untried magnetic technologies and combinations of these technologies and the general functionality is successful, the foundation of a radically new and plausible technology will be laid. The approaches are analysed in table 1.2b next page.

GTS doesn't need space for parking in public areas. Even a self driving car needs a parking lot. People can do different things than just driving and therefore the "Brever law" becomes obsolete freeing up time for other purposes.

The elevated guideway permits automated and fast transportation without creating obstructions at ground level. Preliminary calculations indicate a guideway cost, including propulsion, control and power, of ~5 M€/km double track and ~3 M€/km single track which is less than for normal railways. The reason for this is e.g. that much less work has to be done at the site. The cabin and drivesled weigh less than 1.5 tons net weight, which is less than the weight of a Tesla car. A Tesla car is far more complicated and is likely to be used 5-10 times less hours per year. A Tesla car costs about 55 000 €. Taken together this indicates that an upper limit for a GTS cabin including drivesled is around 50 000 €. Guideways and vehicles are thus, from this simple analysis, economically feasible.

Table 1.2b FETOPEN characteristics and GTS approaches

FETOPEN characteristics	GTS approaches
Long-term vision	GTS embraces a Proof-of-Principles of a proposed new *general transport functionality* having a very small ecological footprint on Earth. GTS offers the vision of a new future global standard, opening a global market far beyond the present State-of-the-Art.
Breakthrough S&T target	The low cost magnetic core technology to be developed facilitates the general functionality of GTS. Other enabling technologies include traffic control software for safe automated operation of the whole system covering platooning and switch operation at high speed, traffic control and logistics.
Novelty	A radically new transport system that offers the efficiency and capacity far beyond that of railways combined with the flexibility of road vehicle system is envisaged. This has never been researched before. The high speed, high capacity, railway type operation is achieved by coupling many small vehicles into platoons. In all, GTS is a unique novelty.
Non-incrementality	Most research in transportation is devoted to conventional propulsion, roads and railways, and fragmentation between private and public means of transport. The general NETwork of GTS, as the long-term vision, is a completely disruptive challenge.
Plausibilty	All drawbacks and shortcomings of CTS, and partly also other frontier technologies, call for a disruptive new paradigm in transportation. The GTSconcept is founded on a solid analysis of both technological and functional opportunities to counteract CTS drawbacks.
Foundational	Once the Proof-of-Principles is presented a new line of technology is likely to emerge. The automotive, rail and infrastructure industry will then benefit as their production facilities may easily be restructured to support a GTS market expansion. GTS is fully in compliance with the Paris UN agreement on Climate change and the forthcoming European Energy Union.
High-risk	It will take many years of pilot plant test and operation before all features of the system can achieve their final structure. But the peak of technological risk lies in this project; Specifically platooning at speed is a severe challenge.
Interdisciplinary	The project concept has a highly interdisciplinary approach. It ranges from advanced technological and operational breakthroughs, exciting new physical design and adequate new environmental traffic planning, passenger behaviour, social and economic analyses; all these factors enable a research development exceeding incremental refinements within existing technologies. Interdisciplinarity is assured by the Interdisciplinary Working Board (IWB).

1.3 Research methodologies

For the functional specification of the GTS control system we will review the existing control systems used in Uppsala, Suncheon, Masdar and Heathrow. They are all designed for low-speed local mobility and need to be developed to cope with high speed. Platooning while moving is an innovative function although it was demonstrated by ARAMIS at low speed and for heavy truck platooning on roads. From the road applications we can benefit from a standardized communication protocol. The control functions will be evaluated in terms of safety integrity, failure modes and effects, flexibility of fleet management and their dependence on power and communication. For this GTSNET project we will specify performance so that it can be adequately modelled in simulation analysis of the proposed application cases (for Uppsala and London).

Demand modelling will be based on logit type models calibrated on surveys and focus groups results. One critical factor will be the preference of the GTS mode in relation to other public modes. Existing simulation models from LogstikCentrum (used in EDICT) and the University of Southampton (used in CityMobil2) will be augmented with the unique GTS capabilites in terms of speed and platooning. Models will be applied on at least two potential networks in Uppsala and London. It is expected that each application may require simulation model adaptions for local conditions and strategies.

Social Cost-Benefit Analysis will evaluate the societal costs and benefits of each application. Focus group interviews will be used to assess the social and behavioural acceptance of GTS among potential user groups.

Table 1.3a Overall research approaches, methodologies and relevance to the specific objectives (see 1.1)

Work Package	Methodologies	Specific objectives
1. Management, Coordination & - Communications (MCC) Interdisciplinary Working Boatd (IWB)	Normal administrative procedures and coordination between all wp and tasks; - Communication activities (COM). Multidisciplinary conferences by the lead participants aiming at strong guidance to the single task works	**Objective 6.** Disseminate, exploit and communicate the findings.
2. Function, Control and Modelling (FCM)	Develop generic simulation models of GTS functionality. Cohesive actions, synergies and exchange between all work packages; Absorbing new ideas.	**Objective 1.** Adapt generic simulation models to reflect the functionality of GTS (speed levels, hieararchy, platooning) **Objective 5.** Conclude the impact of all multiple factors at explored sites (Uppsala, London...)
3. Logistics and Operational Analysis (LOA), Multiple Aspects Assessment on Costs (CBA)	Applications in Uppsala and London; Mathematical performance measures and operational research methodologies; Data Envelopment Analysis (DEA); Discrete-event simulation and multiple criteria decision analysis; Cost Benefit Analysis (CBA).	**Objective 2.** Assess impact of GTS on logistic and operational analysis factors. **Objective 4**. Assess impact of GTS on costs and benefits
4. Strategic Environmental Assessment (SEA)	Strategic Environmental Assessment (SEA) and a Sustainable impact Assessment (SA), broadly in line with the standard procedures and methodologies used across the EU, e.g. the Dutch MER or the Reference Framework for European Sustainable Cities (RFSC).	**Objective 3.** Assess impact of GTS on environmental and social factors.

1.3.1 Social and gender issues

GTS is designed for multipurpose trips for all. Unpaid labour for the upkeep of a household, with care for children, elderly, shopping etc. is poorly understood in ordinary public transport planning. This category however, stands for a quarter of all public transport use. Women without cars are often responsible for the majority of care work. Here GTS may bridge inequity between genders and other social categories (Global Goal 05). GTS combines the efficiency of the car with that of public transport, and avoids their respective drawbacks. As an example, trip-chaining is made easy by GTS as there are no constraining schedules. It is also much easier to load a bicycle, a pram or a wheelchair on board a GTS cabin than on a bus, train or car. It is therefore often unnecessary to own a car or to have a driving licence to obtain free mobility. These attractive features of GTS will be analysed in wp 2 and 4; reference to

http://ec.europa.eu/research/science-society/gendered-innovations/index_en.cfm (Rethinking Concepts and ...)

1.4 Interdisciplinary nature - and general functionality

It is difficult to envisage a completely different order, in which all sorts of shortcomings in today's transport complex, are swept away. But less than 30 years ago, there were few of us who could imagine that today we would be carrying around our telephone, radio, TV, newspapers, books, music player, world maps with our current position and all libraries of the world, wireless, in a tiny module in our pocket. GTS aims for a similar revolution for physical transportation. Fragmentation of mobility would come to an end just like it has done in the information sector. We call this a general functionality. Most of our mobility needs would be solved by one system. The GTS concept differs from other frontier technologies in transport by this interdisciplinary unification.

Our project will have a special supervision of the complex interdisciplinary effort by the Interdisciplinary Working Board (IWB), consisting of all lead particpants, even from the NET proposal, whether NET will be accepted or not.

Section 2 **Impact**

If successful, the project comprises the following results, compatible with the specific objectives explained in section 1:

1. A unique General Functionality is demonstrated and proven plausible by multiple factors at explored sites;
2. A unique transport operation is demonstrated and shown plausible using simulation software;
3. A unique NETwork with strength and design is visualised and shown both plausible and acceptable;
4. A Cabin design is communicated and demonstrated to be both plausible and comfortable.

These results will be disseminated and exploited worldwide to support a breakthrough and leading to further development with support from EU, the GTS Foundation and Consortium, strategic partners and relevant companies.

2.1 **Impact on industry, transport, nature and society**

The impact will be groundbreaking (and indeed ground saving!), reducing the ecological footprint of transport substantially. GTS has the potential to solve many conflicts between urban development and natural conservation.

The Proof-of-Principles target for this first stage should also have an intellectual impact. We have to tackle a blind spot in society for foundational breakthroughs of novel ground transport technologies. The eye-opening effect of this project will be of importance in itself. It will clearly show that efforts to refurbish old fragmented public transport have limited effects. GTS has the ability to become a disruptive new service changing demographic, economic and social patterns. This calls for a very sensitive handling of the matter.

The European Union would play a decisive role. GTS would change so many conditions in the transport business that new legal structures must be considered. An adaptation of the established transport infrastructure must also be initiated. The vision is to establish a global standard for GTS. Automotive, steel and construction industries would adapt some of their production capacity to serve the need for GTS cabins and structures etc. The GTS Foundation would become the holder and licenser of a global standard, and the European Union would provide the legal, planning and audit instruments required. This is an envisioned impact for the future. In the near future the impact would be a request for an on-going development of the GTS technology and standard.

We have indications that parts of the automotive-, rail-, electric-, steel- and building industry certainly will be interested in producing the GTS system. We also have indications that Standards Institutes (e.g. SIS, Swedish Standards Institute) would be willing to help establish the GTS standard as soon as a specific trade sector emerges. Simultaneously we must be aware of the fact that we may have an opposition between the FET "gatekeepers" and various stakeholders, who may fear a competitive technology (see further under 2.3).

A full-scale cabin mock-up will be designed and produced for presenting the GTS to the public at large. In these communications there will also be presentations of the state-of-the-art of the propulsion, levitation, switching and platooning e.g. the development of the drivesled. These presentations should also lead to a widespread understanding of the GTS revolutionary function in society (see also 2.3c). For the general public we will develop a virtual reality tool to show how GTS works, behaves and how it is perceived.

2.1.1 **Case study Ultuna Link, Uppsala, Sweden**

At Arlanda international airport and adjacent Uppsala, podcars and GTS have been discussed and demonstrated repeatedly over the last decades. In a current general plan proposal for Uppsala there is a 4 km desirable peripheral link between two southern urban sprawls towards the airport. However, the link would cross a national park and the Fyris river, where both a car-road and a light-rail-line would harm the environment unforgivably. Thus the city and the GTS Consortium have an understanding that the GTS project should study a GTS line in this location and analyse the possible advantages and further connections by different modes, both to the city centre and the airport.

Uppsala, with some 200.000 inhabitants, is the northern node in the Uppsala – Stockholm labour market and business region (fig 1). Uppsala has two universities and thriving trade and industry, e.g. prominent research and business in areas such as life sciences and energy physics.

The population and the commuting and business trips in the Uppsala-Arlanda-Stockholm corridor are growing rapidly. So is the city of Uppsala.

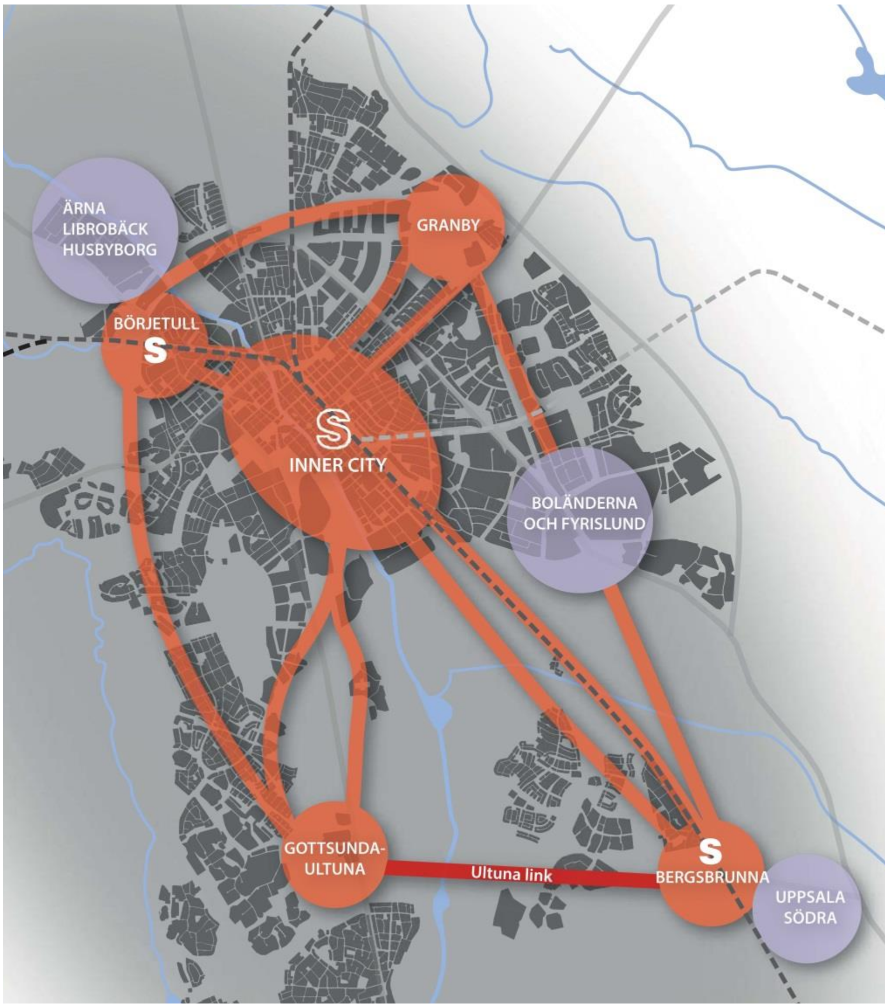
The projected population growth for Uppsala is an increase up to about 135 000 new inhabitants and 70 000 new jobs by 2050. This means that by 2050 the city and its transport system need to be able to serve a population of 340, 000 inhabitants.

In 2016 the city council of Uppsala adopted a new comprehensive plan for city development until the 2050:ies. The plan provides a framework that can contain and sustain the projected growth in a long-term sustainable manner. Four complementary urban centres are to be interconnected with each other and the inner city with fast and frequent public transportation links with high capacity (fig 1).

The public transportation system that should connect the four complimentary centres is to be developed in the future. In some directions the road infrastructure or space is not sufficient to support fast ground transportation. In other directions there is no road infrastructure existing at all at present.

The transportation system in the city centre has to be relieved in the coming two decades, especially around the central railway station. Two of the most important structural foundations to be developed within the next 15-20 year period are the new commuter train station at Bergsbrunna (southeast) and the transportation link between Bergsbrunna and Gottsunda-Ultuna.

Figure 1. The 2050+ five nuclear structure of Uppsala. Urban centers interconnected with fast "public" transportation links. The Ultuna Link is marked in red.



The new station in Bergsbrunna and the important link to Ultuna-Gottsunda - the Ultuna Link - will provide commuters to and from the south western parts of Uppsala with an opportunity to connect to Arlanda and Stockholm faster and easier than via the city centre. It will also allow for further urban development in the southwestern and in the southeastern part of the city. It will also increase the regional accessibility for the universities and research-based business that mainly are located in the western and southwestern part of town. Around the new train station the fourth urban centre will be developed as well as the third larger industrial area of the city.

The Ultuna Link is supposed to serve as a main route of public transport between the southwest and southeast. Bicyclists and pedestrians are to be allowed to use the part of the link crossing the river Fyrisån, but no cars. This means that public transportation will be the fastest way to travel, and keep car traffic between these parts of the city at a low level, despite the substantial growth of inhabitants and activities. To reduce growth in car traffic within the city limits to almost zero is also one of the long-term objectives for the municipality. Thus the end-stop at Bergsbrunna station will also serve people in surrounding settlements and municipalities as a place for intermodal change from car to other means of transportation to reach both the southwestern side and the Stockholm region.

The valley surrounding Fyrisån has substantial landscape values including nature and cultural heritage as well as recreational values. Some of the cultural and botanical heritage is connected to the rise of systematic biology (Linnaeus and followers), and the landscape is put forward to be part of an application for world heritage. At present the municipality is in the process of making a natural reserve of the Fyrisån Valley. Therefore it is of importance that any transportation link must make very little impact on the landscape. Ordinary ground public transport such as bus or tram therefore might not be the best overall solution here, due to the need of embankments and heavy bridge construction. Traffic modelling and design studies carried out in the work with the comprehensive plan have shown that a pod car system might be a good solution. Such a solution might also be prolonged with other links, connecting the other urban centres (the outer circle in fig 2). With careful choice of design it might also be a starting point for a GTS system in Uppsala. The design must then allow for change of technology within the basic structure.

Some of the most desired properties of an Ultuna transportation link are pinpointed briefly below:

1. Faster than ordinary public transportation;
2. On demand and direct transportation to the desired stop for the individual;
3. Nodes/stops for intermodal change and capacity for evacuation of commuter trains;
4. Silent/low noise, no light pollution, no air pollution;
5. Fit in a sensitive rural landscape as well as in an urban environment;
6. No barrier effects and no conflict with passenger boats on the river;
7. No harm to birdlife and other animals;
8. Construction/foundations that do not harm the groundwater, etc;
9. Possibility for successive investments in new stops, higher capacity;
10. Developing technologies such as GTS to improve speed, energy demand, impacts on environment etc;
11. Possibility to prolong the system in other directions, e.g. to the other urban centres of the city;
12. Safe, secure and comfortable;
13. Economically efficient;
14. Self sufficient in terms of energy by e.g. photovoltaic cells covering links and vehicles.

2.1.2 Case study Canary Wharf, Peninsula, London, UK

As a part of this project a study in London (UK) will be developed to explore advantages of implementing a GTS line, but also to learn from the comparison with the Uppsala case study. The London case study has been identified in the recently regenerated area of Canary Wharf and the Isle of Dogs, which presents the confluence of several national walks, such as Lea Valley Walk, Thames Path and Jubilee Greenway. However, limited Thames crossing connections with the Peninsula (square 3 in Figure)makes interchange and the potential of the regenerated area underexploited (Fig 2). Thus, the GTS case study application in London will cover an area of approximately 7 km^2 where more than 100,000 people live and there are 52,000 jobs in the area, with an estimated population growth over 30 percent by 2041 according to the recent 2015 round population projections.

Although existing road network and public transport systems (such as bus and metro/DLR) exist, the connections between the two sides of the Thames (squares 2, 3 and 4 in Figure), especially for nonmotorised mode, are poor, and connectivity between DLR and traditional metro lines is below the average in London. This can be observed looking into the Public Transport Accessibility (PTA) score, which is a measure of the accessibility of a point to the public transport network, taking into account walk access time and service availability, the Boroughs covered by the case study present an average value of 3.6 (with certain census wards below 3.0) compared to a London average of 4.0 and surrounding areas with PTA score above 5.0. Recently this gap of accessibility has been highlighted by a report identifying the need for new river crossings in East London. After a consultation period with almost 7,500 responses received, the analysis undertaken has shown that over 90 percent of respondents expressed support for new crossings and the majority of feedback supported the introduction of new fixed link crossings. The proposed GTS line then will complement the planned pedestrian and cycle crossing linking Rotherhithe to Canary Wharf and the greener Silvertown tunnel (see bottom left and right indicators in the figure).

This site presents an interesting configuration since it has a similar catchment area and expected growth rate of the Uppsala site in terms of population/jobs, but since it is located within a bigger city like London, different dynamics and needs will be identified and modelled, including the higher level of multimodality. This will provide a means to test the level of modal integration for the GTS line and the social and economic impact of multiple factors, such as the different user perception when other modal options are available.

Figure 2. The Canary Wharf GTS Link, London

2.2 Impact on future leadership

Just proving that a new paradigm of thinking is possible within the transport sector, will have a deep impact on the leadership throughout the union. The proud European culture of major transport inventions, has lain dormant for a hundred years now. New radical ideas about transport might come alive again both in academy and in society. The consortium consists of a group of highly experienced scholars in societal, technological and transport science. All partners are aware of the need for a sound generation shift soon and within the project. Younger research fellows and postgraduates will be assigned in all work packages.

2.3 Measures for achieving impact

a) Plan for dissemination and exploitation of results

The GTS Foundation will publicly announce EU support for the project in press releases and public meetings. We will arrange special concluding conferences for disseminating the results of the project. We will also take part in relevant international conferences on transport. Contributions will also be made to respected international scientific journals. The GTS homepage will be extended and used for presentation of the on-going project parts. FAQ:s will be answered, news releases and articles will be published by the consortium and also individually by all scientists in their respective domains. See further under c. Supporting semester and master thesis projects will raise awareness, and also directly aim at involving and communicating to the younger generation.

b) Open research data and organisational measures

The GTS Foundation will be reinforced by raising new capital and appointing several new board members. A standard development and licensing structure will then be prepared. A consortium agreement will be signed to manage key knowledge, IPR and data. The strategy for knowledge management and protection of the GTS Core technology is to leave it open, and establish a Standard & Licensing Structure (SLS). That will support the market exploitation in the most favourable fashion. Research data will thus be spread openly to prevent hostile patent applications. The GTS Consortium AB will be ready to administer and develop the GTS standard, and to collate and preserve data as commissioned by the GTS Foundation. The SLS will be the holder and curator of all relevant data created through the project. All partners in the GTS project consortium will be invited to form the GTS Consortium AB when conditions are ripe. The four stages of organisational development will be structured as conceptualized below:

c) Communication activities

Combining modern communication and physical experience Promotion and implementation of GTS must be presented from a bottom up perspective. This is necessary to secure the interest of policy makers and businesses.

A physical interactive exhibition will be constructed to provide a physical experience of different types of GTS cabins, both exterior and interior. It will be open to the public at the GTS exhibition point on a daily basis. The exhibition point is planned to be located in Uppsala due to its pioneering status. The exhibition can be set up in other locations, as requested.

The visual impact must be visualized and explained.

Public project information and research results, press releases, interviews with key researchers, and technical articles in more popular technical magazines will stream out from the project, reaching transportation experts, architects, urban planners, decision makers and the like. Special promotion of master thesis projects will raise awareness in academia.

In order to reach an international public and wide participation, physical exhibition and traditional communication channels will be accompanied by active presence on the internet via an active web-portal and social media. The portal will provide relevant information and data to user groups such as landscape designers, architects, engineers and construction companies as well as game developers and simulator designers. This allow businesses and citizens to engage and design future transportation solutions with “real” information about the possibilities in GTS.

This will create an ultimate knitting together of real and digital mobility, via online open source participation. We hope to see involvement and contribution from global citizen groups, especially from the younger generation, contributing and showing local examples and virtualization of the possibilities of GTS.

Internally Sharepoint will be used by team members, with shared progress reports, document sharing etc. The management team will distribute newsletters with status, summary and prospects 4 times a year.

Proof-of-Principles project 2017-2019 100% EU support GTS Consortium GTS Foundation	**Proof-of-Concept prototype 2019-2020** 75% EU support 25% Private support GTS Consortium AB GTS Foundation
Small-scale pilot plants 2020-2023 50% EU support 25% Government support 25% Private support GTS Consortium AB GTS Foundation, Licenser	**Large-scale pioneering commercial exploitation 2023-** 90% private 10% public GTS Consortium AB Standard & Licensing Structure (SLS) GTS Foundation, Licenser and Standard holder

Section 3 **Implementation**

3.1 Work plan and intermediate targets

The project is divided into four work packages (wp) described below and initially also under 1.3. Wp 1 has uniting and interdisciplinary obligations to all wp's. Milestones are placed after 2, 4, 7 and 8 quarters. See fig. 3 and table 3.2a

Figure 3. Timing of the different work packages and intermediate targets (milestones)

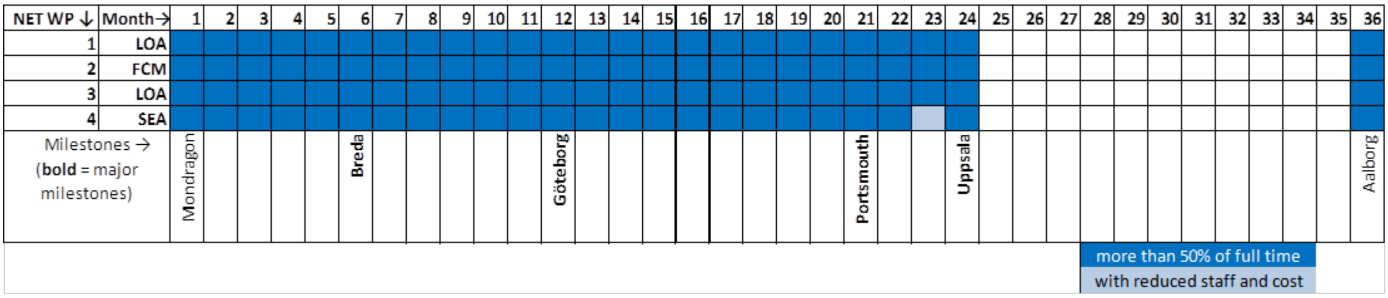


Table 3.1a Work package descriptions

work pack. nr, title	**1. Management, Coordination & Communication - MCC**					Lead beneficiary	**MCC**
participant nr	1.01	1.05		1.10			subcon. 1 Yovinn
short name	**MCC**	MCC - IWB		MCC - COM			Ivar Frischer et.al.
personmonths	36	7		20			
start month M1				end month M24			

Objectives: Conceptual leadership, comprehensive coordination, editing Proof-of Principles and final report; managerial and administrative efficiency, time keeping and accounting;
Interdisciplinary Working Board (IWB), members: MAG and NET wp lead participants;
Communication activities on the web and at exhibition at our location in Uppsala.

Description of work
Task 1.1 Main coordination, visits on all locations, conceptual leadership and final reporting, future structure;
Task 1.2 Financial, administrative and HR management; periodical and final reports;
Task 1.3 Interdisciplinary connections by board analyses and decisions, quarterly meetings, digital and physical;
Task 1.4 Communication activities on a daily basis at exhibition and office location in Uppsala; quarterly reports

Deliverables
1D1Webpage up and running, logo, M1
1dx Press releases on all major occasions
1dy Financial reports quarterly, Q1-Q8
1dz Communications reports quarterly, Q1-Q8
1D2 Intermediate report, M12
1D3 Preliminary Final report,
Research findings and recommendations M24
1D4 Final report, "Inventing a General Transport System" M36

work pack. nr, title	**2. Function, Control, Modelling and CBA**				Lead beneficiary		**LogC**
participant nr	**2.01**	2.02	2.03	2.04	**2.10**		
short name	**FCM**	AAU	UoP	UPA	**LogC- CBA**		
personmonths	**12**	1	2	4	8		
start month M1				end month M24			

Objectives: GTS technological and functional synthesis must be harvested with results from all specific work tasks, for the London Application (LoA) and the Uppsala Application (UPA). This group should also focus on the cohesion of the various work packages: logistic analyses (LOA), social Cost Benefit Analyses, demand analyses and Strategic Environmental Assessment.

Description of Work
Task 2.1 Comprehensive Traffic Analysis; The traffic and environmental challenges for a new tangential link south of Uppsala will be determined (2.04 UPA). The link includes a national park, a river crossing and future links to Uppsala and Arlanda. Similarly, for the London case study several river crossings with existing walk paths and road network will be determined (2.03 UoP). GTS networks in both case studies will be developed as a platform for demand estimation and Cost Benefit Analysis (2.10), integrating GTS with other modes of transport. New strategies for vehicle management and ridesharing will be implemented, optimizing capacity, fleet requirements and travel standard. The two case studies will complement each other with respect to types of area, levels of demand, integration and competition with other transport modes.
Task 2.2 Cost Benefit Analysis The social economy is assessed using a social Cost-Benefit Analysis method (CBA). Benefits have often, but not always, been assessed too o221000ptimistically while costs have been

underestimated. This task will review both benefits and costs ex ante and ex post for some existing systems, e.g. PRT systems. The Generalized cost concept will be used to predict GTS ridership, i.e. walking-, waiting, transfer- and in-vehicle travel times will be added to fares. The mode-split GTS/CTS can then be estimated. The total demand is estimated from an existing origin-destination matrix adjusted by non-linear elasticity. Similar models, available in Sweden, will also be used in wp8. Sensitivity analysis as regards benefit-cost ratio determines the robustness of the analysis. User acceptance will be analysed by a focus group survey together with the Communications group under MCC.

Task 2.3 Extensive summary report LogC 2.01 is responsible editor.

Deliverables

2D1 Synthesis and forecast, intermediate report, M12 2D2 Technological evaluation & synthesis report, M22
2D3 Traffic analysis, environmental & CBA report, M23 2D4 Extensive Summary Report, M23

work pack. nr, title	**3 Logistics and Operational Analysis - LOA**		Lead beneficiary **UoP**
participant nr	**3.01**	3.10	subcontractor TSC (3.10)
short name	**LOA**	UoP - TSC	Eifion Jenkins, Fabio Galatioto
personmonths	**36**		
start month M1		end month M24 (36)	

Objectives: By advanced operational analysis and comparison with present modes of traffic operations (CTS) present GTS advantages.

Description of work

GTS provides a set of technological and operational concepts for reducing the complexity of the existing road and rail transport logistics, and increasing the efficiency and capacity of transport. These novel operational and technological concepts will eliminate the management of some complex operations present in CTS.To evaluate the impact of the GTS in improving the logistics efficiency and capacity of existing road and rail transport systems, we will develop and investigate mathematical performance measures and operational research methodologies. Data envelop analysis (DEA) is one non-parametric linear programming approach capable of comparing the efficiency of GTS to CTS. A more detailed analysis will be undertaken using discrete-event simulation and multiple criteria decision analysis. Some of the standardized performance indicators, which are currently used to measure the technical performance of freight and passenger transport, will be investigated.

The validation of the proposed models will be conducted by an independent sub-contractor, The Transport Systems Catapult (TSC). TSC will use existing validated models and data, representing several million euros of investment by the public authorities. These models, building on a novel High Level Architecture (HLA) approach can be linked to each other and is enough flexible to include other components such as the mode choice for GTS. These models will be adapted to include the mode choice for GTS. The HLA will enable to compare traditional transport models scenarios with those embedding the advanced models being developed in this project. The two case studies proposed will also provide an important set of metrics that will enable to assess the benefit and viability of the proposed GTS for two different cases. This will be done in collaboration with wp's 2 and 4.

Deliverables 3D1 Performance indicators to measure the efficiency of GTS, M9
3D2 Performance analysis models and algorithms, M12
3D3 Validation report, M15
3D4 Comparative analysis and evaluation of the impact of GTS in improving the logistics efficiency and capacity of CTS, M22

work pack. nr, title	**4 Strategical Environmental Assessment**		Lead beneficiary **BOnDS**
participant nr	**4.01**		
short name	**SEA**		
personmonths	**26**		
start month M4		end month M24	

Objectives: By broad analyses of the multifold of environmental and social drawbacks in present modes of traffic we will be able to compare the possibilities of GTS.

Description of work

A **Strategic Environmental Assessment (SEA)** will be undertaken to exclude environmental uncertainties and describe social and economic impacts. We will analyse how GTS performs in comparison with CTS on the aspects health, nature, water, air, soil, noise, external safety, climate, landscape, light pollution, magnetic and high current radiation and energy use. We will also estimate the impacts of GTS on the economy, society and human wellbeing following the requirements of the 2016 Paris Agreement on climate change and the EU policies as described above. To analyse the extent to which GTS fulfils the mobility needs of people we will mindmap existing knowledge gathered in several 5th and 7th Framework Programme projects such as EDICT and Citymobile 1 and 2. All SEA aspects of the CTS and GTS, including economic costs and benefits established in wp 3, will be accumulated in a matrix. The analysis will be deepened by means of a sustainability impact assessment (SA) of the social/cultural impacts; we will examine the accessibility of the transport systems as measured by inequalities for user groups and places, in line with the 2016 UN Sustainable Development Goals. In a final comparison between CTS and GTS, the results from wp's 2 and 3 will be combined with those from wp 4 to establish a Multiple Aspects Assessment. Finally we will develop descriptions, especially the zero concept, how and to what extend GTS complies with the

Paris Climate AgreementDevelop description, esp. the zero concept and accordance with the Paris Climate Agreement.

Deliverables

4D1 Strategic Environmental Assessment (SEA), M12 4D2 Multiple Aspects Assessment (SEA), M21

Table 3.1b List of work packages

wp nr	work package title and acronym	Lead P nr	Lead P acronym	Person months	Start month	End month
1	Management, Coordination & Communications (MCC) Interdisciplinary Working Board (IWB) Communication activities	1.01 1.01 1.03	GTS IWB COM	36 7 20	1	24-36
2	Function, Control and Modelling (FCM) Social Cost Benefit Analysis (CBA)	2.01	LogC	19 8	1 1	24-36 24
3	Logistics & Operational Analysis (LOA)	3.01	UoP	36	1	24-36
4	Strategic Environmental Assessment (SEA)	4.01	BOnDS	26	1	24
∑				152		

Table 3.1c List of Deliverables

Deliv. nr	Deliverable name	Lead P	Type	Diss.	Deliv.
1D1	Launching website and logo	MCC	DEC	PU	M1
3D1	Performance indicators to measure the efficiency of GTS,	LOA	R	PU	M9
1D2	Intermediate coordination report	MCC	R	PU	M12
2D1	Synthesis and forecast, intermediate report	FCM	R	PU	M12
3D2	Performance analysis models and algorithms,	LOA	R	PU	M12
4D1	Strategic Environmental Assessment	SEA	R	PU	M12
3D3	Validation report	LOA	R	PU	M15
4D2	Multiple Aspects Assessment	SEA	R	PU	M21
2D2	Technological evaluation & synthesis report	FCM	R	PU	M22
3D4	Comparative analysis and evaluation of the impact of GTS in improving the logistics efficiency and capacity of CTS	LOA	R	PU	M22
2D3	Traffic analysis, environmental & CBA report	FCM	R	PU	M23
2D4	Extensive Summary Report	FCM	R	PU	M23
1D3	Prel. Final report, Research findings & recommendations	MCC	R	PU	M24
1D4	Final report "Inventing a General Transport System"	MCCmc		PU	M36

3.2 Management structure, milestones and procedures

The registered GTS Foundation (GTSF) is the main partner in the project consortium. The founders are the main carriers of the GTS concept. As main coordinator and technical coordinator they also support the research and innovation work in all work packages. A financial manager controls the economy, HR and administration. A mind map of interrelations between all work packages is presented in figure 4. The consortium will collectively govern the project by means of a leadership with 7 ordinary and 7 deputy members (ref. IWB). It will establish its office in Uppsala.

Six reporting occasions will be arranged and four will be coordinated with the milestones. They will also include external presentations. Two internal meetings are scheduled. The first two milestones are crucial for alleviating high risks whereas the two latter milestones open the road for the final proof and presentation. See Figure 3 and Table 3.2a. Probable risks are listed in Table 3.2b.

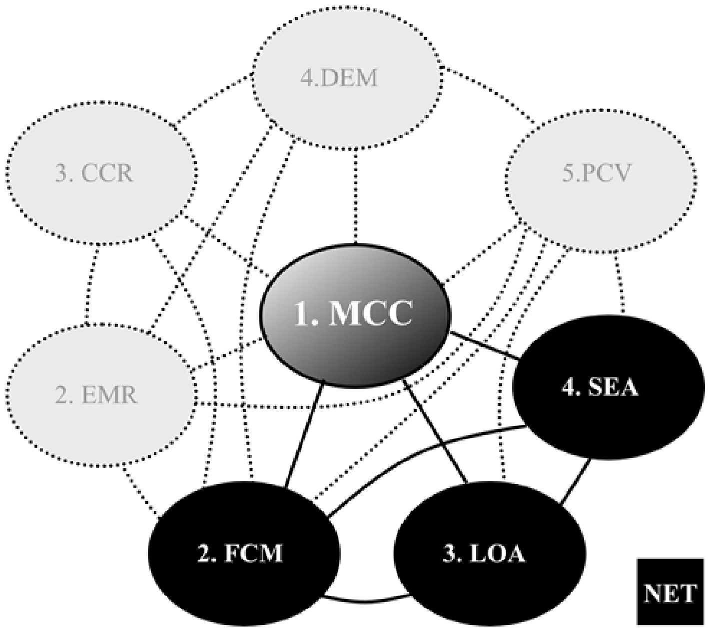


Figure 4. Interrelations between all work packages

GTSF is a non-profit organization but it may own shares or other properties to a limited extent. After a successful project GTSF invites all partners in the project, building firms, cabin manufacturers, electric equipment manufacturers etc to form the GTS Consortium AB (GTSC). GTSC builds the first pilot and pioneering tracks and may then continue to build, in order to develop advanced skills and experience, parallel to competing license-holding industries.

GTSF collects license fees from all GTS producing companies and operative fees from GTS licensed operators. This future business structure will secure the independence of GTSF as the official licenser and standard-holder. GTSF also buys licences from other inventors and incorporates them into the GTS standard when applicable.

Table 3.2a List of milestones (and other occasions, see also Figure 3)

Nr	Name	wp	Date/Venue	Verification
-	Introductory presentations	all	M1 /Mondragon	Seminar papers
1	Core technology, drive sled and beam for laboratory tests **Milestone 1 Performance specification**	all	M6 /Breda (Aalborg)	Deliverables
2	Core technologies, control system, infrastructure & cabin Operational, environmental and financial analyses so far **Milestone 2 Cabin ready**	all	M12 /Göteborg	First Deliverables from most wp's Prototype
-	Closed session, work meeting, preliminary	all	M18 /TBD	Undeliverables
3	Lab.test&validation; control system&simulation software Infrastructure & Cabin design, exhibition, public platform Operational, environmental and financial analyses **Milestone 3 Multiple Factors Analyses**	all	M21 /Portsmouth	Conference Test results Deliverable reports
-	Closed session on Proof-of-Principles, reflections and comprehensive analyses report	all	M23 /TBD	Undeliverables
4	**Milestone 4 Forecast final presentation**	all	M24 /Uppsala	Prel. final report
-	Final presentation Long laboratory test result	all	M36 /Aalborg	Final report

Table 3.2b Critical risks for implementation

Description of risk	**WP involved**	**Proposed risk-mitigation measures**
The functionality does not develop as expected, capacity, logistics, environmental, energy, social or cost performances are too weak	2, 3, 4	The reasons can be avoided by adjustments of premises and early selection of core technical alternatives (by SWOT analysis)
Key staff may unexpectedly be lost	1, other	The leadership has back-ups
Works slow down for various reasons	1, other	The coordinators take actions
Vested interests perform hostile	1, exterior	The leadership takes actions

3.3 Relevance of experience in the consortium

GTSC has been created after years of searching for the right partners. We are now a collection of university research departments, skilled consultants and specific sub-contractors (SME) with special knowledge for creating, inventing, analyzing, synthesizing and visualizing our proposal. All partners also have an open mind that makes our mission possible to accomplish; this is a necessary gate value for bringing our project to a happy end. All lead partners have signed a Letter of Intent. In all we are around 20 researchers, inventors, engineers, architects, economists and analysts, including the 4 sub-contractors. 2 out of 6 lead participants are women. Roughly 5 participants are under 30 years, more than 10 are between 30 and 60, and 5 are over 60. See also section 4.

3.4 Appropriate allocation and justification of resources

(person-months, equipment, budget)

Table 3.4a Summary of staff effort

Staff	wp1	wp2	wp3	wp4	∑pm
1.01 MCC	**63**				63
2.01 FCM		**27**			27
3.01 LOA			**36**		36
4.01 SEA				**26**	26
∑	63	27	36	26	152

Table 3.4b 'Other direct cost' items (travel, equipment, other goods and services)

Work packages - wp 1 - 4	**Cost €**	**Justification**
wp 1 MCC GTS Foundation, main coordination, communications, cabin model exhibition		
Travel	36 000	6 meetings x 2p. + 6 travels by main coordinator; 18 x 2000€
Equipment	20 000	Computers and server, smartphones, network, furniture, all on short-term rental basis if possible
Other goods and services	90 000	Centrally located office for public communication, exhibition and work on short term rental basis; printing service, webpage service, conference costs
	590 000	Full-scale cabin model production, Yovinn AB, Göteborg
Total	**736 000**	
wp 3 LOA University of Portsmouth, subcontractor Transport Systems Catapult, Milton Keynes		
Other goods and services	98 000	Transport Systems Catapult, Canary Wharf Study
Total	**98 000**	