



New Mode of Surface Transportation for 21st Century: Autoway

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Abstract: Autoway is an advanced autonomous transportation system for passengers and light freights, with a focus on commuting and e-commerce. Autoway offers a comprehensive solution to traffic congestion, energy shortage, air pollution, and traffic safety. As a transportation technology for the 21st century, Autoway will bring a lasting economic boom. The business opportunities range from manufacturing, computer software/hardware, communication, e-commerce, and construction.

1. Why we need a new mode of surface transportation?

Transportation is vital to the social and economic development of civilizations. On the one hand, the efficiency to move people and goods is directly related to the efficiency and productivity of a society. On the other hand, transportation industry is a comprehensive industry that utilizes the latest technology advancements in many fields. A significant advancement in transportation technology often brings huge business and job opportunities in a wide range of industry sectors.

For a long time in history, horse-pulled wagons on the roads and boats on rivers and seas were the main transportation means. In the 19th century, railway made a great impact on the economy and bicycles provided more freedom in personal transportation. The widespread uses of automobile and airplane in the 20th century changed the way we live our life and do business. However, we are facing a serious transportation challenge around the world. Traffic congestion, energy shortage, air pollution, and traffic accidents are serious problems in cities around the world.

In order to understand the transportation problems, we will first examine the costs of existing transportation modes, as shown in Table 1. Transportation costs should include fuel, road construction and maintenance, vehicle, and insurance. The values listed in Table 1 are not real cost data, but estimates of reasonable costs achievable for personal transportation for one passenger and mass transit with full occupancy of all seats. The capacity is listed for a normal highway lane or equivalent at comfortable conditions. The direct costs are adjusted for the commuting time for both developed countries and developing countries. For simplicity, we assume the time cost in a developed country is \$15/hr or annual salary of \$30,000 and the time cost in a developing country is \$1/hr or annual salary of \$2,000. In countries with a considerable income distortion from the normal distribution, the costs should be adjusted differently for each class. Of course, the actual transportation costs vary considerably with the construction and operation conditions, excessive taxations, and ridership variations.

There are other factors for commuter's choice of a transportation means, such as convenience, comfort, safety, and availability. It is clear from Table 1 that walking and bicycling are too costly in developed countries except for very short trips. Bicycling is economically feasible only if we consider it as part of a physical exercise program, removing the associated time cost. This would be difficult since most people have other uses for the leisure time.

Table 1, Commuting transportation cost estimation

Vehicle type	Speed (km/hr)	Capacity (1000/hr)	Cost (\$/km)	Adjusted cost (\$/km @ \$15/hr)	Adjusted cost (\$/km @ \$1/hr)
Personal transportation					
Automobile	50-120(80)	2	0.17	0.36	0.18
Autoway	50-150(80)	4-40 (20)	0.03	0.22	0.04
Motorcycle	50-120(80)	4	0.05	0.24	0.06
Bicycle	10-20(15)	12	0.003	1.00	0.07
Walking	5	12	0.001	3.00	0.20
Mass transportation					
Subway	30	10-40 (20)	0.25	0.75	0.28
Bus	10-100(30)	1-40	0.04	0.54	0.07

Automobile is the most cost-effective convenient and comfortable means for passenger transportation at present, but it is also the major source of traffic congestion, energy shortage, air pollution, and traffic accidents. Motorcycle does have a cost advantage over automobile, but it is not a major transportation means in developed countries due to safety and comfort. Practically speaking, automobile is very effective for cities with (1) a moderate population density (less than 2500 per square kilometer or 6500 per square mile) and (2) a moderate total population (less than 750,000). The first condition is due to the low capacity of automobile transportation. The second condition is related to the complexity of traffic condition. In cities with a high population density or a large population, we will run into the problem of traffic congestion.

Another shortcoming of automobile is that a considerable portion of the population cannot drive. School children are too young to drive and some senior citizens are no longer able to drive safely. As the senior population continues to increase, their transportation needs will become a challenge to the society.

It is a myth that mass transit can help reduce the traffic congestion. From the above cost data, traffic congestion is the precondition for a significant rideship on mass transit. Only when the speed of automobile is significantly reduced can we have a comparable cost for both automobile and mass transit. When there is already serious traffic congestion below the average speed of mass transit, then mass transit does help to prevent further deterioration of congestion. Especially for subway, its high direct cost means heavy subsidies are necessary almost everywhere in the world. In addition, the economic structure of a modern society further tilted the balance in favor of personal transportation.

Public transportations like buses, subway and railway trains are no longer convenient for the dispersed, distant and complex urban transportation.

Therefore, we have a traffic problem that cannot be addressed by existing modes of transportation. This has been proved by the traffic realities in major cities around the world. It is time to think outside the box and to develop a new mode of transportation.

2. The basic features of Autoway

Autoway is an advanced autonomous surface transportation system for passengers and light freights, with a focus on commuting and e-commerce. It can be constructed with a minimum impact on existing structures due to its small space requirements. Sitting in an executive chair in your private vehicle, with your favorite music in the background, you are browsing the news over your morning coffee. This would be the commuting experience on Autoway. The only thing you need to know is your destination. It is as easy to operate as the elevator, suitable to all people from school children to senior citizens.

As for e-commerce, Autoway provides a cost-effective system for local delivery of light freights of less than 220 lb (100 kg). As an automatic system, it is ideally suited to e-commerce for businesses and consumers. A distribution center can handle a region with a radius of 100 miles. People can also choose their preferred delivery time.

The main features include:

- 1) Convenience, comfort, reliability, safety, and privacy;
- 2) Fuel efficiency: 500 mile/gallon (200 km/liter);
- 3) Lane capacity: 11,180 person/hr; and higher for emergency evacuation;
- 4) Speed: 65 mile/hr (100 km/hr) in urban areas, 90 mile/hr (150 km/hr) for intercity traffic;
- 5) Cost: \$5 million/mile including vehicles, guideway, and control system, or 5% of subway.

There are many benefits derived from the new transportation mode of Autoway:

- 1) People-friendly: Especially useful to school children and senior citizens;
- 2) Energy efficient: 20 times higher than automobile;
- 3) Environment-friendly: Reduce air pollution, noise pollution and soil erosion;
- 4) Wildlife-friendly: Minimizes interference with wildlife habitats;
- 5) Significantly improve the air travel efficiency and highway safety;
- 6) Ideal transportation mode for e-commerce.

3. The principles of Autoway

Autoway has the following technical principles:

- 1) Fully automated vehicles capable of operation without human drivers. Just input the destination and go. Even school children can use it.
- 2) Small vehicles. The vehicle is for only one adult, or one adult plus two pre-school children seated in rear-facing positions. This results in the lightweight vehicle.
- 3) Small exclusive guideway. As a result of the small vehicle, a very small guideway can be used, and it can be constructed with a minimum impact on existing structures due to its small space requirements. It can be located above ground, at ground level or underground. Normally Autoway is built as an overhead construction.
- 4) Vehicles able to use all stations on a fully coupled guideway network from origin to destination without the necessity to transfer or stop at intervening stations. Put it another way, all stations are on side branches of the guideway. Therefore, Autoway vehicles can move at a high speed without the stop-and-go behavior of buses and subway. Autoway stations can be built directly inside office buildings, apartment buildings, shopping centers, hotels, restaurants, hospitals, schools, and airports.
- 5) There are private vehicles and public vehicles on Autoway. Service is available on demand rather than on fixed schedules for all vehicles, private or public.
- 6) Parking is automatically performed by the system for all vehicles, private or public.

Autoway fits the definition of Personal Rapid Transit (PRT) system. The concept of personal rapid transit has been proposed for about 50 years. The PRT system at Morgantown, West Virginia, has been in safe and continuous operation since 1975. Critical questions have been raised about the economical feasibility of the concept. See, for example, V.R. Vuchic, *Personal Rapid Transit: An Unrealistic System*, Urban Transport International (Paris), No 7, 1996, page 35. It seems to be mutually incompatible between the small size vehicles for low-density travel and the substantial infrastructure investment for guideways, stations and sophisticated automation justifiable only for heavy traffic volumes. This is a reasonable argument in consideration of the costs of existing guideway systems such as subway, rail and monorail, and some previous personal rapid transit systems suffered from the dilemma. Attempts to increase the capacity by short headways of less than one second may face safety concerns similar to those of the automated highway system.

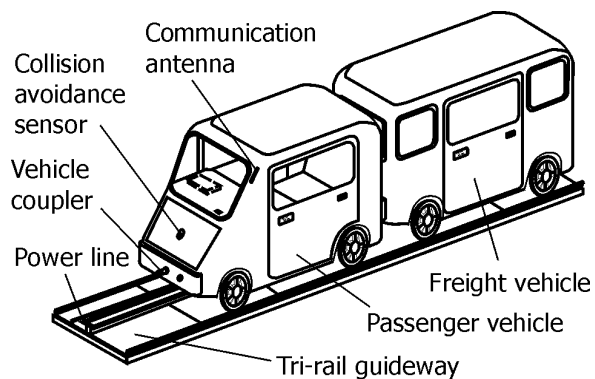
Autoway goes to the extreme of small vehicles with the vehicle for only one person. A Chinese proverb says that things will develop in the opposite direction when they become extreme. This extremely small vehicle will actually give rise to a high capacity for high-density travel.

Another noticeable departure from previous approaches is the extensive use of private vehicles. PRT is usually presented as a public transportation system in order to attract public funding. It is originally proposed as a public transit system for areas of medium to low population density, in a 1968 report of US Department of Housing and Urban

Development, *Tomorrow's Transportation: New Systems for the Urban Future*. The irony is that PRT has never obtained any significant government funding for its development. The important thing is to clearly understand the task at hand and the priority. The limited resources are (1) time, (2) road, and (3) energy, in that order. Private vehicles are more efficient in the use of the limited resources.

4. The technical design of Autoway

Passenger vehicle: The recommended size is 85 centimeter in width, 150 centimeter in height, and 200 centimeter in length. The vehicle is for only one adult, or one adult plus two pre-school children seated in rear-facing positions. This results in the lightweight and small vehicle. The small weight of the vehicle, which is about 100 times less than a typical railway car, has significant implications. First, the small weight allows for easy control of the speed and braking, and a short headway of 2 seconds can be used. Second, the cost and size of guideway can be significantly reduced. Third, the small size vehicle for one person fits the prevalent commuting pattern of a modern society. Most people in United States drive alone for their commuting trips. Fourth, the small vehicle significantly reduces the energy consumption. The fuel consumption is only 5% of automobile.



Each vehicle has its own identification and computer control system for autonomous operation. The vehicle has a wireless communication antenna to communicate with the Autoway central control system. The vehicle is equipped with a collision avoidance sensor. The collision avoidance sensor is also used to facilitate the dynamic coupling of vehicles into a train through the vehicle coupler.

The vehicle has wheels engaged on the side rails for supporting and driving. The vehicle has guiding wheels engaged on the vertical surfaces of the central rail for guiding. The guiding wheels prevent the noise associated with the lateral vibration of the vehicle in conventional railway. The tri-rail arrangement also prevents the possibility of derailling. The driving wheels are powered by electric motors with regenerating braking capability for energy saving. An additional wheel is provided to engaging on the horizontal surface for extra driving and braking power as a rail-gripping condition can be applied.

The small vehicle provides a spacious seat for one passenger. As the vehicle is autonomously driven, the passenger is free to do what he wants. He can listen to music, read newspaper, browse the internet, watch a movie, make a phone call, drink a cup of coffee, or even have a good sleep. The passenger is provided with a seat belt for safety reason.

Freight vehicle: The freight vehicle is similar to the passenger vehicle except the shape for easy handling of cargos. The overall size should be determined by the design of the passenger vehicle. The load capacity is limited to less than 100 kg.

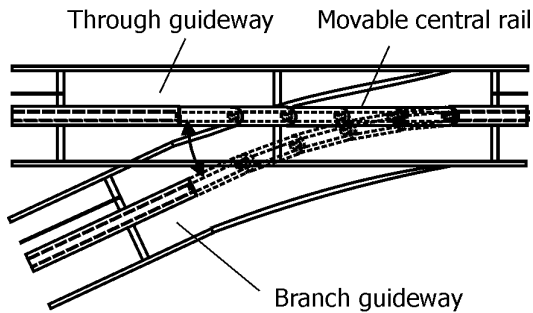
Guideway: A unique tri-rail guideway is used on Autoway. The Autoway rail gauge is recommended as 80 centimeters. The side rails support the vehicle and the central rail guides the vehicle. The T-shaped central rail has vertical surfaces with a low friction for the guiding wheels of the Autoway vehicle. The horizontal surface of the central rail has a high friction so that it can provide additional acceleration and braking power when engaged by a wheel of the vehicle.

A comparison between Autoway tri-rail guideway and conventional rail and monorail will further illustrate the characteristics of the tri-rail guideway. The conventional rail has two parallel rails for the flanged wheels of the vehicle, and the reaction between the wheels and the rails guides the movement of the vehicle. Occasionally derailing will happen for the conventional rail. Monorail uses the horizontal surface for supporting and driving the vehicle and the vertical surfaces for guiding the vehicle. Derailing is essentially eliminated for monorail. Since the monorail is a heavy structure, switching takes a long time of about 15 seconds, in comparison with the switching time of a couple of seconds and even 0.6 second for some modern switches in the conventional rail. The Autoway tri-rail guideway, like monorail, also separates the guiding wheels from the driving wheels and also essentially eliminates the danger of derailing. Since the central guiding rail of Autoway does not support the weight of the vehicle and the weight of the vehicle is 100 times less than the monorail vehicle, the central guiding rail can be made small and light. As a result, switching can be performed in a very short time.

The tri-rail guideway is typically mounted on an open-frame structure as an overhead construction. In urban areas, it is typically constructed at a height of about 7 meters. The land needed for the guideway is the site for the construction of the small supporting columns. The narrow and light guideway can be built over sidewalks on existing roads. Therefore, the guideway can be constructed with a minimum impact on existing structures due to its small space requirements. In rural areas, the overhead construction minimizes the interference with wild life and reduces the soil erosion related to road construction.

The open-frame structure of the guideway makes Autoway less susceptible to weather conditions like fog, rain, wind, hails, snow, and ice. The guideway does not collect snow, and snow and ice on the limited rail surfaces can be easily removed with a specially designed machine.

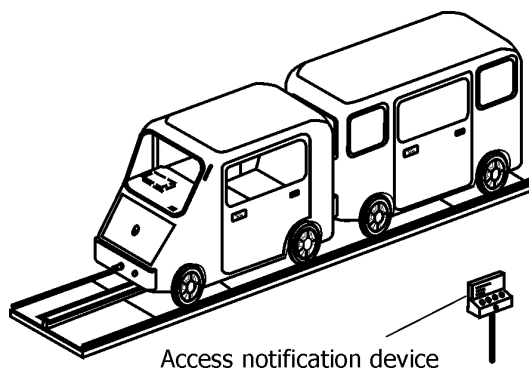
Switch: Switching is performed by a wayside control system according to the instruction from a central control system. Switching is accomplished by moving the central guiding rail from one branch to another branch with the side rails fixed and continuous. The switching arm is like a mechanical arm of a robot with several segments. The movement of each segment can be controlled by a servomotor. Since all the segments can move



simultaneously and each segment only moves a very small angle, switching action can be done in a short time of a tiny fraction of a second. The mutually exclusive switch construction also prevents collisions due to malfunctions of switches.

Propulsion and power: Electric motors are used for propulsion. The main power source is a power line mounted on the guideway track. A small backup battery is provided for (1) the reliable operation of the vehicle control system and sensors, (2) power for the electric motors when the main power line is disconnected for safety and operation reasons at stations and switches, (3) emergency backup power to move the vehicle to the nearest station during power outage.

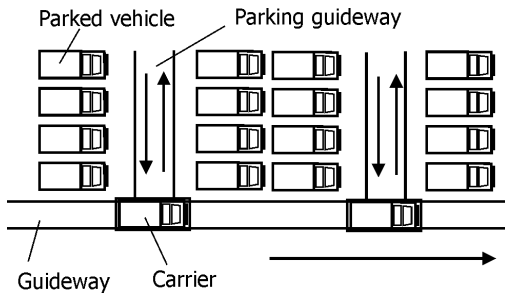
There are several advantages of electricity power source. Removing the power plant from the vehicle to large electricity power plants reduces the weight of the vehicle, improves the reliability of the vehicle, and increases the energy efficiency of the system. The energy efficiency of Autoway will be 20 times higher than conventional automobile. Since nearly all kinds of energy can be converted to electricity, this will significantly reduce the oil dependence of transportation. Renewable energy sources can be conveniently used by Autoway.



Station: Autoway stations are built on sidetracks. Just add a small access notification device, and a station is provided. Passengers use the access notification device to inform the central control system, and their vehicles are dispatched to the specified station.

The concept of station on Autoway is different from that on railway and subway. Subway and railway stations are large and expensive to build. Autoway stations are more like places to call a taxi. Autoway stations are built for the dispersed personal transportation. There will be many stations but only a small number of people at each station. Autoway stations can be built directly inside office buildings, apartment buildings, shopping centers, hotels, restaurants, hospitals, schools, and airports. When Autoway becomes a well-developed network in the future, every home can be an Autoway station.

Parking: The major difference in the parking facility of Autoway to conventional parking facility for automobiles is that all the parking on the Autoway is varlet parking. The Autoway system will automatically move the vehicle to a nearest parking facility, saving

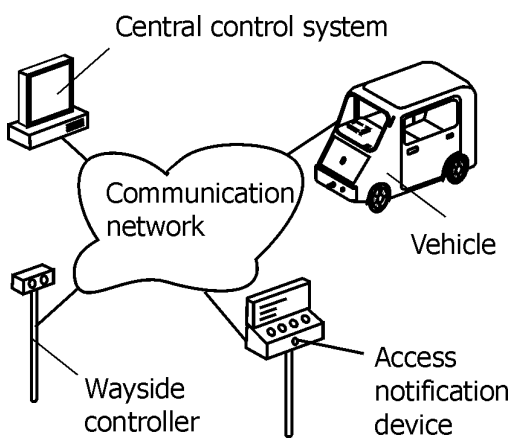


people the trouble to find a parking lot and then walk back from the parking lot. The system keeps track of the locations of all vehicles and transfers a particular vehicle to the location of demand. This can be very convenient when the available parking lot is far away or when people get into a large shopping mall from one entrance and get out from another entrance.

According to the types of access mode, the parking facility can be of two types: the random access type and the sequential access type. The random access parking is for private vehicles and exclusive rental vehicles, and each vehicle can be accessed independently. A carrier residing on the parking track can move along a carrier track perpendicular to the vehicle track to put the vehicle into a parking position. The sequential access parking is for public shared vehicles. Multilevel parking is possible and even more efficient when the carrier can move vertically at the entrance and exit point. In this case, multiple carriers can be used to move in a vertically circular form to improve parking speed. Depending on the parking arrangement, a parking lot can handle 6-12 times more vehicles than automobiles.

The concept of vehicle carrier can be further extended to move vehicles to offices and apartments in high-rising buildings. The carrier can move both vertically and horizontally along a special carrier track. People can use their vehicles directly from their apartment rooms to their offices.

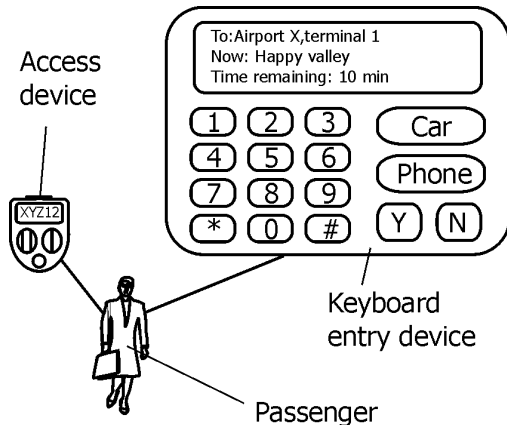
The vehicle carrier can also be used to move vehicles between tracks at different levels of height. For example, the transition between underground tracks and overhead tracks can be accomplished at a special facility with the vehicle carriers. In mountain areas, the vehicle carriers can be used to avoid high grade climbing.



Control system: The control system of Autaway is divided into three levels: central control system, wayside control-point control system, and vehicle control system. The central control system is responsible for functions related to the whole Autaway system, such as vehicle registration, user registration, and traffic control. At any moment, the central control system knows the locations of all parked vehicles, the destinations of all moving vehicles, and the approximate locations of all moving vehicles within a known track segment.

The central control system delegates the switch operation and the speed control to the wayside control system and the vehicle control system. The wayside control system is

responsible for switching operation. The vehicle control system is responsible for the safe operation of the vehicle. This arrangement provides fast responses and reduces the communication burden in comparison with the high guideway cost of the fixed block system and the demanding communication requirements of the moving block system used in conventional railways. In the fixed block scheme, the guideway is divided into segments called blocks and apparatus is provided in each block to detect the presence of a vehicle. The minimum separation between vehicles is at least one block. When a short headway is desired, the infrastructure cost becomes excessive. In the moving block scheme, each vehicle transmits its location to the central control system and receives instructions from the central control system on a periodic basis. The headway is related to the communication rate. When a short headway is desired, the communication load becomes excessive. The control method in Autoway is feasible due to the collision avoidance system of the vehicle and the ability of the vehicle to stop in a short distance like an automobile.



People interface: Autoway is an autonomous transportation system and the people interface is very straightforward and simple. Every passenger is given an access device, which is equivalent to a keyless entry device for automobile. There are an open button to open the door and a close button to close the door. The display shows the identification of the vehicle for the passengers. This device is also used for communication with the access notification device at a station.

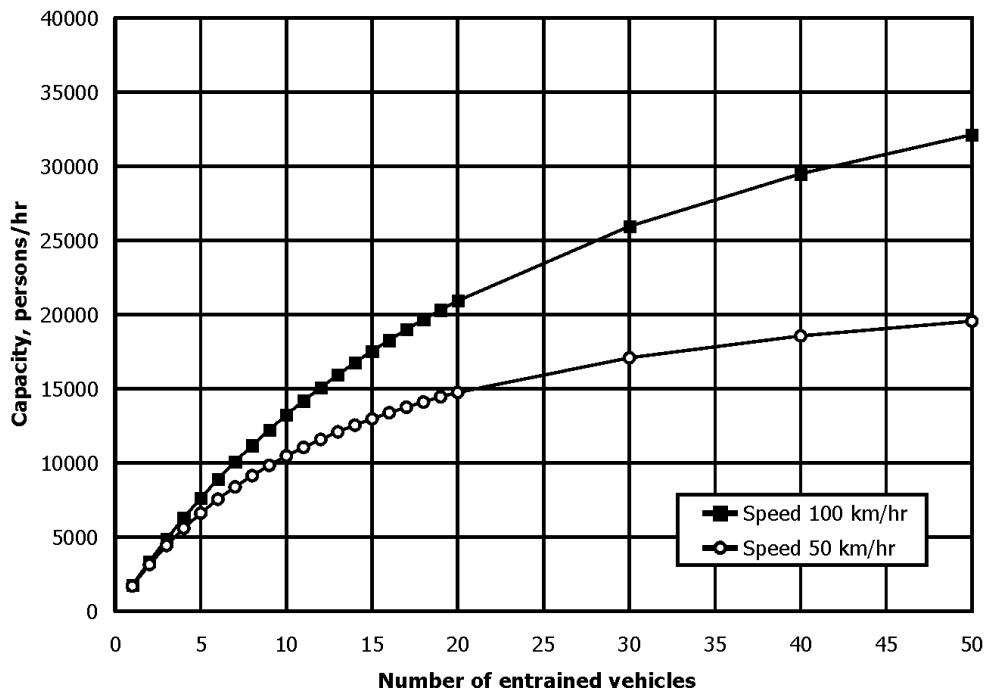
Inside the vehicle, there is a keyboard entry device for the passenger to input the destination information. This is similar to pushing the button for the floor number in an elevator. The display shows the destination, the current position, and the time needed to reach the destination.

Capacity: The short headway and the dynamic coupling lead to the high capacity of Autoway. Conventional subway and monorail cars have a weight of about 25 tons. The low adhesion surface for conventional rail makes rail transportation energy efficient. On the other hand, this results in a long braking time and braking distance. For the safe operation of trains, a long headway of at least 90-180 seconds is often necessary. The primary reason for the high capacity of train is the number of passengers per train. For example, a 5-car train with 400 seats at a headway of 180 seconds can have a capacity of 7,812 passengers per hour. If another 400 people stand in the train, the capacity can be doubled to 15,624 passengers per hour.

For guideway transportation, normally the capacity will decrease as the number of passengers per train decreases. Autoway vehicle takes the extreme case of only one passenger, and things develop in the opposite direction. Due to the small weight of the vehicle, a short headway can be used. The headway of 2 seconds for safe operation of

automobile is used for Autaway. This is a conservative choice in consideration of the lighter vehicle, the collision avoidance system, and availability of rail-gripping braking system. The headway of 2 seconds will give a minimum capacity of about 2,000 passengers per hour.

It is the dynamic coupling that significantly increases the Autaway capacity. Several factors contribute to the success of dynamic coupling. First, the destination is known to the system at the beginning of travel. This allows the central control system to plan the coupling of vehicles. Second, the lightweight vehicle and the collision avoidance system make it possible to control the speed of the vehicle for coupling. Third, the lightweight vehicle makes it possible for the bumper and suspension to absorb the impact of coupling. Fourth, the guideway design makes the coupling easy. Fifth, the electronic coupling between the vehicles makes the mechanical coupling safe since actions can be taken simultaneously.



The capacity of Autaway is related to the traffic pattern. We will explain the baseline capacity of 11,180 passengers per hour. The line capacity of 7,812 passengers per hour for subway is equivalent to 2.17 persons per second. It takes only 3.6 seconds to have 8 people to share the same direction, and the time of 3.6 seconds for the computer to route the vehicles is barely noticeable by the passengers. Therefore, the choice of 8 cars per train seems to be reasonable, and it gives a capacity of 11,180 passengers per hour. When the subway capacity is doubled during rush hours, the capacity of Autaway can also be

doubled. For intercity traffic in which most vehicles share the same direction for a long distance, a much higher capacity can be assumed. In a sense, Autoway has certain elasticity in capacity to accommodate an increase in the traffic flow. Roughly speaking, one lane of Autoway is equivalent to one subway line or one 6-lane highway. Since four lanes of Autoway can be accommodated in the space of one highway lane, a 4-lane Autoway may have a capacity of four subway lines or four 6-lane highways.

Autoway is a personal transportation mode, but is fundamentally different from previous personal transportation modes of automobile, motorcycle, and bicycle in its behavior. In previous personal transportation modes, the vehicle behavior is related to the personality of the driver, random and unpredictable. It is possible to have sporadic congestions on highway and streets without any particular reasons or accidents. However, the behavior of the Autoway vehicle is programmed for optimal operation. The traffic flow on Autoway is coordinated by the central control system. This coordinated traffic flow is fundamentally superior in efficiency and reliability.

When a network of Autoway is established in the future, the traffic on Autoway will not be affected by isolated damages and maintenance. The system can automatically route the traffic flow to bypass the problematic spots. This is similar to the internet, and the user will not even notice any isolated damages on the network.

Accessibility: Autoway is designed to provide easy access to most people. School children can use this safe personal transportation system to go to school and to participate in after-school activities. Senior citizens can safely use it for social and personal activities. Autoway can be directly connected to business and residential buildings to take advantage of existing elevators and stairways. This provides people easy access and at the same time saves the construction cost of stations.

For the physically challenged, specially designed vehicles can be used to accommodate the special requirements. Vehicles can be designed for blind people. Vehicles can be designed for wheelchair access. Vehicles can be designed for hand-free operation. This personal transportation system provides much better accessibilities to the physically challenged than existing personal transportation systems of automobile, motorcycle, and bicycle.

Autoway is not intended to address all the traffic needs, instead it is complementary to the road network to greatly improve the efficiency of the whole transportation system. The focus of Autoway is commuting and e-commerce of light freights. Therefore, large group activities are better handled by chartered buses, large and heavy freights are handled by trucks, and ambulances and fire engines are on the road only.

Emergency management: An advantage of Autoway over mass transit is that Autoway does not have the problem of mass emergency evacuation. How to handle emergency evacuation for a large number of people in an enclosed space is always a challenge to

mass transit, as shown in the occasional subway fire accidents. On Autoway, emergency is related to a relatively small number of people.

The strategy to safety on Autoway is prevention. The reliable vehicle, redundancy, and built-in failure-recovery procedures in the system, all contribute to the safety and reliability of Autoway. The vehicle does not have an engine, and avoids the problem of engine failure. The guideway design prevents derailing. Redundancy in electronic components and automatic checkup make sure that the system functions properly. Isolated component failures can be handled by the built-in failure-recovery procedures in the system. For example, if the collision avoidance system in a vehicle fails, the system is immediately notified of the problem. If the vehicle is coupled behind other vehicles, the operation will not be affected and the vehicle will be sent to repair after the trip. If the vehicle is the first vehicle of a train, it will be slowed down and then pulled away by another vehicle. In case of power outage, a vehicle can move to the nearest station by its battery. The central control system is connected with other disaster warning systems to better handle natural disasters like earth quakes and tornadoes. In case of a crash, for example, from a falling tree, the incident will be immediately known to the central control system, and a rescue team will be sent out to the accident site from the maintenance staff or local fire department. The team is equipped with a ladder, or special equipment to handle the situation.

5. Applications of Autoway

Autoway is an essential addition to existing transportation modes to effectively address the transportation challenges in the 21st century. The focus of Autoway is commuting and e-commerce. Autoway does not replace existing transportation modes, instead it changes the way we use existing modes of transportation and improve the performance of the whole transportation system.

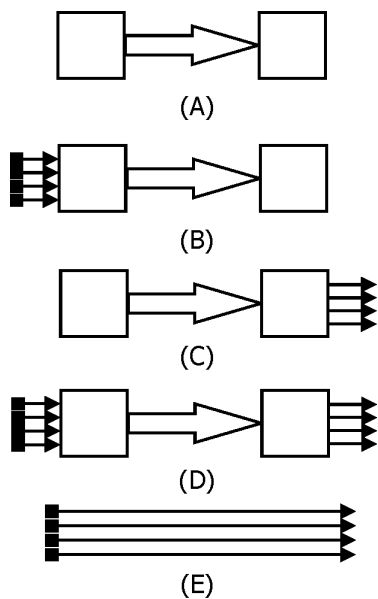
Autoway is well suited to the dispersed, complex, and distant commuting pattern of a modern city. The high capacity of the Autoway can meet the transportation needs of the most densely populated cities in the world. At the same time, Autoway also solves the air pollution problem. Urban areas will no longer be plagued by traffic congestion and air pollution. Suburban areas will have a convenient alternative to get around. Rural areas will have an easy access to urban facilities. In the 21st century, Autoway will become a major transportation means for commuting.

Autoway can significantly improve traffic safety. The major cause for automobile accidents is human errors: inattention, road rage, fatigue, drunk drivers, and unskilled drivers. Autoway is a very safe transportation system. By reducing traffic congestions, Autoway reduces the road rage and possibilities of traffic accidents on the highway. By providing a safe alternative, it reduces problematic drivers on the highway. If you decide to have a good time drinking beer and wine, take Autoway.

Autoway will significantly improve the efficiency and convenience of air travel. The most time consuming part of air travel is get to the airport. Due to possible traffic congestion

on the highway, you have to leave earlier. You need time to find a parking space, take time to go from the parking lot to the terminal, and take time to check in your luggage. Autoway will reliably take you to the terminal at a high speed a few minutes ahead of the boarding time. Autoway can take your luggage to the airline before you go to the airport. At arrival, you do not need to wait for your luggage. Autoway can automatically take your luggage to your hotel.

Autoway can be first implemented in the following areas: (1) Congested urban areas for immediate relief. At this stage, Autoway will actually increase the ridership of existing mass transit as mass transit can act as a feeding mechanism to Autoway. (2) Internal transportation system for large corporate campuses, shopping malls, university campuses, sports and recreational facilities. (3) Regional rapid transportation system connecting several cities in an economic zone. (4) Connecting urban centers with mass transportation systems like airports and railway stations. (5) Natural parks, mountainous areas, and lake areas to protect the environment and provide people easy access.



Freight transportation types

For freight transportation, Autoway is complementary to existing transportation modes. Freight transportation can be classified into the following types: (A) High volume transportation from origin to destination. High volume transportation is best performed by rail, trucks, and ships. (B) The freight is collected from dispersed origins and then transported in high volume to the destination. (C) The freight is transported in high volume to the destination and then distributed to dispersed final customers. This is a typical distribution pattern of manufactured goods. (D) The freight of dispersed origins is collected, transported in high volume, and then distributed to dispersed destinations. This is typical for mails and packages. (E) The freight is transported from dispersed origins to dispersed destinations. This is typical for many local deliveries of goods. Many items are small in size and light in weight, which make delivery by ordinary trucks and cars not very efficient. Autoway is suitable for the transportation of light freights with

dispersed origins or destinations. As an automatic system, it is ideally suited to e-commerce for businesses and consumers. People can also choose their preferred delivery time.

It should be emphasized that we cannot just copy the practices for railway and highway for the design and construction of Autoway. A new perspective is necessary to fully take advantage of Autoway. Autoway may be built as a public utility like electricity, gas, and telephone service. Autoway can be publicly owned or privately owned, which may not make any practical differences since the user is charged for the actual use. The

construction and operation of Autoway does not need government subsidies, instead Autoway is a profitable business. The vehicle can be private, public, leased, or rented.

Autoway is not just a transportation system. It is an integral part of the landscape and culture of a region. The active involvements of urban architects, environment experts, transportation experts, government planners, business leaders, and ordinary citizens should be encouraged from concept and design to construction and quality control. The small size of the guideway allows for many creative choices of aesthetic structures. Design competitions can be held and public discussions on the media are encouraged to select the most appropriate design for a city.

6. The social and economic impacts of Autoway

Autoway will contribute greatly to our social and economic development. Think about the railway industry in the 19th century and how it transformed the economy. Think about the automobile industry and airline industry in the 20th century and how they changed our personal and business world. Autoway will further extend the physical boundaries of daily human activities and enrich our personal, professional, and cultural experiences. If we take two hours as the time limit for most human social and economic travels, Autoway will extend the physical boundary to a region with a diameter of 200 miles. Especially, Autoway provides a cost-effective freedom of travel to school children and senior citizens.

Autoway is environment-friendly. It will significantly reduce air pollution and noise pollution related to traffic. It will spare the surface landscape from erosion related to road construction. As Autoway is typically built as an overhead structure, it will significantly reduce the interference of traffic with wildlife.

Energy shortage is a global crisis. Oil dependence has become a security issue and a source for international conflicts. For example, in the United States, cars and light trucks account for 43% of oil consumption, and ships, trucks, and airplane account for 25% of oil consumption. Autoway can have fuel efficiency 20 times higher than that of automobile. Renewable energy sources and other alternative energy sources can also be used for Autoway. Therefore, the widespread use of Autoway around the world will significantly alleviate the pressure of energy shortage and oil dependence.

According to World Health Organization, every year 1.2 million people were killed and 50 million people injured in road accidents around the world. The annual death tolls from road accidents are 42,500 people in the United States and 127,000 people in the European region. The situation is even worse in developing countries such as China and India. Traffic accident is the No. 1 cause of death for school children and young adults. To bring attention to this major health threat, World Health Day 2004 was dedicated to road safety. Autoway provides a safe mode of transportation and it will significantly reduce road accidents by providing a safe alternative.

As a transportation technology for the 21st century, Autoway will bring a lasting economic boom to countries with mass production and construction of Autoway. The economic opportunities range from steel making, manufacturing, computer software/hardware, communication, e-commerce, and construction. Many traditional manufacturing industries in developed countries have suffered a long time of downturn with significant loss of jobs. This technology-based manufacturing of vehicles, guideway, communication and control equipment will provide the opportunity of prosperity and employment for these industries and affected regions.

Tomorrow, commuting will be no longer a rush in congestion. Cities will be no longer a noisy place with air pollution. We and our children will be able to walk leisurely on the street, breathing the clean air.

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