

Role of ITS and GIS in Urban Transport

Dr P. K. Garg

Professor

Geomatics Engineering
Civil Engineering Department
Indian Institute of Technology Roorkee
Roorkee 247667 (Uttarakhand)
Email: pkgiitr@gmail.com

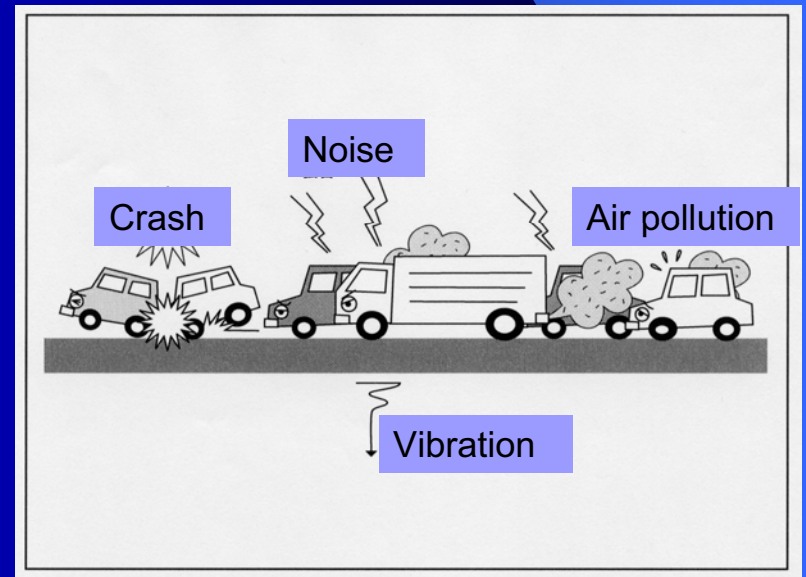


Sustainable Cities

- Transportation systems affect the economic prosperity & liveability of cities
- Prosperity and liveability are *related*
- Both are vital for sustainability

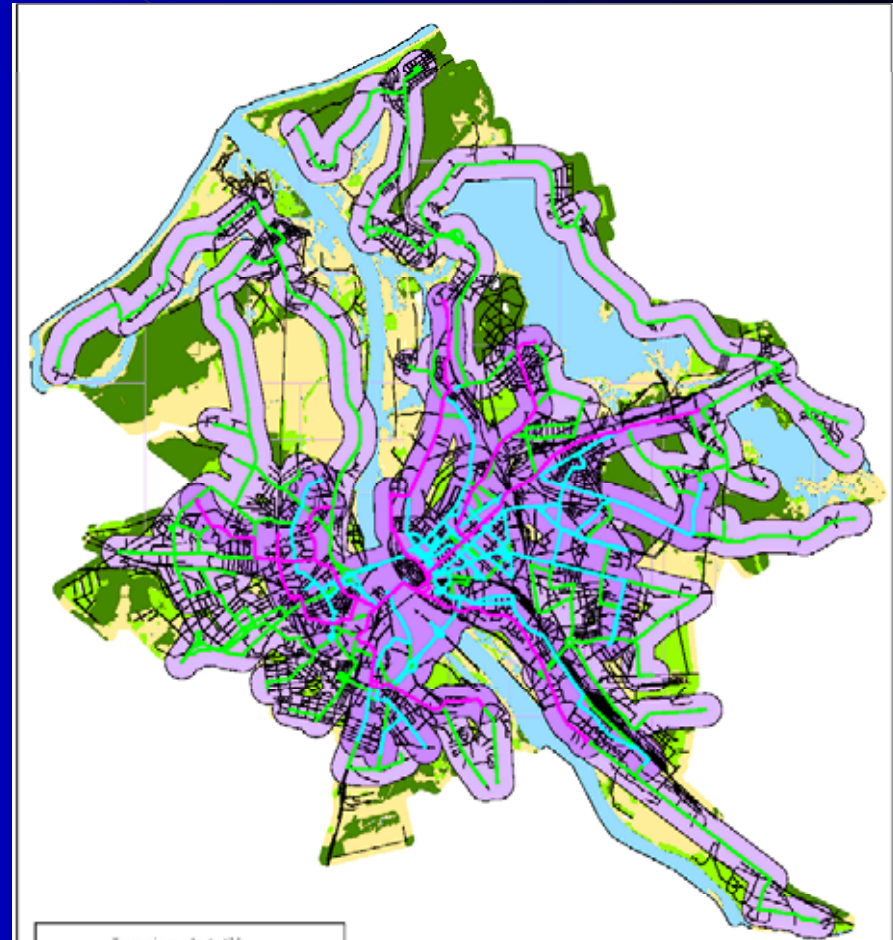
Challenging Issues

- Increase in urban transport
 - Congestion
 - Negative environmental impacts
 - Emissions (Particulates & GHG)
 - Crashes
 - Energy consumption
 - Noise
 - Vibration



Need to Implement Urban Transport Control System

- High density of the transport streams
- Comparatively low driving speed
- Frequent traffic congestions
- Significant overload of the road network
- Difficulties in driving because of wrong car placement for parking
- The public transport does not cope well with passenger traffic volumes and couldn't be considered as a worthy alternative to private transport means



Navigation Systems

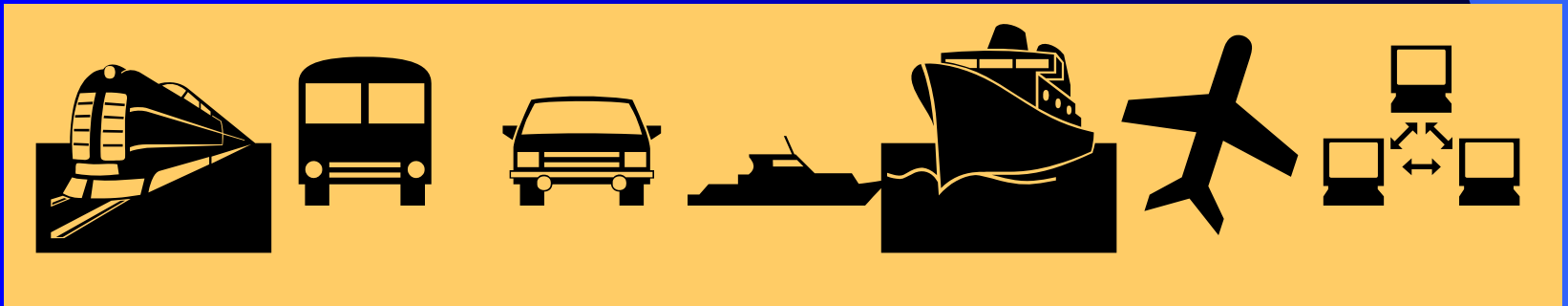
- Navigation in transportation is an important application
- Vehicle navigation systems
 - Offered on many luxury cars
 - Services provided:
 - map destination given a street address
 - compute the shortest route to a destination
 - Help drivers follow a selected route

Intelligent Transport System

- ITS is new age transportation system for land, air and marine transportation.

ITS is useful

- to avoid traffic accidents for safety
- to maximize traffic flow for economy



ITS Key Elements

- Intelligence

- gaining knowledge (data collection & information processing)

- Integration

- connecting & co-ordinating key elements



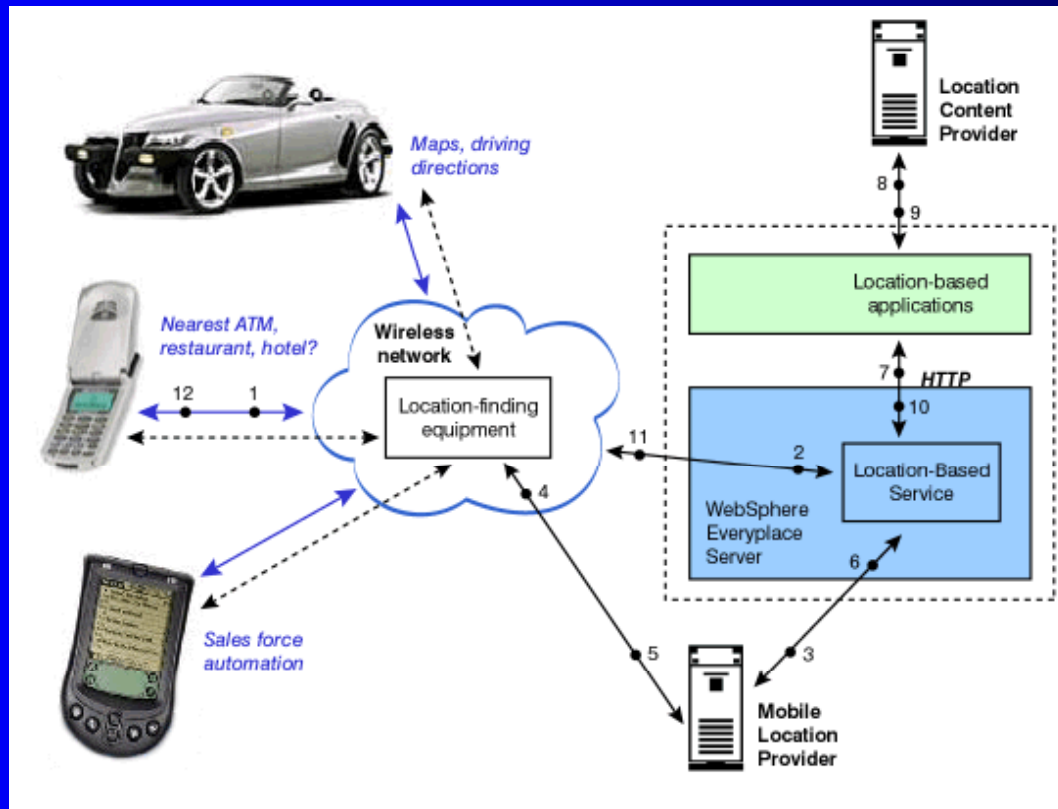
Types of ITS Implemented

- **Advanced Traffic Management Systems**
- **Advanced Traveler Information Systems**
- **Advanced Vehicle Control Systems**
- **Electronic Toll Collection Systems**
- **Advanced Public Transportation Systems**
- **Commercial Vehicles Operations**



Location Based Services (LBS)

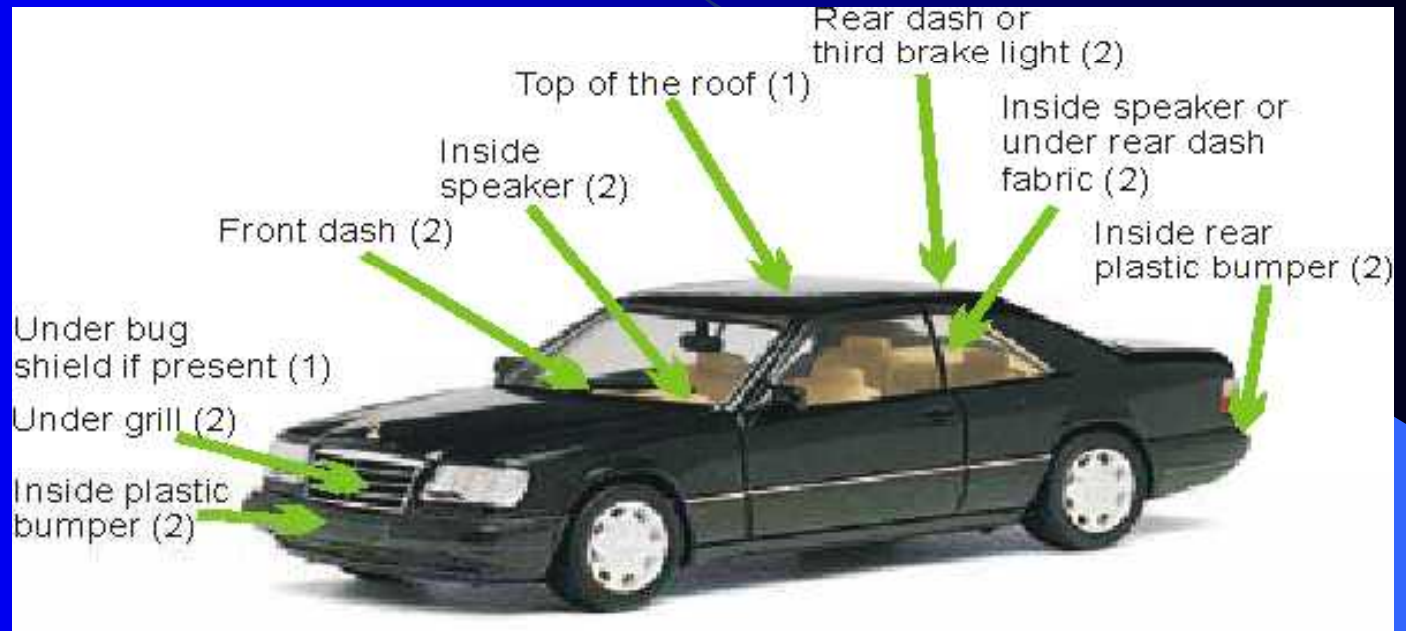
- Wireless Internet application
- Information based on location in real time



What is Automated Vehicle Location (AVL)?

- AVL systems are computer-based vehicle tracking systems that use a positioning system-
 - **GPS (Global Positioning System)**
 - **GSM (Global System of Mobile) and**
 - **GIS (Geographical Information System).**
- Vehicle locations are transmitted at regular intervals to Data center, where GIS based software convert it into location and address on spatial map for decision making.

Where to install AVL device?



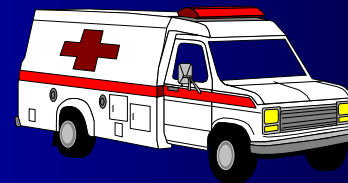
Application: Emergency Services

- To cut emergency response time
- Dynamic route assessment
- Confirmation of message delivery

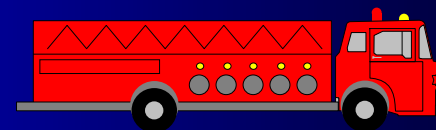
- **Police Force**



- **Ambulance**



- **Fire Service**





What is GPS ?



GPS, developed by the U.S. Department of Defense for the military, is a worldwide, satellite-based, radio navigation system that will give you the exact position of your vehicles, no matter where they are, what time it is, or what the weather is like.

A total of 24 satellites orbit the Earth. These satellites transmit signals that can be detected by GPS receivers located in your vehicles to determine their location.



GPS



Real-time processing



What is GSM ?

Global System of Mobile (GSM) is a popular Mobile communication system provided in India by companies like Airtel, Idea, BPL, Hutch etc.



It is available in most mobile handsets used by us.

GSM Mobile communication system can be intelligently used by electronic devices which collect the data and send it to the central place using SMS or GSM data call.

GSM is very useful in Vehicle tracking systems because GPS system only receive location information from satellites, and GSM sends this location information to the central control room.



What is GPRS ?

General Packet Radio Service (GPRS) is a new communication service introduced by GSM operators. These services are part of same GSM network which allow secure and confirmed transfer of content, like digital photos or other data to other GPRS capable system.

GPRS is required in case we want to take snaps and transfer them to the central control room. Example of services is MMS (Multimedia Messaging Service)

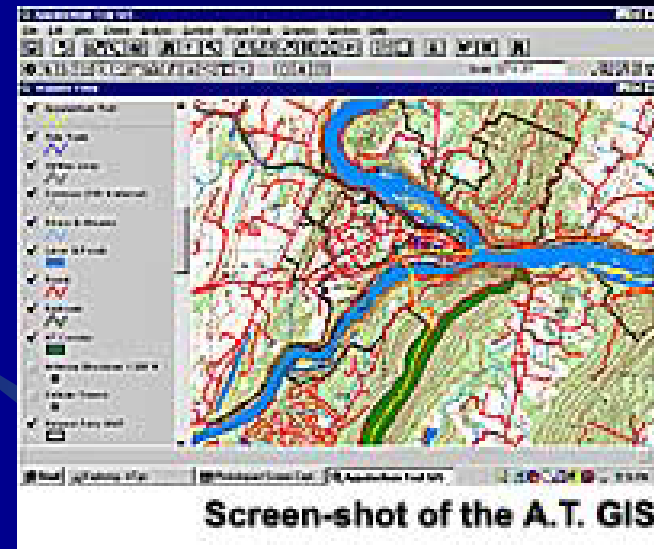
GPRS does not involve additional hardware but we need to use more advanced GSM modules which support GPRS.

GPRS services are not provided by all GSM operators.



What is GIS ?

GIS is a software which is used to represent comprehensive and detailed maps of the city with longitude and latitude information of each place, street, junctions and address.



These maps are useful to locate the address of a vehicle fitted with GPS system.

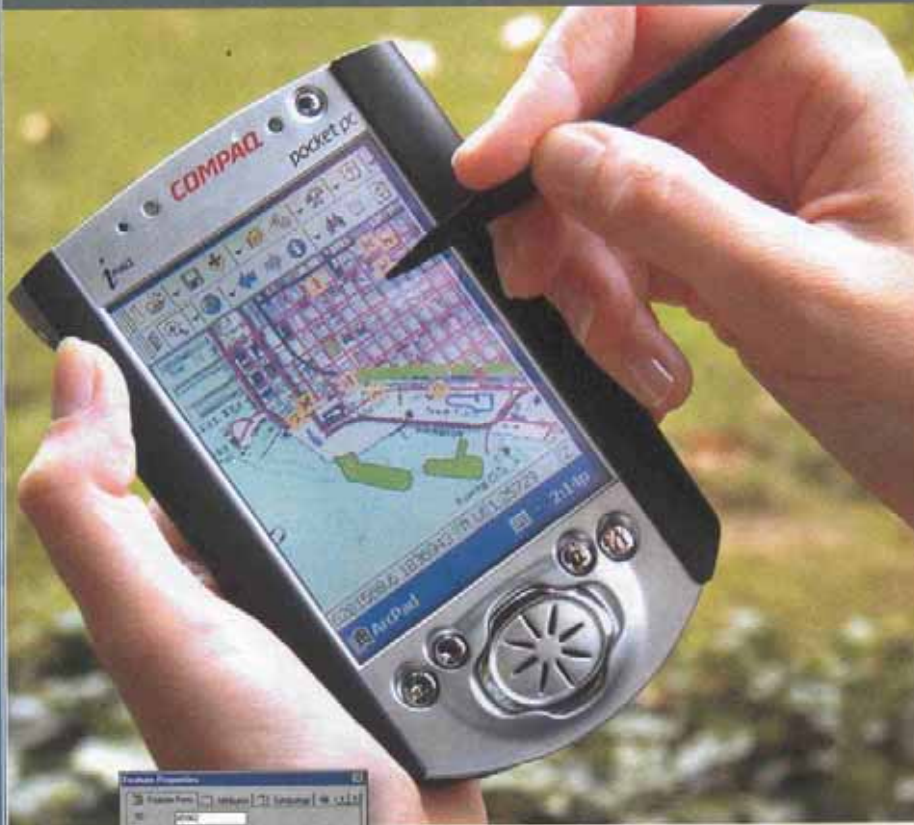
GPS-GSM system only provides the longitude and latitude of the vehicle but GIS software if properly developed can provide details of exact or nearby address where the vehicle is present.

With the availability of GIS maps of the city, it would be easy to track the vehicle in a very short time.

MOBILE MAPPING AND GIS

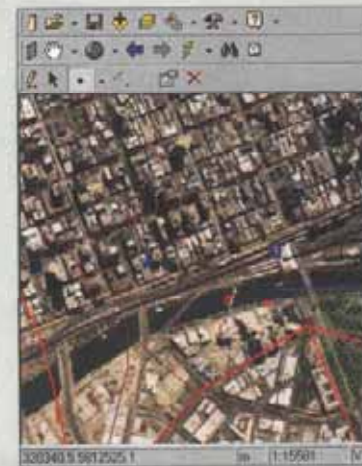
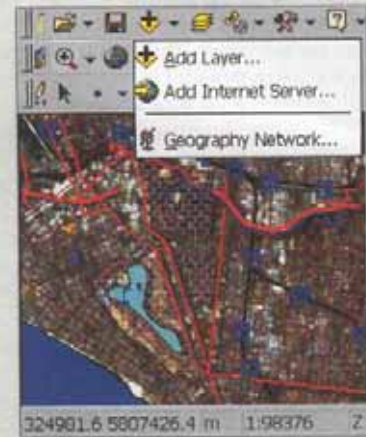


ArcPad Mobile Mapping and GIS



ArcPad supports

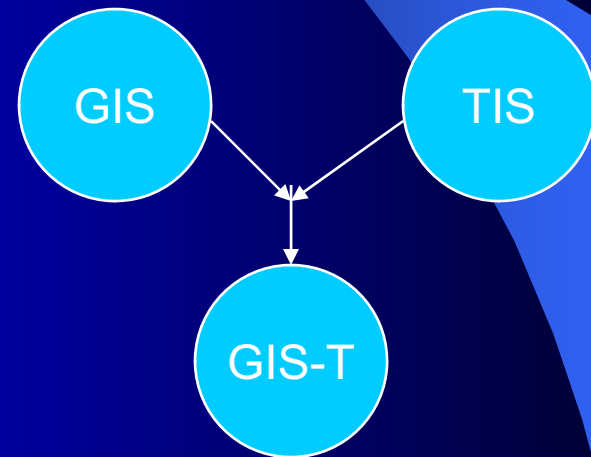
- ▶ Shapefiles
- ▶ MrSID™ image format by LizardTech
- ▶ Wireless data acquisition and query



Role of GIS in Transportation

GIS applications in Transportations are currently used broadly by transportation analysts and decision makers in different areas of transportation planning and engineering

- **Infrastructure planning**
- **Design and management**
- **Traffic safety analysis**
- **Transportation impact analysis**
- **Public transit planning and operations**
- **Intelligent transportation systems (ITS).**



GIS Models Used in Transportation

- In general, three classes of GIS models are used in transportation:
 - **Field models** of the continuous variation of a phenomenon over space (e.g., land elevation).
 - **Discrete models**, depending on which discrete entities (points, lines or polygons) populate space (e.g., toll barriers, urbanized areas).
 - **Network models** to represent topologically-connected linear entities (e.g., roads, rail lines, or airlines) that are fixed in the continuous reference surface.

Models

- **Examples of Transportation models include**
 - **Shortest path and routing algorithms**
 - **Spatial interaction models**
 - **Network flow problems**
 - **Facility location problems**
 - **Travel demand models**
 - **Land use transportation interaction models**

Examples of Queries in GIS

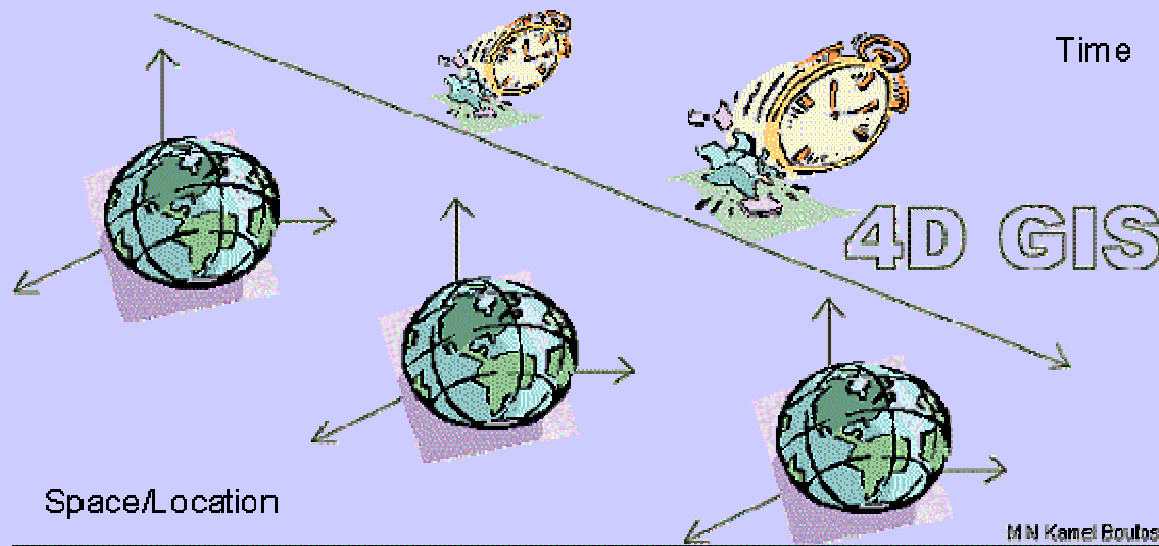
• Railway network

1. Find the number of stops on a given route.
2. List all stops which can be reached from a Place.
3. List the route numbers that connect two localities.
4. Find the last stop on a route.

• Road Network

1. Find shortest path from a location to a destination.
2. Find nearest hospital by distance along road networks.
3. Find shortest route to deliver goods to a list of retail stores.

4 Dimensional GIS

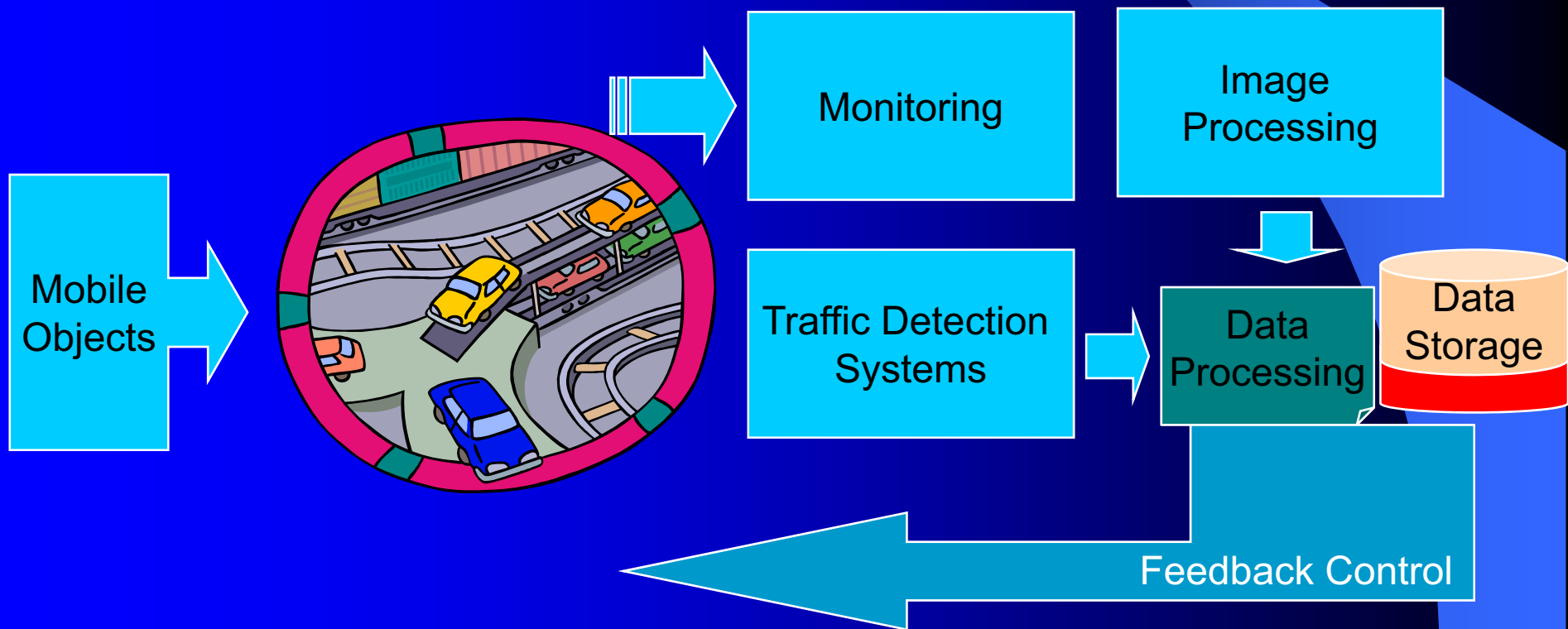


Logical architecture of traffic management integrated information system

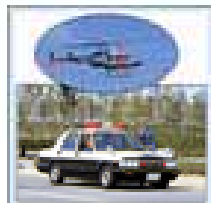


Gathering Data: Measurement Techniques

- Direct measurements
- Indirect measurements



Gathering Traffic Information



■ Helicopter,
■ Patrol car,
■ Police officer



■ Ultrasonic
vehicle detector



■ Infrared
beacon



■ Image processing
vehicle detector



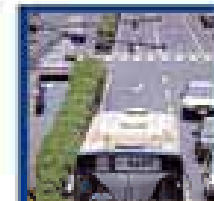
■ Radar
vehicle detector



■ Traveltime
measuring (AVT)



■ CCTV
camera



■ Bus
detector

Providing Traffic Information



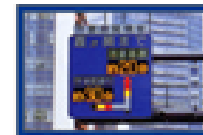
Character information board



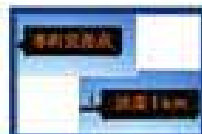
Present message board



Variable message board



Formulated information board



Small character information board



Parking guidance system



Small travel time information board



Variable road sign



Roadside radio traffic information



Personal traffic information service
(VICS in-vehicle units,
Information terminals and Radio broadcasts)

Metropolitan Traffic Control Center



Side View



Front View with Fish Eye Lens

Figure 6

17

Metropolitan Police Department

AHS (Advanced Cruise-Assist Highway Systems)

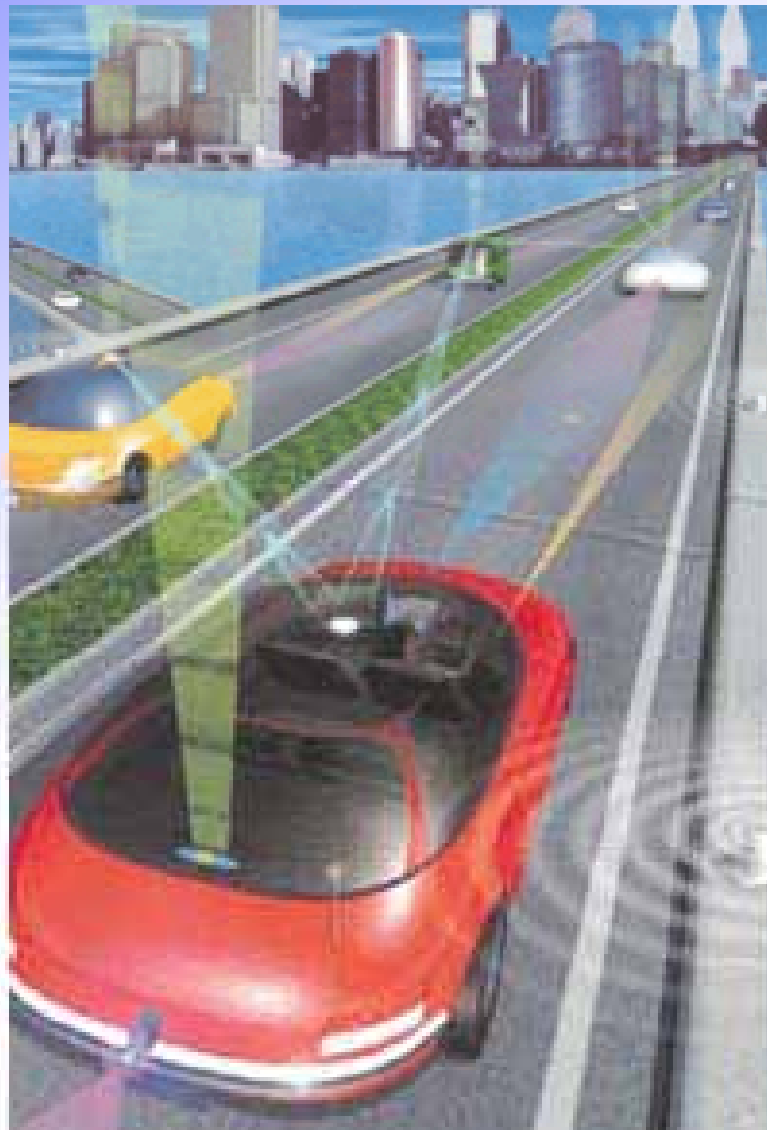


collect information
from the road



warn the driver

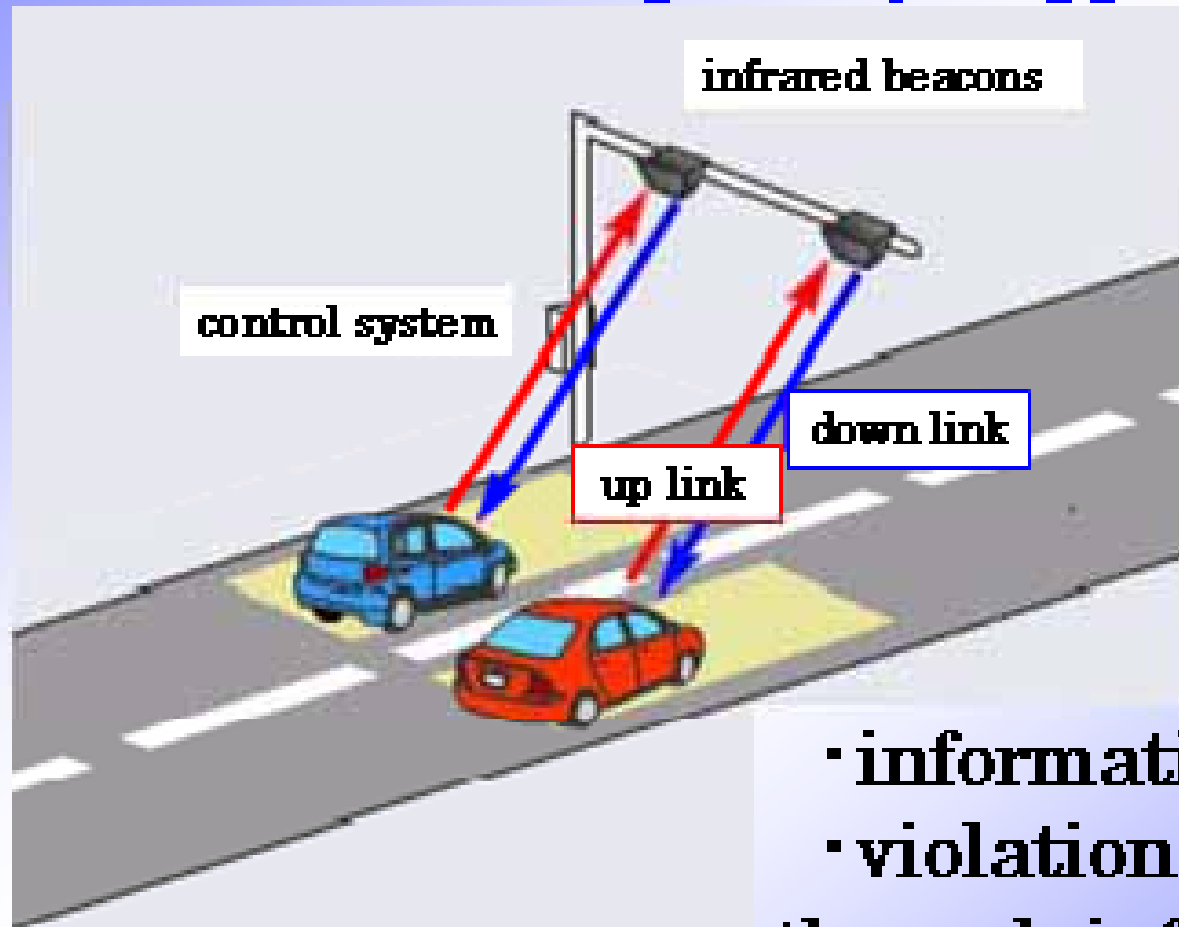
- obstacles ahead
- speeding



ASV (Advanced Safety Vehicle)

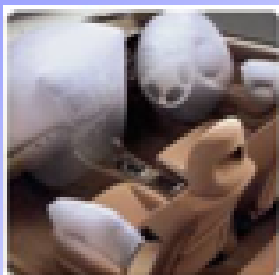
- **millimeter
wave radar**
- **automatic
braking system**

DSSS (Driving Safety Support System)



- information ahead
 - violation warning
- through infrared beacons

HELPNET and Doctor Helicopter



emergency
medical transport



- Correctly identify the vehicle location using GPS
- Automatic emergency calls at air bag development

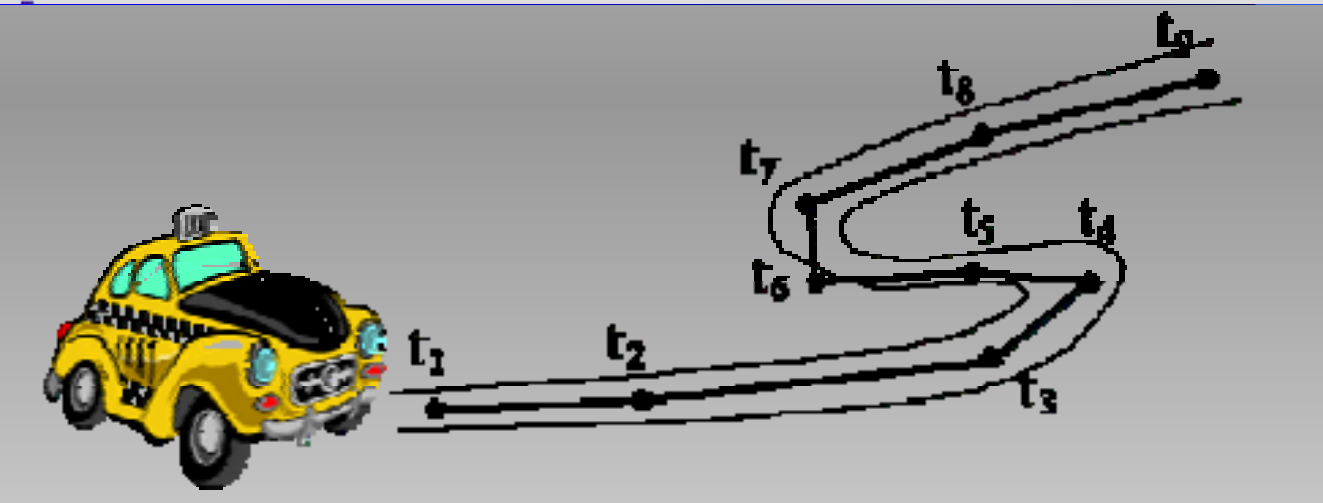
Road Test



Road Test



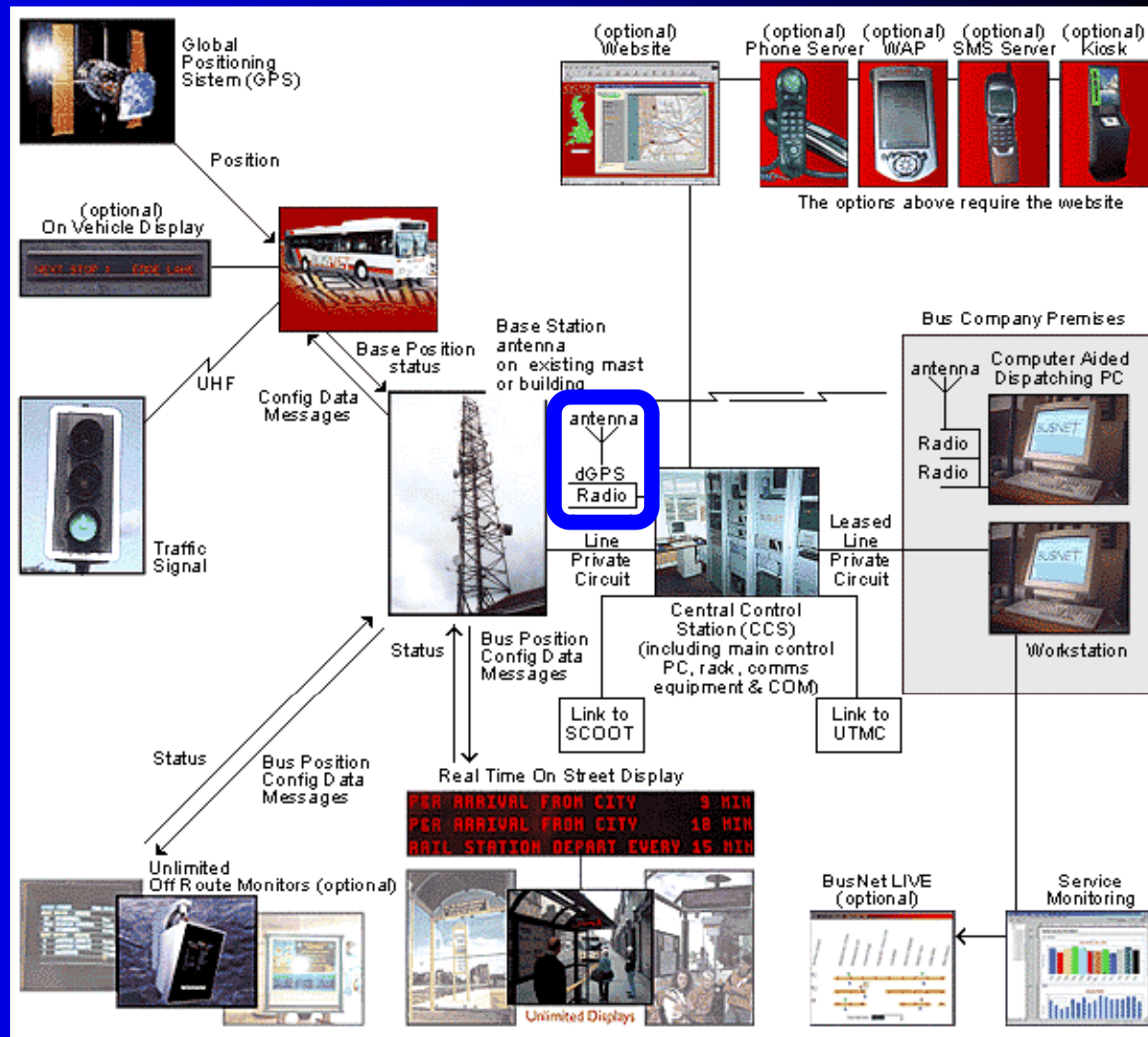
- Stand-Alone GPS can provide a horizontal positional accuracy of approximately 15 m when Selective Availability (S/A) is turned off.
- Differential GPS (DGPS) can significantly improve GPS accuracy down to 1 to 5 m when using data collected by a reference GPS station.
- Real-time Differential GPS provides similar accuracy when the vehicle GPS receiver corrects its position by using differential corrections radio-transmitted by a reference GPS station in real-time.



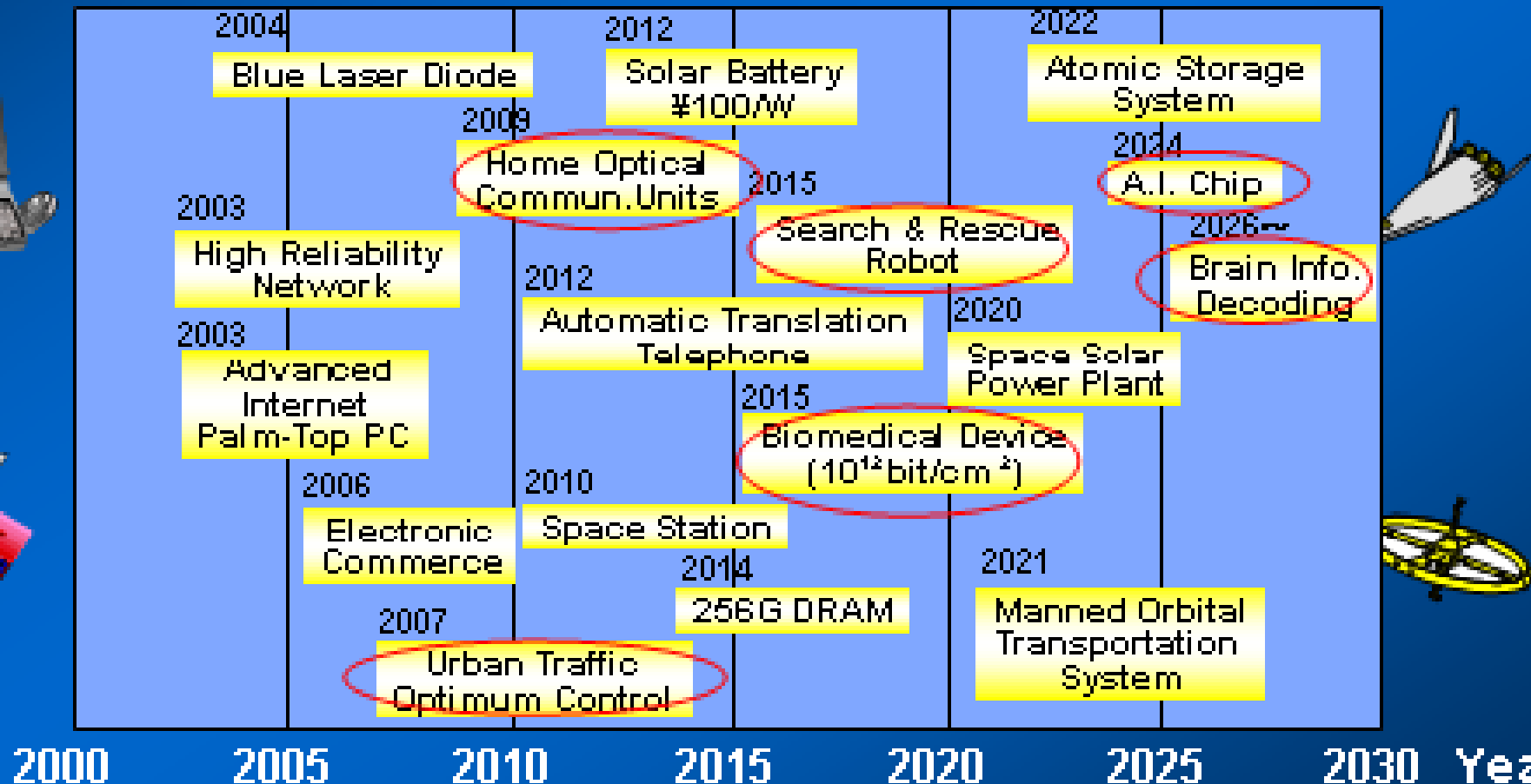
Mobile Object Control With Navigation Satellite Systems

At present, there are many companies in the world that develop and produce similar systems.

The given system is a control system for city public transport and is used in many cities of Europe.



A Next Generation Technology Forecast

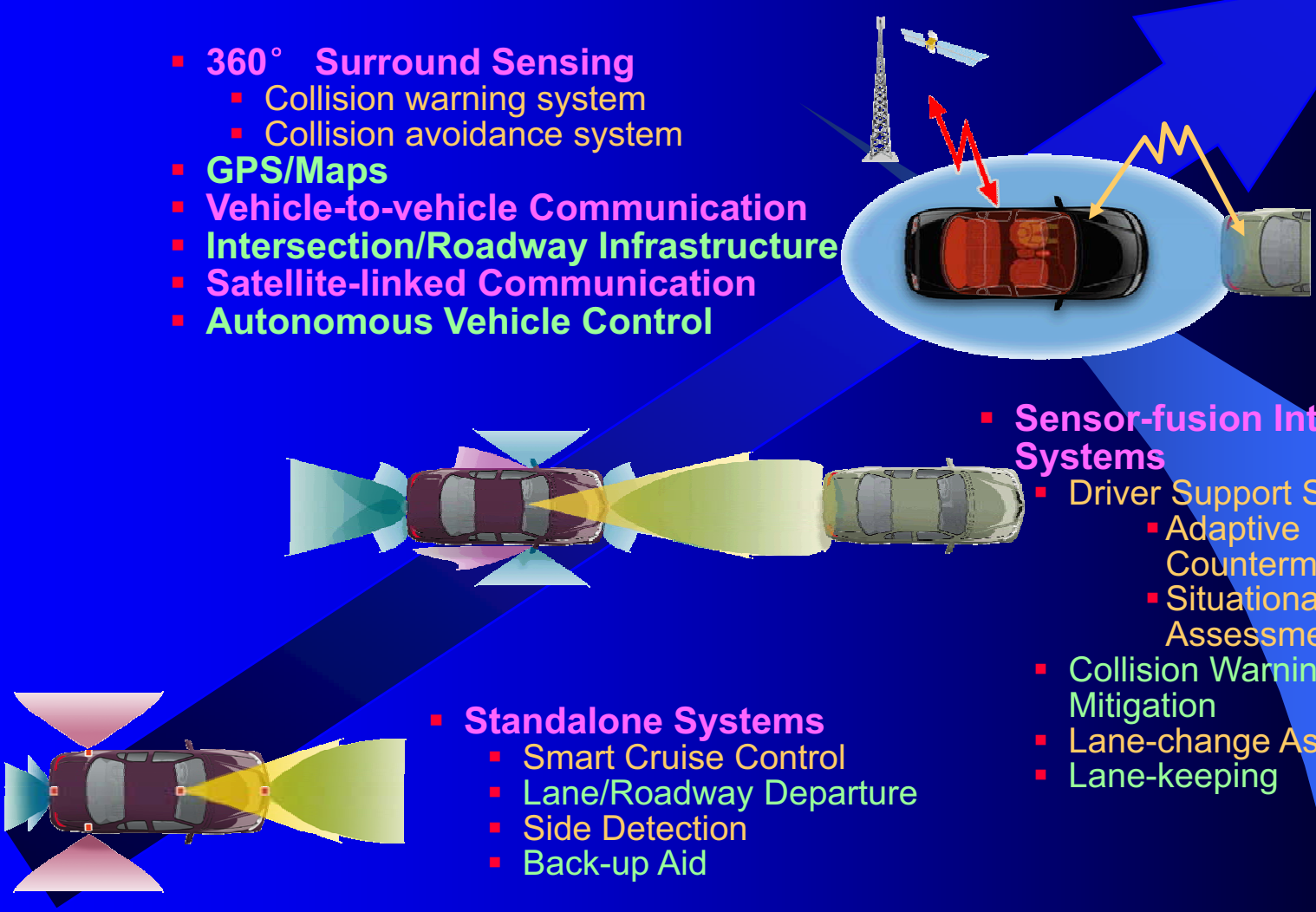


Need for a Multi-disciplinary Effort

- Physical planning, including urban and commercial development, should be better coordinated with the infrastructure planning through unified planning
- Future work should concentrate on the use of ITS and GIS for safety on Roads.

Roadmap for Developing Safety

Increasing Vehicle Autonomy/
Decreasing Driver Intervention



- **360° Surround Sensing**
 - Collision warning system
 - Collision avoidance system
- **GPS/Maps**
- **Vehicle-to-vehicle Communication**
- **Intersection/Roadway Infrastructure**
- **Satellite-linked Communication**
- **Autonomous Vehicle Control**

- **Standalone Systems**
 - Smart Cruise Control
 - Lane/Roadway Departure
 - Side Detection
 - Back-up Aid

- **Sensor-fusion Integrated Systems**
 - Driver Support System
 - Adaptive Countermeasures
 - Situational Assessment
 - Collision Warning and Mitigation
 - Lane-change Assist
 - Lane-keeping

Today

Future

The Road Ahead



THANK YOU