# Towards the Development of Intelligent Transportation Systems

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# Introduction

- **Purpose**
  - To study the achievements attained in the last years and to give an overview of possible directions towards future research in the field of Transportation
- **Problematic Scenario**
  - Growing number of vehicles
  - Saturation of the transportation infrastructures
  - Traffic congestion
  - Accidents
  - Transportation delays
  - Larger vehicle pollution emissions

# Introduction

- Earlier Solutions
  - Implementation of safety systems
    - Safety belt
    - Safety airbags
  - Construction of more roads
  - Construction of better roads
  - Construction of highways

***Building more roads to reduce traffic congestion is not the "right" solution***

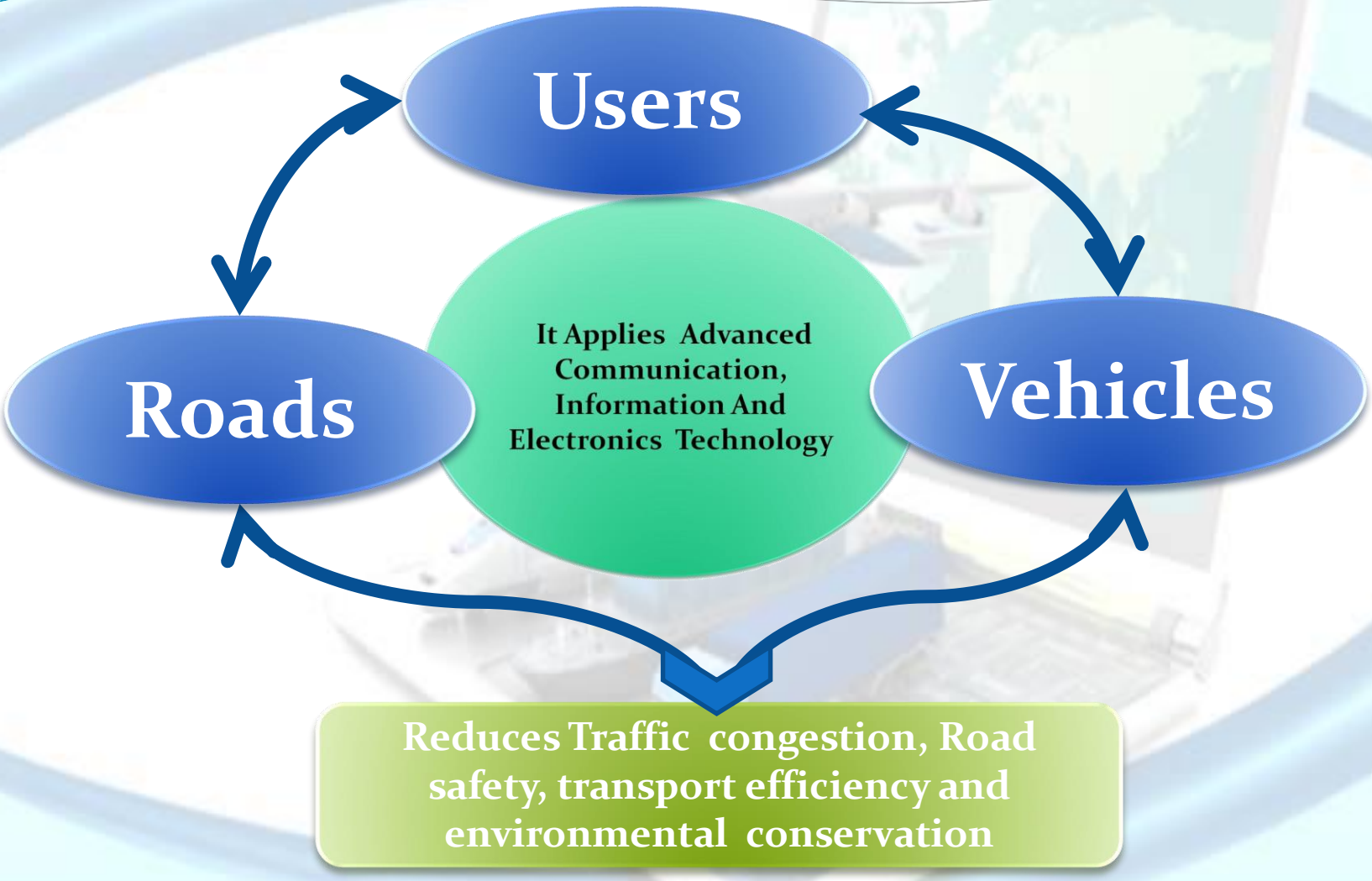
  - Very expensive,
  - Cause considerable Environmental Impact
  - Require large Space (limitation within urban areas)
- Ultimate Solution
  - **Intelligent Transport Systems**

# Intelligent Transport Systems (ITS)

- Safer road-vehicle system
- More efficient road-vehicle system
- Environment friendly
- Conventional road-vehicle systems depend almost entirely on human drivers
- Modern road-vehicle systems incorporate some intelligent systems or technology **to assist** human operators

- Deals with
  - Electronics
  - Transportation Control
  - Communications
  - Sensing
  - Robotics
  - Signal processing
  - Information systems
  - Knowledge Transfer
  - Cooperation among different research areas

# ITS Computer Model



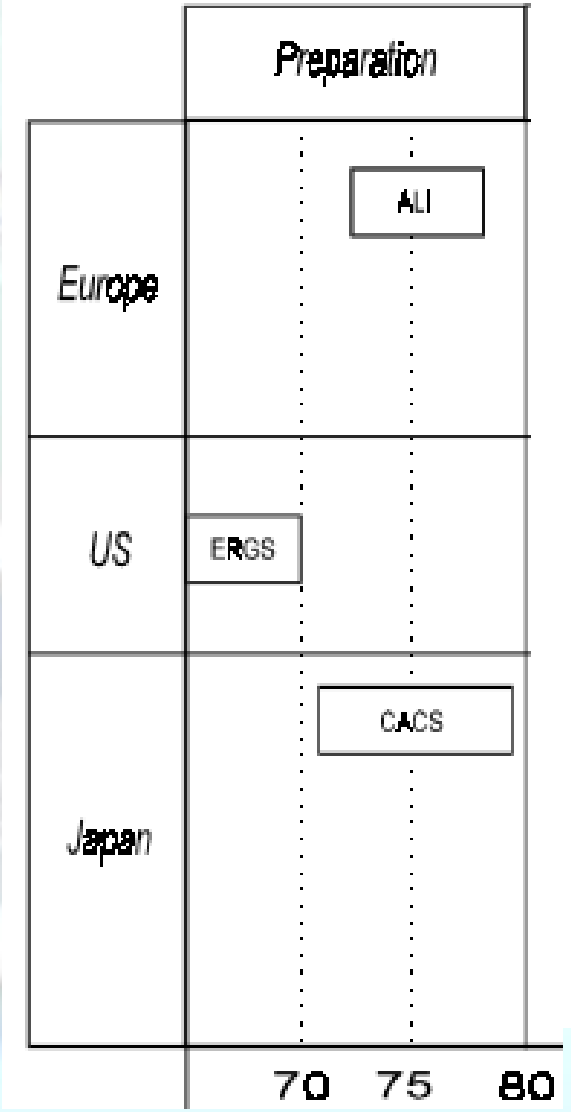

***Purpose of ITS is to take advantage of the appropriate technologies to create "more intelligent" roads, vehicles and users***

# Major Developments on ITS

- Preparation (1930-1980)
- Feasibility Study (1980-1995)
- Product Development (1995- Present)

# A. Preparation (1930-1980)

- Technologies had not yet matured enough
- Construction of new roads was more attractive than development of ITS
- First/ original ITS system was the electric traffic signals_1928.
- First computer controlled traffic signals in US _1960
- From 1960s-1970 in US ERGS (Electronic Route Guidance Systems) was developed which used a two-way road vehicular communication to provide route guidance
- During 70s CACS (Comprehensive Automobile Traffic Control System) and the ALI (Auto fahrer Leit und Information System) in Japan and Germany respectively, were developed which were dynamic route guidance systems based on real traffic conditions
- This decade was also important for ITS, because microprocessor were introduced and the GPS development began
- These technologies are now major components of many ITS systems; nevertheless they were not associated with ITS at that time



# B. Feasibility study (1980-1995)

## Europe

- In Europe, governments, companies and universities of 19 countries established the PROMETHEUS (Program for European Traffic with Efficiency and Unprecedented Safety)
- Several ITS technologies were developed in this program between 1987 and 1994
- In 80s the test vehicle VaMoRs was demonstrated
  - Two forward-looking TV cameras with the purpose of an automatic lane and road following
- In 90s, a group lead by Daimler-Benz developed the test vehicle VITA II
  - Incorporated 10 cameras and 60 processors
  - Kept the vehicle in the center of the lane, kept a safe distance from the car in front, changing lanes and overtaking other cars with collision avoidance

# Europe

- Other projects were developed in the scope of PROMETHEUS, namely the ARGO project, which aimed to design, develop and test of innovative solutions for the vehicles of the future.
- This program was followed by DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe) for the development and test of the communication system, for drive assistance and traffic management.
- The public-private sector organization ERTICO (European Road Transport Telematics Implementation Coordination Organization) was set up to provide support for refining and implementing the Europe's Transport Telematics Project

# United States

- In late 80s, the Mobility 2000 study team laid the groundwork for the formation of the IVHS America (Intelligent Vehicle Highway Systems),
- In 1994 the USDOT (United States Department of Transportation) changed the name from IVHS to ITS America (Intelligent Transportation Society of America)
  - Several projects were developed at more than eighty places across the US
  - A key project, AHS (Automated Highway System) was conducted by NAHSC (National Automated Highway System Consortium) formed by the US Department of Transportation, General Motors, University of California and other institutions.
    - Under this project various fully automated test vehicles were demonstrated on California highways

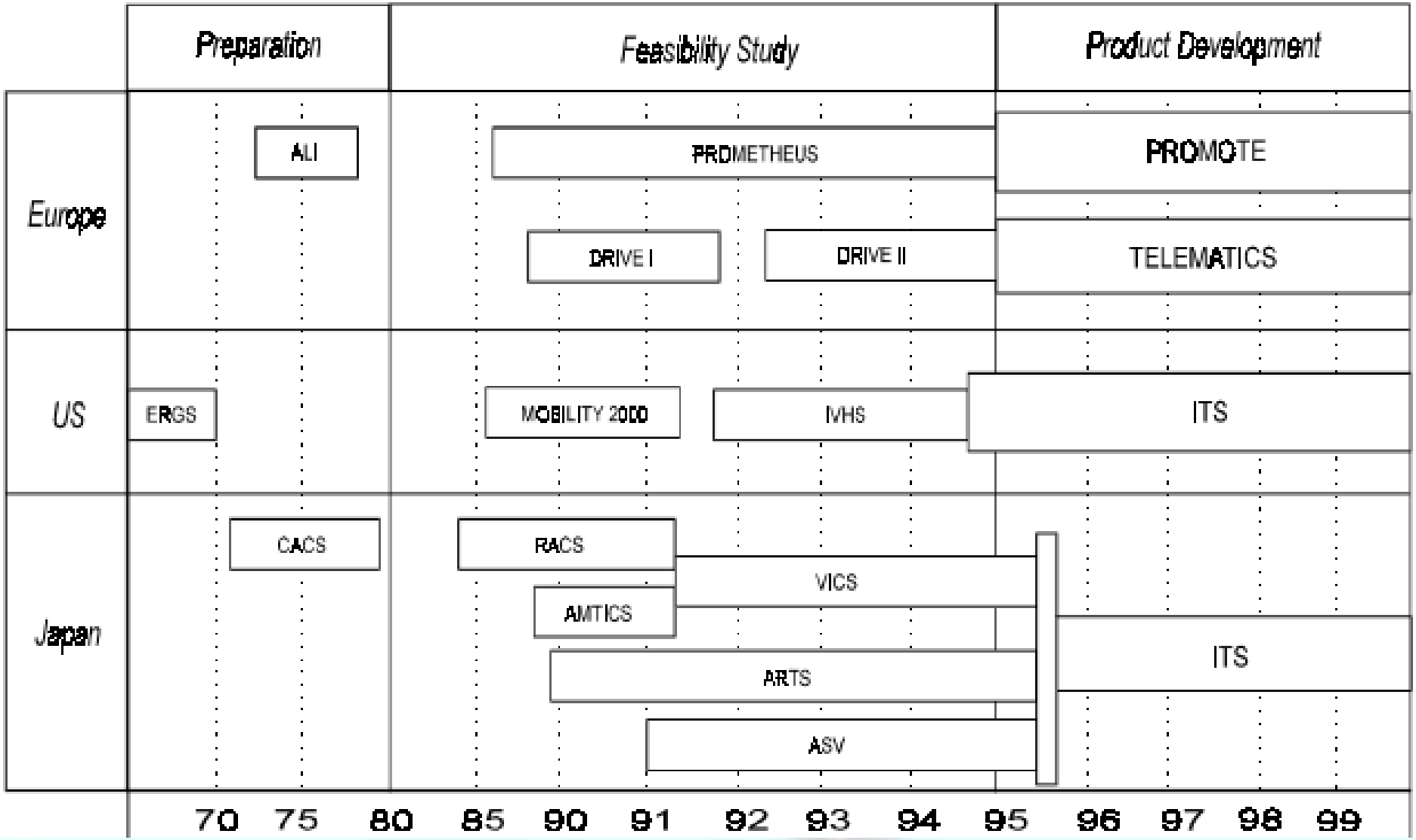
# Japan

- **In 80s,**
  - RACS (Road Automobile Communication System) by the Ministry of Construction & AMTICS (Advanced Mobile Traffic Information and Communication System) by the National Police Agency.
- **In 90s,**
  - With combining efforts of the Ministry of Posts and Telecommunications, two projects were combined into VICS (Vehicle Information and Communication System).
  - A VICS terminal provided a locator for displaying the vehicle's coordinates on the map screen, and allowed the communication with the ground stations to acquire traffic conditions for route planning.
  - Examples of other developed projects are ARTS (Advanced Road Transportation Systems), by the Ministry of Construction, for the advance of road traffic through integration of roads
  - Representatives of academia and industry organized the VERTIS (Vehicle, Road and Traffic Intelligent Society). That conducts a variety of ITS related activities, namely information exchanges with its European and American homonymous, ERTICO and ITS America.
  - In 1996, the Ministry of Construction and 21 major companies, namely Toyota, Nissan, Honda & Mitsubishi, formed the Advanced Highway System Research Association, and implemented various fully automated vehicles on a highway .

# C. Product Development (1995-to date)

- Since middle of the 90s Several projects were or are being developed.
  - Chauffeur project (Europe) having a truck automatically driven following another one conducted by a human driver.
  - In US, by the late 90s, the main focus of ITS programs shifted to large-scale integration and deployment.

# Major Developments on ITS



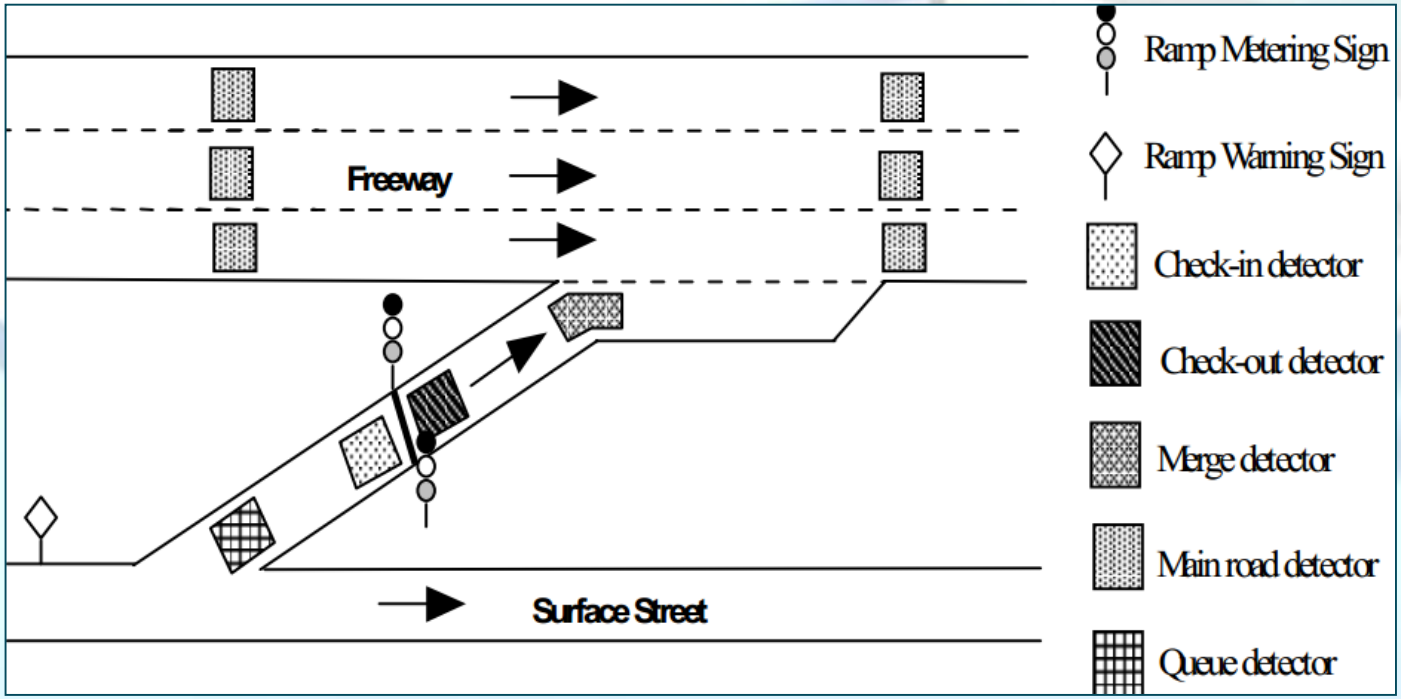

ITS Development Chronology in Europe, US and Japan

# MAJOR CATEGORIES OF ITS

## a) Advanced Traffic Management Systems (ATMS)

- ATMS are used to
  - Improve traffic service quality
  - Reduce traffic delays
- ATMS operates
  - With a series of videos
  - Roadway loop detectors,
  - Variable message signs,
  - Network signals
  - Ramp meter timing schedules
  - Roadway incident control strategies from one central location to respond to traffic conditions in real time

- ATMS elements:
  - Collection data team _ monitor traffic conditions
  - Support systems –cameras, sensors, semaphores and electronic displays. Help system operators to manage and control real time traffic
  - Real time traffic control systems –these systems use the information provided by the two previous elements they can change semaphores, send messages to electronic displays and control highway access
- The best example being used for several years at some metropolitan areas is Ramp Metering Elements:

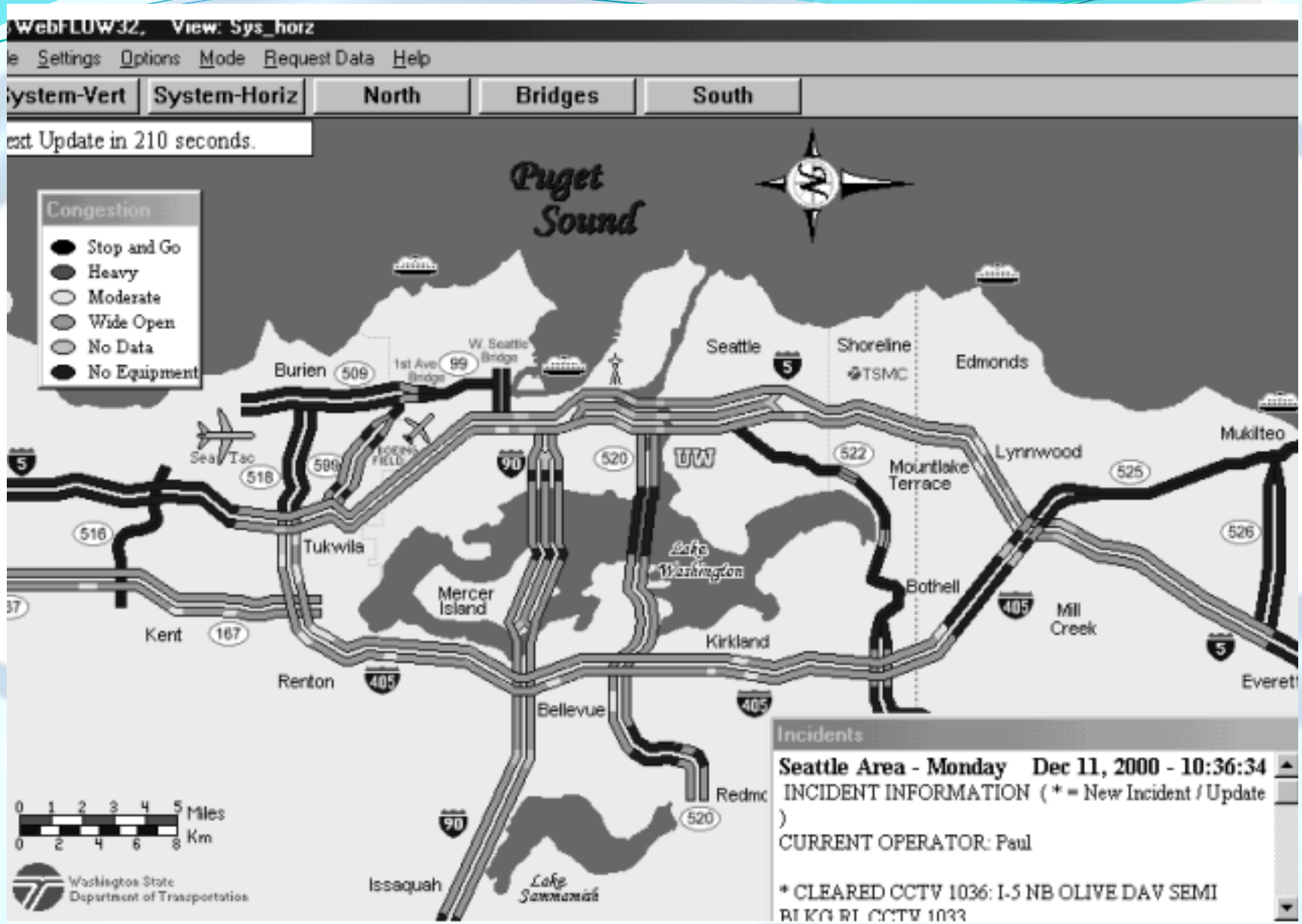


- Concrete Jersey Barriers Removal Machines
  - A machine has been created which moves the concrete jersey barriers dividing many highways.
  - Using such a machine, traffic into and out of urban areas can be more efficiently handled through the creation of an extra lane in the direction of heavy travel especially during peak hours

Moving the concrete jersey barriers dividing the highway

## b) Advanced Travelers Information Systems (ATIS)

- With this system travelers can decide which is the most advantageous road to reach its destiny, the most favorable transportation service and the most appropriate schedule to adopt
- This information can be provided through electronic panels,
  - portable systems connected to the Internet
  - radio systems
  - In-vehicles systems (displaying the map with information of its location, the state of the neighborhood traffic, traffic delays or accidents)
- In the most advanced systems the driver also gets information about most advantageous routes too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Burien
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1st Ave Bridge
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TSMC
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Lynnwood
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Tukwila
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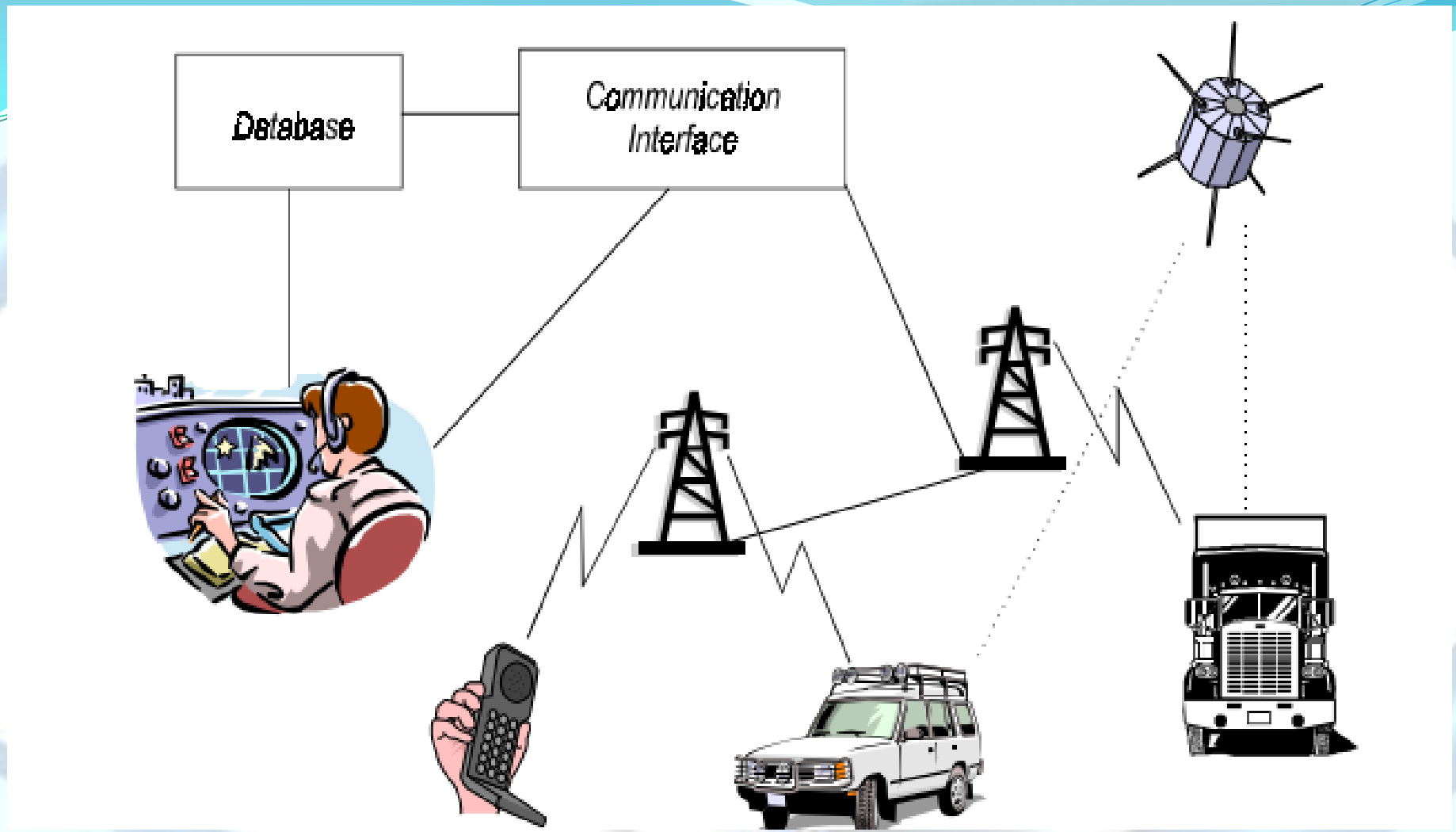
Washington State Department of Transportation
Issaquah
Lake Sammamish
Incidents
Seattle Area - Monday Dec 11, 2000 - 10:36:34
INCIDENT INFORMATION ( * = New Incident / Update )
CURRENT OPERATOR: Paul
* CLEARED CCTV 1036: I-5 NB OLIVE DAV SEMI

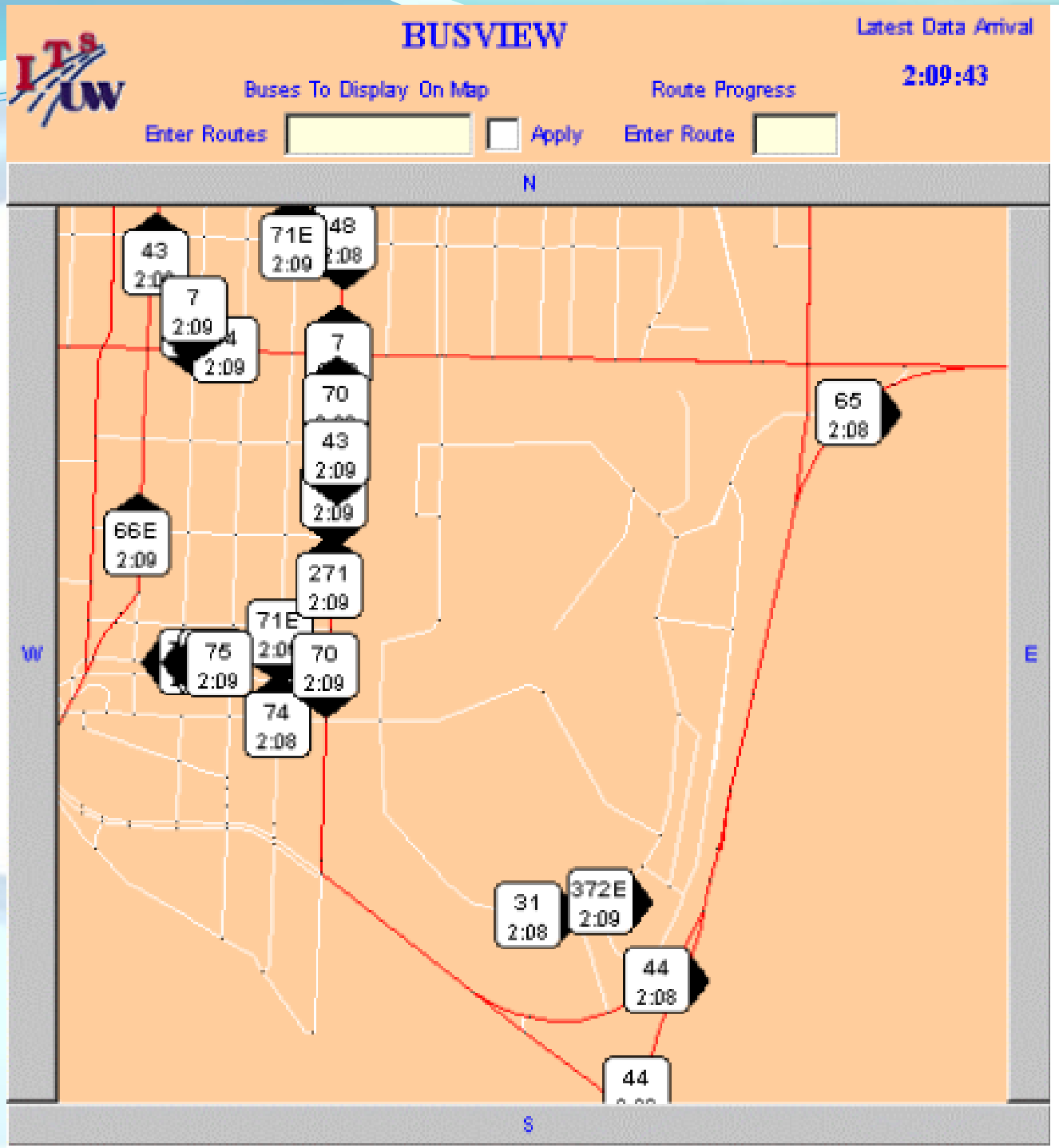
# c) Commercial Vehicles Operation (CVO)

- Increases safety and efficiency of commercial vehicles and fleets
- increases the speed of goods delivery, patient transport and reduction of costs operation
- Best example is Commercial Management using GPS (Global Positioning System) and GSM (Global System for Mobile Communications) technologies
- Includes following technologies
  - Automatic Vehicle Identification
  - Automatic Vehicle Classification
  - Automatic Vehicle Location
  - Pedestrian Movement Detection
  - Board Computers
  - Real Time Traffic Transmissions


Database
Communication Interface

# d) Advanced Public Transportations Systems (APTS)

- Used to improve the operation and efficiency of high occupation transports
- They use technologies from ATMS and ATIS
  - Improves the mass transport service,
  - Allows route information,
  - Travel schedules and costs
  - Provide Real time information about changes in transport systems
- Example:
  - Interface of a bus location system _ BUSVIEW
- Also include the automatic payment systems
  - stored credit
  - automatic capture of passenger information and journey profile


BUSVIEW
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Buses To Display On Map
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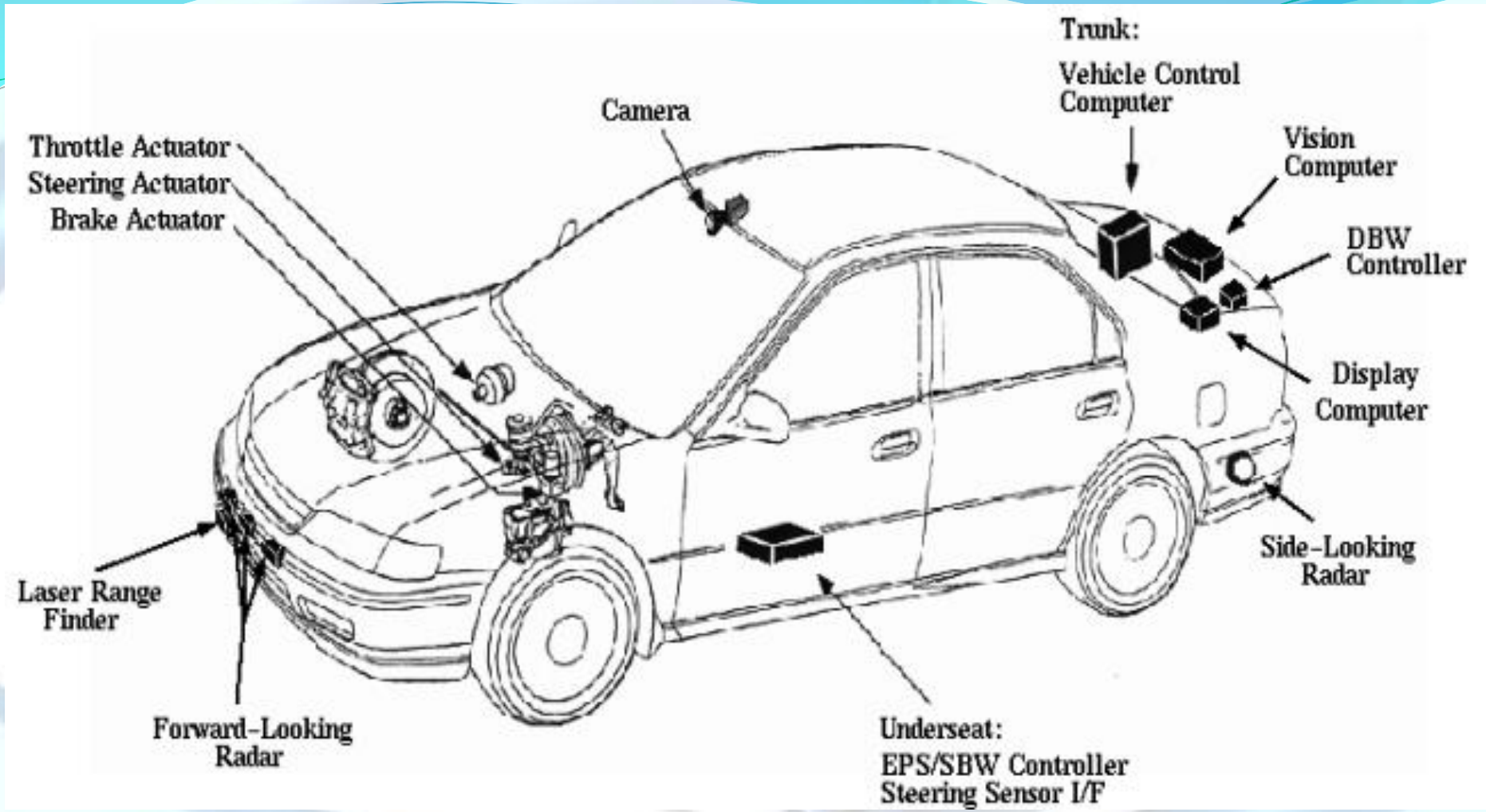
44

# e) Advanced Vehicles Control Systems (AVCS)

- AVCS joins sensors, computers and control systems to assist and alert drivers or to take part in vehicles driving
- With in-vehicle the driver can receive visual and hearing information about traffic, dangers and all vehicle situations
- On the other hand, automatic control allows to react in danger situations in a faster and effective way
- Example
  - automatic vehicle developed at the Ohio State University Centre for Intelligent Transportation Research (CITR)
  - This vehicle demonstrated
    - advanced cruise control,
    - automated steering control for line keeping and autonomous behavior,
    - automated stopping
    - lane change in reaction to other vehicles




**Structure of OSU Autonomous Vehicle**

# f. Advanced Rural Transports Systems (ARTS)

- ARTS are designed to solve the problems arising in rural zones (communities or areas with less then 50,000 residents)
- Rural areas roads have a unique set of attributes such as
  - steep grades,
  - blind corners,
  - Blind curves,
  - few navigational signs,
  - mix of users,
  - few alternative routes.
- Some of the referred systems used in the urban areas already begun to be implemented in rural areas, such as ATIS, ATMS and APTS

# POTENTIAL DIRECTIONS OF FUTURE RESEARCH GLOBALLY

- 1) Traffic management
  - SMARTEST's software tool based on a microscopic simulation approach,
    - provides a detailed modeling of the traffic network
    - Distinguishes between different types of vehicles and drivers,
    - Models incidents
    - Manoeuvres conflicts
  - The outputs consist of an animated graphical representation of
    - The traffic network
    - Statistical data
    - Data gathered by the simulated detectors
- 2) Driver steering behavior
  - One of these projects consists of the development of a driver's model, representing his real behavior, based on issues like surveillance and steering expertise.
  - For example the model considers the driver's control actions tacking into account the point where he fixes his attention

# Conclusion

- ITS involves a large number of areas but paper is focused on some generalized and important ones.
- Following future directions need to be followed:
  - Improvement of road-vehicle systems (navigation systems, board computers, real time traffic transmissions).
  - Introduction of fully automated systems (like the "car-sharing" concept).
    - Car-sharing (US) or car clubs (UK) is a model of car rental where people rent cars for short periods of time, often by the hour
  - Development and refinement of models of roads, vehicles and humans so that we can simulate Urban Areas of Developing Countries
  - No cost effective practices or solutions for rural areas or even for urban areas of developed countries have been discussed
  - ITS being practiced in US, Europe and Japan till 2001 still seems unobtainable in country like Pakistan