

# Automatic Vehicle Location System & Automatic Identification System



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- What is AVLS?
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# Mobile unit Comparison

CNS,AVL,ITS Comparison

- CNS**
- Basic component
  - Vehicle A/V system Integration
  - Vehicle engine control system integration
  - Driver Interface(Display System)



- AVL**
- CVO system
  - Transportation status
  - Wireless communication
  - Full-duplex Control station
  - Total information system



- ITS**
- SOC
  - Infrastructure
  - Ministry of Construction and Transportation joined
  - US example:  
TEA21 in May, 1998  
Put 1280 million in ITS during 6 years from 1998

	CNS	AVL	ITS
<b>Application Scope</b>	Individual (Driver)	Specific group(logistics company)	The whole (Government)
<b>System Configuration</b>	GPS Display	GPS,Display Center station Wireless communication	Highway System Transmitter/Receiver Visual Recognition Incident
<b>Input Information</b>	GPS(DGPS) Dead Reckoning Device,map Broadcasted information	CNS+ Center Command	CNS+ Integrated Vehicle Info Sensors Info Transportation Environ. Information
<b>Output Information</b>	Heading,Direction Notice Voice Guidance	CNS+ Command Execution Vehicle Location Logging	CNS+ Automatic Determination&Driving, Caution,logging
<b>Reality</b>	Several Year's in Market (Japan Leading)	Already in Service (USA leading)	Partial operation (CVO,APTS)
<b>Other transportation relation</b>	Aviation,marine Service GPS Navigator plotter	AIS ATC CCCI	Vessel automatic Navigation

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# ITS status in Korea

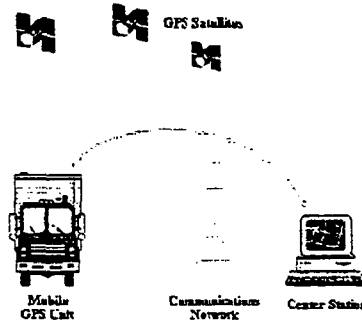
Classification	Part	System
<b>ATMS</b>	Traffic control Manage Emergency situations Automatic Enforcement System Heavy Vehicle Management	Urban Traffic Management System Freeway Traffic Management System Rural Traffic Management System Automatic Enforcement System Electronic Toll Collection System Heavy Vehicle Monitor System
<b>ATIS</b>	Provide Transportation Information Introduce Integrated Travel Introduce Optimum Course	Traffic & Road Info System Value-added TI System
<b>APTS</b>	Provide Public Transportation Information Public Traffic Management	City Bus Information System Express Bus Information System Inter-city Bus Information System
<b>CVO</b>	Freight and Fleet Management Hazardous Material Monitor	Integrated Log Information
<b>AVHS</b>	Prevent Accidents Increase Road Capacity	Advanced Vehicle System Advanced Highway System

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## What is AVLS?

- Technology used for tracking vehicles, vessels, and mobile assets such as trailers, containers, and equipment.
- Each mobile unit has a GPS receiver to know its position and wireless communication device to communicate with the center station over a communications network.
- This allows the base station to monitor the entire fleet and manage the mobile assets.



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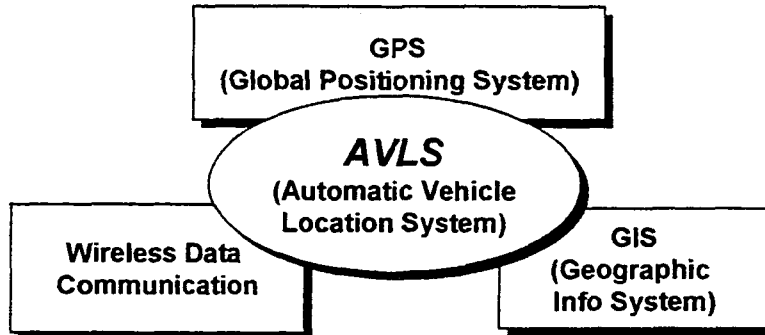
## Why use AVLS?

- Return on Investment
  - ↳ manage your fleet more efficiently
  - ↳ As a result, your operating costs can be reduced
- Quicker Dispatch
  - ↳ For emergency services, AVLS often reduces the dispatch time from about a minute to less than 15 seconds
- Driver & Passenger Safety
- Security Against Theft
- Navigation Guidance
- Documenting Compliance
  - ↳ The data logging capabilities of AVLS make it easier for you to document
- Routes Optimization
- Better Time Estimates
  - ↳ With AVLS, you can also give your customers better estimates for time to arrival.
- Etc.

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## Major Technology



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## Global Positioning System

- GPS receiver reports mobile unit's current position, speed, heading ...
- Accuracy

<i>technology</i>	<i>accuracy</i>	<i>Etc.</i>
GPS	58m(+SA), 10m(-SA)	No reports when GPS is blocked
GPS+DR	33m(+SA), 10m(-SA)	
DGPS	2m	No reports when GPS is blocked
DGPS+DR	2m	

### ↓ Limitations

- ✓ Report frequency
- ✓ Communication latency
  - Real time characteristic is deteriorated in proportion to the increase of report frequency interval and communication latency.

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	PCS(Selection)	PCS	Wireless communication network	Digital TRS
Transmission Mode	Circuit switched	Packet switched	Packet switched	Packet switched
Frequency band	Inbound:1750-1780 Out:1840-1870MHz	.	In: 898-900MHz Out: 938-940MHz	376-381MHz 394-381MHz
Communication speed	1440bps Extended Function(1S-95B)	.	maximum 7200bps	maximum 9600bps
Cell radius	0.5-5 km	.	50-60 km	2-5 km
Base Station Capacity	2800Subs/Cell	.	Not determined	60 Simultaneous connection
Data Service region	Nationwide network	.	Large cities, Kyung-in province	Large cities, Kyung-in province
data Reliability	good	Data latency occurrence	Good	Hard to use for a long time
Cost	low	.	High	normal
Scalability	good	Good	Normal	Normal
Characteristic	First investment Low in price 1:1 connected	Short Call setup time	Expensive Communication equipment	Simple system configuration

Comparison of wireless data communication network in Korea (1999.5)

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- System design
- Subsystem Implementation
  - ↓ Communication Manager subsystem
  - ↓ Database Manager subsystem
  - ↓ User Interface subsystem
  - ↓ GIS Engine subsystem
- Adaptation algorithm
  - ↓ Map matching by road centerline extraction
- Applications
  - ↓ Use in emergency management system

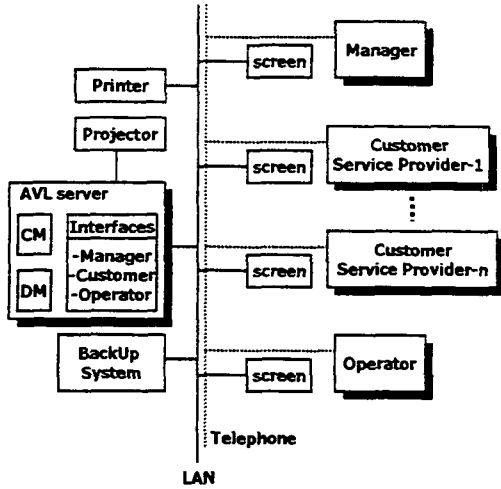
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# System Design

## Center Station Configuration



- ☐ Manager
  - ↓ Make Vehicle's driving plan
  - ↓ Input data into database
- ☐ Customer Service Provider
  - ↓ Customer management
- ☐ Operator
  - ↓ Real time monitoring of MDTs
  - ↓ Command Transmission
- ☐ AVL Server
  - ↓ Data communication and DB management
  - ↓ User Interface
    - ✓ Manager Interface
    - ✓ Customer Interface
    - ✓ Operator Interface

Configuration of Center Station

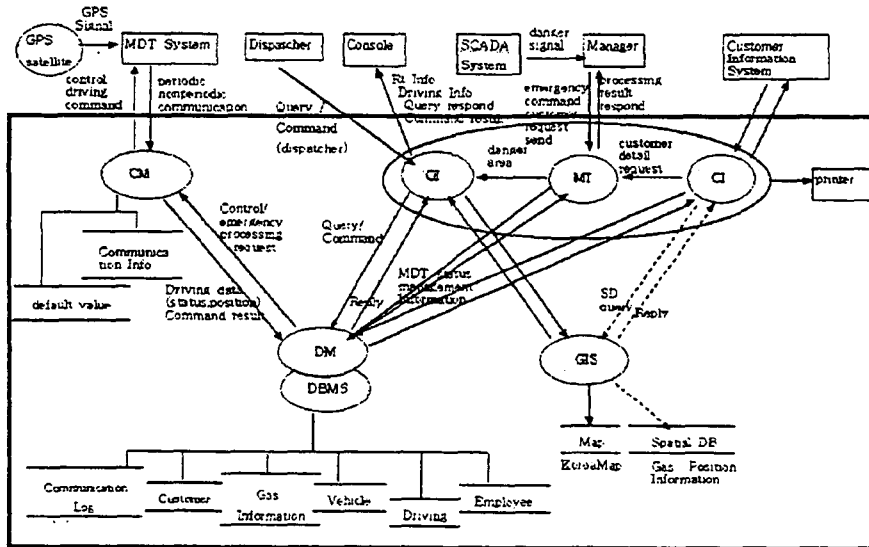
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# Design

## System Data Flow Diagram

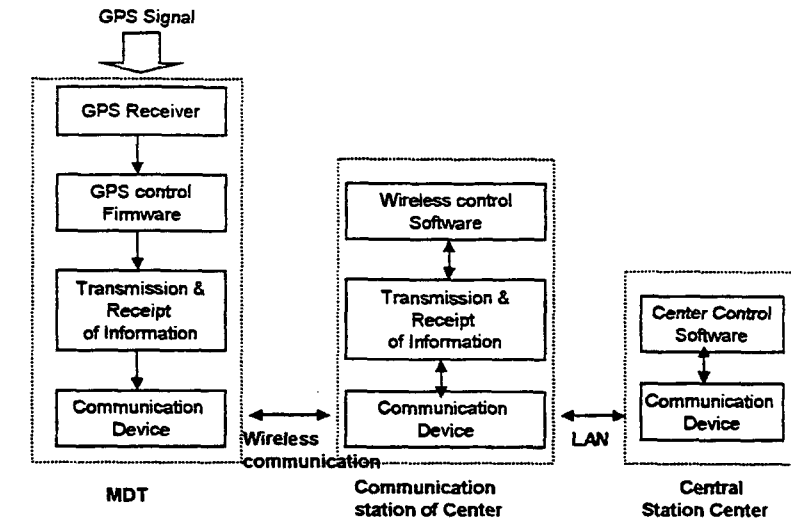


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# CM Subsystem communication data flow

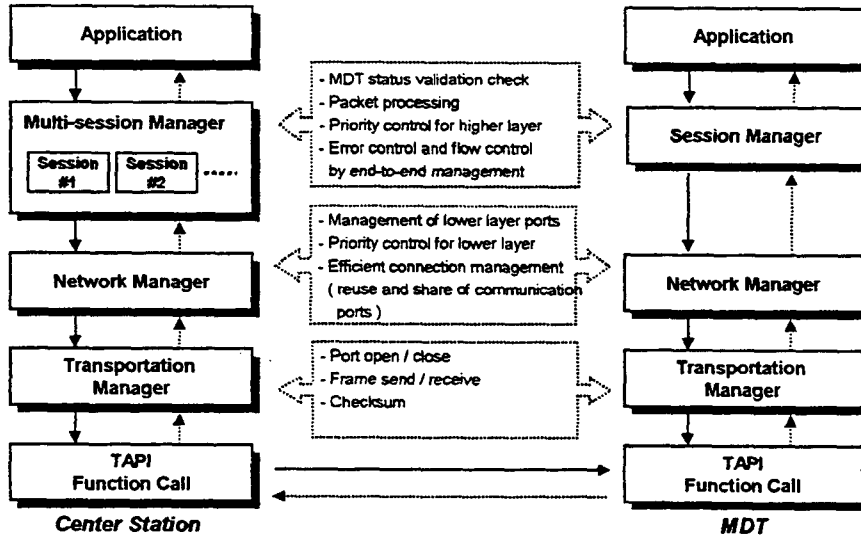


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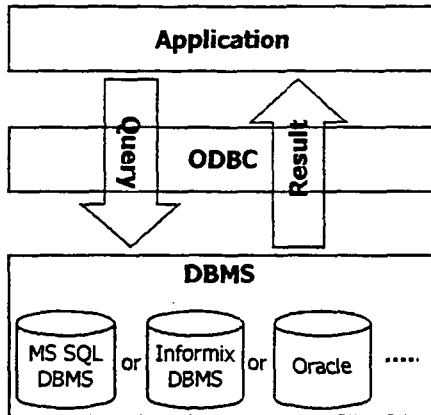
# CM Subsystem Protocol Reference Model



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## Database Management Subsystem



- ODBC
  - ↓ Open Database Connectivity
  - ↓ Upper application is independent specific DBMS

□ Table

Table Name	Use
Driving	Current status of driving vehicle (latitude, longitude, speed, status)
Customer	Information about customer (address, position, the last transaction date)
Logging	Logging route of vehicle
Driving	Driver of driving vehicle (Car number, driver name)
Employee	Information of driving person (date enter a company, address)
Communication Log	Logging communication contents
Vehicle	Vehicle Information (type of car, holding equipment, communication period)
Operator Log	Logging information about operation

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## GIS Engine subsystem #1

- Database( spatial data ,attributes data )management
  - ↓ Map database management
    - ✓ Map data for visualization
      - Map management for display
      - Tiling, layer management
    - ✓ Map data for processing
      - Management of Road data for multiple operation
      - Optimum routing , blocking, add new road ,
      - Real time update of road data( current traffic condition ,weather )
  - ↓ Attributes database management
    - ✓ Management of Attribute data related to spatial data
    - ✓ Ex> foreign key
  - ↓ Vehicle database management
    - ✓ Movement trace or current position

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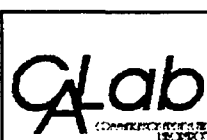


## GIS Engine subsystem #2

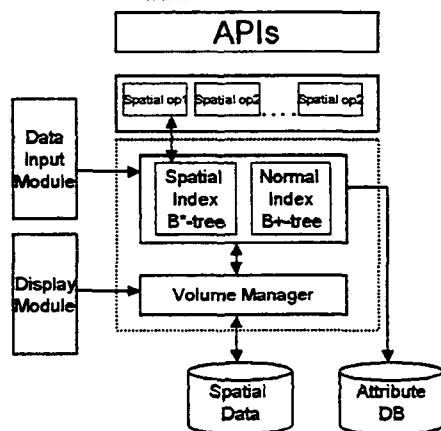
- Display
  - ‡ Display of Main map, road, vehicle per each layer
  - ‡ Display attribute information
  - ‡ Zooming ,Panning ,Marking ,Labeling
- Report document
  - ‡ Report form design
  - ‡ Report print
  - ‡ Data analysis
  - ‡ Statistical processing

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## GIS Engine Subsystem Architecture



GIS Engine Architecture

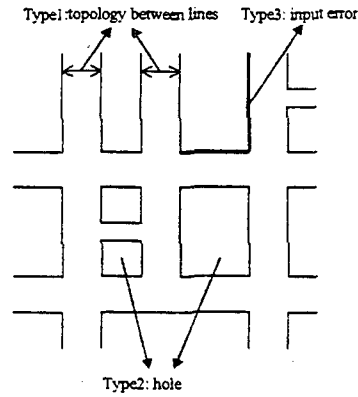
- Operator
  - ‡ Based on Spatial data
  - ‡ APIs are composed of operators
- Index
  - ‡ R+ tree
    - ✓ Use MBR
  - ‡ B+ tree
    - ✓ Use Object ID
- Volume Manager
  - ‡ One volume construction per spatial object
  - ‡ Volume construction and overflow processing for variable length
- APIs
  - ‡ API for volume management
  - ‡ API for Index management
  - ‡ Operator API for spatial objects
  - ‡ Etc...

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## Adaptation Algorithm map matching by road centerline extraction

- ❑ Error occurrence
  - ↓ Because of inaccuracy of GPS
    - ✓ Vehicle are displayed on building
- ❑ Solution
  - ↓ Road centerline extraction
  - ↓ Vehicle position update:  
select nearest road centerline
- ❑ Technical problems of road centerline construction
  - ↓ No topology between lines
  - ↓ Road data have hole
  - ↓ Input error

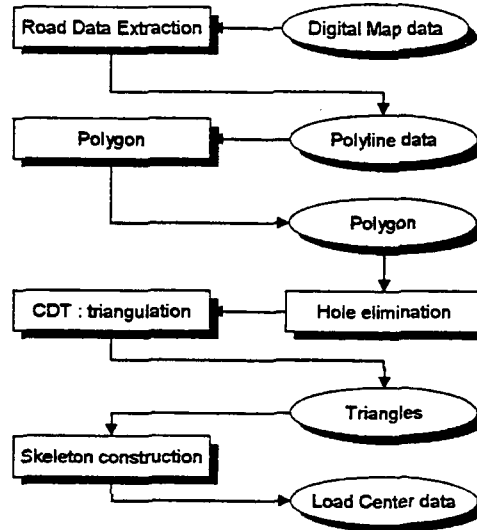


technological problem of road centerline construction

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## Adaptation Algorithm road center-line data construction



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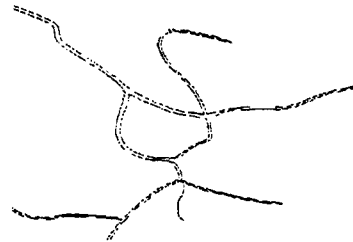
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## Adaptation Algorithm

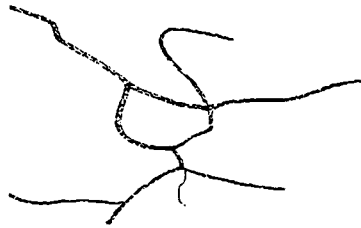
ex> Road center-line construction



Numerical Map



Road construction



triangle(CPT)division



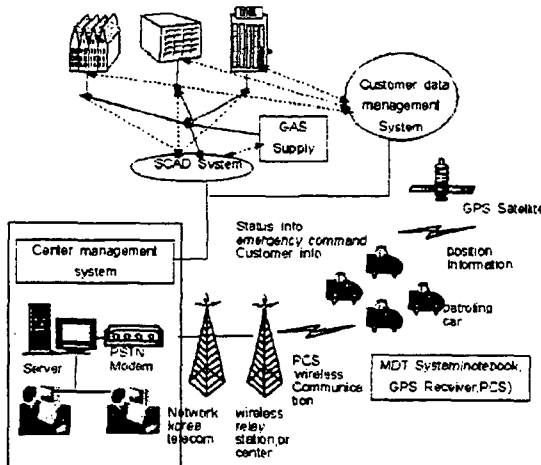
Road centerline extraction

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## System application Model

AVLS for Gas Distribution Company



- Center station
  - ↓ Real time display of patrol vehicle
  - ↓ SCADA(center control) , CIS(customer management system) Interface :
  - ↓ Emergency processing

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## System development environment

### □ Center station

- ↓ System specification
  - ✓ 750Mhz single Intel Pentium III
- ↓ OS
  - ✓ Windows 2000 server
- ↓ GIS Engine
  - ✓ Self manufactured engine
- ↓ Database
  - ✓ Informix-DB7.2.2 server/client
  - ✓ Informix-CLI ODBC
  - ✓ Korean map data
- ↓ Communication
  - ✓ Multi-port device
  - ✓ Serial modems
  - ✓ TAPI 2.1
- ↓ Development language
  - ✓ Visual C++

### □ MDT

- ↓ System Specification
  - ✓ Pentium II Notebook
- ↓ OS
  - ✓ Windows 98
- ↓ GPS receiver
  - ✓ Garmin GPS receiver
  - ✓ Motorola GPS receiver
- ↓ Communication
  - ✓ 019 PCS phone
  - ✓ 019 PCS data service kit
  - ✓ TAPI 2.1
- ↓ Development language
  - ✓ Visual C++

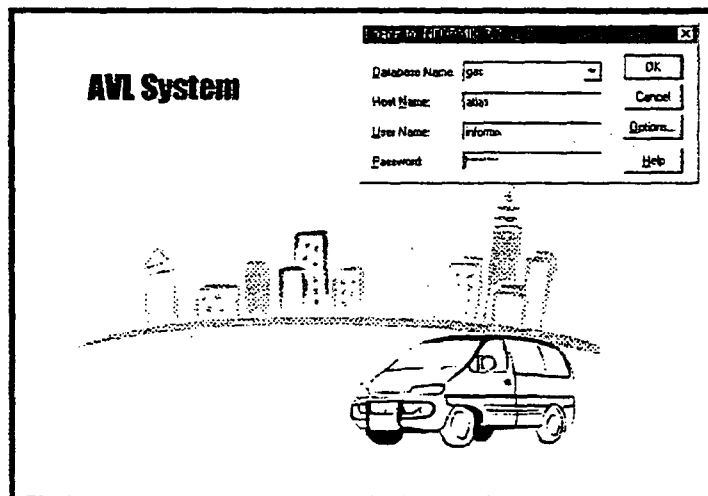
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## Presentation

### Logon



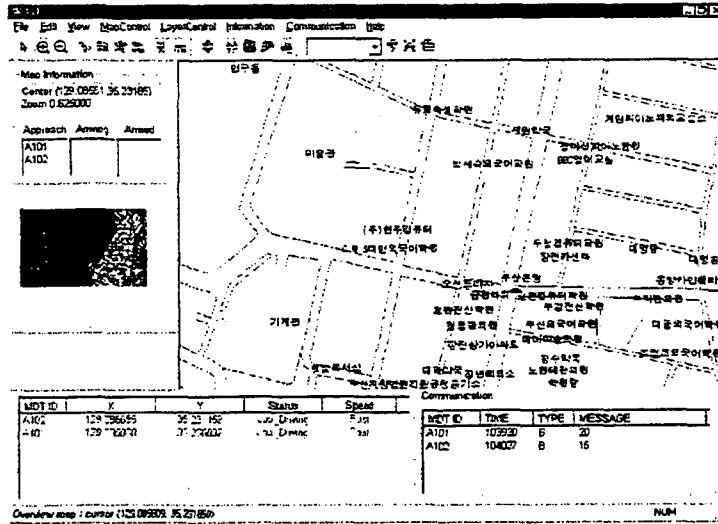
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# Presentation

## Main display of Autotracking



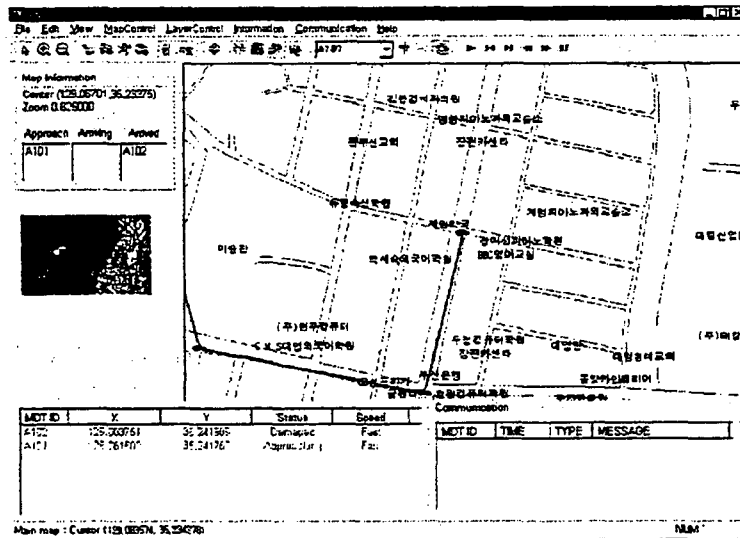
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# Presentation

## Tracking



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# AIS messages vs. AVLS messages

AIS messages	Associated AVLS messages
<b>Voyage Information</b> ↓ Vessel type and cargo category ↓ Navigational status ↓ Destination ↓ ETA date and time ↓ Etc.	<b>MDT Information</b> ↓ Position ↓ Speed ↓ Heading ↓ MDT Status ↓ MDT ID ↓ Etc.
<b>Static Station Information</b> ↓ Vessel name ↓ Call sign ↓ IMO number ↓ Antenna location, length and beam ↓ Etc.	
<b>Short safety related messages</b> ↓ Safety messages ↓ Binary messages	<b>MSG</b> ↓ Short text message  <b>NOTIFY</b> ↓ Enter Approach zone ↓ Enter Arriving zone ↓ Accident ↓ Etc.
<b>Route Plan</b> ↓ way points	<b>Command( Driving Plan )</b> ↓ Driving Plan Initialize ↓ Driving Plan Require ↓ Driving Plan Update
	<b>Command</b> ↓ MDT state require ↓ MDT state update ↓ MDT return  <b>Response</b>

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# Message Format Comparison

		Message structure																																																		
		Approval sentence	Query sentence	Proprietary sentence																																																
AIS (ASCII based)		<table border="1"> <tr><td>&lt;AP&gt;</td><td>Start of sentence</td></tr> <tr><td>&lt;AB&gt;</td><td>Talker ID</td></tr> <tr><td>&lt;ACD&gt;</td><td>Sentence delimiter ID</td></tr> <tr><td>&lt;A1&gt;</td><td>Data field delimiter</td></tr> <tr><td>&lt;A2&gt;</td><td>Data sentence block</td></tr> <tr><td>&lt;AO&gt;</td><td>Optional checksum indicator</td></tr> <tr><td>&lt;AO&gt;</td><td>Optional checksum field</td></tr> <tr><td>&lt;AE&gt;</td><td>End of sentence</td></tr> </table>	<AP>	Start of sentence	<AB>	Talker ID	<ACD>	Sentence delimiter ID	<A1>	Data field delimiter	<A2>	Data sentence block	<AO>	Optional checksum indicator	<AO>	Optional checksum field	<AE>	End of sentence	<table border="1"> <tr><td>&lt;AQ&gt;</td><td>Talker ID of requester</td></tr> <tr><td>&lt;AQ&gt;</td><td>Talker ID for service from which data is being requested</td></tr> <tr><td>&lt;AQ&gt;</td><td>Query character ID</td></tr> <tr><td>&lt;A1&gt;</td><td>Data field delimiter</td></tr> <tr><td>&lt;AO&gt;</td><td>Approved sentence</td></tr> <tr><td>&lt;AO&gt;</td><td>Summary of data being requested</td></tr> <tr><td>&lt;AE&gt;</td><td></td></tr> <tr><td>&lt;AE&gt;</td><td></td></tr> <tr><td>&lt;AE&gt;</td><td></td></tr> </table>	<AQ>	Talker ID of requester	<AQ>	Talker ID for service from which data is being requested	<AQ>	Query character ID	<A1>	Data field delimiter	<AO>	Approved sentence	<AO>	Summary of data being requested	<AE>		<AE>		<AE>		<table border="1"> <tr><td>&lt;AP&gt;</td><td>Proprietary sentence ID</td></tr> <tr><td>&lt;AO&gt;</td><td>Manufacturer's alphanumeric code</td></tr> <tr><td>&lt;AO&gt;</td><td>Manufacturer's data</td></tr> <tr><td>&lt;AE&gt;</td><td></td></tr> <tr><td>&lt;AE&gt;</td><td></td></tr> <tr><td>&lt;AE&gt;</td><td></td></tr> </table>	<AP>	Proprietary sentence ID	<AO>	Manufacturer's alphanumeric code	<AO>	Manufacturer's data	<AE>		<AE>		<AE>			
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- ITS solves transportation and and transportation and environment problem
- Improvement
  - ↓ Real time improvement
  - ↓ Error correction
  - ↓ Map data correction
- Application plan
  - ↓ Use in EC system
  - ↓ Use in ITS business
  - ↓ Traffic information service, traffic management system -> National traffic management system
  - ↓ Mobile communication business
  - ↓ IMT-2000
  - ↓ Application in marine and aviation