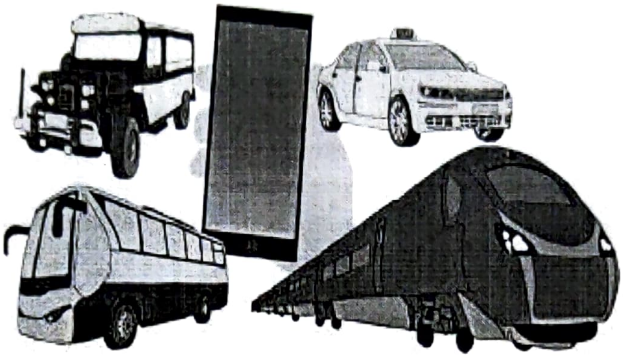
Module 3

PUBLIC TRANSPORTATION AND REGIONAL PLANNING

3.1 Public Transportation



City life and urbanization have introduced mobility problems and raised issues concerning transportation of both people and goods. Public transport (also known as public transportation or public transit) refers to shared passenger transport service, which is available for use by the general public. Public transport modes include vanpools, buses, trolleybuses, trams and trains, rapid transit (metro/subways/undergrounds etc.) and ferries. Public transport between cities is dominated by airlines, coaches, and intercity rail. High-speed rail networks are being developed in many parts of the world. Implementing public transport networks is becoming more difficult due to the continuous urbanization, which makes transportation networks grow in size and, on the other hand, to the ever-increasing complexity of managing transportation networks. Implementing new intelligent decision support and control systems is becoming necessary to manage public transportation networks, and to assist authorities, who are investing in new means, infrastructures, information and control systems to improve mobility in cities. Advanced (Intelligent) Public Transportation Systems (APTS/IPTS) are a subsystem of Intelligent Transportation Systems (ITS), which aim to control public transportation networks, to maintain their performance, and to provide users (passengers and decision makers) with up-to-date information about trips and network operating conditions

3.1.1 Basic Parameters

The basic parameters which influence the selection of a mode of transport and thus the success of public transport, are:

- time availability – expresses the possibility of using a given mode of transport at the point in time of reaching the point serviced by public transport until the arrival of a suitable connection,
- travel speed,
- price for the users,
- comfort, quality of the fleet and scope of add-on services in the mode of transport,
- inside safety – in relation to the transport process, probability of an accident,

- outside safety – the risk of an unlawful act, protection against terrorism, vandalism and other similar unlawful acts and pathological social phenomena and protection against natural elements,
- reliability – transport system must operate with a high probability of running according to the published time table,
- accessibility of the public transport system to passengers with limited movement and/or orientation ability,
- passenger awareness

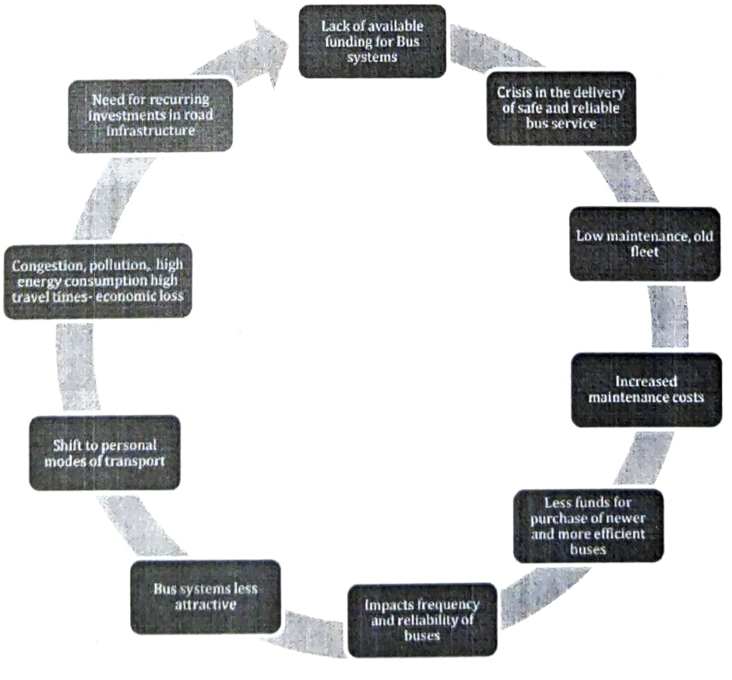
3.1.2 Requisites to make public transport a preferred mode choice

The following are the requisites to make public transport a preferred mode choice:

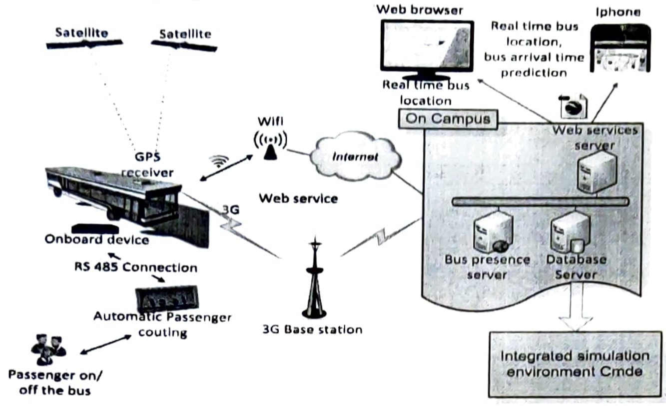
- Reliable - high frequency, timely service
- Flexible - rational routing systems, adaptive to change in urban densities
- Comfortable - comfort in aspects of entry/exit, seating, leg space, ventilation and other aspects, buses which provide accessibility for the differently-abled
- Affordable - To various socio-economic groups
- Energy and emission efficient
- Seamless connectivity to other transport/paratransport modes - Use of Intelligent Transport Systems
- Integrated planning (last/first mile connectivity) - Feeder systems, accessible bus stops

3.1.3 Effect of Noninvestment in Public Transport

The following figure shows the effect of noninvestment in public transport:



3.2 Advanced Public Transportation systems



Intelligent transportation systems (ITS) offer a broad range of technologies to improve operational efficiency, customer service and convenience, safety and security, and overall management in public transportation. Advanced Public Transportation systems (APTS) are a collection of technologies that increase the efficiency and safety of public transportation systems and offer users greater access to information on system operations. The implementation of APTS technologies is transforming the way public transportation systems operate, and changing the nature of the transportation services that can be offered by public transportation systems. The goal is to provide public transportation decision-makers more information to make effective decisions on systems and operations and to increase travelers' convenience and ridership. The following direct traveler benefits due to APTS technologies can be expected:

- travel time savings and reduced uncertainty in travel times;
- improved accessibility;
- improved content, medium and quality of transit information;
- increased flexibility in travel choices;
- improved (accident) safety and security;
- ease of transit use, improved travel comfort and convenience; and
- improved satisfaction with transit service and customer feedback.

3.3 Components of APTS

ITS provides opportunities to more easily analyze critical performance data as well as facilitate coordination and cooperation among multiple transit providers in a region, and enhance multimodal transportation. Following are the classification of activities within Advanced Public Transportation Systems:

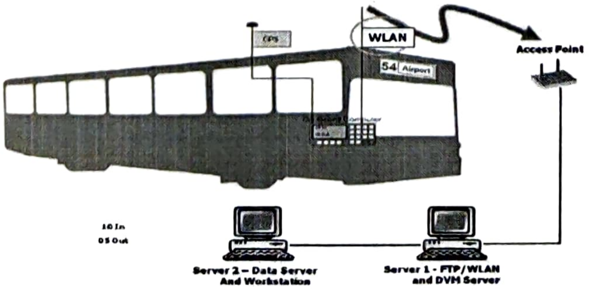
- **Fleet Operations and Management** - covers technologies that are implemented to facilitate transit operations and provide input to senior management in terms of overall system performance;
- **Traveller Information** - covers the customer-facing technologies that provide the public with information regarding trip planning and real-time operational information;

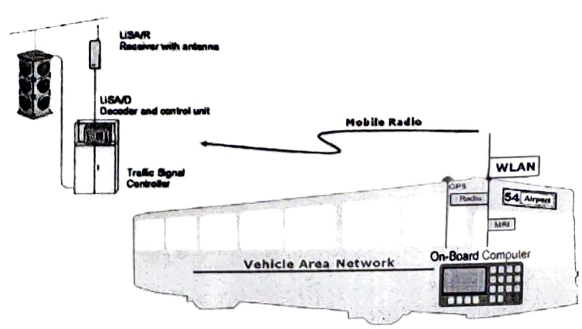
- **Safety and Security** - covers those technologies that improve the safety and security of transit staff and passengers through on-board and facility technologies;
- **Automated Fare Payment** - covers fare collection and payment technologies, including fare media and mobile payment applications;
- **Maintenance** - covers technologies that facilitate maintenance activities, such as engine and vehicle component monitoring and tracking of scheduled and unscheduled maintenance activities and inventory systems; and
- **Other** - covers a variety of other technologies and systems that do not fit into the other categories, such as data management and the use of open data.

3.3.1 Fleet Operations and Management

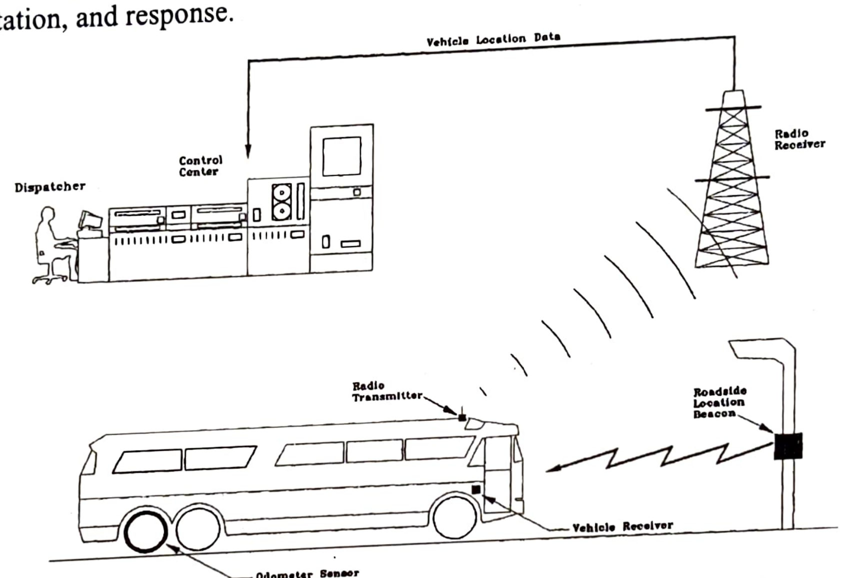
The following are various ITS technologies that can be adopted in Fleet Operations and Management activities of APTS:

1. **Communications Technologies:** Communication technologies is absolutely critical to the integration and implementation of specific transit technology applications, such as AVL and en-route/wayside traveler information. Communication systems provide critical links among drivers, dispatchers, emergency response, customers, and other personnel involved in transit. There is a trend to migrate from analog to digital communications in public transportation. Digital communication provides a level of security that is not available with analog, it is less likely to be affected by noise and interference, and it tends to be less expensive than analog communication. Wireless communication systems provide the operational backbone for many technologies and include the following:
   - **Wide area wireless (WAW)** - communications networks based on radio frequency broadcasting. These networks can be generic or proprietary.
   - **Wireless local area networks (WLANs)** - data communication systems (analogous to a wireless internet connection) that allow transit vehicles to communicate with a base station or vice versa. WLANs are used to upload or download data over the air, eliminating the need to use wired communications.
   - **Dedicated short-range communications (DSRC)** - a beacon/tag combination used in transit signal priority (TSP) systems and toll collection on bridges, tunnels, turnpikes, and parking facilities. The electronic tag, or transponder, contains a small radio transmitter that is used to emit a short-range radio signal that a beacon, or tag reader, receives. The beacon then transmits the data to the necessary computer hardware and software via radio frequency. needs. The tags can be either active or passive.
   - **Land line and cellular telephone networks**; and
   - **Internet and intranet**



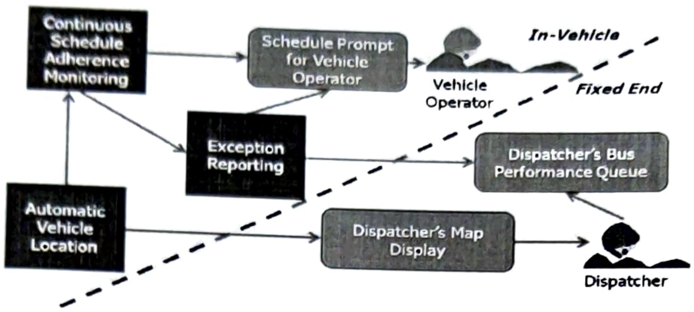


2. **Automatic Vehicle Location (AVL):** AVL system is defined as the central software used by dispatchers for operations management that periodically receives real-time updates on fleet vehicle locations. In most modern AVL systems this involves an onboard computer with an integrated Global Positioning System (GPS) receiver and mobile data communications capability. AVL systems allow transit managers to monitor the actual or approximate location of transit vehicles in their fleet at any given time. AVL, GPS, and dispatching software are independent technologies, not all one and the same. Essential to an AVL system is the on-board computer (known as a mobile data terminal [MDT] or mobile data computer [MDC]) and the means to transmit the data back to a central dispatch location via a communication system for processing, interpretation, and response.



3. **Computer-aided Dispatch (CAD):** Computer-aided dispatch (CAD) software provides decision-support tools used by transit dispatchers and supervisors to monitor operations in real-time, allowing them to manage the operations proactively (handling delays, disruptions in service, and incidents as they occur). A CAD system typically provides dispatchers with at least two displays: one that shows the locations of vehicles on a map and one that shows a queue of incidents or calls from vehicle operators (from the CAD system). Using these screens together, dispatchers can "identify and respond to problems on their routes. When a [vehicle] operator calls, the dispatcher sees a message showing the [vehicle] number on the CAD screen (which prioritizes the operator calls). The dispatcher selects the vehicle calling from the incident list and refers to their Automatic Vehicle Location screen for its location. The CAD system helps dispatchers track route performance by notifying them of early, late, or off-route buses. Using the communication system (voice or data), dispatchers or supervisors can communicate with vehicles individually, in a specific group (e.g., all buses on Route 5) or with all vehicles. On board the vehicle, the on-board computer (MDT or MDC) is constantly checking the actual location of the vehicle vs. where the vehicle should be (based on the vehicle's schedule), resulting in the determination of schedule adherence. When the

schedule adherence is outside a specific tolerance (set by the transit agency), this exception condition is reported to a dispatcher.



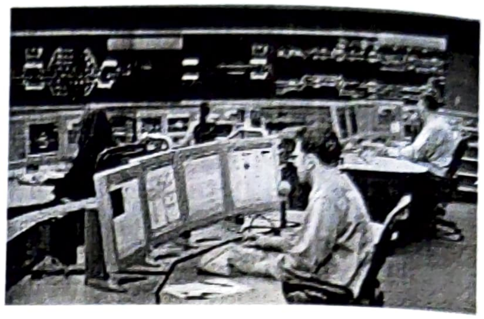
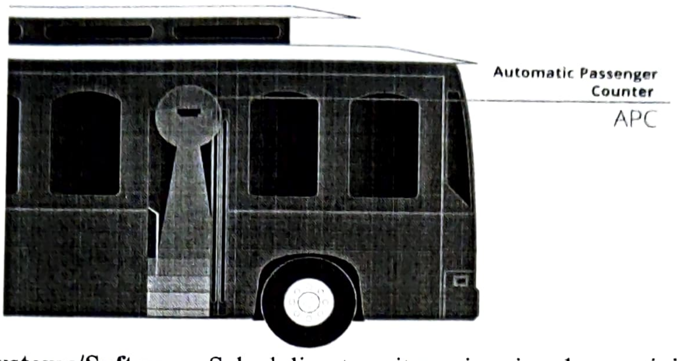


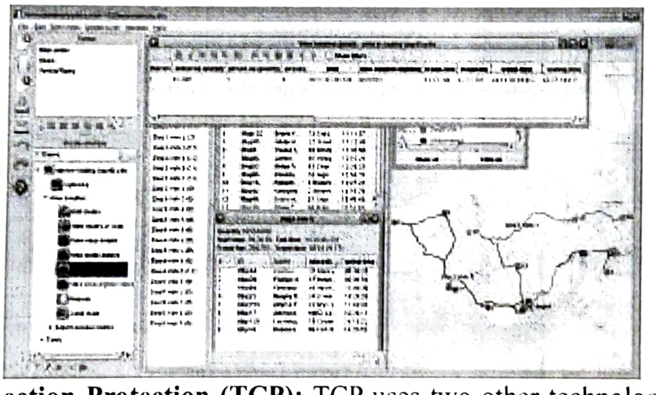
Table below contains the hardware and software associated with a CAD system.

CAD/AVL Component	Hardware/Software	Comments
GPS Receiver and Antenna	Hardware	GPS receiver reports date and time, latitude, longitude, speed and direction of travel
Schedule Adherence	Software	Current schedule adherence status typically displayed to the vehicle operator and dispatcher
Route Adherence	Software	Computation of whether vehicle is running on-route or off-route.
Mobile Data Terminal (MDT) or Mobile Data Computer (MDC)	Hardware	Vehicle operator display that is used for vehicle operator logon/logoff, vehicle location reports, voice call management, data messaging, display of schedule adherence etc
Automated Voice Announcements (AVA)	Hardware and Software	An AVL system allows automated announcements to be made on board the vehicle according to the vehicle's location
Automatic passenger counting (APC) - described later in this module	Hardware and Software	An AVL system is used in conjunction with an APC system to determine when and where passengers are boarding and alighting
Real-time arrival/departure information	Hardware and Software	The calculation of real-time vehicle arrival or departure information is based on data generated by an AVL system

4. **Automatic Passenger Counters (APCs):** Automatic passenger counters (APCs) refer to technologies that are used to count the number of passengers boarding and alighting a transit vehicle. A microprocessor monitors the passenger activity and uses an algorithm to determine when a passenger has entered or exited a vehicle. There are several types of APC technology; the two most common ones are treadle mats and infrared technology. APC systems are often implemented to reduce the cost of manual data collection can also be used for route scheduling. Transit operators typically deploy APC equipment on 12 to 25 percent of their vehicles and then rotate the vehicles on different routes as needed.



5. **Scheduling Systems/Software:** Scheduling transit services involves activities including trip building, blocking, runcutting, and rostering. The scheduling process is different for fixed-route and paratransit services. For fixed-route services, scheduling software provides a "tool that provides the scheduler with greater flexibility, functionality, and control over scheduling their services. It also works to reduce mistakes, improve vehicle and operator efficiencies, reduce staff time on tedious activities, and provide better reporting capabilities.



6. **Transfer Connection Protection (TCP):** TCP uses two other technologies mentioned earlier. An MDT (mobile data terminal) operates in conjunction with a CAD/AVL system to provide TCP. TCP is triggered when the vehicle operator of an incoming vehicle makes a transfer request. The incoming vehicle's operator is able to use the MDT to enter the outgoing route, by selecting from a predefined list.
7. **Transit Signal Priority (TSP):** TSP systems give authorized transit vehicles the ability to automatically change the timing of traffic signals. This is often limited to extending the green cycle, but can result in red cycle truncation and phase insertion. Further, it may only be done "conditionally" based on passenger load, type of service (BRT vs. local), and schedule adherence. The goal of these systems is to give priority to transit, and priority or preemption to emergency vehicles by reducing wait time at traffic signals without having an adverse impact on traffic.
8. **Yard Management:** Yard management provides a tool to manage fixed-route vehicles when they are located in the yard. Typically, the location of vehicles is visually displayed on a digitized map of the yard layout. The system normally automatically locates fixed-route vehicles within a certain distance accurately inside the yard. This

system often provides an interface with a CAD/AVL system to record pull-in and pull-out time, and assigned vehicle operators. Also, the system can be interfaced with fixed-route scheduling software to access vehicle operator information in real time.

9. **Intelligent Vehicle Technologies (IVTs):** Several IVTs reduce the probability of vehicle accidents through the use of vehicle controls and driver warnings. These systems help drivers process information, make better decisions, and operate their vehicles more effectively. One of these areas is collision avoidance systems (CAS). CAS technologies range from providing a warning to taking control of the vehicle. In terms of safety, fewer accidents translate to big savings in legal fees and lawsuits. In terms of operations, fewer collisions mean that a larger portion of the fleet is in running condition. CAS include the following:
    - **Rear Impact Collision Warning System**: this system provides visual warnings on the rear of a bus to warn following drivers of a potential collision.
    - **Side Collision Warning/Object Detection System**: This is also called Lane Change and Merge Collision Avoidance. It provides support for detecting and warning the vehicle operator of vehicles and objects in adjacent lanes (e.g., blind spots).
    - **Frontal Collision Warning System**: this system senses the presence and speed of vehicles in the bus lane, and provides warnings and limited control of the bus speed, to minimize the risk of collisions.
    - **Intersection Conflict Warning System**: used to provide substantial warnings to drivers at intersections where poor site distance or gap acceptance have contributed to high crash rates.
    - **Lane Change/Merge Warning System**: "These in-vehicle electronic systems monitor the position of a vehicle within a roadway lane and warn a driver if it is unsafe to change lanes or merge into a line of traffic.
    - **Pedestrian Collision Warning**: This type of system can "provide warnings to transit vehicles of a pedestrian's presence in the roadway—either in a crosswalk or outside of the crosswalk.
10. **Lane Control Technologies (LCTs):** This concept consists of using a general-purpose lane that can be changed to a bus-only lane just for the duration of time needed for the bus to pass. Afterward, the lane reverts back to a general-purpose lane until another approaching bus needs the lane for its movement.

3.3.2 Traveller Information

The following are various ITS technologies that can be adopted to give information to Travellers under APTS:

1. **Automatic Voice Announcements (AVAs):** An AVA system provides audio and visual announcements to on-board riders and those waiting to board. As each fixed-route vehicle approaches a stop or other designated location, a digitally recorded announcement is automatically made over the on-board public address (PA) system

speakers and displayed on dynamic message signs (DMS) inside the vehicle to inform passengers about upcoming stops, major intersections, and landmarks.

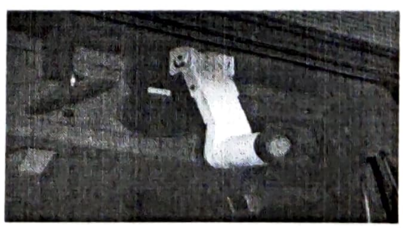
2. **En-route/Wayside Traveler Information:** Today, transit travelers, expect to have comprehensive information about multiple modes available to them quickly, in one place or from one source, on a variety of media and at any point during their trip. Providing static and real-time transit information using new strategies is a priority for many transit agencies around the world. These strategies include the use of en-route/wayside technologies such as the mobile Internet, dynamic message signs (DMS), and wireless mobile devices.
3. **On-board Internet Access:** On-board Internet access is being provided by some transit agencies, particularly on vehicles that service lengthy routes. Some agencies have leveraged on-board communications hardware that provides both data communication for the agency and Wi-Fi for passengers.
4. **Third-party smartphone applications:** Several third party apps provide transit information, including Google Transit, Apple Maps, Maps.Me, etc. Google Transit is a web-based application that imports agency data in specific file formats to provide a portal for transit trip planning by the general public using Google Maps.

3.3.3 Safety and Security

The following are various ITS technologies that can be adopted to ensure safety and security of Travellers under APTS:

1. **Mobile (On Board and Exterior) and Fixed Video Surveillance:** One of the two most common safety and security systems among transit agencies are on-board (interior) and exterior cameras. They can be used for the following purposes:
   - Review recorded images
   - Potential crime prevention
   - Identify criminal activity and perpetrator(s)
   - Identify improper driver behavior
   - Incident/insurance investigation

   Some digital video systems allow authorized users to access the systems via Wi-Fi. This allows these users, such as police or transit supervisors, within a certain range of the transit vehicle, to view what is occurring inside the bus by accessing images from video cameras during an incident.



2. **Covert Emergency Alarm and Covert Live Audio Monitoring:** Covert microphones and other security technologies are also being heavily deployed along with new AVL/CAD systems.The purpose of a covert microphone is to allow the dispatchers to listen in on what is going on inside the vehicle while an incident is taking place. Covert

microphones are one-way communications in order not to alert the person responsible for the incident that the dispatcher/police are listening in.

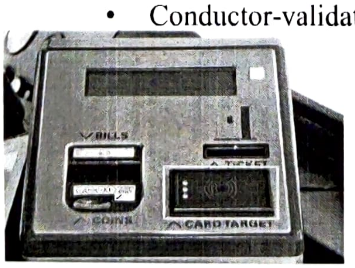
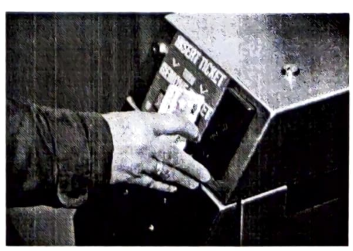
3. **On-board Digital Video Recorders (DVRs):** DVRs are connected to on-board cameras to record images from the cameras. DVRs are equipped with a recording drive. The DVR may have the capability to use Wi-Fi to upload video once the vehicle enters the yard or garage. This allows authorized transit personnel to request video from a specific transit vehicle to review incidents, customer concerns, or for investigations.

3.3.4 Automated Fare Payment

The following are various ITS technologies that can be adopted to reduce delay in ticketing to Travellers under APTS:

1. **Automated Fare Media:** There are currently three basic types of electronic fare technologies that have been used for transit purposes: magnetic stripe cards, smart cards, and mobile payment. Transit agencies are implementing QR code and [Near Field Communication] NFC mobile platforms for transit payments. Mobile ticketing apps using visual and QR code validation are software-based and relatively easy to deploy. Choice of a particular technology can affect both the efficiency of the fare collection functions and the range of feasible payment options. Automated fare payment provides convenience for the customer in terms of payment options, but also benefits customers by speeding the fare payment process, thus reducing queuing time and resulting in less time for the transit vehicle to remain stopped. The less time stopped boarding customers, the better the chance of an on-time service delivery. Further, automated fare payment reduces the cost of fare collection for a transit authority. Cash fares normally involve tokens, coins, and small bills. This results in high fare collection processing cost due to the relatively small value but high-volume transactions.


2. **Automated Fareboxes and Faregates:** Automated fareboxes and faregates are integral parts of automated fare collection systems. There are four types of fare collection, two of which use fareboxes and faregates, as follows:
   - Barrier
   - Pay on boarding
   - Self-service/barrier-free or proof of payment (POP)
   - Conductor-validated

3. **Ticket Vending Machines (TVMs):** TVMs are used by many transit agencies to dispense various types of fare payment media. The types of transactions that can be performed by TVMs are as follows:
    - Accept coins only
    - Accept bills and coins
    - Accept credit cards
    - Accept debit cards
    - Make bill change
    - Accept tokens
    - Accept paper coupons
    - Validate vouchers
    - Reload smart cards

3.3.5 Maintenance

The following are various ITS technologies that can be adopted to Fleet under APTS:

1. **Engine and drivetrain systems monitoring (aka Vehicle Component Monitoring):** In-vehicle diagnostics system that monitors conditions of transit vehicle components, especially the engines, and provides failure warnings. This system includes software that manages the maintenance records of each transit vehicle and parts inventories. This type of system is also known as Vehicle Component Monitoring [VCM], Automatic Vehicle Monitoring, and Maintenance Tracking. A VCM system, which can be a key component of a maintenance management system, is a set of sensors that monitor various components of the vehicle and report back on components performance.

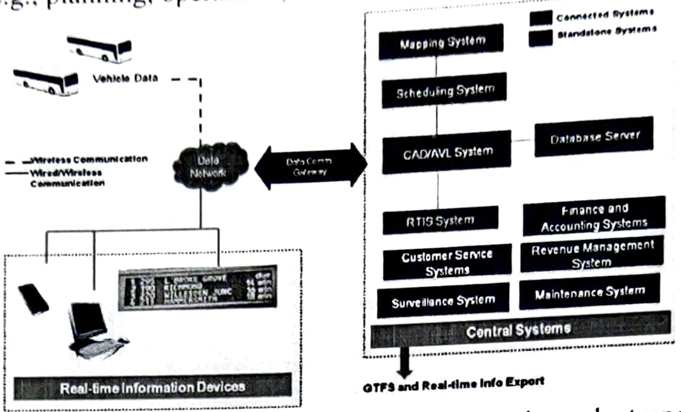
2. **Maintenance software** to schedule and track scheduled and unscheduled maintenance activities, and manage parts inventory

3.3.5 Other

The following are various ITS technologies and systems that do not fit into the categories as above:

1. **Data Management:** Public transit ITS components installed in vehicles, at central locations, or at other locations (e.g., stops and shelters) generate an enormous amount of data typically collected and archived in the individual databases of systems that generate the data indicated in Figure below. The extent of field data collected on-board vehicles depends on the configuration of the ITS systems and subsystems on vehicles or at other locations. Once the ITS data is archived, it is used for a variety of "after-the-

fact" analyses and reporting by different business units within a public transport organization (e.g., planning, operations, customer service).



2. **Technology Integration:** Many transit ITS technologies are dependent upon each other to function. Further, there are opportunities for technologies to be integrated with systems that are external to a transit agency, such as a regional traffic management center or an information services provider. Thus integration, when implemented from an enterprise-wide perspective and a regional perspective, improves the overall usability of a technology environment made up of products from many different vendors. Integration is also valuable to transit ITS in that it facilitates a 'system' of interconnected ITS applications that collectively produce services and advantages far greater than the ITS applications could achieve independently.
3. **Geographic Information Systems (GIS):** GIS are computer software programs that provide database management capabilities for the display and editing of geographically referenced entities and underlying attribute data. Databases most relevant to transit are streets and highways, operational facilities, layover locations, passenger facilities including multimodal centers, bus stops and shelters, designated transfer points, and major landmarks. GIS provides the ability to perform analyses of geographic features such as point databases (bus stops, communications transmitters, customer facilities), lines (streets, bus routes, subway tracks, rights-of-way), and areas (census tracks, census blocks, traffic analysis zones, zip codes). These analyses can combine multiple geographic layers to answer such questions as how many transit dependent households are located in a selected census tract of a county or to identify locations where communications should be provided in languages other than English.
4. **Service Coordination Facilitated by Technology:** The use of technology to facilitate the coordination of transportation services has been the focus of the Mobility for every citizen. Conducting the foundation research that identifies the most appropriate technology to facilitate the development of transportation management coordination centers (TMCCs) and to develop a Concept of Operations is the main goal.
5. **Open Data:** The process for agencies to provide open data includes exporting their data in acceptable formats. Many agencies create a license agreement or terms of use to govern how data can be used by developers. Finally, agencies need to keep developers aware of changes to schedule data and other pertinent information so third-party applications are providing accurate information.

3.4 ITS and regional Planning

The **Regional Transportation Plan (RTP)** is a long-term blueprint of a region's transportation system. Usually RTPs are conducted every five years and are plans for thirty years into the future, with the participation of dozens of transportation and infrastructure specialists. The plan identifies and analyzes transportation needs of the region and creates a framework for project priorities. Factors considered in Development of RTP are:

- Support the economic vitality of the area, especially by enabling global competitiveness, productivity, and efficiency
- Increase the safety of the transportation system for motorized and non-motorized users
- Increase the security of the transportation system for motorized and non-motorized users
- Increase the accessibility and mobility of people and for freight
- Protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and State and local planned growth and economic development patterns
- Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight
- Promote efficient system management and operation
- Emphasize the preservation of the existing transportation system.

3.4.1 Goals and Objectives

Goals generally define a desired result, or outcome, while objectives support a specific goal and provide additional details, or strategies, on how the goal will be achieved. Below are the goals and objectives used by planning agencies to develop RTP:

Goal 1: Improve mobility for all people

- Objectives
  - Improve connectivity across multiple modes including vehicular, transit, bicycle, pedestrian, and air
  - Promote equity of all people independent of age, race, ethnicity, economic status, and physical ability
  - Explore using innovation and technology when appropriate
  - Create and implement context-sensitive design standards.

Goal 2: Enhance quality of life

- Objectives
  - Improve the safety of all users of the system for all modes of travel
  - Maintain the cleanliness and good repair of transportation infrastructure
  - Prioritize transportation projects that enable active, healthy communities
  - Use transportation infrastructure to help create attractive communities
  - Prioritize environmentally sustainable projects using a sensible, balanced approach
  - New projects should respect the character and plans of cities, neighborhoods, and adjacent communities.

Goal 3: Improve economic vitality

- Objectives
  - Improve access to jobs for both residents and employers in region
  - Improve access to education for all students within the region
  - Provide for the efficient movement of goods by both rail and truck
  - Maintain and enhance real estate values across the region
  - Allow for balanced and equitable growth
  - Strengthen the connection between transportation and land use.

Goal 4: Focus on implementation

- Objectives
  - Fund and maintain the existing transportation system adequately
  - Select new projects that can be efficiently maintained
  - Prioritize projects into multiple tiers by recognizing the limited funding currently available and preparing for possible additional sources
  - Identify new sources of funding to grow local transportation dollars
  - Support a renewed trust in elected leaders and public confidence in the process through transparency, open communication, and collaboration across agencies
  - Encourage strong community engagement in the planning process and in the County's future growth and development.

3.4.2 Key Principles

The following are principles that should be adopted in Regional Transportation Planning

Principle 1: Transportation facilities and services are well maintained

Principle 2: Transportation facilities and services enhance mobility within and between areas, making services and opportunities more accessible

Principle 3: Transportation facilities and services support the metropolitan area's existing and future economy

Principle 4: Transportation facilities and services promote safe travel

Principle 5: Transportation facilities and services support local, regional, state, and national security

Principle 6: Transportation decisions and resource impacts are integrated

Principle 7: Travelers are provided multiple mobility options

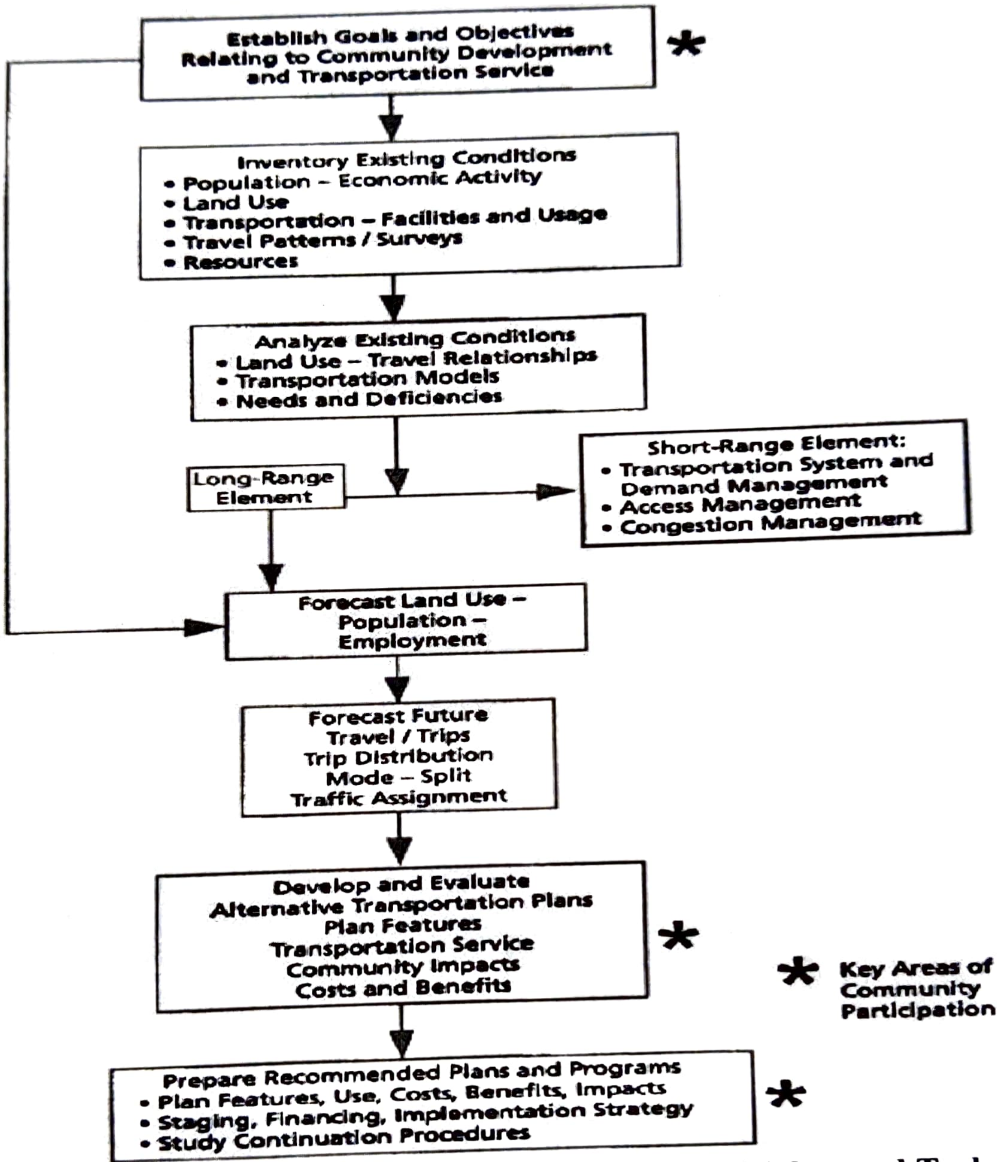
Principle 8: Transportation infrastructure and service development, system expansion, system maintenance, and system operations are adequately provided

3.4.3 Transportation Planning Process

Transportation planning helps in shaping a well balanced transportation system that can meet future demands. Transportation planning is an iterative process which include problem identification, solution generation, analysis, evaluation and implementation. This can be integrated with ITS using computers, communication systems and software. As planning is normally made for long period, installing ITS facilities needs to be updated and one should ensure that the equipments and technologies are compatible for future improvement and expansion. The steps in traditional transportation planning are as follows:

1. Establish goals and objectives
2. Inventory existing conditions

3. Analyze existing conditions
4. Long range/ short range element
5. Forecast land use, population/employment
6. Forecast future travel/trips
7. Develop and evaluate alternative transportation plans
8. Prepare recommended plans and programs



3.4.5 Relation between Problems, Conventional Approach and Advanced Technology Approaches

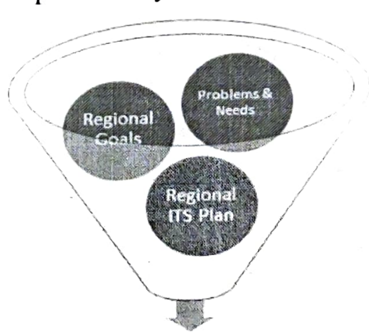
ITS transportation planning process differs from the traditional transportation planning process. ITS has the unique capability to integrate different modes of transportation such as public auto, transit, and infra-structural elements through communications and control. The multi-modal integration potential provides a great opportunity for planning across modes. The comparison between ITS approach and conventional approach for solving various transportation problems are shown for few problems are shown in table.

Problem	Solutions	Conventional Approach	Operational Approach with ITS	Supporting ITS Components	Considerations
Traffic Congestion	C Increase roadway throughput	C New roads C New lanes	C Advanced traffic control C Incident management C Corridor management C Advanced vehicle systems	C Surface street control C Traveler information C Real-time toll/parking fee management C Regional traffic control C Railroad operations coordination	*Conventional and Advanced-* C Environmental considerations C Land use & community needs *Advanced-* C Near-term services yield modest benefits C Interjurisdictional issues
	C Increase passenger throughput	C HOV lanes C Carpooling C Fixed route transit	C Real-time ridematching C Integrate transit & feeder services C Flexible route transit C New personalized public transit	C Real-time ridesharing C Multi-modal coordination C Demand response transit operations	C Privacy & personal security
	C Reduce demand	C Flex time programs	C Telecommuting C Transportation pricing	C Real-time toll/parking fee management	C Amount of non-discretionary travel
Lack of Mobility & Accessibility	C Provide user friendly access to quality transportation services	C Expand fixed route transit & paratransit services C Radio & TV traffic reports	C Multi-modal pre-trip & en route traveler information services C Real-time response to changing demand C Personalized public transportation services C Enhanced fare card	C Interactive traveler information C Demand-response transit operations C Transit passenger & fare management	*Conventional-* C Declining ridership *Advanced-* C Interjurisdictional cooperation C Equitable access to information
Disconnected Transportation Modes	C Improve intermodality	C Construct inter-modal connections	C Regional transportation management systems C Regional transportation information clearinghouse C Disseminate multi-modal information pre-trip & en route	C Regional traffic control & information sharing C Multi-modal coordination C Interactive traveler information	*Conventional-* C Often slow to adopt change *Advanced-* C Existing system incompatibilities C Standards
Budgetary Constraints	C Use existing funding efficiently	C Existing funding authorizations & selection processes	C Public-private partnerships C Barter right-of-way C Advanced maintenance strategies	C Transit maintenance	C Market uncertainties make private sector cautious C Telecommunications deregulation makes right-of-way barter a near-term opportunity
	C Leverage new funding sources		C Increased emphasis on fee-for-use services		C Equity
Transportation Following Emergencies	C Improve disaster response plan	C Review & improve existing emergency plans	C Establish emergency response center C Internet with law enforcement, emergency units, traffic management & transit	C Emergency response C Incident management C Emergency routing	C Conventional interagency coordination challenges C Advanced interagency coordination issues C Standards
Crashes, Injuries, & Fatalities	C Improve safety	C Improve roadway geometry & sight distances C Grade-separate crossings C Driver training C Sobriety check points C Install street lights C Reduce speed limits C Post warnings in problem areas	C Partially & fully automated vehicle control systems C Vehicle conditions monitoring C Driver condition monitoring C Driver vision enhancement C Advanced grade-crossing systems C Automated detection of adverse weather & road conditions, vehicle warning, & road view notification C Automated emergency notification	C Intersection collision avoidance C Vehicle safety monitoring C Driver safety monitoring C Driver visibility improvement C Advanced railroad grade crossing C Network surveillance C Traffic information dissemination C Mayday support	*Conventional and Advanced-* C High costs C Human error is primary cause of accidents *Advanced-* C Mixed results for initial collisions warning devices C Tort liabilities issues hinder innovative deployments

3.4.6 Regional ITS Architecture

Rapid advances in information processing and communications technology have created new opportunities for transportation professionals to deliver safer and more efficient transportation services and to respond proactively to increasing demand for transportation services and mounting customer expectations. However, many of these new opportunities are predicated on effective coordination between organizations—at both an institutional and a technical level. To encourage this coordination, the development of National ITS Architecture and related tools to help identify and exploit these opportunities for cost-effective cooperation becomes very much essential.

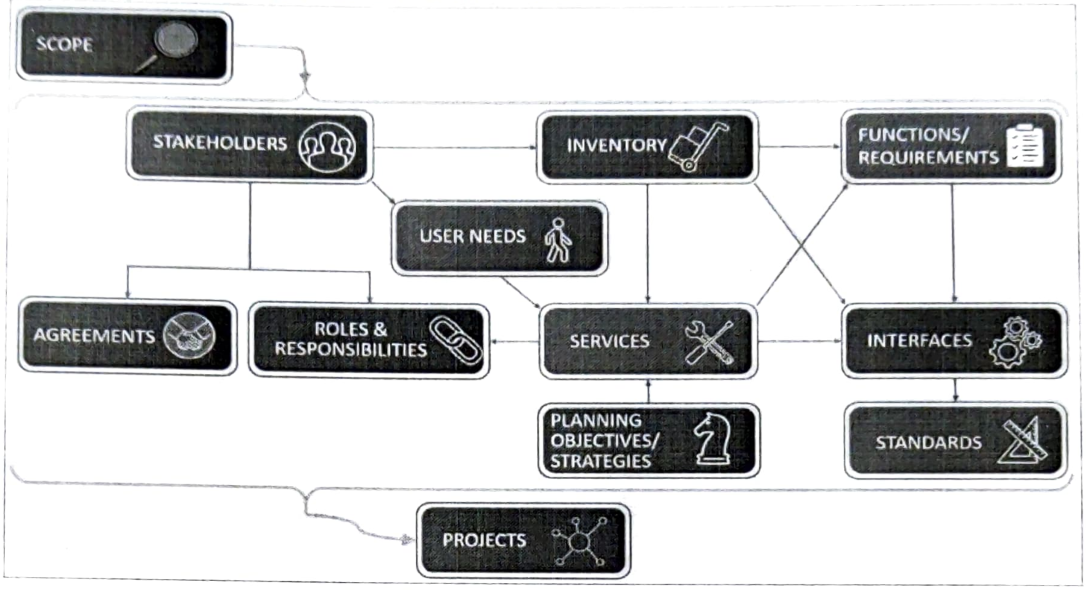
A National ITS Architecture is a useful tool for integrating ITS into the traditional planning process. Regional ITS Architecture is defined as a regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects in a region. Typically, a region contains multiple transportation agencies and jurisdictions. These may have both adjoining and overlapping geographies, but all of the agencies have a need to provide ITS solutions to transportation problems such as traffic congestion and safety hazards. The purpose of developing a regional ITS architecture is to foster regional integration so that planning and deployment can proceed in a coordinated and organized manner. Regional integration allows for the coordination of activities and sharing of information among different transportation systems to efficiently and effectively operate.



Integrated ITS Projects for Your Region

Regional integration also has a synergistic effect in that information from one system may be used by another system for another purpose, reducing the need for redundant systems. A regional ITS architecture illustrates this integration and provides the basis for planning the evolution of existing systems and the definition of future systems that facilitate the integration over time. This regional integration can only take place with the participation and cooperation of the organizations within a region. These stakeholders must work together to establish a regional ITS architecture that reflects a consensus view of the parties involved. A regional ITS architecture's most important goal is institutional integration; providing a framework within which regional stakeholders can address transportation issues together. **A strategic plan** is a road map for implementing a system of strategies over a period of time. It provides a starting point for bringing ITS projects and systems together into an integrated plan, and identifying transportation related needs that can be addressed by ITS applications within the context of a systematic approach.

3.4.7 Components of Regional ITS Architecture

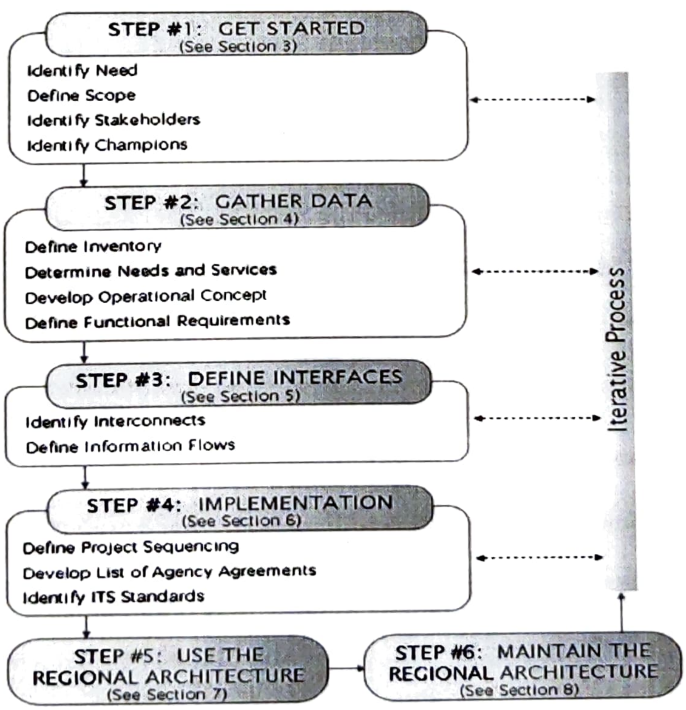


The components that make up an architecture include:

- **Architecture Scope**: Architecture Scope provides a description of the region for which an ITS architecture is developed. There are three dimensions to the scope: geographic, time horizon, and scope of services.
- **List of Stakeholders**: Stakeholders are the agencies and organizations that own, operate, maintain or use the ITS systems in the region as well as other agencies/ authorities/ other-entities that have an interest in regional transportation issues. This includes both public and private organizations.
- **Connection of architecture to Regional Planning Goals, Objectives, and Strategies**: Transportation planning considers changes to be made to a region's transportation network in order to address regional needs. These needs are expressed by a set of goals, objectives or strategies
- **Inventory of ITS Elements**: ITS Elements are the systems, devices, or equipment, that provide ITS services or share information as part of the ITS services. An inventory also includes non-ITS elements that provide information to or get information from the ITS elements. A comprehensive inventory of "ITS elements" is one of the key building blocks for a regional ITS architecture that represent these systems.
- **Regional ITS Services**: ITS services are transportation services performed using ITS elements that are deployed to meet the region's operational goals and objectives. In a regional ITS architecture service packages are used to identify the pieces of the architecture that are required to implement a particular ITS service.
- **User Needs**: A user need is a capability that is identified to accomplish a specific goal or solve a problem that is to be supported by the system

- **Operational Concept (Stakeholders' Roles and Responsibilities):** Typically, in transportation stakeholders own, develop, operate, or maintain portions of the transportation system. Responsibilities cover activities that the stakeholders engage in as they perform their roles.
- **System Functions and Requirements:** Functional requirements are a high-level description of the required functionality for each ITS element to provide the ITS services that have been identified for the region. They describe WHAT a system must do to provide the ITS services. In a regional ITS architecture, the functional requirements focus on the highlevel requirements that support regional integration.
- **System Interfaces Supporting the Services:** Interfaces include the electronic exchange of information between ITS elements.
- **Communications and Device Standards**: ITS standards are documented technical specifications sponsored by a Standards Development Organization (SDO) to be used consistently as rules, guidelines, or definitions of characteristics
- **Interagency Agreements to support ITS services and projects**: To deploy the services and projects defined in the architecture, agreements between stakeholders may be required especially when inter-jurisdictional interfaces are involved.
- **Sequence of Regional ITS Projects:** Project sequencing is defined as any relevant ordering of the projects in order to contribute to the integrated regional transportation system depicted in the regional ITS architecture.

3.4.8 Regional ITS Architecture Development, Use, and Maintenance



The following are the steps in Development, Use, and Maintenance Regional ITS Regional ITS Architecture:

i. **Get Started:** The regional ITS architecture effort begins with a focus on the institutions and people involved. Based on the scope of the region, the relevant stakeholders and one or more champions are identified, the team that will be involved in architecture development is organized, and the overall development effort is planned.

ii. **Gather Data:** Once the stakeholders are involved and a plan is in place for assembling their input into a consensus regional ITS architecture, the focus shifts to the ITS systems in the region. At this step, the existing and planned ITS systems in the region are inventoried, the roles and responsibilities of each stakeholder in developing, operating, and maintaining these ITS systems are defined, the ITS services that should be provided in the region are identified, and the contribution that each system will make to provide these ITS services is documented.

iii. **Define Interfaces:** Once the ITS systems in the region are identified and functionally defined, the existing and planned interfaces between these systems are defined. First, the connections (or "Interconnects") between systems are identified, and then the information that will be exchanged on each of the interfaces is defined.

iv. **Implementation:** Once the system interfaces are defined, additional products can be defined that will guide implementation of the projects that will flow from the regional ITS architecture. These include a sequence of projects, a list of needed agency agreements, and a list of standards that can be considered for project implementation.

v. **Use the Regional ITS Architecture:** The real success of the regional ITS architecture effort hinges on effective use of the architecture once it is developed. The regional ITS architecture is an important tool for use in transportation planning and project implementation. It can identify opportunities for making ITS investments in a more cost-effective fashion. This step is where the benefits are realized.

vi. **Maintain the Regional ITS Architecture:** As ITS projects are implemented, new ITS priorities and strategies emerge through the transportation planning process, and the scope of ITS expands and evolves to incorporate new ideas, the regional ITS architecture will need to be updated. A maintenance plan is used to guide controlled updates to the regional ITS architecture baseline so that it continues to accurately reflect the region's existing ITS capabilities and future plans.

3.4.9 Challenges to Agencies

Integrating ITS into transportation planning process require overcoming some obstacles and some changes in the business practices of many institutions. The major challenges in mainstreaming ITS into everyday operations of transportation agencies are:

- Institutional coordination and cooperation for sharing information and data
- Technical compatibility among ITS projects

- Human resource needs and training
- Financial constraints and opportunities to involve the private sector.

The Intelligent Transportation System Deployment Analysis System (IDAS) developed by U.S. Department of Transportation (DOT) is one of the useful tool for integrating ITS in the traditional transportation planning framework.

~&$#END#$&**~**

Note: Refer Textbooks.