

**Public Transport and Complementary Services**

**The Role of ITS in Public Transport**

**The World Bank**   **Australian Government AusAID**   **ESMAP** Energy Sector Management Assistance Program   **PPIAF** PUBLIC-PRIVATE INFRASTRUCTURE ADVISORY FACILITY

Cluster 4/Module 2 (C4/M2): The Role of ITS in Public Transport.

This presentation is one of the support materials prepared for the capacity building program **Building Leaders in Urban Transport Planning (LUTP)**.

Support for LUTP was provided by:

- The World Bank,
- Australian Agency for International Development Aid,
- The Energy Sector Management Assistance Program (ESMAP), and
- Public-Private Infrastructure Advisory Facility (PPIAF) .



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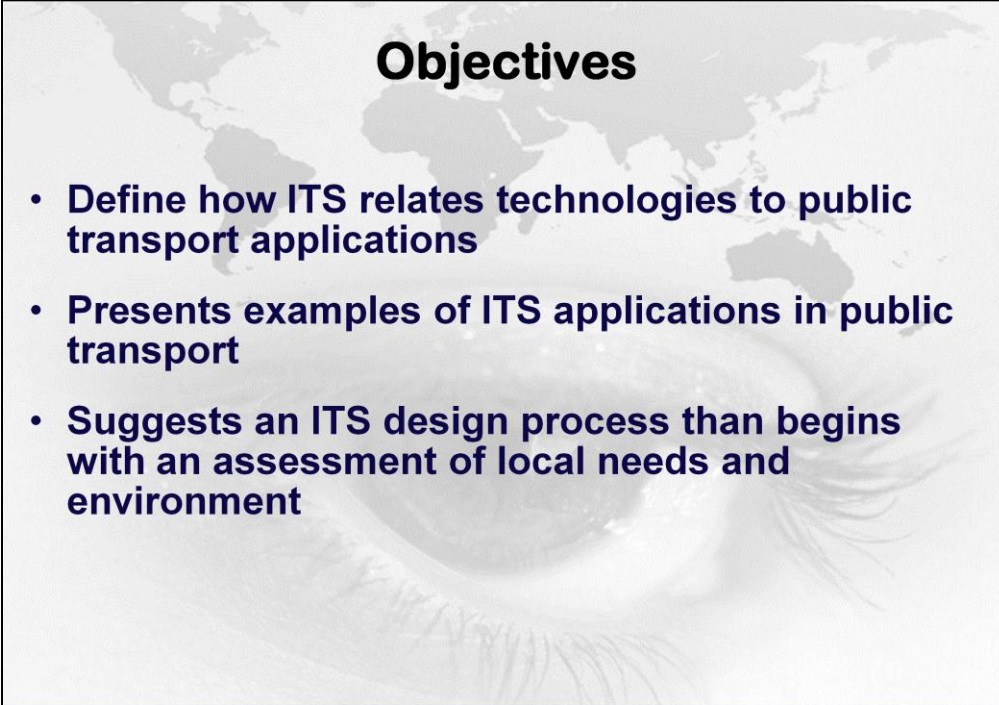
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## Objectives

- Define how ITS relates technologies to public transport applications
- Presents examples of ITS applications in public transport
- Suggests an ITS design process than begins with an assessment of local needs and environment

**LUTP** The Role of ITS in Public Transport (C4/M2) 2

This presentation provides an overview of the applications of Intelligent Transport Systems (ITS) technologies to public transport. The presentation first defines ITS by relating ITS technologies to relevant public transport applications.

The presentation then discusses some examples of ITS technologies in four application areas — management and operations, vehicle priority, safety and security, and customer service.

Finally, the presentation suggests an ITS design process than begins with an assessment of local needs and environment.



## Opening Exercise The Situation



- **Rapidly growing city**
  - **Population and employment**
  - **Increasing incomes and resulting motorization**
  - **Increasing congestion**
- **Public transport system**
  - **Operates 2,000 buses, 5 maintenance facilities**
    - **Changing buses in fleet**
      - From all diesel, high floor, front engine, 10.5 meter
      - To mix of current buses and CNG, low floor, 10-12 meter, rear-engine
    - **Concerned about staffing**
      - About 6 employees per bus (above average)
      - Have trouble finding trained drivers, mechanics, supervisors
  - **Must address service challenges**
    - Revenue speeds low, dropping on existing routes
    - Expanding to serve newly urbanizing area

The purpose of this exercise is get you thinking about how advanced technologies can help public transport systems improve their operations and meet the challenges of rapid growth.

Lets us think about a common scenario in developing countries.

The situation is a rapidly growing city that faces the problems of increasing motorization and congestion.

The public transport system operates 2,000 buses from 5 maintenance facilities. It has several challenges.

One challenge is that the system moving away from a fleet of high-floor, diesel buses to a mix of buses that includes low-floor, CNG buses.

Another challenge is employee staffing. The system has a high number of employees per bus. At the same time, it has trouble finding trained operating employees

The system also faces service challenges. Revenue speeds continue to drop on existing routes. The system must expand service to newly-developing areas.

## Opening Exercise Customer Satisfaction is Low



- **Key customer issues (survey)**

- **Low speed, reliability**

- **Crowding**

- **Inconvenient**

- **Too much waiting, transferring**

- **Travel to employment, shopping in outer areas requires using several bus routes**



- **Low satisfaction main reason system losing increasing amounts of money**

- **Management opinion**

In spite of the system's effort, customer satisfaction is low.

A recent survey found that the majority of customers feel that the bus system is slow, unreliable, and crowded.

Most customers feel that the service is inconvenient with too much waiting and transferring. Although fringe area employment and shopping are served, the trips are long and require several transfers.

Most managers feel that the low customer satisfaction is the main reason that the system is losing increasing amounts of money.

## Opening Exercise Questions



- **What are the management and operations challenges faced by the executives of the public transport company?**
- **How could advanced technologies help meet these challenges?**



Thinking about this common scenario, please answer the following questions:

What are the management and operations challenges faced by the executives of the public transport company?

How could an advanced technologies help meet those challenges?

Please spend about 5 minutes on these questions.

## What is ITS?

- **Intelligent Transport Systems**
- **Key elements**
  - **Support public transport applications**
    - Management and operations
    - Vehicle priority
    - Safety and security
    - Customer service
  - **Use advanced information, communications technologies**
- **Objectives of ITS**
  - **Improve transport efficiency, effectiveness**
  - **Make services more user-friendly**



ITS is the acronym for Intelligent Transport Systems. Intelligent Transport Systems are a suite of applications used to support the planning, operations, and management of public transport services. Examples of these applications are monitoring of driver schedule adherence, fare collection, provision of vehicle priority, security surveillance, and the provision of schedule information to the public.

ITS applications use advanced information and communications technologies. These technologies take advantage of recent advances in computerization and communications. They often use multiple data sources, mostly in real time, to make improvements. Examples of ITS technologies are automatic vehicle location, electronic fare collection, and “next-bus” displays at bus stops.

ITS applications benefit operators, public transport authorities, and passengers. Many applications improve the efficiency and effectiveness of specific functions within a public transport company such as fare collection, management of street operations, and security monitoring. Other applications make public transport services more user-friendly by providing better service information to passenger as they travel on their journeys.

Let us now discuss some examples of ITS technologies in four application areas:

- Management and operations
- Vehicle priority
- Safety and security
- Customer service

## Improving Management and Operations Applications through ITS



**Driver/crew/service management**



**Monitoring vehicle condition**



**Fare collection**

The first application area is management and operations applications.. We are going to look at three areas that can be improved through ITS :

- Driver/crew management
- Monitoring vehicle condition
- Fare collection

## Driver/Crew/Service Management

- **Applications**
  - Prepare service schedule
  - Develop vehicle, driver assignments
  - Manage dispatching of vehicles, drivers
  - Monitor service, supervise drivers
  - Record vehicle, driver statistics
- **Management information produced**
  - Schedule effectiveness and efficiency
    - KM/vehicle, scheduled pay per service hour
    - Riders/KM, crowding
  - Dispatching, supervision efficiency
    - Missed trips, pay per service hour
    - On-time performance



Driver (crew) and service management is concerned with developing and implementing an efficient daily service schedule. This process involves the following activities:

- Developing a passenger timetable that meets existing or projected passenger demands
- Preparing efficient work schedules of vehicles and drivers to operate all trips
- Daily assigning specific vehicles and drivers to the work schedules
- Monitoring the on-time performance of the operation of the daily trips
- Recording daily vehicle statistics and driver work hours for payroll

Management needs information to assess the schedule and dispatching efficiency in the following ways:

- Do we have an effective schedule that provides service that meets passenger demand? This can be assessed using measures related to overall productivity (e.g., riders/km) and crowding (e.g., maximum number of passengers on a bus at any point on a route).
- Are we efficiently assigning vehicles and drivers to provide this service? This can be evaluated by looking at scheduled pay per hour of service operated.
- Are we efficiently dispatching drivers and vehicles? This can be reviewed by looking at the number of missed trips and the actual pay made to drivers per service



## Slide 8

hour

- Are we operating on-time? This can be determined by comparing the actual with scheduled arrival and departure time



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## Driver/Crew/Service Management ITS Technologies

- **Software**
  - “Complete” scheduling software
    - Timetable building, vehicle/driver assignment
  - Dispatching software
    - Assignment of vehicles, drivers
    - Real-time trip dispatching
- **Automatic vehicle location (AVL) systems**
  - GPS
  - In-pavement loops



The key ITS technologies are software (used for scheduling and dispatching) and automatic vehicle location systems (AVL).

A complete scheduling software package can produce passenger timetables and vehicle and driver work assignments. It should provide output that can be used by other programs:

- Timetable information for delivery of passenger information.
- Vehicle and driver work assignments for dispatching

Dispatching software can automate the daily assignment of vehicles and drivers. It should provide data that can be used for preparing driver payrolls.

AVL systems are critical for real-time monitoring of service performance. AVL systems also provide data for building improved schedules that meet passenger demands and provide on-time service.

## Remote Vehicle Monitoring

- **Application**
  - **Continuously monitor critical vehicle functions**
    - e.g., temperature, oil, fuel
- **Management information produced**
  - **Performance of vehicle systems**
- **ITS Technologies**
  - **On-board diagnostic system**
    - Computerized sensors monitoring critical vehicle functions
    - Data recording, transfer
  - **Communication system**
    - Radio
    - AVL



ITS technologies have also been applied to vehicle performance monitoring. It is important to monitor critical vehicle functions such as engine temperature, oil pressure, fuel levels, and tire pressures. Generally, this has been a driver responsibility. However, drivers have many operating responsibilities and sometimes fail to notice changes in these functions or take appropriate actions.

New transport vehicles now have on-board diagnostic systems that monitor and provide warnings when critical functions start to fail or are close. These systems can be integrated with radio or AVL systems to provide remote monitoring of these functions. This can increase timely and appropriate responses to the functional warnings. It also creates an electronic database of vehicle system failures that can be analyzed by maintenance managers.

## Fare Collection

- **Applications**
  - Calculate fare for specific trip and user
  - Collect fare
  - Record transaction
- **Planning, Management information produced**
  - Breakdown of fare revenues and trips, by
    - Route
    - Boarding (alighting) location
    - Travel by time-of-day
    - Origin-destination flows
    - Number of customers by fare category



Fare collection is important to both users and transport managers. Users want to be able to quickly calculate and pay their fares. Transport managers want revenue control — monitoring to insure that the correct fares are charged and that no revenue is lost between fare payment and the deposit of fares into a bank.

For revenue control, transport managers need detailed reports on daily travel by route, time-of-day, and user categories. This information provides a comparison of the following:

- The revenue should have been collected based on the numbers of passengers carried and
- The revenue that was actually collected.

These data are also a useful base data for planning new fare plans and new service changes.

## Fare Collection ITS Technologies

- **Integrated circuit (IC) card systems**
  - **Commonly used**
- **Mobile phones**
  - **Emerging technology**
- **Automatic vehicle location (AVL) systems**

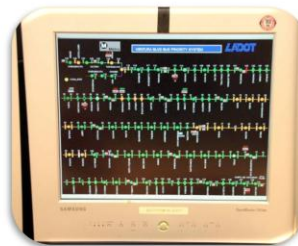


ITS technologies offer improvements in three areas of fare collection.

1. **Integrated circuit card systems (IC).** IC are becoming a standard ITS approach in many systems. The IC card is “charged” by the user with a certain money value. The card is read by an electronic reader and the fare is deducted from the card. Generally, this is done through radio-frequency induction which means that the card only needs to be close to the reader to work. The benefits of the IC cards are user convenience and much quicker processing of fare payments. The quicker processing time can mean that travel speeds will increase since less time will be spent at transport stops.
2. **Mobile Phones.** Some phones now have applications which function like IC cards.
3. **Automatic Vehicle Locations (AVL) systems.** AVL systems can be integrated with electronic fare boxes to transmit fare payment data by location and time-of-day.

## Vehicle Priority

- **Application**
  - **Changes traffic signal programs to favor surface public transport vehicles at junctions**
- **Management information produced**
  - **Delay times at junctions**
  - **Number of priority events**



Let us now move from management and operations to vehicle priority. Vehicle priority is relatively new concept for improving transport speeds and reliability.

Junctions with heavy cross traffic can delay and slow down transport vehicles. Vehicle priority systems change the green and red light phases at the junctions to favor transport vehicles. This is done for an approaching transport vehicle by either:

- Extending the green phase or
- Shortening the red phase.

Data are needed to monitor priority needs and make improvements. The data needed are delay times and number of priority events at the junctions. A priority event occurs when a traffic light phase is changed to help a transport vehicle.

## Vehicle Priority ITS Technologies

- Automatic vehicle tracking (AVL) systems
- Vehicle priority software
- “Smart” traffic signal controllers



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Vehicle priority systems require three ITS components.

First, an automatic tracking system is needed to determine when a transport vehicle will arrive at a junction. An AVL system is the best form of tracking system although other approaches can be used such as infra red detection signs.

Second, software is needed to determine how much the green time should be extended or the red time shortened for the oncoming transport vehicle.

Finally, a smart traffic signal controller is needed to accept the changes from the priority software.

The implementation of vehicle priority requires coordination between the transport system and the government traffic authorities. This coordination is as important as the ITS technologies themselves.



## Passenger Safety and Security

- **Applications**
  - Continuously monitor activity on vehicles and at stops, stations, and terminals
  - Respond to incidents
  - Investigate, analyze incidents
- **Management information produced**
  - Incident numbers, types
  - Passenger counts
  - Speed profiles



A third general application area is safety and security. Safety and security is a concern to all passengers, but particularly for young passengers, old passengers, and female passengers.

Transport systems have incident response and post-incident investigation responsibilities. In real-time, a transport system should monitor and respond to incidents on vehicles and at stops, stations, and terminals.

After incidents occur, the transit systems should investigate each incident to assess causes and responsibilities, and, as appropriate, take corrective actions. Periodically, the systems should analyze incident trends to determine if corrective actions should be taken such as employee training or physical changes to the vehicles or passenger waiting areas.

Transport managers need detailed information about each incident to make these assessments.



## Passenger Safety and Security ITS Technologies

- Continuously recording cameras
  - Real-time communications
  - Data storage
- Automatic vehicle location (AVL) systems
- Silent alarms



Recent advances in ITS technologies have improved safety and security management. Some systems use continuously-recording cameras to monitor and respond to incidents on vehicles and at stops, stations, and terminals. After incidents occur, the transit systems can review the recordings of each incident to assess causes and responsibilities, and, as appropriate, take corrective actions.

AVL systems are needed to effectively identify and respond to incidents that occur on vehicles.

In some systems, transport drivers and station attendants have silent alarms for alerting law enforcement officers of security incidents.

These alarms are sometimes provided in metro trains for passenger use in cars that do not have operating personnel. Often the first car has an operator. However, the trailing cars often do not have any operating personnel.

## Passenger Information

- **Applications**
  - **Provide routes/schedules/fare information**
    - System wide, specific trip (e.g., O-D, time-of-day)
    - Pre-trip, real-time
  - **Deliver information to customers at different locations**
    - Home, work, in-route at stops, on board
- **Management information produced**
  - **Breakdown of requests for information**



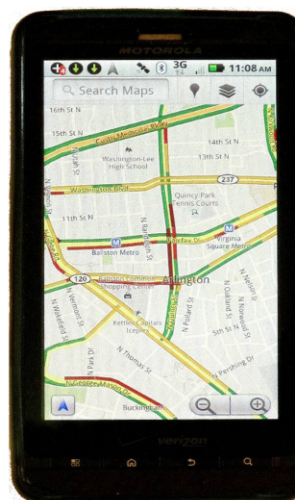
Passenger information is our last general application area. Providing timely public information is important to the success of a transport system. Users need route, schedule, and fare information for the system as a whole to determine when they can consider public transport a travel option. They also need specific trip information when they are planning their trips and as they take them.

A real challenge in providing information to transport users is that the information must be given to users at different locations — at home, at their destination (for example work) and while in-route.

It is also helpful for transport managers to monitor the information flow. Understanding what kinds of information are being requested and where and when the requests are being made is helpful in continuing to manage a successful transport system.

## Passenger Information ITS Technologies

- Trip-itinerary building software
- Real-time vehicle location
  - Automatic vehicle location (AVL) systems
- Information delivery
  - Telephone
  - Internet
  - Smart phone applications
  - Next-bus (train) displays @ stops
  - On-vehicle display, audio systems



ITS technologies offer improvements in three areas of public information.

1. Trip Planning. First, software has been developed to help people plan their trips. Many people have trouble reading transport schedules and route maps. The software asks people to enter their desired destination, as well as desired time frame for beginning and completing their trip. The software tells them how to take the trip, providing such information as routes, stops, and times.
2. Real-time vehicle location. Many users also want to know when the next bus is actually coming to their stop. AVL systems provide this information through the use of radio and GPS technology. AVL has always been a part of signaling systems for modern metro rail systems, but now it is a possibility for bus systems as well.
3. Information Delivery. Technology also improves information delivery. Automated telephone systems, Internet web sites, and smart phone applications are advances from traditional paper schedules. Electronic displays of next-bus (or train) arrivals at the bus stop can soothe anxious passengers and make their trips easier and more enjoyable.

## Needs Analysis Should Guide ITS Design

- **Every local environment is different**
  - **Size of operations**
  - **Size, skills and wages of work force**
  - **Management and operations structure and processes**
  - **Financial resources**
- **ITS involves significant changes**
  - **Business processes of transport operator**
  - **Services offered to customers**
- **Conclusion**
  - **ITS design should meet unique local needs**

The examples that we just discussed suggest the potential of ITS. Now we will discuss how you might design ITS for your system.

A wide range of international experience has shown that there is far more to ITS than just purchasing and installing equipment to support the applications that we just discussed. The experience suggests that ITS systems should be designed to meet the unique needs of a transport operator.

You may ask how can this be true when the ITS application areas that we just reviewed are very common among transit operators.

The answer is that every local environment is different. Operationally, there are differences among transport systems in terms of operation size and modes, facilities, and equipment operated. The capabilities and compensation of the work forces vary. Available financial resources also may be different.

Management and operations structures are generally designed to address these differences. Therefore, while the applications or activities that transport operators conduct may be similar, due to local conditions, the management and operations processes also are different.

For example, one operator may now have a work force with limited skills and a limited budget. This operator may use a low-technology management approach.

In contrast, another operator may have a highly-skilled work force and have a more ample budget. This operator may use a high-technology management approach.

While both operators perform the same basic transport activities, it makes sense that their ITS designs should be different and tailored to their local environments.

This is a needs-based approach. Many systems have failed in their ITS effort by starting with a given ITS



technology and then trying to fit it to their systems.





## Needs Analysis Approach

- **Begin with analysis of how public transport system is managed and operated**
  - **Do not start with a given ITS technology and try to fit to system**
- **Identify applications**
  - **Existing ones that could be improved**
  - **New ones enabled by better information**
- **Evaluate alternative ITS technologies**

What is a general outline of a needs analysis?

It is important to begin the analysis of how the transport system is managed and operated. You should not start with a particular popular ITS technology and try to force-fit it to your business processes.

You next should identify potential application improvements. These applications should not be limited to exiting applications, but new ones that could be implemented using new ITS information. For example, different fare discounts could be offered riders based on how many times they rode in one week. This new application could be made possible through the use of ICC fare cards that provide data on passenger usage.

Finally, you should evaluate alternative ITS technologies and not focus on just one technology approach.



## Design Cautions

- ITS are not an end in themselves.
- ITS will not mend a broken or poorly organized urban passenger transport system.
- ITS only effective where there is willingness to change organizational and operational procedures.

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There are some important cautions that you should consider in the design of ITS:

• **Intelligent Transport Systems are not an end in themselves.** It is important to identify and assess the local environment and operator needs before examining the appropriateness of an ITS-led approach.

• **Intelligent Transport Systems will not mend a broken or poorly organized urban passenger transport system.** ITS can only act to enhance one that is already reasonably effective.

• **Intelligent Transport Systems are only truly effective where there is a willingness to change organizational and operational procedures to take advantage of the opportunities being created.** Using technology to do the same things as before will make little difference to the overall outcome.



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# Passenger Transport ITS Toolkit



- **Presents overview of all aspects of ITS**
- **Offers step-by-guide for ITS development**
  - **Planning**
  - **Design**
  - **Implementation**
- **Provides sequential decision process of 14 questions to help assess ITS needs**
- **Visit: [www.ssatp.org](http://www.ssatp.org) to use the Toolkit**

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The World Bank recently prepared **Passenger Transport ITS Toolkit**. The Toolkit provides key information that will help you understand:

- The basic characteristics of ITS
- How to:
  - Assess the need for potential ITS applications through careful evaluation of public transport planning, management, and operations functions
  - Identify ITS system inputs, outputs, information processing, communications, and system architecture requirements
  - Estimate initial ITS implementation and ongoing operating and maintenance costs, and
  - Estimate potential ITS benefits

It provides a sequential decision process of 14 questions to help you assess the needs of your transport system.

You can access the Toolkit at [www.ssatp.org](http://www.ssatp.org).



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## Summary



- **Public transport service and service delivery can be improved through ITS**
- **ITS development process should begin with assessment of local needs, opportunities**
- **Passenger Transport ITS Toolkit is a valuable resource for ITS planning and design**

This presentation provided a quick overview of ITS applications. A key message is that business processes can be improved through intelligent application of ITS.

Another message is that ITS development process should begin with assessment of local needs, opportunities

Finally, ITS can appear to be confusing area. The Passenger Transport ITS Toolkit is a valuable resource for ITS planning and design.