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Design of Electronic Financial Transaction Using European ITS Framework Architecture (FRAME)

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Abstract: *The potential complexity and size of Intelligent Transport Systems (ITS) required to be implemented through a systems engineering approach based on the use of ITS Architectures. The FRAME Architecture has been created for use as the starting point for any deployment of ITS, and a methodology for its use has been developed. Therefore, this study designed integrated Intelligent Transport System (ITS) solution supporting Electronic Financial Transaction using European ITS Framework Architecture (FRAME) Browsing Tool. The system enables the Human Machine Interface (HMI) to present the traveller with information about the different types of services available, and record the choices that travellers make for use by other functionality. The system shall give exact details of any financial transaction to the traveller. In addition, it shall be able to use a variety of relevant payment electronic methods, including central account and post payment, central account and prepayment, on-board account, etc. The system reads the information about the transaction, and extract the operators ID and service concerned. Furthermore, the system designed with maximum security necessary for electronic financial transactions, which collects evidence on the non-payment of tolls, and other illegal financial transactions, and evidence of unauthorised access when payment has not been received.*

Key words: *Architecture, Electronic, Financial, and Transaction*

1.0 Introduction

Intelligent Transportation Systems (ITS) is the application of computer, electronics, and communication technologies and management strategies in an integrated manner to provide traveller information to increase the safety and efficiency of the surface

transportation systems. These systems involve vehicles, drivers, passengers, road operators, and managers all interacting with each other and the environment, and linking with the complex infrastructure systems to improve the safety and capacity of road systems. Information and communication technology (ICT) is considered a tool that enables safe and efficient operations in freight transportation and that improves visibility, responsiveness and performance in supply chains (Giannopoulos, 2004; Coronado Mondragon et al., 2012). There is an enduring global need for the effective transportation of people and goods across land. Global trends such as increasing populations, urbanization, economic uncertainty, climate change, and vulnerability to loss from manufactured and natural events are employing pressure on current land-based transportation systems and abilities. At the same time, the world is moving and functioning faster through the use of the internet, cell phones, computers, and the telecommunications networks that allow the transmission of these digital signals. All of this has placed new challenges, opportunities, and complexity on our capacity to transport ourselves and withstand economic development. Land transportation in the 21st century must address such challenges, take advantage of the opportunities, and reduce or contain the complexity. To achieve these results will require the application of a system of systems approach that unifies prevailing, diverse transportation approaches and systems into a functioning whole, optimizes their operations, and permits future capability growth to respond to national, regional, and local needs (Parker, 2010).

Intelligent transport systems (ITS) and services apply information and communication systems and services (advanced technologies in electronics, communications, computers, control and sensing and detecting) to all kinds of transportation systems in order to improve the safety, efficiency and service of traffic and transport. The key element in ITS is real-time information of traffic or transport situations. (Aakre et al. 2012). The objectives of using ITS include improving traffic safety, relieving traffic congestion, improving transportation efficiency, reducing air pollution, increasing energy efficiency, and promoting the development of related industries (Pihlajamaa et al, 2013).

Furthermore, the need for Intelligent Transport System (ITS) Architectures was recognised in the early 1990's, when the number of possible applications and services that ITS could provide increased greatly. However, instead of producing unique architectures for each deployment, it was also realised that it would be much more efficient to have a Framework Architecture, from which individual ITS Architectures can be developed (Jesty, & Bossom.2011). Transport systems are a feature of many people's lives and therefore have a material impact on their quality of life. It is estimated that 40% of the world population spend at least one hour of their time on the road every day (Zhang et al, 2011) and people are becoming more and more dependent on transport systems. Because of this dependency, which involves large-scale use of the various modes of transport, transport systems must meet a number of challenges that are of vital importance to modern societies. The first of these challenges is the problem of congestion in many parts of the world, mainly in the most populated urban areas. Congestion leads to increased fuel consumption, pollution levels and difficulties in deploying mobility plans based on the use of public transport (Shawe-Taylor et al, 2006).

2.0 Related Studies

2.1 ITS Infrastructure Challenges

Figure 2.1 offers a comprehensive overview of ITS. On the left are the activities carried out by authorities and bodies responsible for transport systems; in the centre, the main challenges or objectives of ITS and, on the right, the problems to be solved and consequences thereof. Management of ITS-based transport systems requires continuous monitoring of what is happening in the transport systems and feedback for system improvement and development. The focus is always on the main obstacles to citizen mobility and, in the case of this study, on the obstacles to mobility using public transport (Shawe-Taylor et al, 2006).

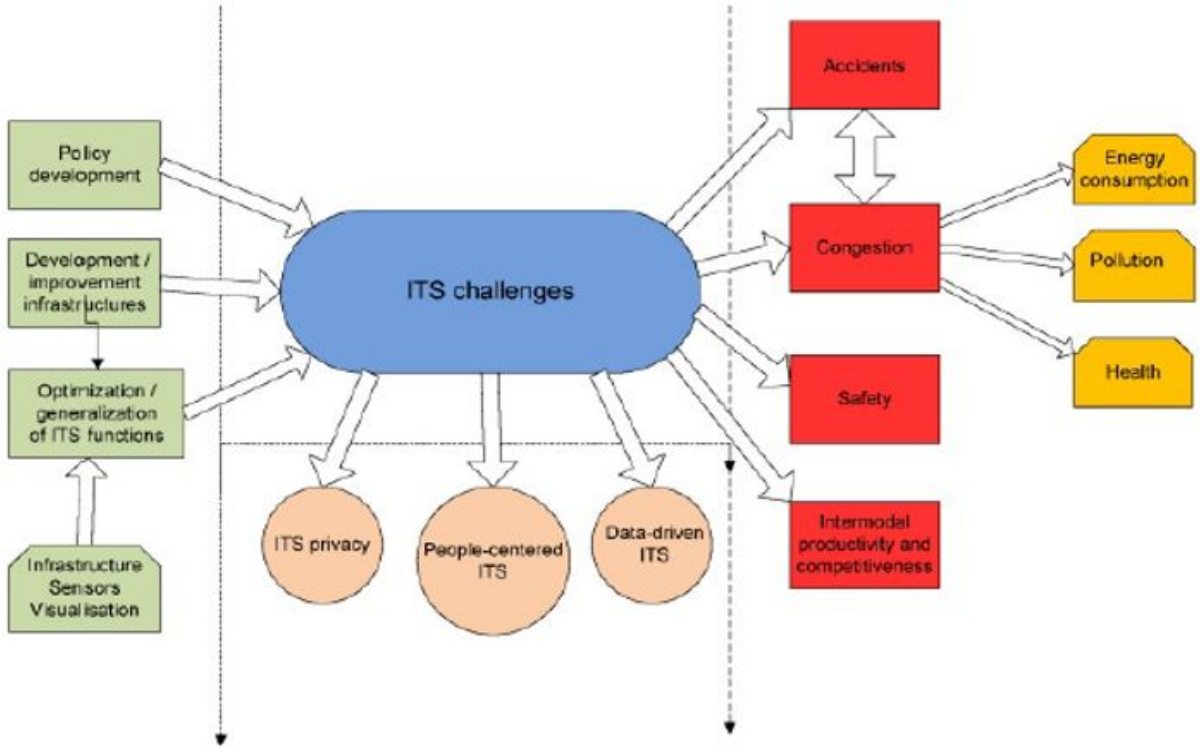
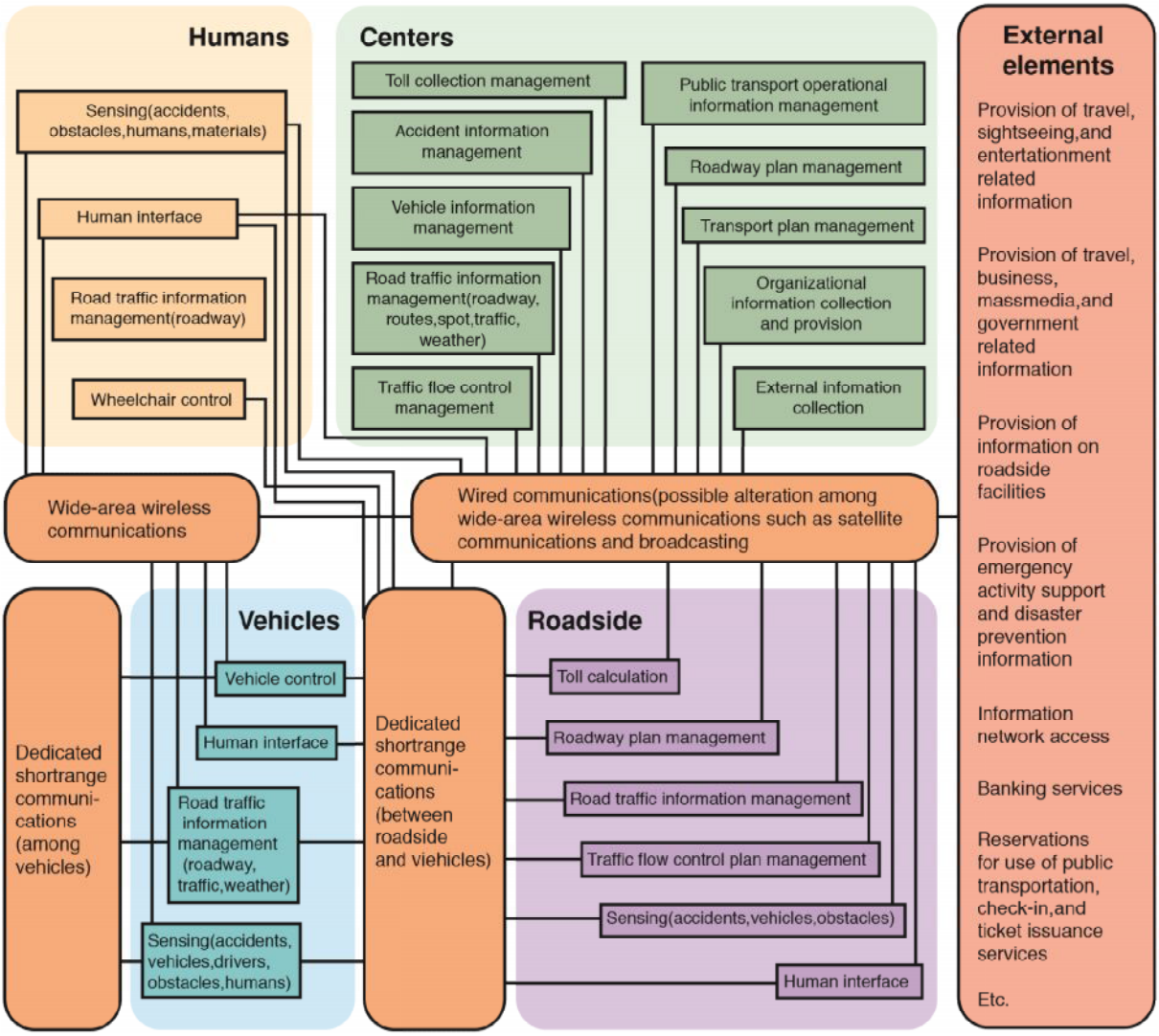


Figure 2.1: Overview of Intelligent Transport Systems (ITS): activities, challenges and problems. (García et al, 2016)

2.2 Japanese ITS System Architecture

Transport Management Systems aim to improve the efficiency, reliability and safety of transport system operations. They provide reliable information that users may access from their homes, workplaces or places of recreation to plan their trips, or even during travel to obtain information on the route they are currently using (Diab and El-Geneidy, 2012). This information is accessed using various types of mobile or fixed personal device and both fixed and mobile communications infrastructures. The provided information is georeferenced and relates to routes (planned or currently underway), timetables, fares, etc. An example of a system used by transport authorities in the ITS field is Automatic Vehicle Location (AVL) (Yan, 2012) and (Padrón and García, 2014). According to Yokota, T., and

Weiland R.J., (2004) the Japanese ITS System Architecture was accomplished in 1999 via the collaborative efforts of five government ministries involved in ITS, also in collaboration with VERTIS (now ITS Japan). The Japanese ITS architecture comprises an enumeration of user services as shown in Table 3 and a physical architecture also shown Figure 2.2.



http://www.its-jp.org/english/arch_e/doc/summary.pdf, p20

Figure 2.2: Subsystem Interconnect Diagram from Japanese Physical ITS Architecture

Source: Yokota, T., and Weiland R.J., (2004).

2.3 Australia architecture

According to James et al.,(2010), Australia, architecture was developed in the form of a multi-modal ITS future big picture, with the aim to improve the future development and deployment of ITS services within Australia by providing a framework for the development of standards, promoting integration of systems and providing a basis for education as shown in figure 2.3.

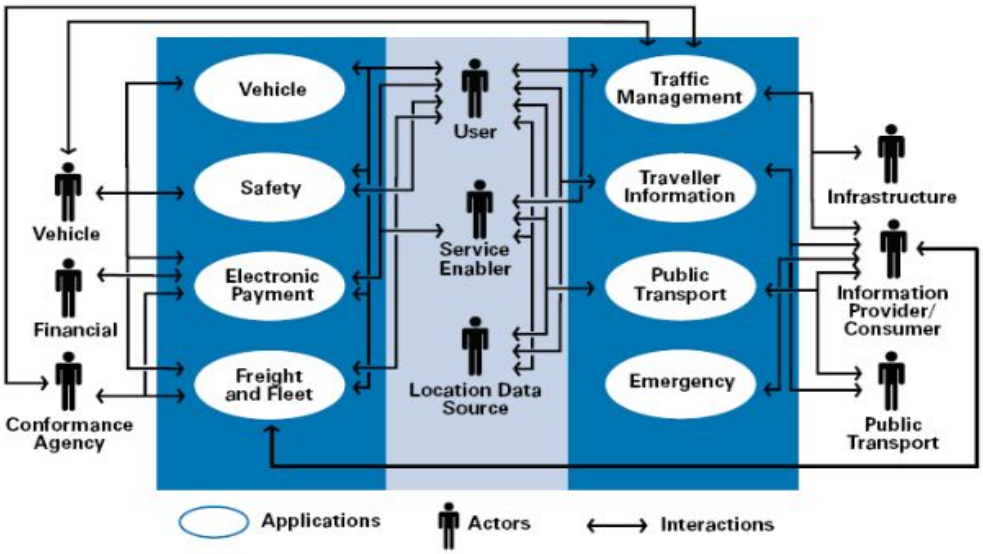


Figure 5.5 Australian ITS architecture
Source: James et al., (2010)

3.0 Method

3.1 Debit User's Account

3.1.1 Overview

i. This Function shall be capable of providing the following facilities: The ability to debit the Traveller's Electronic Payment account as the result of the recently performed transaction.

ii. If the Traveller's account becomes overdrawn the ability to send a message highlighting this situation to the “Credit Control” function.

3.1.2 Functional Requirements

i. Read the transaction message, and extract the user's ID, account ID, corresponding fee

ii. Get the balance of the E-Payment account

iii. Debit the balance by the amount of the transaction, and record the operation in the

iv. Stores of "transactions" Data and "user's account" Data

v. If the "user's account" is now overdrawn, send an overdraft message to the traveller and to "Credit Control".

3.2 Load User's Account

3.2.1 Overview

i. This Function shall be capable of providing the following facilities:
A Human Machine Interface (HMI) that provides the Traveller with the ability to credit their Electronic Payment account.

ii. The HMI shall also include the ability to display to the Traveller the different contracts available to that person, read the information related to the desired transaction.

iii. In addition to the HMI, the ability to check the credit rating of the source account and if credit worthy, credit the Electronic Payment account, plus notify this to the Financial Clearinghouse terminator, and to the store of Transaction Data.

iv. The ability to also check the amount that is being credited to an account previously included in the black list, and if the new balance is sufficient, send a message to the "Credit Control" Function to remove this account from the black-list.

3.2.2 Functional Requirements

i. Read traveller's ID

ii. Extract from the store of Contract Data the contracts that have already been established for that person

iii. Present the traveller with this list of contracts

iv. Read the traveller's selection and the loading parameters

v. Check the balance of the "source" account at the financial clearing-house

vi. If source account does not have sufficient funds, display an error message to the traveller, else, record loading transaction in the store of "transaction" Data, load the Electronic Payment account, and send the notification message to the financial clearing-house

3.3 Inform Users on Transactions

3.3.1 Overview

This Function shall be capable of providing the following facilities:

i. A HMI through which the Traveller can be provided with a list of the transactions they have performed.

ii. The HMI shall also provide the Traveller with the status of their Electronic Payment account(s).

iii. In addition, the HMI shall only provide both types of information following a specific request from the Traveller and shall only provide information that is directly relevant to that Traveller.

3.3.2 Functional Requirements

(iii) Read the traveller's request for information

(iv) If asked extract from the store of "user's account" Data the status of the traveller's account

(v) If asked extract from the store of "transactions" Data the list of all the transactions performed by the traveller during the specified period, with the application of filters according to traveller's requests

(vi) Present the information to the traveller.

3.4. Detect Payment Violations

3.4.1 Overview

i. This Function shall be capable of providing the following facilities: The ability to check the status of a user's (Traveller or Driver) account.

ii. If an overdraft notification has been received for this account (or for several different accounts with the same owner), the ability to include the account(s) in the

"black list", which means that the user shall not be allowed to use this account until sufficient funds have been provided to rectify the situation, unless an "agreement" message has been received.

3.4.2 Functional Requirements

i. Process the status changes of user's account: if an overdraft notification received, write the account number in the black list. Conversely, if new account balance is above a certain threshold, remove it from the black list.
ii. If an agreement message is received, indicate that the user is allowed to use the service.
iii. Send the fraud notification to the PSLE area
iv. Register s all payment violations in the store of "fraud" Data, and initiate a block on the use of that service.

3.5 Block Access to Service

3.5.1 Overview

i. This Function shall be capable of providing the following facilities
The ability to control the access of a user (Traveller or Driver) to the requested service.
ii. Upon detection of a violation, the ability to send a message to the access violations detection functionality.
iii. If an accident has been detected, the ability to send a warning to functionality in the Manage Traffic Functional Area.
iv. The ability to let the user proceed upon receipt of an agreement message from the violation detection functionality.
v. A HMI through which the user can be informed about whether or not access to the requested service has been granted.

3.5.2 Functional Requirements

i. Upon reception of a message indicating a violation, prevent the user from using a service
ii. Upon reception of a "free" command, allow the user to proceed
iii. Send a warning message to the manage traffic area

3.6 Inform and Guide User

3.6.1 Overview

This Function shall be capable of providing the following facilities:

i. A HMI through which the Traveller or Driver can be guided to provide the precise definition of the service that they want, and the way that they wish to pay for it.
ii. The HMI shall also enable the Traveller or Driver to select the appropriate contract, inform them about their rights to use the service, and display the associated price.
iii. The ability for the Function to be activated by functionality in either the Manage Public Transport Operations Area or the Provide Traveller Journey Assistance Area, or even directly for simple operations.

iv. The ability to ask for a credit check to be done on the Traveller or Driver and also to check to see whether an advance payment has been made.
v. The ability to initiate the recovery of any advanced payment, or else initiate the computation of the fee.

3.6.2 Functional Requirements

i. Get the information about the service requested from the MPTO or PTJA areas, or directly from the user.
ii. If these areas just ask for a tariff (and not a transaction), go to (g)
iii. Get user's ID
iv. Obtain the corresponding contracts
v. Get user's choice of contract
vi. Check with "Access" and/or "Credit Control" and, if necessary, register a violation.
vii. Send the choice and contract to check if advanced payment has been made
viii. Send the different elements to initiate the computation of the corresponding fee
ix. If payment has already been completely made, send an agreement to the "Access Control" system
x. If not, reduce the fee by the amount already paid, send the elements to recover fees

Table 3.1: Functional Requirements for Descriptions of Electronic Financial Transaction

User Needs	Descriptions	Function No.	Function Name
4.1.0.1	The system shall be able to use a variety of relevant payment methods either electronic or not, including central account and post payment, central account and prepayment, on-board account etc	1.1.1	Create E-Payment Contract
4.1.0.3	The system shall give exact details of any financial transaction to the traveller.	1.1.1	Create E-Payment Contract
4.1.0.4	The system shall be able to manage tariff policies (define fares/fees according to selected criteria, e.g. type of Traveller or traffic conditions, etc.).	1.3.3	Check User's Contract
4.1.2.2	The system shall enable a single payment to be paid for services offered by different related transport systems (e.g. metro, bus, train, road and parking).	1.3.5	Compute Service Fee
4.1.3.3	The system shall have the maximum security necessary for electronic financial transactions.	1.5.5	Block Access to Service
4.1.3.4	The system shall have a low number of incorrect transactions (e.g., non-effective transactions < 1 in 10E-6; erroneous transactions < 1 in 10E-8)	1.3.2	Identify User
4.1.3.5	The system shall provide information in the native language at the output	1.3.4	Inform and Guide User

	location, and/or from a user selected choice of other appropriate foreign languages		
4.1.3.1	The system shall be able to exchange financial information between roadside equipment (e.g. toll collection unit) and a moving traveller (e.g. a vehicle).	1.4.1	Distribute Fees Revenue
4.1.0.3	The system shall give exact details of any financial transaction to the traveller	1.3.6	Check Advanced Payment
4.1.4.1	The system shall be able to be able to collect evidence on the non-payment of tolls, and other illegal financial transactions	1.5.2	Detect Payment Violations
4.1.4.2	The system shall be able to collect evidence of unauthorised access when payment has not been received.	1.5.3	Detect Access violations
4.1.1.2	The system shall have a minimum impact on the driving task	1.3.1	Detect User

4.0 Result and Discussion

As shown in figure 4.1, the designed electronic financial transaction system, manages customer data (identification, account, rights of residents, etc.). The system shall give exact details of any financial transaction to the traveller. In addition, it shall be able to use a variety of relevant payment methods either electronic or not, including central account and post payment, central account and prepayment, on-board account etc. Furthermore, the system shall also be able to manage tariff policies (define fares/fees according to selected criteria, e.g. type of Traveller or traffic conditions, etc.). The designed system shall be able to use a variety of payment or receipt means, including contactless "smart cards". Also, the System provides management information to the recipients of tariffs. The system enable a single payment to be paid for services offered by different related transport systems (e.g. metro, bus, train, road and parking). Finally, the system shall be able to share revenues between road network operators.

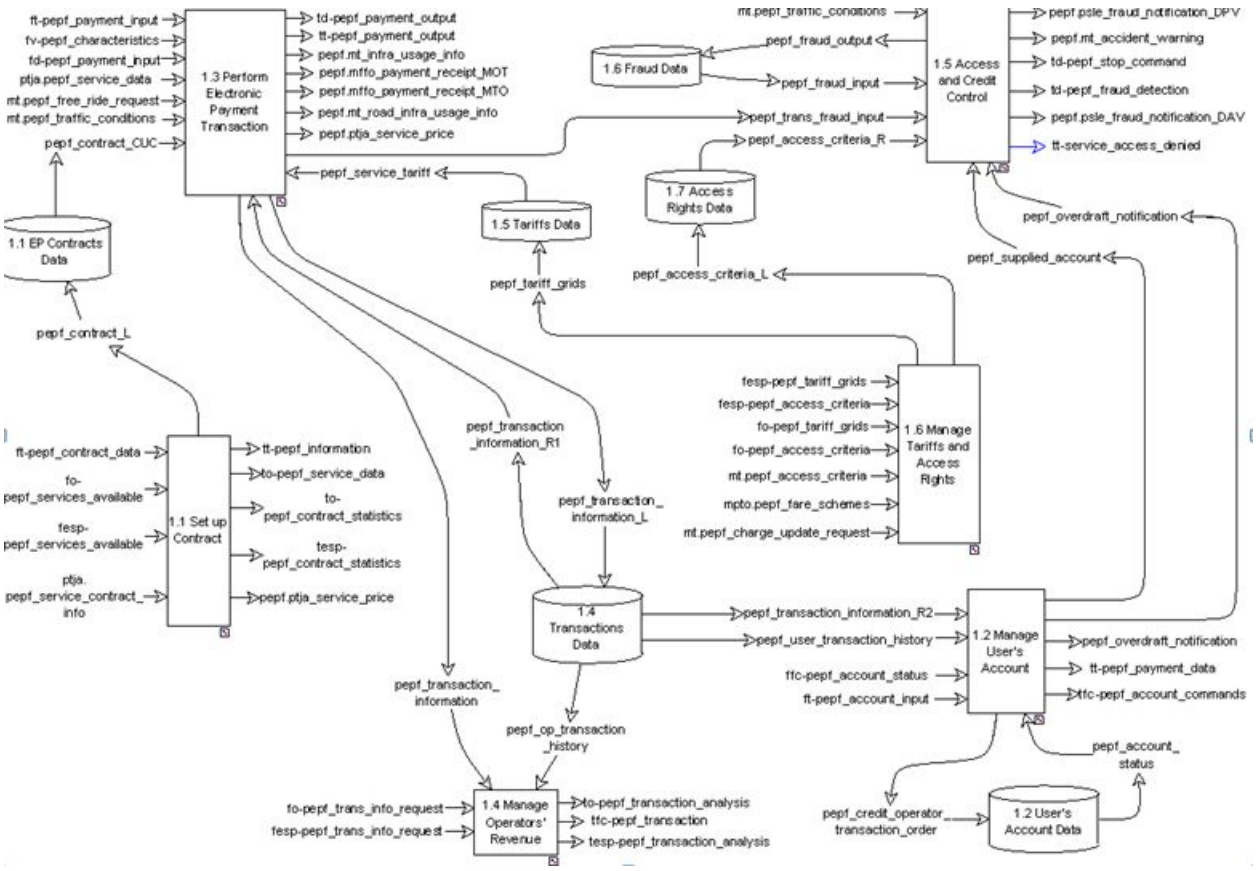


Figure 4.1: Data Flow Diagram for Electronic Financial Transaction

Conclusion

Electronic Financial Transactions System was designed using European ITS Framework Architecture (FRAME) Browsing Tool and the following conclusions were drawn. The system shall be able to:

i. exchange financial information between roadside equipment (e.g. toll collection unit) and a moving traveller (e.g. a vehicle).
ii. make atomic electronic financial transactions, I.e. that are never partially complete whatever the circumstances, even in degraded system modes.
iii. have the maximum security necessary for electronic financial transactions
iv. collect evidence on the non-payment of tolls, and other illegal financial transactions.
v. collect evidence of unauthorised access when payment has not been received

References

Coronado Mondragon, A.E, Lalwani, C.S, Coronado Mondragon, E.S., Coronado A case of role and contribution through wireless vehicular networks in a sea port location', *International Journal of Production Economics*, Vol. 137 No.1, pp. 165-a175.

Mondragon, C.E., Pawar, K.S. (2012) 'Intelligent transport systems in multimodal logistics:

Diab E.I., El-Geneidy A.M. (2012) Understanding the impacts of a combination of service improvement strategies on bus running time and passenger's perception. Transp. Res. Part A: Policy Pract; 3:614–625.

García, C., Quesada-Arencibia, A., Cristóbal, T., Padrón, G., & Alayón, F. (2016). Systematic development of intelligent systems for public road transport. *Sensors*, *16*(7), 1104.

Hardgrave, B.C., Aloysius, J., Goyal, S. (2009) 'Does RFID improve inventory accuracy? A preliminary analysis', *International Journal of RF Technologies: Research and Applications,* Vol. 1 No. 1, pp. 44-56.

Jesty, P. H., & Bossom, R. A. (2011, June). Using the frame architecture for planning integrated intelligent transport systems. In *2011 IEEE Forum on Integrated and Sustainable Transportation Systems* (pp. 370-375). IEEE.

Padrón G., García C.R., (2014) Quesada-Arencibia A., Alayón F., Pérez R. Using massive vehicle positioning data to improve control and planning of public road transport. Sensors; 4:7342–7358.

Parker, J. M. (2010). Applying a system of systems approach for improved transportation. *SAPI EN. S. Surveys and Perspectives Integrating Environment and Society*, (3.2).

Pihlajamaa, O., Heino, I., & Vilkman, A. (2013). *Multi-Service Architecture for mobility services*. VTT.

Shawe-Taylor J., de Bie T., Cristianini N.(2006) Data mining, data fusion and information management; Proceedings of the 2006 IEEE Intelligent Transportation Systems Conference; Toronto, ON, Canada. 17–20 September 2006; pp. 221–229.

Yan Y. (2012) Bus transit travel time reliability evaluation based on automatic vehicle location data. J. Southeast Univ.2(1) p100–105.

Yokota, T., and Weiland, R.J., (2004). *ITS Technical Note. ITS System Architecture for Developing Countries.*

Zhang J., Wang F., Wang K., Lin W., Xu X., Chen C.(2011) Data-driven intelligent transportation systems: A survey. IEEE Trans. Intell. Transp. Syst. 2011;4:1624–1639.