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DATA ASSESSMENT FOR ITS/CVO TECHNOLOGY DEPLOYMENT

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ABSTRACT

The processes involved in motor carrier credentials administration and enforcement are complex involving interactions among a number of public and private sector organizations Most government agencies involved with commercial vehicle operations are unable to share commercial vehicle related information in an effective and efficient manner. The deployment of intelligent transportation systems for commercial vehicle operations (ITS/CVO) technologies use communications infrastructure to enhance efficiency and effectiveness in commercial vehicle related data exchange. A critical step in selecting and deploying ITS/CVO technologies is an assessment of current data and information exchange mechanisms. The assessment also involves the application of information engineering methodologies to understand the data elements, attributes, relationships, data flow, processes among agencies involved in CVO activities. This paper presents a framework for assessing commercial vehicle related data and establishes requirements for ITS/CVO technology deployment. The framework identifies important data entities and major processes for ITS/CVO technology deployment.

1.0 INTRODUCTION

The deployment of intelligent transportation systems for commercial vehicle operations (ITS/CVO) for motor carrier credentials administration and roadside enforcement processes is rapidly gaining popularity at state and regional levels within the United States. The scope of the Commercial Vehicle Operations (CVO) component of the national Intelligent Transportation System (ITS) policy initiative includes operations associated with passenger

and freight movement by commercial vehicles and the activities necessary to regulate these operations (FHWA, 1997). The national ITS/CVO goals are accomplished within a framework defined by three functional areas: administrative processes (includes carrier systems), electronic roadside screening, and safety information exchange (JHUAPL, 1999). The underlying goal of ITS/CVO system deployment is to integrate commercial vehicle information systems to facilitate communication among all motor-carrier related databases. The success of any ITS/CVO initiative therefore is an efficient data sharing and exchange mechanism.

The initial step in developing ITS/CVO systems is the development of a business plan. The plan outlines the vision of the program, identifies the goals and objectives, identifies prioritized projects to be carried out, and also identifies the roles and responsibilities of the various state agencies involved with motor carrier activities. The business plan serves to guide the ITS/CVO program development process.

The next major step is the development of an ITS/CVO deployment plan. This document identifies functional areas and the technologies to be deployed in each functional area, and estimates the budget for each component deployment.

A critical step in the deployment process that is often overlooked is the assessment of the existing data and mechanisms for sharing and exchange data among government agencies involved with CVO. The assessment process involves identifying deficiencies of existing relevant carrier-credentialing and safety-performance databases, data sharing, transfer mechanisms, and establishing requirements for deployment of ITS/CVO technologies. This is achieved through the application of information engineering methodologies to understand the CVO processes, the process-entity interactions, and the associated data elements, attributes, relationships, and data flow. This paper presents a framework for assessing commercial vehicle related data and establishes requirements for ITS/CVO technology deployment. The framework identifies important data entities and major processes for ITS/CVO technology deployment.

Data assessment provides the inputs and insights for developing a CVO database architecture for linking the various regulatory databases. Such linkage will reduce the need for carriers to provide the same information to multiple agencies. Connectivity among administrative processes and roadside operations will facilitate data exchange and improve efficiency and cost-effectiveness in state regulatory processes.

2.0 DATA ASSESSEMENT FRAMEWORK

A major problem with current CVO information systems is the difficulty of data exchange. Data assessment framework, which is directed at resolving the data exchange problem, involves a number of interdependent building blocks discussed below.

1. Identify the various business processes involved in commercial vehicle activities (e.g., credentialing and roadside processes).
2. Identify the entities within CVO and to develop a data model consisting of entity-relationship diagrams (ERD), graphically depicting the relationships between these entities. The data model also includes definition of data entities, attributes, and relationships.
3. Determine the processes and develop a process model consisting of data flow diagrams (DFD) to show:
   - Where data is used and stored
   - The interfaces between processes
   - The equipment packages' interfaces with external equipment package(s).
4. Develop interaction matrix that maps business area processes to data entities.
5. Review the data properties of current processes in terms of data exchange and sharing among agencies.

These building blocks are discussed in the following sections.

2.1 Business Processes

It is important to identify the business processes and the government agencies involved with commercial vehicle regulation and enforcement activities. The responsibilities and roles of each agency are captured during this initial process. Having identified the key business areas and the contact persons, the next step is collect relevant data on important elements, including the following:

- Business functions, information inputs/outputs, and personnel responsibilities
- Definition of the roles and responsibilities of each agency in CVO
- Description of processes in each business area
- Types of data collected, methods of data collection, handling, and storage
- Data requirements and standards
- Current level of integration among various databases and systems
- Ease of use of current databases and systems
- Current system degree of functionality and improvement needs
- Technical environment, constraints, and available equipment and needs
- Current automated and manual system and associated deficiencies
- Opportunities for deployment of higher technologies.

This identification and data collection process provides the background information needed to develop the data and process models.

2.2 Data Model

The data model establishes data entities, needs, and requirements for use by all major CVO information users. The model is a comprehensive representation of all information relationships with all state agencies as well as the motor carrier industry and other

jurisdictions. The data model consists of ERDs of the entities' information classes, definitions, and relationships. The attributes indicated in the ERDs represent the key identifiers with some representative data attributes. The ERDs show the major components associated with each key business data entity. The ERDs also show the major data elements of each agency's database and the attributes associated with each data element. The primary purpose and use of a data model is to develop a central uniform set of data elements that can be shared by developers and users whenever possible. The data model provides an analysis tool to analyze interface requirements and operations in detail. Part of the development of this diagram includes defining the attributes (data elements) of each entity. Components of the ERD are:

Entity: Any person, place, thing, concept, or event that has meaning to the enterprise and about which data may be stored. (Example: vehicle)

Attribute: A named characteristic of an entity. Data attributes are sometimes also referred to as data elements. (Example: vehicle_reg_weight)

Relationship: An attribute whose value is the identifier of another entity. (Example: carriers manage vehicles).

ERDs are usually developed for key data entities that are fundamental to CVO and are common to multiple agencies. Examples of entities relevant to commercial vehicle regulatory activities are:

1. Account entity
2. Audit entity
3. Carrier entity
4. Driver entity
5. International Registration Plan (IRP) filing
6. Roadside inspection entity
7. Tax return entity
8. Trip entity
9. Vehicle entity.

An example of the ERD for Roadside Inspection entity is shown in Fig. 1. ERD can be developed according to information engineering standards. ERwin software (Platinum, 1999a) was used in developing the ERD shown in Fig. 1.

2.3 Process Model

The process model describes key processes of each business area in terms of what is done. The process model does not represent who performs the process or how it is performed or how often the process is performed. The process is represented as a logical model that provides a technology-independent description, and serves as a tool to analyze CVO activities to help identify the types of information flows that would be required to support identified interfaces.

The process model consists of process definitions and two graphical representations of business processes. The two graphical representations are: (a) node diagrams which are

hierarchical decomposition diagrams of processes from a high-level to more detailed ones, and (b) data flow diagrams (DFD) showing details of the information flow for each process and sub-process. In addition to the graphical representations are definitions on the various processes. Fig. 2 illustrates a partial DFD for one of the credentialing process. BPwin information engineering software (Platinum, 1999b) was used in developing Fig. 2.

2.4 Interaction Matrices

Interaction matrices help identify linkages between data and processes and identify the level of data usage and sharing as well as missing links in data exchange among agencies among agencies in terms of CVO functions. These matrices show the linkage between data and processes and identify the level of data usage and sharing as well as missing links in data exchange among agencies.

The matrix, by portraying the existing data usage and sharing by organizations for each process, provides the information necessary to define the size and scope of the applications of business areas and to determine the sequence of implementing projects designed to address limitations of data sharing and exchange among organizations. This matrix enhances the understanding of collection, collation, storage, retrieval, transfer, and communication of data among various business areas and processes.

In developing the process-entity matrix, the subject areas or data associated with each business area are defined. This matrix maps key processes of each business area to the subject areas. The subject area represents a grouping of information that tends to be used in the performance of business processes. A CRUD (or process-entity) matrix shows data dependencies between the processes and subject areas (data). The following abbreviations are used in the CRUD matrix:

C – Created, i.e., data points can be created by the process
R – Retrieved, i.e., data is accessed or retrieved in performing the process
U – Updated, i.e., data can be updated during the process
D – Deleted, i.e., data can be deleted during the process.

The CRUD matrix clearly shows which areas operate independently of other agencies or organizations and which agencies do interact with other agencies in performing their CVO functions. The matrix shows the level of data sharing and usage among CVO business areas. It also provides a means to easily identify the missing links in developing an integrated system. Table 1 illustrates a partial CRUD matrix for two business processes.

2.5 Data Quality

The following are definitions for some major criteria used in assessing the quality of existing CVO information systems network in terms of effective data sharing and exchange and for identifying problems, needs, and opportunities for deploying ITS/CVO technologies.

Accessibility – Relates to accessing data required for a process but resident in another agency and not readily available. For example, ability to access carrier and vehicle data by field personnel and roadside operations. This could also refer to inefficiency in existing systems and also inability to access systems that may contain data (e.g., slow mainframe connection, secured access to mainframe.

Accuracy / Consistency – Data accuracy relates to correct information that is provided from data sources or correct interpretation of information that is being provided. Data consistency relates agreement or logical coherence among different elements of data.

Availability – Availability of certain pieces of information required in carrying out processes but currently not available in data sources. For example, lack of historical safety information may prevent appropriate analysis and identification regarding carriers/ vehicles drivers/ highway areas that are unsafe.

Definition – Standardization of definitions of same or similar data used by different systems, applications, and their manuals, is necessary to allow analysis of data quality and correct interpretations and accesses. This may cause inappropriate linkage and sharing and hence inaccurate retrieval, transmission, or analysis. The data may be used in different processes but may mean different things in each process.

Standards – Relates to information exchange standards, such as open Electronic Data Interchange (EDI). The transactions involved in such exchanges are largely system/application independent. Absence of such standards may make information exchange difficult or even impossible. If there is no computer system linkage presently existing for information exchange, then the issue of such standards is irrelevant.

Presentation – Pertains to the format in which the data is presented so that it is understood and useful for the process, or else misinterpretation is possible. This may lead to data inaccuracies.

Security – Concerns of security of data for certain processes may limit the level of data access and data sharing that can be permitted among agencies. This concern may translate to inefficiency in certain processes.

Redundancy – Refers to same data entity collected and/or stored by multiple agencies (paper-based or computer-based). Sometimes this is necessary because of the way processes and activities have evolved and changed. However, same data in multiple locations can be the main cause of data accuracy and consistency problems, especially when data update is not synchronized.

Handling and Storage – This is a problem typical of paper based transactions. The need to handle, store and archive large volumes of paper applications and documents may be a problem. Also associated is the retrieval of information from archived data.

Sharing – Relates to inability or difficulty in sharing data with other agencies through direct computer linkage or other means. This may be due to incompatibility of data and/or systems and processes. Differences in data definition or standard, lack of integration and lack of user interfaces can create data sharing problems.

3.0 CONCLUSIONS

Data assessment is critical and a necessary step in developing ITS/CVO deployment plan. However, such an assessment has been generally overlooked, inadequately emphasized, and certainly not documented very well. An information engineering methodology / framework was established to facilitate the data assessment and its documentation. This framework allows a logical approach that defines different levels of detail in the data and process modeling and the outputs to be generated at each level.

Such framework and documentation can lead to development of a more effective ITS/CVO deployment plan and could be of definite benefit to those initiatives that are embarking on or contemplating about development of ITS/CVO deployment plan.

4.0 ACKNOWLEDGEMENTS

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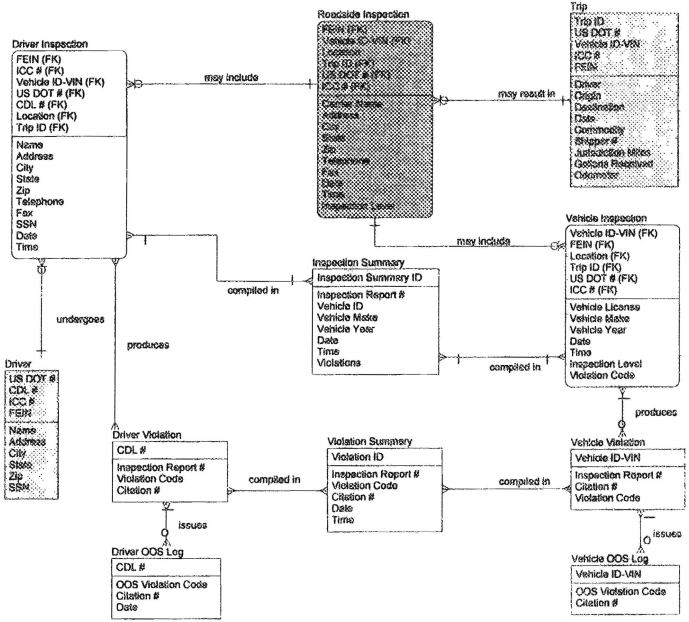

Figure 1. Roadside Inspection Entity ERD

Source: Fekpe and Varma, 1999

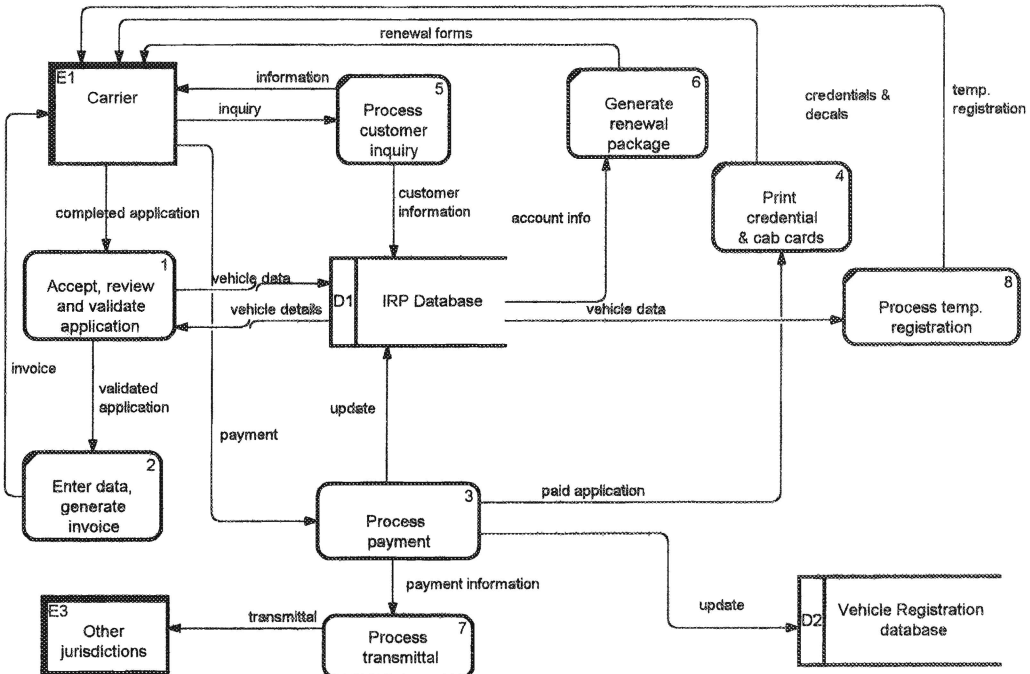

Figure 2. Partial Data Flow Diagram for IRP Process

Source: Adapted from Fekpe and Varma (1999)

Table 1. Example of CRUD Matrix

Process \ Data Entity	IRP	Account	Carrier data	Vehicle data	IRP payment	IRP credential	IRP registration data	Law and regulation	Audit	IFTA	Account	Carrier data	Vehicle data	IFTA payment	Tax return	Audit	IFTA credential	vehicle registration data	IFTA registration data	Law and regulation
IRP																				
Accept, review and validate application		CRUD	CRUD	CRUD			R	R			R	R			R					
Create carrier account		CRUD	CRUD	CRUD			CRUD	R												
Process payment		RUD	R	R	CRUD									R						
Print credential						CRU	RU													
Prepare transmittals		R	R	R	R															
Process customer inquires		R	R	R	R	R	R	R												
Conduct IRP audit		RU			RU		R	R	CRUD											
IFTA																				
Accept and process application		R									CRUD	CRUD	CRUD						CRUD	R
Create and update carrier account											CRUD	R			C				CRUD	R
Process payment					R								CRUD	CRUD						
Issue credential											R						CRU		RU	
Process cancellation request											R	RUD							RUD	R
Process tax returns											R			CRU	U					
Prepare transmittals											R	R		R	R					
Conduct audit											RU			RU		CRUD			R	R
Process customer inquires											R	R	R	R	R		R	R	R	R

C - Created R - Retrieved U - Updated D - deleted

Source: Adapted from Fekpe and Varma (1999)