Annex D – ATCCIS REPLICATION MECHANISM

ATCCIS (Army Tactical Command and Control Information System) was an international programme consisting of NATO nations (although not formally a NATO effort) aimed at identifying the minimum set of specifications to be included within C2ISs to allow the automatic transfer of selected command and control (C2) data. Their objective was to develop a specification for a hardware/software/vendor-independent interoperability solution. The ATCCIS programme ran from 1982 to 2002.

The Multinational Interoperability Programme is an international programme consisting of NATO nations (also not a NATO effort) whose focus is the fielding of an interoperability solution for multinational C2ISs. In 2002, ATCCIS merged with MIP. MIP adopted the products of the ATCCIS work as the basis for direct database-to-database exchange. However, MIP also maintains a structured message exchange mechanism.

The ATCCIS concept of interoperability is based upon the automatic transfer of standardized data elements based upon a common data interchange model called the Land C2 Information Exchange Data Model.

The ATCCIS programme also developed the specification for a mechanism that will permit interoperability of automated C2ISs through partial replication of database content. The ATCCIS Replication Mechanism (ARM) is selective in: (a) data to be exchanged; (b) recipients of the data; and (c) transfer facility to be used.

Under the ATCCIS concept, nations use the common data model to preserve the meaning and relationships of the information exchanged between C2ISs across national boundaries. The ARM manages the exchange of information between databases of C2ISs across national boundaries based on the common data model.

The major component areas of an ATCCIS compliant system are shown in Figure D-1.

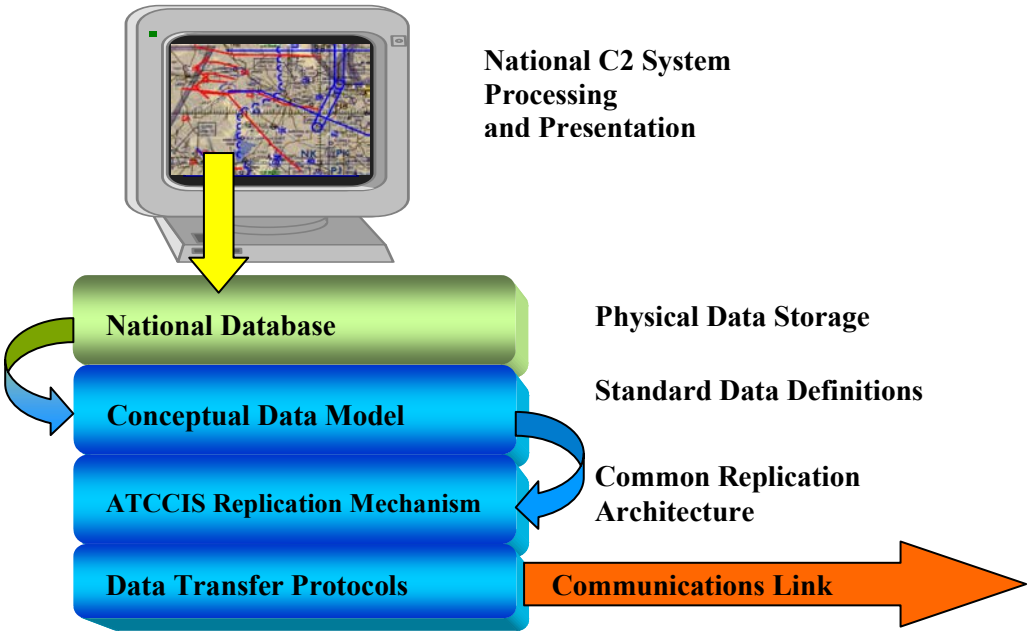

Figure D-1: ATCCIS Concept of Operations.

The top two levels, that is the national application and national database, represent that portion of the implementation that is a national responsibility. Nations develop independent applications that support national operating procedures and language. They also maintain national information within their own databases.

When an update to C2 information occurs in the National Database, and the update needs to be shared, the data to be exchanged are referred to a conceptual data model, the Command and Control Information Exchange Data Model (C2IEDM)[1].

If the data are identified as part of replication contracts pre-established with other systems for Command and Control purposes, they are packaged as part of a replication Protocol Data Unit (PDU) and the PDU is formatted within the selected commercial transfer protocol (e.g., TCP) for transmission. The ATCCIS Replication Mechanism provides this functionality. The ARM can be considered to consist of three layers as shown in Figure D-2. The principal responsibilities of each layer are shown in the figure.

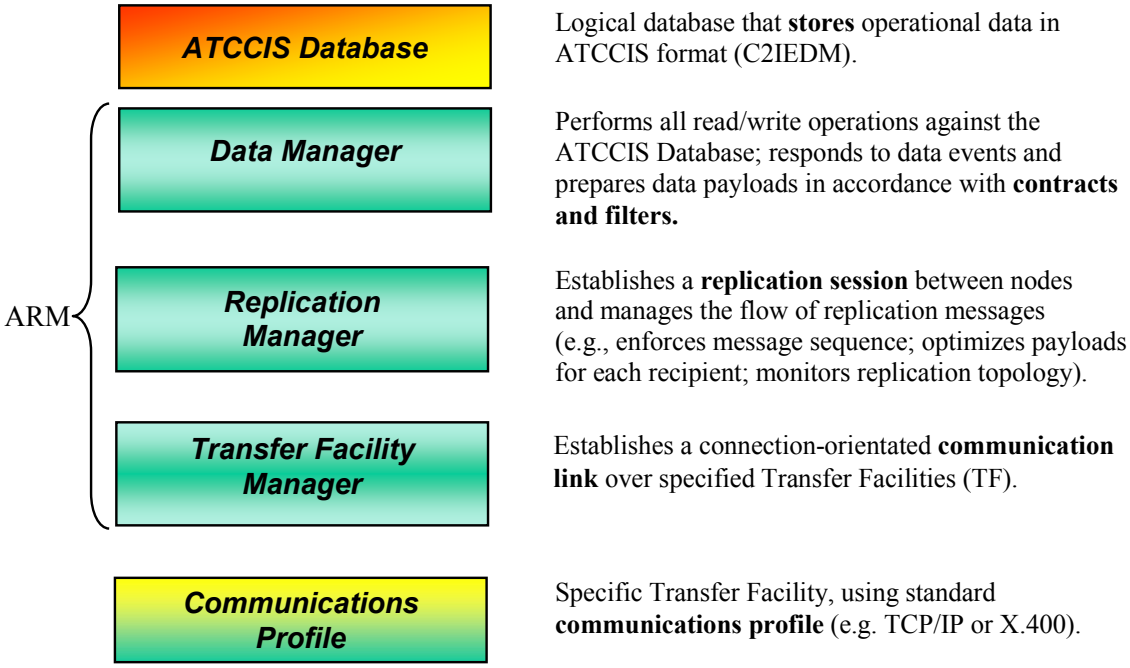

Figure D-2: ARM Layers.

The ARM employs the concepts of contracts and filters.

A *replication contract* is the means for controlling (selective) replication of database changes. A contract is established between a pair of replication nodes, designated as Data Provider (DP) and Data Receiver (DR). In the contract, the DP and DR agree that the DP will provide the DR with all data that satisfies the conditions of the contract. A contract specifies a *filter* and parameter values used to set filter conditions, as well as a DP and a DR. A filter is a set of criteria applied to the instances of a database in order to reduce the total set of data selected to a subset. Examples of filter types include geographical area, time, and order of battle (organizational). The contracts enforce a 'push' model for information exchange in which the only data

[1] The Land Command and Control Information Exchange Data Model (LC2IEDM) developed under ATCCIS has been extended under MIP to serve Joint Force requirements. The extended data model is referred to as 'C2IEDM', without the qualifier 'Land'.

pushed to recipient nodes are those negotiated with the recipient node under the pre-agreed contract. To modify the set of data pushed to a particular data recipient by a data provider, a filter must be applied or the contract must be modified.

The ARM supports three types of exchanges. A *bulk* update is the total set of data elements required to satisfy all valid contracts between a DP and a DR at a given point in time. A bulk update is used for database synchronization when a connection between nodes is established for the first time (e.g., initializing database content prior to deployment of C2ISs). A *partial bulk* update is used for database synchronization when one or more existing contracts between a DP and a DR are modified or a new contract activated. An *incremental* update is a copy of a set of one or more database transactions that have occurred since the most recent bulk or partial bulk update.

The ARM implements a selective data distribution model. Advantages and disadvantages in the tactical wireless domain of this distribution model versus an 'all-informed' distribution model are discussed in Section 4.2.2.6 of the main report.

The ARM enforces a single data ownership model (see Section 4.2.2.2 of main report). A data element is associated with one, and only one, data owner throughout its lifetime.

The C2IEDM is a relational data model. A relation is a mathematical term for a table. In a relational model, data are perceived as being organized in tables (and only tables). Database operations performed on these tables always result in new tables. The rows in a table must be unique within the table. To ensure uniqueness, one or more columns in the table are designated as a primary key. A primary key is a set of columns selected so that the set of values associated with those columns uniquely specify a table row (i.e., do not repeat within the table). Relationships between tables are established by including the primary key from one table in another table (the primary key is said to *migrate* to the second table). In this case, the primary key from the first table becomes a *foreign key* in the second table. A foreign key is defined as a set of columns that is a primary key in another table. The foreign key is said to *refer back* to the table for which it is the primary key. The table with the foreign key is the *referencing* table, and the table with the primary key is the *referenced* table. The structure of primary and foreign keys is the means by which relationships between different tables are established and maintained. If this structure is corrupted, the traceability of relationships between entries in different tables is compromised. Preservation of *referential integrity* refers to the act of ensuring that no invalid foreign key values exist in the database (i.e., that every foreign key value refers to an existing primary key value in another table). When data are replicated between databases, preservation of referential integrity is an important consideration.

The C2IEDM model design encompasses two categories of objects: those that can be identified individually (OBJECT-ITEMs) and those that represent grouped or class properties, e.g., a tank, a ship (OBJECT-TYPES). The two categories are used in parallel as basic structural elements of the model. Every instance of OBJECT-ITEM must be associated with an OBJECT-TYPE at its time of creation (for example, a particular tank belonging to an organization might be identified as type 'M1A1 Abrams'). Since the values of attributes of OBJECT-TYPES tend to be relatively static or persistent, OBJECT-TYPE information in the model is regarded as referential information that is *inherited* by each instance of OBJECT-ITEM associated with it (the above-mentioned instance of an M1A1 Abrams tank would inherit all the characteristics such as calibre of main gun, track width and load class associated with that type of tank). This referential information about OBJECT-TYPES is stored in the database of each replication node and is not replicated across the network, although references to OBJECT-TYPES can be replicated. This parallel structure of the C2IEDM model that obviates the need to share TYPE information across the network permits important savings in terms of bandwidth.