Formatted Message Exchange in a Multinational Environment

Col. Dr. Murat Ucuncu
Lt. Jr. M. Umut Demirezen (M.Sc.)
Turkish General Staff Information Systems Division
Ankara
TURKEY

murat.ucuncu@tr.net
udemirezen@tsk.mil.tr

ABSTRACT

It is important to exchange meaningful and useful data in a multinational environment. However, several nations have different data dictionary and data models. There are also cases where there are different data models in a nation, e.g. The Army data model and the Navy data model could be different for their information systems. In such cases, it is almost impossible to exchange data and utilize these data to obtain a situation display.

Several techniques have been developed to take over this problem. One of them is database replication and other is the Formatted Message approach. Each method has its own advantages and disadvantages. Formatted Message Approach is used to exchange data among the different information systems in our study.

We have developed an algorithm, which tries to handle this interoperability issue. In the algorithm, core software is developed which checks all the received formatted messages and corrects the possible specific errors according to ADatP-3 rules and inserts or updates the database with this received and corrected data. Software can be thought as a gateway between the GIS application and National information systems that send formatted messages. It converts formatted messages to database entries so that GIS application can use the received data and display them.

The software developed was tested during Joint Warrior Interoperability Demonstration – 2003 (JWID-03). During JWID-03, OWNSITREP (Own Situation Report), ENSITREP (Enemy Situation Report), NAVSITSUM, (Naval Situation Summary) and NAVSITREP (Naval Situation Report) formatted messages prepared and sent by almost 9 different nations, were received, parsed, filtered and recorded in an ORACLE 9i database. ATCCIS (Baseline 11) data model was also implemented in the database side and utilized in our software development.

IRIS IMT was used to model both the formatted message and the database. It is also used to record received data via formatted messages. After each database insert or update, unit positions, unit coordinates, battle of order information etc. are displayed on a GIS system (TACCIS).

In Conclusion, all the different formatted messages coming from different nations are possible to processed and after the probable errors are corrected. Useful data is recorded to database to obtain a Multinational Common Operational Picture, by the developed software.

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Introduction :

The term interoperability is defined in several ways. One of the definitions (US Joint Publication 1-02) is repeated below;

"*The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces, and to use the services so exchanged to enable them to operate effectively together.*" [1]

For decision-making, the *exchange of information* between military organizations or nations is fundamental. Three-level interoperability is defined in the literature. One of them is *Link level*. Link level deals with the connection of communication systems. The second level is *Information Exchange Level which is about the use of the same language.* The third interoperability level is the ambiguity level. There must no ambiguity about the exchanged-information. That means, users have to understand and speak one another without any problem. The information to be exchanged must therefore be concise, accurate, easy to understand and unambiguous. To solve this problem a commonly agreed vocabulary is required. In order to achieve a common agreed vocabulary, an artificial language can be created with a vocabulary restricted to words (including abbreviations and codes) for which unambiguous meanings have been agreed by all participants. This is particularly important in a multi-language community. Furthermore, the sentence structure in this artificial language can be restricted to predetermined formats so that as much information as possible is conveyed by the position of the words in the sentence. This common agreed vocabulary also allows fully automated processing of information [3],[4].

In this study, Formatted Messages are implemented for the information exchange. Below firstly, formatted message concept is summarized. In second part, Turkish Tactical Area Command and Control Information System (TU-TACCIS) is mentioned shortly. Next, Modeling both Database and Formatted Messages together with the full system architecture is cited. Finally, the developed software (TU Message Parser) and its functionalities are explained.

1. Formatted Message Concept:

A "Formatted Message" is a character-oriented message body that is composed of "Set Formats" that include one or more fields.

"Field Formats" have data code lists or data code ranges.

Both set and field formats can be repeated when required.

Formatted messages are defined by using certain rules and procedures. These rules and procedures are included in NATO Allied Data Publication-3 (ADatP-3).

In formatted message concept; a paragraph is simulated as a formatted message body, sentences as sets and words as fields.

ADatP-3 also includes formatted messages used for information exchange in NATO. These formatted messages improve interoperability between different national and NATO authorities and systems.

2. TU-TACCIS :

TACCIS is a situation monitoring and assessment tool with Intelligence, Operations and Logistics Information System including crisis and message management systems.

The primary use of TACCIS is to view and analyze order of battle information with Geographic Information System (GIS) capabilities to form the Land and Event Recognized Picture (LRP/ERP).

Basic components of TACCIS are; an operational database, a Geographic Information System (GIS) database, a Database Replication Mechanism, a Message and Crisis Management system and an application software.

The TACCIS data model uses ATCCIS Baseline 2 Version 5.0.

3. Modeling and Mapping Database and Formatted Messages [8]

Modelling Database and Formatted Messages is vital to this study in that there has to be perfect match between formatted message fields and database fields. To visualize this matching and mapping, *IRIS Information Modeling Tool (IRIS/IMT)* used to model and map the fields.

The Information Modelling Tool (IMT) assists users in defining models and mappings between models. The models represent data structures in a database or a formatted message. Models can be created manually or generated automatically. A mapping specifies how to automatically move information between models. Express and Express-X are used as modelling and mapping languages, respectively. IMT is a general tool supporting a number of tasks involving modelling and transformation of data. IMT includes functionality to automatically derive so-called data models from a variety of sources, such as formatted messages and databases, and supports the specification of mappings between data models, i.e. translation between different data formats. A mapping in IMT specifies a relationship between two data models. A mapping specification is independent of the specific syntax of the source of the data model. Examples of the mappings, which can be made by using the interfaces that are currently supported by IMT are shown in Figure 1. Four formatted messages which were OWNSITREP, ENSITREP, NAVSITREP, NAVSITSUM were used to model for this study. Naval Situation Summary (NUVSITSUM) IMT model is illustrated in Figure 2.

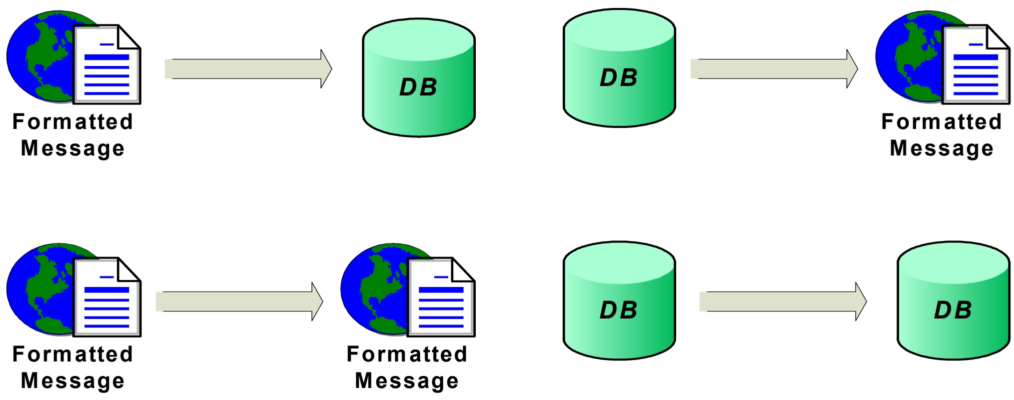

Figure 1: IMT Mapping Capabilities

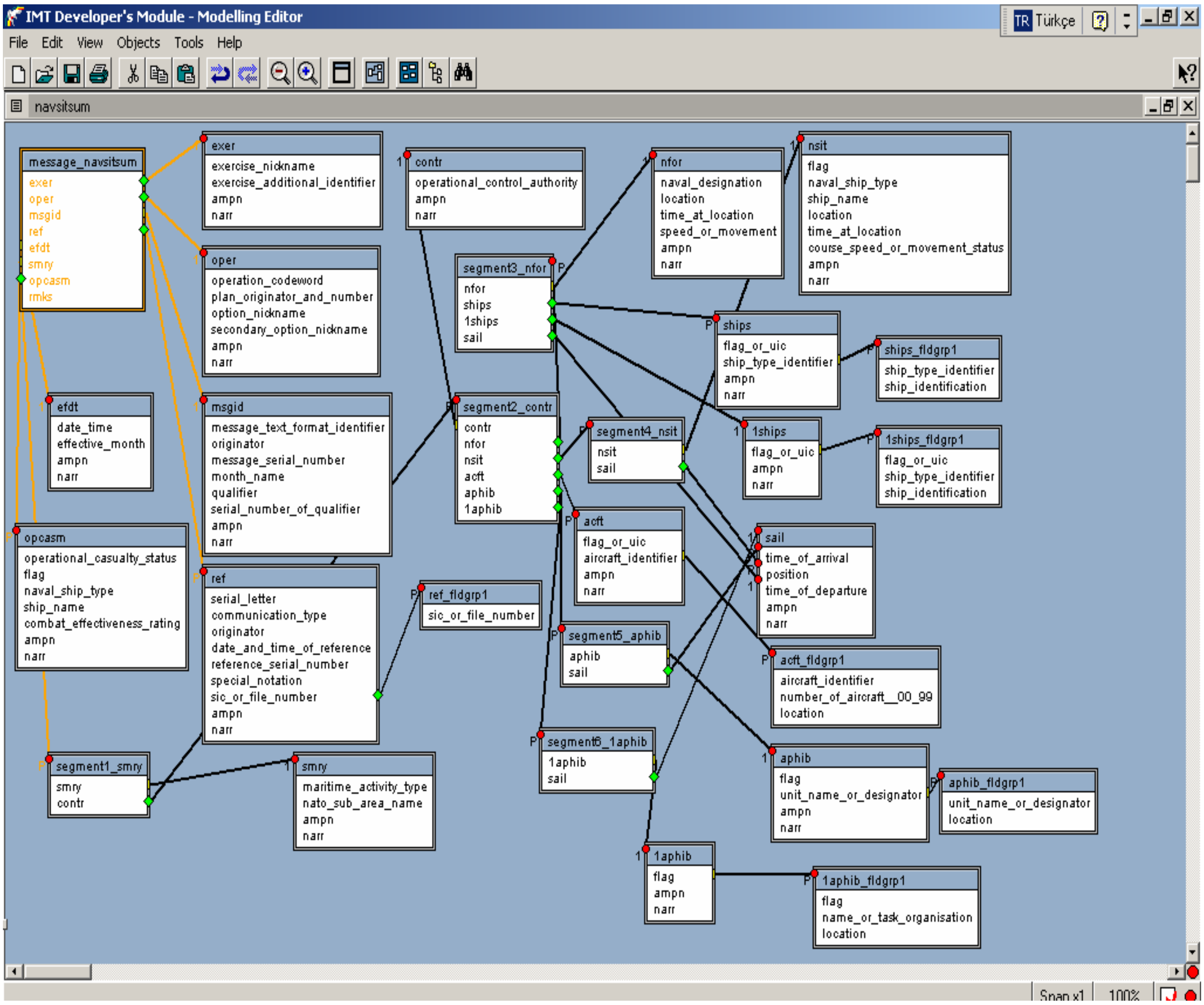

Figure 2 NAVSITSUM IRIS/IMT Model

All possible message sets, segments, fields etc. are shown in the model. This approach, information modeling, is very useful to visualize, see and recognize the whole picture of the information. ATCCIS Baseline 2 Version 5.0 was also used to constitute physical database by ErWin 4.1 software with Oracle 9i. IMT Model of the generated database is shown in Figure 3. All tables from the generated database are not shown in Figure 5 because not all the tables from the ATCCIS data model were needed for storing the information receiving from the formatted messages mentioned above.

After modeling messages and the database, all necessary IMT scripts were written with IRIS/IMT tool in Express-X language to map the information between formatted messages and the database. Some mismatches and incompatibilities were also present but these problems and eradication methods are going to explain in the error correction part elaborately.

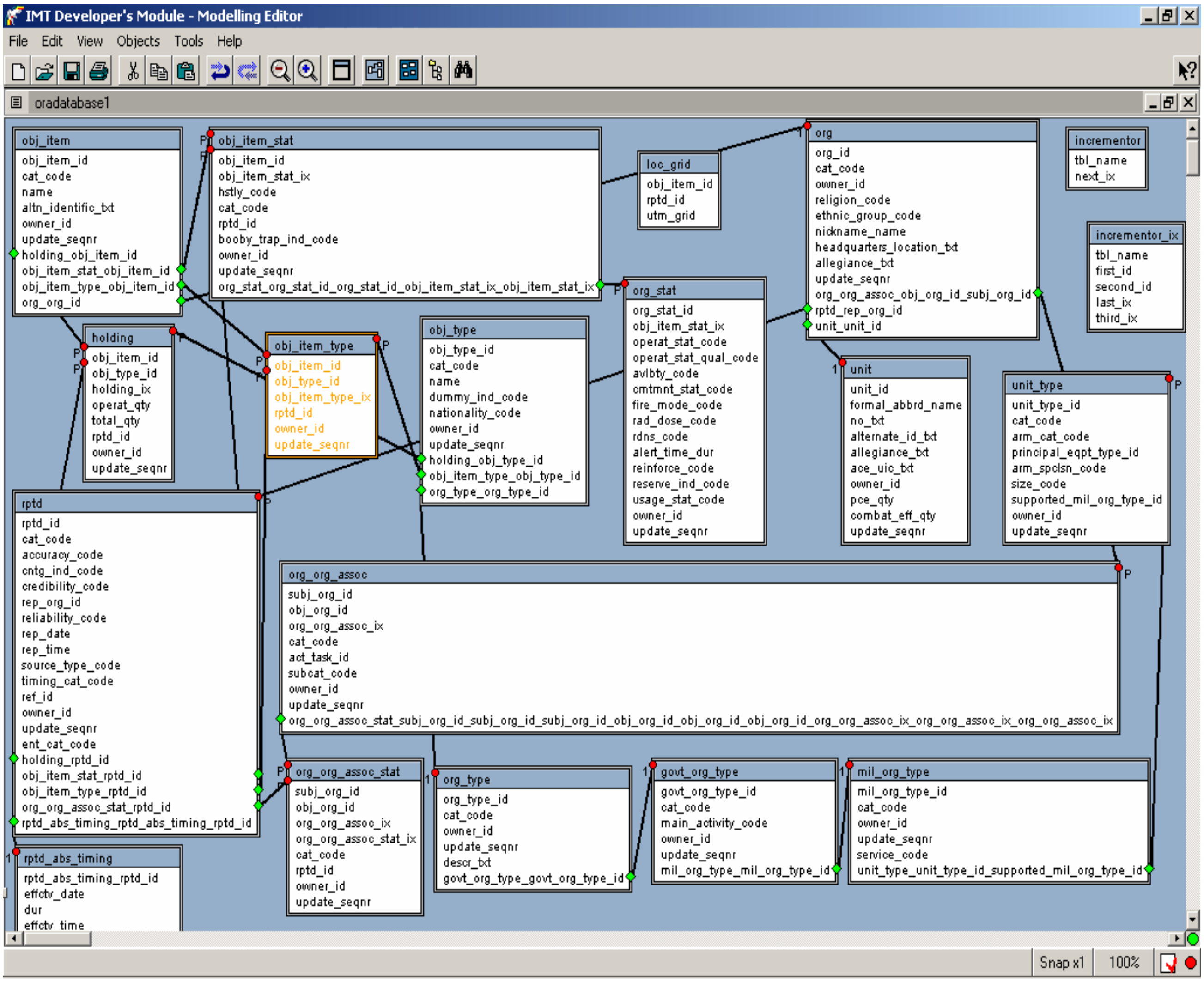

Figure 3: ATCCIS Baseline 2.0 Version 5 IRIS/IMT Model (Partial)

4. System Architecture

So far, all necessary pieces have been explained briefly to understand to over all system. In this part all system architecture that is formed with the pre-explained pieces is going to be described. The whole system architecture is shown in Figure 4. System can be separated 3 layers to investigate.

Layer I consists of TU- Military Message Handling System (MMHS) and can be thought as a input/output communicator layer. This layer is responsible for sending and receiving incoming/outgoing ADatP-3 formatted messages. Its main part is an MS Exchange Server (MSES). MMHS contains its own Directory Server that stores all e-mail addresses for the other nations.

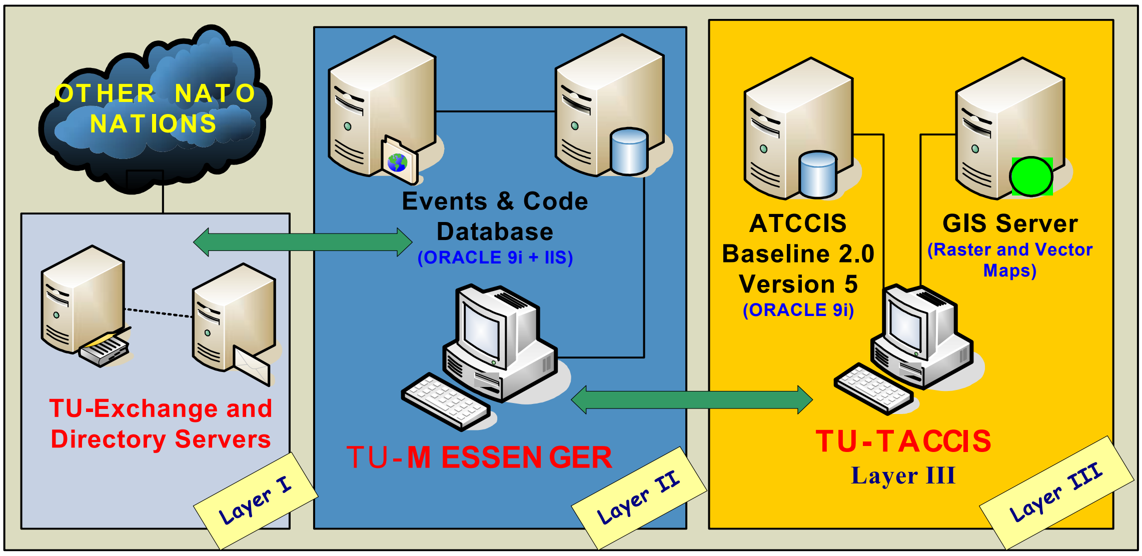

Figure 4: TU - System Architecture

Layer II is the most important part of the system. TU-Messenger program runs on this layer and it does all necessary actions for this system. System flow diagram is shown in Figure 5. Each nation has a profile on the TU-Messenger (TUM) program. It provides TUM to behave each received message in a different way. If a nation's system sends faulty messages, even after sending 5000th message possibly, sent message may still include the same fault unless system's bugs are corrected. Generally it is not possible to correct them in the middle of an exercise or an operation in a short time. So the key point is that the each nation has own profile to update the operational database via formatted messages. This profile includes adapted IRIS/IMT scripts according to that nation's system; special error correction steps adopted and designed peculiar to that nation's system. All of them are stored in Events & IMT Code Database.

When an ADatP-3 formatted message is received by MMHS, TUM detects this receiving action and gets its message body and header information from the MSES. After this step it starts to identify the message (NAVSITREP, NAVSITSUM, OWNSITREP, ENSITREP) and also updates the Events database to log this action. It starts to parse pre-received message, finds its errors and if it is possible, that errors are corrected automatically by TUM and logs the whole action. After this process Operational Message (OPM) is obtained and is ready to update operational database. Unless it is possible to correct the errors, program sends a signal to warn an operator to stimulate the operator something is wrong.

After receiving that signal, the operator starts detecting how to correct the error and how to update the operational database via this formatted message. If it is possible to find the solution, operator is generated a new mutant Express-X code and stored in the Events & IMT Code Database in that nation's profile to use other incoming formatted messages sent by this nation. This process is done only one time. Once this step is completed, all the necessary steps which were regenerated can be used for new messages continuously.

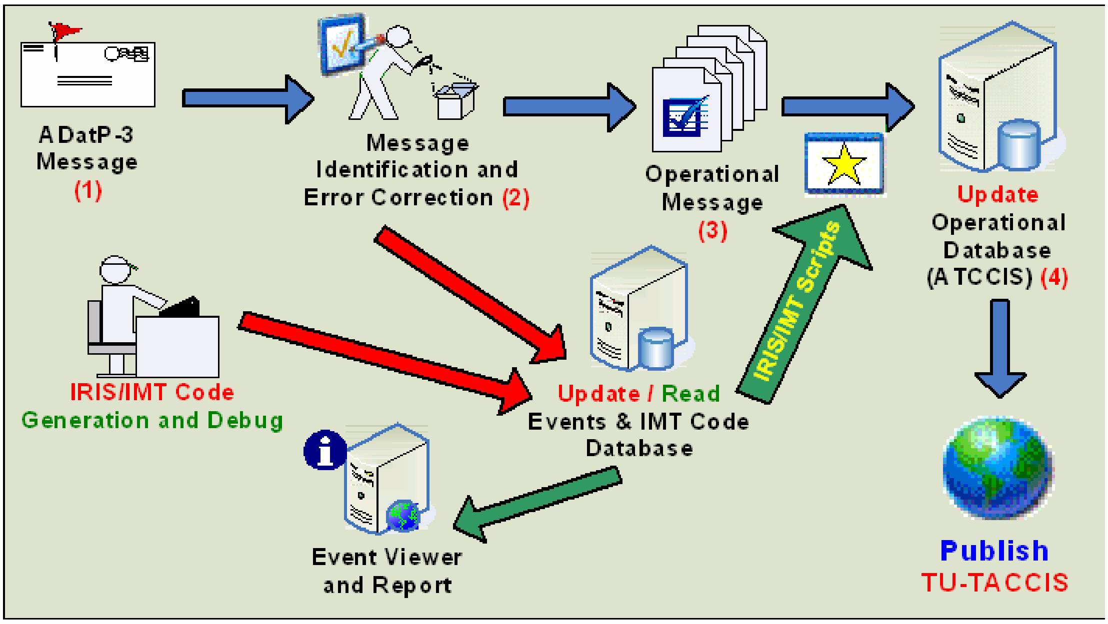

Figure 5: Processing an ADatP-3 Message

After operational database is updated via operational formatted message, TUM sends a signal to the TU-TACCIS to declare new message is received and units and its situation are updated then TU-TACCIS updates its state and shows the new situation on the display. Because each action occurred in the system is logged, everything can be displayed via Event viewer and Report module.

Event viewer and Report module provides to observe all the events (message is received, message is parsed, an error is found, profile is updated, database is updated successfully... etc) and errors occurred in the system (set is missing, data code is not valid in FUD XXX/X … etc.) and report it to users. Report part of this module was developed with Active Server Pages (ASP) technology on Internet Information Server 5.0 (IIS) and logging part is developed via Borland C++ Builder 6.0 programming tool.

Layer III is the gate which opens he real world to visualize what is happening in the database side. After receiving each formatted message, the operational database is updated and TU-TACCIS updates the situation on the display and it has one different function. It also provides the generated formatted message from the situation display. When a user selects a unit or units, it is possible to send its information via an ADatP-3 formatted message.

This time reverse workflow exists. This process is shown in Figure 6. Process starts with user selection of units desired to be reported then TU-TACCIS sends all the necessary information required for generation operational message and sends it to the TUM. Once TUM receives this information, it easily converts it from natural text format to ADatP-3 format. TUM prepares an e-mail message and puts the operational ADatP-3 formatted message in it. Finally TUM delivers prepared e-mail message to the MMHS.

Error Correction

Different error types have been detected from previous messaging experiences so far. These errors cause interoperability problems because faulty messages cannot be parsed and generally necessary information obtained from the formatted message cannot be stored in a database. So sometimes error correction algorithm usage is vital to obtain newer and more valuable information from the faulty formatted messages.

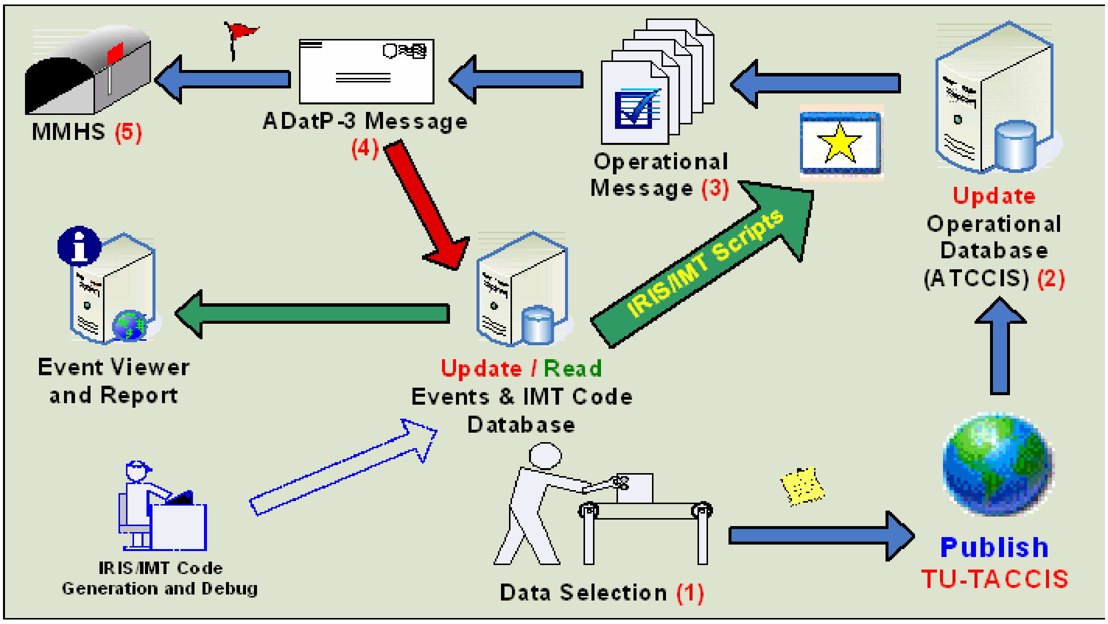

Figure 6: Generation of ADatP-3 Message

Formatted message errors can be classified in two types. One of them is Semantic error and the other is structural error. Semantic error cannot be corrected completely but sometimes it is possible to correct structural errors. Reference formatted message structures can be used to correct these errors thanks to ADatP-3 Baseline. Incoming message structures are compared with the reference model in ADatP-3 Baseline and than this comparison discrepancies are obtained. For instance these discrepancies can be invalid or deficient set names, missing fields, invalid data codes/items etc. By using these discrepancies it is possible to correct some of them. TUM uses an algorithm to correct errors. Algorithm senses the differences from the reference model and applies pre-defined rules and then that part of the message is replaced with corrected pieces. Correction rules are classified and stored in a database. According to error type, TUM applies these rules that are related to that error. If the message errors are corrected partially or cannot be corrected, TUM stores that message, and history of applied rules in the database and sends a signal to an operator. After realization of this situation, the operator tries to develop new rules to correct error. If the operator finds the way of error correction successfully, the whole error correction procedure is transformed into a rule, and store in the rule database to use it in the error correction processes else unfortunately nothing is done with that message. Nation's profiles include these error correction rules. This means that each nation's profile consists of some rules unless core IRIS/IMT scripts cannot be used to data mapping between formatted message and database.

Another difficulty is called code mismatching(but not an error) which is the data code maladjustment between ADatP-3 formatted message data items and ATCCIS Baseline 2 Version 5 domain values. Several data items are not the same as the domain values in ATCCIS data model. Unless a data item from formatted message is the same as the domain value in ATCCIS data model (due to an Oracle database constraint), it cannot be stored in the database. For example unit size indicator field in the ORGIDSCE set in ENSITREP contains data items. One of them is "BATTLE GROUP" and its data code is shown "BG". But unit size indicator has a different domain value in the ATCCIS data model. Battle group is shown with "BATGRP". This is not the only one situation. A lot of code mismatching is encountered during mapping process. Code mismatching can be overcome via using lookup tables. TUM does this action automatically while it is parsing the incoming formatted message.

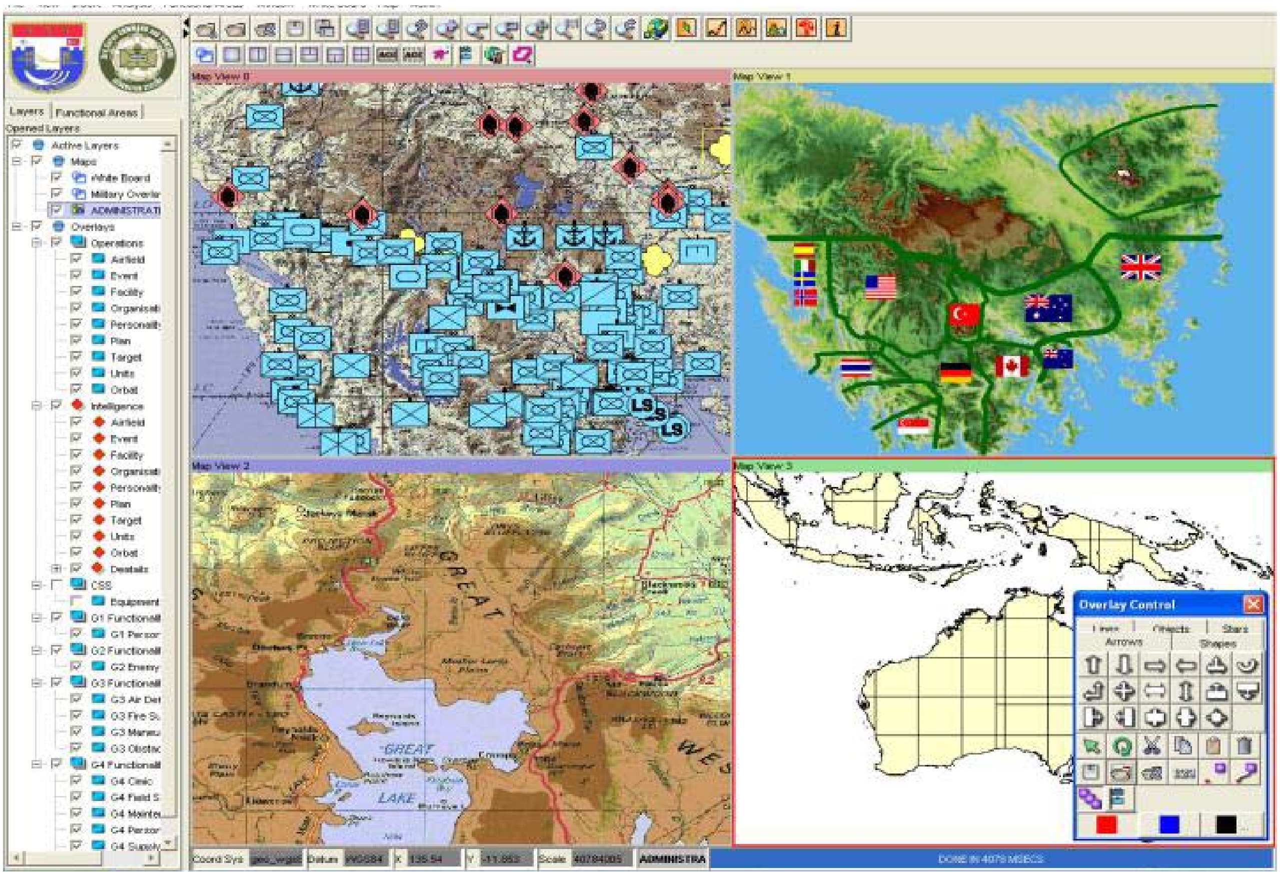

Figure 7: TU-TACCIS Operational Display

Now TUM is still developing software. After gaining lots of experiences, TUM was modified for a new approach. Now TUM is a Adaptive – Self Adjustable Message Processor *WITHOUT* Guidance. A Neural Network module was developed and integrated to TUM. This module trains itself from incoming messages automatically and generates the correction rules. TUM Neural Network module can be trained online or offline via back propagation algorithm.

Conclusion

A new approach was implemented to process ADatP-3 formatted message. New system can be defined as an Adaptive – Self Adjustable Message Processor with guided manner. This system learns how to correct some errors from the operator (guide) and uses this experience for processing the subsequent incoming messages. Fixed systems sometimes cannot be successful to process formatted messages. Fixed structure does not allow adapting itself into extraordinary situations. This handicap is overcome by designing the adaptive and self adjustable systems. TUM learns all the necessary correction rules with guidance of an operator and then it uses these experiences in the following another formatted message processing. TUM does not behave each nation in the same manner. It adapts itself according to incoming messages from a nation's system and then gives formatted messages with unique response accordingly.

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