DECISION SUPPORT SYSTEM FOR A COMMANDER AT THE OPERATIONAL LEVEL

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Abstract: A current trend in command and control visualization systems is to show a real situation in relation with 3D terrain data and real information about objects, tactical symbols, waters, woods and roads as well. Implementing the Network Enabled Capability (NEC) concept is the main transformation process in the Czech Army. The one of the main NEC outputs is a common operational picture. This article deals with a design and an implementation of services for common operational picture data visualization supported by Service Oriented Architecture. The article is built on a current status of a NEC implementation process. The main output of this project is a prototype of visualization system that can be used by a commander and its staff at the brigade level. The operator can easily see the real situation at the theatre supported by LINK 16 standard and a connection with Czech ground C2 system and virtual reality devices. This system is designed to support decision making process of a commander.

1 INTRODUCTION

The industrial age began in 18th century. Energy and engines were widely used in this age. The information age was its successor. In this age, in 20th century, a value is gained by information sharing and communication nets using. The information age also affected the warfare. The main factors of information age in the warfare are:

- Data and information;
- Communication environment;
- Security;
- Interoperability;
- Warfare digitalization.

The warfare digitalization can be characterized by using an information technology in the processes of data acquisition, data storage, data transformation, data change and data and information evaluation in the area of interest of the warfare. The main aim of the warfare digitalization is to create a shared common operational picture of the warfare. The common operational picture is the main instrument of the Networked Centric Warfare (NCW) concept in the US army and the Network Enabled Capability (NEC) concept in NATO nations. The common operational picture shows the commander the current situation in the battlefield in real time. He can easily see the position of friendly and enemy units. This must be supported by a communication and information infrastructure (CII). The CII includes sensors in high altitudes, unmanned aerial vehicles (UAV), alert radars, ground sensors, etc. The CII harvests data and transforms them into information that is used in the common operational picture. The common operational picture is usually displayed on the visualizations devices, such as monitor, LCD or projection system. The common operational picture brings better situational awareness.

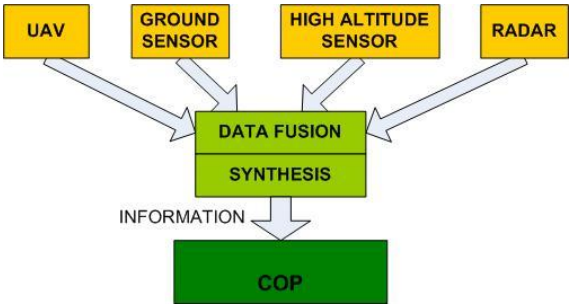

Figure 1: Common operational picture – architecture approach.

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2 VIRTUAL REALITY PROJECT IN CZECH C2 SYSTEM

In 2007, The Defense department of the Czech Republic accepted a new research project called:" Virtual reality devices in ground forces tactical command and control system (GFTCCS)". The project concentrates on increasing commander situational awareness at a tactical and operational level in three dimensional (3D) terrain visualization. This project is based on integration of virtual reality devices into command and control process.

The main project goal was a demonstration of a new presentation layer of GFTCCS with virtual reality devices. A global architecture of GFTCCS was designed in 1999 and its presentation abilities were obsolete. The commander could get information about battlefield in 2 dimensions (2D) only. The terrain spatial data were available but they were not used to visualize the battlefield in 3D. Communication between the commander and GFTCCS was supported only by a mouse or keyboard. A resolution of visualized battlefield was given by output devices abilities - CRT or LCD monitors. The old presentation layer offers common features of Geographic Information Systems (GIS) such as zoom in, zoom out or movement of actual position over a map.

The main ability of GFTCCS is to show a position of friendly forces as it can be seen on the picture bellow.

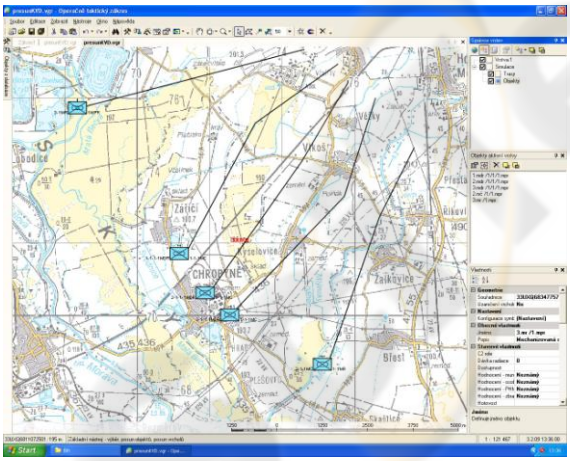

Figure 2: Old presentation layer of GFTCCS.

The new presentation layer comes out from experience with virtual reality devices in the modeling and simulation world. The virtual reality devices are heavily used in this field. Head mounted displays (HMD), data gloves and tracking systems are implemented in the training process of individuals and units at the tactical level.

Knowledge of virtual reality devices opened a new way to command and control in military domain. The main idea is to increase the level and quality of information about battlefield. This can be rapidly increased by virtual reality devices. The actual battlefield situation is projected into HMD in very high resolution. The commander can operate the virtual reality environment by head movements. The left head rotation moves the current scene into the left area of interest. The right head rotation works on the contrary. The movement of the whole body of commander creates effect of flying over the virtual terrain. The commander can also use a data glove to communicate with a new presentation layer. Predefined gestures can manipulate the virtual reality battlefield. In this way, the commander can get the more detailed information about the area of interest, or detailed information about selected unit. The HMD and data glove is tracked by tracking sensors to get the information about head and hand position. The important fact is that the current situation of the battlefield is projected in 3D. This feature is supported by terrain database generator. It offers 3D model of the area of interest created from digital map resources. This data can be shared by GTFCCT or duplicated in special data storage.

The picture bellow shows the current view on the battlefield in 3D. This scene is projected into HMD and the commander can use virtual hand to work in virtual reality environment.

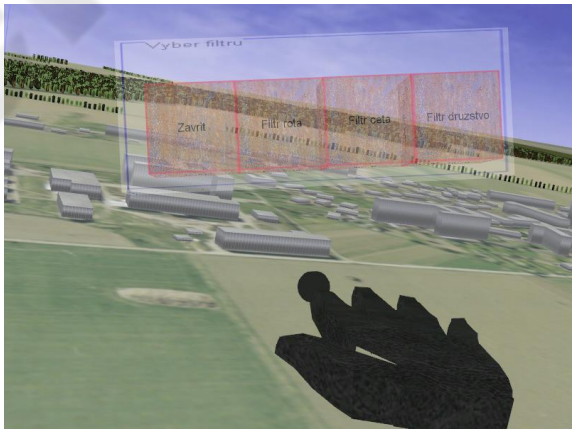

Figure 3: New presentation layer of GFTCCS.

The new presentation layer with virtual reality devices is designed to be used at the brigade level.

3 NEW PRESENTATION LAYER ARCHITECTURE

Essential applications of GFTCCS that must be used in a new presentation layer with virtual reality devices (PLVR) are tactical situation (TS), identification of friendly position (FP), identification of enemy position (EP), electronic overlays (EO). These applications create inputs from GFTCCS into PLVR and are used to visualize quantitative and qualitative information about friendly and enemy forces and other battlefield objects. The picture bellow shows the global architecture of design of a new presentation layer GFTCCS.

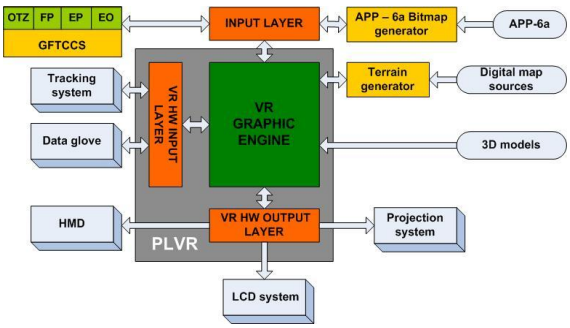

Figure 4: PLVR architecture.

Input layer is designed as a web service. It can be implemented as Service Oriented Architecture (SOA) for interoperability achievement in the case of interconnection with another C2 system. This layer provides services such as current position of friendly units. This layer offers connection into MS SQL Server in an implementation scope. MS SQL Server contains data about position of units and its code for visualization of tactical symbol in APP – 6a. MS SQL Server contains complementary data about units and its hierarchy. This information can be used in an aggregation function. Input layer also provides bitmap representation of APP – 6a tactical symbol.

Terrain database generator offers 3D model of the area of interest that is prepared from map sources. This digital data are shared in GFTCCS or can be located in data storage. The generation is power consuming operation thus runs separately on a local computer based on 64-bit platform. The connectivity with graphics engine is solved by SOA implementation. VR HW input layer supports interconnection between the data glove and a graphics engine and also interprets its positions into VR environment coordinate system. It is implemented as API with local function call. This layer also implements gesture recognition and translation that can be used by the commander to operate the VR environment.

VR graphic engine visualizes the area of interest in 3D with data from input devices, input layer and preprocessed 3D model of trees, roads, buildings, etc. The final scene is sent into VR HW output layer that must correct it to visualize in HMD, LCD systems, projection system or combination of already mentioned devices.

Figure 5: Panoramatic visualization.

4 DATA REPRESENTATION

The current state of the art in data representation is set by the US Force XXI Battle Command Brigade and Below (FBCB2) system and its new presentation layer component Command and Control in 3 dimensions that renders the battlefield information into a 3 dimensions environment in real time (“CG2 C3D”, 2007). But this solution uses neither VR devices nor tactical symbol representation in 3D. Data representation is based on ontology that was designed to interpret knowledge of NEC concept for human being (Hodicky, 2009). Topic maps method was chosen to describe information of NEC domain. Tactical symbols are visualized as a block or a spatial object that is semi transparent. They have also the APP – 6a bitmaps on the surfaces and other important information about current status of unit. Additional information (combat efficiency, velocity, fuel, etc.) are visualized as bar graphs.

5 POSSIBLE ENHANCEMENTS

A new presentation layer with VR devices creates a supplementary tool to get common operation picture of ground forces. The main tool that support command and control process remains the old presentation layer. A new one enhances the GFTCCS ability to show the common operational picture in 3D. Information from air forces domain can be also sent into this presentation layer. The current communication between aircrafts and ground

support system is based on tactical data link called LINK 16. The new presentation layer is designed as open architecture. We can easily modify input layer, especially web services that will interpret LINK 16 code into graphics engine. It can support joint operation between ground and air forces. In the joint operation center the commander can see the position of aircrafts, helicopters and ground forces as well.

This presentation layer is designed to support staff at the brigade level. GFTCCS is currently able get information about units' positions. It is not possible to get information about vehicles and individual soldiers. This should be changed this year. After this improvement, the presentation layer can be easily transformed to visualize battlefield with models of individual vehicles and even soldiers. This can support battlefield operation for intelligence units or tactical units at the company or battalion level.

The VR HW output layer can be also modified to be able to connect to projection system that will be used by commander staff in the same time as the commander.

Figure 6: Prototype of HW realization.

6 CONCLUSIONS

The new presentation layer with virtual reality devices is a support tool that shows the common operational picture to the commander at the brigade level. It visualizes the area of interest in real time into HMD in relation with 3D terrain data and units' positions. It supports the decision making process of a commander. The picture bellow shows the prototype of HW realization of the new presentation layer. This system with only a few modifications has been deployed in the field exercise Network Challenge on May 2009 at the brigade level and was favorably accepted. The level of battlefield knowledge was increased by 3D terrain implementation and a new style of data representation.

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