

**Bartosz Czaplewski*, Sylwester Kaczmarek*,
Jacek Litka*, Mariusz Miszewski***

VISUALIZATION OF EVENTS USING VARIOUS KINDS OF SYNCHRONIZED DATA FOR THE BORDER GUARD

ABSTRACT

STRADAR project is dedicated to streaming real-time data in a distributed dispatcher and teleinformation system of the Border Guard. The Events Visualization Post is a software designed for simultaneous visualization of data of different types in BG headquarters. The software allows the operator to visualize files, images, SMS, SDS, video, audio, and current or archival data on naval situation on digital maps. All the visualized data can be synchronized in time.

Key words:

Border Guard, data visualization, distributed systems, multimedia.

INTRODUCTION

STRADAR [1] is a project designed for the use of the Polish Border Guard. Its main purpose is to allow for visualization of events that were noticed and indicated by generation of an appropriate 'task'. STRADAR allows for the generation of the tasks both by the operators working in the Border Guards stationary centers, as well as operators working in the mobile unit. The project itself is a continuation of the previous project KONSOLA [2, 3]. Assumptions, requirements, implementation concept, methods, and analytical models can be found in [1, 2, 3].

* Gdansk University of Technology, Faculty of Electronics, Telecommunications and Informatics, Department of Teleinformation Networks, 11/12 Gabriel Narutowicza Str., 80-233 Gdansk, Poland; e-mail: {bartosz.czaplewski; kasyj}@eti.pg.edu.pl; jacek.litka@onet.pl; mariusz.miszewski@dgt.pl

The project's principle is to allow an operator to visualize multimedia data corresponding to an observed event. For this purpose, a solution consisting of number of entities connected through an IP network has been proposed. The most important entities of the system are: Center Server (CS) which is tasked with the management of reported tasks and hosts the Map Server (MS) application designed for the purpose of the project, Archival Server (AS) which stores archived multimedia data regarding events that occurred and Events Visualization Point (EVP) which is designed for visualizing multimedia data for tasks generated by itself, as well as tasks generated by the operators in the field. The generated tasks may be vessel-oriented and in that case the data is gathered by a number of geographical information gathering tools (e.g. AIS, ARPA radars, GPS) and stored in the MS. In this respect, the discussed solution is similar to Vessel Traffic Systems (VTS) which have been discussed in [4, 5].

The Event Visualization Point is a software-based solution installed on a PC with connected two displays. One of them is a management screen which is used to manage and create tasks and their multimedia elements for visualization. The second display is a multidisplay which a set of monitors that work together as a single logical display of high resolution. It works as a surface on which multimedia data regarding tasks is visualized. The multimedia data that can be visualized include: SMS and SDS, video streams (both archival recording from AS and live camera streams), audio streams, maps with data regarding situation on the sea (both archive and live), images and files. The EVP allows to synchronize the data of multiple types. Data is accessed from the AS based on the appropriate query.

The article focuses on a general description of the functionality available to the user. This functionality is due to the wishes of the Border Guard, which outlines the assumptions and design requirements. In the article we present only a general description of the system due to the high level of detail of the system and the need to maintain confidentiality about the details of the project. Due to the limited volume of the article, only a fragment of the functionality of the system is presented.

NOTIFICATION OF NEW VISUALIZATION TASKS

Notification of new visualization tasks can be performed in EVP application or in dispatcher application at stationary or mobile consoles (fig. 1).

The first thing to be done to generate new visualization task is to declare a priority and optionally add a text description about the task. Then, the operator



has to add some elements to the task, that can be of various types: map, object browser, file/image, SMS/SDS, video, or audio. Every task must consist of at least one element, and simultaneously there is no upper limit to the number of elements in the task. The operator can choose to add an element from a macro, which is a predefined and saved form of an element, or to define a custom element. Macros allow for quick designing of tasks consisting of frequently used elements, while the advanced form for unique elements is still available to the operator.

The screenshot shows the 'Generowanie nowego zadania' (Task Generation) window. It is divided into two main sections: configuration on the left and a task preview on the right.

Configuration Section (Left):

- Buttons:** Wyślij zadanie, Historia, Wyczyść, Zamknij.
- Fields:** Login operatora: CzuplewskiBartoszSWZ; Priorytet zadania: normalny; Notatka do zadania: Sprawdzić obraz z kamery 9.
- Task Element Type:** nagranie wideo (with buttons: Modyfikuj, Zapisz formularz, Anuluj).
- Stream Type:** strumień bieżący, strumień archiwalny.
- Recording ID:** (empty field).
- Map Objects:** (empty field).
- Camera ID:** 9.
- Source ID:** (empty field).
- Operator Login:** (empty field).
- Coordinate Format:** DMS, DD.
- Geographic Width:** od 55°55'00"N do 55°00'00"N.
- Geographic Length:** od 33°00'00"E do 33°32'57"E.
- Start Time:** nieokreślona, określona.
- End Time:** nieokreślona, określona.
- Recording Duration:** od [] do [] (empty).
- Search Type:** subskrypcja, archiwum.
- Recording Note:** (empty field).

Task Preview Section (Right):

- Buttons:** Liczba elementów: 6.
- Table:**

[Czas wystania]		[]	[]	[]
1	Mapa	[]	[]	[]
2	Przeglądarka obiektów	[]	[]	[]
3	Plik/zdjęcie	[]	[]	[]
4	SMS/SDS	[]	[]	[]
5	Nagranie wideo	[]	[]	[]
6	Nagranie audio	[]	[]	[]

Fig. 1. A view of TaskGeneratorControl during the generation of new visualization task [own work]

In case of the custom element, after selecting the desired type of element, the operator has to define its parameters. Defined parameters will be used as search filters for the AS. Every element must consist of at least one defined parameter although the operator can define all the parameters. In the case of multiple defined parameters, the search filter will be a logical conjunction of them all.

The set of parameters for the element type of video recordings is as follows:

- current or archival stream indicator;
- video ID;
- naval object IDs associated with the video;
- camera ID;
- login of the operator who uploaded the video;
- source ID from where the video was uploaded;



- geographical coordinates associated with the video;
- time of creation of the video recording;
- duration of the video recording;
- subscription indicator;
- text note attached to the video recording.

The set of parameters for the element type of situation on map is as follows:

- current or archival situation indicator;
- range of geographical coordinates;
- naval object IDs for presentation of more detailed information;
- naval object IDs for presentation of trails of traveled routes;
- filtration rules for symbols of naval objects;
- filtration rules for labels of naval objects.

The operator has access to a history of previously sent tasks, which he can browse and select tasks to resend them or to modify and then resend them.

When the task and its elements are ready, it can be send to the CS. If the task was defined in EVP, it's sent directly to the CS. Otherwise, i.e. the task was defined in stationary or mobile console, it's sent to the Universal Radio Controller (URC) which redirects it to the CS. The list of all the tasks is man-aged in the CS.

MANAGEMENT OF TASKS

After logging in the EVP, the list of tasks is presented on the right side of the management display of EVP (fig. 2). The list is updated after each change in the CS. Tasks can be sorted according to dates or priorities. Each task includes the list of elements presented by its type. For the purpose of presentation management, tasks can be minimalized to hide elements. The operator is able to accept, reject or preview a whole task or its specific element.

If the operator chooses to reject a task or a single element, then the EVP informs the CS about that fact and, after the response, updates the task list. The rejected task is completely removed from the system.

If the operator chooses to preview a task or a single element, then an additional user control appears, called TaskPreviewControl, which presents all the declared data on the task and criteria of the element, discussed in the previous Section. From there, the operator is able to accept or reject the selected task or element in similar matter than from the task list.



If the operator chooses to accept a task or a single element, then EVP informs the CS about that fact. The CS begins the dialogue with the AS to obtain a collection of metadata about documents that meet the search criteria defined in the element. After the response, the EVP updates the task list and notifies the operator that the collection of metadata is available in TaskPreviewControl for that specific element. Then the operator should preview the element and browse through the obtained metadata to select a desired data to visualize.

After the selection of metadata, the operator chooses a place for visualization on the left side of the management display (fig. 2), where a new user control appears, called ManagementControl, which is different depending on the type of the element and has multiple functions. Firstly, ManagementControl processes metadata and creates an appropriate visualization control on the multiscreen presentation display. Secondly, ManagementControl enables GUI for the operator to control the visualization process. For each element type, there is a different GUI for controlling the visualization process, which is specific to capabilities of a considered visualization control. In figure 2, examples for controlling of audio recordings (on the left) and image (in the middle) have been presented. Moreover, the operator can show or hide the metadata on the presentation screen below the visualized data. Thirdly, ManagementControl allows to move or resize the visualization control on the multiscreen display since it can be dragged across the screen. For the purpose of relocation of controls, the operator can use a customizable grid or move them freely.

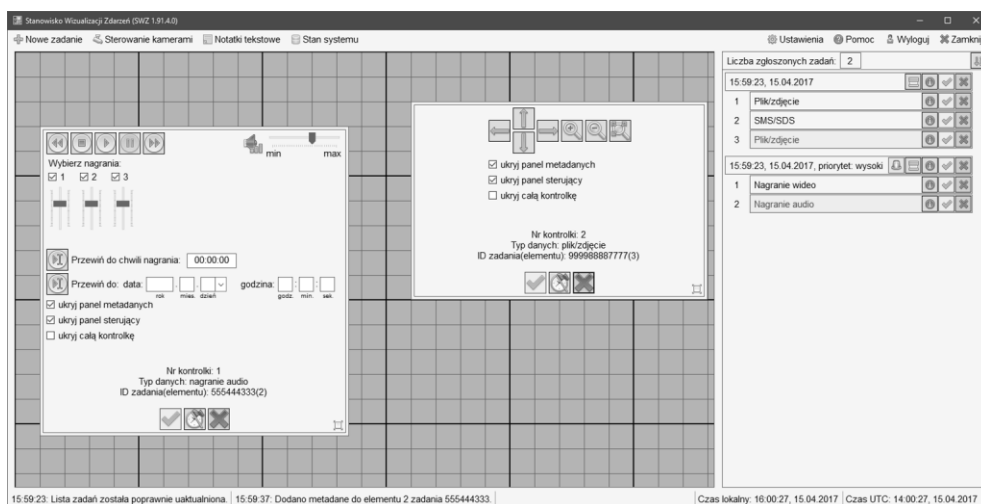


Fig. 2. A view of Events Visualization Post during operation [own work]

VISUALIZATION OF VIDEO RECORDINGS

One of the features of the EVP is an ability to visualize video streams regarding reported tasks. Both archive and live video can be managed and presented on the multidisplay. The video data is accessed from the AS by connecting to an appropriate RTSP video stream.

In order to visualize a video stream, the EVP initializes a new VideoUserControl object. A set of methods defined in VideoClassLibrary allow for communication between the EVP and the user control. This collection of methods is used to control the received video stream. GUI of the control is presented in figure 3 (in this case the metadata panel is hidden). To start visualizing the video stream a certain number of steps has to be taken. Firstly, the EVP sends a request for a search of metadata regarding a given task. After those metadata are received, a new VideoUserControl object is initialized. Next, the AddVideoMetadata method is called, which is designed to send the selected metadata to the control including, among others, an URL address of the RTSP stream to which the control connects to receive access to the stream.

From the operator's point of view, the functionality of the VideoUserControl can be divided into three groups:

- basic video player functionality: play, forward, backward, pause and stop;
- an advanced control over the stream: forwarding to the specified number of seconds of the stream, forwarding to a real time moment in the stream corresponding to a specified date, change of forward and backward step;
- presentation of the metadata.



Fig. 3. A view of VideoUserControl during the visualization of video recording [own work]



VISUALIZATION OF NAVAL OBJECTS ON DIGITAL MAPS

Visualization of naval situation on digital maps is realized by the MapControl which is a custom user control contained in the MapClassLibrary. MapControl is divided into two main modules: the map management module and the sender-receiver module. The map management module is responsible for rendering the map, controlling the map engine, providing the graphical user interface, forming request messages to the database, and interpreting reply messages from the database. For the rendering of digital maps, MapControl uses the TatukGIS map engine. The sender-receiver module is responsible for communication with the MS in the CS.

The data for visualization in MapControl is provided by the MS in the CS. The data may come from the following sources: AIS receivers and radars of the Marine time Office delivered via web service, AIS receivers on mobile units of the Border Guards, ARPA radars on mobile units of the Border Guards, GPS devices on mobile units of the Border Guards.

The important fact is that the automatic deduplication of supervised objects is performed in the MS. This means that e.g. if a single object was detected by ARPA radar and AIS receiver, then the data from both sources will be identified and merged into one object. The graphical user interface for the visualization of naval situation on digital maps is presented in figure 4.

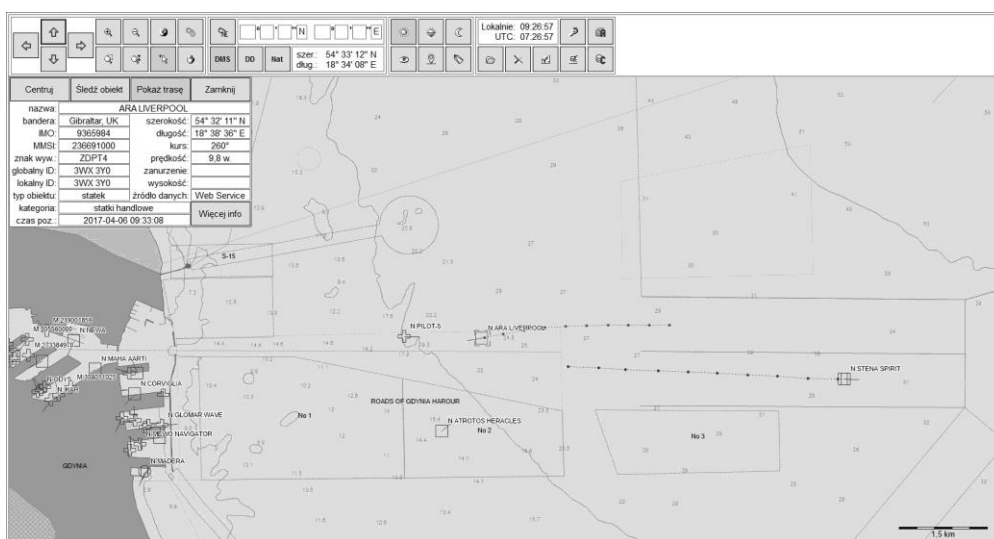


Fig. 4. A view of MapControl during the visualization of naval situation of digital maps [own work]



The brief list of the most important functionality for data visualization on digital maps is as follows:

- rendering of digital maps in various formats (optimized for S-57 maps);
- filtering of displayed layers and sub-layers of digital maps;
- selecting of any geographic coordinate system by EPSG code;
- presentation of geographical coordinates in DMS and DD formats;
- navigating through the map using buttons or the cursor;
- presentation and filtering of categorized graphical symbols of the objects;
- presentation of panels with detailed information on the objects;
- presentation of trails of traveled routes by the objects;
- tracking of a selected object;
- reconstruction of archival situation on the map with different playback speeds;
- downloading data from the CS;
- presentation of the current local time and UTC.

SUMMARY

The EVP, which is a part of the STRADAR project, is a solution for precise monitoring of activities in regards to the works of Border Guard which leads to improving the quality of observation and increasing marine time safety. Cooperation with the Archival Server and the Map Server and a variety of multimedia user controls allow different types of data to be synchronized in time and simultaneously displayed on a high-resolution display. The functionality presented in the previous sections are not all the system functionality but only a small portion. Other system features will be outlined in the following articles.

Acknowledgements

This work has been co-financed by NCBiR (National Center for Research and Development), projects DOB-BIO6/10/62/2014.



REFERENCES

- [1] Blok M., Czaplewski B., Kaczmarek S., Litka J., Narloch M., Sac M., *The system of the supervision and the visualization of multimedia data for BG*, 12th Int. Conf. Marine Navigation and Safety of Sea Transportation TransNav 2017, Gdynia 2017.
- [2] Blok M., Czaplewski B., Kaczmarek S., Młynarczuk M., Narloch M., Sac M., *Multimedia distributed system for visualization of ongoing and archival events for BG*, 7th Int. Conf. Naval technologies for defense and security NATCON 2016, Gdańsk 2016, pp. 61–76.
- [3] Czaplewski B., Cwalina K., Blok M., Kaczmarek S., Miszewski M., Młynarczuk M., Sac M., *A system for visualization of operational situation on digital maps for mobile units of the Border Guard*, 7th Int. Conference Naval technologies for defense and security NATCON 2016, Gdańsk 2016, pp. 51–60.
- [4] Eide M. S., Endresen Ø., Brett P. O., Ervik J. L., Røang K., *Intelligent ship traffic monitoring for oil spill prevention: Risk based decision support building on AIS*, 'Marine Pollution Bulletin', 2016, Vol. 54, Issue 2, pp. 45–148.
- [5] Tetreault B. J., *Use of the Automatic Identification System (AIS) for maritime domain awareness (MDA)*, MTS/IEEE Oceans Conference 2005 OCEANS '05, IEEE, Washington D.C. 2005, pp. 13–17.

WIZUALIZACJA ZDARZEŃ PRZY UŻYCIU RÓŻNYCH RODZAJÓW DANYCH DLA STRAŻY GRANICZNEJ

STRESZCZENIE

Projekt STRADAR jest poświęcony strumieniowej transmisji danych czasu rzeczywistego w rozproszonych systemach dyspozytorskich i teleinformatycznych Straży Granicznej. Stanowisko wizualizacji zdarzeń jest oprogramowaniem przeznaczonym do jednoczesnej wizualizacji danych różnych rodzajów. Oprogramowanie to umożliwia operatorowi wizualizację plików, zdjęć, SMS-ów, SDS-ów, nagrań wideo, nagrań audio oraz bieżących lub archiwalnych danych o sytuacji na morzu na mapach cyfrowych. Wszystkie wizualizowane dane mogą być zsynchronizowane w czasie.

Słowa kluczowe:

Straż Graniczna, zobrazowanie danych, system rozproszony, multimedia.

