

Application support for tactical and technical control of artillery units – PVNPG-14M

Martin Blaha, Milan Kalina, Karel Šilinger

Abstract—This paper is focused on Application support for tactical and technical control of artillery units – PVNPG-14M, especially on setting a method of determination of Fire for Effect firing data in the perspective of automated artillery fire support control system. Artillery units of the Army of the Czech Republic, reflecting the current global security neighborhood, can be used outside the Czech Republic. The paper presents principles, evolution and functionality in the process of complete preparation, from results arising from creating a fictional auxiliary target; by using an adjustment gun; abridged preparation and simplified preparation. The paper presents expertise using of application of current Artillery communication and information system and suggests the perspective future system.

Keywords—Fire for Effect, Application, tactical and technical control of fire, automated fire system, software development.

I. INTRODUCTION

THE basic task of artillery weapon systems is an indirect firing, thus keeping fire on targets kilometers away and beyond the line of sight. Calculation of the **fire elements** is a lengthy process based on the mathematical apparatus of several disciplines such as Ballistics, Meteorology, Geography and Theory of probability. Automation of the entire process of calculation of fire elements accelerates and reduces the likelihood of errors.

At the same time, the user removes the necessary knowledge of basic principles and procedures for calculating the fire elements of fire and creates the illusion of correctness of himself. Because of the destructiveness of artillery fire, the feelings of perfection cannot be relied upon. The basic operating rule of tactical using of artillery fire is supervised calculated of fire elements for fire at a target before real start.

Artillery of the Czech Army identified deficiencies in the ability to conduct timely, best simultaneous control outputs its primary automated fire control system, and calls for the introduction of substitute and control software – **PVNPG-14M** to calculate and control fire elements for the firing. To fulfill their supervisory functions must

software fully respect the valid artillery procedures of manual (classical) calculation of fire elements. From the perspective of the application, software must be open for easy deployment of internal adjustments and additional functions, use common programming language and allow install and run on modern touch platforms with the Windows operating system, which is implemented in the Czech Army.

II. SOFTWARE DEVELOPMENT

A. Development tools

Applications PVNPG-14M is completely programmed in C # for Windows Store applications. C # for Windows Store is a cross-platform programming language as it can be compiled for both desktop processors and ARM processors.

As a development environment is used Visual Studio Express 2013, which is equipped for developing Windows applications store. To access to persistent data it used SQLite database, which is under the administration of the application. The database is stored as a file with the extension pdb.

To communicate with the database is used open-source NuGet package *sqlite-net* from Frank Krueger.

B. Target platform

PVNPG-14M application is developed under environment Windows Metro, which is supported by Windows 8 and above, and Windows Phone 7 and above. Application control is tuned for touchscreen devices, but the application can be used on devices that do not have a touchscreen.

Windows 8 uses a native WinRT library, which supports the programming languages C, C ++, C #, VB or JavaScript. These languages can be combined with other languages to define the appearance of the application, XAML or HTML / CSS. XAML is a special language based on XML to define the graphical interface.

For optimal performance, it is advisable to mix the languages C, C ++, C #, VB and XAML with JavaScript with HTML / CSS.

WinRT library is illustrated in the following figure 1.

C. Architecture of applications

Source codes are holding the object-oriented paradigm, which is used mainly the composition of classes and class inheritance. With a large extent it is used the ability of the language C # to automatic data management, called Binding. This principle uses a public class whose instances are

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Martin Blaha is with the University of Defence, Brno, 602 10 CZECH REPUBLIC (phone: 973-443456; e-mail: martin.blaha@unob.cz).

Milan Kalina is with the University of Defence, Brno, 602 10 CZECH REPUBLIC (phone: 973-443456; e-mail: mar.blaha@email.cz).

Karel Šilinger is with the University of Defence, Brno, 602 10 CZECH REPUBLIC (phone: 973-443456; e-mail: karel.silinger@unob.cz).

kept in ObservableCollection, which is the mediator between the container that displays data, and instances of the class that stores the data. If the data is changed in a container, such as deleting, then automatically translates the action of a given instance of a class will therefore be canceled. With this feature, the source code much easier and simpler. The disadvantage of this principle of the management of application data is the locality of all elements in the container, so it is impossible to access without using a unique name.

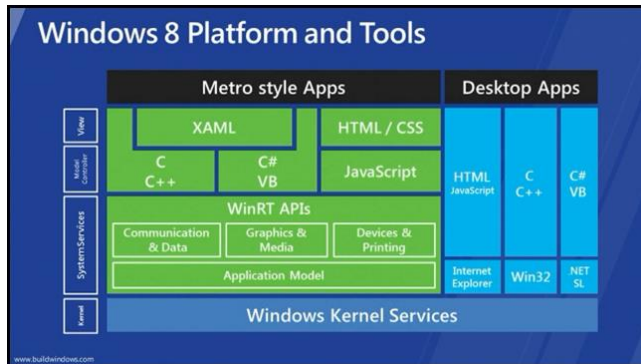


Fig. 1 WinRT

The basic core of the application is divided into website, a class enriched of XAML definition, and static class that kept the methods used across applications. Within applications, there is one special class created when the application starts.

From this class is created an instance of the main class, which serves as a container which is used to display the individual sections of the application.

Application architecture describes the following figure 2.

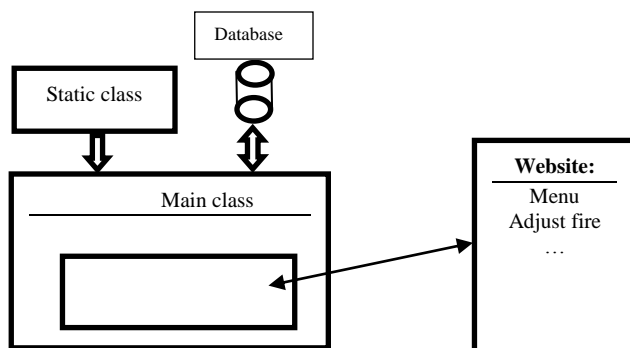


Fig. 2 Scheme of architecture of PVNPG-14M

III. EXPERTISE USING OF APPLICATION

There are several ways to set firing data for Fire for Effect (FFE) of artillery units. They differ in accuracy and terms, which permit us to apply FFE. For FFE it is important to decide the most accurate way of setting the firing data in every situation.

This decision making action was provided by artillery commanders during training activities, where they generally had only instruments and information, which usually resulted

in one and the only way of setting firing data for effective fire. While using Artillery Fire Support Control System (PVNPG-14M) it is necessary to define specific terms for setting firing data for effective fire by different means.

Firing data for FFE can be set by these methods:

- Complete preparation – Accurate Predicted Fire (APF);
- By results from creating fictional auxiliary target;
- By using an adjustment gun;
- Abridged preparation;
- Simplified preparation. [26]

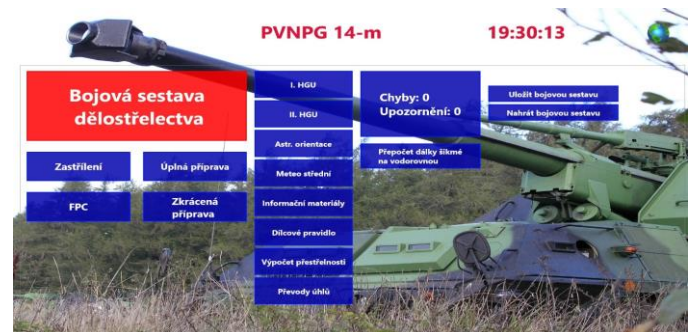


Fig. 3 Main menu

A. Accurate Predicted Fire

The Complete preparation (APF) is the way of setting FFE firing with such accuracy that adjustment of fire is not necessary. This is the key to achieving the effect of surprise.

Due to this reason APF is the main way of setting firing data for effective fire. For calculation of data using complete preparation these measures have to be included:

1. Topographical-geodetically preparation;
2. Reconnaissance and target detection;
3. Meteorological preparation (Fig. 9);
4. Ballistic preparation.

B. Fictional auxiliary target creation – Registration fire

According to the results of fictional auxiliary target creation (FPC) it is possible to determine data for FFE with such accuracy, after which it is not necessary to adjust fire. At the same time the following restrictions have to be met:

- observer distance of created FPC cannot exceed artillery reconnaissance instruments technical possibilities (Fig. 6);
- adjusted distance and direction corrections can be used only for projectiles with the same table corrections for fire conditions changes;
- time period of validity for values, determined by fictional auxiliary target creation is up to 3 hours;
- switch of fire by simple method can be used in the case of high-pitched trajectory fire, if the difference between the fictional auxiliary target bearing and eliminated target bearing (switching angle) equals 300 dc or if it is smaller than 300 dc, and if the difference between fictional auxiliary target topographical distance and eliminated

target topographical distance equals 1 km or if it is smaller than 1 km;

- switch of fire by coefficient of fire method can be used in the case of flat and rounded trajectory, if the switching angle equals 300 dc or if it is smaller than 300 dc, and if the difference between fictional auxiliary target topographical distance and eliminated target topographical distance equals 2 km or if it is smaller than 2 km. [8]



Fig. 4 Section of combat artillery battalion

C. The application of an adjustment gun

A publication Pub-74-14-01 Pravidla střelby a řízení palby pozemního dělostřelectva establishment results in a statement that fire data for an effective fire can be determined by using an adjustment gun, if the fictional auxiliary target is created by one of guns of the whole battery and if a discrepancy between platoons (batteries) master guns and a battery master gun, which created a fictional auxiliary target, is known. [14]

Use of PVNPG-14M suppose directing fire from distracted fire positions and therefore from the one fire position area.

And so these tasks are not performed by fire batteries but by a specific number of guns, which can be considered as one compact unit. In this case it could be possible to determine firing data for FFE by switch of fire from a fictional auxiliary target. (Fig. 5)

The determination of firing data by using an adjustment gun could be considered as a good idea, if the subordinate task force will have an assigned fire unit, which would take a different fire position than other battalion fire units.

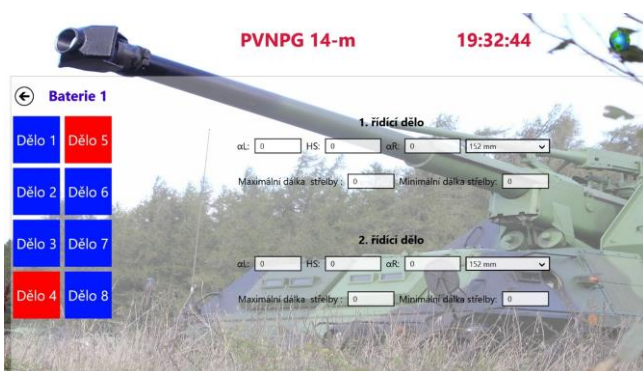


Fig. 5 Guns section - set the general direction of control gun

This situation may happen in a case when it is necessary to support a task force which is performing tasks on its own direction, this means in an area where the fire cannot be directed from the main fire position area because of too long a range of fire. Then it is excluded that units from the main fire position area and assigned fire units could conduct fire into the area, where they could use results of a fictional auxiliary target creation by the second fire unit.



Fig. 6 The submenu of setting observations and targets

The distance between fire positions is also very important. However, the publication Pub-74-14-01 does not set results of fictional auxiliary targets' validity by using an adjustment gun in terms of mutual distance between units, which created a fictional auxiliary target and which will use all the results for the determination of fire data for an effective fire. For a case where it could be possible to use an adjustment gun to determine fire data by a unit located in another area, the determined process is represented in a scheme - The way of setting fire data for an effective fire, an adjustment gun. [1]

PVNPG-14M by this way, mentioned above, finds a value of a discrepancy between all of the guns and a master gun, which had created a fictional auxiliary target. Then this value is multiplied by a table distance correction for the 1% change of a beginning projectile speed for the specific projectile, filling, topographical distance and the final value is added to adjusted corrections for a fictional auxiliary target. By this action we can get calculated distance for a target to engage.



Fig. 7 Section complete preparation - graph of corrections

Calculated direction (calculated side divergence) is obtained by a sum of topographical direction (topographical side divergence), adjusted direction correction

and the difference between derivations on an eliminated target and derivations on a fictional auxiliary target. (Fig. 7)

D. The Abridged preparation

In the publication Pub-74-14-01 it is mentioned that fire data preparation is considered as an abridged preparation, if any of all conditions are not met, or if there is data gained from a fictional auxiliary target creation used for a setting fire data and if these data are from 3 to 8 hours old. [3] In these cases, fire data for effective fire have to be set by adjustment fire. A decision-making process for considering achieving conditions is represented in a scheme - The way of setting fire data for an effective fire, using a complete preparation and according to results of a fictional auxiliary target creation. [8]



Fig. 8 Illustration of output correction using Abridge preparation

The fire data for effective fire set by abridged preparation can be used for effective fire without any adjust fire, if that fire is led by a battalion on a multiple target with a purpose of “Scotch”, where conditions for complete preparation are not met within a maximum of two points and at the same time these borders are not overstepped:

- fire positions coordinates are set topographically from the map of scale 1:50 000 and by using instruments;
- orientation bearings are set magnetically including the calculation of a compass correction, set in a 10 km distance from fire positions;
- target coordinates are set by some of the ways mentioned in table T-2.1 of publication Pub-74-14-01 with the level of accuracy 1,2 or 3;
- fire meteorological conditions are set from the meteorological message METEO-STŘEDNÍ PŘIBLIŽNÁ, which is not older than 1 hour and which is used up to 1600 m height;
- there is included only the change of initial shell speed, caused by wearing out of the barrel, where corrections for changes of all shell ballistic characteristics are calculated, which are mentioned in tables for fire. (Fig. 8, 9)



Fig. 9 Meteorological report

For PVNPG-14M it is necessary for this case to exactly set the number of firing guns. From the table T-1.4 from publication Pub-74-14-01 it is clear that the battalion can have 2-3 batteries and the battery can have 6-8 guns. This means that the battalion can have 12-24 guns. For PVNPG-14M, a principle can be formulated, that if the system sets 12 or more guns for fire on the multiple target with the purpose of “Scotch!” and if all conditions from the chapter Abridged preparation will be met, it will not be necessary to do an adjust fire for the setting of fire data for effective fire.

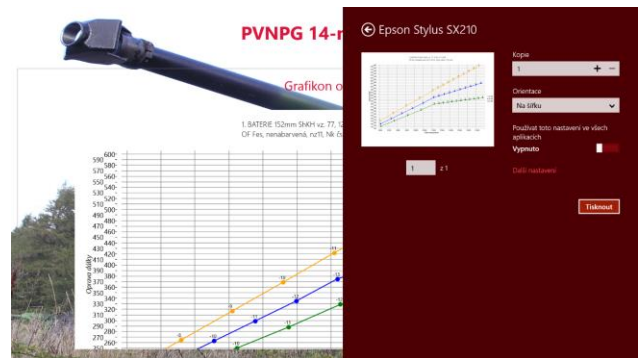


Fig. 10 Illustration of printing the scheme correction

Conditions and variants for setting fire data for an effective fire by abridged preparation are mentioned in the scheme - The way of setting fire data for effective fire, The Abridged preparation. (Fig. 10, 11)

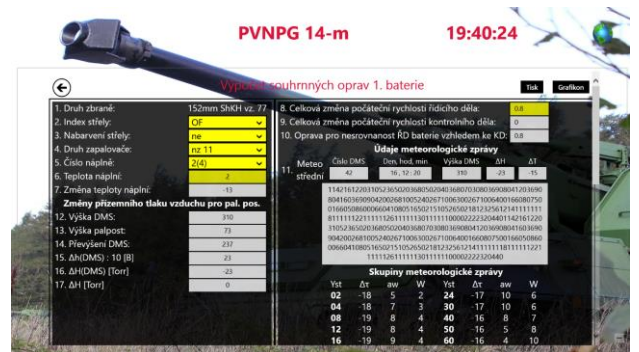


Fig. 11 Complete preparation – input data

E. The Simplified preparation

Fire data set by simplified preparation is set extraordinarily for a battery, which in the case of ASRPP-DEL means 6 to 8 guns only if it is not possible to set fire data in another way. In the case of simplified preparation it is necessary to set firing data for an FFE by adjustment fire.

IV. NEC FRAMEWORK IN THE CZECH REPUBLIC ARTILLERY

The Czech Artillery units can realize specific tasks of fire support which can help to fulfill Czech military forces commissions in the multinational operations in new, turbulent conditions. In accordance with presupposed artillery functionality and future development can be assumed that artillery will act lethally at enemy troops and non-lethally at its information and communication systems, sensors, and awareness. Artillery can also contribute to joint planning process and perspective operations commanding in NEC conditions through its specific integrated sensor systems.

NEC conceptual framework including capabilities of Czech Republic Artillery can be determined in the following way:

- Decision Ascendancy Achievement presupposition

Effective Artillery Command, Control, and Communication System, which ensure all functions of command, control and communication of the Czech Artillery reconnaissance system and the executive elements. This system must be able to fulfill complex fire support in NEC conditions.

- Operational Effectiveness Achievement presupposition

Effective Artillery Reconnaissance (sensor) system – recognition abilities about enemy objects, effective using of Targeting cycles system and ISTAR system for adequate reaction suggestion of friendly forces including criteria evaluation effect. Effective lethal and non-lethal artillery fire – artillery join connection operations capabilities for fulfill capabilities of power demonstration, fire for effect etc. Resistant artillery units – active and passive defence equipment using.

- Achievement of Deployment Presumption

Well-time artillery unit's attainability – to be able to accord the fire support in the operation area.

Artillery positioning and mobility – Artillery deployments capabilities.

Effective Supply – logistics support capabilities of artillery units.

The last point (Achievement of Deployment Presumption) is not Fire Support Control System problematic and that is why it is not in detail resolution on next text.

V. CONCLUSION

The global environment changes, threats and new tasks require new approach of the Czech Republic defence strategy. Future security environment will be characteristic by dynamic changes of situation. The threat of terrorism causes changes of strategy, which turns from using massive armed forces to effectively using modern, sophisticated forces with quick Command, Control and Decision process supported

by information technologies. The aim of this article was not to describe detailed principles of fire control system running, every communication flow data, or difficult linkages and priorities, but to introduce the most important system of the Artillery Battalion Fire Control System of the Artillery of the Army of the Czech Republic and highlight significance of perfect communication system of today and future fire control system or command and Control operational tactical systems. The above mentioned requirements on necessary changes the Czech Automated Artillery Fire Support Control System represent absolutely basic conditions for approach to the NATO standard (NEC Capabilities). [24]

Financial sources are significantly limiting possibilities of the army progress, especially in current time of financial crisis. However, investments are necessary for achievement of NATO standard.

The perspective system must assure Command, Control and Artillery Reconnaissance Connection, Coordination and Fire Control of effectors (Weapon Sets) on the brigade level with Mechanized Forces Control System. The Czech Artillery units need to have intuitive system for mathematical computations what assures prediction capabilities for adequate fire support provision - PVNPG-14M should be the best choice in current conditions. It is necessary to connect Future Artillery Fire Support Control System to the NATO network philosophy system within the Network Enabled Capabilities.

Contrarily, a more accurate observation instrument provides less accurate positioning and orientation. By expression of meeting requirements of accuracy for setting fire data by complete preparation in the part of reconnaissance and target detection the information from the artillery observer about accuracy of setting the target position is “accurate”. Otherwise (the setting of a target position is “not accurate”) the adjustment of fire is necessary.

Using adjustment gun spatial standards of created fictional auxiliary target (FPC) validity, depending on distance of units both creating FPC and using FPC results, must be set.

These units will also use these results for setting fire data. Fire data for FFE on an abridged preparation basis can be set by adjustment fire or without it.

For PVNPG-14M it is necessary to exactly set all conditions for each variant of setting fire data for effective fire.

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