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UNIVERSAL MODULAR TRACKED PLATFORM AS A CARRIER FOR ARMAMENT AND SPECIAL EQUIPMENT

Abstract. Reference is made in the article to the current normative documents regulating the process of acquiring military equipment and services for the Armed Forces of the Republic of Poland (AF RP). The progress of work on developing a Universal Modular Tracked Platform (UMPG) as base chassis is discussed. The feasibility of manufacture of UMPG by the Polish industry is presented based on the results of completed projects and conclusions drawn therefrom. The various variants of tracked land vehicles of various application using UMPG as the base chassis are presented.

Keywords: modernization of land forces, Universal Modular Tracked Platform, base chassis, tracked vehicles, infantry fighting vehicle, main battle tank.

1. INTRODUCTION

Entry into force of the following current normative documents:

- Decision No. 349/MON of the Minister of National Defence [1];
- Decision No. 72/MON of the Minister of National Defence [2];
- Decision No. 479/MON of the Minister of National Defence [3],

that regulate acquisition of military equipment (including equipment fabricated by way of R&D and implementation process) and define the scope and content of technical documentation on equipment under development provides an opportunity to present the possibilities of introducing modern products into the service of the Polish Army in place of obsolete technical equipment.

The article presents the advantages of being able to develop and produce weapons and military equipment (materiel) based on an innovative engineering solutions of the Polish researchers and production capabilities of the native defence industry. The implementability of UMPG created on the basis of studies and conceptual work included in the Feasibility Study of the Infantry Fighting Vehicle based on the Modular Tracked Platform [4] and in the Feasibility Study of the Remotely Controlled Turret System [5] is discussed. Both of these documents analyze the life cycle cost (LCC) of a product. The adopted model of estimating LCC of the APC is discussed in a separate paper [6]. The work of expanding the concept of UMPG conducted within the framework of the Direct Fire Support Vehicle (WWB) project was in response to a long-term government army modernization programme announced in 2013, re-defining the development scope of the potential of the armoured land forces. The main results of the studies and conceptual work presented in these documents, including a list of attainable tactical and technical parameters and final structural form, present the capability of the national defence industry to provide the AF RP with the new main battle tank (NCP) and the Universal Modular Tracked Platform (UMPG). According to the requirements expounded in [4], [5], [7], [8], [9], UMPG is to constitute the base chassis for both the NCP and the Infantry Fighting Vehicle. The feasibility of completing the UMPG base chassis

project, where UMPG constitutes the basic module for installing armament and engineering, logistic and recovery equipment, was described in more detail in [9] and [10].

2. MEETING THE REQUIREMENTS OF THE AF RP FOR MILITARY DEVICES AND EQUIPMENT

The requirements of the Polish Armed Forces with regard to military devices and equipment may be satisfied by way of conducting research and development projects in Poland or by purchasing finished products abroad or by importing equipment from abroad and adapting it to national requirements.

The national entity that conducts research and development work, especially in the area of tracked land vehicles, is OBRUM. During its history of nearly fifty years, OBRUM has developed and fabricated a number of military products that perform specific defence functions resulting from the requirements of the battlefield, including armoured equipment the range of which spans from tanks, through to recovery vehicles, engineering tanks and mobile tank-launched bridges. These products have been put into production and are in the service of the AF RP and of armed forces of other countries, for instance India and Malaysia. OBRUM has carried out more than 60 major projects (development of new products, implementation of purchased licences and modernization of equipment used by the army), including projects involving military equipment of modular design.

Some of the vehicles of modular design developed at OBRUM included:

- SPG-1 and SPG-1M - chassis of radar station NUR – 21 [10] shown in Figs. 1a and 1b. (About 40 vehicles in service of the AF RP).
- WZT-3 - recovery vehicle, codename BIZON, predecessor of future structural developments, such as:
 - MID (engineering and road vehicle) and MID-M (Malaysian version).
(Vehicles are in service of the AF RP and Malaysian Armed Forces. A total of 15 of these vehicles were manufactured. MID was the first tracked vehicle with proportional hydraulic controls to enter service with the AF RP).
 - WZT-4 (recovery vehicle).
(6 vehicles in service of the AF of the Kingdom of Malaysia). They are fitted with an innovative protective system of the main winch and crane of improved performance with measuring pins and CAN bus in the control system).

17 WZT-3 recovery vehicles were manufactured for the AF RP and 203 for the Indian Army.

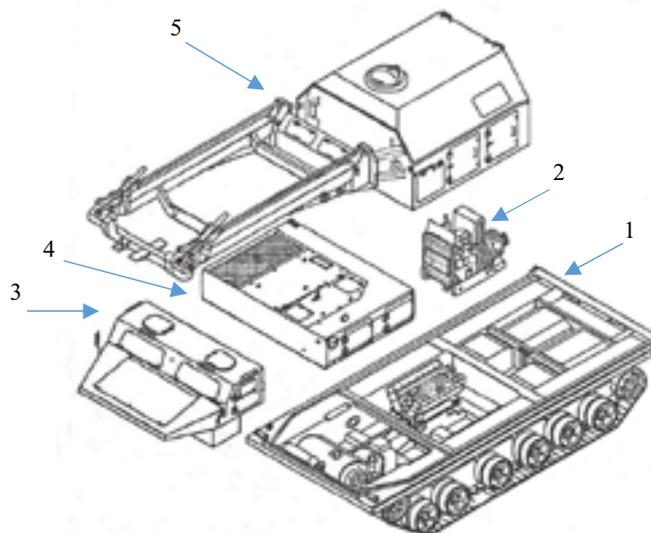


Fig. 1

a) Modular design concept; b) NUR-21 radar station

1 - carrier base, 2 - power generation module, 3 - crew module,
4 - equipment module, 5 - operating assembly

The modular design concept, as exemplified by WZT-3, MID, WZT-4 vehicles [10], is effected by exchanging the main equipment and is shown in Fig. 2. The basic setup of the platform – base chassis is not changed in this case.



Fig. 2. Modular design of tracked vehicles illustrated with examples of:

a) WZT-3; b) MID; c) WZT-4.

The modular design of vehicles developed at OBRUM was also implemented in an extended version in the development project no. O R00 0030 5 titled "Light Tank based on Tracked Multirole Platform" [8], the result of which was a technology demonstrator (Fig. 3). The project, run by a research consortium comprising: OBRUM, Military University of Technology (WAT), WZM Siemianowice S.A. (now ROSOMAK S.A.), in addition to the real object, covers analytical work and studies (including a draft of Initial Tactical and Technical Specifications), in most part carried out by WAT. After successful experimental tests (tactical and firing), the technology demonstrator was presented at the International Defence Industry Exhibition (MSPO) in Kielce in 2010.

Based on the experience gained in the project, more embodiments of the design were put into effect, as shown in Fig. 3, and were presented at international fairs and exhibitions:

- light tank with a 120-mm RUAG smoothbore gun - *MSPO, Kielce 2010*;
- infantry fighting vehicle with a HITFIST 30 manned turret - *MSPO, Kielce 2010*;
- infantry fighting vehicle with an OWS unmanned turret - *MSPO, Kielce 2011*;
- fire support vehicle with Belgian CMI turret and 105 mm gun
– *EUROSATORY, Paris 2012*.



Fig. 3. Vehicles based on UMPG

As a result of work carried out at OBRUM the following projects were completed in 2012:

- Feasibility Study of IFV based on Modular Tracked Platform inclusive of product life cycle (LCC);
- initial draft Tactical and Technical Specifications for:
 - infantry fighting vehicle based on Universal Modular Tracked Vehicle;
 - Universal Modular Tracked Vehicle.

The government long-term army modernization programme, announced in 2013, which re-defined the development scope of the potential of the armoured land forces, resulted in clarifying the concept of UMPG, which was used before as part of the "Direct Support Vehicle" project, in consultation with representatives of the Armament Inspectorate of the Ministry of Defence.

The results of the work carried out so far can be directly implemented in the UMPG development project, in accordance with the adopted and approved Tactical and Technical Specifications. The experience gained ensures timely completion of the task.

3. COMPETENCE IN THE AREA OF UMPG DEVELOPMENT AND PRODUCTION

The UMPG project can be carried out in a research and industrial consortium represented by Polish entities having appropriate knowledge and experience in conducting research and development in the field of tracked platforms, which is confirmed by a diagram in Fig. 4 which shows the competencies of the Leader of the UMPG consortium.

In the realization of the project a rule was adopted, for many years applied by OBRUM, that the value added in the cost of domestic product manufacture should be as high as possible, within their intellectual, engineering and technological competence.

With the involvement of Polish public funds in the UMPG project and in the future production, the share of the national added value in the final product based on UMPG is estimated at 70%.

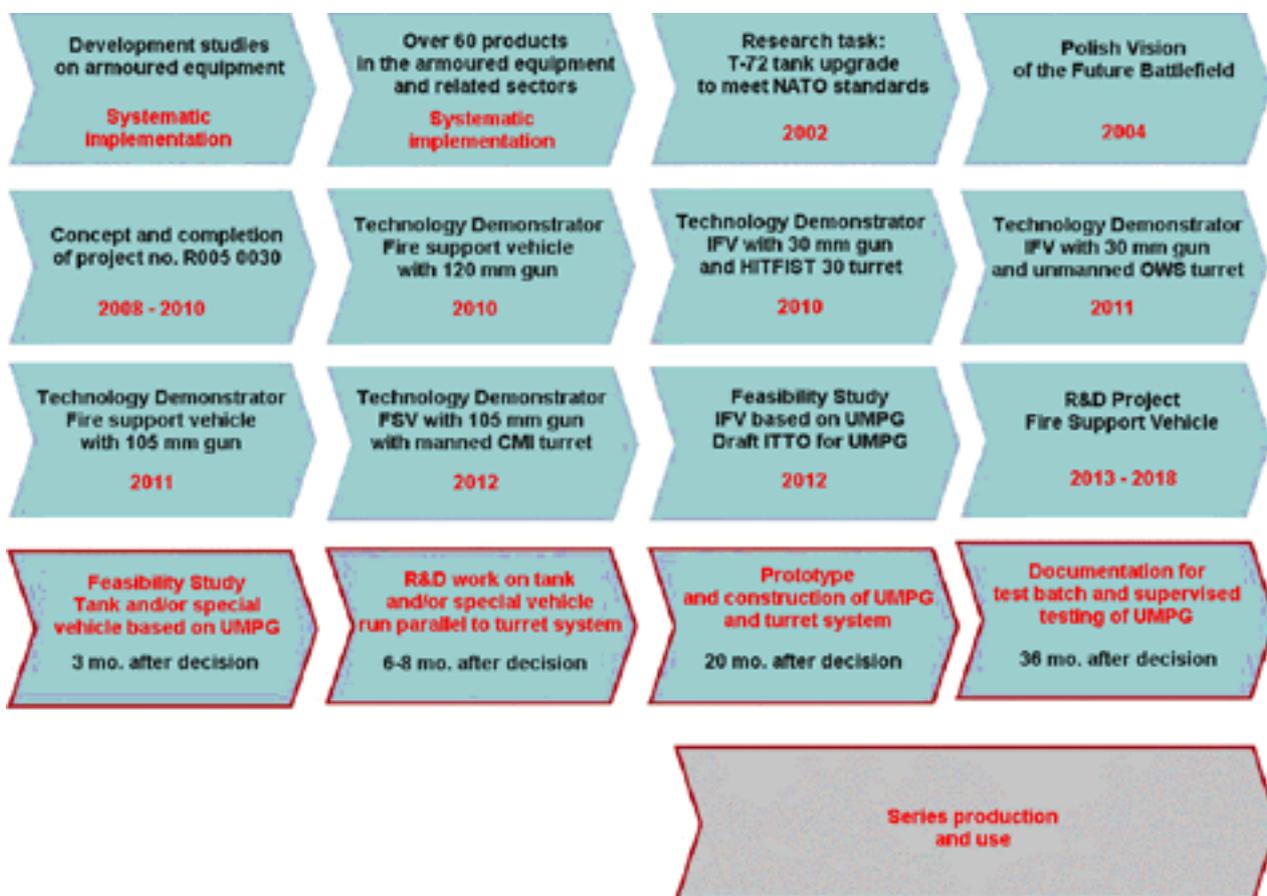


Fig. 4. Competence and capabilities in the area of creating military equipment based on UMPG

Fig. 4 schematically shows the concept of implementing a new class of equipment utilizing the experience and the intellectual capacity of OBRUM's research and engineering personnel.

3.1. Platform configuration

The ultimate objective of the creators of the UMPG project is to develop and implement the production of a new class of armoured equipment: combat and support vehicles based on the same modular tracked platform. These vehicles may include: infantry fighting vehicle, light tank, artillery carrier, engineering vehicle, radar equipment carrier (see Fig. 5).

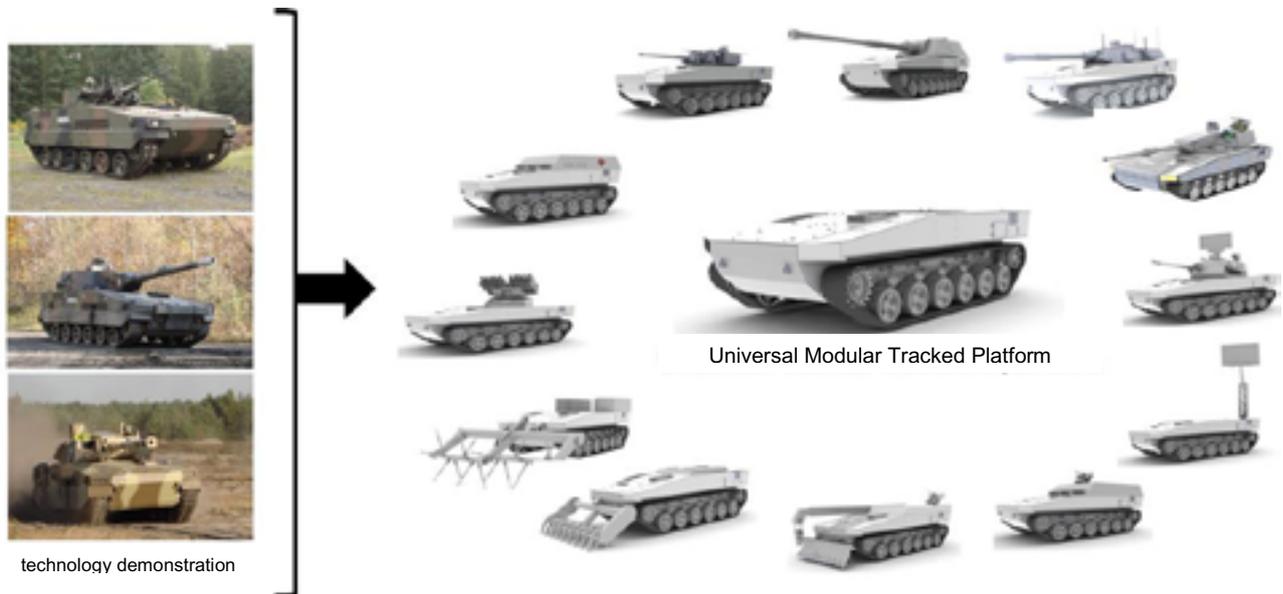


Fig. 5. Combat and special vehicles based on UMPG

The concept of the tracked platform design is based on modular design with a high degree of standardization of the units involved in the process of integration with the weapons system and special equipment for detecting, fighting and neutralizing fire threats. These units, when appropriately selected and arranged, ensure the achievement of tactical and technical performance exceeding or at least level with that currently achieved by the state of the art solutions.

The UMPG according to the concept developed at OBRUM is characterized by identical units and components in the area of:

- hull - identical modular design;
- fixing points for hull equipment - identical in many structural points;
- monitoring and diagnostic instrumentation;
- internal and external communication means;
- air conditioning;
- power generating unit;
- systems, including:
 - drive control and related mechanisms;
 - power transmission, including: main engine and gearbox with subsystems: fuel, exhaust, cooling, air supply, final drives and drive wheel;

- electrical;
- others (e.g.: fire fighting, engine heating, emergency start up system).

Hull arrangement and structure were designed to enable changing the role of the vehicle at any time by replacing special units.

For instance, the transformation of an IFV with an unmanned turret into:

- a fire support vehicle is effected by replacing the unmanned turret with a calibre 105 mm or 120 mm turret system set on an intermediate ring;
- a self-propelled mortar by replacing the unmanned turret with an automatic mortar, e.g. RAK;
- an anti-aircraft artillery or missile system by installing anti-aircraft turret modules in place of the dismantled unmanned turret;
- a tracked engineering transporter by installing GPRs, on-board mine detector, replacing the commander's and operator's station after replacing the unmanned turret with an RWS;
- a recovery vehicle, by installing working attachments and carrying out minor assembly and fitting operations and dismantling of the unmanned turret;
- other versions, including logistic transporters.

3.2. Tracked vehicles based on UMPG

UMPG may constitute a base carrier for:

1. Turret weapon systems, e.g.:

- manned turret of an infantry fighting vehicle with an automatic gun calibre 20 to 50 mm;
- unmanned turret systems with automatic gun calibre 20 to 50 mm, integrated with, for instance, a Spike missile launcher and GROM missile launcher for infantry fighting vehicles of light/floating, medium and heavy versions;
- turret of fire support vehicle calibre 105-120 mm with autoloader;
- turret of automatic mortar calibre 120 mm (single- or double-barrel);
- turret of anti-aircraft artillery systems with guns calibre 35 mm (e.g. LOARA);
- turret of gun-howitzer calibre 155 mm.

2. Turret-less weapon systems, e.g.:

- anti-aircraft missile launch systems;
- other.

3. Systems of special equipment:

- engineering equipment;
 - reconnaissance vehicles;
 - engineering support vehicles;;
 - mine throwing vehicles;

- logistic:
 - recovery vehicles;
 - ambulance vehicles;
 - ammunition vehicles;
- command level;
 - reconnaissance vehicles;
 - command and communication vehicles;
- main battle tank;
- other.

The common features of the tracked vehicles shown in Fig. 5 would include:

- deep standardization of the chassis;
- high ballistic resistance (add-on armour);
- common fuels and lubricants;
- unified structure that simplifies the systems of supply, maintenance and training;
- advanced ergonomics;
- transportability in all means of transport, including air transport;
- upgradability ensured at the stage of design.

The use of UMPG as base chassis for specialized weapons and equipment (including mission modules) of different weight will create vehicles with total combat weight ranging from 25 to more than 50 tonnes.

3.3. Timely completion of research and development type project

Research and development projects, despite the many innovative technical solutions, should be implemented in accordance with the adopted schedule, and the introduction to the design of imported components not produced in Poland should not affect the completion date of the project. This state of affairs largely warrants agreement on Tactical and Technical Objectives (TTO) and placing orders on the components available either on the domestic or foreign market, in sufficient advance.

The problem raised now, concerning the timely completion of projects of special tracked vehicles, applies to limited availability on the Polish market of some important components, such as: main engine, gearboxes, tracks. The lack of the above units and components affects project execution, but it does not preclude its completion. In this situation alternative solutions are sought.

- **Engine**

The problem of the main engines is to be tackled by Wojskowe Zakłady Motoryzacyjne S.A. Poznań in order to meet the engine requirements of the AF RP. Engines of medium power are readily available in several countries, both in Europe and in Asia. In that case the engines can be matched with gearboxes in power-packs. This action enables diversification of suppliers and independence from export capabilities. Using engines of

different make in UMPG is made possible due to the modular arrangement of the power transmission compartment.

- **Power transmission system (assembly/merging into a power-pack)**

The components of the power transmission system assembled with the engine and transmission, designed by OBRUM, will be provided with control, monitoring and diagnostic systems designed by OBRUM engineers - a solution applied and tested in project No. RO 0030 05 [9].

- **Tracks**

There are no appropriate solutions available in Poland. This component is available abroad in many versions (including those with rubber pads).

- **Power-pack**

Another problem of timely completion of projects is the indication of the optimum location of the power transmission system, including the power-pack.

Analyses carried out at OBRUM have shown the definite advantage of location of the power transmission in the front part above the installation in its rear part.

3.4. Platform setup

The platform setup presented in Table 1 was conceived for two analyzed options of power transmission location (rear or front). Complete analysis of the possibilities of stiffening the power transmission system is given in the article "Criteria and rules in the design of modern combat vehicles with large-calibre armament" [11]. The analysis of setup possibilities was supplemented by specifying the availability or capacity to develop units and components in Poland, which is indicated in the table with a (+) mark. Lack of domestic solutions means that finished components of foreign make must be purchased, which is indicated in the table with a (-) mark, or that they must be fabricated in Poland using imported parts, which is indicated in the table with a (+/-) mark. The formal and legal considerations in the process of foreign purchasing were neglected in the analysis.

Acquisition sources are indicated in the table in the following manner:

- (+) - domestic;
- (-) - foreign purchase;
- (+/-) - domestic fabrication using foreign components.

Table 1. UMPG setup (the adopted percentages in terms of the share in overall UMPG cost are estimates made by the authors)

Main unit	Subunit	Option I engine in front	Option II engine in back	Source	% share of subunit	Main unit - % share in chassis
Chassis body	Welded structure with machining	Shape different from option II	Shape different from option I	+ (domestic supplier of metallurgical materials)	4	11

Main unit	Subunit	Option I engine in front	Option II engine in back	Source	% share of subunit	Main unit - % share in chassis
	Bottom mine protection	Not in the welded hull structure. Removable component. Not factory installed.	Welded in between outer and inner bottom plate. Escape hatch in bottom.	+	1	
	Driver's hatch	identical	identical	+	0.5	
	Landing hatch	yes	no	+	0.5	
	Landing ramp	yes	no	+	0.5	
	Armoured partition plate of ammunition compartment	yes	no	+	1	
	Service hatches and components welded to hull	yes	yes	+	0.5	
	Spall and dampening liners	yes	yes	+	1	
	Add-on armour	different shape	different shape	+	2	
Wheels, tracks, suspension	Hydropneumatic suspension	Identical for both options		+	6	22
	Road wheels			+	4	
	Tension wheel with tensioning system			+	Elastomer bumpers	
	Buffers			+	0.5	
	Drive wheel			+	3.5	
	Track			+	4	
	Hydraulic system controlling suspension	Identical setup - different layout	Identical setup - different layout	+	2	
Power transmission system	Oil filters	Common solution		+/-	1	23
	Air filter with cleaning system and strangler control	Common solution, different connections		+	1	
	Power-pack	Identical engines, different transmissions		-	8	
	Exhaust system	Common solution, different connections		+	1	

Main unit	Subunit	Option I engine in front	Option II engine in back	Source	% share of subunit	Main unit - % share in chassis
	Cooling system arrangement	Common solution, different connections		+	1	
	Negotiating water obstacles	Water cooled fans	Covers for radiators and exhaust louvers necessary	+	1	
	Engine compartment ventilation	Common solution, different connections		+	1	
	Fuel system	Common solution, different connections		+	6	
	Emergency startup systems	Common solution, different connections		+	3	
Chassis power system	Startup equipment	Common solution, different connections		+	5	24
	Emergency power generator with air conditioner compressor drive	Common solution, different connections		+	4	
	Power supply and power distribution control units	Common solution, different connections		+/-	6	
	Power system and network protection cables	Common solution, different connections		+/-	7	
	Battery set	Common solution, different connections		+	2	
Driving mechanism control systems		Common solution, different connections		+/-	3	3
Filtration and ventilation and air conditioning system		Same units in different arrangements		+	2	2

Main unit	Subunit	Option I engine in front	Option II engine in back	Source	% share of subunit	Main unit - % share in chassis
Contamination detection and automatic system control		Common solution, different connections		+	2	2
Additional ammunition store with ammunition for GPMG, HMG, grenade launcher, 902A and active vehicle protection system		Capacity 28 pcs. of ammunition cal. 120 mm + complete set of additional ammunition Fabricated as right-hand and left-hand units for easy removal to enable transportation of injured or landing troops. Located behind armoured partition	Capacity ca. 15 pcs. of ammunition cal. 120 mm. Location of ammunition for additional weapons not specified, manual gun loading not provided	+	10	10
Observation devices				+	2	2
Fire and explosion suppression system				+	1	1

4. SUMMARY

The results of analyses presented in this article show that the Polish research and industrial consortium is in a position to develop and manufacture a Universal Modular Tracked Platform that incorporates multiple options listed in the Strategic Defence Review and presented in the Catalogue of the Capabilities of the Polish Armed Forces. The implementation of the new solution will be warranted by:

- research and engineering staff resources,
 - manufacturing capabilities;
 - support facilities
- and
- competencies.

The proposed mode of implementation under domestic conditions is not the case of working from scratch. It is based on the results and conclusions drawn from development project no. RO 0030 05 titled "*Light Tank based on Tracked Multirole Platform*" which concluded in a tested technology demonstrator corresponding to the 6th technology readiness level.

The technological success of this solution is also demonstrated by adaptation and assembly tasks of turret systems cal. 120 mm (light tank), cal. 105 mm (CMI), HITFIST 30P and OWS turrets (for IFV type platforms) and the positive results of field and fire trials of UMPG with a turret with a cal. 120 mm gun and autoloader for NATO standard ammunition installed in the rear part of the turret, described in more detail in [4], [5], [6], [10].

The Universal Modular Tracked Platform is, in terms of architecture and applied technologies, a completely novel new generation chassis adapted to the needs of the Polish Armed Forces, created as a result of collaboration of a number of leading, Polish and foreign manufacturing plants of the military sector. The adopted objectives, in the final outcome, meet the requirements set down for modern land platform designs.

The development projects run in recent years at OBRUM helps maintain OBRUM's leading position as a research and development institution on the domestic market and remain an important partner on the European market in the area of the design of tracked vehicles.

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