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Challenges of equipping with 155 mm self-propelled howitzer systems from a DOTMLPF-I perspective

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Abstract

Fire support systems represent a combat power multiplier for force structures, making a significant contribution in all types of operations, as they directly facilitate the force's ability to accomplish its mission. Considering national programs for equipping with modern military systems, this article has addressed the potential challenges of transitioning land force structures from being equipped with 152 mm towed artillery systems to NATO standard 155 mm self-propelled artillery systems. The challenges have been considered through the lens of the NATO capability foundation model, described by the acronym DOTMLPF-I (Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities and Interoperability). This paper aims to underline some aspects that may influence the integration and exploitation of fire support capabilities, provided by equipping national land forces structures with this type of 155 mm self-propelled howitzer system. I have structured the article into two sections, aiming in the first part to briefly present the relevant basic ideas of the NATO capability foundation model, and in the second part to argue the challenges of equipping with 155 mm self-propelled howitzer systems and to include some actions, which I consider necessary, on the eight directions described by the acronym DOTMLPF-I. The perspective presented aims to highlight useful ways to enhance the national-level fire support capability provided by the new NATO-standard 155 mm self-propelled howitzer systems.

Keywords:
equipping; fire support; self-propelled howitzer; NATO model; DOTMLPF-I.

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Equipping national land forces structures with 155 mm self-propelled howitzer systems implies, first and foremost, a revision of the doctrines and combat manuals in force concerning the use of these systems in operations. National armed forces structures will be able to exploit the new fire support capabilities acquired both in combat operations, in stability and support operations and for peace support operations. Thus, existing doctrines, combat manuals or various operating procedures will have to be adjusted or updated in some way to allow the potential of these capabilities to be exploited in the actions and activities carried out by force structures in all types of operations.
Updating the current doctrinal framework is not the only measure needed to integrate and exploit the full potential of the new fire support capabilities that will be introduced in land force structures. In order to have a more comprehensive perspective on all the implications of this new equipment, I have used the NATO capability foundation model (NATO 2021, 7) with the eight action lines described by the acronym DOTMLPF-I (Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities and Interoperability).

In writing this article I applied the method of documentary analysis as a research method for the systematic review and evaluation of physical and electronic documents (Bowen 2009, 27) in the field of study. Being a method specific to qualitative research, the documentary analysis in this case involved the examination and interpretation of data on the equipping with 155 mm self-propelled howitzer systems, in order to be able to understand the implications of the substantiation of the new capabilities obtained by the national armed forces structures. *"What are the implications of equipping with 155 mm self-propelled howitzer systems from the perspective of the NATO capability foundation model?"* is the research question that I set out to answer in this paper. To this end, I explored open sources of information - mainly websites, NATO-level publications and authored papers, detailing the conceptual way of capability foundation as well as relevant aspects of military equipping and exploitation in operation, so that I can argue for actions needed at national level on the eight directions described by the NATO model.

According to the Army Media Agency's website we have, as a strategic objective, the modernization of the Romanian Army through the development of capabilities according to the Romanian Army 2040 program and the Multiannual Plan for Equipping the Romanian Army, which includes a program for the equipping with Battalion level 155 mm self-propelled howitzer system (Bâtcă 2024). The systems agreed upon at the national level are the 155 mm self-propelled howitzers - K9 Thunder (Curtifan 2024) and the contract with the Korean manufacturer Hanwha Aerospace, foresees the acquisition of 54 K9 self-propelled howitzer systems and 36 K10 refuelling vehicles.

The equipping of land forces structures with such systems will lead to doctrinal and organizational changes, in terms of how to use self-propelled howitzers in operations,

in order to exploit the full potential of these modern fire support platforms. In addition, the novelty and specific nature of self-propelled howitzer systems will also create a need for tailored training of military personnel, both for their operation and maintenance and for their timely exploitation in accordance with the operational needs of the force structures they will be part of. From another perspective, the commissioning of the new systems will only take place once the organizational status of the designated structures has been updated and the territorial infrastructure and the quantities of materials of all classes of supply will ensure the minimum necessary for the proper operation and maintenance of the howitzers. In my view, these aspects presented argue the need to identify the measures required at the national level, along the eight lines of the NATO capability foundation model.

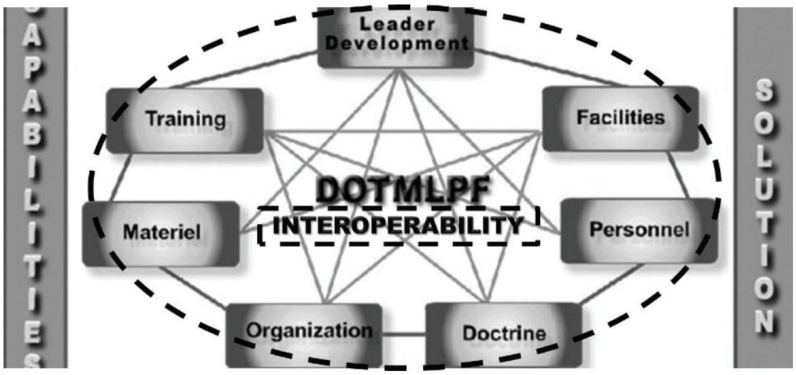

Figure 1 NATO capability foundation model
Source: Adaptation in accordance with MD Harris Institute 2013

How can we use the NATO capability foundation model?

The NATO capability foundation model, described by the acronym DOTMLPF-I, is a comprehensive standardized methodology (Willi 2016) in my view, that can be used to assess the impact of equipping national land force structures with 155 mm self-propelled howitzer systems. The NATO model is also a useful tool for the identification of potential needs for preliminary enhancement of the forward-looking capability in the eight action lines under the acronym DOTMLPF-I. The exploitation of the fire support potential that self-propelled howitzer systems can have in an operation, depends on a multitude of factors that can be addressed within the aforementioned action lines. This comprehensive perspective will ensure, in my view, the maximum level of effectiveness of 155 mm self-propelled howitzer systems in national armed forces structures operations.

The actions identified in the *doctrine* direction aim primarily at standardization, so that specific activities and actions are carried out according to the same "best practice guide" implemented uniformly across force structures. The common doctrinal framework ensures clarity and efficiency in the exploitation of the capability and is the basis for training personnel in the accomplishment of their missions so that the capability can be effectively exploited according to operational needs.

Concerning the *organization's* direction, the actions aim at achieving the optimum operational effectiveness of force structures. Efficient organization involves clearly establishing the command authority and the role of personnel within the structure so that the objectives set can be effectively achieved. The level of coordination of component elements and structural functionality determines the maximum available capability potential.

The *training* actions aim to ensure and maintain the optimal level of training for the force structure personnel in order to be able to perform their specific tasks effectively in all types of situations or scenarios. The purpose is to build and maintain a competent and flexible force structure capable of accomplishing its mission in a dynamic operational environment. Force education and training are indispensable to performance and ensure the ability to meet all operational challenges. The way in which training is carried out is clearly established by the normative framework in force, which includes doctrines, field manuals and regulations with specific tactics, techniques and procedures.

The actions identified in the field of *materiel* are aimed at the efficient management of military equipment and materiel so that the capability in question is permanently operational. This line of action covers all military equipment throughout its life cycle, including all aspects of the logistic support required by force structures.

As far as *leadership* is concerned, the actions in this direction focus on the training of military leaders with emphasis on the development of their specific skills and competencies – high level of professional knowledge, integrity, responsibility, adaptability, etc. The exploitation of a capability directly depends on the level of professional competence of military leaders, as they train the force structure personnel and influence their operational effectiveness. Moreover, military leaders are also those responsible for initiating the process of adaptation of the military organization at the tactical and institutional levels (Nistorescu 2024, 205).

The identification of actions in the *personnel* direction is aimed at staffing force structures with highly qualified personnel, able to exploit the full potential of the capability pursued. The available human resources influence the capability's level of operability, the effective management of individuals in positions/functions suited to their skills and competencies ensuring a force structure truly capable of accomplishing the entrusted mission. Actions in the area of *personnel* also aim at maintaining the health and morale of individuals with a direct impact on the performance and operability of the pursued capability.

Actions in the *facilities* direction are mainly aimed at providing the required infrastructure in order to properly operate and maintain the operational status of the targeted capability. This also includes those actions resulting from assessing conformity or operational status of existing national facilities, including those in

barracks or road communications to be operated by the new capabilities. Military personnel and equipment must be provided with all those elements of infrastructure – spaces, buildings, utilities, etc., on which the operational status of any capability is directly dependent.

The *interoperability* action line can be explored through its three domains – technical, human and procedural interoperability. Actions in this direction aim at both the component elements' interoperability of a capability and its interoperability as a whole with other elements, systems or capabilities already existent or deployed. As this article explores the way to apply a NATO capability foundation model, interoperability is an integrating element of all the action lines addressed.

What are the implications of equipping with 155 mm self-propelled howitzer systems?

The utility of the NATO model detailed above is reflected in ensuring the operational effectiveness of the new capabilities by focusing the effort on each direction of the DOTMLPF-I acronym. Some requirements can thus be identified for updating, adjusting or harmonizing the existing doctrinal normative framework, the current logistic support and the way in which the beneficiary force structures must reorganize or train so that the new capabilities acquired can be exploited and leveraged according to the purpose for which they were developed and acquired.

The perspective presented below comes as a response to the research question *"What are the implications of equipping with 155 mm self-propelled howitzer systems from the perspective of the NATO capability foundation model?"*, arguing potential actions along the eight strands of the DOTMLPF-I acronym, thus applying a method of analysis used at the alliance level (NATO 2018).

***Doctrine* direction**

The current doctrinal normative framework does not detail how self-propelled artillery systems are to be employed in operations. Although the artillery missions and the specific lethal/nonlethal tasks they accomplish in an operation are basically the same for all fire support systems, the employment of the new 155 mm self-propelled howitzer systems has some particularities. A first doctrinal action would be to detail and integrate the particularities of the use of self-propelled howitzers in the current doctrinal normative framework, so that their superior characteristics – mobility, firepower, maximum striking range, automated fire control system, etc., can be used in the actions of land force structures.

Considering as starting points the specific documentation provided by the manufacturer, alongside the training and expertise gained by the military personnel involved in the takeover from the Korean partner, we will have to develop (update)

our own doctrines, field manuals and specific regulations to clarify how to use in combat the new 155 mm self-propelled howitzer systems. In my view, the relevant publications available from the alliance or NATO member militaries operating such tracked self-propelled howitzers will prove useful in this regard. Exploiting the potential of 155 mm self-propelled howitzer systems can also be the subject of joint operations, but in my view, this should be done based on a joint fire support doctrine, a national-level necessity that I have argued in another paper: "Implementing a joint fire support doctrine - a requirement of joint operations". (Mirea and Stanciu 2024)

Another action that I consider necessary in the *doctrine* direction is implementing in current national doctrines, field manuals and regulations, those lessons learned in recent conflicts within which tracked self-propelled artillery systems (M109, PZH2000, AS-90 and Krab), similar to those that will be used in our national land forces structures, have proven their relevance and operational effectiveness. In addition, the increased interest of Western armies (Vlad 2024) in the development of the conflict in Ukraine is recognized, as they have the opportunity to test in combat both military equipment and doctrines in force. The need to implement the lessons learned in recent conflicts is all the more obvious if we consider that, at the national level, the last self-propelled tracked artillery systems (the Romanian self-propelled howitzer cal. 122 mm, md. 1989 - **2S1**) were removed from our land force structures in 2005 (Stroea and Băjenaru 2010).

***Organization* direction**

The new 155 mm self-propelled howitzer systems are operated by a small number of crew members compared to the towed artillery systems they will replace, and this will also be reflected in the organization of beneficiary artillery structures. If the 152 mm towed artillery usually had a total of 8 crew members (Military-history Fandom 2025), the new 155 mm self-propelled artillery systems, have 5 crew members (Global Defense News 2024). In addition to the implicit issues of reorganizing personnel currently assigned to the new structure, certain challenges arising from the reduction in the number of servicemen operating self-propelled systems must also be considered, such as the challenges of providing the physical protection needs of force structures, like: guard duties (in peacetime) or the close defence of firing positions (in wartime). Another challenge caused by the reduction in the number of servicemen is the operation of self-propelled howitzer systems for long periods of time, specific to a high-intensity conflict, where the physical and mental attrition of the personnel involved (24 hours a day) is an important element that can influence the very combat power of the artillery structure as a whole.

Following the analysis of the above-mentioned implications, actions in the *organization's* direction will also include, in my view, an appropriate resizing of personnel structure (including, for example, one or more guard/military police/ infantry sub-units), as well as a review of specific tactics, techniques and procedures, thus reducing the risks associated with the downsizing of the new self-propelled

tracked artillery units/sub-units. The artillery structure must have the appropriate regulatory framework and the resources of all types in order to be able to accomplish its mission both in peacetime and in war.

***Training* direction**

Given that, as mentioned, the last self-propelled tracked artillery systems were removed from our land force structures in 2005 (Stroea and Băjenaru 2010) both the training of personnel, directly involved in the operation of the new self-propelled howitzers and of those involved in their operational exploitation, have a lot of catching up to do. Until the doctrinal normative framework is established (updated) we will use for training purposes the specific documentation provided by the manufacturer with the expertise gained by military personnel involved in equipment takeover from the Korean partner and the publications in the field available at the alliance level or at NATO member armies equipped with tracked self-propelled howitzers. Moreover, lessons learned from recent conflicts such as the one in Ukraine, where, as mentioned above, tracked self-propelled artillery systems (M109, PZH2000, AS-90 and Krab), similar to those that will be used in our national land force structures, have proved their operational effectiveness.

Another *training* action aims at specific training of force structure staff through command post exercises, field applications, joint exercises, etc., in order to integrate the potential of self-propelled howitzers into all operational processes. The advantages and disadvantages of exploiting the new capabilities in operations must be understood by all the personnel of the beneficiary force structures, especially those responsible for planning and providing fire support using such systems.

Given the fact that Romania is a member of the ASCA community (Artillery System Cooperation Activities) (Orjanu 2023), and that 155 mm self-propelled howitzers have modern fire control systems interoperable at the NATO level, it offers the possibility of implementing specific actions in the *training* direction, through the integration and participation of national land force structures equipped with such systems in training activities conducted in a multinational context. In addition to joint training with members of allied and partner armies (Statul Major al Apărării 2021), the benefits of involvement in such training activities include the validation of the doctrinal normative framework on the use of new capabilities in operations and the possibility of implementing lessons identified (including from recent conflicts), aspects which provide an up-to-date perspective on the potential of self-propelled howitzers.

***Materiel* direction**

The availability of modern equipment in accordance with the equipping programs (Ministerul Apărării Naționale 2025) generates, as mentioned above, multiple challenges for the force structures (updating the doctrinal normative framework, the need for reorganization, training, etc.) so that the newly acquired capabilities can be exploited according to the purpose for which they were purchased. Some of the

challenges of equipping with modern systems stem from the need for harmonization, at least in the first phase, regarding the use of new capabilities together with old or existing ones at the force structure level. Thus, until we replace all 152 mm artillery systems, there will probably be a transitional period during which the two types of artillery systems – 152 mm towed and 155 mm self-propelled, will be operated simultaneously. A first action in the field of *materiel* would be, in my view, to review logistic support at the force structure level to ensure the operability of new and old capabilities alike, at least during the transition period. Resourcing new and old capabilities alike will entail a considerably greater effort for logistic structures given the different needs for fuels, lubricants and maintenance products, 152 mm and 155 mm NATO standard munitions or 12.7 x 99 mm NATO standard munitions).

Another action on *materiel* is to review the current national equipping rules. The revision of the organization of the land force structures directly benefiting from new equipment must be accompanied by a revision of the rules of equipping with all types of resources so that the specific needs of the new capabilities are covered from all points of view. In my opinion, all materiel quantities available to force structures equipped with modern systems should be reviewed in order to identify possible shortfalls in the efficiency of the units in their core mission. The main argument is that the changes brought about by equipping with 155 mm self-propelled howitzer systems, will have an impact on all the elements that define the structure of the operation (displacement of forces, available fire system or engineer support). The quantities of military equipment and materials of all types available to the force structures must ensure operational effectiveness in all respects.

***Leadership* direction**

Training military leaders represents an outcome of the entire educational process and the development of their skills and competencies is based on the training, and adequate professional and personal development of individuals. Equipping with modern self-propelled artillery systems will determine, as a first step in the *leadership* direction, the identification, promotion and filling of command positions, starting from the lowest hierarchical level, with the most suitable available personnel with the appropriate level of training, skills and qualities of military leadership. The operational effectiveness of the newly acquired capabilities will depend on these personnel. From a different perspective, the attractiveness of positions will be higher in these structures targeted for equipping with modern artillery systems, and will probably generate competition, including for leadership positions in such structures, a positive aspect that will result in a larger selection base and in identifying the most suitable personnel for the available positions.

Another action in the *leadership* direction is, in my view, to update the curriculum of career courses for field artillery officers, in order to include in the professional training of current and future military leaders the study of new self-propelled artillery systems with their specific technical and operational features. In my view,

the same *leadership* direction actions also include the appropriate professional training of command post staff members responsible for planning and integrating fire support into operations. The fire support coordinator (at the brigade level he is also the commander of the organic artillery battalion) together with his staff are the 'first' specialists in the operational exploitation of self-propelled howitzer systems and are also responsible for training subordinate personnel to exploit the full potential of the new fire support capabilities in operations.

***Personnel* direction**

The novelty of modern capabilities, which are or will be part of our national armed forces structures, makes them more attractive and is thus an argument in favour of increasing the professional quality of the military personnel directly involved in their exploitation. As stated in the leadership direction, the attractiveness of available positions in the structures targeted for equipping with modern artillery systems is likely to generate greater competition for their recruitment – with a larger selection base, the professional quality of the personnel recruited will also be higher. A major challenge, in my opinion, will be the staffing of functions that are novel for the current artillery structures, such as the driver functions for each tracked vehicle in the perspective organization. There is thus a need for action on the *personnel* side in terms of retraining existing personnel (to receive a certificate of professional competence as drivers), specific training of new soldiers in training centres (Agenția Media a Armatei 2017) or identification of those already certified. This is a requirement to transition from towed artillery structures – with truck drivers – to self-propelled artillery structures - with specialized drivers, and certified personnel who will be on every K9 self-propelled howitzer, every K10 supply vehicle, every K11 fire control vehicle, and also on other armoured vehicles that the acquisition contract include.

Once the positions are filled with the most suitable individuals, another *personnel* action will be the development (consolidation) of professional knowledge and skills of all personnel involved in the operation and exploitation of the new capabilities. By the time the new self-propelled howitzers arrive in the country, at least some of the personnel of the structures concerned will be involved in training activities adapted to the requirements of the new systems. This training may take several forms, including participation in specialization courses organized by the manufacturer of the systems, by prior training of a small number of soldiers on the *train the trainer* basis, or it may be carried out gradually directly in the units which will be equipped with the new systems during their arrival in barracks. In either case, there will probably be a transition period necessary for the personnel involved in operating the new systems to be trained in order to switch to the new organization of artillery structures and achieve full operational capability.

Another *personnel* action that I consider necessary is the training of responsible staff members on how to capitalize on the new capabilities in operations. In addition to

the aforementioned action to train military leaders, the training of all personnel involved in the planning and integration of fire support into the operation, as well as in the target management process, should be considered. Command post exercises are a good opportunity, in my view, for members of the various cells or working groups with responsibilities in the field of fire support and target management, to visualize and practice ways to exploit the full potential of the new capabilities available.

***Facilities* direction**

A first action in the *facilities* direction would be to assess the infrastructure of the territorial units (if it has not been done so far), where the new self-propelled howitzers will be exploited and maintained in operational condition. The aim is to identify possible shortcomings in ensuring the minimum required conditions for the physical protection, safe operation and proper maintenance of all components and materials intended for the new systems. I appreciate that such modern equipment has a higher sensitivity in terms of requirements for preservation, operation and specific maintenance compared to the towed artillery systems they will replace. A further argument for the need to assess the available infrastructure may be the different requirements for palletization, transportation and storage of 155 mm munitions. Such an assessment may highlight some related needs for the beneficiary territorial units, such as the need for forklift trucks, the need for reworking of the earth cover and protection for storage or the need to keep storage spaces within certain temperature and humidity limits. Enforcing new, NATO level, regulations may be required in order to properly secure storage conditions for the new 155 mm munition type (e.g. *AASTP-1 Manual of NATO safety principles for the storage of military ammunition and explosives*).

I will mention among the ongoing actions at the national level in the direction of facilities, the commitment of our defence industry in the opening of assembly lines and production of the K9 self-propelled howitzer starting in 2026 (Defense Romania 2024), and with the entry into the country of the first systems, will begin the production of 155 mm NATO standard munitions (Grădinaru 2024). Once materialized in the form of production units, these actions at the national level will ensure the operability of 155 mm self-propelled howitzer systems without the land force structures being dependent on any external manufacturer or supplier of components and materials.

Another action in the *facility's* direction is to analyze the opportunity of setting up or delimiting a training range within national territory that would allow firing at long distances to test, for example, the accuracy of 155 mm rounds fired at maximum range. We should consider that the transition from 152 mm calibre ammunition to the standard NATO 155 mm calibre ammunition will make it possible to engage targets at long distances, with higher lethality and accuracy than with 152 mm rounds. The munition used by the K9 self-propelled howitzer systems can hit

targets at ranges of 30 km (with standard explosive projectiles) and 40-50 km using rocket-assisted projectiles - RAP (Global Defense News 2024; European Security & Defence 2022). The existing nationally approved training areas ensure the firing of artillery munitions within certain limits. In my opinion, the possibility of firing 155 mm self-propelled howitzers at maximum range on national territory (perhaps offshore?) should be considered or, failing that, a solution should be identified in a suitable range of an allied or partner state, so that this new capability-specific target engagement solution can be periodically tested and validated. The utility of using such a range can also be extended to other systems in the current or prospective equipping of national armed forces structures, for example, to M142 HIMARS (High Mobility Artillery Rocket System) or Bayraktar drones.

***Interoperability* direction**

The capability foundation model described by the acronym DOTMLPF-I is a NATO model, and at the alliance level, interoperability itself is a force (NATO 2023). The interoperability requirements for elements of the new capabilities, provided by equipping with 155 mm self-propelled howitzer systems, should be analyzed from the perspective of its three domains - technical, human and procedural interoperability.

From the perspective of technical interoperability K9 155 mm self-propelled howitzers come with automated fire control systems that will most likely be integrated into the IFATDS (International Field Artillery Tactical Data System) already operated by national structures equipped with HIMARS. As this is an international command and control system, it can be estimated that K9 155 mm self-propelled howitzers ensure a high degree of technical interoperability. The above-mentioned actions on *facilities*, concerning the local production of 155 mm ammunition, sub-assemblies and K9 systems also used by other allied armies, reinforce the high degree of technical interoperability of the new capabilities.

A necessary action in the technical interoperability direction is, in my view, to ensure the compatibility of 155 mm self-propelled howitzer systems with current and future systems intended for command and control of force structures and for ISR (Intelligence, Surveillance and Reconnaissance). The superior characteristics of the new self-propelled howitzer systems and their full operational potential can only be exploited in operations if they are combined with equally high-performance command and control and ISR systems.

Human and procedural interoperability will be ensured in particular through the above-mentioned actions in the *doctrinal*, *leadership* and *personnel* directions. Intending to update the doctrinal framework and implement tactics, techniques and procedures specific to operating 155 mm self-propelled howitzers, in a form similar to those in force in allied armies, I believe that they will constitute a common basis for the professional training of personnel and for the participation of force structures, equipped with self-propelled howitzers, in military exercises in an allied or multinational context.

Conclusions

Equipping land force structures with modern military equipment, according to our developing national programs, comes with some challenges in terms of ensuring all the necessary conditions to exploit the full potential of the new capabilities thus acquired. Updating the doctrinal framework in force, reorganizing the force structures directly involved in operating the new systems or ensuring the infrastructure and facilities corresponding to the new requirements, are just some of these challenges. In addition to the operational impact of the new capabilities, a comprehensive perspective on equipping with modern systems can, in my view, be achieved by addressing all areas influenced by the implementation of current or prospective acquisition programs.

I believe that the NATO capability foundation model, described by the acronym DOTMLPF-I, is a useful tool for analyzing the implications of equipping with 155 mm self-propelled howitzer systems and, through this paper, I was able to argue its relevance. Focusing on each of the DOTMLPF-I model's eight directions for action, I have highlighted potential shortfalls in exploiting and harnessing the new capabilities and presented some actions to eliminate or mitigate the influence of these shortfalls. I have thus come up with a reasoned answer to the question *"What are the implications of equipping with 155 mm self-propelled howitzer systems from the perspective of the NATO capability foundation model?"*.

Assumed capabilities, for strengthening the national defence capacity and as a contribution to NATO collective defence, must be analyzed from both an operational perspective and through DOTMLPF-I type instruments, as some related procurement requirements, harmonization or optimization needs for the current context of deployment can be identified. On meeting these needs may depend the actual ways of exploiting the new capabilities in operations.

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