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MANAGING SUPPLIES IN WAR

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Abstract:
In any war, if the troops do not have *ammunition*, they cannot inflict damage to the enemy. Without *food* and water, the soldiers will lose the will to fight and switch their attention to getting nourishment instead of seizing military objectives. No *fuel* means that everything that runs on it will stop running – and nowadays it's hard to conceive war without planes and mechanized equipment. All these mean that *supplies* in war are paramount.

1. Introduction

The paper will be focused on the importance of supplies when conducting warfare, describing the importance of each class of supply and the way it influences operations. All considerations will be made from a strategic point of view but sometimes, for better understanding, operational or even tactical level aspects will be used.

2. Supplies: definition and classification

This chapter will present and describe supplies as they are defined by the military organizations in NATO. The word in itself is leading towards a definition: according to FARFLEX online free dictionary *supplies* mean **an amount available or sufficient for a given use; stock [3].**

The NATO definition is not far away: **supply covers all materiel and items used in the equipment, support and sustainment of military forces [1].** Taking out *the military forces* from the definition, you get the broad definition that is used by all organizations starting with the lowest level – let's say a household - and up to an organization as large as NATO or UN.

Supply is also a functional area of logistics: **the supply function includes the determination of stock levels, provisioning, distribution and replenishment [1].** In other words, when talking about supplies it is not enough to just have them somewhere, you need to estimate (sometimes even to guesstimate) the quantity the fighting forces need it, and the figure out a way to distribute them to the beneficiary in sufficient time to be used accordingly. I will cover this briefly later on, since the two topics, supply and distribution, are closely related.

In NATO, supplies are classified in five main groups, named *classes of supply,* and each of them will be described below. But even in NATO some countries considered different approaches when classifying supplies. For instance, the US armed forces has ten classes of supply, but classes I, III, IV and V are the same, and this goes for the other NATO countries, mainly class II being broken down into other classes or sub-classes.

2.1 Class I

The definition of class I in NATO is as follows: **items of subsistence, e.g. food and forage, which are consumed by personnel or animals at an approximately uniform rate, irrespective of local changes in combat or terrain conditions [1].** In other words, food and water (for drinking, not for other activities such as laundry) for soldiers and for livestock. The definition may be misleading when it says that the consumption rate is uniform, no matter what the terrain or the combat conditions are. The explanation is that, yes, the rate of consumption is the same, but what the soldier is consuming will vary pending on the abovementioned conditions: in a hot environment the water apportionment is different than in a temperate one, or when we send a military formation in a long patrol mission their rations are different than what they get when stationing in a base (i.e. more calories, less volume).

2.2 Class II

This class is where some nations chose to either break it down in sub-classes or in separate classes on their own. It is not the purpose of this paper to go on and explain which way is the better. Let us see first how NATO defines it: **supplies, for which allowances are established by tables of organization and equipment, e.g. clothing, weapons, tools, spare parts, vehicles [1].** Easy to understand why some nations decided to break it down further: whilst the definition of class I is narrow enough to be easy to comprehend and use, the definition for class II is very broad and may lead to confusions. A *table of organization and equipment* is basically a descriptive document of a military structure which comprises all authorized positions for personnel (to include details for their military rank, military occupational specialty etc.) and their authorized equipment (i.e. weapons and weapon systems, vehicles, communication equipment and so on). The easiest way to identify a class II item is to compare it with the other four classes of supplies. By the end of the definition chapter you will understand why.

2.3 Class III

The importance of this class comes from its definition: **petroleum, oils and lubricants (POL) for all purposes, except for operating aircraft or for use in weapons such as flame-throwers, e.g. gasoline, fuel oil, coal and coke [1].** For aviation, there is class IIIa – aviation fuel and lubricants. The division of class III for aviation was necessary due to the fact that the fuel and lubricants' specifications for aircraft are different (i.e. anti-freezing agents), but some nations decided a different approach: the single fuel policy. In the US Armed forces, the fuel for aircraft, called JP-8 or Jet Propellant-8, is used also by most of army's equipment – tanks, trucks, power generators etc. Still, due to the costs involved, not many nations can afford this solution, so class IIIa is used by the majority of NATO countries. In a nutshell, class III is mainly *fuel* and all kinds of other products from oil refining process. The type of fuel is irrelevant, being jet fuel, gasoline or diesel, since fuel in general is very important not only in war but also in peace time.

2.4 Class IV

Class IV may seem less important, but in Crisis Response Operations (CRO) proved to make the difference, especially in what the military calls Force Protection. So, class IV is **supplies for which initial issue allowances are not prescribed by approved issue tables. Normally includes fortification and construction materials, as well as additional quantities of items identical to those authorized for initial issue (Class II) such as additional vehicles [1].** To better understand it, focus only on *fortification and construction materials*. As I mentioned before, this class of supply was very important in CRO operations in Afghanistan and Iraq, being used for protecting the troops in their bases

as well as helping local populace with different construction projects (schools, official buildings etc.). It ranges from the ubiquitous sandbags and concertina to different concrete walls and shelters for self-protection against artillery rounds and small arms fire.

2.5 Class V

This is also a very important class of supply, because it comprises **ammunition, explosives and chemical agents of all types [1].** Along with class III they are the most important classes of supply in modern warfare. Nowadays weapon systems are very different when looking at caliber, type of projectiles, type of missiles, and so on. This class ranges from the simple infantry cartridge to the most sophisticated inter-continental nuclear missile. It gets even more complex because it also involves the chemical and biological weapons, along with the nuclear arsenal.

As a conclusion of this chapter, all classes of supply have their own importance in warfare, but some of them can have a more immediate effect in winning or losing a battle or the whole war, such as classes III and V, and this fact has been proved by history.

3. Supplies in war

In order to have a better understanding of supplies, I have to introduce you to a new term used in army terminology: Day of Supply or DOS. A DOS will always be used in connection with a specific class of supply, i.e. class III *number* of DOS, and it represents the quantity of a supply to be consumed / fired / burned / eaten by a consumer (be it a weapon system, a vehicle or a soldier) in one day. It has a reference value and can be altered by different factors. The un-altered DOS is sometimes called Standard DOS or SDOS, whilst the affected DOS is called Combat DOS (CDOS) or Modified DOS (MDOS). Let us take an example for a better understanding. A truck has, according to its technical specifications, a fuel consumption of 40 liters of diesel for running 100 kilometers fully loaded. So the SDOS for this truck is 40 liters. In an operation conducted in a mountainous terrain this truck will consume more fuel, due to the terrain conditions and the operational tempo, so the SDOS will be corrected by a terrain factor, let's say *t*, and an operational tempo factor, we can call it *o*. The correction factors are usually known, being determined using statistical methods or by special computer programs. In the end, the CDOS (or MDOS) is SDOS x *t* x *o*. The same goes for the other classes of supply, except for class I (remember the *uniform rate* from the definition).

The introduction of DOS was necessary for planning purposes and for making it easier to a commander to understand the level of supplies of his forces. Its usage starts from the lowest level, soldier, and goes up to the whole armed forces of a country. It is easier for a commander to know that he's got 4 DOS of class III, 2 DOS of class I and 6 DOS of class V, meaning fuel for approximately four days, food for only two days and ammunition for another six days. What if the logistic officer would report him that the level of supplies was as follows: 1,360 liters of diesel, 2.5 tons of food and 10.5 tons of ammunition? For a small military formation, i.e. a squad or even a platoon, this may be clear enough for the commander to understand where he is at, but for larger formations, DOS will give him a better picture. As we go higher in the military structure, the need for using DOS is more obvious.

3.1 Preparing for war

Most nations prepare for a possible conflict by stockpiling supplies in peace time. The reason for doing that is to make sure that the national economy has some time to turn from peace time production to a war time one. Some countries plan to stockpile supplies

for 30 or more days (30 DOS) and this quantity is all the troops have for that period of time until the economy is supposed to pick up the pace and start producing for war (also debatable but not for this paper). This amount of supplies (let us consider 35 DOS) is broken down to the soldier/weapon system level, where the value is usually 1. So the soldier/weapon system has 1 DOS, the battalion/similar may have additional 5 DOS, the brigade/similar has another 2 DOS and the division has 17 DOS. That means that a division has a total of 25 DOS, the remaining 10 DOS being stored by the respective service (Army, Navy etc.) or a specialized one. As you may have already guessed, two problems emerge out of this method of stockpiling: where do you store all supplies and for how long?

To answer to the former question, usually, each echelon is responsible for storing their allotted number of DOS for all classes of supply. For smaller, maneuverable units (up to brigade level), the supplies are stored in peace time installations (barracks) and are ready to be loaded and transported by its organic means of transportation. For the higher formations, things get more complicated, mainly because of the quantities involved. Obviously all class V and class III dumps are primary targets for an enemy. There are ways to overcome this problem (especially for class V) by storing these commodities on ships or trains, but the solution is costly and can be applied only for specific items (i.e. nuclear warheads).

The other issue is about the storage time. Fuel and ammunition are perishable goods. While fuel can be continuously replaced by normal usage, in close conjunction with the national economy consumers, class V cannot keep the peace time pace. The Soviet Union had a policy of storing 90 DOS of class V, until most of the ammunition exceeded its shelf life and had to be destroyed. Moreover, after significant amount of time, the ammunition becomes unreliable, and in combat the worst surprise is to pull the trigger and see that nothing happens. In 1982 Falkland war, a large number of bombs did not go off, even when hitting the target, to the frustration of Argentinian pilots. In Russia, after the disintegration of Soviet Union, many ammunition dumps suffered catastrophic explosions due to degradation of explosives and propellants stored for too long. So the solution for this problem is not an easy one. New ammunition has a longer shelf life, but in the same time class V stocks are decreased to a level that can insure a replacement plan through peace time usage.

For class II, when looking at major equipment such as tanks and other vehicles, it is hard to create stockpiles. The first thing to do is to select a list of class II items that are considered critical, have an increase rate of loss or attrition in war and then establish the amount to be stockpiled. Even so, mothballing equipment is costly, and there are some other factors to rake into account: some subsystems of the more complex equipment (i.e. communications gears, fire control systems and such) have to be upgraded from time to time to keep the pace with the same equipment in use. Modularity concept in manufacturing the equipment is the best solution, and can be applied for all complex items, but it is costly.

The storage facilities to preserve complex equipment have to be large enough, with a controlled environment and protection from the elements. Not so difficult for vehicles, but way more challenging for aircraft or ships. The US found a solution by using an area in the country that meets the requirements naturally: the Arizona desert (see below).

Fig.1 B-52 Bombers mothballed in Tucson, Arizona

Another critical issue in stockpiling class II is repair parts. All nations are reluctant to produce extra repair parts besides what is needed for maintaining the equipment operational in peace time. A way to alleviate this was to create a kit of repair parts that accompanies the equipment at the delivery, and will have its inventory kept at 100% throughout its life cycle. The kit consists of items more prone to break down, but they are destined for basic repairs, usually performed by the crew. Another way of solving this problem is to have a flexible economy that can react quickly to war necessities. In 1991 Iraq war, the US economy quickly adapted to the new, unpredicted requirements generated mainly by the harsh climate. This may always work when you do not wage war on your backyard. Once war reaches your facilities, things will not go that smoothly. In World War II (WWII), Germany faced this situation, when its research and production facilities came under direct attack by allied forces, whilst the Soviet Union and the US factories kept producing goods without any fear of enemy fire.

As a conclusion, all nations must prepare for war by stockpiling some of the supplies, but the quantity and the selection varies according to their economic strength and the flexibility of their economy. NATO has its own policy in this respect, setting the number of DOS for units belonging to its force structure and, whenever there is a NATO led operation (usually a CRO), dictating the level of support for all actors involved. In the latter instance, NATO commander sets the number of DOS for all classes of supply to be available in the Theatre of Operations (TO) and nations have to comply individually or, most of the times, collectively. For instance, in TO Afghanistan, the level set by NATO Commanding General was 30 DOS for classes I, III and V. Whilst class V is most of the times a national responsibility and it is covered individually, for classes I and III there were collective (multinational) solutions that decreased the costs and the logistic footprint.

3.2 Supply in war

Once the war breaks out, supplies will be in high demand by fighting forces, but with respect to classes of supply the demand is not even: up to 60% of the weight of supplies moved in an operation is fuel (class III), almost 20% is ammunition (class V) and the rest is made of small percentages of classes I and II. Class IV may see an increase when preparing a thorough defense operation or setting temporary or permanent military bases. The percentages changed throughout history, but class III started its increase during WWII. The German Army at that time required 28 pounds per day per man, out of which 40% was ammunition, 38% fuel and the rest was class I and II (especially repair parts). Nowadays, a US division requires between 100-500 pounds per day per man, of which classes III and V comprise more than 75%.

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History has showed that usually class I is overlooked in favor of classes III and V. That forced the soldiers to make do with whatever they encountered on the ground. This may go somewhat for infantry, but not so much for navy, where class I plays a crucial role (especially food, since water can be obtained from the sea water using desalinization equipment). For instance, for vessels with nuclear propulsion, class I is setting the operational range, which is not the case for land forces.

For the air force, the operational range is dictated by class III, but the number of sorties is closely related to the availability of repair parts and the ground facilities for maintenance.

In war, supply is always a high value target for the opponent. A well skilled commander will always try to deny the enemy its supply whilst protecting his own stocks. The worst case scenario is when forces are encircled, preventing a normal or any of the supplies to flow in. The battle of Stalingrad is the "by the book" example, when German forces could not maintain an aerial re-supply system and eventually had to surrender. In 1991 Iraq war, Iraqi army found itself isolated in the desert, with dire consequences.

At the national level the main concern is to protect the facilities producing supplies. This may be relatively easy when the war is waged far enough from the country's borders, but way more complicated when it reaches them. In WWII German factories were bombed day and night by allied forces. To protect them, Germany took two main courses of action: increased their defense, by moving the facilities under thick concrete walls, using artificial fog for daylight bombing, concentrating Air Defense equipment and fighter squadrons around, and so on; the other course of action was to decentralize production throughout the country (in other words not having all the eggs in one basket). The architect behind this strategy was Albert Speer, who managed to increase war production to the highest level in the second half of 1944. This worked very well until Germany was completely cut out from all raw materials, and consequently the war industry starved out.

The very first commodity to get critical in war is class III. Fuel is what is driving the war machine on, and without it the forces have to stop the operations. Whenever the attacking forces overtook the supply line, they had to stop. Rommel saw it happen in North Africa, and the US troops encountered this situation in Iraqi desert in 1991. Napoleon Bonaparte tried to solve this by establishing intermediate temporary depots with food and ammunition, but the Russian forces made sure he never used them.

Most of the countries rely on national reserves and the output of their economies, but sometimes that is not enough. In WWII, one of the reasons the German forces advanced so quickly in France was because they seized French fuel reserves. The French government did not take action to prevent it, and consequently the invading forces had enough fuel to top off their tanks and all they had to do was to pull over at the French gas stations, thus allowing the Wehrmacht to maintain a high tempo of the offensive operation. The Soviet Union took a completely different approach: they destroyed all oil facilities that were in danger of being occupied by German forces, whilst moving their own resources deep in the country, out of the reach of German Luftwaffe. When German troops advanced towards Baku (now in Azerbaijan), the soviets prepared all oil installation to be destroyed, Stalin's order to his man in charge of Baku was clear: if you destroy the installations unnecessarily, you will get shot, if the Germans seize them before you destroy them you get hanged. Stalin also ordered all technicians from the oil industry in Baku to be evacuated deep in the Soviet Union. Thus, the little oil shafts that the German did seize could not be used immediately, and by the time they could be put in action it was too late.

Still, lack of fuel cannot prevent troops to fight a guerilla war, as it happened in Vietnam. The North Vietnamese troops (NVA) used bicycles and livestock to supply their forces, transporting the goods covered by the thickness of jungle. The famous Ho Chi

Minh road was never completely cut off by US bombing campaign, so ammunition and food kept flowing to supply NVA in South Vietnam.

But supply is all about numbers, so below there are some estimates of the supplies required in a day (1 DOS) by a US armor division in two types of operation: offense and defense.

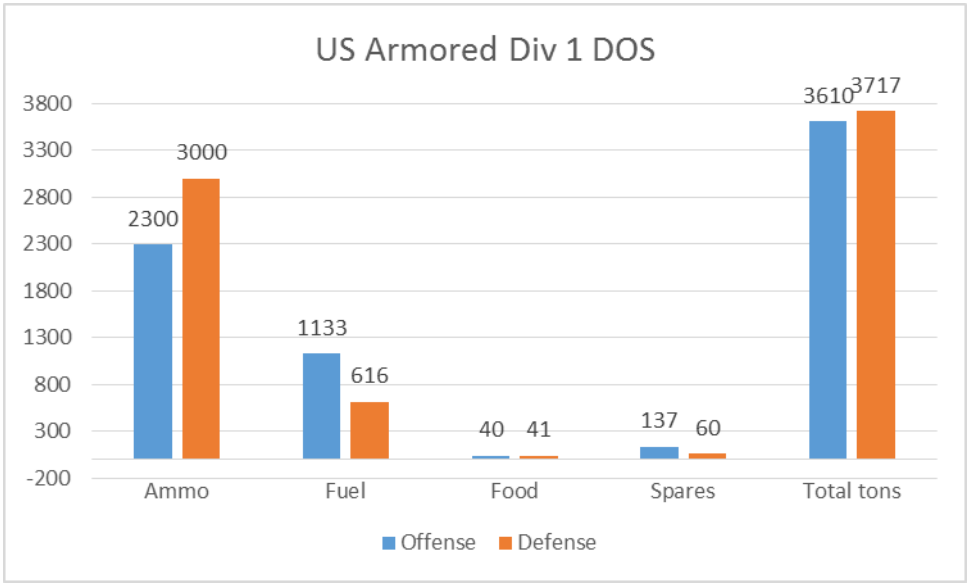

Fig.2 Break down of 1 DOS for offense and defense operations [2]

Out of the chart it is easy to notice that ammunition and fuel take the lion's share. Also notice that for defense the total amount necessary is slightly higher than for offense. Of course, the numbers come from statistics and simulation programs, reality may be very different. But let us consider these numbers and try to create 30 DOS of stocks for the division in case. For that we will consider the highest amount of supplies, since the division has to be able to fight both operations. These leads us to the following numbers:

Supply type	**1 DOS**	**30 DOS**	**60 DOS**
Ammo	3,000	90,000	180,000
Fuel	1,133	33,990	67,980
Food	41	1,230	2,460
Spares	137	4,110	8,220
Total tons	4,311	129,330	258,660

Fig.3 The amount of supplies needed for one day, one month, and two months

It is easy now to understand that stockpiling 90,000 tons of ammunition for one division for only one month of combat is not an easy task. It would require 450 ammunition storage bunkers (usually they have a 200 tons capacity). In a regular ammunition dump you may have around 50 bunkers, so that would lead to 9 ammunition dumps only for one division.

For the air force, the number estimates are depicted in the table below:

Aircraft	Tons carried		Average sorties per day	1 DOS
	Fuel	Warload		
MIG-21	2.1	1.5	1	**3.6**
MIG-25	15.1	2	0.5	**8.55**
MIG-29	4	4.5	2	**17**
MI-24	1.5	1.7	4	**12.8**
F-16	3.2	6.9	3	**30.3**
A-10	6.1	7.2	5	**66.5**
UH-60	2	3	5	**25**
AH-64	7	1.7	4	**34.8**
F-18	5.1	7.7	3	**38.4**

Fig.4 The amount of classes III and V for 1 DOS [2]

So for a squadron of MIG-21 with 24 aircraft, for 30 DOS you will need to store 1,512 tons of fuel and 1,080 tons of warload (class V). For an A-10 squadron, the numbers grow more, with 4,392 tons of fuel and 5,184 tons of class V (see below the comparison). Also from the comparison you can notice that the amount required by western design aircraft is far bigger than that of the Russian types, mainly due to a higher number of sorties.

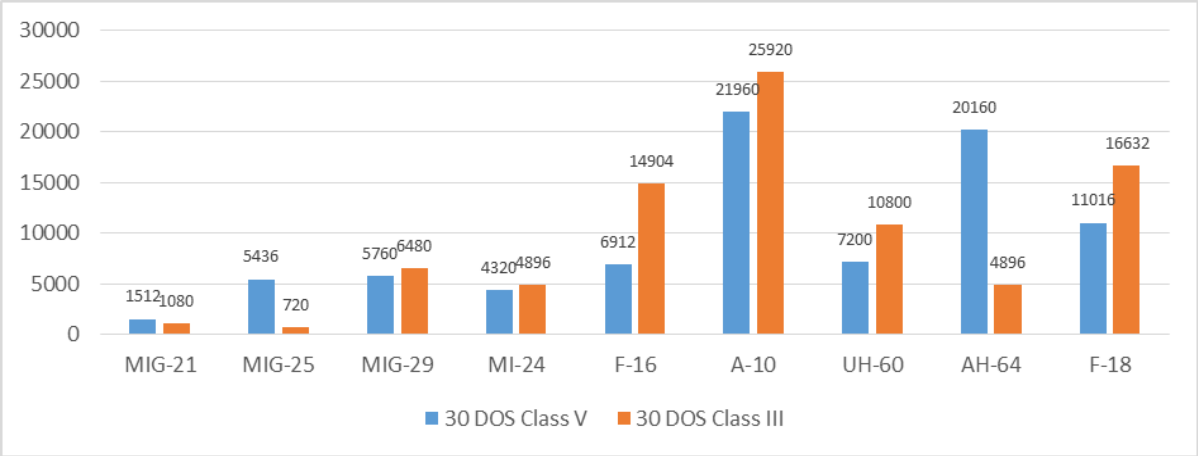

Fig.5 The amount (tons) for classes III and V for 30 DOS/aircraft squadron

Luckily, airbases are usually far away from fighting areas and have plenty of space around them, but that is not the case of the aircraft carrier. The F-18 requirements from the chart above are for an aircraft carrier. So if the carrier has 72 aircraft, then it will need no less than 1,101 tons of fuel and 1,663 tons of ammunition for 1 DOS. A carrier task force can consume up to 5,000 tons of supply per day at sea, therefore the task force includes several support vessels to re-supply, not to mention strategic ports all over the world.

3.3 Supply as a functional area of logistics

As I mentioned at the beginning of chapter 2, supply is also a functional area of logistics, meaning that logisticians are in charge for determination of stock levels, provisioning, distribution and resupply.

In preparation of an operation, the logisticians always have to estimate the supplies needed to achieve success. This process is conducted at all levels, and the figures are compared with the real possibilities to meet the demand, the outcome being the shortfalls that a commanding officer has to be aware of. There are several ways to estimate the amount of supply for a specific operation. Some armies rely on historical data, but the wars in the modern era have gotten very complex and thus the method is not very accurate, leading to higher than necessary amounts, especially for class V. In NATO there are two computer programs that help the logisticians to estimate the supplies for a specific operation: Sustaining Planning Module, or SPM, and Allied Commands Resource Optimization Software System, or ACROSS. They both take into account the possible enemy to be encountered, and based on the composition of own forces determine the estimated amounts of supplies necessary to achieve success. The tools are useful for higher echelons, division and above, since they are in charge of re-supplying the lower echelons (brigades and below). The higher echelon will set the tempo and the amount of resupplying the lower echelon, based on the estimates and on the supply on hand.

There are two systems of distributing supplies: *push* and *pull*. The *push* system is used when consumption follows a uniform rate, such as class I. The only adjustment needed is based on the strength of the unit and the types of rations. As the name implies, the higher echelon is pushing the supplies downwards regularly, without the risk of exceeding the stocks. The *pull* system is based on the unit's request to its higher echelon. This is usually done at the end of each day of the operation, based on the level of supply estimated prior of the beginning of the operation and the current stocks. In this way the unit will avoid excessive stockpiling, with the inherent risk of having to discard or destroy them due to lack in means of transportation. The system addresses mainly class V and in some cases class III.

4. Conclusion

In war supplies play a very important role. Some of them are utterly showstoppers, due to their importance in warfare, such as classes III and V. There is always the debate of how much to stockpile in preparation for war, and ammunition is in lead when it comes to difficulties in storing it. Still, lack of class V stocks might be seen as a chance to prevent a WWII type war, whilst a nation that suddenly increases class V production can signal to the others that it is preparing for something.

Today's nations commit less money to the armed forces, the trend starting after 1990. Initially, that left the armies, which shrank continuously, with large amounts of supplies, especially classes II and V. But in the past 25 years the ammunition stocks have decreased drastically, by degrading or by fueling small wars over the world. Class II supplies have become obsolete and useless, the major equipment being sold to poorer countries. With the nuclear deterrence in place, one might consider that a classic WWII war is almost impossible, but the evolution of the global economy, the degradation of global environment and the struggle for resources may change that. How to set the balance right is never an easy task, and it will always involve both political class and military expertise to struggle to reach a compromise.

NATO, as an alliance, provides some advantages concerning the provision of supplies in war. In the first place, NATO promotes the concept of interoperability, and the technical part of the concept helps alleviate some of the supply problems. For instance, the NATO calibers for small arms are generally the same throughout the whole alliance: 5.56 mm, 7.62x51 mm, 9x19 mm, 12.7x99 mm. Even for artillery, NATO has its standardized calibers: 105mm, 120mm, 125mm and so on. During the war, if a country has problems supplying class V, it can turn to another NATO country for provisioning. Also, it is hard to

believe that all NATO countries' facilities for war production will be under direct enemy fire. In this way, supplies can be shifted within the alliance's territory. So even though some NATO countries do not have all stocks at the required level, before their economies can switch to war production they can very well import the needed supplies from within the alliance. The higher the degree of interoperability, the easier to provide supplies among NATO countries.

For class II, things are somehow different, since major equipment is normally produced within the country. There are exceptions, especially for multinational projects (Typhoon multirole plane, Tiger attack helicopters, A-400 transport plane etc.), and this would seem the right solution for the whole alliance, but for the existing equipment the producing countries try to get their invested money back or have special policies concerning the exports of what is considered strategic items (see F-22 fighter plane). But the main idea is that generally speaking, an alliance is less costly and provides more security than what the nations individually can do in this respect.

5.References:

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