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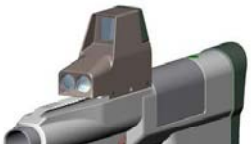
NATO INFANTRY WEAPONRY MASTER PLAN









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- Swedish Defence Materiel Administration, FMV
- Swedish National Research Establishment, FOI
- Swedish Armed Forces Land Warfare Combat School, MSS

Feed-back should be sent to the Swedish HoD at the address bellow.

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Per G. Arvidsson
Chief Engineer
Centre of Expertise for Technical System Management
FMV
S-115 88 Stockholm
Sweden

Tel: +46-8-782 4181
Fax: +46-8-782 6412
E-mail: per.arvidsson@fmv.se

NATO INFANTRY WEAPONRY MASTER PLAN

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NATO INFANTRY WEAPONRY MASTER PLAN

BACKGROUND

An extensive work was performed during the early nineties by Land Group 3 Close Combat Infantry (then named Panel III) called “Programme for Collaborative Research Into Small Arms Technology”. The results were used to develop STANAG's and to elaborate the D/7 document “Infantry Small Arms Post-2000” (NATO AC/225(LG/3)D/7). That document was revised in 1997. D/7 covers only small arms. As this is only part of LG/3’s terms of reference it was decided to create a new document covering all weapon systems primarily used by the Infantry. This new document being called the “NATO Infantry Weaponry Master Plan”

PURPOSE

As a fundamental part of its remit from the NAAG, LG/3 seeks to identify ways of facilitating:

- the exchange of information between nations for their mutual benefit
- co-operation or collaboration between member states on bi or multilateral acquisition programmes
- interoperability across member states through the mechanism of STANAG’s

The Infantry Master Plan is to be:

- a document that contains unbiased non commercial information
- a reliable information tool when considering to start national studies for new procurements
- a structured plan leading to elaboration of a Programme of Work for LG/3 which addresses:
    - structured exchange of information
    - definition of common requirements
    - definition of existing problems
    - detection of future issues of standardization
    - detection of possible collaboration or cooperative development
    - updating of existing STANAG's and documents or elaboration of new ones
- a vision of near-term, mid-term and far-term capacities related to Infantry weaponry

METHODOLOGY

The Master Plan is a living document that as such will require regular update. SWEDEN, as Lead Nation, has accepted to maintain this document as a reference and to update it as new requirements are identified by member nations of LG/3.

The annex attached to the master plan gives an overview of ongoing studies performed by LG/3. These are part of the annual programme of work that is yearly submitted to and approved by the NAAG. These studies should take logically their foundations within the master plan since it lists the full spectrum of matters related to Infantry weaponry that fall under LG/3 concerns.

GENERAL TECHNOLOGIES

1. High explosive warheads
The high explosive warheads achieve their effect by fragments, pressure and heat.

1.1 Fragmenting warheads
Older warheads have a shell body made out of steel. It is ruptured by the detonation of a high explosive charge. This produces so called natural fragments, which vary in size, mass and initial velocity. More recent shell bodies are pre-fragmented (embossed). On these pre-breaking points are pressed on the inside of the body. Upon detonation they break at these points, causing regular fragments. Other designs utilize steel ball bearings often encapsulated in plastics. This also creates even size fragments. Some modern design uses tungsten balls. For the same given mass the number of fragments is reduced, but their penetrating power is greatly increased, even against targets wearing body armour.

1.2 Thermobaric warheads
Thermobaric warheads do not use fragments as its lethal means, but work by creating pressure and heat over a relatively long time. This is created by burning small metal particles that are thrown out of the warhead by a relatively small high explosive charge. The lethal area is increased in comparison to warheads using fragments.

2. Programmable ammunition
With the ongoing miniaturization of electronic components it has in recent years been made possible to build small compact fire control systems that include a laser range finder, a ballistic computer and some kind of display. After measuring the range the computer calculates and displays an aiming pointer. In programmable ammunition the fuze contains a electronic module that the fire control system can communicate with during firing. Usually the fuze receives its time of flight to the target, counts down to zero and initiates the warhead above the target thereby increasing the lethality of the warhead.

Programmable ammunition is sometime called “air burst munition”, but that is just one of many modes the fuze can be programmed to do. Others could be impact and impact delay.

3. Metal storm
Metal storm is a development by an Australian company with the same name. It is a weapon system that consists of projectiles with an individual propellant charge stacked behind each other in a barrel. These are fired individually from the front to the rear of the barrel. As there are no moving parts (except for the projectiles) a very high rate of fire can be achieved. The system lends itself mostly to low pressure rounds like pistol calibres and 40 mm grenade ammunition. It is anticipated that such a system can be fielded within the next ten years given enough funding for its development.

4. Directed energy weapons
Most of the current designs of directed energy weapons are non lethal. In the future energy levels could be increased to make them lethal. There are currently four areas:

- Lasers
- Tasers (electro-muscular disrupt)
- Acoustic
- HPM (high power micro wave)

High power microwave (HPM) weapons are likely to be commonly used against electronics in the future. A typical HPM weapon radiates an electromagnetic pulse having a frequency between 100 MHz and 10 GHz and of several gigawatts peak power. Microwaves of high power induce currents in the electrical circuits and cause temporary or permanent damage to the electronics. The sensitivity of the electronics depends on the shielding and angle of incidence of the radiation upon the target. The range of an HPM weapon is therefore difficult to determine and could instead be defined as the range below which a certain field strength is generated.

HPM-weapons mounted on vehicles or ships would have sufficient space for antennas allowing a range of up to ten kilometres. The space available in a vehicle or ship would provide higher microwave power and energies.

An HPM weapon could be fitted into an UCAV or into an ordinary bomb. On such platform, the size of the antenna could be moderate giving a range up to a few kilometres.

Mortar or howitzer launched HPM ammunition would probably have much shorter range, 10's of metres, due to the limited space for an antenna.

Microwave weapons operating at frequencies around 94 GHz have been developed to target humans. The microwaves are non-lethal but cause pain and paralyse the person subjected to it. The intended use of this kind of microwave weapon is for crowd control e.g. in international operations.

5. Non-lethal weapons

The NATO policy on non-lethal weapons defines them as follows:
“Non-lethal weapons are weapons which are explicitly designed and developed to:

- incapacitate or repel personnel, with a low probability of fatality or permanent injury;
- disable equipment, with minimal undesired damage or impact on the environment.”

NLW are divided into two main categories: anti-personnel technologies and anti-materiel/-infrastructure. The anti-personnel technologies have been divided into six main categories:

1. Electromagnetic technologies
    - Microwaves
    - Lasers
    - Tasers (electro-muscular disrupt)
2. Chemical technologies
3. Acoustic technologies
4. Mechanical technologies
    - Rapid barriers
    - Nets & entanglements
5. Kinetic technologies
    - Blunt impact
6. Combined technologies
    - Kinetic/Acoustic
    - Laser/Radiation
    - Optical/Heat

The anti-material/-infrastructure technologies have been divided into three main categories:

1. Electromagnetic technologies
    - Radio frequency devices
    - Lasers
2. Chemical technologies
    - Chemical
    - Slippery foam
    - Sticky foam
    - Super adhesive substances
    - Super caustics
    - Graphite powders
3. Mechanical technologies
    - Rapid barriers
    - Nets and entanglements
    - Tire puncturing techniques

6. Light weight high strength materials

Nano-structured materials as well as amorphous materials can be tailor-made to a specific design criteria's. It can be given properties such as high strength, lightweight, super plasticity and for special weapon applications, pyrophorous. Nanocrystalline ceramics can be made transparent by using sparc plasma sintering methods, and thus be used as electro-optic windows in high-speed missiles.

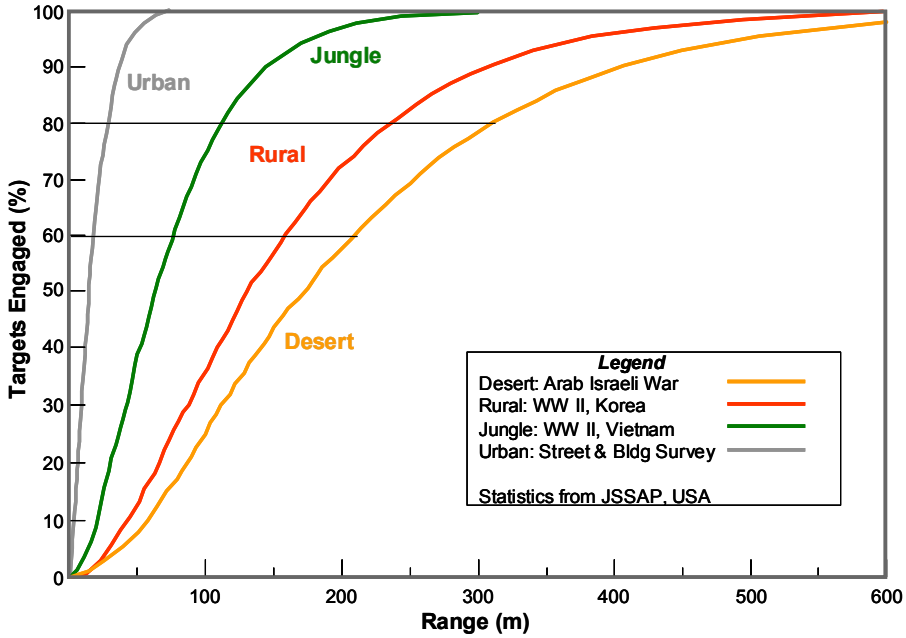
7. Explosives and propellants

In this area the research is directed forward along two routes: Evolution and Revolution. Along the evolutionary route many new energetic molecules is studied. The aim is towards more energetic contents, increased safety, lower environmental impact, less signatures and the ability to tailor made it into specific applications. Along the revolutionary route there is expectancy of gaining a lot more energy content, maybe up to 2 to 5 times the present energetic materials.

Range

The USMC after action report from Iraq states about enemy engagements that almost all fire fight engagements conducted with small arms (5.56mm guns) occurred in the 20-30 meter range. Shots over 100m were rare. The maximum range was less than 300m. Most sniper shots were taken at distances well under 300m, only one greater than 300m (608m during the day).

The following US graph illustrates the range for target engagements with infantry weapons.



Today approximately 45% of the world's population live in cities. It is expected that some 70-85% will live in cities by 2025. This means that MOUT will most probably be more common in the future. Combat ranges for low-level units will therefore be short. Short ranges however often means quick engagements. Future weapons must therefore be able to quickly engage targets.

Use of Body Armor

US predicted percentage of conventional and special combat forces wearing some form of body armour.

	Today	***2013***	***2023***
First World Countries	50%	80%	90%
Second World Countries	10%	25%	50%
Third World Countries	5%	10%	15%
Average	22%	38%	52%

Note: US have not encountered any substantial use of body armour by combatants during the last 13 years to current day.

Targets

The target which small arms have to defeat is found in Document 7 (D/7) “Infantry Small Arms (Post-2000)” (NATO AC/225(LG/3)D/7), and STANAG 4512 “Dismounted Personnel Targets”. This target is known as the “NATO Protected Man” or formerly as the “CRISAT Protected Man” or the “CRISAT Target”. As the experience from NATO and PFP members are that this target has not been encountered during the last 13 years of international peace-keeping operations, it is generally regarded as irrelevant. A new STANAG should be made for an unprotected man.

Vehicle targets encountered during these missions have also proven to be of older heritage than planned during the cold war. Targets have typically been soft skin vehicles, and light armoured IFV like BTR’s, MT-LB’s, and BMP-1’s. New relevant targets should be standardized.

Background
Small arms have been the soldier's primary weapon for hundreds of years, and will be so for a long time to come. Just prior to World War 2 automatic individual weapons were introduced. Since then calibres have been reduced, and weapons have generally been constructed of more lightweight materials than traditional steel.

Small Arms Weapons
In the last 20 years more and more countries have gone from rifles in calibre 7.62mm to 5.56mm. This reduces the weight of the weapon with approx. one kg, and the ammunition by 50%. This has in most cases, however not reduced the load that the soldier carries, as they generally carry more round today than they did 20 years ago.

Current weapons are made out of steel, aluminium and plastics. This will remain the standard materials even in the far term, but many parts that today are made of metal will in the future be made of plastics (ex. receivers and magazines).

Most weapons today have a rail on top of the receiver on which an optical sight, NVD or Thermal sight can be mounted. Today this rail is different on most weapons. In the future all weapons will most probably have a standardized "Picatinny rail" according to "PFP (NAAG-LG3)D(2001)1" (MIL-STD 1913).

The general trend is to have optical sights as standard on rifles instead of iron sight, which still can be found as back-up sights. The trend regarding optical sights is to go from telescopic sights with approx. four times magnification to red dot sights without magnification.

It is foreseen that future weapons - even in the far term - will continue to fire kinetic projectiles and use metallic cartridge cases.

Small Arms Ammunition

Caliber
The general trend within small arms ammunition is to develop lighter ammunition, thereby reducing the load soldiers have to carry. This can be done by either reducing the calibre or by changing the material in the cartridge case from brass to aluminium.

Caliber	***Mass of round (g)***	***Mass of projectile (g)***
7.62 x 51mm NATO	24	9.5
5.56 x 45mm NATO	12	4
5.7 x 28mm	6	1.7

Materials
The mass of the brass cartridge in a 5.56 x 45 NATO round is 54%, bullet 33% and propellant 13%. If the brass in the case would be exchanged to aluminium, the reduction in the mass of the round would be approx. 30%. Several countries currently investigate this.

Caseless ammunition
Development of the G11 rifle with its caseless ammunition started in Germany in the late 60's. It was cancelled after approx. 20 years. Even with a fairly complicated weapon design it could not match the reliability of traditional designs. It is therefore highly unlikely that this can be accomplished even in the far term. The metallic cartridge case has more functions than one initially thinks of. Some of these are: obturation, protection from the elements, keep component together, removal of heat and centring of the projectile.

Other designs
Instead of trying to reduce the mass of the ammunition by trying to develop caseless ammunition, new unorthodox design with a plastic case could be developed. This was done by the Austrian Steyer company for the US ACR (Advanced Combat Rifle) program in the late 80's. This will however require a substantial development that only few countries can afford.

Armour piecing ammunition
Traditional designs utilize steel cores. More modern designs utilize a tungsten carbide core. These are often referred to as "APHC" (Armour Piecing Hard Core) rounds. The armour penetration is increased several times in comparison to steel cores.

Single shot grenade launchers
The first single shot grenade launcher adopted was the US M203 in the late 60's. 30 years later it still remains the most common launcher. No major improvement has yet been seen, but in the near term it is anticipated that they will be equipped with a fire control system and will be able to fire programmable ammunition.

Automatic grenade launchers
The Mk19 AGL was developed in the 60's, and improved during the late 80's. It was used extensively during the Gulf war. During the short ground fighting, it was reported that these caused half of the enemy casualties. Several competing designs are currently available on the market, but they all show relatively little improvements for the user, especially regarding weight. New lightweight designs are however currently developed. It is expected that these will be fielded within the next five years.

Grenades
Current rounds all have an impact fuze. Some are available with a self-destruct function. The requirement for this will increase in the future. The next generation will have an electro-mechanical fuze that can be programmed by a fire control system. These will start to be fielded within the next five years. With a fire control system and programmable ammunition the number of round required for a given scenario will be reduced in comparison with traditional systems, which lack both fire controls and programmable ammunition. The system weight can therefore be reduced.

Current rounds have a warhead that is fragmenting and/or have a shaped charge. New designs with a thermobaric warhead are currently designed. It is anticipated that these will be fielded within the next five years.

All current launchers are in the 40mm calibre. Launchers in new calibres (25mm) are currently being designed. They offer a flatter trajectory and lower mass, at the price of decreased lethality. They therefore need a accurate fire control system to be lethal. It is anticipated that these can be fielded within ten years.

Personal Defence Weapons (PDW)
PDW's consist of submachine guns and pistols mainly used for personnel protection at short range by non-combat troops. They were first mentioned in D/7. NATO wanted to standardize a calibre for these. Tests were performed during 2002, but no clear candidate could be selected. The NAAG then organized a QRT (quick reaction team) to further investigate this. The QRT recommended the 5.7x28mm cartridge. As NATO has decided not to standardize a PDW the term is not used in the breakdown structure, and the two types of weapons will be found under pistols and submachine guns.

Non-Lethal
Current anti personnel NLW's consists of:

- Spay bottles with irritants (ex. tear gas "CS" or pepper spray "OC")
- Hand grenades with pyrotechnical charges or irritants.
- Blunt impact ammunition for 12 Gauge shotguns or 40 mm grenade launchers

Most of the current designs are based on kinetic energy firing a blunt plastic projectile from a 12 Gauge shotguns or a 40 mm grenade launcher. Other designs include irritant and distraction grenades. New designs include tasers (electro-muscular disrupt), HPM (high power micro wave) and area denial devices (ex. micro wires). It is anticipated that in the far term rounds will have combined effects (ex. kinetic + taser, kinetic + micro wire).

Breakdown structure
Individual Weapons

- Handguns
- Submachine guns (incl. PDW – Personal Defence Weapons)
- Assault rifles and carbines
- Sniper rifles
- Shotguns
- Grenade launchers
- Combination weapons
- Non-Lethal weapons
- Directed Energy weapons

Crew-served Weapons

- Machine Guns
- Automatic grenade launchers
- Directed Energy weapons

Platform mounted weapons

Ammunition

- Small arms
- Grenades
- Muzzle launched devices
- Non-Lethal

Sights

- Optical
- Laser pointers
- Night vision (I^2= Imaging intensifying)
- Thermal imaging (TI)

Fire Control Systems

- Laser range finders.
- Ballistic computers with laser range finders.
- Ballistic computers with laser range finders and aiming point.
- Ballistic computers with laser range finders and aiming point that can communicate with the ammunition.
- Network interface.
- IFF (identification friend or foe)

Interfaces with other Systems

- Mil-Std 1913 Rails
- Weapon mounts

Others

Current technology

Technology	***Major issues***	***Weapons***
Weapons made of steel, aluminium and plastics. Calibre 5.56 mm. Optical sights are common. Laser pointers. NVD on weapons. Development of thermobaric warheads.	CRISAT Document D/7 AGL breakthrough Picatinny rail SOPMOD 40 HV is standardized.	Barrett M82 HK G36 Colt M4 Carbine Mk19 FN P90 HK MP7

Near term perspective (5 years)

Technology	***Major issues***	***Example of weapons***
Titanium and composites are used in weapons. Optical sights are standard. Thermal sights on weapons. Fire control systems.	Programmable ammunition. Green ammo is standard. Lighter ammunition (ex aluminium cartridge cases) Modular weapon systems. Thermobaric warheads.	Striker AGL with programmable ammunition PDW's US XM8 US XM25 SWE SSW

Mid term perspective (10 years)

Technology	***Major issues***	***Example of weapons***
Light weight material. Composite materials. I^2+Thermal fused images. Compact fire control systems.		US XM29 OICW US OCSW

Far term perspective (15 years)

Technology	***Major issues***	***Example of weapons***
Fully integrated weapon systems with combined day and night sights, and integrated in the network.	New type of cartridge.	

TABLE OF CONTENTS, MEDIUM CALIBRE CANNONS

Background

Medium calibre cannons are used as main armament on light and medium armoured vehicles. Targets are armoured vehicles, aerial targets, buildings and personnel. Several types of ammunition are needed to be able to handle all types of targets.

Integration in turrets are beginning to be more complex due to new technologies within sensors (CCD, NVG and TI), battlefield management system (BMS), Defence Aid System (DAS), identification systems (BTID, DSID, IFF) etc. Several countries are studying both upgrades on present vehicles and development of new vehicles, which will, includes a number of new technologies.

A modern turret today is fully stabilized and manned with a crew of two, commander and gunner. Sights with thermal imaging and ballistic computer are used for the gunner. Some vehicles also have an advanced sight for the commander.

Breakdown structure

Cannons

- Conventional automatic cannons
  - Gas operated automatic cannons
  - Electic driven automatic cannons
- Recoilless automatic cannons
- Metal storm technologies
- CTA technologies (Cased Telescopic Ammunition)
- ETC technologies (Electro Thermal Chemical)

Chemical energy ammunition

- High explosive
  - Fragmentating
  - Thermobaric
  - Shaped charge
- Directed Energy weapons
- Combined effects
- Adaptive effects

Kinetic energy ammunition

- AP (armour piercing)
- APDS (armour piercing discarding sabot)
- APFSDS (armour piercing fin stabilized discarding sabot)
- “AHEAD” (canister)

Combined effects

- MP (Multipurpose: fragmentation and armour piercing))

Fuze technologies

- Impact
- Time
- Self destruct
- Proximity
- Programmable

Sights

- Optical
- Laser pointers
- Night vision (I^2= Imaging intensifying)
- Thermal imaging (TI)

Fire Control Systems

- Ballistic computers with laser range finders and aiming point.
- Ballistic computers with laser range finders and aiming point that can communicate with the ammunition.
- Network interface.
- IFF (identification friend or foe)

Remote controlled (overhead) weapon stations

Current technology

Current cannons are mostly in the 25x137mm and 30x173mm calibers. They are either gas operated or electric driven. Ammunition includes HE, MP, AP, APDS, APFSDS and variations on these. A CTA cannon is under development.

Near term perspective (5 years)

No dramatic changes compared with present systems are expected. Different upgrades are possible on present systems but mostly regarding sensors and information systems. The calibres will be within the 25-40mm range. Programmable ammunition and improved APFSDS can be expected. ETC cannons are under development, as are other types of ammunition (ex. thermobaric).

Mid term perspective (10 years)

Several upgrades have been done on the present systems. New technologies have led to deliveries of new vehicles with remotely controlled weapon stations or turrets. The sensor technology gives possibilities for a high level of sensor-fusion in a battlefield management system (BMS). The calibres will remain in the 25-40mm range. ETC cannons are in use, if the increase in performance can justify the increase in cost. The performances have improved on several ammunition types. Higher muzzle energies can be expected with new types of propellant in combination with ETC. The effect in different targets will improve with new kinds of explosives. IM (insensitive munition) will most probably be a mandatory requirement.

Far term perspective (15 years)

Most systems will use programmable ammunition. Ammunition with a capacity to defeat a wider range of targets will be developed. New technology will produce cannons with new principles and materials. Future calibres will be a compromise between weight, volume and the required performance. The trend to larger calibres will not necessarily continue.

TABLE OF CONTENTS, SHOULDER FIRED WEAPONRY

Background

Infantry shoulder fired weaponry is deployed against a variety of target types including medium tanks, light armoured vehicles, concrete and/or brick structures, bunkers and personnel. In addition to these some systems support the use of other types of munitions such as smoke and illumination. Currently, there is a suite of weapons suitable for these targets as no single system is effective against all. There may be a variety of weapons suitable for use against the same target. Shoulder fired weaponry can be either of disposable or reloadable type.

As for several other areas a recent focus is the capability of shoulder-fired weaponry in Military Operations in Urban Terrain (MOUT). New systems and/or ammunitions and technologies are sought to support this. However, large in stock inventories and a relatively high cost attached to the development and fielding of new systems will lead to that upgrades of today's systems can still be expected to be an important part of the coming years.

In MOUT-operations these weapons must be able to be launched from confined spaces (CS). The CS capacity is already incorporated in some systems, but an effort can be foreseen to make these weapons almost free from signature, thus giving the gunner complete freedom of finding a suitable firing position. For reloadable weapons programmable ammunition is possible to achieve using a fire control system. This can be used to compensate the launch itself for environmental impact, and/or to control air-burst of fragmentation grenades, thus covering large areas or engaging fox-holes, gun-emplacements, and similar targets.

Warheads with HEAT capability have up till now been the norm. In MOUT-operations there are additional demands. Therefore weapons or ammunitions with the ability to defeat enemies in buildings are required. These can be wall-penetration with a follow through fragmentation or thermobaric warhead, or a wall-breaching grenade able to blow a large enough hole into walls so soldiers can get inside. These weapons must also be capable of defeating light armoured vehicles and smaller bunkers and gun-nests. Ammunition with thermobaric effects will be common.

Breakdown structure

- Disposable systems
- Reloadable systems

Warheads/Ammunition

- Fragmentating
- Shaped charge
- Thermobaric
- Bunker defeat
- Wall breaching
- Combined effects (incl. selectable)
- Directed energy weapons
- Adaptive effects
- Low collateral damage
- Confined space launch

Fuze technologies

- Impact
- Time
- Self destruct
- Proximity
- Programmable

Sights

- Optical
- Laser pointers
- Night vision (I^2= Imaging intensifying)
- Thermal imaging (TI)

Fire Control Systems

- Laser range finders
- Ballistic computers with laser range finders.
- Ballistic computers with laser range finders and aiming point.
- Ballistic computers with laser range finders and aiming point that can communicate with the ammunition.
- Network interface.
- IFF (identification friend or foe)

DAS-countermeasures (Defence aid system)

- Decoys
- Low signature missiles
- Jamming

Current technology
See background.

Near term perspective (5 years)
Mainly upgrades using already developed system components to perform quick adaptations. Increased lethality by the use of better optical sights, laser range finders, fire control systems and night vision technology.

The family of systems with MOUT capabilities is likely to grow slightly within the period mainly through upgrades to existing systems.

Challenges & aims for the period
- An increase of weapon capability through sight and night vision upgrades.
- Development of features and capabilities that modern operations and threats require and choosing the desired mix.
- Finding ways to reduce development cost and increasing interoperability through standardization.

Mid term perspective (10 years)
Driven by the fielding rate of NVG the combination with red-dot sights or night vision aids separately mounted is likely to be a standard feature.

Fire control systems with low weight will be available. Supported by this some systems can towards the end of the period utilize these sights to communicate with the ammunition and exchange data such as fuze setting, ammunition id, propellant temperature etc.

Technology for high performing wall-breaching ammunition available.

Thermobaric warheads available on a wide variety of systems.

Challenges & aims for the period
- Launch of development and if possible initial fielding of multi-purpose MOUT specific systems/ammunition
- Using technology to save weight

Far term perspective (15 years)
Confined space capability regarded as the norm. Sight and ammunition communication is standard where required. Fielding of multi-purpose MOUT specific systems/ammunition. Shoulder-fired weapons are also used for other purposes than delivering lethal rounds. These can be: visual smoke, IR-screening smoke, sensors and non lethal rounds.

Challenges & aims for the period
- Field MOUT specific system.
- Significantly reduced weight of weapon components.
- Enable gunner and/or sight to receive and deliver information to C²-network.
- Introduction an IFF system and/or function.

TABLE OF CONTENTS, GUIDED MISSILE SYSTEMS

Background

Guided anti tank missiles are deployed against a variety of target types including heavy and medium tanks, light armoured vehicles, concrete and/or brick structures and bunkers. Currently, there is a suite of missiles suitable for these targets as no single missile is effective against all.

Most of the current systems are characterised by being wire guided. A smaller number are guided via laser, fibre optics or an auto tracker. Most of the systems can be carried and fired from vehicles as well as from a tripod mount or from the shoulder. Most missiles penetrates the target in the axis of flight, except for BILL1, BILL2 and TOW 2B that penetrates at an angle of 30-90 degrees to the flight path (top attack).

The more complex systems will most probably continue to be platform mounted. For a launcher integrated on a platform an important factor is that the launch tubes should be reloadable under cover and the fire control system integrated into the platforms own fire control system. In the near future BLOS (Beyond Line Of Sight) systems will be fielded, some with fiber-optic guidance and some laser beam riding. Fiber-optic guidance gives the gunner the ability to “see” the target before impact and enable him to abort if the target is not valid. Missiles with the ability to defeat NLOS (Non Line Of Sight) targets will be equipped with fire and forget capability. These can search for targets at a given GPS-coordinate or be directed towards the target by a laser designator. The ability to select a direct fire mode or a top-attack mode is valuable in built-up areas.

The main tasks for these missiles will be to defeat main battle tanks and APC’s. The ability to defeat explosive reactive armours will still be important. The ability to defeat DAS systems is developing. This includes the use of jammers, anti-jammers and other counter-measures. Missiles will be equipped with adaptive warheads so that optimal effect is reached in the target depending on its type. This includes MOUT-operations for engaging high-threat targets. Warheads capable of defeating bunkers are under development.

Breakdown structure

- Vehicle mounted
- Crew served
- Shoulder fired

Missile warheads

- Fragmentating
- Shaped charge
- Thermobaric
- Bunker defeat
- Wall breaching
- Kinetic (HVM: high velocity missiles)
- Combined effects
- Directed Energy weapons
- Adaptive effects
- Low collateral damage
- Confined space launch
- Soft launch
- Propulsion

Fire control systems

- Optics and electro optics (night vision and thermal imaging)
- Laser range finders
- Platform integrated fire controls
- Guidance systems
    - Lasers
    - Fibre optics
    - Gyros
    - Auto trackers
- Line of sight (LOS)
- Beyond line of sight (BLOS)
- No line of sight (NLOS)
- Network interface.
- IFF (identification friend or foe)

DAS-countermeasures (Defence aid system)

- Decoys
- Low signature missiles
- Jamming
- Signature reduction at launch

Current technology
See background.

Near term perspective (5 years)
Important within this timeframe is to develop/finalise the defining requirements and targets for transferring the in stock systems into the modern threat scenarios.

Within this period there should be a study performed to establish mutual requirements concerning range (both close and far distance), time to engage targets, weight and vehicle carried or man carried, needed warheads (target definition),

Incorporate network communication on low level.

Introduce CS-capability.

HPM and thermobaric warheads are under development.

Mid term perspective (10 years)
Study techniques to accomplish target defeat beyond line of sight (BLOS).

Study techniques to accomplish low signatures on missiles and at launch.

Study techniques to defeat active countermeasures.

HPM and thermobaric warheads are in service.

Far term perspective (15 years)

TABLE OF CONTENTS, MORTAR SYSTEMS

Background

Mortar systems are used to support units mainly on battalion and lower levels and to defeat different enemy target types. They are one of the oldest methods of bringing heavy firepower onto an enemy at close range and remain a valued part of today's firepower support. Mortar bombs have been provided with more lethal payload potential in addition to that all important combat necessity of further reaching range. With these enhancements have come changes to make the mortars more portable and handy.

The mostly used mortars have a calibre of 120mm, and it is in this calibre that the most significant recent innovations have been witnessed. They can be either crew-served or vehicle-mounted. An example of vehicle-mounted is the AMOS-system, a twin barrel 120mm turret mounted, reloadable under protection.

It can be foreseen that especially vehicle-mounted launchers will be fitted with inductive programming of the ammunition, thus enable a more versatile use. The programming could be used for the ammunition effects and/or for corrections of environmental behaviour of the launch and for flight-motors, thus increasing the precision.

Conventional rounds with fragments will continue to be used. New rounds will be developed that could be equipped with flight motors extending the range out to about 15 – 20 km. Rounds with "Thermobaric" warheads for urban warfare operations will be developed.

Precision engagement and scalable effects will be the next important step to make. Thus make it possible to perform "real" surgical strikes in MOUT operations in international peace keeping operations to minimize collateral damage.

Breakdown structure

Guidance
- infra-red based seeker system
- laser guided

Fragmentation
Fuzes
- time fuzes
- impact fuzes
- proximity fuzes
- multi-option fuzes
- fuze setting equipment

Cargo Projectiles
- fail-safe fuzes for bomblets
- expulsion techniques

Combined Cargo & guided munition
Fire Control Systems
Sights and laying equipment
Communication
Explosives and propellants

Light- Squad/Platoon/Company calibres (< 81mm)
The smallest standard calibre is the crew portable 60mm light mortar. A few 51mm so called commando mortar types may still be encountered. Some armed forces are contemplating the conversion of their standard 81mm to 60mm due to portability advantages and enhanced range with the 60mm mortar ammunition.

- Tube, mount and Base plate
- Ammunition:
    - Fragmentating
    - Extended range
    - Smoke
    - Illuminating
    - Non lethal
- Fire control system

Medium calibres (81mm)
Compared to the 120mm, the 81mm have undergone improvement to a lesser extent, but long range mortar barrel and streamlined projectiles have been developed.

- Tube, mount and Base plate
- Ammunition:
    - Fragmentating
    - Extended range
    - Smoke
    - Illuminating
    - Non lethal
- Fire control system

Heavy calibres (120mm)
As mentioned above, it is with the 120mm calibre that the most significant recent innovations have been witnessed. Here we have cargo munitions, guided munitions and combined guided and cargo ammunition.

- Tube, mount and base plate
- Ammunition:
    - Fragmentating
    - Thermobaric
    - ACED - autonomus target seeking submunition
    - Cargo
        - fail-safe fuzes for bomblets
        - dual purpose bomblets
    - Precision guided
        - infra-red based seeker system
        - laser guided
        - with low collateral damage
    - Smoke
    - Illuminating
    - Non lethal
    - Directed energy
- Fire control systems
    - Range finders, GPS –aid
    - Platform integrated fire controls
    - Laser designation

Current technology
See background.

Near term perspective (5 years)
- No dramatic changes from today in terms of revolutionary new systems and technology.
- Less sensitive or insensitive ammunition will be introduced.
- Ammunition development for automatic handling for turreted or self-propelled mortars.
- Ammunition with HPM and thermobaric warheads are developed.
- Non lethal rounds are developed.

Mid term perspective (10 years)

- Development off ammunition for precision engagements.
- Ammunition for automatic handling available.
- Guidance enhanced for 120mm. Guidance will probably not be available for the smaller calibre mortar projectile since the cost for smaller and larger calibres is the same. Therefore the smaller calibres will be to expensive and it is better to invest in the most effective type.
- Enhanced cargo ammunition
- “Green ammunition”
- Fully developed and fielded turreted or self-propelled mortars available
- Multi-option fuzes available for mortars, with appropriate environmental properties for autoloaders, fixed magazines etc.
- Munitions with rocket propulsion where the impulse can be adjusted in flight (120mm)
- Munitions with muzzle velocity measurement capability for accurate rocket ignition or guidance start (120mm)
- Low cost course correction add-on devices for legacy 120mm mortar rounds
- Increased interoperability based on standardized interface between breech loaded 120mm mortars and ammunition
- Fire on the move capability with selected turreted or self-propelled 120mm mortars.
- Unitized package for rounds; simplifies automated handling (fuze/round/propellant/primer/etc).
- Mortars have much improved very high/low angle fire for MOUT, through both improved fuzes/rounds and improved fire control.
- Ammunition with HPM and thermobaric warheads are in service.
- Non lethal rounds are in service.

Far term perspective (15 years)

As with the 10 year perspective, and including the following.

- New materials to reduce weight in new mortar systems. Weight/volume considerations - soldier burden.
- More common with vehicle mounted mortars.
- “Smart” ammunition is more common.

TABLE OF CONTENTS, HAND GRENADES

Background

Hand grenades have been available for several hundred years. Early ones were hollow iron balls filed with black powder and ignited with a fuze cord. In the early 1900's pyrotechnical time and mechanical impact fuzes were introduced. The pyrotechnical time fuze remains the most common. There are two types of lethal hand grenades:
-the defensive hand grenade
-the offensive hand grenade

The difference lay in the types of fragment used. The defensive hand grenade is used when the user is under cover and defending himself against an assaulting enemy. They contain many fragments. Most defensive modern hand grenades are prefragmentated. The offensive hand grenade is used when the user is in an assault against an enemy. There are few fragments (if any at all). The lethal effect is mainly caused by the blast.

The following will list available hand grenades and similar devices. Items of the future have also been injected in the structure. In such cases the estimated time frame of their realisation 5, 10 or 15 years have been given in brackets.

Breakdown structure

- Defensive
    - Time fuze
    - Impact fuze
    - Selectable air burst with directed fragmentation (5)

- Offensive
    - High explosive
    - Thermobaric
    - Selectable strength high/low (0-5)

- Dual purpose - Multi purpose
    - Offensive/Defensive (separate fragmentation sleeve)
    - Offensive/Shaped charge

- Smoke
    - Visual screening
        - White phosphorus
        - Red phosphorus
        - Pyrotechnical
    - IR screening
        - Red phosphorus
        - Solid particle aerosol (0-10)
    - Signal
        - Coloured smoke

- Illuminating
    - Illuminating / Electro-optical blinding

- Incendiary
  - Materiel destruction
    - Termite
  - General incendiary
    - Pyrotechnical
    - Red phosphorus

- Non-Lethal
  - Irritants
    - CS
    - CN
    - OC
  - Kinetic
    - Rubber balls
  - Diversionary
    - Flash and bang
  - Stun
    - Pyrotechnical charge
    - Reduced high explosive charge
  - Dye markers
    - Visible
    - Visible in ultra-violet light only
  - Blinding
    - Short and extremely powerful light burst
  - Malodorants
  - Combinations
    - Flash and bang with CS or smoke
    - F & B with smoke with see-through properties with goggles (5)

- Electronic
  - Light emitting (IR / Visible remote controlled)
  - Imaging sensor (5-10)
  - HPM (5-15)

- Others

Current technology
See background.

Near term perspective (5 years)
The defensive hand grenade has a low hit probability as it is designed for ground burst. Small irregularity of the ground will shield the target if it is in the prone position. Currently developing is a defensive hand grenade with selectable air burst with directed fragmentation. It will offer top attack and be designed to project the main part of fragments downward thus highly increasing hit probability. If air burst is not selected an ordinary ground burst will occur.

To minimize collateral damages better-defined lethal radius will be demanded. Developments of amorphous metals will probably offer possibilities of fragmentation with a small and very defined radius still retaining good penetration performance.

The offensive hand grenade will have to perform in different roles. Some of them, as non-lethal use or combat in modern building with thin walls, will demand a relatively small explosive charge. A divided or sectioned charge could offer an offensive hand grenade with on-the-spot selectable strength.

Mid term perspective (10 years)
The development of IR screening smoke will be governed by environmental and toxicity requirements. Solid particle aerosols could offer solutions but their performance in other areas are not yet acceptable in the hand grenade format. This is an area of research where co-operation should be encouraged.

“Electronic hand grenades” will be an increasing group of devices that adheres to the concept of hand grenades when handling is concerned but are not hand grenades as such. One concept is the imaging sensor, which transmit a fish-eye image via a video link back to the thrower. Another, existing, is the on-off-on IR and/or visible light emitting device that can be thrown to illuminate a room or similar. In the IR mode the light is visible with goggles.

Developments in the explosively generated HPM may yield hand grenade sized, or near hand grenade sized, devices capable neutralizing electronic equipment.

Far term perspective (15 years)

NATO INFANTRY WEAPONRY MASTER PLAN

ELECTRO OPTICS

	Timeframe			
Equipment class	**Today**	**In 5 years**	**In 10 years**	**In 15 years**
Optical / optronical sights, with or without fire control.	**IW**: Mostly iron sights, optical 4x, 10x and red-dot sights on selected weapons. **CSW**: Iron sights and reflex sights. **CV/MBT:** optical sight together with LRF and Thermal sight, ballistic fire control. **SFW:** As CSW **GM:** Optical, single and dual FOV	**IW:** Ordinary infantry soldiers will have mostly red-dot sights. Still optical 4x in service. Snipers will have access to Thermal sights. **CSW:** Stand-alone-LRF, sights compatible to NVG. **CV/MBT:** unchanged. **SFW:** **GM:**	**IW:** Ordinary infantry soldiers will have mostly red-dot sights. Sights with combined optical and thermal/image intensifying possibility on selected weapons. (Snipers and sharp shooters). **CSW:** Sights with LRF and ballistic calculation. Possibility to set ammunition parameters (ex. air burst) Thermal/ Image intensified clip-ons available. **CV/MBT:** All optronics, no optical channel. Possibility to send and recieve information about targets and images. **SFW:** **GM:**	**IW:** Most infantry soldiers will have red-dot sights. More advanced soldiers will have sights with combined optical and thermal/image intensifying possibility. LRF together with GPS on ordinary soldiers. Possibility to send and recieve information. **CSW:** Thermal/Image intensified sights as standard, possibility to send and receive images, otherwise no change. **CV/MBT:** Unmanned **SFW:** **GM:**
Image intensified (I^2) sensors on sights (performance)	**IW:** 1) Dedicated Image intensified sights, mostly 3-6x magnification. 2) Clip-on devices in combination with the optical day sight. 3) Integrated or modular day/night sights, mostly 6-8x magnification. 4) MNVG in combination w/ red-dot-sight. **CSW:** As 1) and 2) above. **CV/MBT:** **SFW**: **GM**: Performance: Depending on I2 tube used and optics. Still gen 1 exists, mostly gen 2 and 3 of various specifications. Weights: IW and CSW between 1-2 kg (gen 1 even more).	Developments mainly in tube performance. Gated tubes facilitates a wider range in light conditions. Increased sensitivity gives better low light performance. This is a gradual enhancement in performance. High sensitivity camera detectors coupled to the I^2 will facilitate video-out signal with much better performance than today's systems.	Increases in tube performance may trigger development of smaller tubes which can cut weight and sizes of the sights in half. Non-I^2 camera solutions will start to replace I^2 for very low light levels. Fused systems (VIS-I^2, I^2-TI) are beginning to emerge.	Possible to send and receive information. Image fusion.

IW-Infantry Weapon, **CSW**-Crew Served Weapon, **CV/MBT**-Combat Vehicle/Main Battle Tank, **SFW**-Shoulder Fired Weapon, **GM**-Guided Missile.

NATO INFANTRY WEAPONRY MASTER PLAN

ELECTRO OPTICS

	Timeframe			
Equipment class	**Today**	**In 5 years**	**In 10 years**	**In 15 years**
Thermal imagers (TI) on sights (performance)	**IW:** Un-cooled Thermal image based on both Bolometre and Ferro-electric FPA detectors in the 8-12 µm region. Thermo-electrically cooled CMT FPA detector in 3-5 µm. The FPA from 160x160 to 360x240 pxls. All dedicated thermal sights. Optics with single and dual FOV; 9°/15° typical, snipers 3° **CSW:** Same as IW but with narrower FOV; 3°/9°. **CV/MBT:** Cooled, scanned systems, normally integrated with the day sight, both in the 3-5µm and 8-12µm regions. Up to 640x480 pxls FPA systems starting to be fielded. **SFW:** N/A **GM:** Cooled (both bottle and cooling engine), scanned systems. Both stand alone and clip-on systems Performance: The uncooled has poor to moderate performance. Are good for detecting. No recognition. Problem with display performance. Weights 2,5-4 kg. The cooled, scanned and FPA, systems have long detection ranges, good recognition and moderate identification capability. Uses image processing techniques for picture enhancement.	**IW & CSW:** Thermal image clip-on devices interchangeable with I^2 equivalents, using day optics. FPA 640x480 pxls will be available. **CV/MBT:** 640x480 pxls FPA. Dual-band systems (either intra 3-5µm or 3-5/8-12 µm solutions) are system ready. **SFW:** N/A **GM:** As CV/MBT. Performance: Sensitivity and resolution significantly better (partly due to better software processing capacity). Fused systems in small quantities will be ready for fielding. Weight: will be reduced for the IW/CSW systems by 30-50%.	**IW & CSW:** Continued increase in performance and decrease in weight, size and power consumption. **CV/MBT:** Very high resolution systems w/ HDTV-standard Facilitates wider FOV for the gunner. Great enhancement in signal processing. Automated target recognition and other functionality. **SFW:** Lightweight, uncooled Thermal image. **GM:** As CV/MBT	

NATO INFANTRY WEAPONRY MASTER PLAN

ELECTRO OPTICS

	Timeframe			
Equipment class	**Today**	**In 5 years**	**In 10 years**	**In 15 years**
Laser pointers (LP)	**IW & CSW:** NIR and visible lasers. In configuration from barrel to rail mounts. Simple push-button trigger. Combined systems VIS & NIR, Coded versions for FAC functions. **CV/MBT:** N/APerformance: Intensities from 0.1 mW to 10 mW (higher if FAC mode needed). Variable (normally two levels) output. Manually variable beam.	**IW & CSW:** Fully adjustable intensity, Integrated in combination w/ Combat ID and laser range finder. Illuminator mode.Weight: Less than 0.5 kg.	**IW & CSW:** Multifunctional, single laser unit. Remote (wireless) controlled. Weight: Less than 200g.	
Bore sight	**IW & CSW:** Manual systems based on laser or optical correlator bridge. No system for TI. **CV/MBT:**	**IW & CSW:** TI bore sights available **CV/MBT:**	Fully automatic systems.	

ELECTRO OPTICS

	Timeframe			
Equipment class	**Today**	**In 5 year**	**In 10 year**	**In 15 year**
Illuminator	**IW:** Barrel mounted or hand guard integrated torch systems. LEDs available. Both visible and NIR. Visible (and NIR) flares of different sizes and burn-out time. **CSW:** ? **CV/MBT:** NIR-illuminators on former Warsaw pact vehicles. Performance: Batteries still a problem.	**IW:** Will be integrated together with lasers in a single rail mounted box. Power supply may be supported from soldier main power supply, possibly by charging batteries.	Illumination may be supplied from UAV with strong directed LED-arrays, both visible and NIR.	
Designators	**IW:** Systems exist based on an Image intensifying sight on the weapon, designator is a powerful laser pointer (not coded) on a TI which designate the target. **CV/MBT:** N/A **Others:** Class 4 designator for surface-surface missiles. Handheld air-surface FAC units.	**IW:** N/A **CSW:** **Others:**	**IW:** Will be integrated in the laser unit together with other functions. **CSW:**	

ELECTRO OPTICS

	Timeframe			
Equipment class	**Today**	**In 5 year**	**In 10 year**	**In 15 year**
Laser Range Finders (LRF) on weapons (performance)	**IW**: N/A **CSW**: Diode lasers being introduced. **CV/MBT**: LRF, mostly hazardous but eyesafe are introduced in new systems. Characteristics: NdYAG (1064nm shifted 1550nm), Erbium (1570nm). Up to 10Hz prf, range 10+km, Diode (1550nm), around 1Hz prf, range 2-4km typical.	**IW**: Single shot diode laser, <400m (stand alone). **CSW**/sniper: Stand-alone-LRF <1500m. **CV/MBT**: Nd Yag lasers insensitive to retroprisms, "eyesafe".	**IW**: Single shot diode laser, <400m (integrated in sight). **CSW**/sniper: LRF <1500m integrated in sight. **CV/MBT**: Nd Yag lasers with automatic adjustable intensity, "eyesafe".	
Combat ID (CID)	Only manually communication via radio or passive systems like thermal panels and training in Visual ID **CV/MBT**: For air defence IFF interrogator.	**IW & CSW**: DSID systems will be fielded. Based on laser interrogation and rf response. **CV/MBT**: BTID integrated in the sight.		
Integrated systems	**IW**: N/A **CSW**: LRF, red-dot sight and an az-alt corrected aiming point **CV/MBT**: Fire control with integrated LRF, ballistic correction, Thermal image, POS/GPS	**IW**: Dynamic aiming points (red-dot, cross-hair) will be available together with LRF. **CV/MBT**: Simple integration with Command & control (C^2) systems. CID systems integration.	**CV/MBT**: Complete integration with C^2 systems	

Abbreviations

BTID=Battlefield Target Identification Device
C2=Communications and control
CID=Combat ID
CMT=Cadmium Mercury Telluride
DAS= Defence Aid System
FAC=Forward Air Controller
FCS=Fire control system
FOV=Field of view
FPA=Focal Plane Array
GPS=Global positioning system
HDTV=High Definition Television
I2=Imaging intensifying
ID=Identification
IFF=Identification friend or foe
LED=Light emitting diode
LRF=Laser range finder
NIR=Near infra red
NVG=Night vision goggles
POS=Inertia positioning system
PRF=Pulse repetition frequency
TI=Thermal imaging
VIS=Visual (part of the electromagnetic spectrum)
UAV=Unmanned aerial vehicle

ANNEX TO NATO INFANTRY WEAPONRY MASTER PLAN

STATUS OF LG3 STUDIES

Domain	Custodian	Reference document
Sniper equipment	FR	tbp
Future small arms	UK	tbp
Future infantry cannon	BE	tbp
Future infantry armoured vehicle	GE	tbp
Mortars	UK	PFP(NAAG-LG/3)D(2003)4, dated 19 June 2003
Shoulder launched weapons	CA	PFP(NAAG-LG/3)D(2003)1, dated 12 February 2003
Hand grenade	CA	PFP(NAAG-LG/3)D(2003)2, dated 6 March 2003
Non lethal weapons	US	PFP(NAAG-LG/3)D(2003)3, dated 27 May 2003
Electro optics for combat system	FR	tbp
Reference targets	US	tbp