Preliminary Assessment for Replacing the Capabilities of the Hornet Fleet

Final Report

To the Minister of Defence

Helsinki, 8 June 2015

Major General Lauri Puranen (ret), Ministry of Defence, Chair,
Governmental Counsellor Jari Takanen, Ministry of Defence,
Colonel Pasi Välimäki, Defence Command Finland,
Master of Science Jukka Rautalahti, Finnish Defence Forces Logistics Command
Colonel Sampo Eskelinen, Finnish Air Force,
Lieutenant Colonel Jouni Junttila, Finnish Air Force
Colonel Petteri Seppälä, Defence Command Finland, Secretary

On behalf of the working group

Chair
Major General (ret) Lauri Puranen

Puolustusministeriö
Försvarsministeriet
Ministry of Defence

Eteläinen Makasiinikatu 8
PL 31, 00131 HELSINKI

www.defmin.fi

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Summary

The working group proposes that the capabilities of the Hornet fleet be replaced by a solution based on a multi-role fighter. The capabilities of the multi-role fighters will be supplemented with those of ground-based air defence. The need for and the possibilities of procuring unmanned aerial vehicles and other complementary capabilities must be analysed at a later date.

The primary purpose of Finland's defence capability is to establish deterrence against the use of military force as well as the threat thereof, and to repel attacks on Finland.

Finland's geopolitical standing and the changes in its operating environment emphasise the importance of maintaining and developing the defence capability. The goal is to maintain a defence capability that meets the requirements of the operating environment and the tasks of the Defence Forces. Defence cooperation is increasingly important in maintaining and developing the defence capability.

A modern air power and air defence system is a key element in Finland's defence capability. The Hornet fleet's capabilities are a major component of the air defence and of the Defence Forces' capability in engaging land- and sea-based targets. Furthermore, the Hornet fleet's capabilities supplement the Defence Forces' integrated intelligence, surveillance and command environment. Developments in the operating environment, the changing concepts of war and battle as well as the tasks of the Defence Forces, the Air Force and the air defence necessitate that the capabilities of the Hornet fighter fleet be replaced by the end of the next decade.

The planned service life of the Hornet fleet will end by 2025–2030. There are three major factors that limit the service life of the fleet: weakening comparative capabilities, structural fatigue and challenges in obtaining system support for the aircraft. Substantial additional costs would be incurred should the service life of the Hornet fleet be extended. Moreover, this would not provide additional options for replacing its capabilities. Extending the service life of the Hornet fleet is neither a cost-effective solution nor would it be sufficient in terms of Finland's defence.

It is impossible to substitute ground-based air defence systems or the current, or future, unmanned aerial vehicles for the Hornet fleet's capabilities. Both of the aforementioned systems encompass but a part of the Hornet fleet's capabilities. In order to maintain defensive deterrence the Hornet fleet's capabilities must be replaced with a system based on a multi-role fighter starting from 2025.

The project for replacing the capabilities (HX programme) must be launched in the autumn of 2015 at the very latest. Project-related decisions associated with Requests for Information and Requests for Quotation must be taken during the electoral term of 2015–2019. The decision to procure new multi-role fighters must be taken in the early 2020s. It is not possible to replace the capabilities of the Hornet fleet within the framework of current defence budget levels. Rather, separate financing must be earmarked for the project.

Replacing the capabilities of the Hornet fleet is a strategic project which is of crucial importance to Finland's defence system. In order to properly guide the planning and implementation of the project an HX steering group, reporting to the Ministry of Defence as well as an HX programme coordination group which reports to the steering group and coordinates the planning and implementation of the project, must be set up. Other than this, the planning and implementation of the capability replacement project will be carried out in accordance with the Defence Forces' standards.

Replacing the capabilities of the Hornet fighter fleet significantly impacts Finland's security and defence policy standing, and widely affects Finland's bilateral relations.

On the basis of the preliminary assessment the working group proposes the following as regards the implementation of the project:

1. Adhere to the Hornet fleet's original service life because, as per the preliminary assessment, there are no grounds for extending its service life.
2. Replace the Hornet's capabilities with a solution based on a multi-role fighter.
3. Launch the HX programme no later than the autumn of 2015.
4. Set up an HX steering group, an HX programme coordination group and an HX programme secretariat, and establish their tasks, competence and composition.
5. Implement the acquisition process in a normal manner: promulgate the Request for Information in 2016, and the Request for Quotation in 2017–2018.
6. Make use of the derogation of the EU Directive on public contracts, permitted by Article 346 TFEU, because the procurement processes pursuant to the Directive on Defence and Security Procurement are not suitable for this acquisition.
7. Draw up a defence industrial strategy and establish the project-related requirements for an independent capacity and security of supply.
8. Establish the need and possibilities for external auditing (quality assurance, QA).

1. Introduction

On 6 May 1992 the Government took the decision to procure F-18 Hornet fighters. The decision, taken amid security policy transformations in Europe and on the eve of an economic recession in Finland, had far-reaching effects on the future of Finland's credible defence and on its international acknowledgment. For its part, the acquisition bolstered Finland's standing in the western community and facilitated the intensification of security and trade policy relations with the United States and western European countries.

At present, the Hornet fleet forms the foundation of the air defence. During peacetime it carries out the most important tasks associated with territorial surveillance and the protection of territorial integrity. The capabilities of the Hornet fleet play a significant role in establishing deterrence against the use of pressure on Finland or, in the worst case scenario, Finland becoming the target of military force or an attack. In wartime the Hornet fleet has the key role in protecting society's vital targets and functions, in supporting the other military services with air defence, and in repelling an attack by means of air-to-ground strikes.

The planned service life of the Hornet fleet will end between 2025 and 2030 as the aircraft reach the end of their 30 year service life. The factors that come into play then are structural integrity, unobtainability of spare parts, equipment and system support as the other countries in the Hornet user community decommission their fleets as well as the weakening comparative capabilities of the Hornets in view of the development in our security environment.

As the replacement of the fighter fleet's capabilities takes approximately 15 years, the Ministry of Defence (MoD) saw it fit to commission a preliminary assessment so as to optimise the launching of the project. Therefore, on 8 October 2014, Minister of Defence Carl Haglund set up a working group to start planning the project for replacing the Hornet fighter fleet's capabilities as a part of maintaining a modern defence system. This report is a preliminary assessment drawn up to pave the way for future decision-making and formal arrangements. The working group was tasked to compile and prepare a basic analysis covering the following topics:

- The role of the successor of the Hornet fleet's capabilities as an element of the overall defence system,
- Initial operational requirements and the matters to be included in the Requests for Information,
- The options for extending the service life of the Hornet fleet,
- Relevant research requirements outside the administrative branch and possibilities for cooperation with Finnish industry,
- Organising the potential fighter procurement within the defence establishment and factors affecting the procurement schedule, and
- Other factors that arise and affect the potential launching of the project and decision-making, in accordance with case-by-case MoD guidelines.

The composition of the working group was:

- Lauri Puranen, Ministry of Defence, Chair,
- Jari Takanen, Ministry of Defence,
- Pasi Välimäki, Defence Command Finland,
- Pertti Immonen, Defence Command Finland (until 12/2014),
- Jukka Rautalahti, Finnish Defence Forces Logistics Command (as of 12/2014),
- Sampo Eskelinen, Finnish Air Force,
- Jouni Junttila, Finnish Air Force, and
- Petteri Seppälä, Defence Command Finland, Secretary.

In addition, the Chair invited Sami Nurmi, Ministry of Defence, to provide expert information to the working group.

The preliminary assessment was carried out as official business, led by the Ministry of Defence. The deadline for the report was 31 May 2015. The work was carried out by making available information prepared and adopted by the defence establishment for this assessment. The essence of the report is based on the results of the long-term planning of different organisations in the defence establishment, expert comments received during the working group's fact-finding trips and meetings with aircraft manufacturers.

The report of the working group answers the questions set in its tasking. Furthermore, Chapter 3 extensively elaborates on the technical development of air warfare as it significantly affects the replacement of the Hornet fleet's capabilities.

The working group held seven meetings, during all of which official minutes were taken. In addition, two separate workshops prepared the preliminary assessment. During its work the group talked to several experts and familiarised itself with the way Denmark, Norway and Canada have set up and implemented their respective fighter procurement projects, including the key lessons learned. Official memoranda were written of the fact-finding trips. Additionally, the working group organised a seminar in which the key persons of the previous fighter procurement presented the success stories in the Hornet programme, and its most important lessons.

The working group also arranged a four-day seminar in which Deloitte, a consulting firm that supported the fighter procurement programmes in Denmark and the Netherlands, presented the key phases, instruments, challenges and lessons learned in a fighter procurement project. Experts representing different sectors in the MoD and the Defence Forces participated in the seminar.

The working group also participated in fact-finding sessions organised by the defence establishment in which representatives of the industry and government of different countries presented their systems. Official memoranda were written of these meetings. The results of the analysis of the global fighter aircraft market, launched by the Finnish Air Force in 2013, were also made available to the working group.

The working group commissioned two research projects and one study. The models for organising the potential capability replacement project were charted under the guidance of the Chair of the working group.

The unanimous recommendations of the working group for further action to be taken are the key results of the preliminary assessment.

2. Strategic planning principles

Maintaining Finland's defence capacity will demand sizeable capability-related projects in the 2020s. The goal is to achieve a defence capability suitably tailored to our operating environment and the tasks of the Defence Forces.

As part of maintaining the offensive engagement capabilities of the air defence and the Defence Forces the most important capability-related project in the 2020s involves the replacement of the capabilities of the Finnish Air Force's Hornet fleet, which is scheduled to be phased out by the end of the next decade.

Replacing the capabilities of the Hornet fighters significantly affects Finland's security and defence policy relations and standing.

2.1 The operating environment of defence

Finland's defence is being developed in an operating environment in which the actors are increasingly interdependent and the resources available for defence finite. Military capabilities will be developed from the standpoints of Finland's military defence. The Defence Forces must be able to meet both conventional military threats and more wide-ranging ones. Without comprehensive international cooperation it will be impossible to meet these threats.

The operating environment is increasingly fluid, unpredictable and uncertain. Strategic surprises are a possibility to be reckoned with. The range of instruments being used in warfare is becoming more expansive and flexible. The consequences of warfare impact the whole of society, rather than the armed forces alone. The possibility of the use of military force must always be taken into consideration. It is ever more difficult to discern and, especially, anticipate the precise onset of war. Securing the vital functions of society, crisis resilience and security of supply as well as the importance of defence cooperation become highlighted in the flux of the operating environment.

Russia's actions in Ukraine serve as an example of 'hybrid warfare' which combines military and non-military means, covert operations, offensive information operations and cyber-attacks as well as economic, political and military pressure, fomentation of ethnic strife and the creation of uncertainty and imbalance. Special forces will be used in larger numbers and in a more versatile manner from the very outset of a crisis. Alongside military development, the change in Russia's military doctrine and the crisis in Ukraine demonstrate that it also has the political willingness to utilise this capability.

Both the Government Security and Defence Policy Report 2012 and the Final Report ('Long Term Challenges of Defence') of the Parliamentary Assessment Group state that while Finland faces no military threat at this moment, the situation may change. Change in the operating environment as well as Finland's geostrategic position, its being on the border of a military alliance and neighbouring a great power, must be taken into account as conclusions regarding the Defence Forces overall capacity and development are being made.

The geostrategic importance of the Baltic States and the Baltic Sea region has risen and controlling the approaches to the Gulf of Finland has, yet again, become a key strategic factor. Military activity has increased in the Baltic region, which emphasises the importance of, especially, air and maritime surveillance. In the long term one must also take into consideration the growing significance of the Arctic region due to the opening of new sea lanes. This also has some effect on air traffic which is on the rise and the increasing military- strategic importance of the region.

The transformation of the character of battle is influenced by, among other things, the diminishing number of troops in the battlefield, which underscores speed, firepower, reach and readiness. The focus of armed forces development lies on interoperability which encompasses comprehensive battlespace management that covers all domains of warfare (land, sea, air, space, information), long-range strike and missile defence capabilities, and cyber capabilities. Great powers utilise the air/space/information domains in their pursuit for information supremacy. The importance of peacetime military formations is diminishing. High readiness, power projection capability, digitisation and information management are key factors. A long-range strike capability from land, sea and air as well as the capability to conduct network attacks beyond national borders become highlighted.

The capabilities of air power will grow within the sphere of armed forces development. Air operations will include the use of modern multi-role fighters in all weather, day and night conditions, the use of precision-guided munitions (PGM, aka 'smart weapons'), long-range strike capability and the use of unmanned aerial vehicles (UAV). Fighters' stealth characteristics, deep penetration capability and sensor suites as well as the ranges of ground-based air defence systems will only improve. Command and control (C2), intelligence and surveillance capabilities in air operations will become integrated by means of C2 system digitisation.

Air operations give emphasis to high readiness, flexibility and the capability to rapidly create a centre of gravity and to concentrate force. This capability is developed, including improvements in tactics, by participating in exercises. The new opportunities and the changes in training syllabi made available by the introduction of new aircraft will take effect in Russia's Air Force in the early 2020s.

2.2 Defence policy grounds

Defence capability

The primary purpose of Finland's defence capability is to establish deterrence against the use of military force as well as the threat thereof, and to repel attacks on Finland. The maintenance of deterrence will remain the top priority of our defence. This entails the capability of the Defence Forces to raise defence readiness proactively and a genuine capability to meet its tasks.

Finland's defence solution is built on a territorial defence system covering the entire area of the country, which will be implemented through general conscription as a militarily non-aligned country. In the future Finland will also defend the entire area of the country; the Defence Forces will use its capabilities to protect the vital functions, targets and areas of society and the Defence Forces. Owing to the limited number of troops the ability to direct and concentrate key capabilities in the entire area of the country becomes highlighted in employing the Defence Forces' capabilities. Correctly tailored Finnish Air Force capabilities in view of our operating environment play a critical part in our deterrence, and defence capability.

The Defence Forces need higher operational readiness and improved combat resilience to carry out their tasks. Because of Russia's actions, and as a consequence of the changed operating environment, the significance of high readiness is especially gaining newfound import in Europe. The Defence Forces' most capable, and rapidly and flexibly deployable units and weapon systems such as the Air Force's multi-role fighters, can raise the threshold against the use of force in an anticipatory manner and, when necessary, begin to repel an attack in a high peacetime readiness formation.

Military capabilities will be used in accordance with the tasks of the Defence Forces in the military defence of Finland, in support of the other authorities and in international military crisis management.

Foreign actors continually evaluate Finland's defence capacity and its development. Estimates of the level of our deterrence and defence capability consist of several different factors. Military assessments focus on our overall military capabilities; the primary criteria include the resources allocated to defence and the solutions concerning development. Furthermore, the defence capacity is evaluated on the basis of performance demonstrated in operational action and international exercises. It is possible to maintain credibility and demonstrate Finland's deterrence by safeguarding an air defence capability which is sufficient to carry out the statutory tasks.

Supporting the other authorities is a statutory task of the Defence Forces. This will be further improved. The goal is to bolster society's comprehensive security through defence capabilities in concert with the other authorities and by jointly and flexibly utilising the available resources. The Air Force's capabilities are invaluable in managing 'renegade' situations (e.g. a highjacked civilian aircraft), in monitoring restricted and prohibited airspace as well as in providing protection to international summits.

International military crisis management is a part of Finland's foreign, security and defence policy. The Defence Forces implement international military crisis management operations in accordance with the decisions taken by the President of the Republic, the Government and Parliament. Future crises and conflicts will be increasingly complex. In the future the Defence Forces will be expected to be able to participate, as required, in progressively more challenging crisis management missions.

The development of capabilities needed in military crisis management is carried out as an integral part of developing the national defence. The key goal is to improve cost-effectiveness by intensifying multinational cooperation and by enhancing the quality of capabilities. Pursuant to the decisions taken by the state leadership the Finnish Air Force will participate in international military crisis management tasks and operations with the units and capabilities included in the national troop register for military crisis management.

The Defence Forces' material readiness will markedly degrade as early as the end of this decade. Without additional financing it will become impossible to maintain the capabilities at the present level, or to improve them. Without sufficient investments in materiel the basic defence solutions – defending the entire area of the country, general conscription and military non-alignment – will have to be reevaluated during

the 2015-2019 term of Government. At the very least, the additional financing proposed in the Government Security and Defence Policy Report 2012 will be needed to correct the materiel-related shortcomings in capabilities. This was also the recommendation of the Parliamentary Assessment Group.

Nevertheless, the proposed additional appropriations do not solve the quandary of financing the strategic capability projects of the 2020s, i.e. replacing the Hornet fleet's capabilities and the capabilities of the Navy's ageing warships. It is not possible to cover the financing requirements of these capability projects within the framework of current defence budget levels. Rather, separate financing must be earmarked for them. Procurement-related preparations and planning must be initiated during the electoral term of 2015–2019.

Defence cooperation

Defence cooperation is a key part in the development, maintenance and utilisation of Finland's defence. Active defence cooperation not only strengthens our defence capacity, it also improves our deterrence, the ability to repel attacks, and it safeguards the development of military capabilities. While defence cooperation does not imply any military security guarantees, it facilitates the provision of political, military and other assistance in a situation where our own resources prove inadequate. Defence cooperation also carries a strong security and defence policy implication which strengthens Finland's security.

According to a guideline in the Government Security and Defence Policy Report 2012, cooperation is carried out under the auspices of the EU and NATO partnership, in regional groups and bilaterally. The EU and NATO play supporting roles in multinational projects. Concrete cooperation between willing countries occurs in groupings, of which the most important from Finland's perspective is the Nordic Defence Cooperation arrangement NORDEFCO. Other partner countries important to Finland include, especially, the United States and the countries in Northern Europe. Cooperation promotes military interoperability, the creation and development of capabilities and it strengthens our capacity for international crisis management participation. NATO standards and procedures are the mainstay of interoperability for everyone.

As a non-aligned country Finland prepares to repel all military threats without outside assistance and, therefore, sustains all capability areas and critical capacities in its defence system. At present, there are no treaty arrangements in place which would guarantee the provision of needed air support to Finland in a conflict or other key capabilities, not even from our closest partner countries.

Finland needs air power and air defence capabilities both in normal and emergency conditions. A possible military alignment is a political decision which by no means eliminates the need to maintain a national defence capability. Irrespective of Finland being militarily aligned or not, Finland must continue to see to its sovereignty and the protection of its territorial integrity. Even if Finland were militarily aligned, it would be expected to provide an effective first response in repelling an attack on its territory.

The manner in which the strategic capability project is carried out will significantly impact Finland's security and defence policy standing, and widely affect Finland's bilateral defence relations. An example of such a project is Finland's Hornet fighter programme which, in practice, resulted in the United States having become Finland's most important bilateral partner in defence-related questions. In the wake of the Hornet procurement, in addition to the Air Force the effects of bilateral cooperation have extended to the other military services and functions as well. In addition to the extensive foreign and security policy consequences the Hornet acquisition is also estimated to have generated positive trade policy momentum for Finland. Being a militarily non-aligned country, it is particularly important for Finland to carefully select its partners in capability-related projects.

Material capability

The Defence Forces' material capability will be safeguarded right from the beginning of the capability project's planning and development phases by procuring suitably task-oriented and internationally interoperable defence materiel and by guaranteeing its life-cycle management. It is imperative that the materiel be usable for each main task of the Defence Forces. Off-the-shelf and proven products are the mainstay of materiel procurement projects. Already since the end of the 1990s procurements have coherently aimed at achieving international interoperability as per NATO standards.

International defence materiel cooperation is a precondition for cost-effective acquisitions, international compatibility, the capability to receive foreign assistance, securing the military security of supply and the Defence Forces' ability to participate in international crisis management operations. Large procurement projects facilitate the deepening of partnerships.

When it comes to security of supply, national preparedness and the preservation of critical knowhow is important. Yet, it is equally important to safeguard the functioning of the Defence Forces' international supply channels and access to materiel. Finland is dependent on multinational cooperation in developing and maintaining its military capabilities, and in military security of supply. It is necessary to cooperate in order to secure these capabilities. The goals of cooperation in different groupings and structures are mutually augmenting and complementary.

Defence cooperation can also help find support and upgrades for the Defence Forces' capabilities and simultaneously strengthen Finland's security policy position. The perspective must be widened from materiel-related matters and joint procurements to capabilities – i.e. to a bigger picture which encompasses instruments and their users, proficiency, performance and effectiveness.

2.3 Military-strategic grounds

In addition to the guidelines provided by the state leadership, proportioning the defence capacity builds on analyses of the operating environment, the Defence Forces' statutory tasks (Act on the Defence Forces) and available resources. An appropriately suited defence capability establishes sufficient deterrence and safeguards Finland's territorial integrity and the ability to defend the entire area of the country. This demands the ability to create the centre of gravity for defence with high-readiness, deep-strike-capable and rapidly retargetable Air Force capabilities. The performance of the Air Force is ensured by having modern aircraft suited to our operating environment.

The Finnish Air Force's (FiAF) warfighting capacity, i.e. the ability to engage important targets on land and at sea as well as the ability to protect the critical assets and infrastructure of society and the Defence Forces, constitutes a central element of our deterrence; it also bolsters the credibility of our defence. The FiAF is responsible for monitoring and protecting the territorial integrity of Finland's airspace. The FiAF and air defence protect the formation of units during mobilisation as well as the battle of the Army and the Navy, and deny the adversary his capability to paralyse our society and defence system. By using the multi-role fighters' strike capability the FiAF participates in ground and maritime defence, and carries out long-range strike missions. In wartime the capabilities of the multi-role fighters play a central role in protecting society's vital assets and functions.

Air Force and GBAD sensors generate information for the ISTAR system. Data transfer systems installed in airborne systems facilitate a flexible and rapid increase of data transfer capacity in terms of time and place.

At present, the Air Force is well able to carry out its tasks effectively. The Hornet multi-role fighter fleet is a key element of Finland's defence, forming the nucleus of the air defence. The Hornets fleet's capabilities have been systematically improved through mid-life upgrades, and its relative performance will peak at the end of the 2010s. Following the mid-life upgrades the fleet is also able to carry out strike missions, which can impact the adversary deep in his territory, as well as participate in ground and maritime defence.

The FiAF is interoperable with its western partners. In emergency conditions it must have the capability to receive and provide external assistance. The capability which derives from the Air Force's aircraft and equipment, expertise and operating principles, is high at present, and is sufficient in relation to our surroundings.

The security of supply and cost-effectiveness of the air power and the air defence system is strengthened through defence cooperation which, for its part, also guarantees the usability of the system in times of crisis.

The performance of the Air Force will rapidly degrade when the decommissioning of the Hornet multi-role fighter fleet starts in 2025. Phasing out the aircraft becomes a reality when they are about to reach their structural flight hour limits between 2025 and 2030. Simultaneously, the missile arsenal of the air defence will diminish because of ageing missiles and, additionally, some anti-aircraft artillery will be decommissioned in the 2020s. This being the case, units, targets and bases will be much less protected from the mid-2020s onwards.

3. Development of air warfare and the operating environment

3.1 The character of air warfare and battle

The offensive phase conducted by the coalition in the Persian Gulf War in 1991 is considered an example of a modern air campaign in which the new elements of success included the mass use of conventional cruise missiles, the suppression of enemy air defences by radar-homing missiles and by electronic attacks, the use of stealth fighters in paralysing heavily defended key targets as well as a 24/7 real-time battlespace surveillance and target acquisition.

Since then, airborne air and surface (ground and sea) surveillance as well as monitoring of the adversary's C2 systems and networks has been augmented by situational awareness information provided by unmanned aerial vehicles (UAV) and satellites. The usability of intelligence and surveillance information has been markedly improved through the introduction of standardised joint information systems and data transfer services. This facilitates an effective and mutually complementary use of the different military services' systems, creating the preconditions for an increasingly intensive operations tempo. Normally the first phase of warfare aims at achieving control of the air to guarantee freedom of action, alongside which the actions to destroy or paralyse key targets on land and at sea are launched. Strategic bombers, strike aircraft and multi-role fighters can engage targets from a very long distance with cruise missiles and long-range PGMs in all weather, day and night conditions. These aircraft can employ both conventional and nuclear weapons. Weight of effort in the campaign can easily be readjusted through the use of multi-role fighters and air-to-air refuelling.

The air defence must prepare for the aggressor's ruthless employment of air power. The attacker can use air power in a wide-ranging manner, aiming to seize the initiative and control the battlespace, or even resolve the conflict in one decisive operation by using force very intensely. Historical examples of using offensive force include the Six Day War in 1967, Israel's air operation against Syria in the 1982 Lebanon War, the Gulf War in 1991, the Iraq War in 2003, the War in Georgia in 2008 and the War in Libya in 2011. Common to these conflicts was the fact that control of the air and air power had a decisive role in the conduct of war. The military solution in the Kosovo conflict (1999) was, uncommonly, achieved through the employment of air power.

Air missions are yet another example of the surprising use of air power. Operation Urgent Fury in Grenada in 1983 and Operation Just Cause in Panama in 1989 serve as examples of such operations, as does the invasion of Crimea which started with Russia using its transport aircraft in an airborne operation. The biggest risk against these kinds of air missions comes from the target area's air defences; in practice, they can be repelled with an effective air defence in high readiness.

Air power means the ability to project force from the air and space to impact the actions of humans and to shape events.
Air defence encompasses all actions of the Defence Forces and the other authorities implemented in monitoring Finland's airspace and adjacent areas, protecting the integrity of its airspace, protecting society's vital functions from air attacks, wearing down the airborne aggressor and repulsing all air attacks.
Air operations are such military measures or missions which are primarily carried out using aircraft to attain the goals of a battle or a military operation.

In an internationally tense situation the effects of the adversary's electronic attacks, anti-aircraft systems, interdiction and long-range weapons set limits on the use of one's own aircraft. In such cases, the airspace which is permissive for air operations can shrink considerably, with one only being able to operate in uncontested areas where the adversary cannot freely employ his weapon systems.

Operations deep into the adversary's territory are often necessary to engage his key targets and to achieve a successful result in the war effort. Targets are in areas which the adversary tries to hold by maintaining a continuous air defence capability. The means for limiting operations in the rear include: the denial of base operations in areas from where an air operation could be launched; denying the use or airspace by active counter-air defence in areas important to one's own operations, and limiting or denying the C2 and situation and intelligence picture capability as well as launching direct pre-emptive attacks on the adversary's offensive forces. Operations deep into heavily defended areas intended to resolve the outcome of battle or war are extremely risky. In order to limit the risks the effectiveness of the defence is degraded by jamming intelligence, surveillance and C2 systems through means of electronic warfare (EW) or cyber warfare, by destroying the adversary's weapon, intelligence, situation-picture and C2 systems, and by protecting against the adversary's missiles, rockets or bombs.

The effectiveness of deep operations will improve in the future due to longer-reach real-time intelligence as well as the increasingly commonplace PGMs and long-range weapons. In tandem with the first strike the goal is to paralyse the defence with a mass use of long-range weapons such as cruise missiles. An example of this is the operation against Libya in 2011 which started with a strike of 112 Tomahawk missiles followed by the strikes of B2 Spirit bombers and fighter aircraft. The increasing prevalence of 'smart weapons' can be illustrated by their relative share of all weapons used: whereas during the Gulf War in 1991 the share of smart weapons was 8% of the total, eight years later in the Kosovo conflict it was already 20% and ten years later in Afghanistan it was 60%. Twelve years later in Iraq the relative share of smart weapons peaked at 68%. At the same time the battlefield has become much more dynamic. According to estimates, during the Cold War 90% of all targets could be pre-targeted. Nowadays, in comparison, 80% of targets are moving targets, the precise locations of which need to be pinpointed in nearly real-time. In order to be able to generate this kind of target data one must, in practice, be able to monitor the target area from the air or from space.

Even though airborne platforms are expensive, through the introduction of PGMs they have become a cost-effective option at every level of warfighting, as the desired effect or goal can be achieved rapidly and much cheaper compared to other alternatives. The use of air power is attractive because of its versatility, projectability, fast response, relative effectiveness and its small deployment footprint.

3.2 Air warfare technology

Space

Satellites are increasingly used alongside air power and in support of it. Because of this, for example, the United States treats airspace operations as a whole, which also includes the cyber domain. When it comes to air operations, important space technology domains include situational awareness, navigation services and data transfer.

Satellite navigation plays a major part in military operations. Systems in Europe include the USAF-operated Global Positioning System (GPS) and the Russian GLONASS (Globalnaja navigatsionnaja sputnikovaja sistema). Individual aircraft, vessels and vehicles as well as persons make use of satellite navigation. Moreover, many smart weapons systems utilise GPS. It is used in inertial system position error correction; the accuracy of these systems has improved and will continue to improve in the future.

The performance and usability of imaging satellites have crucially improved through the development of digital technology. Imaging technology is used in intelligence, meteorological observation and in detecting the launches of ballistic missiles. The resolution in the visible and infrared spectrum is sufficient for detecting military action and for target acquisition. It has become possible to replace the very risky strategic photoreconnaissance flights with satellite imaging. The introduction of synthetic aperture radar (SAR) satellites reduces the limitations posed by weather or lighting conditions in satellite imaging. Whereas the 1 metre resolution of commercial SAR satellites is sufficient, for example, to detect vehicles, the 30 cm resolution of imaging satellites can identify the type of vehicle. Military satellite performance data is not available to the public.

Missile defence relies on technology designed to detect missile launches and track missiles in flight. The missile defence of the United States and NATO relies on the US Space Based Infrared System (SBIRS), which is capable of providing missile warning, missile defence, technical intelligence, and battlespace awareness.

Data transfer has become the bottleneck of modern warfighting. It is only possible to solve the requirements posed by battlespace fragmentation, deep operations and critical reach back capabilities by using satellites in trans-horizon radio communications. Satellite communications can be used in air operations for, among other things, relaying intelligence information, operating UAVs and in forward air control.

The application of nanotechnology plays a significant part in satellite development. The diminishing price tag of satellite technology and increasingly less expensive satellite launches are expediting access to and coverage of satellite services. Even though better satellite services play a big part in air operations planning, briefing and mission implementation, when it comes to fighter operations one must also prepare for disruptions or complete breakdowns in satellite services.

Fighter development

As the original purpose of a fighter was to destroy airborne targets, fighters were normally relatively small, single-seater fast jets furnished with 1-2 engines. Even though the fighters' multi-role capabilities are continually advancing, due to physical constraints they cannot replace transport, ISTAR and C2 aircraft, or strategic bombers in other tasks assigned to air forces.

Whereas aerodynamic characteristics and powerplant technology define the fighter's performance as an aircraft, its warfighting capability is based on its sensor technology, weapons, self-protection and communication systems as well as the situational awareness and decision-making systems intended to support the pilot. It is commonplace to use survivability and mission success as the metrics of a fighter's warfighting capability.

Recently, numerous references to fighter generations, and especially to the differences between the 4th and 5th generations, have been seen in public. Most seem to believe that the factors that separate these generations include stealth technology, manoeuvrability, super cruise capability, avionics and sensors, and sensor fusion. Even though this kind of a classification makes it easier to compare different types of aircraft and the fleets used by different air forces, their comparability suffers as the classifications and associated terminology become skewed, serving the interests of commercial actors. While the clearly unique characteristics of 5th generation fighters are being emphasised, many manufacturers are introducing new variants of 4th generation fighters furnished with 5th generation properties as '4+ or 4++' generation fighters. Bearing in mind the abovementioned criteria, there is only one 5th generation fighter in operational service in the world: the American F-22 Raptor.

The classification of fighter generations is extremely inconsistent. The aircraft used in WW I are considered to be the first generation, WW II fighters the second generation, and the fighters used in Korea and Vietnam the third generation. Correspondingly, when it comes to jet fighters the subsonic fighters used in Korea were the first generation. The shift to the second generation took place in the 1960s when fighters reached the speed of Mach 2. It was necessary to develop fighters that could fly fast at a high altitude as well as missile weapons in order to shoot down jet bombers. Fighters are still required to achieve this mission, which becomes highlighted in sorties associated with territorial surveillance and the protection of territorial integrity in peacetime. The shift to the third generation occurred in the early 1970s; since then the differences in fighter performance could be seen, first and foremost in sensor, self-protection and weapon system development. The fourth generation now in use is so far the longest-serving fighter generation. The original manoeuvring and system requirements of this fleet, mostly harking back to experiences from the Vietnam War, spawned a class of multi-role fighters whose sound basic solutions have made it possible for the industry and different countries' air forces to use and improve them for several decades.

Achieving a shooting position in air combat, in a strike against surface targets and survival in a battle situation are the primary factors driving the development of fighters, their systems and principles of use. The speed and the altitude an aircraft can reach still matter greatly when it comes to the range of its weapon system and to the possibility of defensive fire being used against it. Stealth characteristics and EW performance, correspondingly, define the observability of an aircraft, and its vulnerability to the adversary's defensive fire within the range of his sensor and weapon systems.

Observability and stealth technology

The survivability of a fighter, or any military aircraft for that matter, in a threat environment is based on vulnerability management. In the first phase the goal is to degrade the adversary's possibilities of detecting by defeating or suppressing his air defences. In the second phase, when the characteristics of a fighter come into play, one must avoid detection, direct contact with the enemy, and becoming the target of defensive fire; evading the threat is the last option. Observability plays a central part in each link of the survivability chain.

An aircraft is not invisible. The adversary, such as the pilot of another aircraft or a GBAD system operator, will inevitably react to a threat in a combat situation irrespective of the source of the observation. In beyond-visual-range (BVR) operations the estimates about the target and its actions are based on information generated by on-board sensors or other systems supporting the aircraft. Visual contact may be of great importance since the existence of a target, and the target itself, can only be positively confirmed visually. Within-visual-range (WVR) air combat and the use of supporting systems, such as helmet mounted cueing systems and close range air-to-air (A-A) missiles as well as short-range man-portable air-defence systems (MANPADS), essentially rely on the pilot's or the shooter's ability to continuously follow the target. Image creation technology is increasingly important in recognising air and surface targets and in solving questions associated with improving the detection range. Simultaneously, as visual detection and visual range need to be redefined as concepts due to improving sensor technology, the development of low-observability technology becomes highlighted.

The primary objective in reducing aircraft observability is the prevention of becoming the target of defensive fire. Physical size, emissions and sound generated by the aircraft as well as the amount of reflected energy to an external sensor are the factors that affect an aircraft's observability and detectability from the background. Stealth technology refers to the solutions in the design and structures of an aircraft intended to reduce its observability. Even though it is impossible to design entirely invisible aircraft, stealth technology can help delay the moment of detection enroute to the target area or in close air combat with another fighter, shorten the time when the aircraft becomes exposed to fire, and create the preconditions for the first use of weapons.

Observability and stealth technology have been researched for decades. Most aircraft manufacturers have taken stealth factors into consideration in new aircraft design and implemented appropriate solutions in older fighters' modification programmes, as applicable. It is safe to assume that several 4+ generation fighters incorporate the results of stealth research and that appropriate low-observable technology and design solutions have been retrofitted into them. The term stealth aircraft is normally only used in conjunction with such aircraft which were specifically designed and built as low-observable aircraft. Such aircraft include, among others, the US F-117, F-22 and B-2.

Solutions geared at improving air combat performance, such as increased payload, range, sensor range, and having several engines, increase the physical size and emission level of an aircraft. Since air combat performance and observability, in practice, require conflicting design solutions, modern fighters incorporate several compromises which, depending on the manufacturer, have resulted in clearly dissimilar design concepts as regards electronic attack (EA) systems and stealth technology, among other things.

A target's detectability on radar depends on the radar system in use. The radar cross section (RCS) is a measure of how detectable an object is with radar. For example, the RCS of a legacy fighter can be estimated at 3-20 m2, that of a bomber or a transport aircraft 20-100 m2 and the RCS of a cruise missile less than 1 m2, depending on the physical size of the target, radar frequency or the incident angle (orientation of the target to the radar source). According to some estimates stealth technology can reduce the RCS by a factor of 10-1000. As the change in RCS is not directly proportional to the change in the detection range, it is possible at best to reduce the detection range of an aircraft to less than a tenth from normal through stealth design and technology. A reduction of such magnitude makes it significantly more difficult for the adversary to employ his radar homing weapons. In a practical combat situation this generates a decisive advantage to the stealth aircraft.

Solutions used in reducing the RCS are not a panacea against different radar systems. Thus far the employment of stealth technology has focused on making it more difficult for the adversary to use his radar homing weapons, i.e. prevent a shooting solution. Even if the effect of stealth technology solutions used in fighters can be diminished by integrating the air defence system and by new, longer wavelength radar systems, the advantage achieved through stealth technology will not entirely disappear. Fire control radars used in weapon systems will continue to operate well into the future in the spectrum for which stealth fighters' low-observable technology was designed. Although the capability for stealth fighter detection will improve, vulnerability to ground and air-launched radar homing missiles will not significantly increase.

It is impossible to eliminate the thermal footprint of an aircraft or its weapons. In addition to the engine plume, the friction caused by high airspeed generates an apparent temperature difference, clearly detectable from the background. Even though infrared (IR) technology incorporates certain weather-related constraints, IR systems are the most promising sensors suited to replace and complement radar systems, and to detect stealth targets and small targets such as cruise missiles.

Aerodynamics and powerplant

Improving the aircraft's manoeuvrability, speed and range are the most important goals in fighter development. Absolute speed and a speed advantage over the adversary determine the fighter's ability to implement its counter-air mission, engage the adversary in combat and break off from the fight.

The flexible operational use of multi-role fighters depends on their range and endurance as well as survivability in the operating environment. While high airspeed is an indisputably important factor in aircraft survivability, it is challenging to

maintain from the perspective of fuel efficiency. Engine technology has improved alongside with fuel efficiency. The most modern fighters can now maintain 'super cruise', which stands for supersonic flight without the use of afterburner. These fighters achieve approximately Mach 1.2–1.7 which, coupled with stealth technology, remarkably decreases the fighter's vulnerability to anti-aircraft fire and improves its chances of evading the adversary's fighters. However, even this capability comes with adverse side effects. Even though supersonic flight can be achieved without using the afterburner, which considerably raises the engine's thermal footprint, the high airspeed nonetheless raises the fighter's detectability in the IR range. Still, a super cruise capability does improve the fighter's ability to choose the optimum moment for combat and its chances to join the fight, and to break off from it on its own terms.

Even though aircraft manoeuvrability has already reached the limit of human tolerance, a fighter's turning ability will always remain relatively modest at the extreme ends of its airspeed range. It is not cost-effective to improve agility by boosting engine power, nor would it solve all air combat-related manoeuvrability requirements. The development and introduction of digital flight control systems revolutionised aerodynamic design and the utilisation of flight characteristics.

Much of the difference in manoeuvrability between 3rd and 4th generation fighters results from using fly-by-wire flight control. The solution for improving agility at the corners of the flight envelope was found in thrust vector control (TVC), which makes it possible to extremely rapidly and momentarily alter the direction and, especially, attitude of the aircraft. Thrust vectoring is used in F-22, Su-35 and Sukhoi T-50 fighters, to name but a few. Jet engines are continuously evolving. Development aims to resolve the shortcomings in acceleration and manoeuvrability at all airspeeds, altitudes and payloads. These shortcomings arise from compromises which limit the operational use of fighters.

The strategic development requirements of air power are associated with the ability to launch long-range strikes with conventional weapons. Deep penetration bombers that make use of stealth technology as well as cruise missiles such as the American Long Range Strike Bomber concept and the Russian Tupolev-manufactured PAK-DA represent the most important lines of development, as do concepts that strive for fast response by employing hyper-fast aircraft. According to estimates the United States and China are presently engaged in such projects. Hypersonic technology aims at achieving Mach 5–20. The Falcon Hypersonic Technology Vehicle 2 (HTV-2), a US technology programme demonstration vehicle, has already reached its target speed. Nonetheless, it is estimated that hypersonic technology will enter operational service in the 2030s at the very earliest.

Aircraft weapons

The factors that limit the utilisation of the full capabilities of a multi-role fighter include its maximum payload and the strictly specialised weapons against targets in the air, on land or at sea. The development of aircraft weapons has been vigorous during the past two decades. Owing to weapon system integration as well as sensor, targeting and datalink system development a fighter can fire missiles and drop bombs in all directions without having to change its heading. Most munitions are 'fire-and-forget' weapons, which means that they independently home in on the target after having been released. Then the aircraft can break off from the fight without delay in order to evade a threat or to attack the next target.

Air-to-air missiles can destroy both manned and unmanned aircraft and cruise missiles. Modern IR and radar missiles can defeat airborne targets from the distance of tens of kilometres. The average turning ability, speed and range of A-A missiles can be drastically improved, among other things, by replacing the solid propellant rocket motor with a ramjet engine. As a result, it is estimated that their range will be more than double the one of present missiles. Missile agility has considerably improved through the introduction of guidance systems that utilise thrust vector control. When thrust vectoring is incorporated in long-range missiles it reduces the need to arm the fighter with several A-A missiles of different type.

Missile and bomb sensor technology development increases their multi-role usability. It is likely that the weapons used against sea- and land-based targets and those used in the suppression of enemy air defences (SEAD) can, at least partly, be phased out over the next 10–15 years.

Precision-guided bombs will retain their status as effective and inexpensive basic weapons against hard and soft surface targets as well as against hardened bunkers and underground targets. Their accuracy in different weather and lighting conditions can be improved by utilising systems that combine satellite and inertial positioning as well as pattern/shape recognition and laser homing. Laser-guided bombs can also be used against moving targets.

Glide bombs are bombs that incorporate flight control surfaces for added distance. Their range is approximately 20–100 km, which is considered to be sufficient to engage targets at distances far-enough away to evade the target area's anti-aircraft systems (stand-off), thereby allowing air-to-ground missiles to be replaced with glide bombs. It is necessary to keep improving the weapons' multi-role capability and reduce the assortment of different role-specific weapons; this is particularly important from the perspective of stealth aircraft multi-role capabilities and the optimum utilisation of their internal payloads.

Even as glide bombs are increasingly becoming ubiquitous, alongside them multi-role short-range missiles such as the MBDA Brimstone 2 and the Lockheed Martin Joint Air-to-Ground Missile (JAGM) are being developed. Short-range missiles are eminently suitable for destroying single, stationary and mobile, land- and sea-based targets from up to 10–20 km. Because they are so small, one wing pylon can fit several of them. Short-range missiles can also be used in UAVs.

Cruise missiles are unmanned missiles furnished with jet engines, flying most of their pre-planned route at a constant airspeed. They are used against the adversary's well defended and critical targets which are hard to reach by other means and are often located deep inside the adversary's territory. Anti-ship missiles are cruise missile type weapons designed to defeat surface targets. The central objectives in long-range missile development are improvements in their multi-role usability and improvements in air defence missile performance. Technology solutions that aid penetrability through air defences are, among other things, stealth technology and the use of ramjets. Examples of these include the JASSM missile, soon to be introduced in the Finnish Air Force, and the Brahmos missile which can reach Mach 3, a weapon of Russian-Indian design.

Sensors

The active electronically scanned array (AESA) has become the principal sensor of the multi-role fighter. This kind of multi-role radar can be used in all weather and lighting conditions to search for and track air-, land- and sea-based targets at a distance of tens, even hundreds, of kilometres. As radar performance, such as resolution and other characteristics, improves, they can be used in ISTAR and EW. Because radars work by broadcasting an active signal, the signal can be detected at a long distance and, hence, the radar easily becomes a target of EW. Radar properties and methods which make the signal more difficult to detect (low probability of intercept) are continuously being developed so as to minimise the fighter's vulnerability.

Sensors generating a picture in the visible, infrared (IR) and ultraviolet (UV) range of the electromagnetic spectrum are passive by design and so they do not reveal themselves to the target. Imaging systems are used to detect, track and recognise land- air- and sea-based targets. Sensors are also suitable for missile launch detection and tracking as well as navigation at night and during the day. The systems play a central role in maintaining situational awareness, in generating warnings and in supporting the employment of weapon systems.

IRST systems (infrared search and track) generate tracking information from airborne targets. While the IRST is a passive system, primarily in use alongside the radar, on a case-by-case basis it can even supersede the tracking information generated by the radar. There is renewed interest in passive sensors owing to the growing prevalence of stealth technology and electronic attack systems utilising digital radio frequency memory (DRFM) technology. As a rule, IRST systems detect airborne targets due to their infrared signatures, following which they generate the needed tracking information for the weapon system. The system can find and track airborne targets at a distance of approximately 50–100 km, which is considered to be sufficient for modern A-A missiles. More sophisticated IRST systems can also create images for target recognition, and for observation of surface targets.

A passive forward looking infrared system (FLIR), based on thermal imaging, and an electro-optical sensor (TV camera), which is normally incorporated into the system, compile data for tracking and identifying surface targets which can be used to launch missiles and bombs against surface targets at a distance of tens of kilometres. Some modern FLIR systems can also search, track and identify airborne targets, much like IRST systems.

Different self-protection system sensors augment the fighters' weapon system sensor suites. Their primary purpose is to continuously scan the threat environment and warn of attacks against the fighter. The warning systems consist of radar warning receivers that measure electronic emissions and missile approach warning systems operating in the IR and UV ranges. In addition to cueing the self-protection systems, the information sourced from the most modern self-protection sensors can be used in support of the fighter's other mission configuration.

Sensor fusion, system integration and datalinks

Weapon system integration occurs at several levels. The integration of information generated by different sensors aims at compiling, maintaining and clarifying the situation picture required by decision-making, improving the quality of information needed in cueing the weapon system and preventing the jamming or suppressing effect of the adversary's countermeasures. In addition to individual fighters or systems, sensor fusion can also be implemented among several dissimilar systems.

Relaying the information generated by a single fighter aircraft, other aircraft or actor to the other members in the network improves the preconditions of the entire system and facilitates joint fire support. Examples of highly integrated systems include the US Navy's Cooperative Engagement Capability, which fuses data from the battle force's air defence sensors and enables its non-platform specific use as well as aircraft weapons' datalink guidance, which makes it possible for some other member in the network to change the target or the aim point of a weapon already in flight.

Unmanned aerial vehicles

The development of unmanned aerial vehicles (UAV) is intensifying as technology becomes cheaper. UAVs can be used in a flexible manner in different tasks such as intelligence, surveillance, target acquisition, and recognition missions, in strikes against surface targets, over-the-horizon relaying of information, electronic warfare, combat search and rescue (CSAR), chemical, biological, radiological and nuclear warfare (CBRN), logistic replenishments and counter improvised explosive devices (C-IED) in a favourable environment or in areas where the risk level is elevated. Thus far the UAVs have played a supplementing role, rather than having completely replaced any given system. This is because they can only be used in a heavily air defended area after air supremacy has been achieved.

UAVs are extremely suitable for long missions that strain flight crews or put them in harm's way. Two advantages can be gained by eliminating the flight crew: 1) performance improves (range, endurance, increased payload and manoeuvrability, smaller physical size and lower observability) and; 2) the ability to take higher risks. A UAV is a complete system and the critical factors of its operability differ from those of manned aircraft. Even if the flight crew were removed from the aircraft itself, it would not make the system an unmanned one or eliminate the human factors associated with its use. Although the elimination of the risk to one's own personnel lowers the threshold for using UAVs in the adversary's air-defended area, the risks of losing an unmanned aircraft must already be taken into account during the planning phase. When it comes to planning and operating Unmanned Aircraft Systems (UAS), one must also take into account long mission endurances and the need to rotate operators in order to avoid human error caused by fatigue.

Operating a UAS always requires personnel. The fact that the aircraft is unmanned does not eliminate the need for training, or reduce the human effort to operate the system. The personnel must by competent in their field and maintain all required certifications. The air vehicle operator (AVO) and the mission payload operator (MPO) as well as maintenance personnel, the mission commander and the intelligence analyst get just as tired as the personnel operating manned aircraft. The type and the purpose of the UAV system dictate the size and composition of the crew. According to the experiences of countries that use these systems in high volume, so far no significant savings have been accrued from using the systems suitable for the hardest combat missions.

Operating a UAV system requires a dedicated C2 system, which may vary between dissimilar solutions. Operating the vehicle and its systems can be done in a centralised fashion from a single ground control station, or it can be done in a dispersed manner between several mobile or fixed stations. The simplest tasks can be automated and assigned to one AVO. Then, for example, one AVO can fly several aircraft while each vehicle's own MPO is responsible for using its systems as per the requirements of the mission.

Controlling UAVs requires communications which can be maintained through radio communications within line-of-sight ranges, or through satellite communications when operations occur beyond the horizon. The communications must remain continuous in order to facilitate the actual operation and flying of the aircraft. It is possible to extend the range of UAV operations from the ground control station by rotating control responsibilities between stations. A drawback of radio or satellite communications-enabled flying and operating is the possibility of becoming exposed to EW and cyber-attacks.

Many functions of a UAV can be automated to lighten the workload of operators. An unmanned system can operate completely independently, under supervision or in phases where human controllers separately approve each step, such as a new waypoint. Increased safety and reliability and a lower probability of human error, lighter workloads, improved reaction times and performance as well as the capability to continue operating in conditions where no radio communications exist are considered to be the benefits of fully automated UAV operations. Improved operational effectiveness and cost savings accrued through UAV systems also arise from the capability to reallocate the human resources freed up by the lighter workload. Even though, in theory, an unmanned system can independently compile a mission-specific situation picture and carry out different offensive missions, it is not considered possible or ethically supportable to entrust tasks such as the release of lethal weapons in air combat missions, which requires independent decision-making, to an aircraft guided by artificial intelligence. There is always the risk that independent action based on artificial intelligence may result in losing control and in the erroneous interpretation of situationally relevant variables.

The benefits of lighter unmanned systems in ISTAR-related tasks are indisputable. The logistics requirements of heavier, unmanned combat aerial vehicles (UCAV) are roughly analogous with the deployment footprint of a similar-sized manned aircraft. International law also poses some challenges to the independent operations of UCAVs. Therefore, they require continuous, hands-on supervision which, in turn, calls for more complex C2 systems. Modern UCAVs such as the MQ-9 Reaper can operate at altitudes exceeding 15 km and remain airborne for tens of hours at a time. However, their weapon loads and speed remain much below those of fighters. Even if the price of a heavy unmanned aircraft is somewhat lower than that of a fighter, its performance and survivability alone does not meet the requirements of the combat environment.

NATO's Joint Air Power Competence Centre analysed the performance of and threats against unmanned aerial vehicles in its publication: Remotely Piloted Aircraft Systems in Contested Environments – A Vulnerability Analysis, September 2014. According to the report the trend of UAV proliferation is about to peak. The US armed forces, in their own UAV analysis, have stated that the presently used UAV are for the most part not designed to operate in the area of the adversary's integrated air defence system (IADS), which is why neither the number nor the quality of US UAVs is in balance with the requirement.

Deep penetration UAVs are still in early design phases both in Europe and the United States. The design of these aircraft focuses on stealth characteristics and on increasing their payload, endurance and range. Owing to higher payloads the aircraft's sensor and weapon load options have increased. In Europe and the United States deep penetration UAVs are seen to fulfil a supporting role. UAVs can be used in, among other things, target designation for long-range weapons and in suppressing enemy air defences along the route of the strike package. Deep penetration UAVs are developed for independent operations and in accordance with the requirements of real-time compatibility with manned aircraft. It is estimated that the capability for a mass use of deep penetration UAVs will be achieved by the 2030s. As far as it is known no country is presently engaged in a programme aimed at developing an air combat capable UAV.

In some cases UAVs can carry out missions better and cheaper than manned aircraft. The widespread proliferation of micro air vehicles (MAV) which are difficult to detect is on the cusp of becoming extremely challenging for air defences. Even the smallest UAVs are suitable for intelligence and PGM target designation. Moreover, they can double as weapons, even inside buildings. The most radical concepts focus on replacing the intelligence-targeting–fire chain; they aim at achieving a rapid weapons effect with the coordinated use of swarming unmanned aerial vehicles. This requires sufficient survivability and cost-effectiveness from UAVs in order to saturate the defence.

The survivability of a multi-sensor or multi-weapon UAV in a contested airspace may be inferior to that of an aircraft, which raises the threshold of using such systems in a risk-prone environment to a very high level. In practice, air supremacy is the precondition for using heavier unmanned systems.

Different armed forces are studying the possibilities of using combined manned-unmanned air operations from several different standpoints. They include, for example, using deep penetration UAVs in air operations alongside 4++ generation fighters and operating UAVs as, for instance, elements in a bomber or fighter detachment. The combined use concepts are associated with, for example, the development of new deep penetration UAVs, the development of fighters' avionics suites and datalink packages as well as using 4th generation fighters in the area of the adversary's integrated air defence system.

Ground-based air defence and missile defence

For many countries air defence is one of the paramount tasks of their armed forces. Two guiding principles can be set for organising ground-based air defences (GBAD): minimise the damage to the target being protected or maximise the damage to the aggressor. These goals are interdependent – the more enemy aircraft are shot down before they reach their targets, the smaller the force that can attack the targets being protected. Weaknesses of anti-aircraft systems include the lack of operational mobility, the limited reach of ground-based weapons, radar gaps and the inherently reactive nature of GBAD. Compared with fighter defence, anti-aircraft systems can only cover very limited areas. Then again, fighter defence is not an omnipresent resource either.

Anti-aircraft systems can remain in high readiness for extended periods, respond rapidly and effectively to an air attack, and be suitable for engaging all kinds of airborne threats, which is why anti-aircraft systems are used to defend high-value assets that require permanent protection. The requirements for GBAD development arise from the airborne threat and the role of GBAD as an element of the integrated air defence. The goal of GBAD is to protect critical civilian and military assets, and to guarantee the armed forces' freedom of action by incurring losses to the adversary's air power.

The effectiveness of air defence stems from the performance of its systems, the depth of defence and the number of systems available for defence, i.e. air defence density. The development of aircraft sensors and weapons as well as that of long-range weapons guides the development requirements of anti-aircraft systems and their operating principles.

Ballistic missiles, cruise missiles and stand-off weapons such as glide bombs as well as stealth targets are difficult to shoot down because of their low observability, trajectory or speed. Modern smart weapons make it possible for aircraft to engage targets in all conditions, both at altitude and far away from the target. Strike aircraft, operating at low and medium altitudes, and helicopter gunships will continue to retain their importance, especially in providing close air support to army units. Unmanned aerial vehicles will become more advanced and a more commonplace element of the air threat. Surface-to-air weapons are required to have a long range so as to be able to destroy aircraft before they reach the distance for launching modern stand-off weapons. Since it is presumable that not all attacking aircraft can be defeated before they release their weapons, surface-to-air systems must also be able to repulse the attacker's most lethal weapons, such as cruise missiles and ballistic missiles. In order to detect and defeat stealth targets, new surveillance systems, highly integrated command and control systems and suitable weapon systems must be procured.

The focus of missile defence development is on systems suitable for protecting against ballistic and cruise missiles. When it comes to introducing comprehensive missile defence systems the great powers are only in the early phases of development. The main parts of such a system includes a satellite-based early-warning system, surveillance and fire control radars and the actual launchers, missiles included. The end-stage missile systems, such as the MIM-104 Patriot PAC-3/PAAC-4, SAMP/T, MEADS, David's Sling and S-400, are suitable for short-range ballistic missile defence. The reception of sufficient early warning is a challenge to missile defence. Even though most missile defence systems can also protect against air targets, the situation might require that the units be only limited to carrying out one main task at a time.

The high price tag is what limits the proliferation of ballistic missile defence systems. In addition, protecting against medium- and long-range missiles requires exceptionally widespread deployment in an area that can traverse the national borders of countries. The total price of even a short-range missile defence capability will typically run into several billions of Euros. And, although these systems can defeat aircraft at very great distances, their self-protection coverage for radar gaps requires medium- and short-range anti-aircraft systems.

The permanent protection of high-value assets demands that GBAD be able to protect against manned and unmanned aircraft as well as different projectiles such as missiles and bombs. By integrating solutions based on dissimilar technologies in the same geographical area, such as surface-to-air missiles, anti-aircraft guns (AAA) of different range and sensors, it is possible to create a mutually augmenting multi-layered, jamming-resistant and robust whole capable of comprehensively responding to a variety of threats. This can be achieved through positioning different types of GBAD units in the same area and by employing hybrid anti-aircraft systems.

Due to the nature of the Army's battles and the threat the units face, they must have available a sufficient number of highly terrain-capable anti-aircraft systems, such as the RBS-70, Stinger-, Grom-, Igla-S, Crotale- and Tunguska-systems. Typically, medium-range missile defence and hybrid GBAD systems, such as the NASAMS, Spyder, Tor M2 and Pantsir, are the mainstay of the Army's surface-to-air systems. These are supplemented by short-range missile systems to cover radar gaps.

The relative importance of anti-aircraft artillery has declined in conjunction with the development of aircraft and the properties of their weapon systems. However, anti-aircraft artillery continues to be suitable for protecting against helicopters, UAVs and various types of projectiles. In practice, this means that AAA must also have the capability to detect, track and destroy very small targets.

Crisis management operations have an accentuated need to protect the bases of contingents against rockets as well as artillery and mortar rounds (counter rocket, artillery, and mortars - C-RAM). Anti-projectile systems such as the US Phalanx are commonly used on ships as self-protection against anti-ship missiles. The need to maximise cost-effectiveness, the need to defend against small projectiles and the aim to deny the attacker his capability to saturate traditional weapon systems has resulted in a demand for new technological solutions. Directed-energy weapon systems (laser) are the farthest ahead in development. The issue that limits their development is the short range caused by the laser systems' environmental factors. In the future, laser systems will be well-suited to provide self-protection for individual targets such as vessels.

Anti-aircraft and missile defence systems can repulse aircraft, a variety of weapons and ballistic missiles to protect high-value assets or areas in all weather and lighting conditions. Ballistic missile defence, however, is a special task for which even developed countries have only limited means. If one wants to set up a sufficient air defence system by only using GBAD, it requires the parallel usage of dissimilar systems to cover for defilades and radar gaps and to fulfil different kinds of air defence requirements. Therefore, it becomes extremely expensive to defend large areas with anti-aircraft systems. Systems based on directed energy, like high-energy lasers, may play a substantial role in the future as regards protecting individual high-value targets and preventing saturation attacks against the target. A layered, flexible, mobile and long-range anti-aircraft structure is a part of an integrated air defence capability and the overall defence system. Nonetheless, judging by war experiences, a state cannot form its air defences, or achieve and maintain control of the air, by means of surface-to-air systems alone.

Ground-based air defence and fighter defence complement each other, and by using them in a combined manner it is possible to maintain readiness for an extended period, maximise the reach of the air defence, defeat the aggressor before he can release his weapons and minimise the saturation of the defence capability. It is also possible to limit the options for the adversary's air power and ballistic missiles through counter-air operations and a strike capability. GBAD is of the greatest benefit when it is integrated into the air defence C2 system. It must also be able to independently compile a situation picture and manage fire control so as to provide early warning and target designation to the firing units. Surveillance systems must be able to detect and track low-observable targets at different altitudes, and relay the tracking information to the command and control system. Air defence integration creates the preconditions for centralised fighter and GBAD command and control, the generation and dissemination of a situation picture and coordinated offensive engagement, and for the flexible use of weapon systems and sensors in national and international operating environments alike.

3.3 Development and production of fighter aircraft

Multi-role capability is a clearly identifiable trend in fighter design. All countries that manufacture fighters start from the position that individual countries, even individual military services, aspire to replace their different, single-role legacy fighters with one multi-role fighter type which can meet the requirements of several kinds of missions. Owing to different types of mission profiles there are still dissimilarities between the versions of 4th generation fighters that were designed in the 1970s and 1980s. The most modern versions of the '4++' generation fighters represent genuine multi-role capability and, depending on mission configuration, they are able to carry out a variety of missions ranging from air combat to strike, intelligence and surveillance. For the most part the key performance factors of the multi-role capability stem from the more sophisticated weapon system and sensor technology in 5th generation fighters, and the technical solutions used in analysing their data as well as sensor fusion.

Only a handful of countries have been able to maintain enduring, continuous fighter development and production. The strong position of Russia and the United States is the result of their ambition to safeguard a great power-status. Because of national interests, during the Cold War and in its aftermath France, the United Kingdom, China and Sweden created and continued an independent fighter design capability. Since, in practice, fighter development continues to be run by governments as part of their defence system development, serving their national interests, it is extremely challenging to compare

different mutually supplementing types and their development versions, or to consistently categorise them in the appropriate generations. The level of system technology and the software-oriented capability development only increase the challenges.

Worldwide, there are over 50 000 military aircraft in use, approximately 15 000 of which are combat aircraft. The United States is the undisputed forerunner in fighter design and production; it has approximately 2 800 fighters in operational service – twice the number of Russia and China. Most of the fighters flying in the world are manufactured by the American aviation industry. At present, the United States produces F-15 and F-16 fighters for export as well as F/A-18 and F-35 aircraft for export and its own use. It is estimated that only the production line of the F-35 is guaranteed to remain open during the next decade.

In addition to fighter design the United States controls the aircraft weapon market as most European manufacturers and air forces continue to depend on weapon systems of American origin. The average age of the US armed forces' own fighters continues to grow, due to continuous cancellations in development and procurement projects. Nonetheless, the United States will replace a significant share of its aircraft during the coming ten years. Following this, different versions of the F-35 Lightning II, the F/A-18 E/F/G Super Hornet and the Growler as well as the F-22 and the F-15E will be the main fighter types in the US armed forces.

The USA's fighter power comprises of the fighters operated by the Air Force (USAF), the Navy (USN) and the Marines (USMC). According to estimates, by 2030 the USAF will operate more than 1 000 F-35 fighters in addition to the already procured 183 F-22 and 200 F-15E fighters. The USMC will shift to a completely new fighter type by procuring 353 F-35B and 67 F-35C fighters. According to plans, the 368 F-18E/F, 138 EA-18G and 260 F-35C fighters will be the fighter inventory of the USN. Unmanned aerial vehicles play a similar role in the US Naval Air Force as they do in the USAF; the striking power of a carrier wing comprises of approximately 4-6

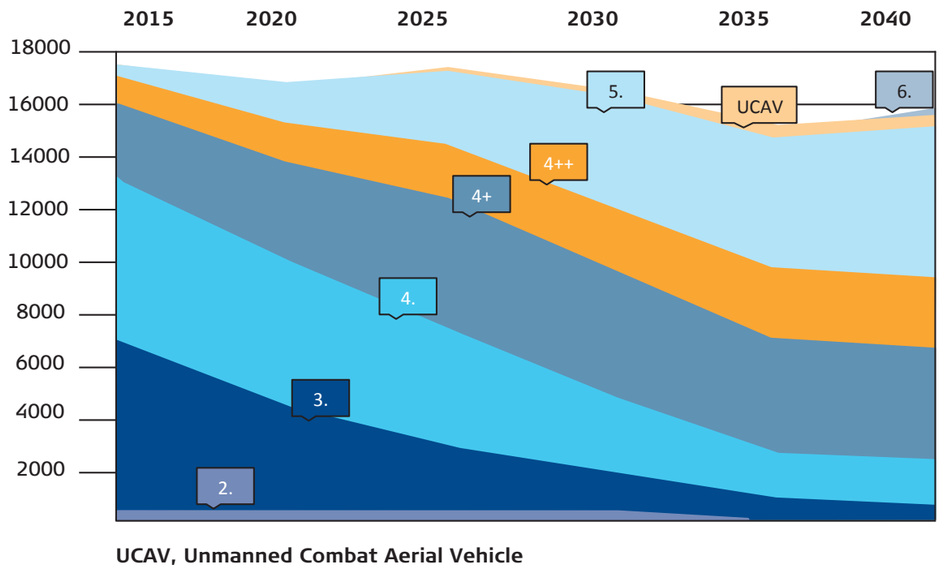


Figure: The estimated numbers of different generation fighters up until 2040.

UAVs, 44 fighters and 5 airborne electronic attack (AEA) aircraft. For the next 20 years the USAF will rely on its existing bomber fleet and 5th generation fighters. Any US decisions on a new deep penetration long-range bomber, 6th generation fighter and the role of UCAVs will no doubt have long-term effects on the other aircraft manufacturing countries' future selections.

The United States continues to develop UAVs. So far UAVs have for the most part been used and developed for long term ISTAR and strike missions against individual soft targets where the risk of losing the aircraft is low. The media repeatedly publishes speculations about replacing combat aircraft with UAVs, but judging by recent decisions made by the USAF the proliferation of deep penetration UCAVs will not happen anytime soon, nor is the introduction of air combat-capable UCAVs to be expected.

In all, the EU countries' air forces have approximately 2 000 combat aircraft, 60% of which were manufactured in Europe, 30% in the USA and 10% in the Soviet Union. European manned combat aircraft manufacturing encompasses the Swedish Saab Gripen, the multinational Eurofighter Typhoon and the French Dassault Rafale as well as the US Lockheed Martin F-35 fighter production which is underway in Italy. As the oldest F-16, Eurofighter and Gripen C/D fighters are being phased out at the turn of the 2030s, barring new procurements, the remaining European air forces' fighter inventory will consist of the newer Eurofighter, Rafale, F-35, F-16 and Gripen NG (Gripen E in Sweden) aircraft.

The European NATO Member States are also developing their air forces in a very independent manner. Neither the integration of the European aviation industry nor a multinational collaborative effort in fighter production is anywhere in sight. There are different estimates as regards the continued production of the abovementioned fighter types. However, each aircraft type's production estimates hinge on finding new foreign customers as the old orders to the main customers will be completed in the coming years. The role of the Swedish industry has clearly changed during the recent decades: while the Gripen is designed and assembled in Sweden, many of its systems are outsourced.

Even though the European and modernised Russian fighter types still in use can be regarded as 4th generation fighters, due to several development versions some of their features are wholly comparable with those of 5th generation fighters. The US F-22 Raptor and the F-35 Lightning II as well as the Russian Sukhoi T-50 (PAK-FA, Perspektivniy Aviatsionniy Kompleks Frontovoi Aviatsii; the future system of Russia's Frontal Aviation) and the Chinese Chengdu J-20 and Shenyang J-31 are considered to be 5th generation fighters. Of these, only the F-22 is in operational service. In addition to the aforementioned types, the Russian MiG Corporation has launched a project for producing a light fighter version by 2025. Nonetheless, any closer evaluation of the fighters in production proves that it is impossible to form any explicit categorisation in practice.

The global fighter market will be reshuffled since the restrictions concerning the sale of the F-35 fighter may impact its proliferation. In spite of this, the F-35 will likely replace the lion's share of the ageing American-made fighter aircraft in Europe and the Far East. No new European fighter programme is underway and, therefore, according to present estimates there will be no European stealth fighter on the horizon before the 2040s. The European 4+ generation fighters still participate in some European, Middle Eastern and Far Eastern competitive tendering processes. Russian manufacturers are also in the same markets to an extent. China is also looking to participate in the international market. However, the national fighter programmes of Japan, Turkey and South Korea are still in process, and so their export prospects are uncertain. Questions associated with integration and access to armaments and weapon systems impede the sales of these aircraft types. Only China has national production in place and, relying on it, China can probably deliver an entire weapon system and the required system support.

European countries have made wide-ranging assessments on the capabilities and development requirements of European air power. According to reports commissioned by the European Defence Agency (EDA) Europe, as a whole, has significant shortcomings in capabilities associated with intelligence, surveillance and recognition (ISR), air-to-air refuelling (AAR), airlift, EW, SEAD and long-range strikes. The large variety of aircraft types, for its part, has encumbered collaborative system design. The European aviation industry has been slow in launching projects intended to offer alternative choices to American weapon systems. While the fact that several European countries participate in the F-35 programme creates the preconditions for a more widespread use of European weapons as armaments for this aircraft type, thus far no coherent European approach has been identifiable.

3.4 Situation in Finland's neighbourhood

The air forces of Finland's neighbouring countries are presently implementing significant aircraft replacement programmes. Sweden will procure 60 Gripen E fighters; a planned additional procurement may increase the number by ten more fighters. While Norway will replace its F-16s with 52 F-35 fighters, Denmark's fighter programme is still incomplete. Russia has undertaken a massive modernisation programme of its air force and air defence equipment.

The Baltic States have no ongoing fighter programmes; their air defence is largely based on NATO's air policing mission and the provision of assistance as per Article 5. The bases used in the Baltic Air Policing operation are Šiauliain in Lithuania and Ämar in Estonia.

The presence and activity of NATO countries' air forces has grown in response to the events in Ukraine. So far no announcements regarding permanent US reinforcements in Europe or expanding NATO's action in the Baltic States have been made.

In its report (Luftförsvarsutredingen 2040) the parliamentary Air Defence Committee, set up by the government of Sweden, analysed long term development requirements of Sweden's air defences. The main points and conclusions of the report reflect the need to re-establish the national defence capability. Furthermore, when it comes to surveillance and situational awareness, anti-aircraft systems, base vulnerability, cyber defence, weapon procurement, C2 systems, modern aircraft and operational performance as well as missile defence the conclusions are very similar to the ones made in Finland. For its part, Finland has already resolved some key questions through projects associated with command and control, surveillance and anti-aircraft systems, and with the strike capability project achieved through the Hornet's mid-life upgrades. It is still too early to evaluate the consequences of the Swedish Air Defence Committee's report with regard to the development of the Swedish Air Force. However, in conjunction with the Gripen E procurement Sweden will likely retain its current base structure until the early 2040s.

> NATO air policing is a peacetime mission which requires an Air Surveillance and Control System (ASACS), an Air Command and Control (Air C2) structure and Quick Reaction Alert (Interceptor) (QRA(I)) aircraft to be available on a 24/7 basis. This enables the Alliance to detect, track and identify to the greatest extent possible all aerial objects approaching or operating within NATO airspace so that violations and infringements can be recognized, and the appropriate action taken. Source: NATO Wales Summit Guide

Norway's status in the F-35 project, its role in the development of the NASAMS anti-aircraft system and the Naval Strike Missile/Joint Strike Missile programme are sizeable efforts in view of Norway's air defence and air operations capabilities, and for its national industry. Even though the decision to concentrate the fighter fleet to one main operating base (MOB) and one forward airfield in the north, which for the main part supports the national defence, shifts the centre of gravity of Norway's fighter operations southward, the Arctic dimension still continues to play an important part in Norway's defence.

Russia's investments in the arms industry will impact, among other things, aircraft production and the development of precision-guided munitions, most important of which being cruise missile programmes. Russia aims at meeting western development at every sector and it continues to modernise its air force by upgrading legacy aircraft and by launching new procurement programmes. The most important ongoing fighter programmes include the modernisation of the MiG-31 and Sukhoi Su-27 fighters, procuring new Su-34 and Su-35 aircraft as well as developing the entirely new Sukhoi T-50 (PAK-FA) aircraft and, possibly, a new light fighter.

Russia maintains a continuous production capability to safeguard the capability of its air force. The Russian Ministry of Defence announced the reopening of the Tu-160 bomber production line, which aims at resolving the shortage of equipment until the entirely new bomber type (PAK-DA) which will replace the Tu-160 and Tu-95 aircraft enters operational service.

The aircraft which were delivered in 2014 satisfy a part of the military equipment's modernisation programme and total requirements. In 2014 the air force received 7 modernised Tupolev Tu-160 and Tu-95MS bombers, 53 Sukhoi Su-30 and Su-35 multi-role fighters, 16 Su-34 bombers, 18 upgraded MiG-31BM fighters, 135 helicopters including 46 helicopter gunships and 72 transport aircraft as well as 179 UAVs. Also, the air force received seven new long-range S-400 anti-aircraft systems. Current orders, options included, comprise of 48 Su-35, 110 Su-34, 135 Su-30, 60 T-50 fighters and 14 Tu-160 bombers, in addition to which the air force is preparing an order for 100 MiG-35 fighters.

The founding of Russia's Arctic Strategic Command has so far not made any impact in weapon system design. By 2018 the air force will receive more than 50 modernised MiG-31-BM fighters. Following their modernisation the fighters will protect the most important strategic areas, the Arctic included. The modernisation will include electronic suites, improved cockpit ergonomy, new radars, better fire control systems and digital datalinks.

Russia continually improves its ability to employ air power and use long-range weapons in Finland's neighbourhood. Alongside the new Arctic Strategic Command Russia operates bases in its western and northwestern sectors. The Russian Air Force's power projection capability is constantly being tested. Air force exercises also include the actions of naval and artillery units in the region. The oldest artillery missile systems are being replaced with the ballistic and cruise missile-capable SS-26 system. Russia's northwestern air defences are being improved by introducing new air surveillance systems and the S-400 anti-aircraft missile system. In addition, there are speculations regarding the introduction of the new S-350 and S-500 systems. By introducing long-range systems Russia is aiming to improve its capability to repulse ballistic and cruise missiles, deny the use of aircraft such as surveillance, AAR and EW aircraft that support air operations, when needed, and to improve its capability to detect and defeat stealth targets.

4. Replacing the Hornet fleet's capabilities as an element of the overall defence system

Deterrence inherently includes the capability of the state to resolutely demonstrate its capability and willingness to guard its borders, respond to an attacker's acts of war and protect the vital functions of society and the independent decision-making capability of state leadership. The primary purpose of Finland's defence capability is to establish deterrence against the use of military force as well as the threat thereof, and to repel attacks on Finland. Both deterrence and the ability to repel attacks necessitate a properly functioning defence system in which sufficient defensive and offensive effects are achieved through the joint effect of the different military services' capabilities.

4.1 The significance of air power to the defence system

Air power as deterrence

The deterrence created by air power consists of capabilities which utilise its special properties, especially in supporting the entire defence system's mobility, reach and effectiveness. The air power's deterrent effect in Finland is built on the credibility of the Air Force; its foundation relies on the willingness to defend the country, demonstrated already in peacetime, on professionalism and performance as well as completed defence materiel acquisitions. A significant share of the Air Force's deterrence stems from fighter sorties implemented to monitor and protect the territorial integrity of Finland, which demonstrate the will and capability to monitor and defend the borders of an independent country even in peacetime. The manner by which Finland reacts to territorial surveillance events impacts other countries' estimates regarding the credibility of our defence. In particular, the reaction time and usability of the fighter fleet comprise an invaluable part of these operations.

The significance of control of the air

Denying the adversary's freedom of operation and access to areas as well as limiting or preventing transports are commonplace means of military pressure, and the first goals in military operations. It must be possible to sustain the core functions of society and the Defence Forces in peacetime and emergency conditions alike. In all situations Finland needs to guarantee the flexible use of airspace, while denying the unlawful use of our airspace. Control of the air plays a key role in securing vital functions, and it has proven to be a crucial factor to the success and protection of one's own operations. Therefore, achieving sufficient control of the air is often the first task assigned to air forces during conflicts.

Control of the air stands for the actions and preconditions which, for their part, guarantee freedom of action to one's own operations by limiting the adversary's air power and air defence capabilities, or by nullifying his operational energy. Sufficient control of the air is a precondition for the success of land, sea and air operations. Offensive counter-air operations are typically used to gain control of the air.

Only in exceptional situations can control of the air be achieved through defensive operations alone. In addition to defensive counter-air operations the adversary's capabilities must typically be limited through offensive operations to achieve control of the air. Relevant missions include, among other things, the following:

- Interception associated with territorial surveillance and the protection of territorial integrity in peacetime,
- Missions associated with monitoring restricted and prohibited airspaces and target protection in special circumstances,
- Air interdiction in emergency conditions to protect troops and targets (defensive counter-air), and
- Defeating the adversary's aircraft in the air and on the ground (offensive counter-air) to guarantee free and safe access to airspace.

Air power and changes in the character of war

Wars between states in recent decades have undeniably proven the crucial significance of air power and technology. In recent years warfare has developed in a direction where conventional warfighting is combined with, among other things, unanticipated means. Alongside open warfare battles have been fought, for example, in networks and through the means of guerrilla warfare. The events in Ukraine and the talk of hybrid warfare have raised a new debate on the increasingly blurred concepts of war and the moment when war breaks out. Even though the operating environment and means of warfighting keep changing, air power does not seem to have lost its essence. Rather, it has remained viable even in hybrid warfare and in its prevention.

Control of the air and offensive engagement are equally important elements in the use of air power. Sophisticated navigation and homing systems also make it possible to more accurately target air-launched weapons against increasingly challenging targets in unconventional warfare. The properties of modern munitions make it possible to attack hardened or mobile targets. The weapons used in long-range strikes are more penetrable, and they can be launched at greater and greater distances. The Air Force's versatile offensive engagement on land, at sea and deep inside the adversary's territory comprises an essential element of the defence system's joint effect, even as the Hornet fleet's capabilities are being replaced.

Sophisticated sensors, command and control systems and C2 networks have dramatically shortened decision-making and reaction times, and reduced the number of weapons needed to create the desired effect in combat situations. Integration between different platforms' sensors and offensive systems, and the nearly real-time data transfer between them does not only improve warfighting capability, it also revolutionises conventional warfare. Integration between airborne as well as land- and sea-based systems increases their effectiveness, makes it more difficult to locate individual systems and to engage them with counter-measures. System integration, timely access to relevant information, lower observability and long-range PGMs create the preconditions for successful control of the air and an effective air-to-surface strike capability.

4.2 The role of the Hornet fleet as an element of the defence system

Key grounds for maintaining and developing military prowess include the preservation of equilibrium between states and the prevention of military conflicts. Foreign countries are also continuously evaluating the credibility of Finland's defence. The Hornet procurement and its regular modernisations have, for their part, helped Finland maintain international balance and deterrence and conflict prevention in the transformed operating environment. Considering this, the development of the Hornet fleet was systematically planned and implemented from the very start of its lifespan. Development mainly focused on achieving the ability to repel the potential aggressor's first strike and, following this, on the capability to render the attacker's efforts futile.

The context of the Hornet procurement

The Hornet acquisition, carried out in the 1990s, can be seen to be a carry-over from the 1960s when, as a result of scepticism regarding the credibility of Finland's defence, measures were taken to boost the air defence capability. Following the Note Crisis[2] Finland improved its air defences for two decades. The report of the Third Parliamentary Defence Committee (1981) issued recommendations for the long-term development of defence: the focus lay on developing troops and units capable of creating deterrence and repelling an attack in order to meet the performance requirements of the 1990s. The task of these troops was to convincingly demonstrate Finland's resolve and capability to comprehensively protect its territorial sovereignty and prevent its unauthorised use. The troops were to be relatively well-equipped in order to be 'convincing', and limited in numbers. In its five-year plan (1982-1986) the Committee included the first stages of setting up a third fighter squadron. Along with the third fighter squadron and anti-aircraft missile projects, Finland's air defence reached a level at which, within resources, we had a rudimentary capability to meet the requirement of securing the vital functions of society nationwide, and to defend the territory of Finland, beginning at its borders.

The preparations for replacing the three ageing MiG-21 and Saab Draken squadrons commenced at the end of the 1980s. Weapon technology development proved that Finland's fighter aircraft were completely outdated as regards the then character of battle, the main task of the Defence Forces and the requirements posed by the operating environment. Furthermore, in its report the Third Defence Committee had already stated that cruise missiles pose a new and significant challenge to the air defence.

When the Hornet programme started, the 4th generation fighters, developed as a result of experiences from the Vietnam War and the wars in the Middle-East, had already seen operational service for a decade. Owing to new technology fight-

2 The Note Crisis was a political crisis in Soviet–Finnish relations in 1961.

ers could now operate in all weather and lighting conditions. Moreover, new electronic attack systems and anti-radiation missiles were available to counter the threat of anti-aircraft missiles. Digital computers created the preconditions for the development of new multi-role fighters, and Doppler radars as well as new radar-guided missiles could also engage targets flying at low altitudes. This development placed Finland in a situation in which the performance of the fighter fleet in a likely counter-air scenario would have been severely inadequate. Air operations carried out at night or in adverse weather, supported by electronic jamming or carried out at low level would have resulted in substantial losses and destruction in Finland.

Monitoring and protecting Finland's territorial integrity demanded a broad flight envelope from the new fighter – the fighter had to be able to identify and, when needed, repulse targets flying high and fast. However, the most important requirements included an 'all-weather capability' and the ability to engage targets flying close to the deck below the fighter, i.e. a 'look down/shoot down' capability. In 1992 the Finnish Air Force recommended that the F/A-18C/D aircraft be procured as the new fighter type; pursuant to evaluations it best met the needs of Finland's air defence and carried the highest development potential.

In the 1980s Finland had an extremely limited strike and reconnaissance capability and the character of the operating environment at that time did not facilitate correcting these capability shortcomings in the fighter procurement, even though all candidates for the procurement were multi-role fighters. This being the case, the procurement was exclusively implemented as an interceptor project in spite of the fact that the aircraft's other functional capabilities could have greatly benefited Finland's defence system.

Developing the capabilities of the Hornet fleet

The fighter procurement, carried out amid an economic crisis, and the decision to procure the aircraft drew criticism in the media. Instead of focusing on the effectiveness of the fighter procurement the debate centred on the price tag of the project, the technological and capability leap over one generation, and the role of the domestic industry. In retrospect, the method in which the pre-procurement evaluation was carried out has proven to be extremely valuable. At the time of the selection the Hornet fleet's capabilities were well known. When it comes to the actual decision the estimates and possibilities regarding the operational capability development needs during the lifespan of the fleet were critical. On the basis of the estimates, two major upgrades were planned to be implemented so as to sustain the operational performance of the fleet during its 30-year service life.

The capabilities of the Hornets, and the increasing significance of air defence, have received much attention during the entire service history of the fleet. The investment decisions associated with the fleet's upgrade requirements have been made on the basis of a long-ranged and research-oriented process. Evaluation, exchange of information among the international user community of the fleet and familiarity with the aircraft acquired through our own use as well as analyses of technology, the character of battle and changes in the operating environment have played key roles in this process. The recommendations on the needs to upgrade the Hornet fleet, stemming from research and expert opinions, have been handled by Parliament through the Government Security and Defence Policy Reports of 1997 through 2012.

According to the analyses it has been appropriate to actively and continuously improve the Hornet fleet's air combat capability to meet the requirements of the changing operating environment. Following the experiences from the Gulf War (Operation Desert Storm, 1991) the significance of air power and air supremacy was reassessed. Since the Gulf War air power, long-range strike capability and analyses of ancillary EW capabilities have been the key themes around which technology development and the military doctrines of NATO, Russia, the United States and China, to name but a few, have evolved.

The Government Security and Defence Policy Report 1997 launched the analysis on expanding the operational role of the Finnish Air Force and the usability of the Hornet fleet. As a result, the possibilities for acquiring weapon systems suited to offensive counter-air and strike operations were assessed. The actual decision to expand the Air Force's operational role, and to establish a completely new capability sector, came into being as a result of a strike capability study. In conjunction with the handling of the Government Report of 2004 the Defence Committee stated that an air-to-ground capability "enables projecting significant firepower from one area to another in the entire territory of the nation over a short period of time", and that "the air-to-ground capability together with the previously described weapon systems forms a robust, versatile and cost-effective total system for repelling attacks."

Even though the Hornet fleet can be flexibly used to defend the entire territory of the nation, the number of the aircraft procured (57 single-seaters and 7 two-seaters) was not based on operational requirements. Rather, it reflected the artificial limitation imposed on Finland in the Paris Peace Treaty of 1947. During the preparations for the 1997 Report additional aircraft procurements were considered in order to remedy the aforementioned limitation. But as it was, Finland's economic resources did not permit the acquisition of any additional aircraft during that planning period. The number of aircraft continues to pose a challenge to the defence of Finland's large geographical area.

So far, through the systematic upgrades of the Hornet fleet the Air Force has been able to sustain a sufficient capability for air operations which includes a flexible counter-air capability, air combat and air-to-ground capabilities, and a long-range strike capability. As a result of these upgrades the interceptor was transformed into a multi-role fighter. The fleet plays a central role as an element of the defence system. In peacetime it carries out key tasks associated with monitoring and protecting the territorial integrity of Finland. In addition, the capabilities of the Hornet fleet play a significant role in establishing deterrence against the use of pressure on Finland or, in the worst case scenario, Finland becoming the target of military force or an attack. In wartime the fleet has a central role in protecting society's vital assets and functions and the battle of the other services from air attacks, and in repulsing attacks by means of air-to-surface strikes.

> The quantity and quality of multi-role fighters must be sufficient to make it possible to carry out air defence and air operations in accordance with the tasks of the Defence Forces in the entire area of the country.

4.3 The need for a multi-role fighter as an element of the defence system in 2030 and beyond

The Multi-role fighter

The capability that will eventually replace the Hornet fleet must meet the demands of an operating environment constantly in flux, which requires a multi-role fighter's high-readiness capability, mobile tactics and flexible and wide-ranging capabilities to react to different situations. Multi-role fighters are primarily used in such nationwide roles and tasks which are beyond the reach of other capabilities alone.

The main forte of a multi-role fighter is its flexibility in forming air operations, since a 'swing role' fighter's mission can be changed as needed according to the situation or need, between sorties or during a mission. The multi-role fighter will likely play a more important part in the defence system because, in addition to the overall air defence system, its performance impacts ground and maritime defence capabilities, intelligence, surveillance and C2 systems and fire support.

The operational agility of a multi-role fighter fleet creates the preconditions for the flexible use of capabilities in the entire area of the country and, when needed, establishes the weight of effort in critical areas. The quantity and quality of multi-role fighters must be sufficient to make it possible to carry out air defence and air operations in accordance with the tasks of the Defence Forces in the entire area of the country.

Even though the use of multi-role fighters in air defence requires seamless integration with the other air defence systems, when needed, they must possess an independent first-response capability against different threats by using information generated by on-board sensors, versatile weapon configurations and the required EW capabilities.

Defensive and offensive counter-air operations

In the future multi-role fighters will be the single most important component in establishing Finland's air defence capability; they also play a central role in creating freedom of action for the Defence Forces as well as in achieving and maintaining sufficient control of the air after having repulsed a first strike. Fighter defence, implemented with multi-role fighters, provides the Defence Forces' wartime units and national high-value targets with protection against air threats, and establishes the centre of gravity for the air defence, as required by the situation. Multi-role fighters deny the enemy his attempts to take advantage of the gaps of the other active air defence components. Fighter power will continue to be a rapid, far-reaching and flexible instrument which can be tailored and adjusted to control different aggressions in accordance with the requirements of the dynamic operating environment. Multi-role fighters establish both the framework of territorial air defence and the counter-strike capability to paralyse the adversary's offensive power.

The defensive counter-air capability, consisting of fighter defence and anti-aircraft defence, is reactive by nature. Fighters respond to air attacks and potentially threatening situations. When it comes to airspeed and altitude, the requirement for fighters performing these kinds of missions are higher compared to other mission types. Weapon system design is presently undergoing a transformation. As a result of this, certain compromises must be accepted in the envelope and manoeuvrability requirements of a multi-role fighter, for example, with regard to the relationship between manoeuvrability, the maximum weapon load and observability.

Defensive counter-air operations highlight the properties of the multi-role fighter's air combat capabilities. Air combat situations are typically close-range head-on situations in which the initiative and advantage hangs on who first detects the adversary and who gets the first shot. Factors affecting first detection and the shooting position include the situation picture, the performance of on-board sensors and the range of armaments. The detectability of the target's electro-magnetic emissions, stealth technology and EW characteristics play a role in observability and in achieving a firing solution. The newest answers associated with the range of A-A missiles and, on the other hand, missile evasion are ramjet missiles and the fighters' super-cruise capability.

Helmet-mounted cueing systems and the newest generation short-range A-A missiles considerably reduce the need for fighter manoeuvrability when missiles are launched in close-air combat. Simultaneously, as the envelopes and ranges of A-A missiles increase, they can be employed against targets whose airspeed and altitude differ substantially from one's own, even in unfavourable situations. It is particularly important to be able to engage targets at great distances as well as small targets.

Control of the air cannot be achieved through defensive counter-air alone as it typically requires offensive counter-air operations as well. Therefore, multi-role fighters are also used to limit, suppress and defeat the adversary's air power and air defence systems. This does not only help achieve control of the air, it also makes it possible to protect one's own land- and sea-based and air operations.

The Defence Forces' joint fires

The Defence Forces' joint fires capability is paramount to the implementation of military operations and to the credibility of Finland's defence. Engagement, such as attacks (kinetic effect) and electronic jamming (non-kinetic effect), are implemented in the air, on land and at sea. Modern multi-role fighters can cost-effectively establish the backbone of nationwide offensive engagement which is employed alongside land- and sea-based offensive capabilities. Multi-role fighters engage mobile and moving land- and sea-based targets, both soft and hardened ones. Multi-role fighters are also able to carry out both kinetic and non-kinetic engagement in all dimensions during one mission, and they can rapidly concentrate defensive power in areas out of reach of other firing units. Multi-use and, when necessary, versatile fighter weaponry and on-board systems place no limitations on target selection, or the conditions to (joint) fires application. If necessary, the mission can be carried out by employing an electronic attack.

> Modern multi-role fighters can cost-effectively establish the backbone of nationwide offensive engagement which is employed alongside land- and sea-based offensive capabilities.

Independent capability and networking are crucial mutually augmenting properties. These make it possible for the multi-role fleet, operating as a detachment or within some other defence system, to minimise the response time in critical situations and independently fly offensive missions in challenging cyber and information warfare environments. Even though multi-role fighters can fly independent offensive missions, other systems can also be used alongside them, or in lieu of them, to saturate the target, to optimise the weapons effect, or to maximise survival.

The Defence Forces must retain the long-range strike capability achieved through the Hornet fleet. Military high-value targets are often located beyond the area being defended which requires the capability to achieve the desired effect in a versatile manner and from far enough away. The way to compensate for the inferred penetration requirement, and to reduce vulnerability, is to use stand-off weapons such as JSOW glide bombs (Joint Standoff Weapon) and JASSM missiles (Joint Air-to-Surface Standoff Missile), both of which are in the Finnish Hornets' weapons arsenal. The long-range missile system is the basic set-up for the Defence Forces' long-range strike capability; it is also an important part of our deterrence.

Along with the long-range strike capability the defence system's joint fires capabilities against moving and time-critical mobile targets must be improved as the battlefield is becoming increasingly dynamic. Target acquisition in the manner required for engaging and firing at the targets demands solid sensor-to-shooter integration. A multi-role fighter is typically a link in this chain. When required, a multi-role fighter can independently detect, recognise and designate the target with its on-board sensors, and engage it with its weapon system.

Intelligence, surveillance, target acquisition, and recognition capability

Intelligence, surveillance, target acquisition, and recognition (ISTAR) and C2 systems create the conditions for the air defence and for the manner in which the entire defence system plans the use of military force, schedules the employment of its capabilities and carries out operations. Battlefield surveillance is normally the duty of satellites, surveillance aircraft and UAVs. Since the availability, usability, reach and scheduling of these systems do not always meet the set requirements, multi-role fighters support and complement ISTAR in areas where it is otherwise impossible to compile correctly-timed information. The multi-role fighters' capability to extend intelligence and surveillance deep into the adversary's territory, to jam his sensor, weapon and C2 systems and to engage him with weapons creates increasingly favourable conditions for the creation of a national centre of gravity, rapid independent air operations and supporting the other services' operations.

Even though the performance of the sensor suites of the next decade's fighters will not equal those of dedicated surveillance aircraft, the survivability of fighters and the added safety found in numbers are irreplaceable in a combat environment in which the possibilities for using surveillance aircraft are weak. ISTAR recognition information generated by the fighters' sensors can be utilised in offensive operations as well as in intelligence and surveillance missions. Traditionally, technology suitable for monitoring surface targets on land or at sea has successfully been installed on transport or passenger aircraft alone. Even though, along with the development of technology, intelligence and surveillance tasks have been assigned to UAVs, the UAVs suited to monitoring vast areas resemble manned aircraft as to their physical dimensions. The use of such slow and large manned and unmanned aircraft requires air supremacy, and the adversary's long-range anti-aircraft fire can limit their use.

As a result of digitisation and growing computing power the new generation's imaging capabilities and multi-function radars make it possible for fighter-class aircraft to be used in supplementing the mission-specific ISR aircraft and satellites. On the other hand, the exponentiation of aircraft participating in ISR missions poses new kinds of challenges to information processing. Gathering information from increasingly wider areas, and the ability to rapidly focus the information-gathering capacity on the target area significantly impact the situation picture and, subsequently, operational possibilities. Owing to its penetrability and survivability the fighter may be the only means for information-gathering in contested areas.

The multi-role fighter's capability in intelligence, surveillance or offensive missions can be regarded as the fighter's ability to succeed in penetrating the area of operations, and in achieving a position where it can acquire target information or attack the surface target without exposing itself to the weapon systems protecting the target. Among other things, the pilot's situational awareness, the observability of the aircraft, its EW suite, and its air-to-air combat capability have an effect on its exposure to adversary's weapons employment and survival.

The multi-role fighter's ISTAR capability, and the supporting real-time information processing and data transfer capacity, makes the fighter more effective in an offensive mission. In a dynamic firing situation the Defence Forces' joint fires capability relies on airborne target designation and real-time data processing, in which UAVs and fighters play key roles. According to some estimates approximately 80% of all targets in the modern battlefield are dynamic, i.e. moving or mobile targets whose precise location is unknown beforehand, or targets which can only be detected for a fleeting moment. Such targets include anti-aircraft missile systems, rocket launchers and missile launchers on land and at sea. The ability to find, recognise and position these kinds of targets, and to be able to engage them, will become highlighted in the future. The sensor suite of a modern multi-role fighter is suitable for providing supplementary real-time information about particularly challenging and time-critical targets – such as low observable-targets as well as mobile and moving targets – to the situation picture which is compiled through other means.

Other mission types

Suppression of enemy air defence (SEAD) and electronic warfare are means for creating favourable conditions for the implementation of different air operations and for all of the services' long-range fire into the adversary's air-defended area. Both SEAD and electronic attack (EA) operations epitomise the air forces' special missions which require special technology and knowhow. Typically, mission-specific aircraft, such as the American EA-6B Prowler, the EA-18 G Growler and the German Tornado-ECR, are used in these missions. Their key mission configurations include electronic attack units and anti-radiation missiles. The new capabilities of the multi-role fighters also make them suitable for SEAD missions. This kind of mission is extremely challenging and poses special requirements on the multi-role fighter's sensor suite and armament. It is likely that it will remain a niche capability for a long time to come; all multi-role fighters are not going to be able to successfully complete this task without some limitations.

Even the latest stealth technology will not render an aircraft or missile invisible. Therefore, it is likely that stealth technology-based systems in the future will have to be supported through various means of SEAD and EW. Still, stealth aircraft have the upper hand over traditional aircraft because stealth technology allows them to retain their edge over typical weapon system sensors, and it is easier to protect stealth aircraft by means of EW. Many countries have ongoing projects intended to degrade the effects of different stealth threats, and to deny the use of the adversary's air power in the area of operations. Taken to the extreme, it is about combining integrated air defence capability with a long-range strike capability, i.e. the 'anti-access & area denial' concept, which aims at denying the adversary's basing and manoeuvring in the area of operations by continuously exposing his aircraft and other air assets to offensive fire.

4.4 The role of unmanned aerial vehicles and surface-to-air systems as elements of the defence system in 2030 and beyond

Unmanned aerial vehicle systems

The capabilities of unmanned combat aerial vehicles (UCAV) presently in operational service, or those to be introduced in the near future, do not match those of a modern multi-role fighter. This is because the multi-role fighter's spectra of missions and capability requirements are much more complex. While deep penetration UCAVs are eminently suitable for specialised missions, they are not a realistic solution for replacing the Hornet fleet's capabilities. No such system that could replace its capabilities is in the works. Nonetheless, UCAVs could very well augment the system that eventually replaces the Hornet fleet's capabilities.

Since no sufficiently reliable information pertaining to the costs of procuring, operating and maintaining (personnel included) deep penetration UCAVs is presently available, it is difficult to compare their operating costs with those of fighters. However, judging by their cost structure it can be estimated that the costs of unmanned systems do not significantly differ from those of fighters. Since the main differences between the systems mostly include flight control and cockpit solutions, it would be safe to assume that it would not possible to acquire a significantly greater number of heavy UAV systems than manned fighters with the same amount of money.

While the employment of UAVs alongside and in support of fighter and surveillance aircraft is a sound solution, it requires, at the very least, that the UAVs possess the capability to operate in contested airspace. This is why, at least in the early stages, supplementing the fighter solution should focus on small and cost-effective UAVs which can generate the needed ISTAR information for offensive missions in conditions that allow one's own fighter operations. As the UCAVs' weapon systems are continually evolving, in the future they will be able to be used in higher-risk offensive missions. The development of joint operations comprising multi-role fighters and unmanned vehicles will open up new vistas for the possibilities of implementing multi-role fighter air operations.

Surface-to-air defence

While surface-to-air defence is indeed an important element of Finland's air defence, it cannot replace the versatile capabilities of the Hornet fleet. The role of surface-to-air defence/GBAD is crucial in protecting critical infrastructure and key assets, but it is impossible to establish nationwide defence against air threats with surface-to-air defence alone. There is no compelling need to alter the traditional role balance within the air defence. The goal of surface-to-air defence/GBAD is to protect critical civilian and military targets and, for its part, to guarantee the freedom of operation for the Defence Forces by incurring losses to the adversary's air assets. Operations in the future threat environment will demand a multi-layered surface-to-air defence system, at which time the surface-to-air defence/GBAD systems will be able to sustain high readiness in select areas for extended periods, and participate in creating and sustaining the situation picture. This will make it possible for the multi-role fighters to more flexibly be used in their tasks as a part of the defence system.

A multi-layered, flexible, mobile and long-range surface-to-air defence/GBAD system, for its part, will make it possible to deter and repel a military attack. The surface-to-air defence systems' capability of defeating high-altitude targets will be emphasised in the future because the key trend in air threats involves long-range strikes with ballistic missiles. Long-range strike systems, cruise missiles included, are difficult to defeat because of their low probability of detection, trajectory and high speed. While it is challenging to intercept cruise missiles, it is still possible with the help of several systems. However, ballistic missile defence would require a completely new air defence system, in addition to which a widespread missile attack warning and tracking system would be needed. While the multi-role fighter is not the primary means of meeting the challenges associated with ballistic missile defence, its capabilities can establish deterrence against theatre ballistic missiles (TBM) through its counter-strike capabilities and its ability to destroy the aggressor's missile launch platforms.

> The working group recommends that the capabilities of the Hornet fleet be replaced by a solution based on a multi-role fighter. The need for and the possibilities of procuring unmanned aerial vehicles and other complementary capabilities must be analysed at a later date.

The air defence of mobile and dispersed ground- and maritime units is made up of their 24/7 organic anti-aircraft defence systems, the protection provided by multi-role fighters and other means. The air threat against these units, which primarily consists of attacks carried out by helicopters and aircraft using their own sensors as well as targeting information relayed to other offensive systems by ISR aircraft and UAVs, can for the most part be defeated by short- and medium-range anti-aircraft defence systems. For targets requiring permanent protection it must be possible to prevent the use of the adversary's different drones in the target area. The protection of ground forces requires that the surface-to-air defence/GBAD have mobile and damage-tolerant sensors which can also detect very small targets that operate at low altitudes.

Stand-off PGMs that home in on a set of coordinates and synthetic aperture radars (SAR) pose an entirely new challenge for the air defence. These elements increase the aggressor's options for selecting the favourable conditions, altitudes and sortie profiles to evade defensive fire and improve survival. The growth of the aggressor's operating range calls for increasingly closer air defence and defensive fire integration so as to make use of every opportunity to defeat the aggressor's assets.

The functioning of Finland's air defence relies on a joint, networked command and control system which must enable the flexible use of weapon systems and sensors, in national and multinational operating environments alike. Anti-aircraft defence units must be able to link up with the air defence C2 system. This will facilitate the centralised control of air defence fire, the creation of a situation picture and the implementation of coordinated offensive measures. Anti-aircraft defence systems must also be able to independently create a situation picture and manage fire control so as to provide early warning and target designation to the firing units. Active and passive air defence methods as well as offensive operations must be adapted as a whole to the overall defence system.

4.5 The solution for replacing the capabilities of the Hornet fleet as an element of the overall defence system in 2030 and beyond

The role of the Hornet fleet as the backbone of the air defence system and its improved capabilities, achieved through the MLU2 upgrade, form a versatile whole which must be replaced with a solution based on a multi-role fighter. The future capabilities must be able to carry out tasks associated with monitoring and protecting the territorial integrity of Finland in peacetime as well as tasks associated with defensive and offensive counter-air missions and the Defence Forces' joint effect.

In practice, a multi-role fighter is the only instrument which can effectively carry out the aforementioned missions. A modern multi-role fighter can also support and complement the Defence Forces' intelligence, surveillance and target acquisition capability. This must be taken into consideration in the development of the overall defence system. When the performance requirements for the new multi-role fighter are being determined, one must take into consideration the need for overall defence development.

It would not be cost-effective to replace the capabilities of the Hornet fleet with individual alternative solutions. Furthermore, this would degrade the performance of the overall defence system. The surface-to-air defence/GBAD system, being an element of the integrated air defence, complements the capabilities of a multi-role fighter by incurring losses to the adversary's air assets in protecting critical civilian and military targets, and in guaranteeing the freedom of the Defence Forces' operations.

Unmanned aerial vehicles can augment the multi-role fighter's capabilities in ISTAR-related tasks and, possibly, later as an element of the Defence Forces' joint fires capabilities.

The following table presents the possibilities of replacing the capabilities of the Hornet fleet in a simplified manner. Some of the UAVs' capabilities are based on estimates of technology development.

Capabilities to be replaced	Multi-role fighter	Surface-to-air defence/ GBAD	Unmanned aerial vehicle system
Monitoring and protecting territorial integrity	■		
Defensive counter-air	■	■	
Offensive counter-air	■		
Defence Forces' long-range strike capability	■		
Counter-land missions	■		■
Counter-sea missions	■		■
Command and control, intelligence, surveillance and targeting	■		■

The working group recommends that the capabilities of the Hornet fleet be replaced by a solution based on a multi-role fighter. The need for and the possibilities of procuring unmanned aerial vehicles and other complementary capabilities must be analysed at a later date.

5. The possibilities of extending the Hornet fleet's lifespan

According to the life-cycle plan the Finnish Air Force F/A-18 Hornet will be phased out from 2025 to 2030. The replaced capabilities must be in full operational service in 2030.

There are three major factors that limit the service life of the fleet: structural fatigue, challenges in obtaining system support and the weakening comparative capabilities of the Hornets in relation to the development in our security environment. When the Hornet fleet was procured the projected lifespan of each individual aircraft was 30 years. This has been the guiding principle in acquiring upgrades as well as in planning the use and support of the fleet.

The Defence Forces Logistics Command and the Finnish Air Force have evaluated the possibilities, impacts and costs of extending the lifespan of the Hornet fleet as regards aircraft structures, obtainability of system support and operational capabilities.

Structural fatigue

The Finnish Air Force (FiAF) conducts its exercises and flight operations in training areas which are close to the main operating bases. Short transit times to training areas have made it possible to efficiently utilise the Hornet fleet's available flight hours. In accordance with FiAF mission requirements flight training and exercises include a great deal of air combat manoeuvring which stresses the aircraft's structures. The FiAF has studied, analysed and revised its flight training and exercise syllabi throughout the service history of the Hornet fleet in Finland. The present service life model is based on an adjusted operations profile, which allows for approximately 4 200 flight hours per individual aircraft.

The Hornet fleet's completed and ongoing structural repair projects are optimised to serve the planned use profile. The ongoing structural modification programme was designed on the grounds of a study carried out from 2002 to 2009. Following the structural repairs, on the basis of information received from the international F/A-18 user community and damage inspections, additional structural life-limiting aspects were identified. The most critical points as regards the implementation of repairs were included in the programme in 2014. The structural repair programme for the entire fleet will be completed by the end of 2016.

To extend the lifespan of the Hornet fleet new, augmenting structural modifications would have to be implemented. The extent of needed structural repairs depends on any possible new damage detected, airframe-specific flight hours and the stress caused by flight loads.

Obtainability of system support

System support for the Hornet fleet consists of spares and Line Replacement Units (LRU's), component repair and overhaul, and software support. The technical obsolescence of components and their reduced obtainability create challenges for repair and maintenance, which can, however, be managed. The Hornet contains in all 46 equipment-specific software-driven systems. Eight of them require software updates throughout the service life of the aircraft. The costs of software support keep rising as the other user countries keep phasing out their fleets and, hence, no longer participate in sharing the costs.

The service-life-associated plans of the United States, the main user country of the F/A-18A-D, significantly impact the obtainability of system support. The United States Navy is the most important user of the aircraft type and, according to the present plans, the USN will decommission its F/A-18 C/D models by 2025. The United States Marine Corps will continue using the aircraft until the end of 2031. The USMC and Switzerland are presently upgrading their mission computers so as to be comparable with those in the F/A-18 Super Hornets. Upgrading the mission computer is a long and expensive project. Australia will phase out its F/A-18 A/B aircraft in 2022 and Canada in 2025. In the early 2020s Finland will be solely responsible for the software development of the present mission computer, as a result of which the costs of software updates and support will grow exponentially.

Operational capabilities

The F/A-18 Hornets' comparable operational capabilities stem from the number of aircraft available, the operations environment and the ability to carry out A-A and A-G missions as well as associated ISTAR missions. When it comes to our neighbourhood Norway is replacing its F-16AM/BM fighters with F-35A aircraft during 2019–2025 and Sweden will introduce 70 JAS-39E aircraft during 2023–2027. As part of its armed forces modernisation programme Russia will have upgraded its fighter aircraft by the mid-2020s. The next generation multi-role fighters in our neighbourhood will technologically surpass the Hornet's capabilities. The next generation multi-role fighters are capable of carrying out a variety of missions in the air, on land and at sea, as well as intelligence, even during a single mission if required. The development of Russia's integrated air defence system is yet another change in our operating environment.

The weapon system is the mainstay of the air combat capability. The increasing ranges that missiles will have sets requirements for targeting and self-protection systems. Sensors must be able to detect and relay target information to missiles at greater and greater distances. Correspondingly, self-protection systems must be able to jam and/or prevent missile launches or missile hits in an increasingly efficient manner. The use of stealth technology and the development of sensor technology combined with new A-A missiles and networked C2 environments make it possible for air combat capabilities to advance to an entirely new level. A substantial part of Finnish air defence materiel will become obsolete by the mid-2020s. This missile arsenal must be replenished. The challenge is that without significant system upgrades no new generation A-A missiles can be integrated into the Hornet fleet.

The possibilities, impacts and costs of extending the lifespan

Extending the lifespan of the F/A-18 Hornet into the 2030s, counter to present plans, would translate into added expenses in life-cycle management and increase the cost risks of system support. The relative capabilities of the Hornet fleet will degrade in the 2020s and the most significant degradation falls on its interdiction capability. Extending its structural life and implementing a new, sizeable mid-life upgrade would make it possible to delay the decision to replace the capabilities by five years, at most. The extra costs incurred by service life extension consist of structural repairs, system support and capability upgrades. The need for additional financing for 2018–2022 would amount to EUR 1.2 billion, and the investment decision would have to be taken during 2015–16.

If materialised, a service life extension would also include a sizeable technological risk which relates to any new structural damage findings, the implementation of system integration and software updates as well as the schedules of systems in the product development phase. The already completed upgrades have shown that system upgrades and software development take several years. It is estimated that the capability would be fully available no earlier than eight years after the financial decision is taken. Extending the Hornet fleet's lifespan would not provide additional options for replacing its capabilities. On the contrary, it would limit the options because the production lines of some of the candidates for replacing the capabilities will close.

On the basis of the total analysis, extending the service life of the Hornet fleet would not be a credible or a cost-effective solution.

6. The key findings from fact-finding trips and meetings

One method in gathering information for the preliminary assessment was to get acquainted with the fighter programmes of countries that had been or still are in a similar situation. The working group also arranged a seminar which focused on the key lessons learned from the Hornet procurement. In addition, members of the working group participated in fact-finding missions organised by the Ministry of Defence and the Finnish Air Force.

The working group's fact-finding missions included trips to the Danish MoD's New Fighter Program, the Norwegian MoD's F-35 Program Office and the National Fighter Procurement Secretariat operating within the Canadian Public Works and Government Services. The key findings from the meetings are as follows:

- Replacing the capabilities of fighter aircraft is a major foreign, security and defence policy decision, for which the support of Parliament is indispensable.
- The fighter procurement decision and the evaluation that supports it stem from the state's security and defence strategy so that the capabilities being procured optimally serve the development and maintenance of the state's security. The evaluation comprehensively covers all necessary sectors, ranging from the strategic level to details of combat technology.
- In the countries where the meetings took place the procurements were distinctly organised under one management which was responsible for the overall coordination of the programme. When it comes to programme management it is vital to determine and publicise the rights and responsibilities of decision-making and comply with them – state leadership, Parliament, Government, the Ministry of Defence and the Defence Forces. During the preparatory, planning and implementation phases of the programme close cooperation must be achieved between different administrative branches.
- Key features in the implementation of the programme are openness and traceability, reliability and credibility. Quality assurance (QA) and an all-inclusive project management information system are closely associated with each feature. The importance of third party auditing is central to the credibility and reliability of the programme.
- Determining the evaluation process and compiling the needed data set are critical success factors; it takes time and expertise to properly plan and implement them.
- Open and clear communications play a significant role in the procurement and its preparations. Communication must be timely, proactive and systematic throughout the entire process. The goal of communications is to ensure that the state leadership, political leadership and citizens, at all times, have correct and coherent information on which they can base their opinions about what the fighter defence capability actually means to Finland, and how much it costs to maintain it.
- The purposes of the RFIs and RFQs as well as the schedules of the programme and decision-making must be promulgated among prospective suppliers and decision-makers. This, for its part, guarantees the integrity of commercial preparations for the programme and the fair treatment of suppliers.
- Cost management is a key part of programme management. It underscores the ability to take into account everything that impacts costs as well as a viable cost model. The cost model comprises the total cost and it must be able to itemise the total cost structure. Communication associated with cost estimates must include the message that there are inherent uncertainty factors and that the estimates will become more precise when more information becomes available.
- It is essential to determine the level of industrial participation and security of supply in the early phase of the project so that the grounds and requirements for competitive tendering are defined in a judicially proper sequence.

The guests invited by the working group to the seminar focusing on the key lessons learned from the Hornet procurement included the following persons who held the offices as per their titles at the time of the procurement: Prime Minister Esko Aho, Director General (MoD) Eero Lavonen, Chief of Defence Jan Klenberg, Commanders of the Finnish Air Force Pertti Jokinen and Heikki Nikunen as well as Project Manager Jukka Rautalahti. In addition, MoD and Defence Forces leadership participated in the seminar. The key conclusions of the seminar are as follows:

- There were three great challenges in implementing the Hornet project: geopolitical changes in the global and European context and in Finland's neighbourhood; the Defence Forces' substantial material shortages, among other things, in the Army's spearhead units, and; the state of the government economy.
- Despite the political risks (attitude of the losing candidates), organising a fighter competition between the candidates was not a bad decision.
- In the implementation of the project everyone needed to know which decisions were to be taken by civil servants and which by politicians.
- The Foreign Military Sales process used in the project was a viable arrangement for a small country such as Finland.
- The Finnish Air Force was responsible for evaluating the candidates and preparing the procurement recommendation on technical-commercial grounds.
- The Hornet project's success factors were the following: a flat expert organisation structure, no bureaucratic tiers, each decision-making level had sufficient expertise, well-functioning cooperation and a pragmatic approach to handling issues.
- Communications played a central role in maintaining transparent competition and in committing the candidates.
- In the practical implementation of the project the following factors became emphasised: requirements management, contract management, information management, close teamwork, long-term planning, IT instruments and working conditions, the importance of liaison offices, tacit knowledge and experience as well as the operating culture.
- The assembly of the aircraft and parts manufacturing guaranteed the following capabilities: organic maintenance competence already in place as soon as the aircraft were introduced to service (proficiency must be immediately available) and repair, modification and life-cycle upgrade competencies.

Members of the working group participated in several events organised by the MoD and the FiAF; the topics included, among other things, information-gathering on the potential fighter candidates and the experiences of other countries in their fighters' life-cycle management and procurement programmes. The key conclusions from these events are as follows.

- On the basis of production lines and capability maintenance the probable potential candidates for Finland's multi-role fighter procurement are the Boeing Super Hornet, Dassault Rafale, Eurofighter Typhoon, Lockheed Martin JSF F-35 and the Saab JAS Gripen. Each potential manufacturer already has plans for upgrading the capabilities of its multi-role fighter to meet future requirements. The fact-finding events did not extend to Russian or Chinese fighters; it is therefore impossible to determine their suitability as Finland's future multi-role fighter on the grounds of the preliminary assessment.
- The aforementioned manufacturers have indicated great interest in Finland's forthcoming Hornet-replacement programme.
- The maintenance concepts and possibilities for industrial participation offered by the manufacturers are remarkably dissimilar.
- There are substantial differences in the life-cycle costs as reported by the manufacturers.
- The contract for replacing the capabilities of the Hornet fleet should be signed in 2021 or 2022. Financing the project would probably begin at the same time.
- The manufacturers' opinions as regards participating in competitive tendering differ somewhat from that of those who organised the competitions.
- Should Finland decide to procure a multi-role fighter as the successor of the Hornet fleet, the aircraft's potential and flexibility are the key factors in view of the aircraft remaining operationally viable at least until the 2050s.
- This time the technical evaluation and comparison between aircraft is more challenging than during the Hornet procurement
- Advanced simulator and virtual reality training and exercises (synthetic training exercises) will become an important part of the flight training curriculum.

7. Cooperation with the Finnish industry, taking into consideration security of supply and EU law

7.1 Industrial participation

Industrial participation refers to offsets on defence procurements. In these agreements cooperation between the Finnish defence industry and a foreign supplier is emphasised. Responsibility for the administration of industrial participation is governed by the Ministry of Employment and the Economy and the Finnish Committee on Industrial Participation (FCIP) under the Ministry. The contracting party in industrial participation agreements associated with a procurement contract is the Finnish Ministry of Defence.

Industrial participation in the changing operating environment

Prior to the entry into force of the Act on Public Defence and Security Contracts (1531/2011), and its underlying EU Defence and Security Procurements Directive (2009/81/EC), Parliament required that the Defence Forces' large materiel procurements from abroad include offsets. From the perspective of industrial participation the European operating environment has been in flux. The Defence and Security Procurements Directive is part of wider development in which the goal is to open the European defence market to competition. Following the EU Directive's entry into force, Member States are, in essence, required to put their defence and security contracts out to competition in accordance with the Directive. When it comes to materiel projects implemented by virtue of the Act, industrial participation ('offset' requirement) is not imposed, as a rule, on the supplier. It is only possible to derogate from this principle if the essential security interests of the state so require. In such situations Finland, pursuant to Article 346 of the Treaty on the functioning of the European Union (TFEU), can implement key defence acquisition projects considered necessary for the protection of its essential security interests in derogation of the Defence and Security Procurements Directive, and carry out the procurement in accordance with 'national procedures'. This being the case, these kinds of procurements can still include a requirement for industrial participation. Nevertheless, the contracting authority will always, in advance, assess the need and scope of the possible industrial participation obligation on case-by-case basis. Its justifications shall comply with the provisions of applying Article 346 TFEU, as presented below.

The goals of industrial participation and qualifying transactions

The main goal of industrial participation is to improve the security of supply of systems procured from abroad and promote Finnish research and development. Another objective is to develop other Finnish defence industrial expertise. Secondary objectives include advancing the internationalisation and exports of small and medium-sized industry, transferring new technology to Finnish industry or other significant cooperation between Finnish and foreign firms. Transactions that qualify as industrial participation are defined and prioritised in the Finnish Rules on Industrial Participation concerning defence procurement, with the primary actor in industrial participation being the Finnish defence-related industry. Industrial participation is known as direct industrial participation when it is directly associated with the product to be procured and, respectively, as indirect industrial participation when said cooperation involves the transfer of important technology and knowhow for the state's essential security interests to Finnish defence and security-related industry.

The transaction must involve one of the abovementioned five focus areas specified in more detail in the Rules on Industrial Participation which entered into force on 1 January 2012. Products outside the priority areas, traditional Finnish exports, or continuation of established business relations are not eligible, nor are transactions with an offset value of less than EUR 10 000. Additional requirements include:

- The contractor is instrumental in creating the transaction,
- The transaction significantly benefits Finnish economic interests, and
- The transaction is at least of a similar high technical standard as the procurement of the defence material concerned.

7.2 The logistics concept and industrial participation in replacing the Hornet fleet's capabilities

National security of supply

The state sustains and supports the defence industry associated with its essential security interests as well as its knowhow and services in many ways. The defence establishment, together with the National Emergency Supply Agency, maintains needed defence emergency stockpiles and production capacity for critical consumable wartime materiel such as artillery gunpowder and munitions. Sectors that are critical for military security of supply also include intelligence, surveillance, command and control, target acquisition and recognition as well as offensive operations. The defence establishment makes certain that Finland has sufficient knowhow, technology and production capabilities in the future as well. In a similar fashion it ensures that the capacity for system integration, support and maintenance, and damage repair in emergency conditions is logistically achievable. The defence establishment ensures that Finland will continue to possess the sufficient expertise, technology and defence industrial production in the future as well. It will configure system management and support by utilising strategic partnership arrangements.

The Hornet fleet's logistic concept

The Defence Forces' logistic concept for the F/A-18 fleet is based on an organic ability to provide immediate logistic support for combat units, and on the domestic aviation industry's strong commitment to I/D level maintenance. The concept is based on the national objectives of security of supply. For the most part it was only possible to establish the repair and maintenance capacity in Finland through primary procurement, domestic assembly, system upgrades and associated offset obligations. It is the extensive domestic maintenance and repair capacity which has kept the fleet on the flight line. Having an extensive own maintenance capability has made it possible for FiAF to focus on the problems detected in the fleet; it has also enabled FiAF develop its own modifications or change the maintenance policy if needed.

The Defence Forces Logistics Command is responsible for the contracts, financing and planning associated with the life-cycle support of aircraft. The industrial support concept is based on the national objectives of security of supply, and its capacity has been formed along with the Defence Forces' system procurements. The industry is an integral element of the Finnish Air Force's peacetime and wartime structure. The most important industrial partners are Patria Oyj, INSTA ILS Oy and Finnair Technical Operations.

The logistic support arrangements of FiAF aircraft are supported by foreign services above and beyond such maintenance readiness or contractual support which is not possible or economically feasible to implement in Finland. The foreign support services are based on FMS contracts signed with the United States or direct commercial sales. Furthermore, the international Hornet user community and its many fora offer the possibility of active participation in the implementation and development of logistics. Cooperation with the United States, the international user community and the domestic and foreign aviation industry has made it possible to create and sustain a cost-effective national logistics system capable of independent decision-making.

Logistic concept and industrial participation in the Hornet fleet capabilities replacement project

In view of security of supply, it would behove Finland to acquire as much Hornet capability replacement-associated maintenance, repair and overhaul expertise as is cost-effective, possible and necessary. In this way, through industrial participation, the programme would establish the vital expertise and capacity in the Finnish defence industry required by security of supply. This can be seen as a means to sustain the defence capacity of a small country such as Finland who is dependent on large weapons manufacturers.

The options for the concept of industrial participation must be determined no later than at the time the RFIs are promulgated. Moreover, the requirements for an independent capacity and security of supply must be established from national interests. In this context one must take into account the possibilities of making use of the strategic partnerships signed with the domestic defence industry as well as determine the role of the domestic industry in the preparatory phase of the programme.

7.3 Treaty on the functioning of the European Union, and the application of Article 346 (1)(a) and Article 346 (1)(b)

Article 346 TFEU

The Act on Public Defence and Security Contracts (1531/2011; hereafter Defence and Security Act) shall apply to contracts awarded in the fields of defence and security.

The purpose of the Act is to improve the effectiveness of government spending without undermining the essential security interests of the state, to promote high-quality procurements and to guarantee the non-discriminatory treatment in awarding supply contracts, service contracts and works contracts to businesses and other entities by contracting authorities in public defence and security competitive tendering. The contracting authority must utilise the existing conditions of competition, ensure the equal and non-discriminatory treatment of all tenderers, and operate in accordance with the principles of transparency and proportionality, unless otherwise provided in Article 346 (1)(b) TFEU as regards the state's essential security interests. National procedures as described in Part III of the Act apply to contracts subject to Article 346 (1)(a) TFEU. However, contracts subject to Article 346 (1)(a) TFEU are completely outside the scope of application of the Defence and Security Act.

An EU Member State can sign a defence and security contract in derogation of Article 346 TFEU if it is justifiable with regard to the essential security interests of the state. This kind of a situation may arise, for example, with such defence contracts where the state's essential security interests require special arrangements and requirements on security of supply, and where the rules of the Defence and Security Procurements Directive are not sufficient to safeguard its essential security interests. A corresponding situation may also be in question as regards procurements which are so vital to national sovereignty that the rules of the Directive do not sufficiently safeguard the Member State's essential security interests. This kind of a situation may arise, for example, when some defence equipment or service contract is strategically so critical to its national defence that any dependency on another state, such as an export licence issued by it, could be construed to undermine the state's essential security interests.

When it comes to defence contracts, security of supply may necessitate invoking Article 346 (1)(b) TFEU, especially when the subject matter entails a key defence system which includes detailed requirements concerning maintenance and support. For example, preparedness for access to needed logistics and support services, also in times of conflict, may require that the services to be procured are also available in Finland in normal conditions. For this purpose it may be necessary for the service provider to establish himself in Finland or create the needed capacity and knowhow in the Finnish defence industry.

The Defence Forces' logistics arrangements in emergency conditions may demand that the provider of the key systems' support and maintenance services also prepare for emergency conditions, and assign his services to the Defence Forces in times of crisis. Such requirements may necessitate that the most critical service providers are Finnish citizens. The security-of-supply requirements established to safeguard the national defence capability often result in the realisation that a procurement procedure pursuant to the Defence and Security Procurements Directive does not sufficiently safeguard the essential security interests of the state. Then, the contracting authority has to invoke Article 346 (1)(b) TFEU. For instance, the project of replacing the capabilities of the Hornet fleet is so crucial to national security that the measures associated with logistics, maintenance support and repairs have to be implemented promptly and dependably also in emergency conditions and the risk of there being longer response times is simply not acceptable.

The essential security interests may require that Finland retain sufficient defence industrial capacity regarding any given critical system. Such capacity may entail technology (e.g. information technology) as well as defence equipment production (e.g. certain ammunitions), or associated maintenance, repair, integration and modification capability. The crux of the matter is whether the object of the contract is so vital to national security that any undue dependency on a foreign supplier could undermine our national security.

The provisions of the Defence and Security Act must not be applied to defence and security contracts if Article 346 (1)(a) TFEU applies to the procurement, i.e. the contract will be classified or if the application of the Defence and Security Act would require the disclosure of information which would undermine the essential security interests of the state. Such a situation may arise when the object of the contract entails a key system for the security of the state and if already the tendering process requires access to such information which is so essential to the security of the state that, for security considerations, it can only be given to those tenderers that have been thoroughly vetted and determined capable of handling highly classified information. In practice, the Request for Quotation will then include classified information in categories I-III.

Case-law

The Court of Justice of the European Communities has interpreted Article 346 TFEU in a measured and judicious manner. This is because Article 346 TFEU is intended to apply in situations that involve the core of national autonomy and sovereignty. Still, the Article is an exception to the Treaty and it, such as any other derogation of the Treaty, must be interpreted in a restrictive way. The defence establishment applies a four-step justification model in interpreting Article 346 TFEU. The model must include the following clarifications:

1. An account explaining that the contract pertains to defence materiel which has a military purpose.
2. An account describing which essential security interest of the government of Finland the procurement involves.
3. An account of the measures which are proposed for securing the essential security interests of the government of Finland.
4. An account explaining why it would be impossible to secure the 'essential security interests of Finland' in a less restrictive manner.

Essential security interests of the state, as per Article 346 TFEU, are indeed associated with the procurement to replace the capabilities of the Hornet fleet. These interests cannot be protected in public competitive tendering pursuant to the Defence and Security Act, which is why the procurement will inevitably result in a situation in which classified information must be provided to prospective suppliers. The procurement involves classified information which, if compromised, could cause significant harm to national security. Nevertheless, the provision of such information is a precondition for tenderers to be able to prepare contractually binding tenders and, consequently, supply a product which meets its performance requirements. The prospective candidates will sign Security Agreements at the RFQ-level and the selected tenderer will subsequently sign a contract-specific Security Implementing Agreement. According to the aforementioned justifications the data protection, security-of-supply and other requirements pursuant to the Defence and Security Act are not adequate in protecting the essential security interests of Finland.

Request for Information and charting the market

Procurement legislation does not issue provisions for the preliminary phase of procurement. The contracting authority can chart the potential market by studying the available supply through brochures, advertisements and the suppliers' Internet pages, and by meeting suppliers or promulgating a Request for Information (RFI) among tenderers. The suppliers can market their products and services and present their service supply to the contracting authority. From the standpoint of the contracting authority it is advantageous to remain aware of available services. While active marketing, face-to-face meetings and presentations conducted by suppliers are not prohibited, it behoves the contractual authority to participate in them in a non-discriminatory manner before launching the actual procurement. The acquisition process, implemented under procurement legislation, begins with a tender notice and/or the promulgation of a Request for Quotation (RFQ).

Procurement process

From the outset, it is possible to imagine that the procurement process for replacing the capabilities of the Hornet fleet can be implemented in many ways: through public competitive tendering pursuant to the Defence and Security Act; under Article 346 (1)(a) TFEU; or in accordance with Article 346 (1)(b) TFEU. Should the procurement be completed under the Defence and Security Act in a fully open manner, it would result in a strictly regulated and binding contractual process, built on the concepts of full transparency, fairness, non-discrimination, proportionality and the promotion of competition. Because of the abovementioned reasons, this alternative will probably not be feasible. Establishing a strategic capability imposes its own, absolute requirements which, on a case-by-case basis and through justifications, can be prioritised over commercial-legal constraints.

If the procurement is completed pursuant to Article 346 (1)(b) TFEU, it will primarily be done under competitive tendering. A sufficient number of tenders must be requested to ensure enough competition in view of the scope and nature of the procurement. The Defence and Security Act does not provide for the details of procurements where Part III of the Act applies (national procedures). However, at the discretion of the contracting authority, the procurement can follow the Defence and Security Act's EU procurement procedures. The contracting authority must, in adequate detail, describe the procedure which applies, either in the RFQ or in the tender notice. Competitive tendering under Article 346 (1)(b) TFEU can also be implemented as a government-to-government contract in such a manner where some tenderer/tenderers will follow the framework of FMS rules. Such a principle, which is somewhat discriminatory

per se, is probably permissible under the national procedures described in Part III of the Defence and Security Act.

Should Article 346 (1)(a) TFEU apply, i.e. Section 7(1) of the Defence and Security Act, the procurement will completely remain outside of the scope of application of the Act. In that case, the procurement can be implemented as best as possible, at the discretion of the contracting authority. Even in this case, in practice, the procurement will be carried out through exhaustive competitive tendering, and by following the steps of a regular procurement process and its phases. Neither a government-to-government contract nor a partial application of FMS rules in the procurement poses any problems.

In reality, both Article 346 (1)(a) and Article 346 (1)(b) will most likely have to be applied in the procurement. Furthermore, a derogation of the Defence and Security Act as regards contracts between governments, at least the FMS procedure which clearly permits it, will be a central element in the procurement. These exemptions also permit the inclusion of industrial participation in the contract, should it be considered appropriate.

7.4 The possibilities of securing Finland's military security of supply in the context of EU law

The EU's legal order

The aforementioned exemption, Article 346 TFEU, means that the scope of interpretation of European law is broad in the context of the EU's legal order and, hence, the legal competence and the means available for the EU Commission to intervene in the Member States' action limiting the market are quite overarching and versatile. During the past 20 years the prevailing case-law advancing the Single Market and, subsequently, EU legislation have resulted in there being narrow chances of success in invoking Article 346 TFEU-exemption without presenting concrete, fact-based evidence. When it comes to offsets it is only possible to derogate from the provisions of the Defence and Security Act if one of the grounds for exemption applies in the procurement, or if the Member State invokes the 'security exemption' permitted by Article 346 TFEU on the basis of essential security interests of the state. This also includes an exemption in a government-to-government contract. The Directive takes the security interests of EU countries into consideration; the objective is for the security exemption in Article 346 TFEU to be applied as seldom as possible.

PDefence industrial participation – offsets in the headwind of internal market legislation

When it comes to offsets, many changes have occurred within the past 20 years. In 1992, when the previous fighter procurement was topical, there was no information regarding the basic tenets of internal market legislation as one of the objectives of offsets was the generation of significant benefits for Finland's economic interests. It is no longer possible to argue for offsets with economic or employment considerations. Consequently, the Offset Rules of 1992 are no longer a guiding principle in the present environment, due to the obligations of our EU membership.

In the 2013 joint memorandum of the Ministry of the Economy and Employment and the Ministry of Defence concerning offsets it is stated that direct industrial participation is still important for the defence system because it has established the capability for life-cycle support, damage repairs and maintenance and, at the same time, the life-cycle support of systems procured for domestic industrial integration. The Rules on industrial participation in defence equipment procurement in Finland, published in 2012, underscore the strategic importance of both direct and indirect industrial participation for Finland.

Offset rules and their application in some reference countries

In order to paint a picture of the possibilities for guaranteeing security of supply in the context of EU law, the working group studied the offset rules and their application in other EU countries. Denmark and the Netherlands were selected as reference countries.

Denmark's National Defence Industrial Strategy includes the basic idea that it is not possible to sustain any given level of performance and quality without industrial participation. The strategy was drafted with the requirements of EU law in mind. It conveys the following chain of thought:

1. Denmark's sovereignty and security is Denmark's own responsibility.
2. This does not merely put increasing demands on the capability of the Danish Armed Forces, but also on the quality of Danish defence industry.
3. As a small country, Denmark is dependent on the procurement of competitive defence equipment from abroad. In this context the European and North American markets are brought forward, which indicates clear political connection to the 'West'.
4. However, it is necessary for Denmark's defence sector to have certain competitive industrial competencies and capabilities which are particularly important for Denmark's defence policy interests.
5. As regards the previous point, the Danish defence industry is expected to be competitive and supply high-quality equipment that can easily be incorporated in Denmark's international military operations.

The logic described above prepares for the fact that the 'security exemption' in Article 346 TFEU can legitimately be included in the implementation of the national strategy when the essential defence interests are defined at the national level. This is directly linked with which kinds of RFQs it is possible to promulgate as regards public procurements.

The Defence Industrial Strategy of the Netherlands links together the Ministry of Defence, the national defence and security industry as well as information-creating institutions such as research institutes and academies. The strategy emphasises that, in practice, the industries of smaller EU Member States must get access to international defence supply chains. The following real arguments making a case for industrial participation can be identified in the strategy:

1. National security is a responsibility of the government. In other words, every nation must defend itself and independently determine its security policy interests.
2. The economic crisis has prompted the West to steadily reduce defence budgets. As a result, cooperation, both domestic and international, in the defence industry is necessary in practice.
3. The defence market as it stands is neither open nor transparent.
4. The market environment is highly dynamic, which concerns technological advances as well as regulatory changes.
5. The market is greatly fragmented and in Europe there is some overlap in production.

Guaranteeing security of supply

According to the concept of comprehensive defence, defending the country requires the effective utilisation of national resources, both in intersectoral cooperation and civilian cooperation. This impacts the interpretation of Article 346 TFEU in the sense that a description and clarification of national security thinking is a part of the process which can prove the suitability of a derogation of the Treaty, owing to national security interests. In the interpretation of the Article Member State-specific national interests and security policy solutions will be taken into consideration; when it comes to Finland these, first and foremost, include military non-alignment and the concept of comprehensive defence.

For the sake of security of supply and military defence the 'critical infrastructure' which must be secured in all conditions has to be defined. It would be beneficial for Finland to draw up a uniform defence industrial strategy, á la Denmark and the Netherlands, which would take into account inter alia the requirements for security of supply from the national perspective, the special conditions and the focus of procurements in the defence of Finland as well as the requirement of sustaining the international competitiveness of Finland's defence industry. The eventual strategy should be supplemented with distinct guidelines regarding industrial participation.

Using Article 346 TFEU as one justification in the national defence strategy that guarantees security of supply can be seen to embody a proactive law approach, which also improves legal certainty. An official defence industrial strategy can help prepare for any future judicial adjudication situations so that the state can present a clear-cut strategic policy to the market and EU actors alike.

8. Organising the potential fighter procurement in the defence establishment

8.1 A strategic capability project

The role of political decision-making becomes highlighted in strategic projects and ancillary sizeable procurements. Furthermore, the decisions call for wide political consensus. Such projects include, at least, the replacement of the Hornet fleet's capabilities as part of the comprehensive air power solution and the Squadron 2020 project as part of the comprehensive solution in which the Navy's ageing combat vessels being phased out need to be replaced.

Strategic projects have the following characteristics:

- Defence policy impacts both at home and abroad,
- Crucial effect on our defence system,
- Exceptionally large cost impact,
- Widespread interest both at home and abroad, and
- Possibly being of great importance to the domestic industry.

8.2 Grounds for organising the strategic project

The working group familiarised itself with the ongoing fighter programmes in Denmark, Norway and Canada. One of the key issues considered by said programmes was organising the strategic project under one management. In Denmark and Norway the projects were organised under Program Offices which directly managed the fighter projects and their implementation. The Program Offices reported to their respective defence ministries. Unlike Finland, in Denmark and Norway the Defence Command/Staff is organised as part of the defence ministry which, for its part, has made it possible to organise the projects at an exceptionally high level.

In Finland the Ministry of Defence and Defence Command Finland are distinct managing authorities for whom legislation and other norms set their respective tasks and competences. This is why the model adopted by Norway or Denmark cannot be directly applied in Finland. Rather, the seamless planning and implementation of the project must be achieved through a different solution.

When it comes to the development of defence it has been determined that the MoD will establish the preconditions for the development of defence while the Defence Forces remains responsible for developing the military capabilities of the defence system. Cooperation between the MoD and Defence Command Finland ensures that the administrative branch's materiel policy guidance and the material, personnel, financial, real estate, environmental, information management and legislative impacts arising from procurements will comprehensively be taken into account in a timely fashion, already in the planning phases of projects.

The Ministry of Defence is responsible for facilitating the conditions for procurements as part of the defence establishment's resource planning. The MoD manages the materiel policy of the administrative branch, steers the preparations for key defence materiel acquisition decisions and remains responsible for the defence policy guidance of strategic projects. Moreover, the MoD is responsible for intersectoral preparations and the mutual exchange of information. With regard to development the MoD's materiel policy guidance extends from the development programme level to actual procurements.

Defence Command Finland guides and coordinates the Defence Forces' planning and development as well as procurement and materiel functions in line with the set guidelines and goals. The creation and maintenance of capabilities is achieved through projects included in development programmes. Such procurement activity is one of the Defence Forces' core functions. Whereas the Defence Forces' development programmes determine overall capability development, the sought capabilities are achieved through projects. Programmes are normally organised as projects. Procurement, for its part, means actions with the intent to purchase materiel or services.

8.3 The steering groups that manage the MoD's programmes and procurements

The strategic capabilities steering group reports to the Permanent Secretary of the MoD. Its task is to consider and coordinate foreign policy, state economy and trade economy questions when establishing the Defence Forces' strategic capabilities.

Materiel policy guidance in programmes and procurements is carried out through the defence establishment's steering group of materiel policy and the commercial steering group of defence administration.

The steering group of materiel policy, appointed by the MoD, prepares materiel policy related decision-making, steers the implementation of materiel policy and provides expert assistance to the top leadership in issues related to materiel policy. The group also provides guidelines and leads further action on the basis of material given to it, and on the grounds of additional information handled in meetings. The goal of guidelines and guidance is to improve effectiveness and networking in materiel policy planning.

The decisions on acquisition and selling that fall within the remit of the Ministry of Defence and other commercially significant matters are prepared in the commercial steering group of defence administration. The guidelines of the steering group (e.g. in favour, not in favour, discontinue, table, conditional endorsement) are taken into consideration during subsequent preparations and decision-making. The commercial steering group provides guidelines and directs further action on the basis of material given to it, and on the grounds of reports and additional information handled in meetings. The group guides the preparations of a capability project from the drafting of the RFI phase or, at the very latest, from the RFQ phase onwards. The steering group handles all topics that entail commercial preparations prior to presenting them for decision-making. The group provides legal guidance to capability projects, especially, as regards the application of Article 346 (1)(b) TFEU. The commercial steering group also monitors the cost-effective achievement of capability projects.

International materiel cooperation with the governments of the manufacturing countries of all potential candidates will play a central role. Just as in previous large programmes this, for its part, increases the role of the MoD in project guidance.

8.4 Organising the replacement of the capabilities of the Hornet fleet in the defence establishment

A precondition for a successful strategic programme involves correctly-timed MoD materiel policy guidance and the creation of financial requisites as well as seamless cooperation between the MoD and Finnish Defence Forces, a joint situation picture and communications as well as the unrestricted exchange of information between the different tiers of the project. When it comes to planning and implementing a strategic programme the role of the actors outside the defence establishment must also be taken into account – more so than in normal projects. The key actors include the state leadership, the Government, Parliament, the domestic industry and the media. In addition to the MoD the participation of, at least, the Ministry of Finance, the Ministry for Foreign Affairs and the Ministry of the Economy and Employment in the planning and implementation of the programme is important.

Replacing the capabilities of the Hornet fleet is an entirety which encompasses MoD materiel policy guidance and the implementation of the actual materiel programme. Existing project structures do not alone optimally support the implementation of this programme which is why, in order to replace the capabilities of the Hornet fleet, the defence establishment must create an organisation which can concentrate on the planning and implementation of the replacement project.

Hereafter, the replacement of the Hornet fleet's capabilities is known as the HX programme. By using the HX programme-designation it will be ensured that the procurement and project-specific concepts defined in the Defence Forces' set of norms remain unambiguous. The HX programme refers to the planning and implementation of the procurement under the Defence Forces' leadership.

The grounds for the HX programme and organising the possible fighter procurement are as follows:

- Decisions will be taken in accordance with established competencies,
- Activities will follow the existing rules of procedure, norms and regulations of the defence establishment,
- When needed, programme, procurement and project plans will specify the procedures required by activities, and
- Best practices and sound professionalism will be used in procurement and project activities.

It is recommended that an HX Programme Steering Group (which can be the already existing steering group at the Barracks Square[2], augmented with the Commander of FiAF and the HX Programme Coordinator) be established as an instrument of the defence establishment's HX programme guidance. Its task is to coordinate the views of the Mod and the Defence Forces and the shared situation picture during the different phases of the project, and provide guidance and support for project planning and implementation. Its composition should be as follows:

- Director General, Resource Policy Dep't (chair)
- Director General, Defence Policy Dep't
- Deputy Chief of Staff, Strategy, Defence Forces
- Deputy Chief of Staff, Logistics and Armaments, Defence Forces
- Commander, Finnish Air Force
- HX Programme Coordinator, (secretary)

2 The physical location of the Ministry of Defence and Defence Command Finland

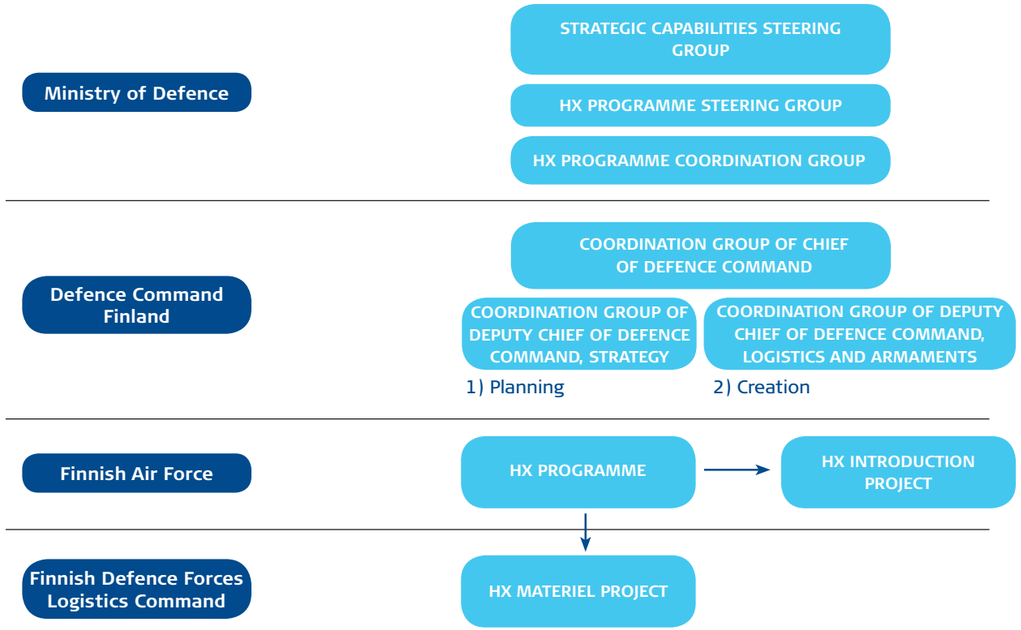
In order to be able to direct the HX programme with sufficient expertise the steering group must remain sufficiently small. Its members must be persons that are directly involved with managing the planning and implementation process of the strategic project. The steering group is not an instrument of informing the leadership; for this purpose, other steering groups must be used.

It is recommended that an HX Programme Coordination Group be established under the HX steering group. Its task is to coordinate the planning, preparations and implementation of the HX programme, and to maintain a shared situation picture.

The HX Programme Coordination Group will coordinate intersectoral cooperation and support the commercial steering group of the defence administration in providing guidance for the preparations. The coordination group prepares the HX programme plan. This plan determines the goals, tasks, responsibilities and modes of operation of the programme, and defines the capability project's materiel and defence policy grounds (= materiel and defence policy requirements). The programme plan also establishes how the HX programme situation picture, communications and Quality Assurance (QA) supporting the project as well as cost management and risk management will be implemented. The coordination group comprises the following members:

- HX Programme Coordinator (chair), MoD
- Representative from the MoD's Materiel Unit
- Representative from Defence Command Finland (as required)

Bodies participating in the HX programme



Finnish Air Force and Finnish Defence Forces Logistics Command steering groups are not shown in this figure

- Programme Manager, Air Force Command
- Project Manager, Finnish Defence Forces Logistics Command
- HX Communications Manager
- HX Programme Secretary, MoD

In order to prepare the guidance for the HX programme at MoD-level a separate unit (an 'HX Programme Secretariat') shall be established. The secretariat will report to the Director General, Resource Policy Department (MoD). Its task is to prepare: the materiel policy guidance, the implementation of intersectoral preparations, the planning of defence industrial participation, communications, the required QA activities, risk management and cooperation outside the defence establishment. The HX Programme Coordinator shall lead the secretariat. The proposed overall organisation is presented in the figure below.

Other than this, the implementation of and guidance for replacing the capabilities of the Hornet fleet will be carried out in accordance with the regular norms of the Defence Forces.

Defence Command Finland guides the programme by establishing the defence system's functional capability and performance requirements, by defining the role of the replacing capability as part of the operational use of units and by allocating the resources for planning, deadlines included. The Deputy Chief of Staff, Strategy remains responsible for planning until the project reaches its capability-creation phase. The Deputy Chief of Staff, Logistics and Armaments is responsible for planning and executing the capability-creation phase.

The Defence Forces' Strategic Plan includes the functional capability and performance requirements for the air defence combat system, the joint combat system and other defence sub-systems. They are used as grounds for planning. The Deputy Chief of Staff, Operations and the Commander of the Finnish Air Force approve the specified requirements used in the Air Force Development Plan. The requirements will be further honed in project planning, and will become the requirements for units and systems. Technical system requirements will be set in accordance with the process of capability-creation.

The Commander of FiAF, being responsible for developing the Air Force, will set up the HX programme. The Programme Manager and his organisation, tasks included, will be determined at that time. The line of command between the Commander of FiAF and the Programme Manager must be as short and clear as possible.

The procurement consists of introduction into service and a materiel project. Air Force Command is responsible for the introduction project and the Defence Forces Logistics Command for the materiel project. These projects include sub-projects and work phases which, together, achieve the materialisation of the programme. Development programme guidance as well as procurement and project management will be carried out in accordance with the prevailing norms and regulations.

The key grounds for taking a decision on the HX programme are security and defence policy, operational capabilities, life-cycle costs and security of supply which also includes industrial participation. The planning responsibilities for these decision-making grounds shall be assigned in the HX programme plan.

Owing to the impact of strategic projects their decision-making processes also differ from those of other acquisitions.

9. Research needs associated with the project

In order to identify the future procurement related-needs for conducting research outside of the defence establishment the working group charted the completed and ongoing research projects on the project's subject matter. The focus of this endeavour was on the research projects of the Finnish Defence Research Agency, research findings and theses of the Finnish National Defence University, and research conducted by Finns at foreign academies. On the basis of charting the research the working group commissioned two research projects, deemed urgent, and one study to serve the implementation of the project.

The first research project addresses the future significance of stealth technology in view of the evolution of possible counter-technologies and counter-measures. It analyses the stealth performance of 4++ and 5th generation fighters vs spatially distributed radar systems that may use multiple frequencies in an agile manner. The salient research question involves characterising differences in 4++ and 5th generation multi-role fighters' detectability from the perspective of an advanced radar system. The study will be completed in 2015.

The second research project addressed safeguarding Finland's military security of supply in the context of European law on materiel acquisitions. The study was completed in April, 2015. It analysed the legal base and possible solutions for safeguarding security of supply. In addition, the study assessed Finland's leeway in this matter within the constraints of EU law. The study was carried out by Juha Rautio, Professor of European law at the Aalto University. The study focused on the following topics:

1. Possibilities of also safeguarding military security of supply through direct and indirect defence industrial participation; the offset rules of certain reference countries and their application – legal analysis,
2. Evaluation of the previous fighter procurement's offset rules in light of modern legislation; what has changed and what is the impact of the new framework, and
3. Article 346 TFEU and the compelling reasons for derogating from EU law because of the essential security interests of the state: What could these reasons be in Finland's security environment?

The final product of this study is a set of recommendations for preparations in defence acquisitions, especially from the perspective of security of supply. The key results of the study are presented in sub-chapter 8.4.

The working group also commissioned a study of the forthcoming project's life-cycle costs, including a comparison of the life-cycle costs of different options. Life-cycle costs typically include all costs associated with the operation of any given capabilities or a system, ranging from investments to operations. There are many models by which costs can be calculated. Different countries calculate costs in their own way and from their own standpoint. This makes it challenging to come up with a uniform calculation model and to estimate and compare the life-cycle costs of different alternatives.

The purpose of this study is to create a suitable calculation model for Finland which can reliably evaluate the life-cycle costs of the future project, and compare the life-cycle costs of different options. The model will also be validated by calculating the life-cycle costs of the Hornet fleet as reference material in such a manner that the results correspond with the true and known costs of the Hornet fleet. The study will be implemented under the leadership of the Finnish Defence Forces Logistics Command. The calculation model, i.e. the result of the study, will be completed by the autumn of 2015.

10. The procurement process and the schedule

Topics to be included in Requests for Information

The goal of the HX programme is to replace the capabilities of the Hornet fleet in the most cost-effective manner to Finland's state economy. The capability which will be created through the procurement must be viable for at least 30 years, and it must be constantly sustained and developed. Materiel procurements will create the required material capabilities for normal and emergency conditions, and security of supply.

In conjunction with initiating the programme a materiel project will also be launched which, on the basis of established capability requirements and concepts, commences the drafting of Requests for Information (RFI). During the RFI phase the requirements and the concepts will be further adjusted. By the time the Requests for Quotation (RFQ) are promulgated the requirements and concepts will be frozen except for minor details which can be specified up until signing the procurement contract.

RFIs can be sent directly to manufacturers or to the authorities administering the defence industries in their countries. When it comes to the HX programme the air vehicle and its systems comprise the products of several companies. In order to guarantee that the complete weapon system will be addressed it is better to send the RFIs to the governments of manufacturing countries. This makes it possible to receive comprehensive support and a sufficiently all-inclusive response regarding the entire system. RFIs associated with the aircraft's sub-systems can be sent directly to weapon or system manufacturers.

Provisionally, the procurement process, from the RFIs to signing the contract, includes the following steps:

1. Drafting the RFIs.
2. Sending the RFIs to the governments of manufacturing countries or directly to suppliers.
3. Providing clarifications to the RFI's, if needed.
4. Receiving the responses to the RFIs.
5. Fine-tuning the concepts and requirements.
6. Carrying out tests, test flights, simulations and analyses that supplement the RFIs.
7. Planning the RFQ phase and establishing the RFQ entities.
8. Creating the grounds for comparison.
9. Drafting the RFQs.
10. Promulgating the RFQs.
11. Providing clarifications to the RFI's, if needed.
12. Receiving the tenders.
13. Analysing the tenders.
14. Evaluations at home and abroad.
15. Contractual negotiations.
16. Preparing the final selection and decision-making.
17. Final decision.
18. Providing feedback to all tenderers.
19. Signing the procurement contracts.

The planned content of the RFI is as follows:

- Introduction: The goals of the programme, schedule, phases as well as the commercial and contractual principles of the procurement process.
- Concepts: A description in coherent terminology of the present modes of operation as well as a presentation of ideas for future possibilities.

The objective is to provide the correct idea to each tenderer:

- Where and how do we operate at present.
- How do we wish to operate in the future.
- What constraints do we have for future options.

so that the tenderers can propose:

- How should one operate in different sectors in the future.
- What functionalities and systems are worth preserving and developing, or replacing.

- Capability requirements: The key requirements and, possibly, those still in the process of being completed.
- System requirements: Only in major detail and to the extent that they create critical constraints to the completion of the procurement.
- System architecture: A preliminary system architecture description.
  - The functional and physical elements to be included in the system.
  - The functional and physical elements that belong (or need to be developed) to this programme, or the functional and physical elements that belong to other programmes.
- Requirement management and selection criteria: A description of the Defence Forces' requirement management regime and requirement hierarchy; capability requirements, functional capability and system requirements as well as commercial and contractual requirements. The tenderers will be given information on how the information received through RFI and RFQs is handled, and how the final selection will be made on the grounds of said information and evaluations. The actual requirements are not included in this item. Rather, the point is to illustrate the process of requirement management as a whole.
- The requested information: An itemised list of the information which must be included in the response to the RFI. As regards concept descriptions, the tenderers are asked to provide feedback and recommendations for improvements.
- Release issues: The tenderers are asked to provide an account of the issues that require release requests in order to make it possible to proceed to the RFQ phase.

Programme schedule

The completed fighter procurement schedules of other countries as well as the completed schedules of the Defence Forces' previous aircraft procurements were utilised in creating the programme schedule. As part of the preliminary process the RFIs are presently being drafted. The goal is to be able to send the RFIs in February 2016. After that, the procurement will proceed as follows.

- Responses to RFIs 10/2016
- Promulgation of RFQs 02/2018
- Tenders 02/2019
- Contracts 02/2021

The HX programme must be initiated no later than the autumn of 2015. The final selection, i.e. the procurement decision, must be made in such a timetable that the preconditions for signing the procurement contract are in place by the end of 2020. The following figure illustrates the rough schedule of the programme.

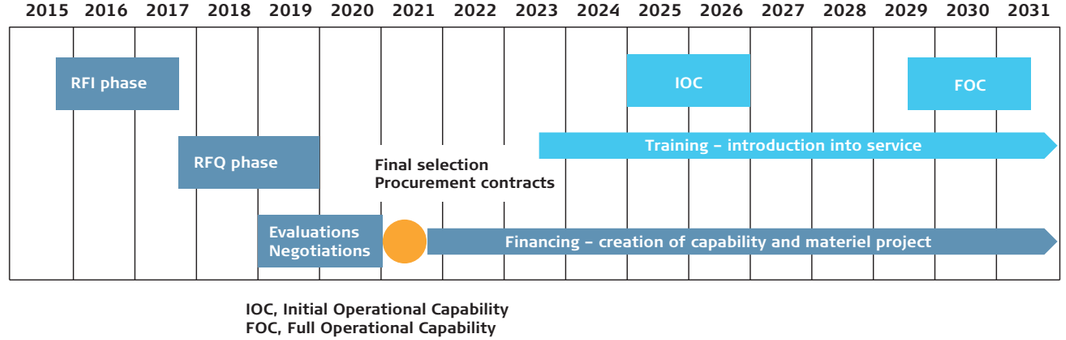


Figure: HX programme schedule

11. The recommendations of the working group

EOn the basis of the preliminary assessment the working group issues the following recommendations for the implementation of the procurement:

1. Adhere to the Hornet fleet's original service life because, as per the preliminary assessment, there are no grounds for extending its service life.
2. Replace the Hornet's capabilities with a solution based on a multi-role fighter.
3. Launch the HX programme no later than the autumn of 2015.
4. Set up an HX Steering Group, an HX Programme Coordination Group and an HX Programme Secretariat, and establish their tasks, competencies and compositions.
5. Implement the acquisition process in a normal manner: promulgate the Request for Information in 2016, and the Request for Quotation during 2017–2018.
6. Make use of the derogation of the EU Defence and Security Procurements Directive, permitted by Article 346 TFEU, because the procurement processes pursuant to the Directive are not suitable for this acquisition.
7. Draw up a defence industrial strategy and establish the project-related requirements for an independent capacity and security of supply.
8. Establish the need and possibilities for external auditing (quality assurance, QA).

Terms and definitions

Protection of Finland's territorial integrity	The use of force or other means adopted by the Defence Forces and other territorial surveillance authorities to prevent or repel territorial violations.
Surveillance of Finland's territorial integrity	The activity of the territorial surveillance authorities which is carried out primarily at Finland's borders to prevent, expose and investigate territorial offences and territorial violations.
Life-cycle	The timespan which begins when the requirement for a system or an item is initially determined until the time when said system is decommissioned.
Programme	The functional entirety through which the capability of a unit or system is created and/or supported, and for which the content, objectives and resources are explicitly defined.
Security of supply	The capability to sustain such vital economic functions of society which are critical to the living conditions of the population, the functioning and security of society and safeguarding the supply of materiel to national defence in the event of severe disruptions and emergency conditions.
Offensive counter-air	Air operations intended to destroy, disrupt, or limit the adversary's air power as close to its source as possible.
Control of the air	The actions and preconditions which, for their part, guarantee freedom of action to one's own operations by limiting the adversary's air power and air defence capabilities, or by nullifying his operational energy. Sufficient control of the air is a precondition for the success of land, sea and air operations. Offensive counter-air operations are typically used to gain control of the air.
Air supremacy	The degree of air superiority wherein the opposing air force is incapable of effective interference.
Air operation	Such military measures or missions which are primarily carried out using aircraft to attain the goals of a battle or a military operation.
Air defence	All actions of the Defence Forces and the other authorities implemented in monitoring Finland's airspace and adjacent areas, protecting the integrity of its airspace, protecting society's vital functions from air attacks, wearing down the airborne aggressor and repulsing all air attacks. All military services, the Border Guard and the civilian authorities participate in air defence.
Air defence system	An integrated system in which all air defence sensors (radars, visual air surveillance and other technical methods) and weapon systems (anti-aircraft guns and missiles, and fighters) are placed under one centralised command and control system.
Air power	The ability to project force from the air and space to impact the actions of humans and to shape events.
Unmanned aerial vehicle	Military unmanned aerial vehicles are used, for example, in intelligence, surveillance, target acquisition and recognition (ISTAR).
Multi-role fighter	A combat aircraft which can perform both air-to-air and air-to-ground missions. A multi-role fighter's tasks can be changed, as required by the situation, between sorties or, when necessary, during a sortie. Air operations can flexibly be formed by using multi-role fighters.
Defensive counter-air	Includes the measures designed to detect and recognise the forces attempting to attack or penetrate through friendly airspace, take the fight to them and destroy or otherwise incapacitate them.
The Defence Forces' joint fires	The optimum use of capabilities led by Defence Command Finland in which the effects of the units and systems available are targeted against the critical systems and targets with regards to the adversary's warfighting capabilities to accomplish the objectives of the operation.
Capability	Comprises the plans and exercised operational and functional routines of a system and/or unit, sufficient and competent personnel, required materiel, required infrastructure and the bases and installations provided by the Defence Forces or society.
Request for Quotation	A document prepared by the buyer which details the target and content of the procurement, provides instructions on preparing the tender and defines the minimum requirements for the tenderer's aptitude and the product to be procured as well as the selection and evaluation criteria, and the other terms of the procurement.
Request for Information	A document prepared by the buyer seeking information on which suppliers are capable of responding to Requests for Quotation, what kinds of system concepts or systems can create the intended capabilities, and what are the constraints for the implementation of the procurement.
Counter-land missions	Air and space operations against the adversary's land-based capabilities.
Counter-sea missions	Air and space operations against the adversary's sea-based capabilities.