



OUTLOOK

Research and development plan
2021–2024

Part 1

FFI Norwegian Defence
Research Establishment

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How FFI thinks and works

FFI is made up of 740 people working towards one goal – to use knowledge and technology to strengthen Norway’s defence capabilities. Outlook provides a brief outline of what we will be doing in the next four years to reach that goal.

For many people, including many in the defence sector, life behind the FFI fences at Kjeller and Horten is an unknown and alien world. What do they all really do in there?

In the first part of Outlook, you can read about this world from the FFI’s perspective. What challenges do we think that the defence sector and Total Defence will face in the coming years? What are the most important technology trends that will affect the Armed Forces’ operations, and what kind of security policy and economic landscape will the Armed Forces have to operate in?

In the final part, we will take a closer look at our research response. How will FFI help to tackle these challenges? What kind of research and development (R&D) is needed? This will show you what we will be doing to achieve our seven new performance goals.

Knowledge and technology is power

When we look at new knowledge or a new technology, there are two questions that we have to answer: 1. How can this be useful for the Armed Forces or Total Defence? 2. How can we defend ourselves if an enemy uses the same technology?

The international security policy landscape is dominated by power shifts and superpower rivalries. Superpowers are increasingly competing to be the leaders in technologies that could give them a strategic advantage. There is a visible need to amass technological knowledge and use it as a tool for geopolitical power. The biggest motivator behind this trend is the growth of China as a technological superpower.

NATO has defined eight groundbreaking technologies (Emerging and Disruptive Technologies – also known as EDTs). Developments in these technologies are considered to be a very important part of enabling NATO to maintain its technological lead. The EDTs are thereby also absolutely central to FFI’s future operations, and form the basis of the R&D plan.

Here in Norway, FFI is responsible for much of the R&D work and virtually all technological R&D in the defence sector. This gives us a very important role in the future, both in terms of Norway’s efforts to strengthen international security policy collaboration, and in terms of developing the national technology and industry base.

Research and development for national security

FFI aims to strengthen the Norwegian Armed Forces’ operational capability, cooperation with allies and Total Defence capability through R&D work and utilisation of developments in technology. If this is to succeed in a long-term perspective, deep insight and understanding are required. In the short-term, the same insight and understanding can be used to make the Armed Forces that we have the best it can be at all times.

FFI mainly performs applied R&D. This means that we work closely with users to turn new knowledge and theory into real new technological solutions that the Armed Forces can apply in operations. This work tends to be based on extensive international cooperation, mainly with NATO and close allies. Innovation, trials and testing are a standard part of what we call R&D. In this respect, our operations are not as far away from practical benefit and use than one might think.

We test and develop technology in locations where the Armed Forces have a presence

FFI is the link between the Armed Forces, scientific teams and the companies that manufacture equipment used by the Armed Forces. In this way, we help the Armed Forces to adopt new technology more quickly, and we contribute to technology development and value creation. Solutions that have been developed and tested by FFI go on to become products that create new jobs in the Norwegian defence industry.

FFI aims to strengthen partnerships between the Armed Forces

and industry in the years ahead, in order to help the Armed Forces adopt the new technology. FFI's new innovation centre, ICE worx, will assume a key role in this work.

Norwegian niche products

But how can a small research institute in a small country keep up with civil technology giants and rapid international development? FFI cannot be a world leader in every area, but we intend to be one in carefully selected fields of technology. If it is to be relevant to the Armed Forces, FFI has to be sensible and efficient in the way it prioritises resources. We will specialise in a range of subjects. At the same time, we will concentrate on tasks that may be difficult for other parties in Norway to tackle, where we can make a real difference for the Armed Forces. We will help Norway to develop technological systems that make us an attractive partner for our allies, which will also give us access to their technology and research communities.

Missile development, from Terne to Penguin and now the Naval Strike Missile (NSM) and Joint Strike Missile (JSM) is one example of a Norwegian “niche product” in which FFI has played a key role for several decades. NSM and JSM were purchased by the United States and other allies because they are the best missiles produced in the West. This helped to share the burden between NATO members and improved the operational capability of the alliance.

We have to take a fresh look at national security

As well as developing and advising on technology, our versatile specialist teams of economists, political scientists and systems developers make us an important partner in the Armed Forces' long-term planning work.

Our collective competence will also benefit society as a whole. New threats and instruments affect various sectors. Every sector of society could be the target of sabotage, crime or the use of force or pressure. In many areas, there is no longer a clear distinction between state security and societal security.

This also affects FFI's role. Solutions and technology, such as sensor technology used by the Armed Forces must be used to improve societal security and preparedness wherever possible. Civil-military cooperation must be strengthened in order to re-

spond to challenges that are still developing and are becoming more complex. In the future, we will be a more visible adviser in this area, and we will play a key role in continuing to develop the Norwegian Total Defence.

We are ready for new missions

To fulfil our role as an agenda-setter for the development of the Armed Forces and Total Defence, we must have independence and freedom of research. For that reason, some of our income is in the form of core funding, which gives us security in terms of long-term research and skills.

However, 80 per cent of FFI's income does not come from regular subsidies. FFI is the only subordinate agency in the sector that is externally funded. This means that the defence sector and civil actors involved in the Total Defence must pay for our services and skills. FFI relies on research planning and development by the defence sector and Total Defence actors, and the money they allocate for this.

We are here for you. Use our knowledge.



John-Mikal Størdal
Director General

From 1 July 2021 onward, John-Mikal Størdal will be Director of NATO STO's Collaborative Support Office. Espen Skjelland has been appointed Acting Director General of FFI from 1 March 2021 until a new Director General is in place.

Soldiers from the Arctic Ranger Company from the Garrison of Sør-Varanger on sniper and collaboration training with F-16 fighter aircraft from the Norwegian Air Force on the Halkavare firing range, during the Cold Response 2020 exercise.
Photo: Simon Amdal / Armed Forces



Primary challenges of the Armed Forces

Our researchers have prepared a “weather forecast” for the economic and political landscape in which the Armed Forces must manoeuvre in the future. Here are the most important strategic decisions we will have to make and the problems we will have to tackle.

The global political, economic and social development trends that have dominated the security policy scene in recent years are likely to continue and intensify in the next four to five years.

Security policy challenges

The international order based on norms and agreements is under pressure, and is largely being challenged by the superpowers who have regarded this order as an instrument of Western interests. What we are seeing instead is a scene involving more intense superpower rivalry and confrontation, although the risk of armed conflict is considered to be small.

However, this is helping to amplify a trend in which the nature of conflicts will change, with the use of power moving from conventional military force to irregular measures such as influence operations, cyber-operations, economic and social destabilisation, etc. This means that it will become increasingly difficult to differentiate between peace and war, between societal security and state security. We must get used to a world of increasing instability and uncertainty, in which we are always living with some kind of confrontation or conflict, but in which the intensity can vary in line with political fluctuations. This tendency has been reinforced by the Covid-19 pandemic, which so far seems to have revealed social vulnerabilities that could be exploited for such purposes.

Ambitious regional superpowers

Internationally, the dominant line of conflict will be the confrontation between China and the United States, in which the American presidential election will have only a limited effect on the long-term competition for a hegemony, particularly in Asia. An American shift towards Asia, combined with the increasing ambitions of countries like Russia and regional superpowers in Asia, Africa and Latin America could lead to the establishment of spheres of interest or zones around the superpowers in which they grant each other the right to interfere. For a small state like Norway which is close to Russia, this is a worst-case scenario in which we must be prepared to come under significant political and military pressure without being able to count on immediate support from our allies. In extreme circumstances, we must be prepared for and plan for heavy military operations.

A natural response to this would be stronger European defence and security cooperation. Stronger European defence cooperation would also help to strengthen NATO, both militarily and politically. Despite the establishment of the European Defence Fund (EDF) and talks about a European defence union and European strategic autonomy, the European countries still do not seem to have come to sufficient agreement on the challenges to better coordinate their work on defence.



We must get used to a world of increasing instability and uncertainty, in which we are always living with some kind of confrontation or conflict.

Combined with unfavourable economic and demographic trends, this is contributing to an ever-diminishing European ability to influence global political conditions and to safeguard the core interests of the European countries.

This trend is creating increasing challenges for Norway as a small country that relies on alliances. This increases our relative dependence on the USA at a time when doubt has grown about the USA's ability to stand by its alliance commitments, but when the Americans continue to have national strategic interests in our local area. At the same time, technological and economic developments are making it more and more difficult to maintain complete and balanced military forces. These developments therefore bring a need to make a range of difficult defence policy assessments and decisions.

- How can we develop **comprehensive national strategies** to detect a more unclear and complex set of threats?

- How can we achieve better **multinational defence cooperation** to reduce unit costs and ensure an optimum defence capability per krone invested?
- To what degree should we prioritise **focussing on reinforcing alliances** at the expense of traditional national defence capabilities, when these will already be inadequate if the reinforcement work is unsuccessful?
- What consequences should **developments in technology** have on operational concepts and the Armed Forces' administrative processes and systems?
- Can and should we develop **integrated civil-military operational concepts** in which a broad range of conventional and new measures are seen in the context of counteracting the new threats?

Economic framework conditions

With the previous long-term plan (Prop. 151 S (2016–2017)), there was a considerable increase in investment in the Armed Forces. Analyses show that previous long-term plans were underfunded, and that economic investment was needed if the economic gap was to be closed.

Since then, the security policy landscape has worsened. Further investment is needed if the Armed Forces are to be able to attend to the same duties. The current long-term plan (Prop. 14 S (2020–2021)) assumes that there will be a considerable increase in the defence budgets in order to make this possible.

Although NATO's two per cent target has been the guide for the financial scale-up in

the long-term plan, later macro-economic uncertainties show that the GDP target is vulnerable to fluctuations: The Covid-19 pandemic has triggered a major recession in Norway, with the result that we have already reached the GDP target for 2020. Despite this, we cannot say that Norway's defence capability is any different to what it would have been at 1.6 per cent of GDP, which is what we thought it would be at the start of the year. However, the long-term plan sets out a schedule for real economic increases, regardless of the size of GDP. It is important to follow this plan if we are to ensure that there is a balance between duties, structure and economy.

However, there are numerous economic factors that could rock this balance. One of these is fluctuations in exchange rates. A major component of a steadily increasing investment budget is exposure to foreign currency risk, and this helps to create uncertainty about the economic framework. Is the framework sufficient to ensure that the planned volume of turnover can continue, or is it too broad? If it is, there is a risk that the plan will have to be modified, and that the modifications will be made where they can, and not necessarily where one would have chosen if the costs had been more predictable.

The overall balance

The current long-term plan for the defence sector points out that the main challenges are the inadequate preparedness, presence and endurance of the Armed Forces. This reflects an imbalance between the Armed Forces' duties, structure and finances that developed since the end of the Cold War and that have continued to the present day, despite mitigation measures

that are a result of a worsening in the security policy situation in recent years.

There have been investments in new equipment. The investment percentage in the defence budget is at a historic high. More "invisible" capacities such as spare parts, emergency stocks, maintenance and communication systems have received less attention. These have had a direct and negative effect on preparedness and endurance.

However, since the last long-term plan, the government has increased investment in these supporting capacities, with the result that the Armed Forces has improved preparedness and endurance in recent years. However, such things take a long time, and the status in this area cannot be expected to be satisfactory much before the end of the decade.

A further challenge is that many of the Armed Forces' main systems are being replaced, which will weaken operational performance and availability for several years to come. It is therefore important to maintain the high pressure needed to rectify those things that are preventing the current Armed Forces from functioning optimally, while at the same time managing to look further ahead and planning for the Armed Forces that we want to achieve when all these new systems are in place.

The Armed Forces will always be in a state of renewal. We must be capable of developing the Armed Forces while keeping them operational.

Particular challenges

Bringing the Armed Forces' operational



The Armed Forces will always be in a state of renewal. We must be capable of developing the Armed Forces while keeping them operational.



Air Force Artillery crew erecting antennae for NASAMS III (Norwegian Advanced Surface to Air Missile System) during the Falcon Response 2020 exercise on the Air Force Rygge base. Photo: Ingeborg Gloppen Johnsen / Armed Forces

capabilities to a satisfactory level involves some challenges that stand out as particularly critical:

- **Long-range, highly accurate missiles** are an increasing threat to the most strategic capacities of Norway and its Armed Forces. We must improve our ability to resist these, through both passive and active measures, such as protection, dispersal, mobility and strengthening the Air Force.
- **The digital and electromagnetic operational environments** are becoming increasingly important domains of warfare. Every day, we are vulnerable to intelligence, criminal sabotage and extortion (ransomware) in cyberspace. But in a conflict, we must be able to expect cyberattacks against civil and military installations. The Armed Forces must improve its ability to resist attacks and operate in conditions where for example its own means of communication and data network have been degraded through such attacks.
- In a situation in which **new technology increases the pace of operations** and gives an adversary weapons that are effective at a long-range, there is a greater need for oversight and situational awareness. The Armed Forces' surveillance and intelligence capabilities are therefore key capabilities, and must be strengthened in the future.

Gray zones and the Total Defence

Concern is steadily increasing about what are known as hybrid/composite threats or grey zone challenges. Methods of influence such as cyber operations and influ-

PRIMARY CHALLENGES OF THE ARMED FORCES

ence operations on social media are difficult to detect. It can be difficult to identify which actors are behind them, and what their intentions are. Such attacks can put civil functions out of action, undermine confidence in society and influence not only political decision-making processes but also a population's attitudes and behaviour in peacetime.

To build up the ability to withstand such threats, the Armed Forces and civil sector must both become better at understanding, detecting, analysing and managing a broad set of measures in the cyber and information domains, while safeguarding privacy and freedom of speech.

Problems like these illustrate the reciprocal interdependence between the Armed Forces and civil society. The Armed Forces support the civil authorities in several areas, such as fisheries monitoring, counterterrorism and search and rescue. But the Armed Forces are no less dependent on civil capacities throughout the spectrum of peace, crisis and war. Consequently, this means that it can be just as effective for an attacker to strike civil targets as military targets. Fuel supply, transport axes, telecommunication and other strategic capacities are vulnerable to long-range missiles, sabotage and cyber operations, to name but a few. Many steps have been taken to strengthen the Total Defence in recent years, but there is still a need to continue improving situational awareness, reduce vulnerabilities and intensify civil-military cooperation.

Personnel and competence

One of several key prerequisites needed by the defence sector if it is to meet higher operative requirements and faster response times, is sufficient access to personnel with the relevant expertise. In the next long-term period, there is expected to be a gradual increase in personnel vol-



Norwegian Cyber Defence Force's operation centre at Jørstadmoen. Photo: Anette Ask / Armed Forces

ume, while the Armed Forces' manpower concepts will be developed to build robustness and endurance into the force structure.

The Armed Forces' ability to recruit and retain personnel must also be improved. Several important changes have been implemented in recent years in the areas of personnel and competence that are expected have a positive effect, including the military rank structure (OMT), education reform and the introduction of gender-neutral military service and further developments in initial military service. New technology and the introduction of new equipment will change the way problems are tackled and affect the Armed Forces' need for skills. The Armed Forces' ability to change and adapt at the same rate as developments in technology will be pivotal to the success of this shift in competence.

Modernisation

The Armed Forces need to adapt their support activities quickly in the years

ahead. While the outside world has high expectations of the savings that can be achieved through efficiency measures, there is a major need within the Armed Forces to modernise and professionalise a number of key operational areas. Modernising the sector's ICT systems and services is a critical component of success here, similar to the importance of improving the sector's skills in administration and modernisation.

FFI has previously found that the defence sector has major problems in successfully implementing complex restructuring processes. This applies particularly to cases in which ICT is a central element and in which improving efficiency is an objective. The Armed Forces therefore need not only to implement the planned modernisation competently, but also to continue to identify new areas and opportunities for modernisation.

Technology development

The Armed Forces must use new technology effectively if they are to survive in the battlegrounds of the future.

Throughout history, technology has emerged that has fundamentally changed the rules of the game and the relative strengths on the battlefield. Planes, nuclear weapons, missile technology and precision-guided weapons – all these innovations changed the terms of armed conflict and created completely new operational concepts.

The question we must never stop asking ourselves is: which new technologies could have a pivotal effect on the Armed Forces' operations in the future? And this is not just a question of which technologies we could make use of, but what we may need to defend ourselves against. When will these technologies be mature enough to be used? And how can we best prepare ourselves for such developments?

Relative strengths are changing

The international technological balance of power also affects the Armed Forces. We are seeing two main trends here: The technological military lead of the USA and West is shrinking, and civil technology development is becoming increasingly important. The USA is still the biggest in terms of defence-related research and development. But the technological gap between the USA and countries like China and Russia may be said to have narrowed in the last few decades, partly because of the enormous economic growth in China and an extensive defence modernisation programme in Russia.

It is now the civil sector that spends the most on technological development, in contrast to the Cold War period. Areas such as biotechnology, autonomy and artificial intelligence are being driven forward by the fact that they have a great commercial potential. Naturally, many of the new technologies also have a military application. Developments affect the threat landscape because the potentially harmful technology is also available to non-state actors and individuals.

The speed of civil developments in technology also challenges the lengthy military procurement processes. A key question for

the future is how the Armed Forces can make faster use of new technology where it is relevant.

Trends

The NATO report "Science & technology trends 2020-2040" highlights eight groundbreaking technologies, also known as EDTs (Emerging and Disruptive Technologies). An investment in these technologies within the NATO alliance is considered to be absolutely essential to maintaining the technological lead. The eight areas are data, artificial intelligence, autonomy, space technology, hypersonic technology, quantum technology, biotechnology and material technology. The disruptive effect is expected to come from different combinations of these eight. (See page 13.)

The EDTs are absolutely key to FFI's future activities. We must show how the Armed Forces' operations are affected by the technology trends so that we can take this into account when the Armed Forces are planning for the future and procuring equipment.

Enormous operational opportunities

Technological trends can never be regarded in isolation. A key term is convergence – how can technologies be used together and reinforce one another? A classic example of convergence is the smartphone, where telephone, computer and camera were amalgamated and changed the way we communicate, buy goods and understand the world.

In a military context, sensor technology combined with autonomous swarms, unmanned systems and artificial intelligence could converge. The technology could potentially give us a far better understanding of a situation in real time. The party that has command of this and can translate it into good decisions and effective measures will have an enormous advantage over an adversary who does not.

Efficiency improvement

Technology can also lead to improvements in efficiency in the



Technology is an important driver of development in the Armed Forces and the rest of the defence sector. Operations must be adapted to the groundbreaking technologies that are available, rather than the other way around.

Armed Forces. For example, an experiment is currently underway in which FFI and a civil technology firm are collaborating to make logistics convoys partially unmanned. Such a concept could have operational and financial benefits, and would put fewer lives in danger. Whether we like it or not – automation and robotisation will reduce the need for human labour in many industries in the future. An important question is how the Armed Forces can adopt such technology to improve efficiency, logistics or administration. The goal of such efficiency improvements must be to ensure that soldiers are better supported and to free up manpower for important duties.

New vulnerabilities require cooperation

Technological developments mean that areas we previously considered to be secure have become more vulnerable. An adversary can strike us with long-range precision weapons with little or no warning. Cyberspace has become a domain of warfare in which attacks can paralyse key support functions. We must analyse and understand these vulnerabilities in order to establish what kind of approach the Armed Forces should take.

The new threat landscape, in which non-state actors and individuals can strike civil and military targets, requires good cooperation across sectors – or in other words, a fully-functioning Total Defence. The distinction between the Armed Forces' duties, the maintenance of state sovereignty, and societal security is no longer as clear.

Technology also gives government agencies a bigger arsenal with which to influence an adversary's population and operate in the grey zone between war, crisis and peace, while we are unable to identify whether a state actor is behind the activity. The Armed Forces cannot respond to such a threat scenario alone.

Our recommendations

The Armed Forces need a holistic approach in which technological opportunities and vulnerabilities are assessed alongside the development of doctrines, concepts, competence and organisa-

tion. Alternative concepts and new technologies must be considered more systematically and effectively during the initial stages of equipment procurement projects.

Success in this area requires an efficient procurement practice and an ability to integrate new technology through testing, experimentation and creative collaboration between the Armed Forces, industry and research communities. The basis for all this lies in FFI's core activity – research and development to build competence, and analyse and develop solutions for the new technology.

It goes without saying that FFI does not perform this work alone. To understand, standardise, procure and develop new technology, we depend on cooperation with allies, industry and national and international technology communities.

In 2019, FFI published the report *Defence technology trends – a general analysis of the impact of technology for an efficient and relevant Armed Forces*. In the report summary, FFI's recommendations were translated into four general recommendations for the defence sector.

- We should prioritise the development of **modern, high-tech Armed Forces**.
- We should rectify significant **technological vulnerabilities**.
- We should make **long-term investments** in the most promising technology areas.
- We should build a stronger culture of innovation in the Armed Forces.

These recommendations remain just as relevant. FFI has many projects and measures that aim to assist the Armed Forces in this direction. You will be able to read more about them from page 16 onward.

New groundbreaking technologies

NATO has defined eight technologies (Emerging and Disruptive Technologies – EDTs) which the alliance must follow up closely in their future technology development work. The groundbreaking effects are most likely to occur when these technologies are combined in new ways.

1 Big data and advanced analyses

Developments in data and computing power make it possible to structure, visualise, interpret and utilise complex and continually increasing volumes of information faster and in new ways. In the military context, big data is particularly important in intelligence, surveillance, reconnaissance and planning. Big data analysis can provide a better decision-making basis and situational awareness, which in turn can provide operational and strategic advantages. The technology can also help to optimise logistics and develop new materials, sensors and training methods.

2 Artificial intelligence

In simple terms, this involves algorithms that give machines the ability to perform tasks that normally require human intelligence – such as recognising patterns, learning from experience, drawing conclusions or acting. Militarily, this technology provides new opportunities in areas such as decision-making support, situational awareness, planning, logistics, target selection and swarm technology, and will become essential as a support tool for the coordination of autonomous and manned systems. The keywords are increased speed and precision in decision-making processes.

3 Autonomy

Autonomy describes a system's ability to interpret and react to its surroundings and make its own decisions in order to solve a problem. NATO is expecting autonomy to increase flexibility, endurance and effectiveness in military operations, not least through the use of autonomous swarms. This technology is providing new opportunities in areas such as urban operations, cyber operations, logistics and situational awareness, but also brings challenges in terms of interoperability.

4 Quantum technologies

Technology development based on the knowledge of quantum physics – which describes matter and behaviour at the atomic and subatomic scale – is another technology that is gaining momentum. Next-generation quantum technologies utilise the fundamental quantum physics phenomena of entanglement and superposition to make greater progress, mainly in complex calculations and computing power, navigation and precision timing and positioning, sensor and imaging technology, secure communication, energy storage and material technology. In the military context, quantum technology could potentially give us secure navigation and positioning without GPS and satellite navigation, even under water.

5 Space technology

This includes all use of technology in space, which is defined as more than 100 km above sea level. This is an extremely impor-

tant domain for future civil and military operations, particularly in navigation, communication and surveillance. Developments in small satellites and sensors are expected to have a major impact. By 2030, there are expected to be five times as many satellites as there are now. This will drastically expand access to space-related services. On the sensor side, microwave photonics could give us satellite-based radars with a much lower weight and higher performance than at present.

6 Hypersonic technology

Hypersonic weapons systems (missiles and vessels) are defined as those which are manoeuvrable and operate at speeds higher than Mach 5 (approx. 6,000 km/h). Speeds like these are reached when re-entering the atmosphere from space, or with the aid of combined propulsion by rocket and scramjet engines. This technology can be used for reconnaissance and long-distance attacks, also with swarms, and will represent a threat to large parts of the current force structure. Countermeasures against hypersonic and manoeuvrable missiles, vessels or swarms are extremely challenging. At the moment, Russia and China seem to have got further than NATO and the USA in their developments in this area.

7 Biotechnology and human enhancement

This covers a broad research field in which biology, genetic technology, new materials, medicine and technological aids are used and combined to strengthen or improve human properties. This can be in the form of smart, biological or living sensors that monitor our state of health, prevent injuries, provide diagnoses or warn of chemical attacks. It can also involve developing various prosthetics, garments, sensors, the human-machine interface and exoskeletons used as equipment by soldiers in order to enhance their senses and improve endurance and strength. Synthetic biology – defined as the design and development of modified or new biological systems – makes it possible to give humans and organisms qualities that they would not have naturally.

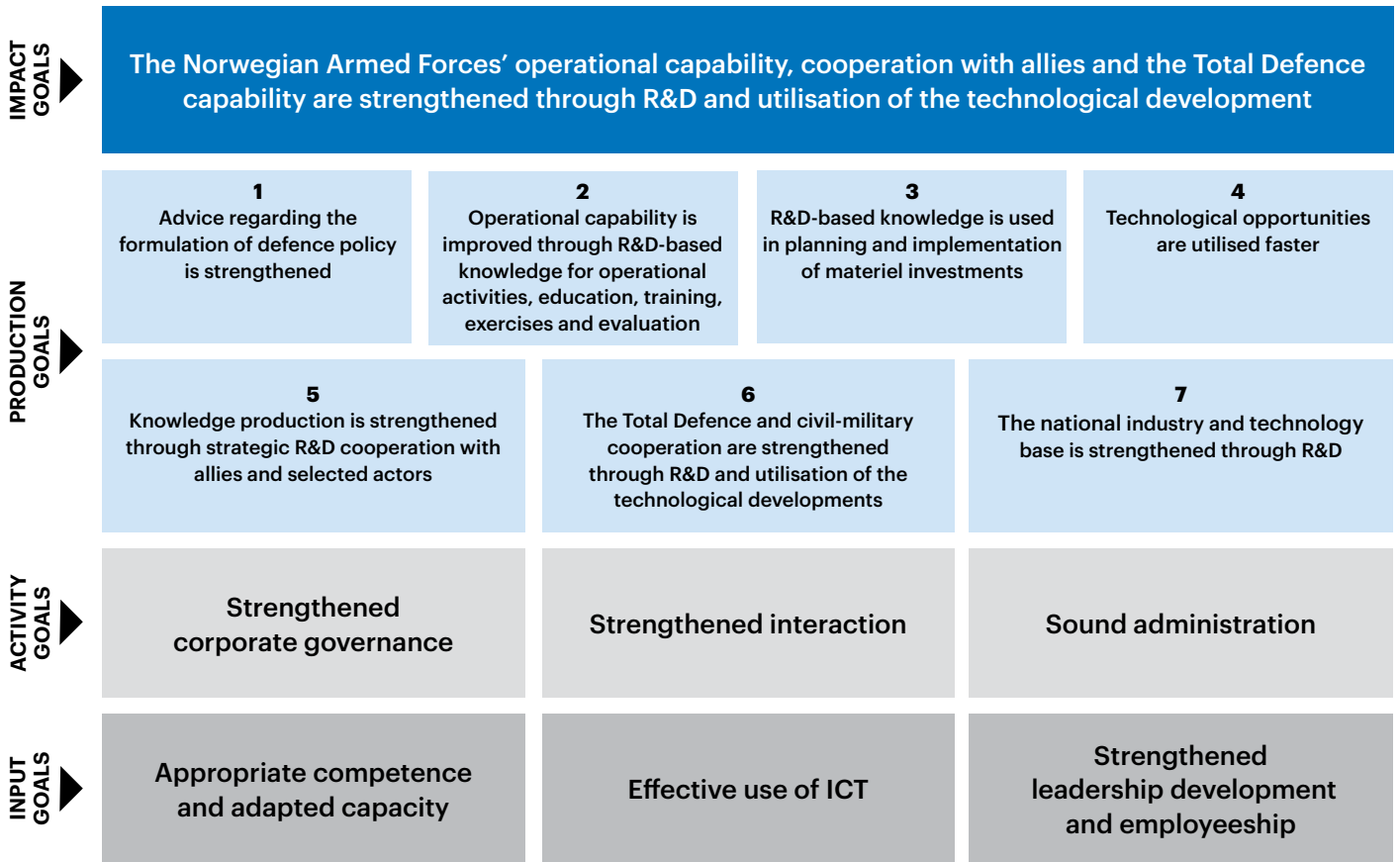
8 Material technology (new materials and manufacture)

This involves artificial materials with unique properties, for example those produced using nanotechnology or synthetic biology. We are expecting new materials to make military equipment and clothing lighter, stronger and more energy-efficient. There are particularly high expectations of graphene and other 2D materials. For example, we are expecting new materials to give us faster communication, more efficient energy storage, more sensitive sensors, new signature-reducing materials and better heat protection at hypersonic speeds. Additive manufacturing, also known as 3D printing, enables the fast production, repair and use of new materials in military contexts.



FFI's goals

2021-2024



<p>VALUES</p> <p>Creative, enterprising, broad-minded and responsible</p>	<p>VISION</p> <p>FFI turns knowledge and ideas into an effective defence</p>
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FFI will elucidate the future for the Armed Forces

Our task is to see things in context, so that our defence policy and strategic choices of direction form good responses to the challenges faced by the Armed Forces.

FFI's production goal 1:

Advice regarding the formulation of defence policy is strengthened

FFI acts as a key advisor in the preparations for a new long-term plan for the defence sector every four years. Here we provide comprehensive, research-based recommendations on arrangements for the Armed Forces over the next four years and in the longer-term perspective. FFI also makes a significant contribution to the Chief of Defence's Military Council (FMR).

FFI's Director General has meetings with the Ministry of Defence's political leaders twice every year. In 2020, we also established the "Military Technology Arena", at which FFI and senior management of the Armed Forces meet twice a year. Plenty of time is set aside here to discuss relevant topics at a confidential level. The meetings discuss technological trends that are significant to the Armed Forces, and the opportunities, limitations and risks of the technology.

The Ministry of Defence and Chief of Defence have both signalled that they would like more support from FFI for long-term planning in the future.

An all-round institute

To provide advice on such a complex subject, FFI needs solid professional knowledge in a range of disciplines, in-depth specialist knowledge of the Armed Forces and its duties, and not least a solid understanding of technology and joint operations.

The key to providing good advice lies in utilising the knowledge of the institute across research projects.

FFI's overall input to the long-term planning work is achieved by gathering knowledge from many different R&D projects and specialist fields. These include:

- **Equipment procurement:** What kind of equipment is needed in order to have effective and relevant armed forces?
- **Combat structures:** How technology and available equipment can be used to achieve the desired effect in a joint operational concept. Can we use scenarios to concretise the Armed Forces' duties and analyse which operations, concepts and strengths are needed to carry out these duties?

- **Finances:** What will the total costs of the Armed Forces be in the long term? What opportunities are there to make the Armed Forces and defence sector more effective?

- **Environmental analysis:** Which trends in high-level politics, technology, economy, population and climate could be significant to the Armed Forces? Which non-state actors could have an impact on Norwegian security?

- **Total defence:** How can the Armed Forces and other civilian and public civil functions work together to strengthen Norway's defence capability?

We are now taking steps to further systematise how all this knowledge is collated and to strengthen the work on long-term planning.

New project will draw all the threads together

In January 2021, we started a new project called "Strategic defence analyses". This project will look at the Armed Forces as a whole, across the various agencies. In it, we will coordinate and collate the work put in by FFI to the strategic development of the Armed Forces. The project will involve dialogue with the Ministry, Chief of Defence Staff, Norwegian Intelligence Service, Norwegian Joint Headquarters and branches of the military.



Chief of Defence Eirik Kristoffersen and Director General John-Mikal Størdal. Photo: Espen Wang-Naveen / FFI

Its main delivery will be an annual, confidential report that analyses the balance between the Armed Forces' duties, structure and finances, and examines selected technology fields in depth.

To enable the Ministry of Defence and Storting to make informed decisions, the project will illustrate the consequences of setting different levels of ambition for defence policy. We will show which risks Norway runs by putting different duties and capabilities higher or lower on the list of priorities. We will also make a cost-benefit analysis of different choices with regard to strengthening, procuring or phasing out major equipment and departments.

The project will prepare base scenarios that describe possible future security challenges for Norway. We will also de-

velop and assess different operational concepts and contribute to technological, conceptual and organisational innovation in the defence sector.

Verbal advice

Obviously, reports are not always the best way of delivering knowledge. Just as important as the formal deliveries and reports is the running dialogue and the formal and informal contact between FFI's researchers and the specialists in the defence sector.

Looking ahead, our goal is to find more arenas in which to share our knowledge and reinforce our role as adviser.

THE GREEN TRANSITION

Climate change is one of the biggest challenges facing society, and it could begin to have a greater impact on security and defence policy. FFI will help the research sector achieve the UN's sustainability targets and the government's climate targets alongside the green transition in the wider community.

This involves looking at instruments and environmentally effective measures that are both financially viable and strengthen the operational capabilities of the Armed Forces.

How FFI will help to improve operational capabilities

Knowledge is of little value to the Armed Forces if it does not provide an advantage where it really matters.

FFI's production goal 2:

Operational capability is improved through R&D-based knowledge for operational activities, education, training, exercises and evaluation

In the next long-term period, the Chief of Defence would like to prioritise preparedness and collaboration in the Armed Forces. Norwegian forces will improve the speed at which they are ready for action and will be better prepared for crisis and war. Joint operational cooperation will also be improved – both between branches of service, with allies and with the actors involved in the Total Defence concept.

An all-round institute

FFI carries out research and development work and provides advice at all levels of the Armed Forces – everything from testing Primus stoves to providing general advice about the long-term structure of the Armed Forces. We look at everything from microbiological threats to space technology. At the end of the day, everything we do should result in improved operational endurance and capability. But FFI also performs research activities specifically aimed at operations, education, exercises and evaluation.

Planning operations

Long-term defence planning generates debate and receives media attention. However, the Armed Forces also relies on planning at the operational level. If different branches of the service are to collaborate, appropriate operational processes and procedures are essential. Joint Norwegian operations must be developed at the same pace as threats, new equip-

ment, technology and changes in our alliances.

In the coming period, we are proposing new projects that will look at command, control and technology in joint operations. The projects will help to develop operational analysis and joint operational processes at the Norwegian Joint Headquarters (NJHQ) and Norwegian Defence Staff.

Electronic warfare is a focus area for the Armed Forces. FFI has experts who can provide advice on how such measures can be used in joint operations, and we can help to ensure that the scope of technological opportunities is utilised to maximum effect.

The work being performed on the Total Defence 2040 project, in which FFI will look at how the civil and military spheres can cooperate in a total defence concept, will help to improve the country's resistance and endurance during a crisis.

Personnel and competence

In recent years, the Armed Forces have made major changes to their personnel policy. These changes include an education reform, gender-neutral military service and the new rank structure for military employees, in which the Armed Forces have adopted a rank structure in line with that of NATO's, with an officer corps (OF) and specialist corps (OR). FFI



Soldiers from the Telemark Battalion planning an attack operation on Setermoen firing range in the multinational Cold Response 2020 winter exercise in Troms. Photo: Ole-Sverre Haugli / Armed Forces

will now study how these reforms have progressed and how they will affect the Armed Forces in the future. We also look into how the Armed Forces can make better use of civilian expertise.

Exercises

In the future, the Armed Forces and Norwegian Joint Headquarters will have better and more systematic access to FFI's knowledge in connection with major exercises. For example, FFI will be given a role when the allied winter Cold Response Exercise is planned, implemented and evaluated in 2022 and 2024. This will also give FFI better access to the Armed Forces' expertise, which is fundamental to our work.

Training in joint operations and across departments is time-consuming and re-

source-intensive. Simulators connected through a network can be a cost-effective alternative during exercises, training and instruction. We are therefore proposing several projects with simulator-based training and exercises that are available in the cloud. For example, we will further develop the project with simulator-based war games in order to analyse plans.

Evaluation

A major element of procuring new equipment involves evaluating how the equipment works, and how it could be improved or made better use of in operations. FFI will continue its support for the development of domains of warfare and main combat systems in the Armed Forces. We will also help to operationalise the F-35 fighter aircraft, maritime P-8 patrol air-

craft, NH90 helicopter and new 212 CD submarines, to name but a few.

With respect to the F-35, FFI will help to ensure that software, planning systems, simulators, weapons and countermeasures are tested and evaluated with the aim of giving the aircraft full operational capacity in 2025.

There will also be evaluations in terms of innovation and finding new applications for technology. For example, in the coming period we will evaluate satellite-based communication services in order to see how these systems can be used innovatively in mobile communication in the Armed Forces.

Norwegian F-35A fighter aircraft at Keflavik Airport as part of the Norwegian Air Force's role during NATO's Iceland Air Policing operation.
Photo: Torbjørn Kjosvold / Norwegian Armed Forces



New equipment must be planned and used correctly

One third of the defence budget will now be spent on investments. Thorough specialist preliminary work must be performed, to allow us to find the most effective way of using the equipment and avoid investing in the wrong technology.

FFI's production goal 3:

R&D-based knowledge is used in planning and implementation of materiel investments

Investing in new equipment is one of the most important driving forces behind the development of effective and relevant armed forces. In an era when technology is developing rapidly, it is vital to invest in equipment that utilises the technological opportunities, and that can be updated throughout its lifespan, allowing the equipment to be modified to suit tasks and the threat landscape.

When we evaluate new equipment, desired effect must therefore be more important than structural solutions. If we use what we want to achieve as a basis, and provide good descriptions of the needs, goals and requirements that must be fulfilled in order to achieve this effect, it becomes easier to analyse alternatives.

The trends we are seeing include the need for systems to collaborate to a greater degree than in the past, and for systems to

be more modular – i.e. systems made up of independent modules based on which tasks are to be performed.

Mistakes must be discovered early

FFI has a long history of supporting every phase of equipment procurement of items such as fighter aircraft, submarines, air defences and surveillance radar systems. We have a broad range of specialist knowledge and operational insight. This means that we can provide invaluable support in the technical assessments and cost-benefit analyses involved in procurement.

In recent years, we have also managed the concept phases of some major, significant projects on behalf of the Ministry of Defence, including regional air defence and new tanks for the Norwegian Army. Looking ahead, one of our goals is to assist at an earlier phase of several major procurement projects for the Armed Forces.

For many years to come, one third of the defence budget will be spent on investments. This makes it important to avoid investing in the wrong technology. Experience shows that mistakes must be picked up on as early as possible in the process. It is considerably more expensive to rectify mistakes at a later stage.

At FFI, our staff will now start to improve their skills in planning, implementing and delivering conceptual work for equipment

procurement projects. The aim is to better link in FFI's collective expertise, and at an earlier stage of procurement projects than at present. We will start a special project focusing on this in 2021. This will involve training specialist researchers in planning, designing complex technical systems, risk management and project management. The function of these researchers will be to act as bridges between FFI's specialists and the procurement projects.

Experiential learning

We must learn from previous blunders and success stories. Procuring military equipment is a speciality. In the USA, this is taught at several of the military universities.

A great deal of knowledge and experience can be obtained from the defence sector's previous procurements. However, the rotation of personnel in the Armed Forces means that there can be poor institutional memory and little experiential learning.

Going forward, we will more clearly identify what has worked well and less well in these processes, so that we can benefit from this learning in future procurements.

Investment projects in the Armed Forces

Here are some of the Armed Forces' high priority investment projects in which FFI may or will play a role in the future.



Soldiers and launcher from the Air Defence Battalion during the Cold Response exercise. Photo: Markus Engås / Armed Forces



Developing and mechanising the Finnmark Land Defence and Northern Brigade have been prioritised by the Chief of Defence. These are soldiers from the Arctic Ranger Company from the Garrison of Sør-Varanger on sniper and collaboration training with F-16 fighter aircraft from the Norwegian Air Force, during the Cold Response 2020 exercise. Photo: Simon Amdal / Armed Forces

AIR

F-35

FFI is supporting the procurement and operational phase-in of the F-35, for example with weapons integration and getting the JSM approved for the F-35. The work will help to ensure that the Armed Forces achieve the desired operational effect of the F-35 and FOC (Full Operational Capability) in 2025. Weapons are important for operational capability. FFI is helping to develop the JSM missile and cannon ammunition for the F-35. Both of these are based on FFI's long history of developing missiles and ammunition.

Air defence

The Chief of Defence's plan and Long-Term Plan for the defence sector (LTP) illustrate an urgent need to strengthen the air defence. We must look into how the range of our air defence could be increased. In the short term, the NA-SAMS air defence system will be upgraded. This system is made up of several components. New missiles and sensor packages to obtain an overview of airspace are being discussed. FFI is ready to support this work with the specialist documentation needed to select concepts and specify requirements.

LAND

Long-range land-based weapons

Land-based, long-range precision weapons have been proposed for Norway for 2026. Before we select the weapons, a Choice of Concept Study will be performed, with the assistance of FFI. Important topics here are how the new weapons could complement and work with other weapons that can take out a target from a distance, and how the systems could give adversaries new challenges and dilemmas to handle. At the same time, the weapons must be adapted to developments in surveillance and situational awareness.

Intelligence drones / tactical UAVs

The Intelligence Battalion is planning to procure UAVs (Unmanned Aerial Vehicles) for intelligence, surveillance, target location and reconnaissance. FFI has strong specialist teams in the technology behind drone swarms and unmanned aerial systems. We have set up a project that will support the procurement. Our job will be to contribute to technology development and testing, enabling the system to be used under Arctic conditions and to fit into the existing framework. The system will be developed in partnership with industry and users.

Tanks

The Northern Brigade's manoeuvre battalions will be getting new tanks from 2025 onward. Tanks must undergo continuous development in order to ensure that they are relevant throughout their service life. FFI has managed the Choice of Concept Study and will now analyse performance, from single tanks to battalions, evaluate upgrades, and provide advice on additional procurements in the project in order to ensure that good use will be made of the tanks.



P-8A Poseidon from the US Navy taking off from Andoya in 2016. In 2023, Norway will get five of these maritime surveillance planes. Photo: Bjørn Volle / Armed Forces

SEA

P-8A Poseidon

Norway has decided to buy five P-8A Poseidon maritime patrol planes for its Air Force. The planes will be in place in 2023 and will be strategically important in terms of maritime surveillance, underwater warfare and developing situational awareness. FFI will help to make these planes operational in a comprehensive anti-submarine warfare concept. This will include

- adapting concepts for sonar operations to relevant areas and needs
- supporting the Air Force with systems for operational planning and for collecting, analysing and disseminating information from the P-8 planes in a joint operational concept
- analysing operational problems such as availability, manpower and maintenance accounts.

Submarines

Norway is getting new submarines, which are scheduled for delivery from 2029 onward. Our researchers are analysing the performance of the new submarines' combat system, including the sensor, navigation, weapons, communication and battle management systems. We are also working on the research and development of power supply and battery safety in order to improve operational capabilities. We are also working on performance calculations for the tasks that submarines could be given in modern joint operational warfare. This work will illustrate the ways in which the submarine could perform the duties for which it is intended.

NSM

New missiles will be developed between now and 2035. FFI is supporting the technical development of seeker head and engine, and we are supporting missile development through analyses of threats and scenarios in which missiles could have a role to play. In the future, it will be important to perform system studies of missiles in order to keep up to date with developments and identify the way forward for next-generation weapons.

Maritime Mine Counter Measures (MCM)

Protecting our waters from mines is important in order to protect national and allied operations, particularly when we will receive support from our allies. FFI is working with the Norwegian Defence Materiel Agency and Norwegian Navy on the development and testing of a new concept. This will involve mine searches by unmanned underwater vehicles, boats and planes, while a mother ship controls the operation from a safe distance. This is a pilot project in the use of autonomous modular systems, which could eventually be used in other domains of warfare.



Student from the Armed Forces' engineering academy during the Initial Entry 2017 exercise. Photo: Daniel Nordby / Armed Forces

CYBER DOMAIN

Virtual combat ICT

The strategic use of information and communications technology (ICT) is critical to gaining situational awareness, commanding operations and using modern weapons effectively. The Norwegian Defence Materiel Agency has been commissioned to acquire ICT to use at the tactical and technical conflict levels. The program (Mime) identifies, prioritises and implements procurements and other actions on the basis of the anticipated operational effect. FFI is providing method support and performing studies and analyses for Mime, for example with the procurement of a new tactical radio system. FFI is also supporting the Mime program in planning and implementing innovation activities.



The Norwegian NorSat-3 satellite will reveal the identity of vessels that are actively trying to stay hidden. Graphic: FFI / UTIAS / SFL / ESA / NASA

SPACE

Situational awareness and communication in our northern regions is important in terms of maintaining and improving our operational capability and for achieving a higher level of preparedness. Norway already has a number of microsatellites and low-orbit satellites that provide us with valuable data. FFI has played a key role in developing these. And more are on the way. NorSat-3 will be launched in 2021, fitted with a navigation radar detector. Satellites with low-light cameras (NorSat-4) are also planned, as well as a satellite to test better tactical communication in the High North (MicroTac-Sat). As well as developing technical solutions, FFI is also contributing knowledge about the use of data from satellites, and supporting the Armed Forces with the procurement and use of large satellite systems.

FFI as a technology incubator

There is an enormous potential effect in adopting new technology in military contexts.

FFI's production goal 4:

Technological opportunities are utilised faster

FFI's production goal 7:

The national industry and technology base is strengthened through R&D

For the Armed Forces, adopting new technology can be risky, when the technology has not been tested or used operationally before. It can also be difficult to imagine how new technology can perform tasks in new ways. For investors and industrial companies, there is risk involved in developing untested technology for new markets.

The fact that new technology is available does not mean that it is a case of “plug and play” for the Armed Forces. The technology must be tested, matured and often developed further before it is ready for use by the Armed Forces. FFI helps to reduce the risks, both for the Armed Forces and for Norwegian companies, by providing the facilities to experiment with and test the benefits of new technology.

Innovation in system form

Since World War Two, the triaxial collaboration between the Armed Forces, FFI and industry has been important in terms of building industry and technical expertise in Norway. We now have a defence industry that is niche-based, high-tech and internationally competitive.

In order to further reinforce the triaxial collaboration and the Armed Forces' capacity to innovate, FFI has set up the Innovation and Industrial Development Division and ICE worx innovation centre. We believe that this is an absolutely essential measure in a world in which te-

chnology is developing so rapidly that the threat landscape is constantly changing.

In this context, innovation does not just mean adopting new technology. It can also mean using existing technology in innovative ways, in an effective interaction between existing and new equipment. Equally, new technology must interact with the people and organisation that will be using it.

New test arenas

So what is needed to successfully develop and utilise technology that satisfies the needs of the Armed Forces? We believe that in the future, facilities must be in place to ensure that operational user communities can work even more closely with researchers and industry to ensure that they have the same understanding of a problem, and of problem-solving, experimentation and developing solutions.

That is why we have an ambition to continue developing existing test arenas and to establish new arenas for innovation and experimentation all over the country in the coming years (see overview on pages 28–29). Here we will invite technology and industrial companies to develop practical solutions for operational needs, in partnership with our researchers and operational personnel.

We believe that this kind of experimental approach increases the likelihood of suc-



FFI researchers Tønnes Frostad Nygaard (left) and David Kolden in deep concentration before a demo at Rena in autumn 2020. Photo: Espen Hofoss / FFI

successfully utilising technological opportunities more quickly, because aspects such as organisation, procedures, training, staffing needs and infrastructure will be tested as part of the experimentation.

Strategic focus on new technology

In order to ensure that we are able to help the Armed Forces with new technology, FFI is starting to have a strategic focus on technology that is not mature enough to use, but that we believe could be of pivotal importance for the Armed Forces in the future.

In 2013, we started focusing strategically on autonomous (unmanned) systems. Work is now underway throughout the institute to create demonstrators in order to reduce risk and mature this technology

for use in a range of operational applications.

We also have an ongoing strategic focus on Artificial Intelligence (AI) and big data. Among other projects, the team is working to automate data processing in the field and on AI methods of interpreting image and surveillance data. Again, the objective here is to streamline tasks and develop new solutions that strengthen our defence capability, as well as improve security and preparedness in the wider society.

But what is the next big strategic focus area? The Tekno project could lead us in the right direction here. Tekno takes international trend studies and looks at the consequences that technological trends could have on military operations in the

regions of the High North in the future. The aim is for the work to result in specific recommendations and evaluations for various aspects of the defence sector, including the operational side.

We are also working internationally to find joint solutions with our allies and benefit from the knowledge and technology being developed and tested there. An example of this is the work performed by the NATO Science & Technology Organisation (NATO STO). This gives us access to R&D and results in fields such as quantum technology, biotechnology, material technology and other technologies anticipated to have a disruptive effect in a defence context.

Help for the industry

An important goal for FFI in the future is to continue developing and to improve the unique Norwegian triaxial model. The FFI project “Innovation in the defence sector” will systematise experiences from partnerships between the research community, industry and Armed Forces. This will give us knowledge about which measures, processes and partnership models could strengthen the Armed Forces’ ability to make use of new technology.

This knowledge will be used to provide strategic advice to actors within the sector and to provide better framework conditions for innovation throughout the defence sector.



Looking ahead, we will continue supporting Norwegian industry with technological expertise, advice on how they can reduce the risks associated with product development and how they can gain access to domestic and international defence markets.

Looking ahead, we will continue supporting Norwegian industry with technological expertise, recommendations on how they can reduce the risks associated with product development and how they can gain access to domestic and international defence markets.

Industrial development = security

Control of technology and industries that have an impact on Norwegian security and preparedness ensures that we are free to act in crisis and war. The national defence industry strategy highlights the following as particularly important competence areas:

- command, control, information and battle management systems
- systems integration
- autonomous systems and artificial intelligence
- missile technology
- underwater technology
- ammunition, rocket engines and military explosives
- material technology especially developed and adapted for military purposes
- lifetime support for military systems.

These competence areas are defined on the basis of basic national defence needs and security interests. They will form the basis of future partnerships between industry and the Armed Forces. A long-term and targeted focus here will form the basis of new military niche products that we can offer our close allies. These are an important contribution to burden-sharing in NATO.

Through systematic experiential learning and knowledge development, we have helped to develop the defence industry strategy. A new Report to the Storting has been written and is scheduled for political consideration in the spring of 2021.



Test arenas

FFI will continue to develop existing arenas for testing and experimentation, and establish three new ICE worx innovation arenas with links to the Armed Forces' operational activities. We will invite technology and industrial companies to these arenas in order to develop practical solutions for operational needs, in close partnership with our researchers and military personnel.

Horten

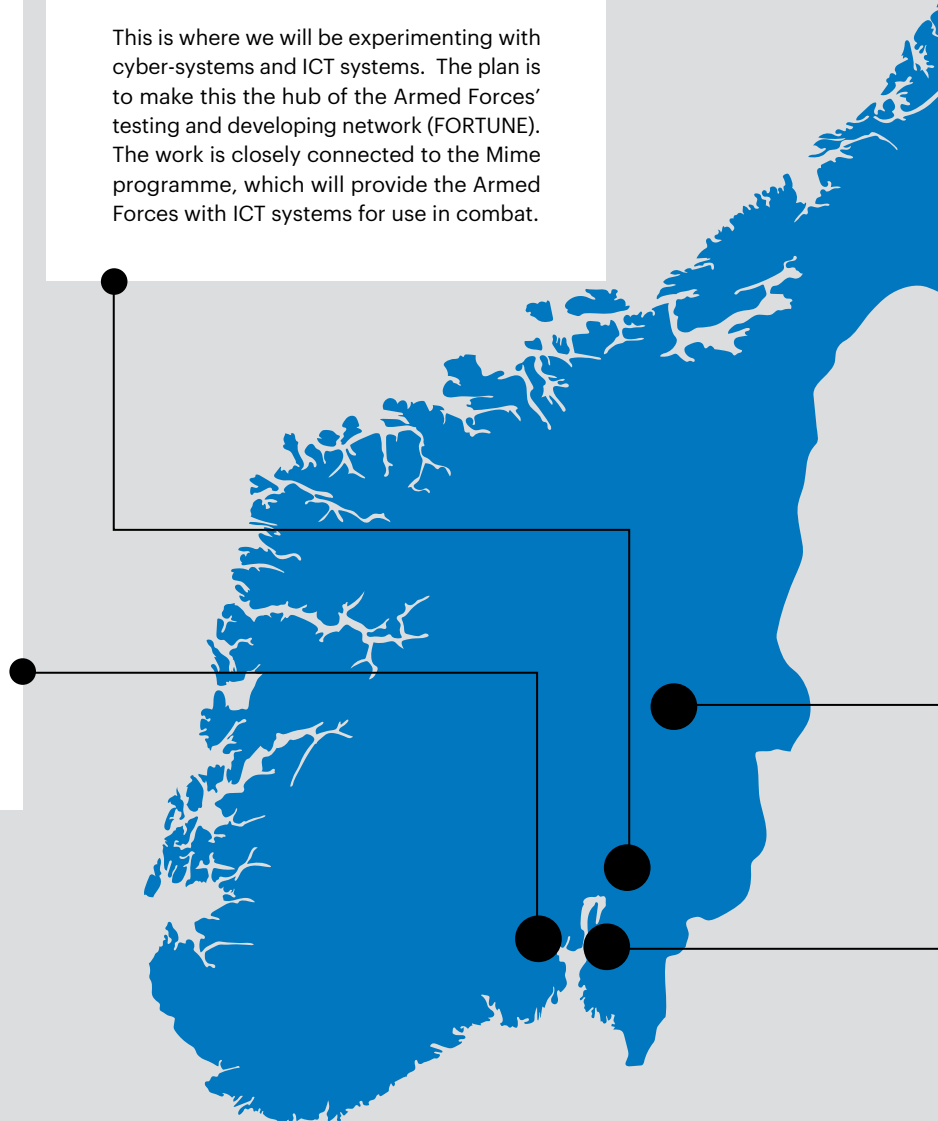
For many years, Horten has acted as a testing and experimentation arena for maritime systems, with a particular focus on modular autonomous systems.

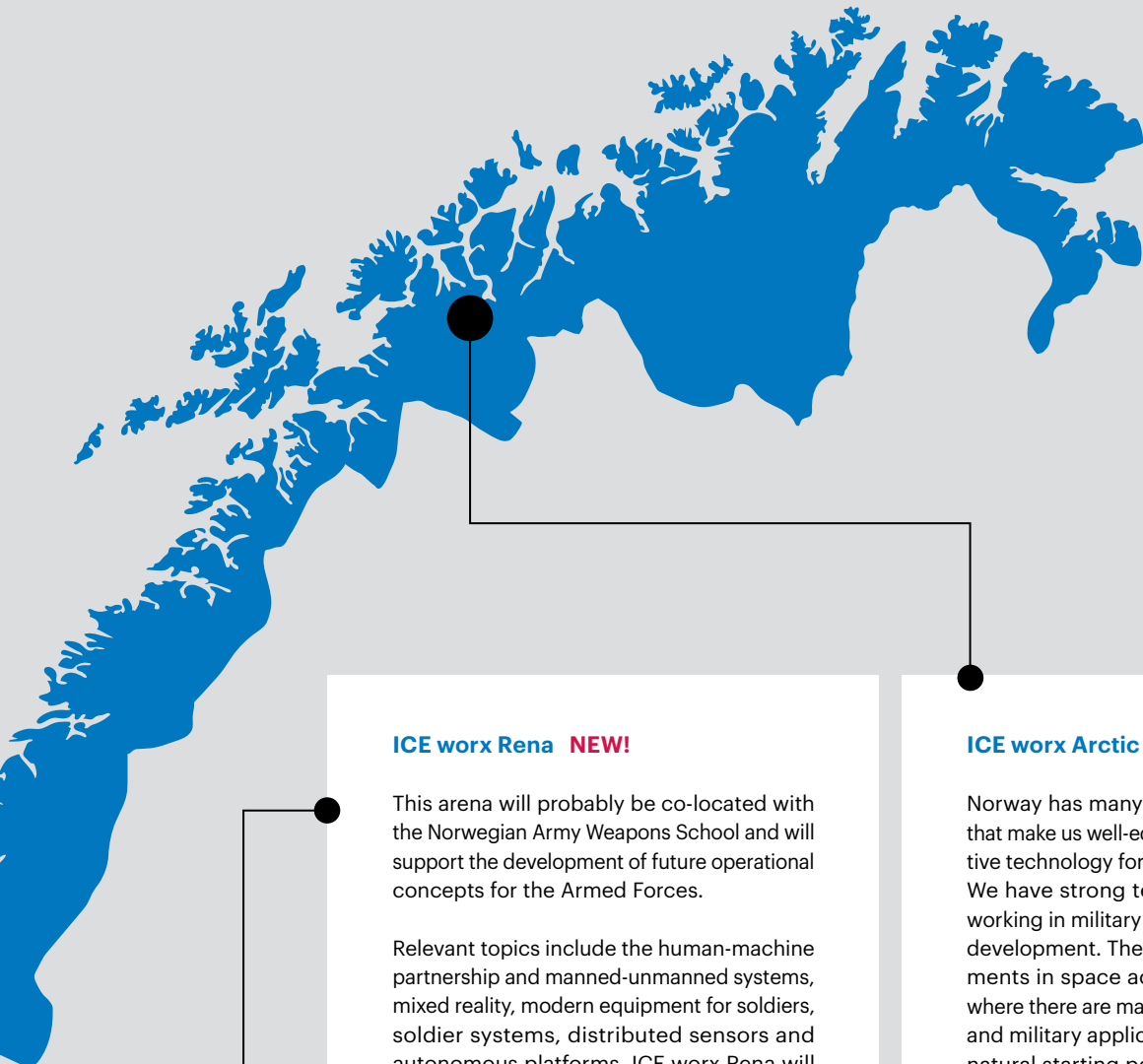
“Modular” means that something is made up of independent modules or “building blocks” that can be put together in different ways for different applications. “Autonomous” means that systems can perform actions and tasks without being directly controlled by people. An example of an autonomous modular system is the new Norwegian Maritime Mine Counter Measure system that will be in place by 2028. This will combine the use of technologies such as autonomous service vehicles and the HUGIN underwater vessel to detect and neutralise underwater mines.

Ultimately, FFI is planning to continue developing Horten so that innovation and experimentation will be reinforced with everything from underwater systems to general command, control and information systems in a joint operational environment.

ICE worx Kjeller **NEW!**

This is where we will be experimenting with cyber-systems and ICT systems. The plan is to make this the hub of the Armed Forces' testing and developing network (FORTUNE). The work is closely connected to the Mime programme, which will provide the Armed Forces with ICT systems for use in combat.





ICE worx Rena **NEW!**

This arena will probably be co-located with the Norwegian Army Weapons School and will support the development of future operational concepts for the Armed Forces.

Relevant topics include the human-machine partnership and manned-unmanned systems, mixed reality, modern equipment for soldiers, soldier systems, distributed sensors and autonomous platforms. ICE worx Rena will develop systems to make it easier to experiment with autonomous vessels working in partnership with manned vehicles.

Rygge

In partnership with the Air Force and defence industry, FFI has been experimenting here since 2019 on solutions for base defence, command/control and area control at fixed bases. Sensor technology, sensor integration and situational awareness have been keywords for its activities.

Looking ahead, planned experiments include autonomous ground service vehicles and countermeasures against drones. The solutions developed must be robust enough for use in an Arctic climate, since they will be used at the bases in the High North.

ICE worx Arctic **NEW!**

Norway has many competitive advantages that make us well-equipped to develop innovative technology for applications in the Arctic. We have strong technology communities working in military technology and industrial development. There are also rapid developments in space activity in the High North, where there are major synergies between civil and military applications. All this provides a natural starting point for a comprehensive focus on innovation in the High North.

ICE worx Arctic's Goal is to help the Armed Forces, civil preparedness authorities and NATO to have effective and relevant equipment that is especially adapted for use in northern regions. The arena will facilitate partnerships with relevant expert communities and industry in this part of the country.

A successful initiative will strengthen Norway's defence capabilities and preparedness. Skills development and business development for a more sustainable and attractive society in the High North are possible additional effects.

Strategic partnerships

FFI works with a range of national and international expert communities to gather knowledge and ensure that the Armed Forces will derive maximum benefit from the rapid developments in technology.

FFI's production goal 5:

Knowledge production is strengthened through strategic R&D cooperation with allies and selected actors

In 2020, FFI and the University of Oslo signed a partnership agreement in which FFI and the Department of Technology Systems will exchange competence in areas such as sensor technology, lasers, autonomy, cyber-security, quantum technology, network technology, space technology, fluid dynamics and material technology. We also have an ongoing partnership with the Norwegian University of Science and Technology (NTNU) in autonomy, in which FFI employees pursue doctoral degrees with supervisors from NTNU. At the same time, FFI employees specialising in autonomy work part-time at NTNU, supervising and recruiting talented students. This partnership allows two of the strongest Norwegian specialist communities in autonomy to exchange information and experience in technological developments in this field.

We also have partnerships that connect academia and industry to the research and development work carried out by FFI for the Armed Forces. An example of this is the partnership agreement between the University of Bergen, Institute of Marine Research, NTNU, University of Tromsø and Kongsberg Maritime regarding the utilisation of autonomous underwater vehicles in maritime research.

Much of the partnership work carried out by FFI and national knowledge communities is currently operational, and linked to specific projects and problems that must

be solved. This type of partnership is not necessarily associated with general agreements, but is achieved through specialist networks, in which people with specialist expertise are brought in from other institutions to contribute to a project or a report. As well as national research and education communities, FFI works with a number of Norwegian technology companies in the development of prototypes and industrialisation of products that could be useful to the Armed Forces. A recent example is the partnership with Yeti Move on the development of technology for autonomous logistics convoys for use in the Armed Forces. FFI's Innovation and Industrial Development Division and our ICE work innovation centre will help to professionalise and systematise this type of development work.

Norway must contribute internationally

However, from FFI's perspective, most important strategic partnerships involving new defence-related technology and development are international. The USA and China are involved in a frantic race for technological hegemony. NATO and our close allies have defined the development of new technology as a strategic linchpin in the efforts to improve defence capabilities and societal security. Norway and FFI are expected to contribute to this work.

NATO's research and development work is mainly performed through the NATO Science & Technology Organisation (STO)

– a network of 6,500 researchers, engineers and analysts from 30 NATO nations and 48 partner nations (2020).

In 2021, NATO STO is looking at how to ensure that sufficient research and development attention can be focused on the upcoming new technologies from the “S&T trends 2020–2040” trend study. This will also be important for FFI in the future.

Norway is one of the ten most active nations in the STO partnership. FFI is the biggest participant from Norway, but other defence agencies, academia and Norwegian industry are also participating in the activities. Norway is an attractive partner because we can offer world-class niche competence, defence technology and defence systems. This is cooperation that will help give Norway access to high-tech military equipment and services, and the knowledge needed to perform its own military research and development (R&D).

From 2020 onwards, FFI has been represented at senior level on three of STO’s seven technical panels. In summer 2021, FFI’s former Director General John-Mikal Størdal will take over the job of Director of STO’s Collaborative Support Office in Paris. Norway will thereby become even more visible and gain more influence in this important corporation arena.

European projects

Although NATO will continue to be the linchpin of the international technology partnership in which FFI is a participant, European partnerships are becoming increasingly important. FFI is represented on bodies such as the European Defence Agency (EDA), Anglo-Netherlands-Norwegian collaboration (ANNC) and the Strategic Mutual Assistance in Research and Technology (SMART).



In September 2017, more than 50 researchers from NATO and selected partner countries came to Kjeller to discuss standardising HF communication. Photo: Christian Tandberg / FFI

In the years ahead, Norwegian specialist teams will compete for funds from the European Defence Fund (EDF), in which Norway has decided to participate. FFI is aiming to become an important actor in this work, and will enlist the best people from the Norwegian defence-related technology communities in order to prepare good applications. FFI is in a unique position to utilise this opportunity through well-established partnerships with industry, academia and international actors.

On behalf of the Ministry of Defence, FFI has allocated personnel and resources to identify, initiate and coordinate international partnerships in the future. FFI has been allocated around NOK 40 million a year for this purpose. Much of this goes on

funding the participation of Norwegian industry and the civil sector in international defence-related R&D partnerships.

Norway’s increased focus on European partnerships in the many EU programmes also imposes new demands on FFI, since we are already actively participating in projects run by the European Space Agency and EU Horizon programme i 2020.

This increased focus has required measures such as the establishment of a separate budget for applications to EU projects. It may also be necessary to create a new position to coordinate this work, and to create incentives to encourage FFI projects to apply to and participate in EU partnerships.

We will continue to develop our Total Defence capability

Civil-military cooperation is a mainstay of Norwegian preparedness and crisis management.

FFI's production goal 6:

The Total Defence and civil-military cooperation are strengthened through R&D and utilisation of the technological developments

The Total Defence concept means that societal and military, public and private resources can all be used to tackle threats against societal security and national security. This involves utilising available and limited resources as well as possible in order to improve the nation's resistance and endurance during a crisis. The Total Defence concept therefore also makes sense from a socio-economic perspective.

Norway's defence capability is based on the Armed Forces' own capability, NATO's collective defences and reinforcement from close allies. But the Armed Forces' capability and the ability to receive allied support depends on cooperation with civil actors, in fields such as supplies, infrastructure and logistics. This dependence on civil actors has increased at the same pace as the reductions in support structure and functions, and the Armed Forces' increase in outsourcing, as well as privatisation and efficiency measures in the wider society.

NATO and the EU have also had an increasing focus on civil preparedness and robust social functions. In recent years, Norway has been the host nation for three major crisis management exercises organised by NATO, the biggest of these being Trident Juncture in 2018.

New knowledge about the Total Defence

The threat landscape faced by Norway is

changing. A consistent feature is that the threats are cross-sectoral. It means that every sector of society could be vulnerable to the use of force or pressure. The traditional distinctions between peace, crisis and war and between civil and military tasks are becoming blurred. Rapid technological developments are also challenging the current systems of system procurement and management. Civil-military cooperation must be strengthened in order to respond to challenges that are continuously developing and are becoming more complex.

In order to be able to continue developing the Total Defence for the future, in 2021 FFI is starting a new project called Total Defence Toward 2040. Some of the questions that the project will seek to answer are:

- What will the threat landscape and conflict landscape of the future look like?
- How will we plan our Total Defence in a society that is continuously changing?
- How can we develop the ability to achieve cross-sectoral situational awareness?
- Which future concepts and technological systems can be developed to improve our Total Defence capability and ability to resist?

Total Defence Toward 2040 will support the Ministry of Defence in its long-term

planning and policy-making, and other actors involved in the Total Defence.

Knowing more about the threat landscape

As well as throwing light on the question of how the Total Defence could and should be structured, FFI has a number of technology projects and research projects that could also help to provide civil sector parties involved in preparedness with more knowledge.

The topics we are looking at include cyber security, cyber operations, composite threats, terrorism, use of artificial intelligence, digital systems and CBRNE – which means research into chemical, biological, radioactive, nuclear and explosive threats. Its CBRNE knowledge and infrastructure proved relevant and enabled FFI to support the health authorities during the 2020 coronavirus crisis. In the years ahead, we will invest in CBRNE research and laboratory functions in order to improve our understanding of threats and continue our function as a national preparedness laboratory.

Influence operations are a less tangible, but equally real threat. One of FFI's new research projects aims to try to understand the entirety and extent of this threat. How could such operations damage central societal areas? Are there any countermeasures against influence operations? We will improve our national ability to understand and carry out information operations, as well as the abilities of society and the Armed Forces to protect themselves against influence operations.

We want to become more visible as a knowledge provider and adviser on Total Defence for the Armed Forces and actors involved in civil preparedness in the 2021–24 period. FFI will therefore enter into long-term partnerships with national and international research and development actors in order to continue developing the Total Defence in line with the government's ambitions.



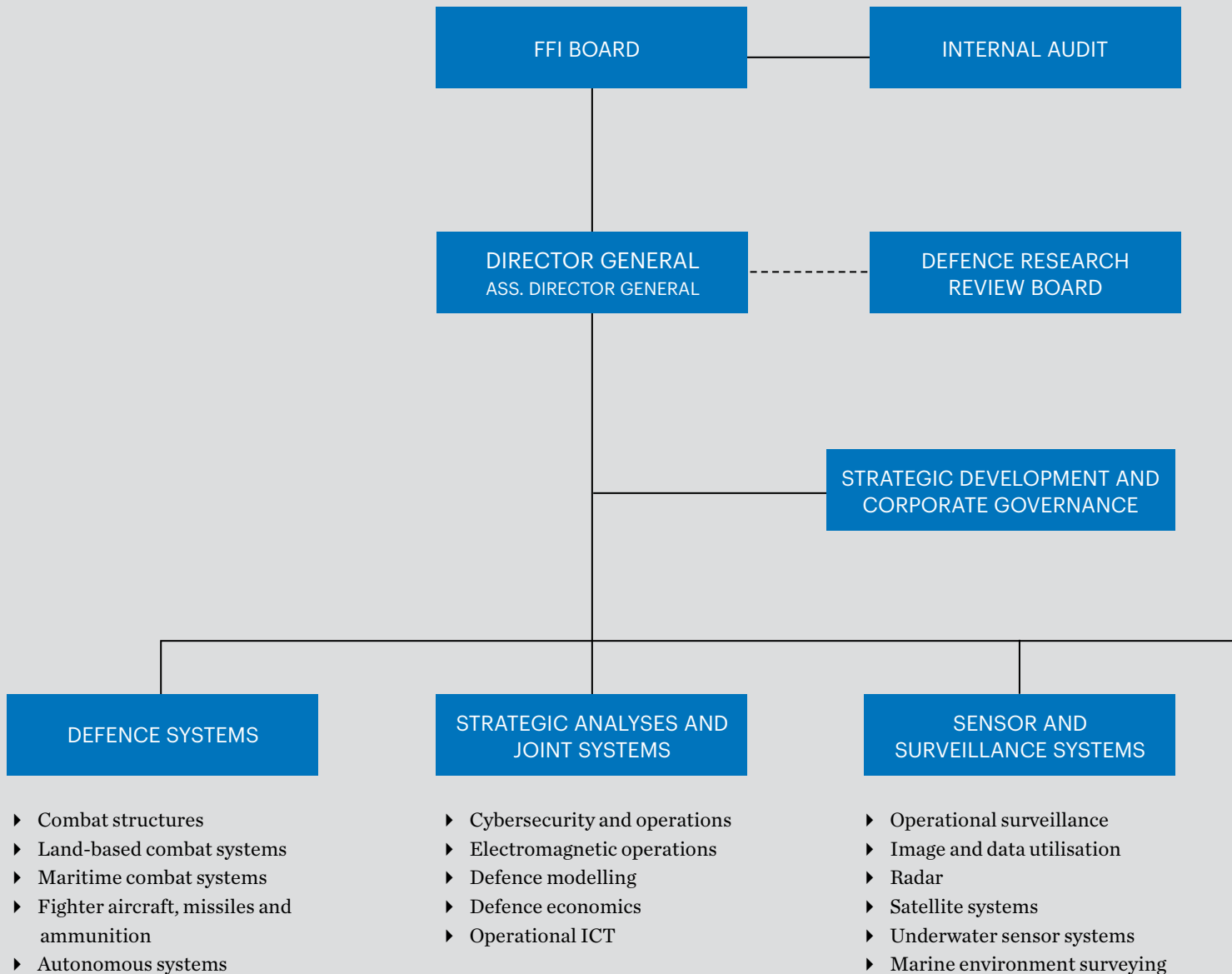
In January 2018, FFI became a national preparedness laboratory that can advise the emergency services and police on potentially hazardous substances. Photo: Lars Magne Hovtun / OBRE



The threat landscape faced by Norway is changing. A consistent feature is that the threats are cross-sectoral. It means that every sector of society could be vulnerable to the use of force or pressure.

Organisation chart

from 1 March 2021



EXECUTIVE GROUP

Espen Skjelland, *Director General (acting)*

Jan Erik Torp, *Assistant Director General (acting)*

André Pettersen, *Research Director of the Strategic Development and Corporate Governance Division (acting)*

Johnny Bardal, *Research Director of the Defence Systems Division*

Tor-Odd Høydal, *Research Director of the Strategic Analyses and Joint Systems Division (acting)*

Trygve Sparr, *Research Director of the Sensor and Surveillance Systems Division (acting)*

Janet Blatny, *Research Director of the Total Defence Division*

Hanne Marit Bjørk, *Research Director of the Innovation and Industrial Development Division*

Tove Johansen, *Director of the Operation and Support Division (acting)*

TOTAL DEFENCE

- ▶ Protection of society
- ▶ Sustainability and performance capacity
- ▶ CBRNE
- ▶ Information and interference
- ▶ Fluids and materials
- ▶ Terrorism and threat analysis

INNOVATION AND INDUSTRIAL DEVELOPMENT

- ▶ Asymmetric warfare
- ▶ ICE work innovation centre
- ▶ Innovation in the defence sector
- ▶ Commercialisation and industrial partnerships
- ▶ Technology trends
- ▶ National technology and industrial development
- ▶ Triaxial model 2.0

OPERATION AND SUPPORT

- ▶ Document centre
- ▶ Communication unit
- ▶ Property, buildings and construction
- ▶ Guards, security and reception
- ▶ HR unit
- ▶ Finance unit
- ▶ IT unit

FFI turns knowledge and ideas into an effective defence

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