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Norwegian long-term defence analysis

— a scenario- and capability-based approach

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Summary

The Norwegian Defence Research Establishment (FFI) supports the political and military leadership of Norwegian defence in their long-term defence planning. In this report, we describe and review the method FFI uses to assess possible future defence force structures' ability to solve future national security challenges.

No one can predict how our security environment will evolve over the time it takes to implement major changes in military forces, but we cannot dismiss the possibility that Norway may be attacked or otherwise influenced by foreign powers. Nor can we predict the nature of such an event, should it happen. The challenge for defence planners is therefore to plan for a flexible force, designed to be able to handle a wide variety of security challenges. Also, this ability should be attained as efficiently as possible. These are the central ideas of FFI's methodological approach.

To ensure that attention is directed to the effects a defence force structure should be able to produce, we state requirements in terms of *capabilities*. A capability is defined as the ability to achieve a specified effect in military operations. In other words, we try not to state premature requirements in terms of input factors such as materiel or personnel. This enables us to compare different force compositions that can deliver the same effects, i.e. the same capabilities, and find efficient solutions.

The capability requirements stem from analysis of FFI's *scenario portfolio*. We do not claim that the scenarios in the portfolio will happen. Nor do we claim that if a national security challenge occurs in the future, it exists as a scenario in the portfolio. The aim of the scenario portfolio is to span the possible security challenges well enough that the capabilities needed in real future situations have been required via the scenario portfolio. The requirements should represent a level of ambition for what the Armed Forces should be able to do, and the scenario portfolio provides an opportunity to express and interpret such levels of ambition.

In the report, we outline our procedures for developing and analysing scenarios for capability requirements. We also explain how we describe a proposed force structure's capabilities and compare these to the requirements. Furthermore, we discuss the inherent uncertainty in our results. Finally, we evaluate our method's strengths and weaknesses, and identify areas of improvement.

Sammendrag

Forsvarets forskningsinstitutt (FFI) støtter den politiske og militære forsvarsledelsen i deres langtidsplanlegging. I denne rapporten beskriver vi metodikken FFI bruker for å vurdere i hvilken grad planlagte eller tenkte forsvarsstrukturer vil kunne løse fremtidige nasjonale sikkerhets-utfordringer.

Vi kan ikke forutsi hvordan Norges sikkerhetspolitiske omgivelser vil utvikle seg i løpet av den tiden det tar å gjøre betydelige endringer i forsvarsstrukturen, men vi kan ikke utelukke at landet blir angrepet eller påvirket av andre nasjoner. Vi kan heller ikke forutsi hvordan et eventuelt angrep vil arte seg. Utfordringen for forsvarsplanleggere er derfor å planlegge en fleksibel struktur som vil være i stand til å løse et bredt spekter av utfordringer. Det er også et mål å finne kosteffektive strukturer. Dette er sentrale ideer bak FFIs metodiske tilnærming.

For å rette oppmerksomheten mot effektene en forsvarsstruktur bør kunne skape, formulerer vi krav til *kapabiliteter*. En kapabilitet er en evne til å skape en gitt effekt i militære operasjoner. Vi prøver med andre ord å unngå å stille krav til innsatsfaktorer som materiell- og personell-kategorier. Dette gjør at vi kan sammenlikne ulike styrkesammensetninger som kan skape de samme effektene, og finne effektive løsninger.

Kapabilitetskravene kommer fra våre analyser av FFIs *scenarioportefølje*. Vi hevder ikke at scenarioene i porteføljen kommer til å skje. Vi hevder heller ikke at en reell nasjonal sikkerhets-utfordring i fremtiden vil finnes som et scenario i vår scenarioportefølje. Målsettingen med scenarioporteføljen er å spenne ut de mulige sikkerhetsutfordringene godt nok til å sikre at vi stiller krav til de kapabilitetene vi vil trenge for fremtidige reelle sikkerhetsutfordringer. Kravene bør representere beslutningstakeres ambisjonsnivå for hvilke situasjoner Forsvaret bør være i stand til å håndtere, og scenarioporteføljen gir derfor en mulighet til å uttrykke og tolke slike ambisjonsnivåer.

I rapporten går vi gjennom hvordan vi utvikler og analyserer scenarioer for å stille kapabilitets-krav. Vi forklarer også hvordan vi vurderer en styrkestrukturs kapabiliteter og sammenlikner disse med kravene. Videre diskuterer vi den iboende usikkerheten i resultatene våre. Til slutt vurderer vi styrker og svakheter ved metodikken vår og peker på aktuelle områder for forbedring.

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Preface

In this report we document FFI's approach to operational analysis support to long-term defence planning. Members of FFI's team have developed and improved the method over the past 15 years. We are grateful to Sigurd Glærum, Steinar Gulichsen, Jørgen André Hansen and Alf Christian Hennum for helpful comments on unfinished drafts of the report.

Kjeller, 21 October 2020

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1 Introduction

Reliable analytical support is critical for successful long-term defence planning. National defence is widely regarded as a vital public service that requires a significant share of our common resources. Ill-advised decisions about future defence can be costly and potentially dangerous. Determining the best development of the armed forces is a highly complex problem with solutions that take years to implement. Even experienced subject matter experts have incomplete knowledge and are prone to bias. Decision-makers therefore rely on advice based on rigorous analytical approaches.

The uncertainty about our future security environment forces us to plan for the unknown. We cannot predict exactly what opposition our armed forces will have to meet in the future, so the ability to take on a wide variety of challenges is necessary. However, we cannot spend unlimited resources and prepare for every contingency. In the end, the decision comes down to a risk judgement: How likely are the various possible threats to our future security, what would the consequences of such attacks be, and how important is it to mitigate that risk when the same resources can be spent towards other needs in society? Answering these questions and their follow-ups leads to some conclusions about how the armed forces should evolve.

The Norwegian Defence Research Establishment (FFI[1]) supports the military and political leadership of Norwegian defence in answering these questions. The aim is to contribute to a balance between the tasks assigned to the armed forces, the force structure and the cost to maintain the force structure. FFI does not advise on how to weigh risk mitigation in defence planning against possible benefits in other sectors of our society. That is a matter of political judgement. FFI's objective is to assess the effectiveness of defence expenditures and contribute to informed decision-making on the development of the future force structure. When the decision-makers decide upon a future force structure, they should be able to understand what the force structure will be able to do, and correspondingly, what it will not be able to do. Our scenario- and capability based approach gives an opportunity to establish a level of ambition that is in line with their risk tolerance and the available resources. We advise on questions like whether it is a good idea to invest in new tanks, or how different mixes of anti-surface warfare units compare. The analysis process should be unbiased, traceable and verifiable.

This report describes FFI's analytical framework for operational analysis support to long-term defence planning. Since 2006, we have used a format closely related to the NATO Capability Requirements Review (CRR), conducted by the NATO Communications and Information Agency (NCIA).[2] Together with advice on economics and cost analysis (which we do not

[1] The Norwegian Defence Research Establishment is generally known by its Norwegian abbreviation FFI (Forsvarets forskningsinstitutt).

[2] The methodology has previously been documented in Glærum and Hennum (2016), and Hennum and Glærum (2007). For NATO's approach and comparisons of different NATO nations' approaches, see NATO (2010). A comparison of analysis support to strategic planning in Australia, Canada, New Zealand, the UK and the US, see Taylor (2013).

discuss here), this constitutes FFI's main contribution to the Norwegian Ministry of Defence's strategic defence reviews.[3]

Our motivation for writing this report is threefold: First, we wish to highlight the importance of rigorous analytical methods in long-term defence planning and make FFI's approach accessible to the public. Second, the report will be useful when we discuss experiences and practices with colleagues in the international defence analysis community. Third, we wish to examine our methods and identify areas for improvement.

After a brief overview of FFI's method, we will describe how we identify requirements and how we assess force structures' ability to meet the requirements in Chapters 2–4. In Chapter 5 we will discuss the uncertainty aspect in our work. Then we evaluate strengths and weaknesses in our approach in Chapter 6, and discuss further development when we conclude in Chapter 7.

1.1 Method overview

FFI's solution to the problem of planning an efficient force for an unknown future has two main features: It is *capability based*, and it is *scenario based*.[4] Capabilities help us achieve flexibility and efficiency, while scenarios help us explore a variety of unknown future problems.[5] Our objective is to identify a well-equipped military toolbox, not to describe the tactics the forces should use in combat, which will depend on the actual situation.

Understanding and expressing requirements for the armed forces are key in defence analysis. We must recognise that the final output of the defence force is the ability to solve security challenges, and that the people, the equipment and the organisation are merely means for delivering this ability. This motivates our language of capabilities. A capability is the ability to perform a certain task or achieve a certain end in a military operation. If we manage to describe the defence requirements in terms of capabilities, we preserve a certain flexibility in what the force structure can look like while still fulfilling the requirements, since there can be many ways to obtain the capability. This allows us to compare the real usefulness of different force compositions, and to evaluate on effect rather than input.

We have therefore defined a set of abstract capabilities that allows us to formulate both the requirements and the ability of a proposed force structure, and to decide whether the force structure meets the requirements. In other words, we do not state requirements in terms of units such as *fighter aircraft*, but rather in terms such as *anti-surface warfare*. Similarly, we evaluate

[3] The latest comprehensive independent FFI study on the future of Norwegian defence is documented in Skjelland et al. (2019). We refer to information from FFI's research on defence economics for costing methodology descriptions, see e.g. Gulichsen (2015) and Nielsen et al. (2018).

[4] Internationally, some defence analysts use the term *capability based planning* more generally to distinguish planning aimed at flexible forces for unknown situations from *threat based* planning, which seeks defence against specific threats. For examples from US security thinking, see Davis (2002). We will use a more restrictive definition of the term.

[5] We use a scenario portfolio as a tool for exploring possible future situations and a testing ground for proposed force structures. We do not try to predict the future. See e.g. Gray (2010) for a discussion of this balance.

a proposed force structure by examining what capabilities it can deliver. We update capability definitions regularly. Chapters 2–4 explain how we evaluate the requirements, the force structure and the gaps.

The requirements stem from analysis of our portfolio of scenarios. The scenarios are hypothetical, though realistic and concrete, challenges to our security up to 20 years into the future. Imagination and creativity is necessary in the creation of scenarios. However, we must keep the creativity in check so we do not require capabilities for situations that are too far-fetched.

In order to make decisions on future force structures, the decision-makers must commit to a level of ambition for what the armed forces should be able to deal with. As explained above, we cannot expect the armed forces to solve every thinkable security problem, but the question is which security problems are likely enough and consequential enough that mitigating the risk is worth the cost. This leads to a decision on which scenarios are within the level of ambition, and which ones are outside it. It can be difficult to obtain formal leadership guidance, but FFI's scenario approach provides an opportunity to express or interpret the ambition explicitly in terms of what the force can achieve. In the political decision, this ambition lies implicit in the chosen organisation and procurement plan.

We do not expect that the scenarios in the scenario portfolio will happen. Nor do we claim that if a national security challenge occurs in the future, it will exist as a scenario in the portfolio. The purpose of the scenario portfolio is to span the range of possible security challenges well enough that the capabilities we need to solve future security problems are required by the scenario portfolio.[6] The scenario- and capability-based approach thus enables us to deal with the uncertainty about what the future will bring.

The time horizon in our analysis is typically 20 years, but the further towards the horizon we look, the foggier is the view. We try to avoid cognitive pitfalls in our estimates of what the future may bring. Such cognitive pitfalls include short-sightedness, premature cognitive closure, bias due to feelings about the military, abuse of historical analogies, and undue application of simplistic ideas to complex problems.[7]

Figure 1.1 depicts the components of FFI's long-term defence analysis approach schematically. We will detail the contents of each component in Chapters 2–4.

[6] Indeed, the best outcome is that possession of the capabilities suffices to deter or otherwise avoid the challenge.
[7] Beadle (2016) identified and explored these cognitive pitfalls in a Norwegian defence analysis context.

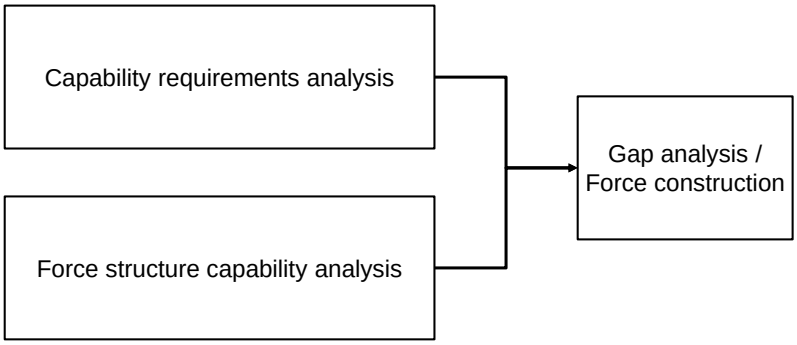

Figure 1.1 A schematic view of FFI's approach to long-term defence analysis.

Box 1.1 Capabilities, Force Structure Elements, and Reference units

For our purposes, we define a capability to be "the ability to perform a certain task or achieve a certain end in a military operation". This definition resembles definitions used by several of FFI's international counterparts, e.g. Canada's DRDC[8], Australia's DSTO[9], and NATO's NCIA[10]. However, the implementation of this concept varies among its practitioners. This often comes down to the analysts' choice of granularity, i.e. the level of detail in the analysis. For one analyst, a capability can be something aggregate like "amphibious attack", which is then defined by certain requirements. For another analyst, a capability can be detailed, like "explosive ordnance disposal". The analysts' choice will depend on the analytic purpose and the information available.

In FFI's current setup, force structures are described as composed of *force structure elements*, which are typically one single navy vessel, one single aircraft or some land force unit (e.g. a battalion, a company or a platoon of a certain type). Capabilities are assigned to the force structure elements in order to describe their abilities. The same capability can be assigned to different force structure elements.

When is it appropriate to say that two force structure elements can deliver the same capability? Frigates and maritime patrol aircraft both have the ability to find and attack submarines, but their characteristics are widely different. To what extent can we claim that with respect to anti-submarine warfare, their contributions are comparable simply by a numeric factor? This depends on the analysts' objectives, but also on what the scenario-derived requirements are.

[8] See Rempel (2010).
[9] See Chim et al. (2010).
[10] See NATO (2010).

In order to compare different force structure elements' capacity for a given capability, we assign a *reference unit* to each capability. This is a yardstick against which every force structure element's capability will be measured. This enables the analyst to describe capability scores, or equivalency factors, for each force structure element. If the capability score cannot be decided, the capability is not sufficiently well-defined.

Since the analysts define the capabilities and reference units, these may be revised whenever the current modelling can be improved with new knowledge. Such new knowledge can stem from outside sources or as a result of our own analyses. The context and scope of the analysis work may also prompt revisions of the capability definitions.

2 Analysis of requirements

In this chapter, we will explain how we analyse Norway's security environment and its implications for long-term defence planning. The process starts with a view of global security trends and ends up with a set of capability requirements for the Norwegian Armed Forces. Figure 2.1 displays the process.

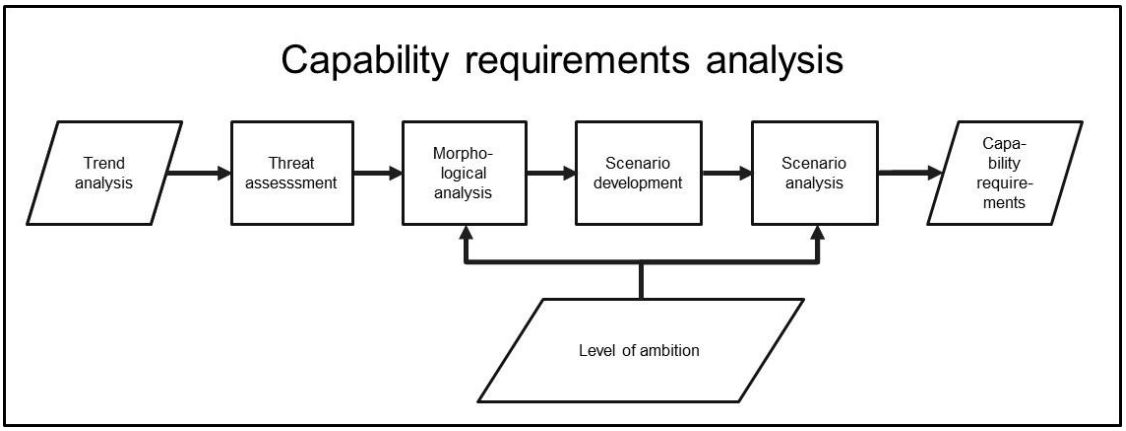

Figure 2.1 Schematic view of the capability requirements analysis.

The portfolio of scenarios that we develop in this process, together with concurrency specifications, represents the overall *level of ambition* for what the armed forces should be able to handle. It should express the decision-makers' preferred balance between risk tolerance and

cost. Some thinkable threats will be outside the level of ambition because they are too unlikely (in our 20 year perspective) relative to the cost of preparing for them.[11]

2.1 Analysis of threats to Norwegian security

The analysis starts with a view of the main global trends and developments that we expect will have implications for Norwegian national security. In addition to trends in international politics, it involves areas such as technology, economics, demographics and climate.[12] This gives awareness of possible future security issues and indicates their likelihoods.

The scope of our analysis is the area of responsibility for the Norwegian Armed Forces, as described in official documents.[13] It would be possible to extend the analysis to include tasks that currently are the responsibility of other government sectors. However, the main purpose of our analysis is to clarify the implications for the Armed Forces. There are certain important areas where the Armed Forces support the responsible authority with niche capabilities, and we need to consider these as well. Notable examples are response to terror attacks and coast guard duties, where military units perform operations on behalf of the police. The Norwegian Armed Forces are also involved in handling situations that are not caused by intended actions, such as search and rescue operations and disaster relief. Requirements for such capabilities are analysed elsewhere and are not within our scope, even though they can have implications for the defence force structure.

We have applied morphological methods to identify and systematize the potential security threats. The analysis was carried out for the first time in 2006. A group of subject matter experts contributed with ideas, and we consulted major stakeholders within the Norwegian Armed Forces.[14] We revised the analysis in 2014 and 2018.[15]

In the first step of the morphological analysis, we identify a set of relevant parameters that characterise threats to Norwegian security. Our choice of parameters in this analysis are *actor*, *objective*, *method* and *means*. There are several possible choices of parameters, and none necessarily best, but our choice has been fit for our purpose, and we left it unchanged in the 2018 revision. Within each of these parameters, we define a set of possible parameter values. We need to keep in mind that we try to look up to 20 years into the future, so we may need to include values that we consider unthinkable in the short term. The values should ideally not overlap and should span the parameter completely. We only include values that have direct implications for the Norwegian Armed Forces. As an example, the possible values for the *means* parameter are “Extensive military force”, “Limited military force” and “Irregular means”. There

[11] Examples of scenarios that are not in our current portfolio are full-scale invasion of the entire country and nuclear attack (deterrance of which is left to NATO).
[12] The most recent global outlook report from FFI is Beadle et al. (2019). The findings’ implications to Norwegian security have been explored in classified work.
[13] The current political long-term defence plan is outlined in Norwegian Ministry of Defence (2016).
[14] Johansen (2006) and Johansen (2018).
[15] Vatne et al. (2018).

are other possible means to threaten Norwegian security, e.g. economic sanctions, but this does not primarily challenge the defence sector.

In the next step of the morphological analysis, we evaluate the consistency of all pairs of parameter values. As an example, "Extensive military force" as a means is consistent with a state or coalition of states as actor, but inconsistent with a non-state actor. After the consistency check, we have a more manageable set of consistent combinations. We then group these combinations into *scenario classes*, which are generic sets of potential challenges.[16] At this point, we also check that the scenario classes are non-empty, i.e. that there is at least one possible scenario in the class. The scenario classes currently in our analysis are Strategic assault, Limited attack, Coercive diplomacy, Subversion, and Terror attack. Table 2.1 shows the set of values for the different parameters. As an example, the values for the scenario class Limited attack are shaded. Four possible combinations of parameter values are part of this scenario class.[17]

Table 2.1 The morphological matrix. Values for the scenario class Limited attack are shaded.

Actor	**Objective**	**Method**	**Means**
State / group (coalition) of states	Conquest / change of regime	Control of Norway's full territory	Extensive military force
Non-state actor	Political change	Control of parts of Norway's territory	Limited military force
	Defence of own freedom of action/movement	Denial of Norwegian and/or allied military operations	Irregular means
	Economical gain	Disruption of Norwegian and/or allied military operations	
		Attack on Norwegian infrastructure or population	
		Demonstrate ability and intent to use military force against Norway	

2.2 Scenario development and analysis

For each of these scenario classes, we *develop scenarios*. Each scenario class has scenarios that should cover a wide enough range of situations for the generic challenge represented by the scenario class.

[16] This corresponds to what NATO calls *Mission Types* in the NATO defence planning process.
[17] This is the revised morphological matrix, which differs somewhat from the original one presented by Johansen (2018).

In order to develop a scenario, we populate the generic scenario class with specific details. This means that we specify the parameter values and fill in details in order to create a hypothetical situation that we can analyse for requirements. We need to describe relevant information about the opponent (RED), including his strategic goal, his order of battle (OOB) and his operational goal and course of action (COA). We also have to describe the timeline for the RED action, counting from the time of the first signal, indication or alert of a possible attack, intrusion or threat, and the domains in which these actions take place.

We invite military and civilian subject matter experts to take part in our *scenario analyses*. Typically, we use table-top map discussions, supplemented with technology considerations and a variety of numerical models to evaluate requirements.

In the scenario analysis, we describe the Norwegian Armed Forces' (BLUE) actions in the scenario. First, we have to clarify the BLUE strategic goal, which must be in line with the overall level of ambition. Second, we have to develop a COA and describe the operational goal. Based on the BLUE COA, we divide the scenario into different phases. The phases represent a rough estimated timeline of the scenario and is a framework for our analysis. In reality, however, the duration of the different phases may vary between the domains, and the phases may overlap in time. In some scenarios, we try more than one COA, and present results for each of them seperately. It can be difficult to compare the effectiveness of different COAs, as explained in our discussion on uncertainty in Chapter 5.1.

In the next step of the analysis, we describe the main tasks that the Armed Forces must accomplish in each phase of the scenario in order to achieve the BLUE operational goal. We then decompose the tasks into a hierarchy with key tasks and capabilities at the bottom level. The full decomposition of tasks, including the capabilities, is platform independent, i.e. it does not specify what type of force structure element should perform the task. This helps us keep materiel options as open as possible.

For each capability, we follow a set of calculation rules for finding the amount of each capability BLUE needs in order to be able to perform the various tasks. The calculations may use scenario parameters such as the size of the operational area, numbers and locations of specific scenario elements and the level of threat as input. As an example, the required amount of anti-surface warfare and anti-submarine warfare capabilities to secure a Sea Line of Communication (SLOC) will depend on the SLOC's length and the threat level in the scenario. Such parameters will be different in different scenarios, but the calculation rules are general and apply across scenarios. Platforms with the relevant capabilities, e.g. frigates, may also possess other capabilities required for other tasks in the same scenarios, but for these capabilities, different rules may apply.

2.3 Capability requirements

The result of the scenario analysis is a set of *capability requirements* for each scenario, which is the combination of requirements for each task. We calculate the requirements for each task, and

we aggregate them to requirements for each phase. In some cases, the total requirement is simply the sum of requirements for each task, e.g. when there is need for maritime capabilities in different areas of operation at the same time. In other cases, it is possible to reuse capabilities across tasks, e.g. operational command and control capabilities or common infrastructure.

The final set of requirements represents the total available and operational capabilities that an ideal force structure should possess in order to meet the challenges posed by the portfolio of scenarios. They depend on the level of ambition for simultaneous operations, i.e. how many scenarios from different scenario classes the Armed Forces should be able to handle at the same time.

So far, we have described our process for deriving threat-driven capability requirements needed to solve possible security challenges. In addition, there will be capability requirements related to everyday peacetime operations such as border patrol and surveillance. These requirements do not fit into our scenario class framework since there is not a single opposing "actor" on the macro level. Still, we often refer to these activities as a "peacetime scenario".

3 Capability analysis of force structures

In this chapter, we will describe how we analyse the capabilities of a defence force structure. The set of capability requirements – derived from a portfolio of scenarios as described in the previous chapter – does not translate directly into a defence force structure, i.e. it does not constitute a suggested defence force structure. However, we use the set of capability requirements as a benchmark, and we evaluate various defence structures against it. To this end, we need to describe the force structure in terms of the capabilities it possesses, the capacity for concurrent capability delivery (called *roles*), and its availability in scenarios. Figure 3.1 shows the steps in the analysis.

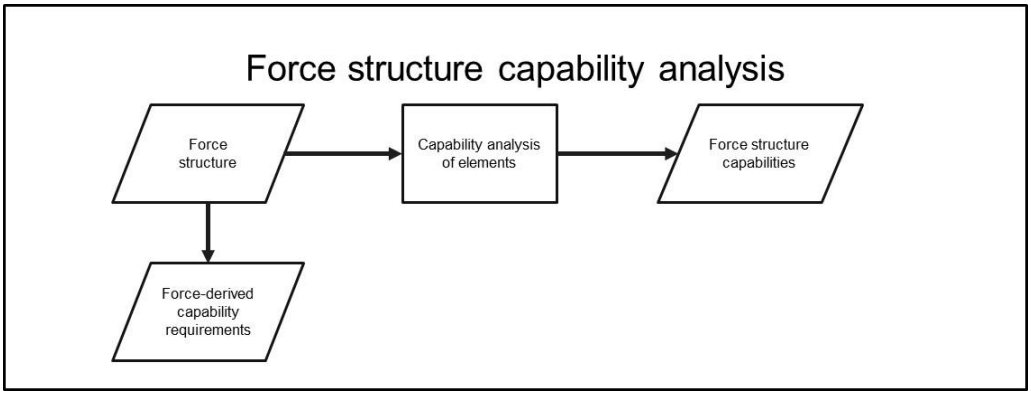

Figure 3.1 Schematic view of the force structure capability analysis.

3.1 Different types of defence force structures

We evaluate the capabilities of different defence force structures:

A. The current defence force structure. In this analysis, we choose a certain date and study relevant detailed inventory lists and status reports for the Armed Forces at this date.[18]

B. A future defence force structure according to a long-term plan. We then describe the defence force structure at a given year in the future, and, usually, we consider a selection of years in order to cover both short to medium term plans and more long-term plans.

C. An alternative future defence force structure. This type of analysis can be part of an independent FFI study or support to long term defence planning conducted by the Ministry of Defence or the Norwegian Armed Forces.[19]

The quality of the underlying information is better for analysis of current and traditional force structures. We have to make more assumptions when we analyse a future force structure.

3.2 Analysis of force structure elements

In order to analyse the capabilities of a defence force structure, we break it down into a number of smaller *force structure elements*. The level of detail of this analysis depends on various factors, including the amount of information available. In a Norwegian context, typical examples of force structure elements can be a naval vessel, an aircraft or a battalion. The analysis is restricted to the parts of the force that is directly involved in the scenario and their immediate support functions. That is, we do not assign capabilities to units such as military schools, strategic planning staff or purely administrative departments.

For each force structure element, we describe the set of capabilities it possesses. For each of those capabilities we evaluate the force structure element's ability compared to a designated reference unit, as described in Box 1.1. This performance ratio provides us with a measure of the force structure element's capacity. As an example, both a maritime patrol aircraft (MPA) and a frigate can have the Anti-Submarine Warfare (ASW) capability. If we take the MPA as our reference unit, we have to define how many MPAs we need to replace one frigate. If two frigates can solve the same task as five MPAs, then each frigate is equivalent to 5/2 = 2.5 MPAs with respect to the ASW capability.[20] In this fictitious example, the frigate's ASW capacity is

[18] A variant of this analysis is to evaluate the potential strength of the defence force structure after a transition period, e.g. twelve months, during which the Norwegian Armed Forces could take measures to increase the availability of the capabilities they already have. We presume there is a change in external factors which stimulates an increase in maintenance work and training, and we explore the effect of these.
[19] These analyses are typically iterative. In a first step, we may identify operational gaps or redundancies that we need to rectify in the next step, or we may end up outside the cost limits for the analysis. An alternative approach for this type of studies is to use optimization methods to identify cost-effective defence force structures.
[20] This example is fictitious, and these values are not used in analyses, which are typically classified.

2.5, given MPA as the reference unit. Note that both of these force structure elements have other capabilities as well. In addition, we have here assumed that the frigate's and the MPA's contribution to ASW are sufficiently similar in nature to allow us to compare them by a numeric factor. This will depend on the scenarios where ASW is required.

We can base the performance ratio calculations on simulations or other numeric models, rules-of-thumb, or subject matter expert judgement. Criteria for comparison include the ability to maintain operations (coverage of time), range (coverage of area) and effect (probability of achieving the objective). The choice of criteria will be different for different capabilities, and depends on the type of task and scenario for which we primarily use the capability.

A *role* is a set of capabilities that a given force structure element can deliver simultaneously or at least in the same phase of a scenario. Some force structure elements have only one role, while others, like fighter aircraft, have various roles, where each of its capabilities belong to one or more of these roles. In the latter case, there is a potential conflict of roles if different capabilities are required in a scenario.

The availability of the force structure elements in the different phases of a scenario will depend on parameters like readiness, transit time and endurance. Estimating these parameters requires careful analysis of factors such as transport resources, stock availability and supply chains, attrition and combat losses. We will not expand on this here.

When we analyse the current defence force structure, we can use status reports to evaluate the availability of force structure elements. When we analyse a future force structure we do not have the same level of certainty or detail. In this case, we have to make some assumptions about the availability of the various force structure elements. We presume that there is a personnel structure and a maintenance regime in place that can provide the required readiness and endurance.

The fact that the force structure needs to be maintained, protected and otherwise supported thus leads to force-derived capability requirements, typically logistics and force protection, that cannot be derived directly from the scenarios, but are generated by the force itself. We use these requirements in the gap analysis, in addition to the scenario-derived requirements.

Significant parts of the defence organisation are outside the scope of our analysis, which deals with units directly involved in handling threat scenarios. Among the excluded elements we find staff that handle several tasks such as strategic planning, personnel management and procurement.

3.3 Aggregation of force structure elements

When we have analysed the capabilities of all the force structure elements in a defence force structure, we can aggregate them. This aggregation provides a complete description of the

capabilities that the defence force structure possesses, and which of these will be available at various time steps in a given scenario.

It is possible to apply our methods to search for optimal force structures, i.e. the force structures that fulfil the requirements at the lowest cost. This requires cost estimates for the different force structure elements and for support systems in the organisation. Allocating the total cost to force structure elements is non-trivial, and we refer to information from FFI's research team for defence economics for descriptions of how FFI models cost implications of force structures.[21] For gap analyses like those that we describe in the next section, cost estimates are not necessary.

4 Gap analysis

In the gap analysis, we assess the differences between the capability requirements identified through scenario analysis (Chapter 2) and the actual capabilities of a force structure (Chapter 3). The capability requirements should include the force-derived capability requirements, which ensure a well-supported force structure (Chapter 3.2).

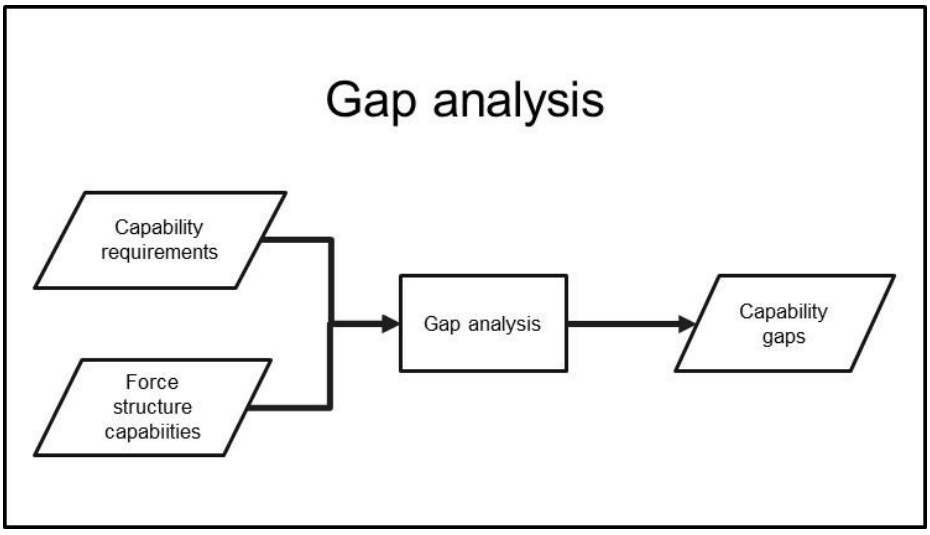

Figure 4.1 The gap analysis is simply a comparison between the capability requirements and the capability description of the present or future force structure.

The target state, or wanted state, in the gap analysis is the total requirements for the Norwegian Armed Forces. It depends on the capability requirements for each scenario and the level of ambition for simultaneous operations. Each possible combination of scenarios that is within the simultaneity ambition represents a benchmark against which we can evaluate a defence force

[21] See e.g. Gulichsen (2015) and Nielsen et al. (2018).

structure. A *driving benchmark* is a benchmark that is decisive for either the size or the readiness level of a capability requirement.[22]

The simplest concurrency ambition is to handle only one simultaneous scenario, in which case there is a one-to-one correspondence between scenarios and benchmarks. The presentation in this chapter is based on this level of ambition, and we use scenario and benchmark as equivalent terms.

In our results, we differentiate between three different types of gap for a capability:

- Force structure gap
- Readiness gap
- Total gap, which is the sum of force structure gap and readiness gap

A force structure gap can occur in two different situations:

- The capability in question does not exist in the force structure, or it exists, but with insufficient capacity.
- The capability in question exists in the force structure, but due to a conflict of roles, the relevant force structure elements will be assigned to tasks with higher priority.

In order to identify a readiness gap, we have to take time and space into consideration. The scenarios contain geographical details and timelines, and the force structure elements have a location and a readiness state. When trying to fulfil the requirements we must consider the readiness of the forces and the time to deploy the forces to the location determined in the scenario. If the force structure element, or more precisely the capability, cannot reach its location in time, we get a readiness gap.[23] Figure 4.2 illustrates what a mapping of capability against a timeline might look like, and the shaded area in Figure 4.3 shows a readiness gap.

[22] Different capability categories can have different driving benchmarks. It is also possible that one benchmark drives the size of the requirement of a certain capability, while a completely different benchmark drives the associated readiness requirement.

[23] Formal and real readiness may not be exactly similar. Some analysis and deliberation is needed to determine the real war time readiness of the capabilities.

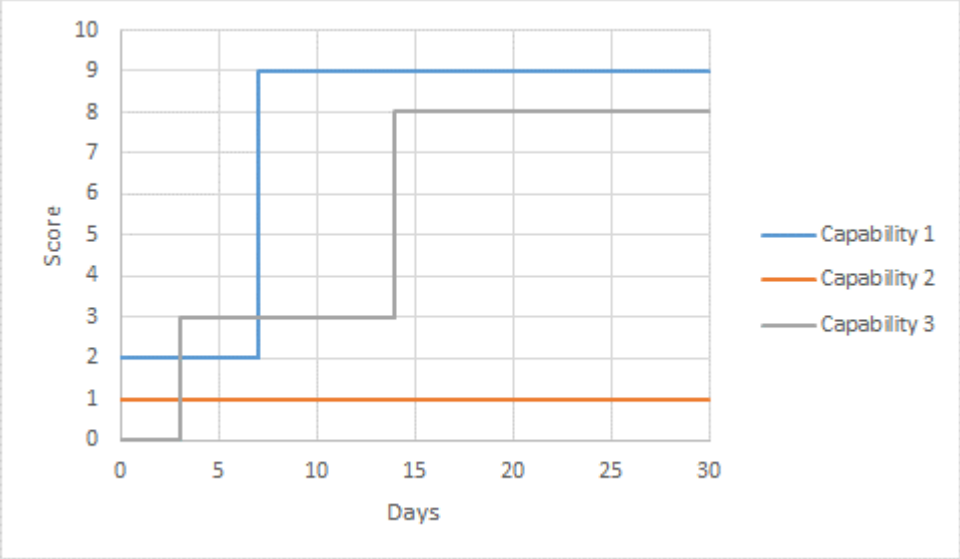

Figure 4.2 Illustration of how the capabilities can have different readiness.

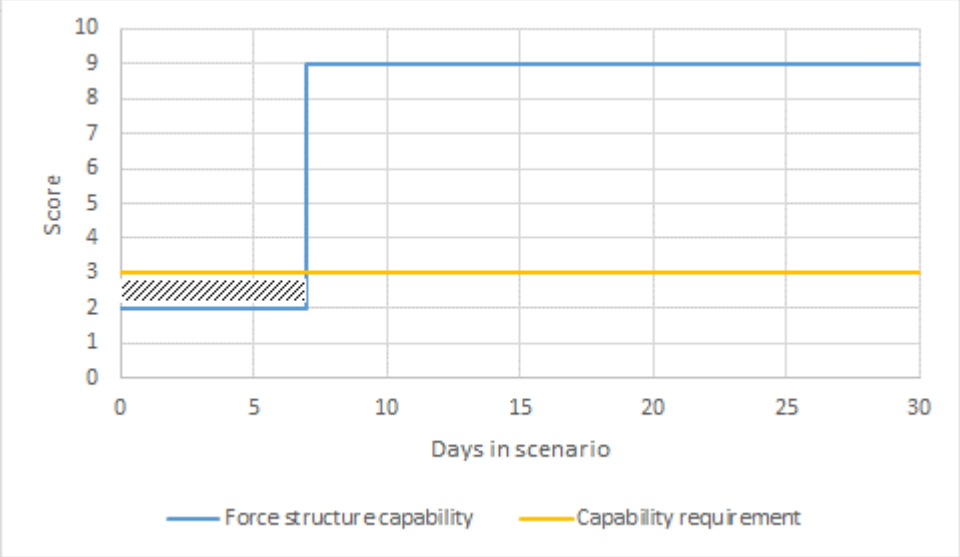

Figure 4.3 The shaded area illustrates a readiness gap. In this case none of the capabilities in Figure 4.2 will fulfil the capability requirement. Capability 1 has been assigned, and the result is a readiness gap of 1 in the first seven days.

We usually present and communicate the capability gaps by scenario class. The list of capability requirements we evaluate the defence force structure against is therefore composed of the maximum of the overall requirements across all phases in all scenarios within each scenario class. We present force structure gaps, readiness gaps and total gaps compared to this list.

When we summarize the gap analysis, we look at the totality of gaps by scenario class. We use a colour scheme to illustrate whether there are critical gaps (red), minor gaps (yellow), no gaps (green) or a redundancy of capabilities (blue). Figure 4.4 illustrates what a summary of a gap analysis might look like.

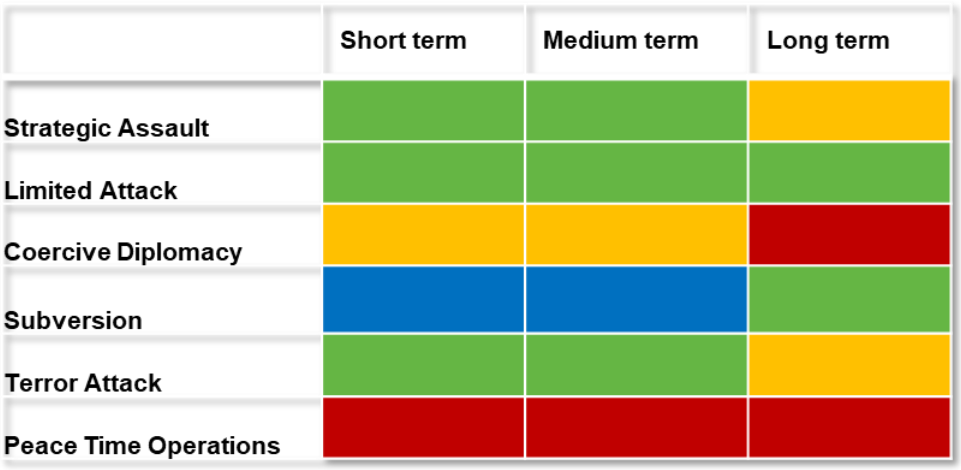

Figure 4.4 Fictitious summary of a gap analysis. This is a simplified summary, and when results are delivered, the underlying reasons for the conclusions are explained.

5 Uncertainty factors

As explained in Chapter 1, uncertainty about the future is the main reason for using a scenario- and capability-based approach to defence planning. However, even with a well-designed method, the results and conclusions are uncertain, and both analysts and decision makers must recognise this. In addition to the external uncertainty about the world and its future, there is internal uncertainty due to possible methodological errors in our work, including oversimplification and underestimation of likelihoods. In this chapter, we will chart the uncertainty aspect in our method and our products and trace the origin of the uncertainty.[24]

5.1 Uncertainty in requirements analysis

The scenario portfolio should span the future security threats that we need to prepare for due to their likelihood and potential impact. The scenarios need not represent every possible contingency, but the overall capability requirements derived from the scenario portfolio should ideally

[24] Risk and uncertainty in our method has previously been discussed in Birkemo (2013).

cover all contingencies. A wide range of scenarios will reduce the risk associated with outlying situations.

Nevertheless, we cannot be certain that our scenario portfolio is sufficiently diverse, and there will be a risk of Black Swan-type situations for which we are not prepared.[25] With a longer time frame in the planning work, the probability of unforeseen threats will be higher. The main source of this risk is limitations in imagination and creativity. On the strategic level, the question is who our opponents and allies will be 20 years into the future. Norway's proximity to Russia is a strategic constant that will influence our defence planning for the foreseeable future, and needs to be considered. However, the effect of this future influence is unknown. To what degree Norwegian defence forces will be involved in operations against other adversaries over the next 20 years, and who those will be, is highly uncertain.

On the operational and tactical levels, the main question is what new courses of action become available with emerging technologies, and what new vulnerabilities we are developing. In particular, the importance of irregular or non-conventional measures seems to increase, opening new possibilities for both parties to a conflict. Such changes increases the uncertainty both in the adversary's actions in a scenario, and in the expected best course of action for the Norwegian response.

In order to derive capability requirements from scenarios, we make assumptions about how the situations unfold. The overall scenario determines the opponent's objectives and general course of action, but aspects such as timelines, geographical specifications, detailed orders of battle and environmental factors (weather etc.) are not fully explored. There is therefore a risk of over-estimating the conclusions' general validity, and sensitivity to changes in these parameters should be discussed.

The capability requirements represent what abilities the force structure needs in order to "handle" the scenario. But what does it mean to "handle" the scenario? It is not possible to estimate this precisely. Two uncertain factors are the opponent's will to keep the conflict going (i.e. what it takes for the opponent to give up, and the likelihood of escalation), and our allies' will to provide military support. The Norwegian defence strategy is founded on NATO and bilateral relations. The will and ability of allies to support us will depend on many factors that are external to Norway's local security problem in the scenario. This again affects the opponent's threshold for discontinuing the operation. The type and effectiveness of allied support are also highly uncertain, and perhaps we base our analysis on the wrong assumptions.

Also, the requirements depend on the chosen BLUE course of action (COA). The scenario- and capability based method itself does not reveal what the best COA is. We analyse this through wargaming and table-top discussions with subject matter experts, but cannot guarantee that the chosen COA is optimal.

[25] *Black Swan* is a common name for a very consequential event or development that is nearly impossible to predict, popularized by Taleb (2010).

Some capabilities appear very explicitly in the analysis and are easily quantifiable. Other capabilities are less obvious and more difficult to assess. Typically, these are crucial support and enabling capabilities such as logistics and communications. Possibly, the requirements for these capabilities are underestimated.

The quality of our capability definitions also gives rise to uncertainty. We have defined capability categories at what we believe is an appropriate level of detail. We wish to compare different means to produce the same effects. A question is whether we have over- or underestimated the platform-specific contributions to the capabilities.

We use a variety of models to quantify the need for different capabilities. There are many factors involved in these models, including combat effectiveness, attrition rates, geographical constraints, maintenance schedules, and endurance. Validation and verification efforts reduce the risk of modelling errors.

5.2 Uncertainty in capability analysis of force structures

When evaluating a possible future force structure, we assume that the armed forces are actually able to implement the long-term plan. We rarely address the capacity for processing investment projects and organizational changes. Estimates of available funds up to 20 years into the future are necessarily uncertain. Projecting procurement and operational costs for future military platforms is also notoriously difficult. Factors such as currency exchange rates and oil prices can have significant impact on the cost. There is therefore a significant risk that the planned force structure will be too expensive because of underestimated costs or overestimated funding, and our evaluation will be too optimistic.[26]

Long delays are also common in defence procurement. Such delays can have ripple effects on the rest of the force structure, because full effect of other capabilities may depend on the delayed capability. An example of this is the reduced capacity of Norwegian frigates due to the delay in procurement of NH-90 helicopters. When FFI concludes that a proposed plan meets the requirements from scenario analyses, the ability to execute the plan is usually not considered. Unsuccessful introduction of key capabilities can undermine the conclusions, and there is a risk of optimism bias.

If the armed forces successfully implement the procurement plan, the question remains whether the force structure will perform as expected. We often think of capabilities as a product of major equipment, but the skills of the personnel are equally important. The defence force needs to recruit qualified personnel throughout the organization, and train these to sufficient ability. Moreover, the personnel must be available when needed. Manning concepts based on mobilization can be efficient in theory, but how fast mobilization can happen in the real world is

[26] One important reason for possible insufficient funding is defence specific investment cost escalation, see e.g. Hove and Lillekvelland (2016).

difficult to test. Assumptions about how mobilization will work can therefore lead to wrong conclusions. These risks are less prominent for force structures based on standing forces.

Combat outcomes can depend on small advantages in the systems of one contender versus those of the opponent. The competition between e.g. submarines and ASW capabilities, between cruise missiles and air defence, or between electronic attack and electronic protection measures can be decisive. We do not really know the effectiveness of our capabilities in combat several years into the future, due to evolving counter-measures. The usual assumption in long-term planning is that state-of-the-art systems with additional modernization and update programmes throughout their operational lifetimes will have similar strength against opponents as today's systems. This assumption may not hold for 20 years.

Some capabilities are notoriously difficult to quantify. Some capabilities, such as command and control capabilities, are of an abstract nature, while others are more tangible. The cyber domain is characterized by the absence of geography and physical borders in the traditional sense, allowing for new potential adversaries. Cyber threats are typically tailored to each specific operation, so generalizing threats and capabilities can be very difficult. Civilian and military digital infrastructure overlap, creating vulnerabilities that lie outside military responsibility or control. Another example is electronic warfare capabilities, where future advances may or may not have offset-effects similar to the Second World War's game-changing radar. It is difficult to assess such effects before they are demonstrated on a battlefield.

Our scope is limited to direct threats to Norwegian national security, and does not include participation in military operations in foreign countries, e.g. in NATO- or UN-led operations. The ability to contribute to such operations will probably continue to be important in the development of the force structure. Candidate capabilities for such contributions may not be the capabilities that we recommend for purely national defence purposes. The decision-makers' considerations concerning the need for such capabilities will be independent of our analyses. External capability requirements like these may affect the validity of our conclusions about the cost-effectiveness of force structures.

FFI's analysts attempt to identify force structures that can deliver capabilities efficiently. Since we can hardly imagine every possible force structure element to deliver the capabilities, we cannot say that the overall force structure is *optimal*.

6 A discussion of the method's strengths and weaknesses

In this report, we have presented FFI's method for long term planning. Like other methods, it has strengths and weaknesses. Weaknesses in our work come in two categories: Some are weaknesses inherent in the method as described in this report, and some are weaknesses in our implementation of the method. In this chapter, we will discuss the method and its quality.[27]

The foremost strength of the methodology is that it facilitates the planning of a flexible defence force for an unknown future. Scenarios provide a framework for discussing why we need a defence force and what types of situations the force should be able to handle. Thus, they help us describe overall levels of ambition. In particular, we can also express what situations are *not* within a level of ambition.

A mindful awareness of the 20-year perspective prevents undue emphasis on current events, which can lead to ill-advised decisions that are nearly impossible to rectify. As an example, the importance of Russia as a possible future threat against Norwegian security was largely forgotten, at least publicly, from the end of the Cold War until the Ukraine crisis and the Russian annexation of Crimea in 2014. The Norwegian Armed Forces were most visible through their contributions to allied operations abroad, notably in the Balkans, in Afghanistan and in Libya. Throughout this period, military attack against Norwegian mainland was still part of FFI's assessment of future threats, contributing to an awareness of the possibility that Russia might re-emerge as an important factor in defence planning. The expeditionary operations did have important consequences for the Norwegian force structure, but if more traditional military attacks had been fully dismissed, several important capabilities could have been discarded.

Similarly, today, much attention is paid to so-called *hybrid* threats. This is a class of threats characterised by increased use of irregular and unconventional means such as information warfare, cyber attack and covert operations instead of overt military intervention. Hybrid threats are important, but FFI believe it is important to keep conventional threats in mind, since these cannot be dismissed as a long-term possibility.

Scenarios are recognisable to both military experts and civilian analysts and form a necessary context for evaluating the usefulness of military systems: If we cannot identify the need for a military system in any plausible scenario, then investment in that system is not justified. Maintaining a scenario portfolio over time as a testing ground for possible force structures also enables us to identify situations that we may have overlooked and that should be included in the portfolio. The stability of the methodology, and the fact that we can redefine scenarios and capability definitions as our knowledge increases, therefore supports improvement.

[27] Some observations in this chapter have previously been documented by Arnfinnsson et al. (2017). That document was the result of an internal seminar devoted to review of our own methods.

The purpose of our approach is to provide an alternative, or rather a supplement, to advice based on expert opinion. Our method is often described as bias-free and purely logical. However, neither we nor any other analysts can eliminate effects of personal judgement on the part of both analysts and subject matter experts whose expertise is needed in the analysis. Actors and interest groups trying to influence the defence planning process are not always transparent and unbiased. The analysts at FFI must have this in mind, use quantitative methods when possible, seek advice from a wide range of experts, and cross-check each other's work to counteract this.

The capability approach ensures that we judge the armed forces by their effect, and not by input factors such as personnel and materiel. This again lets us search for efficient force structures that provide the effect that we need, but at a reasonable cost. If defence planners do not pay enough attention to the effect and are too concerned with the types of equipment or force structure elements, the analysis is likely to be influenced by bias caused by history and tradition. It will also be vulnerable to pressure from stakeholders with broader political or economic interests. When e.g. our frigates approach the end of their operational life, we ask the question of how we can best achieve the necessary future capability within anti-surface warfare, anti-submarine warfare, maritime surveillance, etc. If we instead ask how many new frigates we should have, stakeholders such as naval personnel, shipbuilders and local communities around naval bases have already partially succeeded at the possible expense of efficient use of government resources. It may be that force structure choices that are suboptimal with respect to military efficiency are desirable from a political standpoint, but such decisions should be transparent and not disguised as pure defence planning.

A well-defined method for defence analysis enforces a certain stringency. The analysts must follow defined steps from the beginning to the end of the analysis, which helps them avoid taking shortcuts and jumping to conclusions. The ability to trace the arguments from the national security policy to the capability gaps is a great advantage. It clarifies the underlying assumptions and helps explain why the analysts identify a specific requirement. The emphasis on stringent reasoning and traceability counteracts bias among subject matter experts. Stringency and traceability in our work is further strengthened by our use of JDARTS, a purpose-built toolset developed at NATO's NCIA. See Box 6.1 for more information about JDARTS.

Box 6.1 JDARTS[28]

The toolset JDARTS (Joint Defence Analysis and Requirements Tool Set) was developed by NCIA to support NATO's Defence Planning Process (NDPP).

JDARTS consist of various applications connected through a set of common databases. The tool set covers all steps of the analytic process. It allows the analyst to define and describe task decomposition of scenario classes (mission types), calculation rules for capability requirements, scenario details and force elements with capabilities and roles in different applications. An optimization program is used to generate a force structure to match the requirements. Figure 6.1 shows how the different tools are related.

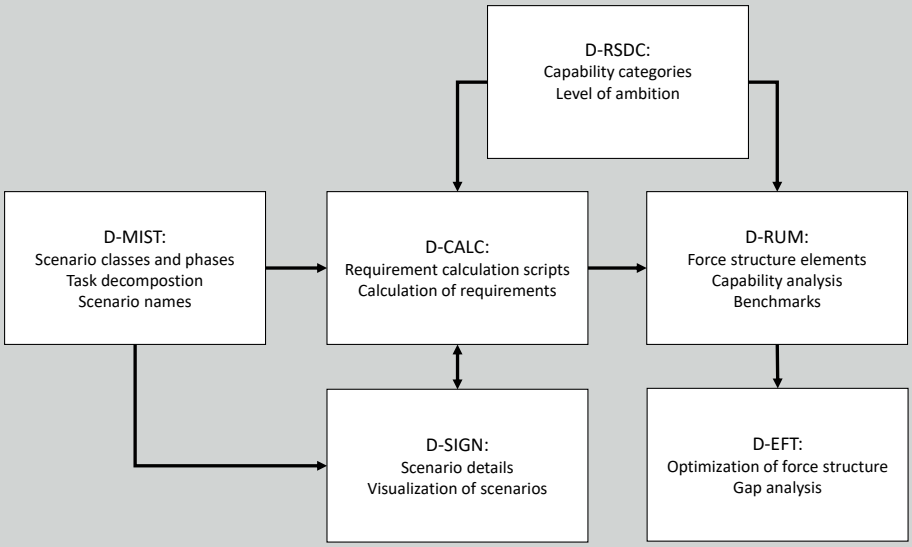

Figure 6.1 JDARTS architecture.

FFI's method for long-term defence planning is also implemented in JDARTS. In a Norwegian context, however, the range of choices for a force structure is more limited than in NATO. FFI use JDARTS mainly as a support tool for storage of data, parameters and results and to ensure stringency and control in the analysis process.

The morphological method used in our scenario class development helps us span the spectrum of possible security threats and make sure that we pay attention to a variety of scenarios, and not just the most dangerous or the most likely threat. However, establishing the scenario classes can

[28] For a more detailed description of how JDARTS is used, see Glærum and Hennum (2016).

narrow down the problem too much. This happens if we are too restrictive in our choice of parameters and in the consistency analysis. Such premature closure can lead to an inadequate scenario portfolio. Another possible source for missing scenarios is lack of imagination in the scenario development. Arguably, having an incomplete scenario portfolio is still better than not having a scenario portfolio at all, but problems appear when the scenario portfolio is presented as comprehensive or "complete" with regard to capability requirements. We try to remedy this by stress-testing our conclusions with so-called wildcard scenarios. These scenarios have been deemed too far-fetched to be included in the official portfolio. Analysing these gives us an indication of the limitations of the planned force structure. Furthermore, we revise the scenario classes and scenario portfolio continually.

The scenarios that we analyse tend to be static. We describe the enemy's objectives and initial course of action, and typically use table-top map discussions to derive the Norwegian response, and a variety of quantitative methods to compute the associated capability requirements. This hides the randomness and dynamics of a real conflict. Interactions between the forces will have many possible outcomes and consequences. There is a danger of underestimating the variety of ways a conflict can develop from similar initial conditions. This can lead to unjustified confidence in our conclusions. Therefore, we are increasing our use of dynamic wargaming of scenarios. This involves playing out several phases of actions and counteractions by both sides in the scenario. Often, this also involves playing other actors, such as allied nations. We use stochastic adjudication of combat encounters, which necessitates iterations of the wargame. We are also planning to increase our use of simulation models on aggregated (theatre/campaign) level in support of scenario analysis. We have previously primarily used simulation models for tactical considerations.

The scenario analysis produces a list of capability requirements. If a force structure's capability exceeds a requirement, we present this as a redundancy. However, a higher capacity has value in terms of better availability and longer endurance, but we do not have a standardised way to incorporate this in the analysis. The value of this redundancy compared to gaps in other capabilities must be discussed with the decision-makers.

The fact that we use capability definitions that we have defined for our purposes makes our communication more difficult. Neither subject matter experts that we need to involve in our analyses nor the decision-makers that are our customers use the same concepts. The capability language is a tool for analysis, and we present our results in terms that are understandable to anyone with knowledge about military operations. However, it does make our analysis less accessible to outsiders. We have frequently been asked to fit our analyses to e.g. NATO's capability definitions, which are more commonly known among military experts. We have so far decided not to do this, although it could make collection of information and communication of results easier. The reason we use our own capability definitions is that this is necessary to preserve analytical flexibility. NATO's capability definitions are designed for setting requirements for forces from different allied nations, on a NATO scale and for use in NATO scenarios. If we commit to using NATO capability definitions, we lose the option to tailor the analysis to a Norwegian context. Changes in the capability framework would be slower and largely outside

our control. Flexibility is necessary in order to e.g. experiment with modelling of technological innovation. NATO's capability definitions are often more closely tied to platforms and equipment than we believe is necessary, making such modelling more difficult.

Having used the same method over time and in a variety of research activities within long-term defence planning, we can use historical data from the analyses to draw conclusions about the evolving state of the Armed Forces and the strategic outlook. However, it does have drawbacks. Custom may discourage revision, and arguments and conclusions may turn into entrenched opinions. Due to the complexity of the subject matter, new team members in training will tend to accept established arguments. To prevent such institutionalisation, it is important that the analysts invite criticism and evaluate their work regularly.

7 Conclusion and further improvement

In order to involve subject matter experts and to get our conclusions across to key people, it is important that they understand our approach. This report is part of an attempt to make our method and its virtues known.

FFI's method for evaluating the effectiveness of possible future force structures is designed to enable a traceable, logical and focused line of reasoning, leading from strategic outlook and overall levels of ambitions to quantitative measurements of effectiveness. We strive against bias and misconceptions among ourselves, subject matter experts and decision-makers, though personal judgement will always be important throughout the process. Method triangulation and use of multiple independent sources help us reduce the impact of bias.

Our goal is to contribute to the decision-makers' awareness of the consequences of their decisions: When they decide upon a future force structure, they should understand what that force structure will be able to do, and correspondingly, what it will not be able to do. Our scenario- and capability-based approach gives them an opportunity to establish a level of ambition that is in line with their risk tolerance and the available resources.

FFI's analyses are useless unless they contribute to informed decision-making. Decision-makers must receive, understand and trust the conclusions. Furthermore, they must understand and acknowledge the inherent uncertainty. For the analyst who presents the results, the balance between clarity of recommendations and awareness of uncertainty is delicate. For the receiver, it is easier to act upon recommendations without risk and uncertainty. Such recommendations would be dishonest. The accuracy and validity of the analysis must be explained and their consequences understood. On the other hand, overstated emphasis on uncertainty can give the impression that there is really no recommendation at all.

We have used our approach in our support to the long-term development of the Norwegian Armed Forces for the last 15 years. Within the frame of the overall method, we always seek to improve our procedures. In addition to our continual development of scenarios, capability definitions and requirements estimates, the following items describe our current prioritised areas of improvement.

- We are increasing our use of wargaming (as opposed to table-top discussions) to better our understanding of the dynamic nature of conflict. This exposes weak arguments and conclusions in previous analyses and contributes to result validation. In addition, it is a good way to involve key people in on-going work.

- We are seeking to introduce a joint-level (theatre/campaign) simulation model for military operations in our work. This will help us keep track of important factors in the scenario and facilitate experimentation with different courses of action. Ideally, it should allow batch runs, so we can study effects of stochastic adjudication. However, it has been difficult to identify a suitable existing model. We are also expecting such an activity to be technically challenging, so we would need to expand our team or work jointly with simulation experts.

- We need to improve our ability to explain the uncertainty in our results, and balance our recommendations with uncertainty when we communicate the results.

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About FFI

The Norwegian Defence Research Establishment (FFI) was founded 11th of April 1946. It is organised as an administrative agency subordinate to the Ministry of Defence.

FFI's MISSION

FFI is the prime institution responsible for defence related research in Norway. Its principal mission is to carry out research and development to meet the requirements of the Armed Forces. FFI has the role of chief adviser to the political and military leadership. In particular, the institute shall focus on aspects of the development in science and technology that can influence our security policy or defence planning.

FFI's VISION

FFI turns knowledge and ideas into an efficient defence.

FFI's CHARACTERISTICS

Creative, daring, broad-minded and responsible.

Om FFI

Forsvarets forskningsinstitutt ble etablert 11. april 1946. Instituttet er organisert som et forvaltningsorgan med særskilte fullmakter underlagt Forsvarsdepartementet.

FFIs FORMÅL

Forsvarets forskningsinstitutt er Forsvarets sentrale forskningsinstitusjon og har som formål å drive forskning og utvikling for Forsvarets behov. Videre er FFI rådgiver overfor Forsvarets strategiske ledelse. Spesielt skal instituttet følge opp trekk ved vitenskapelig og militærteknisk utvikling som kan påvirke forutsetningene for sikkerhetspolitikken eller forsvarsplanleggingen.

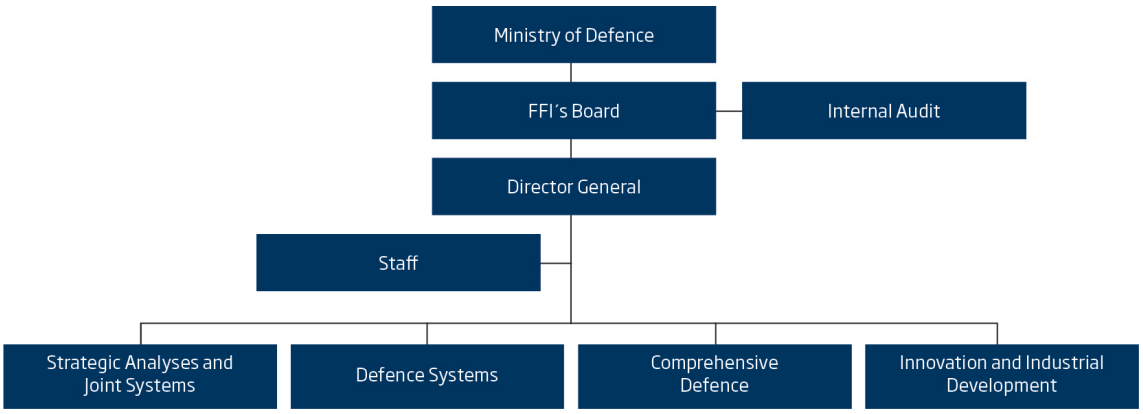
FFIs VISJON

FFI gjør kunnskap og ideer til et effektivt forsvar.

FFIs VERDIER

Skapende, drivende, vidsynt og ansvarlig.

FFI's organisation



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