FORSVARSMINISTERIET
DANISH MINISTRY OF DEFENCE

EXECUTIVE SUMMARY

TYPE SELECTION OF DENMARK'S NEW FIGHTER AIRCRAFT

EVALUATIONS OF EUROFIGHTER,
JOINT STRIKE FIGHTER AND SUPER HORNET

SUMMARY

Objective

The objective of this basis for decision is to present the results of the New Fighter Program's evaluation of the three fighter candidates included in the Danish fighter aircraft selection process.

The Danish Defence Agreement 2013-2017 requires the establishment of the best possible basis for a political decision on fighter aircraft type selection.

The rationale behind the focus on new fighters in the defence agreement is partly an identification of a Danish security policy need for fighter aircrafts and partly a recognition of the fact that the current Danish F-16 fighter aircrafts are nearing the end of their lifespan. In 2020, the Danish F-16 will have been flying for approximately 40 years and there will be significant operational, technical and economic challenges associated with their continued use.

Fighter aircraft candidates

The three fighter candidates in the Danish fighter aircraft selection process are:

- *The Eurofighter*, developed in a partnership between the United Kingdom, Germany, Italy and Spain. The primary manufacturer behind the Eurofighter is the European company Airbus. The German Federal Ministry of Defence is the supplier of the aircraft on behalf of Germany.
- *The F-35A Joint Strike Fighter*, developed in a collaboration between nine partner countries (the USA, the United Kingdom, Italy, the Netherlands, Turkey, Australia, Norway, Denmark and Canada). The primary manufacturer behind the Joint Strike Fighter is the American company Lockheed Martin. The Joint Strike Fighter Program Office is the supplier of the aircraft on behalf of the United States.
- *The F/A-18F Super Hornet*, developed in the USA. The primary manufacturer behind the Super Hornet is the American company Boeing. The U.S. Navy International Programs Office is the supplier of the aircraft on behalf of the United States.

Evaluation areas and frames

In order to provide the best possible basis for a political decision on the fighter aircraft type selection, the three candidates have been evaluated within four specific areas:

- *Strategic aspects*: the ability of the candidates to support or fulfil overarching Danish defence and security policy objectives, including the potential for cooperation with other countries.
- *Military aspects:* the ability of the candidates to successfully conduct fighter missions (mission effectiveness), the candidates' survivability, opportunities for keeping the aircraft operational and technically relevant within its expected lifespan (future development) as well as the risks associated with each candidate that cannot be economically quantified (candidate risk).
- *Economic aspects*: the estimated life cycle costs of the candidates, including costs associated with procurement, ongoing operations and sustainment as well as quantifiable risks.
- *Industrial aspects*: the ability of the candidates to support significant Danish security interests through industrial cooperation with the Danish defence industry.

The evaluations are based on an operational period of 30 years for the new fighter aircrafts (2020-2049). Additionally, the evaluations have assumed a continuation of the

current tasks and level of ambition of the Danish F-16 fighter capability. This means that the point of departure has been that a future Danish fighter aircraft capability must be able to continue to conduct:

- National tasks involved with maintaining a permanent quick reaction alert capability which can perform tasks involving surveillance and defending sovereignty and which can be scrambled with extremely short notice. Additionally, other national tasks such as supporting the Danish national police and other public authorities.
- International operations and NATO's collective defence tasks with a fighter contribution on high alert state in which four fighters can be deployed for a period of up to 12 months every third year. In addition, periodic fighter contributions to NATO Air Policing missions.

The primary underlying basis of information has been the responses to the request for information, the so-called *'Request for Binding Information'* (RBI), which was sent out to the candidates on 10 April 2014. At the time of the resumption of the fighter aircraft type selection process, the Swedish fighter Gripen was also a candidate. However, the Gripen withdrew from the process when the Swedish authorities decided not to respond to the RBI. The New Fighter Program received responses from the suppliers of the Eurofighter, the Joint Strike Fighter and the Super Hornet on 21 July 2014.

In order to ensure the validity of the information in the RBI responses, the responses to each of the approximately 950 questions in the RBI have been carefully reviewed in a validation process. In cases where the New Fighter Program uncovered insufficiencies, unresolved issues or possible risks of misunderstandings, a validation strategy has been implemented at three levels:

- Forwarding clarifying questions to the suppliers within each area of evaluation (so called *'Request for Clarification'* (RFC)).
- Clarifying dialogue in the form of, for example, briefings or information updates by suppliers or the primary manufacturers with a view to understanding the context in which the responses were given or in order to ensure an understanding of any correlations and assumptions which were not clearly set out in the original responses.
- Using reference data, including information on the F-16 fighters.

In the strategic evaluation, the New Fighter Program did not make use of the RBI because Danish defence and security policy interests cannot be assessed on the basis of information from suppliers. Instead, the point of departure has been, among others, Danish and other countries' policy papers as well as countries' reporting to NATO.

Evaluation methods

The New Fighter Program has developed distinct evaluation strategies and models for each evaluation area. The evaluation models were developed prior to sending out the RBI. In the models, there is a detailed description of how the individual evaluations were to be conducted, including the order in which each step of the process was to be completed.

The evaluations of the strategic, military and industrial areas have been largely based on qualitative analyses and evaluations. In these areas, the New Fighter Program has made use of various expert panels, which have ultimately evaluated and ranked the candidates. The participating experts have represented a broad range of competencies and experience related to the specific evaluation areas. The expert panels have been conducted according to the Delphi method which focuses on improving the quality of the expert evaluations through a structured and documented process of repeated rounds of voting and discussions.

In contrast, the evaluation of the economic aspects has been based on a quantitative approach. In this regard, a dynamic economic model was used which was developed by the New Fighter Program in cooperation with Deloitte. This model was used to calculate the estimated life cycle costs of the candidates.

External quality assurance

In order to ensure external and independent control, external quality assurance has been conducted of the products prepared by the New Fighter Program in developing this basis for decision. Quality assurance has been carried out by Danish experts from Deloitte in cooperation with international experts from RAND Europe assisted by QinetiQ and Vorderman Consultancy. As Deloitte was involved in developing the economic model, the quality control of the evaluation of the economic aspects was undertaken by RAND Europe.

Evaluation results

Table 0.1 lists the final ranking for the candidates within each of the evaluation areas.

Table 0.1

Final ranking of the candidates within each evaluation area

Strategic aspects	Military aspects	Economic aspects	Industrial aspects
1. Joint Strike Fighter	1. Joint Strike Fighter	1. Joint Strike Fighter	1. Joint Strike Fighter
2. Eurofighter	2. Super Hornet	2. Super Hornet	2. Super Hornet
3. Super Hornet	3. Eurofighter	3. Eurofighter	3. Eurofighter

A brief review of the results is presented below.

Strategic aspects

In the strategic evaluation, defence and security policy implications along with the potential for strategic cooperation associated with the respective candidate have been identified. The evaluation model has followed a step-by-step approach in which strategic criteria have been developed on the basis of a review of Danish foreign and security policy. The New Fighter Program has provided the basis of information for handling these criteria through analyses of, for example, NATO documents and the policies and historic roles of the respective user countries. Ultimately, an expert panel has assessed the candidates' ability to safeguard and achieve overarching Danish defence and security interests.

The assessment of the expert panel has been that the selection of the Joint Strike Fighter will entail the greatest potential for promoting Danish interests, in terms of both security policy and military strategy and that the Joint Strike Fighter will provide the highest degree of flexibility at the political level with regards to future tasks. The broad scope of the group of Joint Strike Fighter users will foster both Denmark's transatlantic ties and the country's collaborative relations with a range of European partners.

The European dimension in the group of countries using the Eurofighter has been a significant aspect in the expert panel's ranking the Eurofighter number two. The expert panel has particularly emphasised the fact that the Eurofighter will open up for strengthening the defence and security policy cooperation with Germany.

The importance of maintaining a close relationship with the USA in the area of fighter aircraft is particularly stressed by the expert panel in relation to the Super Hornet. However, the small group of Super Hornet users and the geographical location of those users far from Denmark's neighbouring areas have been contributing factors for the expert panel having ranked the Super Hornet number three.

Table 0.2 shows the votes that have led to the expert panel's final ranking of the candidates with respect to strategic aspects. The uneven distribution is due to the fact that the experts have had the opportunity to rank the candidates evenly.

Table 0.2

The expert panel's voting in connection with the final ranking regarding strategic aspects

Ranking	Eurofighter	Joint Strike Fighter	Super Hornet
1	0	10	0
2	8	0	4
3	2	0	6

Military aspects

The evaluation of military aspects comprises the sub-areas *survivability, mission effectiveness, future development and candidate risk*.

The evaluation of *survivability* considers how well the fighter aircraft is capable of protecting itself against enemy weapon systems so as to minimise the risk of loss of aircraft or crew. The evaluation of *mission effectiveness* considers how well the fighter aircraft performs the task assigned. Altogether, survivability and mission effectiveness reflect the fighter's military ability to perform tasks. *Future development* evaluates the extent to which the fighter aircraft is expected to constitute a relevant operational and technically applicable fighter aircraft capability throughout the entire 30-year lifespan of the fighter aircraft, whereas the evaluation of *candidate risk* considers the risks that cannot be quantified economically. The economic costs that will incur provided the individual risk occurs are considered in the economic evaluation. This applies also to the costs associated with risk-mitigating measures.

The New Fighter Program has carried out a large number of technical and operational analyses. Expert panels have subsequently given the candidates marks and ranked them on the basis of the analyses. Using the Delphi method within each of the four sub-areas, the experts have assigned marks to the candidates on a scale from 1 to 5 with 5 representing the best mark.

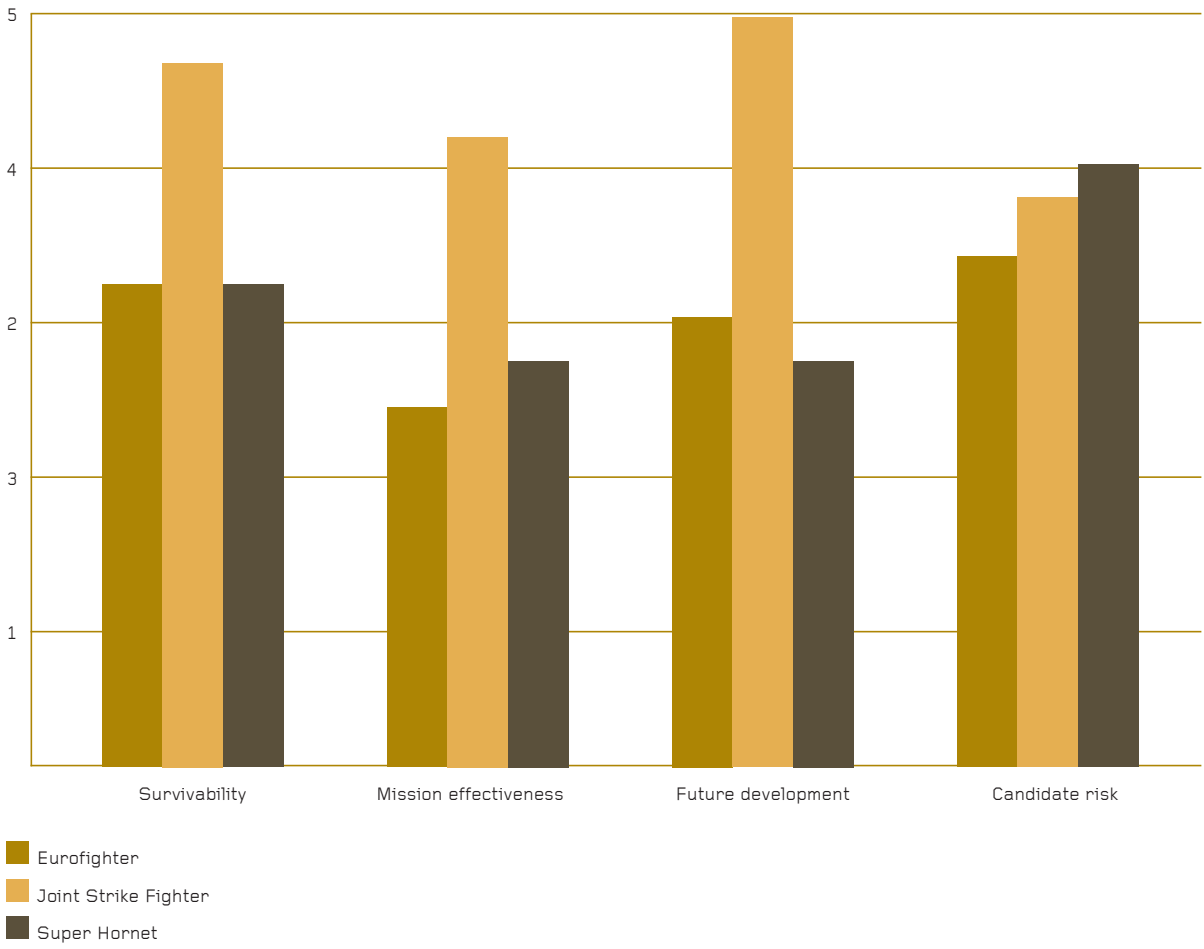
Figure 0.1 displays the candidates' average marks under each sub-area of the military evaluation.

Under survivability and mission effectiveness, the Joint Strike Fighter comes out better than the two other candidates. This is due to a number of circumstances, including for example the low radar signature of the aircraft as well as the application of advanced systems and sensors that enhance the pilot's tactical overview and ensure the survival of the aircraft and efficient mission performance. In terms of survivability and mission effectiveness, the Super Hornet does slightly better than the Eurofighter.

With respect to future development, the Joint Strike Fighter ranks better than the two other candidates. The reasons are, among other things, that the aircraft is expected to be produced in a large number and that the contractual and development basis for keeping the aircraft technically and operationally relevant throughout its lifespan is present. With regard to the Eurofighter and the Super Hornet, the expert panel's evaluation is that the candidates' future development is at the same level.

Figure 0.1

The candidates' average marks within the four military evaluation areas



In relation to the sub-area of candidate risk, the Super Hornet has been assessed to carry the least risk of the three candidates even though the candidates in this area are almost equal. The reasons are, among other things, that already today the Super Hornet is used operationally by other countries, and that risks associated with, for example, the procurement and implementation of the aircraft are assessed to be low. The risks associated with the Joint Strike Fighter and the Eurofighter are assessed to be higher.

Altogether, the result of the military evaluation is that the Joint Strike Fighter is ranked number one, the Super Hornet ranked number two and the Eurofighter ranked number three, noting that there is less difference between the Super Hornet and the Eurofighter.

Economic aspects

The economic evaluation compares the candidates' estimated life cycle costs on the basis of calculations in the quantitative economic model. The life cycle costs cover costs linked to procurement, ongoing operations and sustainment as well as quantifiable risks over a period of 30 years.

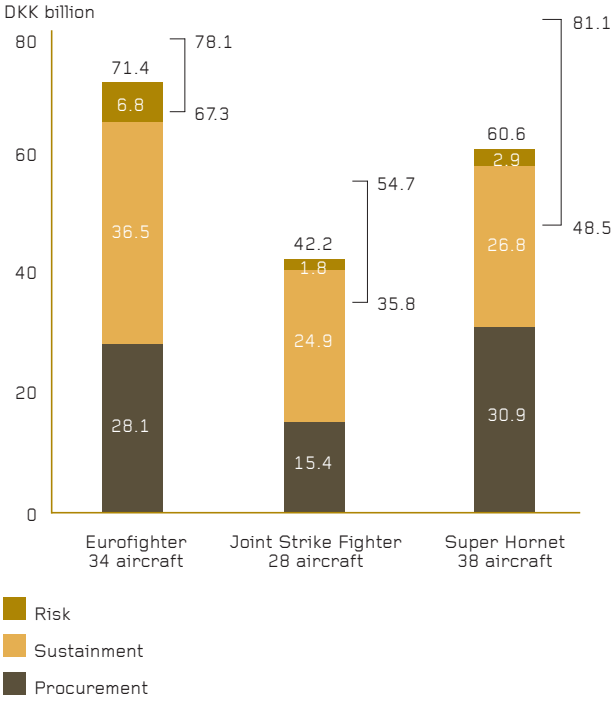
The estimated life cycle costs are lowest for the Joint Strike Fighter, second-lowest for the Super Hornet and the highest for the Eurofighter. The reason is primarily that the airframe of the Joint Strike Fighter is designed to be capable of flying 8,000 hours, whereas the Eurofighter and the Super Hornet are both designed to fly 6,000 hours. In order to perform the required portfolio of tasks over a period of 30 years, fewer Joint Strike Fighter airframes are therefore required compared to the Eurofighter or the Super Hornet. The calculations in the economic model have identified a need for 28 Joint Strike Fighter airframes, 34 Eurofighter airframes and 38 Super Hornet airframes, respectively, in order to perform the same portfolio of tasks. Another reason is that the Super Hornet is a two-seat aircraft, which implies a greater need for flight instruction hours and training of crews than the Eurofighter and the Joint Strike Fighter. Furthermore, the Eurofighter has higher maintenance costs per flight hour than the Joint Strike Fighter and the Super Hornet. The procurement price per aircraft is the highest for the Eurofighter.

Figure 0.2 shows the estimated life cycle costs broken down by procurement, sustainment as well as risks. The vertical line shows the degree of uncertainty of the estimate.

Sensitivity analyses show that the result of the economic evaluation is in general robust with regards to changes to key preconditions such as airframe lifespan.[1]

Figure 0.2

Estimated life cycle costs for the candidates (current value)



[1] Airframe lifespan is a term used for the number of flight hours an aircraft can fly before it has been "worn out."

Industrial aspects

The industrial evaluation assesses the extent to which the fighter manufacturers' proposals for industrial cooperation with the Danish defence industry can support essential Danish security interests. The New Fighter Program has considered the manufacturers' proposals for cooperation initiatives in accordance with current guidelines for industrial cooperation. Subsequently, an expert panel has assessed the initiative packages through the Delphi method. The combined value of the industrial cooperation proposals for the Eurofighter is DKK 18.7 billion consisting of 30 initiatives. The corresponding value for the Joint Strike Fighter is DKK 26.5 billion consisting of 26 initiatives, and for the Super Hornet the value is DKK 15 billion consisting of 68 initiatives.

The expert panel has assessed that the industrial cooperation initiatives proposed by Lockheed Martin (Joint Strike Fighter) support the safeguarding of essential Danish security interests to a greater extent than the initiatives of the other two candidates. This is due to the large volume and duration of the initiatives, the relatively high degree of feasibility, and the maturity of the initiatives. Furthermore it is due to the potential associated with the forthcoming sustainment phase. Therefore, the Joint Strike Fighter is ranked number one with regard to industrial aspects.

The initiatives proposed by Boeing (Super Hornet) and Airbus (Eurofighter) are assessed to support the safeguarding of essential Danish security interests to the same extent. However, the Super Hornet is ranked number two, as the overall package of initiatives proposed by Boeing was assessed to have a higher degree of feasibility and maturity than the package proposed by Airbus. Therefore, the Eurofighter is ranked number three.

Table 0.3 shows the votes that have led to the ranking of the candidates with respect to industrial aspects. For the purpose of the voting, a ranking scale from A to E has been used. The figure shows which indicators the ranking scale has covered.

It should be underlined that the results of the industrial evaluation are associated with a number of significant uncertainties, among other things, as a result of an essential difference regarding the framework for industrial cooperation for the candidates. For the Joint Strike Fighter, there is a particular element of uncertainty associated with the fact that the Joint Strike Fighter will not be subject to an industrial cooperation requirement. The realisation of the industrial cooperation initiatives that Lockheed Martin has proposed is, therefore, conditioned upon the ability of the Danish defence industry to win contracts in accordance with the "best-value" principle. Thus, there are no guarantees that the initiatives will be implemented.

Table 0.3

Voting leading to the ranking regarding industrial aspects. The figures indicate the number of votes

Ranking scale (To which extent are essential Danish security interests supported?)	**Eurofighter**	**Joint Strike Fighter**	**Super Hornet**
To a very high degree (A)	0	2	0
To a high degree (B)	1	5	2
To some degree (C)	6	0	5
To a low degree (D)	0	0	0
Not at all (E)	0	0	0