# The Gripen Fighter: Present and Future Flight


Sweden started producing its own fighter aircraft after the Second World War. The succession of fighters counts to five jet fighter families, all developed and produced by Saab: Tunnan, Lansen, Draken, Viggen and Gripen.

The Viggen was produced in four versions: reconnaissance, sea surveillance, ground attack and air defence. Studies and research started in the 1970s for a replacement of the Viggen fighter. After assessing and abandoning other alternatives, the choice was made to go ahead with a Swedish solution. A decision was taken that what would become Gripen should be a multi-role fighter, optimizing the air defence capability. The Gripen development started with a concept study in 1979, and in 1982 with the first order to Saab, with the first flight in 1988. It was the first fighter to use a fly-by-wire flight control system. To solve this challenge became a serious problem in the early development. The first version, the A/B, became operational in 1996. The next version, the C/D, had its first flight in 1995, and became operational in 2004. By 2008, the last of the 204 ordered A/B and C/D Gripens was delivered to the Defence Material Administration (FMV), for further delivery to the Swedish Air Force. In 2013, FMV signed a contract with Saab for development of the E version. The E version is a one-seater, and the F a double seater. In 2019, the first E was delivered to FMV from Saab. On June 10, 2019, the first successful test flight was performed with the third[1] Gripen E test aircraft.

The plan is to deliver the first E/F:s to the Swedish and Brazilian Air Forces in 2021, and reach initial operational capability in Sweden by 2023, and full operational capability around 2025. 60 Gripen E have been ordered by the Swedish Air Force. Sweden has not so far ordered any units of the F version.

The Swedish government has declared three essential security interests: fighters (2014), underwater capability (2015) and "cyber and parts of C4I" (2017). The implication for Gripen is that Sweden will maintain a domestic capability for fighter development and capabilities, or as expressed in the official government policy: "to maintain national freedom of action regarding fighter aircraft ability and to be able to act without external constraint". As a consequence, this in practice cements Saab's presence in the fighter domain for decades to come.

## Present status

### ♦ *C/D*

The now operative Gripen is the C/D version, with D being a double-seater. The latest modification package – MS20 – is the most comprehensive Gripen modification so far. The equipment and software is delivered and operational, and is under final implementation by Saab together with FMV. The primary capability upgrades with MS20 are the integration of the IFF Mod 5 version, integration of the Meteor missile software and an enhanced CBRN protection. Gripen C/D is planned to be operative until around 2027, in order to be replaced by the E version. There is however no formal decision to phase out the C/D at that time.

Compared to other nation's setup of upgrading fighters, Sweden has a different setup. Most nations upgrade their aircraft at long intervals, where the aircraft is practically being disassembled and most systems, components and features receive a profound upgrade or midlife upgrade up to a new version. The Swedish setup is to have less comprehensive but more frequent upgrades, compared to other nations' less frequent, more fundamental upgrades. An advantage of this is that the specialized engineers and developers engage in further technology and capability development at much shorter intervals – thereby maintaining competence and personnel at the cutting edge. Another advantage is that the production facilities will have a more even level of assignments. As expressed by FMV, more frequent modifications and upgrades also bring with it that sustained operational advantage is maintained over time. An estimate is that the Gripen update tempo is on average five times higher than for comparable fighters produced in other countries. This higher update tempo is also an adaptation to the fact that Gripen is produced in lower numbers than other fighters are. A disadvantage of the higher tempo is that it requires a continuously high level of administration together with more frequent processes and decisions in order to validate full operational capability.

### ♦ *E/F*

The first Gripen E:s will be delivered to the Swedish Air Force in 2021, and are expected to be in initial operating capability operational use in 2023. It will be in operative use beyond 2040. What will happen after that is under discussion.

The step from A/B to C/D was not highly dramatic. The airframes were withheld to a high extent. The E/F should be seen as a new aircraft that builds upon the experience and knowledge from its predecessors and takes it to a new and higher level. The E/F will have a larger airframe that can carry a higher weapons payload. The E will also carry more fuel. It will have a new and stronger version of the General Electric F404 engine, which produces more thrust and paired with the increased fuel capacity highly increases the range of the aircraft. The E/F will not be a 'stealth' aircraft but is described as 'stealthy'.

The most dramatic capability boost – according to interviews - concerns its electronic warfare (EW) capability, which is intended to improve the operational advantage in combat air beyond visual range. The EW capability builds upon new Saab EW antennas, more advanced avionics integration and data fusion, a new Selex AESA radar, IR search and track sensors, and an increased capability for passive surveillance. Instead of having three displays in the cockpit, Sweden chose the integrated single display demanded by Brazil – co-developed by Saab and Brazil. The nozzles have in previous Gripen versions been hydraulically controlled with a separate oil system but will now use the jet fuel as hydraulic liquid.

The E will have two more pylons for carrying weapons, compared to C. The weapons suite will largely be the same as for the C/D, but with the strategically interesting addition of being able to carry a long-range precision weapon, likely the KEPD or the JASSM. This new proposed[2] capability enhancement of carrying a long-range precision weapon would make it possible to perform strike missions for strategic, fortified targets at long range. This can be understood as a proposed sharp doctrine enhancement, adding a higher threshold effect.

Gripen E will also have a new cockpit design. Overall, the avionics development in the cockpit and its data presentation strives to reduce the pilot's intellectual commitment to continuously engage in performing flying manoeuvres, and thereby enhancing the pilot's capability and capacity to continuously optimize tactical decisions and situational awareness. Naturally, this without compromising the aircraft's flight performance abilities. Furthermore, an overarching incentive is to facilitate shorter decision loops. The underlying avionics technology has been designed to separate the operational systems from the flight and safety critical systems. This gives, according to interviews, the advantage of fast upgrades and integration of new technologies through-life without disturbing the flight and safety-critical systems.

An interesting aspect is that the type certificate for the fighter engine was commissioned to GKN (previously Volvo flygmotor) for previous Gripen versions with the GE F404 version – named RM12. The E/F engine responsibility – GE F414[3] – is will be commissioned to GKN, Saab or General Electric.

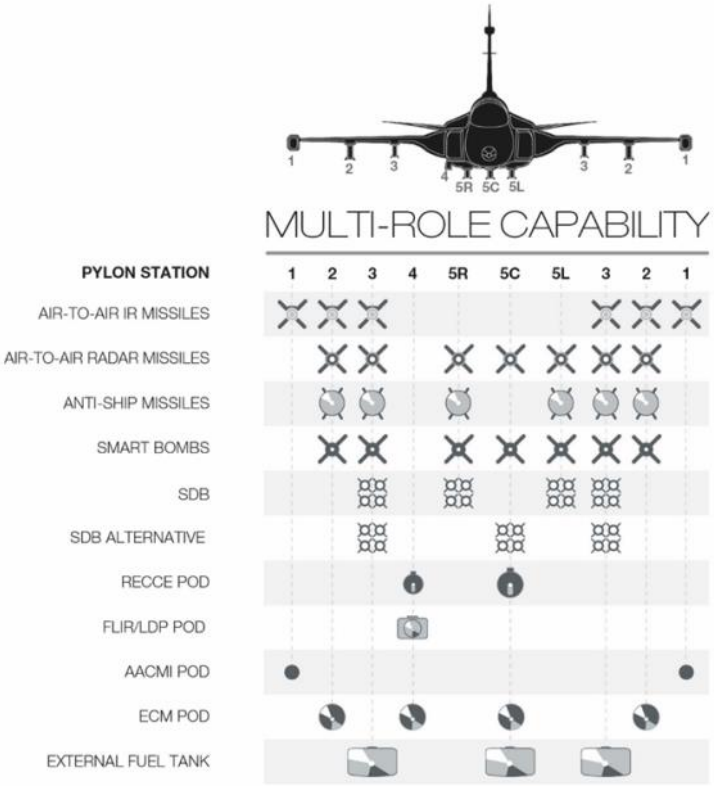


*Figure: Gripen E weapons suite (Source: www.saabgroup.com)*

No final decision is however taken at present. GKN is eager to receive this certificate in order to ensure a long-term presence (beyond 2040). GKN will in any case have the RM 12 certificate until at least at least the late 2030s and can thereby also sustain operational competence and full provide support to foreign users. If Saab is awarded this responsibility, they will have to build up a sufficient competence and infrastructure – likely building upon GKN's present capability. If General Electric is chosen, this has its advantage of not having to sustain a Swedish competence and infrastructure. Disadvantages with a GE solution are primarily two. Firstly, more profound design measures will have to be performed abroad by other European users, or in the US. Clearly, this will add uncertainties and time to the logistics functions. Secondly, Sweden will decrease its strategic autonomy and level of security-of-supply. This dilemma is a pending political question.

## Export

The Swedish Air Force is presently flying the second version, the C/D. This version has also been exported to South Africa and Thailand[4] and is being leased to Hungary and the Czech Republic[5]. The UK has signed an availability contract to have access to one Gripen C/D for use in training. The C/D's for South Africa were co-produced with South Africa[6], the other nations have received surplus C/D's from the Swedish Air Force inventory[7]. The Swedish Air Force ordered a total of 204 C/D, and 40 of these are presently in service in other nations. The Swedish Parliament had decided in March 2000 to reduce the number of Gripen divisions from twelve to eight. Thereby more aircraft were delivered or under production than what the Air Force needed, and therefore a part of the inventory could be offered to other nations.

Saab have responded to procurement interests and is presently (June 2019) offering Gripen at various levels of capability to (at least) the following nations: the C/D version to Austria, Botswana, Bulgaria, Colombia, Malaysia, Philippines and Slovakia; and the E/F version to Canada, Finland, India and Switzerland[8]. Out of these prospective buyers, some are unlikely buyers, and others more promising from a Saab perspective. Paired to this, the Gripen users in the Czech Republic, Hungary and Thailand appear to be long-term Gripen users, and might acquire more aircraft. In South Africa, the Air Force performs limited operative use of its Gripen, apparently due to financing difficulties of operating its fleet.

Regarding its capabilities as a military platform, Saab and the Swedish Air Force stress that the Gripen enables more flexibility and a more decentralized decision making – pilots in other fighters have a narrower protocol for their tactical options and decisions. The Gripen E development has enhanced its Beyond Visual Range (BVR) capability. An extended situational awareness enables detection of threats earlier and at a longer range. The Meteor missile's BVR capability complements this capability.

The efficiency advantages related to cost and maintenance of Gripen – as being put forward by Saab and supporting Swedish government agencies and ministries – are its lower price, lower cost for maintenance and per flight hour, that it demands a smaller personnel turnaround structure and that the turnaround time (10 minutes) is much faster compared to its competitors.

Its competitors tend to stress that Gripen has one single engine (whereas most competitors have two), thereby adding risks if the single engine would fail. However, no engine failures have so far occurred under the Gripen lifetime. Another argument is that it has a limited range. Regarding range, the E/F version has profoundly extended its range with its increased fuel capacity, and it can also be air-fuelled.

The cost of a Gripen is clearly lower than its competing alternatives, on average 30-50 % lower. The competing alternatives for fighters are however difficult to compare. For one thing, different aircraft have their optimized performance, capabilities, range etc. – they can perform different things. Furthermore, nations' choice of fighters is not solely dependent on price and performance. A number of aspects become a part of the deal: e.g. technology transfer; offset of different kinds; support and commitment of the selling nation's Air Force, ministries and government authorities; maintenance and logistics issues; education and training; local investments; local production. How the selling company and its supporting government resources has performed in relation to previous exports will also strongly affect the product's attractiveness. The security policy element also becomes important, for example if a nation wants to have strong bonds with the US – or reversely to *not* become dependent upon the US. A fighter deal constitutes a security policy handshake between the selling nation and the buyer.

In October 2018, Boeing and Saab won the US Air Force order for the next US trainer aircraft, the T-X. In its first phase until 2023, the project will produce five T-X, and the program plans to produce 351 T-X aircraft. The system is planned to be fully operational by 2031 with all aircraft delivered. The aircraft is also likely to have very strong export potential, especially for the international F-35 users. Saab's share of the program is around 10 %, and its production will be undertaken in the US. Swedish procurement plans do not point to that the Air Force will acquire the T-X. Saab's engagement in T-X does bring with it a competition for advanced competence within Saab in relation to the same competence being directed to Gripen development. FMV and the Ministry of Defence keep a close watch on Saab not decreasing its priorities and resources needed for Gripen. According to interviews, Saab manages to balance these two large responsibilities.

## Customer collaboration and development

### ♦ *C/D*

The present foreign users of the C/D version – the Czech Republic, Hungary, South Africa and Thailand – serve as an extended network for the continuous development of the C/D. According to interviews, the existing customers are the most important counterparts. They meet in different forms together with Sweden within the Gripen User group, where they exchange experiences and plan the implementation of upcoming upgrades. These users commit to selected parts of Swedish Gripen upgrades. It is in the interest of Saab and the Swedish Air Force to reach as much shared functionality as possible with foreign users – thereby creating cost-efficient synergies. They also submit important information about experiences from their use of Gripen. According to interviews, the Czech and Hungarian buyers have in a short time period transformed its Air Force from the Soviet legacy systems and are highly committed and motivated in reaching their new air power capabilities in a new security environment.

As stated above, Sweden has sold or leased out some of the acquired C/Ds. Presently, the Air Force inventory does not offer any more produced Gripen units to foreign customers. But if the Defence White book's outline is fully implemented, some 10-20 Gripens could become on offer, based on the outlined division structure. Saab could in theory produce more C/Ds, but the development and infrastructure is now geared for E/F, and a reactivation of C/D production is not plausible. If a very large export order for C/D would arise, I assume that a restart could be arranged.

### ♦ *E/F*

So far, Brazil is the only foreign buyer of the E/F. It ordered 36 aircraft (28 E and 8 F) in 2014 at a cost of SEK 38 billion. In this export setup, the E/F is co-developed and co-produced between Saab and Brazil, with Embraer as the main Brazilian counterpart. An underlying incentive for Brazil is to (in a longer time perspective) be able to have a national capability to develop and produce its own fighter aircraft. Therefore,

Saab performs (under its offset commitment) an extensive knowledge transfer and education program in order to raise the development competence in Brazil. Saab performs educational programs in Brazil for military personnel and engineers regarding e.g. innovation and product development organization; Brazilian engineers and pilots are trained in Sweden; Saab performs together with the Swedish Air Force training and education. Paired to Saab's extensive interaction with Embraer and other Brazilian companies, the Swedish Air Force also has intense interaction with the Brazilian Air Force. The shared Gripen development enables cost sharing, and synergies between national capabilities. Admittedly, the aggregate Swedish competence for building fighters and operating them is at a much higher level than Brazil's. It also appears likely that Brazil will order more Gripen E. One could argue, however, that the E/F "marriage" between Sweden and Brazil and the industrial and production integration to some extent reduces the afore-mentioned freedom of action for Sweden.

### Operational collaboration and integration

In recent years, the Swedish Air Force has intensified its operative integration with other nations' air forces. Large, mutual, border-crossing exercises are performed regularly with neighbouring nations and with NATO constellations. The most intense interaction is with Finland, Norway and Denmark – in that order. Sweden is also a partner in the Baltic Air Policing Mission together with NATO countries. The Czech Republic and Hungary also contribute to this mission, and operative and logistics synergies between these three Gripen users are exploited.

### Future Swedish capabilities

The Swedish parliamentary Defence Commission issued the Defence White book on May 14, 2019. The White book is issued every five years and structures the military priorities for the next defence planning period – in this case for the years 2021-2025. The Defence Commission's White Book by tradition becomes the outline for the next defence planning period; the defence ministry will largely implement it. Overall, the 2019 White Book is highly ambitious and changes the conditions and future of the Gripen fighter. The 2019 Defence White Book describes a deteriorated security situation since the previous 2014 White book that requires fundamental reinforcements of capabilities, personnel and equipment. The Armed Forces will according to the White Book's outline increase from 60,000 to 90,000 personnel until 2025.

One important suggestion in the White book is that the operative use of the C/D version should be extended from the planned year 2027 until around 2038. Thereby Saab will have around ten more years of maintaining the C/D capabilities. This extension of the C/D life is in order to strengthen the long-term air power capability and also to serve as a capability bridge across the first decade of the operative use of E/F. The C/D capability will be organized in C/D air force divisions, and the E in its separate divisions. Two more Air Force divisions will be added, increasing the number to eight. Furthermore, the double-seated D version will serve as the primary advanced trainer until at least 2038.

The parallel use of C/D and E presents opportunities as well as challenges. An opportunity is that it enables an extended capability spectrum with two aircraft versions that can perform different roles in the air defence. The C/D will not be a second-rate alternative to the E – the respective roles will be optimized for the best capability combination based on their respective performance and capabilities. A challenge is that having two different versions will lead to a larger logistics and maintenance footprint, with the two versions requiring partly differentiated resources, facilities and personnel. How these aspects can be implemented is presently not decided.
Another significant suggestion in the White book is to partly rebuild the dispersed base system. The Swedish Air Force had until the late 1990s an extensive infrastructure of dispersed, smaller bases where fighters could be refuelled and rearmed. These bases were placed all over Sweden and served as alternatives to the principal Air Force bases, where the divisions are stationed in peace time. Through this extensive base system, the fighter units could be served by mobile turnaround units - thereby creating dispersed turnaround capabilities and protection. This system was gradually reduced during a decade from around 2000 onwards. The bases can however to a certain extent be reactivated. In sum, this reactivation will improve the Swedish air power capability, but will also require considerable resources and bring with it logistical challenges.

### European industrial restructuring

Presently in Europe, only Sweden and France have the domestic capability to be the full system integrator of a cutting-edge fighter. Globally we can add USA, Russia and China[9]. Sweden sources around half of its systems from foreign companies, primarily from the US, UK and Italy, in that order. France meets its sourcing needs almost entirely from national sources. The United Kingdom, Germany and Italy have abandoned their domestic capability as full system integrators. There are presently three European fighters for sale: Gripen, Rafale and Eurofighter. But what happens after the end of these fighters' lifetimes? Will all nations acquire American aircraft? Not likely.

Extensive and complicated discussions are presently undergoing concerning the future European fighter development capabilities. European combat aircraft manufacturers have laid out a vison for a European Future Combat Air System (FCAS, SCAF in French: Système de combat aérien du futur). The FCAS outcome is intended to take over after the end of the lifetimes of Eurofighter, Gripen and Rafale. The demands, specifications and timelines of the primarily concerned nations (France, Germany, Italy, Spain, Sweden and UK) are not synchronized. Firstly, the nations have different timelines for when to replace their fighters, when to order and when have new fighters in operational use. Secondly, the UK will operate the F-35 for many years to come and strives to develop an aircraft (i.e. their aspired FCAS solution) that complements the F-35 with different performance and capabilities. France and Germany strive to develop an aircraft with similar performance and capabilities as the F-35. The Gripen E's lifetime extends a bit longer than the replacement needs of the other nations. Thus, a tricky and complex negotiation is ongoing.

France and Germany in 2017 initiated a mutual demonstrator program in order to develop a future fighter together, under the umbrella name SCAF. Spain joined the project in February 2019. According to the present tentative outline, France and Dassault will be the primary integrator of this concept.

The United Kingdom have through its strong integration into the Joint Strike Fighter/F-35 program largely bound its fighter development resources for many years to come. Lockheed Martin and the US have also through its F-35 sales in Europe (and elsewhere) bound buyer nation's fighter procurement finances to a large extent. However, the UK presented its FCAS vision – the Tempest sixth generation fighter demonstrator – at the Farnborough Air Show in June 2018. The UK at the same time expressed that Sweden and Saab would be an attractive partner. Italy's Leonardo expressed in March 2019 its interest to be a partner in the program. Saab has expressed an interest and is also courted by the SCAF constellation.

The Franco-German-Spanish SCAF project has compared to Tempest a firmer and more developed structure at present. The latter does not have as firm government declarations and commitments.

This entire complexity regarding an expected restructuring and fusion of national industrial and development capabilities regarding fighters has many possible outcomes. There is immense political prestige and interest in the outcome of the expected restructuring process. Each nation wants to maintain as much strategic autonomy as possible. Each nation wants to sustain domestic, advanced development of such a highly strategic military platform. Each nation aims for a position on as high a tier as possible in the tiered integration hierarchy for fighter aircraft. To maintain the national industry and all the high-tech employment it brings is also a strong political incentive. Added to these national incentives, there is a shared European incentive to maintain Europe's strategic autonomy and to minimize dependency on the US.

So where does Saab and Sweden fit into the equation? High-level discussions and negotiations concerning SCAF as well as Tempest are performed at present with all concerned parties in industry, Air Forces and government. If partnering with the UK Tempest program, Saab has a strong negotiation position in having the capability as full system integrator. The UK and BAE Systems has a strong position with its home government likely ordering a much higher number of aircraft. Saab and Sweden have not committed (to my knowledge) to any alternative or constellation. We should not foresee that two final programs – SCAF and Tempest – already have been formed and serve as the only two alternatives. It is also plausible that France and Germany will not go through with their shared initiative. And of course, the US also has an interest to help to orchestrate an outcome that will be favourable to them – perhaps they will divide and conquer.

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*The analysis in this text is based on an assessment by the author as an academic researcher at the Swedish Defence University. It does not represent an official statement of a Swedish government authority.*

**Notes**

1.Three test versions of Gripen have been produced. These three have been gradually modified over the versions, based on the experiences from testing with the preceding version. So this the first flight with the most developed and advanced Gripen E Test aircraft.
2.Proposed in the 2019 Defence White Book, described at the end of this article.
3.The same engine as in the latest F/A Super Hornet version.
4.South Africa signed a contract in 1999 to acquire 28 Gripen C/D, later reducing the number to 26. Thailand signed a contract in 2008 to acquire six Gripen C/D, and extended the order in 2009 to six more.
5.Hungary signed a contract in 2003 to lease 14 Gripen C/D for ten years. In 2012, Hungary signed a contract for ten more years. The Czech Republic signed a contract in 2004 to lease 14 Gripen C/D for ten years. In 2013 it was announced that the leasing was prolonged until 2029.
6.The South African company Denel produced parts of the rear fuselage.
7.The Swedish Air Force ordered a total of 204 Gripen C/Ds, but later declared that it needed 100. Thereby a pool of surplus C/Ds became available for export.
8.This list of nations is likely not entirely true. Some nations can be omitted, and some can be added. Some nations have previously declared their choice of an aircraft other than Gripen, and thereafter rumors start to circulate in defense press, claiming that they are revising their previous declarations. Furthermore, some nations previously declaring intent may be showing diminishing commitment to acquire new aircraft at all. Thus, this list is tentative and is based on my assessment, based on interviews and articles in defence press.
9.China's ability to bring a cutting-edge fighter to full operational capability still needs to be proven.