Technology Transfer

TECHNOLOGIES WITHIN SAAB **3 2008**

SPECIAL FEATURE: GRIPEN DEMO

+

NCOIC
OPEN SOURCE
RAPID MAPPING
BETTER TOGETHER?

SAAB TECHNOLOGIES

SAAB

Same same but different

DO YOU RECOGNISE TRANSFER? I guess you do, although we have now adapted to Saab's new graphic guidelines. The changes are sublime at a casual glance yet explicit too if you take a closer peek, rendering us a fresh look, breathing One Saab. But keep your hair on: the core of the magazine is just the same as before. You will find the different sections just where you left them in our last issue.

WITH ONE EXCEPTION. This issue's special feature is Gripen Demo, the platform for demonstrating our new technology intended for Gripen upgrading and for the upcoming Gripen NG. A very important theme for Saab, and for Transfer. Therefore, the ordinary number of feature articles has been momentarily increased by 50% – from four to six – and the technological depth within the feature section is down to nuts-and-bolts level. Outside the special feature, we take a look at how Saab helps generating three-dimensional maps of our surroundings, and we learn about NCOIC and open-source code.

WE HAVE HAD SOME TROUBLE with distribution. Therefore, we now introduce an email address which you can use to report any problems with receiving Transfer. Just send an email to **transfer.distribution@saabgroup.com**

MORE NEWS: MY CONTACT information has changed. And I have a new photo as well.

ENJOY THE MAGAZINE!

GUNNAR LINN, EDITOR

TELL ME WHAT YOU THINK!
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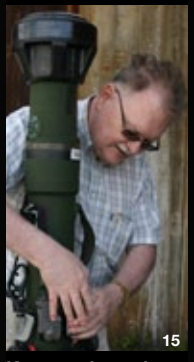
Look, there's my house!



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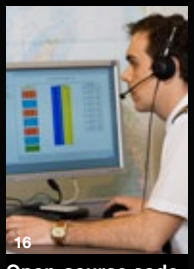
Knows where the fighting is at.



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Open-source code will open doors.

SPECIAL FEATURE:
18–32 GRIPEN DEMONSTRATOR

Photo: RUAG Aerospace

Technology Transfer

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COVER PHOTO
Gripen Demo on the rise.
Photo: STEFAN KALM

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SAAB TECHNOLOGIES

SAAB

Saab is one of the world's leading high-technology companies, with its main operations in defence, aviation and space. Transfer is an internal magazine about technologies within Saab. The purpose of the magazine is to spread knowledge about competencies and capabilities within the group.

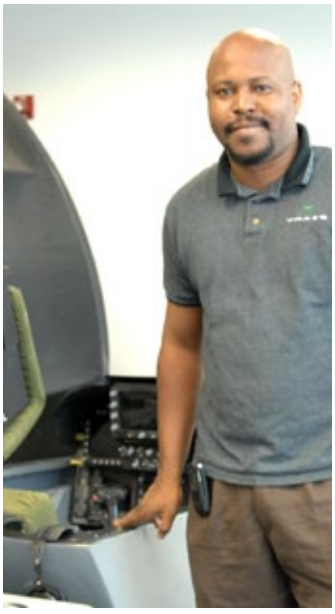

Photo: VMASC

INFORMATION EXCHANGE IN PRACTICE

Saikou Diallo, a PhD candidate at Old Dominion University (ODU) in Norfolk Virginia and senior project scientist at the Virginia Modeling Analysis and Simulation Center (VMASC) has visited Saab as the first stage of a formal exchange program between Saab and VMASC currently being finalized.

The idea of a formal collaboration was first discussed in 2004, and when Saab Microwave Systems was included in Saab Group and a mutually beneficial research opportunity between the two organizations was identified, the time was right for the idea to be put into practice.

Saikou's work focuses on interoperability and semi-automated mapping of information models which overlaps with the WISE family of products.

The goal of Saikou's visit was to make a first evaluation of the WISE platform and assert how it can be used in research at VMASC and potentially in future projects. Saikou also assessed agent structures for behaviour detection which is a research field of focus for VMASC and ODU.

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Photo: Tony Larsson/Swedish Coast Guard

SAAB PREVENTS DISASTER

On September 4th, the tanker Havi Trader was involved in an incident that could have resulted in extremely severe consequences for both environment and people around the Baltic Sea. The Malta-flagged Havi Trader was on its way from Finland to Morocco, with 6 800 tonnes of extremely harmful sulphuric acid, when the duty officer at the Maritime Surveillance Centre on Muskö observed that the vessel was not following the correct route through the archipelago. Instead, it was heading directly towards Storholmen near Väddö, off Stockholm.

The Muskö Maritime Surveillance Centre uses Saab Strima, a system in service around the clock at maritime surveillance centres around the coast of Sweden. The system collects data from the automatic identification system (AIS, which collects data automatically transmitted from vessels with information about identity, position, direction, velocity, destination and similar) as well as radar echoes from radar stations all along the Swedish coastline. This information offers continuously updated situational awareness, with logging facilities, for the operators, who can easily detect any anomalities, sometimes even with the aid of automatic alerts.

So, with input from Strima, the Maritime Information Centre quickly informed Havi Trader about her situation and instructed her to yaw. According to the Swedish Police, the incident was due to the fact that the officer of the deck had fallen asleep.

Strima's successor, SjöC, has already been launched and delivered to one of the Maritime Information Centres. The remaining centres will receive SjöC before the end of 2008. SjöC is based on SAFIR, Saab's family of tactical command-and-control (C2) systems, and provides the maritime situation picture to civil and military authorities in Sweden and Finland.

Future versions of SjöC are planned to provide additional support for automatic surveillance and alerting.

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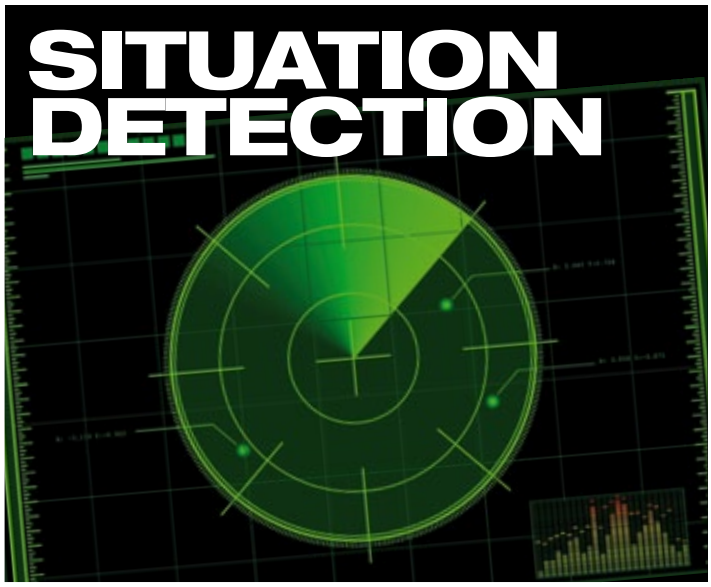
GUNNAR LINN

SITUATION DETECTION



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The tasks during international naval missions can vary significantly from case to case, as can the level of "war". Operator support to increase situation awareness and to detect various situations that are difficult to spot manually can hence be very useful.

During 2008, naval research-and-development funding has been used to develop a situation-detection demonstrator for naval operations. Imagine a scenario where the operator knows which type of situation they are looking for, but does not know where or when it will occur. The situation-detection tool can then find those situations using operator-defined rules from a set of events. The demonstrator contains a simple UAV route-planning function to be used, for example, in search-and-identification tasks.

A successful demonstration of the tool has recently been held for the Swedish Defence Materiel Administration (FMV).

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NEW-GENERATION ACORN

Saab has just developed a prototype of a new generation of the ACORN surveillance sensor. The ACORN (which stands for advanced combat optical reconnaissance node) provides advancing personnel with autonomous monitoring of approaches, cleared areas, and vital regroup or retreat routes. It is suitable for urban warfare operations providing increased security and better flow of intelligence and can be set up and operated by one person.

The ACORN fisheye-lens-sensor camera provides automatic detection of movement within a surveyed area. The fisheye lens allows continuous 360° observation of the area around the sensor.

If movement is detected by the sensor, the system operator is alerted and a video and audio sequence is automatically recorded of the surveyed area.

The sensor can also be used as a man-portable sensor. It can, for example, be mounted on the point man in an advance team to provide information to the troops outside a building about what is happening inside. It will provide crucial life-saving information if the advance team is attacked or ambushed. Another use is as a camp protection sensor acting as an invisible tripwire around the camp.

The sensor nodes may be fitted with an external power supply or a solar-power supply for prolonged operation time.

A new feature is that the sensors can receive input from other sensors such as magnetic, seismic, or chemical sensors or tripwires, to be transmitted using the ACORN radio. Another new feature is that each sensor can be used as a communication node for an external camera.

The new small ACORN weighs 495 grammes, it is 5×5×10 centimetres and has an outdoor radio range of up to three kilometres. It also has new operator-interface software showing information from four sensors at the same time. The software can be installed on any computer of choice.

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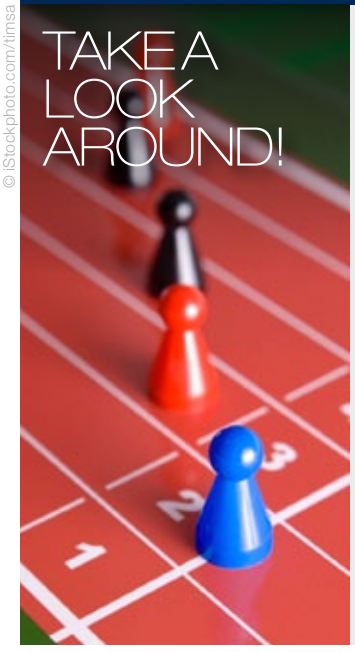
PATENT STUFF



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IN TRANSFER 1, 2008, our business-unit intellectual-property managers set out their goals for 2008. With these goals in mind, let us look at the world around us.

In Europe we are still struggling to find common grounds for a community patent. Despite decades of work with this issue, the European patent system is still complicated and very expensive. The political trend over the last few years has also been to question the need for a patent system. In many countries, there have been movements arguing for the abandonment of systems for protection of immaterial rights, such as copyright and the patents.

In the other end of the world China, Japan, Korea, Singapore and every other growing economy in South-East Asia is focussing on increasing the number of native patents, especially in high-tech areas, with the specific aim to reduce dependency on foreign technology. The Chinese "action plan on intellectual-property-rights protection" includes some 280 measures such as new legislation, education programmes, information campaigns and streamlining of public-office procedures. As a result, we have over the years seen an annual Chinese patent increase of 33%. The Republic of Korea shows a more modest increase of a mere 20% – but with results scaled to population, BNP and investments in research and development, Korea is a world patent leader together with Japan.

These trends obviously have an impact on Saab. We are an international company selling our products, systems and solutions in a global market. With China and other countries in Asia building strong patent portfolios, this will eventually limit our possibilities to address the same markets as companies from these nations. Within the growing civil security area we should be preparing for much fiercer competition. If a Chinese company develops a harbour-security system, establishes proof of concept in a national harbour and then competes internationally with their proprietary technology; where do we want to be?

Getting back to the smaller world that we ourselves are able to influence, it is essential that we have goals for our intellectual property rights that are in tune with our strategies and business plans. Naturally, we must also make sure that we actually achieve these goals.

MARGARETA YDRESKOG

VENTURES STUFF

PORTWISE CIVIL SECURITY

Photo: PortWise

SAAB HAS EXTENDED its relationship to civil-security enterprise PortWise by cooperation and investment. For some time, Saab has been active in the civil-security market, and its focus on the area increases.

Trusted-identity and access-management specialist PortWise provides a comprehensive, integrated and secure software platform protecting the integrity of employee, partner, or consumer interactions with corporate applications and data across the internet. PortWise enables organizations to protect the integrity of their systems with convenient, low-cost, mobile two-factor authentication, and in-depth device security. In a world ridden with identity theft and corporate espionage, PortWise protects over 800 organizations and 6 million users.

The investment in PortWise is a step towards building a product portfolio within the information-security sector. Saab will integrate the PortWise product suite as a proprietary and integrated offer within Saab's civil security offer. After the transaction Saab will have an 18.75 % ownership in PortWise. PortWise will gain access to a strong long-term industrial partner who can contribute with both commercial and technical expertise, while Saab gets access to an important technology and knowledge which is a key component in its civil-security thrust.

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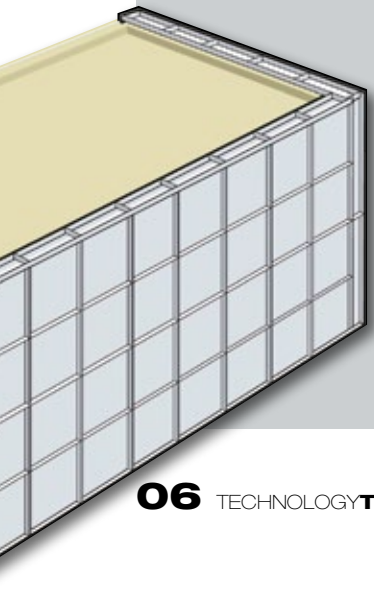
SAAB INVEST IN PROTARIUS



PROTAURIUS AB manufacture and market a self-developed patented ballistic protective material. The material lends itself to many different applications through its flexible construction, re-usability, speed of assembly and the ease with which it is repaired after being shot at. The company's technology, which is close to that of Saab Barracuda, together with good reference customers, means that the company is a natural investment object for Saab, who are injecting venture capital in order to further develop the company with a view to international expansion.

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Photo: Saab Bofors Test Center

Serial production of NLAW, the Next-Generation Light Anti-armour Weapon, has commenced and Saab Bofors Dynamics have already completed their first delivery to the British customer. The programme has thus reached the second milestone for the year.

The delivery was preceded by a number of test-firings with good results where a total of 40 out of 41 weapons fired achieved the expected result. In addition, all the test-firings that have been conducted with the customer have been successful.

Saab signed the NLAW contract with Great Britain in 2002, which is a complex and wide-ranging agreement involving a significant number of British sub-suppliers. The contract, which was won despite tough competition, covers development, serial production and maintenance.

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MARIA HÖKBÅGHE

SLB OVER NARROW-BAND RADIO

On September 2, the team behind the battle-management system SLB were able to demonstrate the capacity of SLB to operate over narrow-band radio systems in a field-test environment. The field test was conducted in Skövde under realistic conditions, together with representatives from the Armed Forces. The test proved that SLB is no longer dependent on expensive broad-band radio equipment such as the tactical data radio system (TDRS), but can utilise radio equipment ranging from the Swedish legacy radio RA180 (VHF) to modern VHF and HF band radios.

During the field test SLB's unique functions for distributing tactical information were demonstrated in a number of scenarios, over both the HF and VHF bands. The cyclic delivery of friendly forces' positions, so-called blue-force tracking (BFT), were successfully demonstrated using the HF-band radio at distances of up to 200 km. Simultaneously, SLB's capacity to distribute tactical messages was demonstrated over the HF-band radio.

The field test was the result of an intensive period of preparatory and development work that commenced in June and continued right up until the test itself. The SLB team is now preparing itself for the next task, SLB as a BFT provider for Battlegroup 2011.

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ERIK KLINTSKOG
JOHAN ERSSON

Photo: Henrik Överstam

SAAB AT ÖREBRO UNIVERSITY

New, specially adapted premises were formally opened on September 18th at the Campus Alfred Nobel in Karlskoga, a part of Örebro University. The premises are equipped with state-of-the-art technology and software in the research field.
The Campus Alfred Nobel has been home to a research centre for modelling and simulation since 2006. The intention is for it to become a creative meeting point where basic academic research is intertwined with applied research in close collaboration with industry and commerce. Saab Bofors Dynamics contribute to the centre with an industrial PhD student attached to the campus on a part-time basis, together with Ulf Bengtsson who is a member of the management group:

"From a recruitment point of view it's always a good thing to have a visible presence at colleges of higher education and universities. In addition we of course have considerable opportunities to influence the types of research to be pursued at the research centre."

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MARIA HÖKBÅGHE

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PRIZED PAPER ON COMMAND INTENT

The network-centric approach enables the interconnection of systems in a dynamic and flexible architecture to support multi-lateral, civilian and military missions. Sounds fine, but the uncertainty within an actual mission, and the variety of potential organizations that support the mission after it is underway, makes command intent (CI) a critical concept for the mission team. With new and innovative information technologies, CI can now be made available to the team of organizations in a coalition environment. Per Gustavsson, PhD student at Saab and the University of Skövde, has, together with his co-writers, been awarded the Willard S. Vaughan, Jr. Best Student Paper Award for "Machine Interpretable Representation of Commander's Intent" for the 2008 International Command and Control Research Symposium.

CI representations need to be able to express the mission team's purpose, the anticipated end-state of the mission and desired key tasks. In this work the expression of CI has been developed to enable the structure and dynamics of collaboration support. The paper presents the operations intent and effects model (OIEM) – a model that relates CI to effects, and supports both traditional military planning and effects-based operations.

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Q&A

LARS-ERIK SVEDLUND, 50, PROJECT DIRECTOR GRIPEN NEXT GENERATION, SAAB AEROSYSTEMS

Why Gripen Demo?
The demonstrator is used to perform flight testing and market demonstrations of a number of new functions. These new systems and capabilities are planned to be introduced in the coming next generation of Gripen but could also form the basis for further upgrades of the current Gripen C/D fleet.

How did you select what to demonstrate?
We used the results of pre-studies regarding increasing market demands regarding range, load capability and next-generation tactical capabilities. We also looked at the value of market demonstrations and the need for concept proofing and risk mitigation.

The greatest challenge in the project so far?
The complex technical changes in themselves were of course a challenge, probably in parity with any extensive fighter-upgrading program. But the big challenge was to introduce the changes and to get flying within such a short period of time – and within an extremely tight budget. The key factors to this success were a crew of very dedicated and competent project team members in combination with a slimmed organization, short decision routes and efficient work processes inspired by the principles of the famous Lockheed Martin's "skunk works".

THE WORLD IN 3D

... brought to you by Saab!

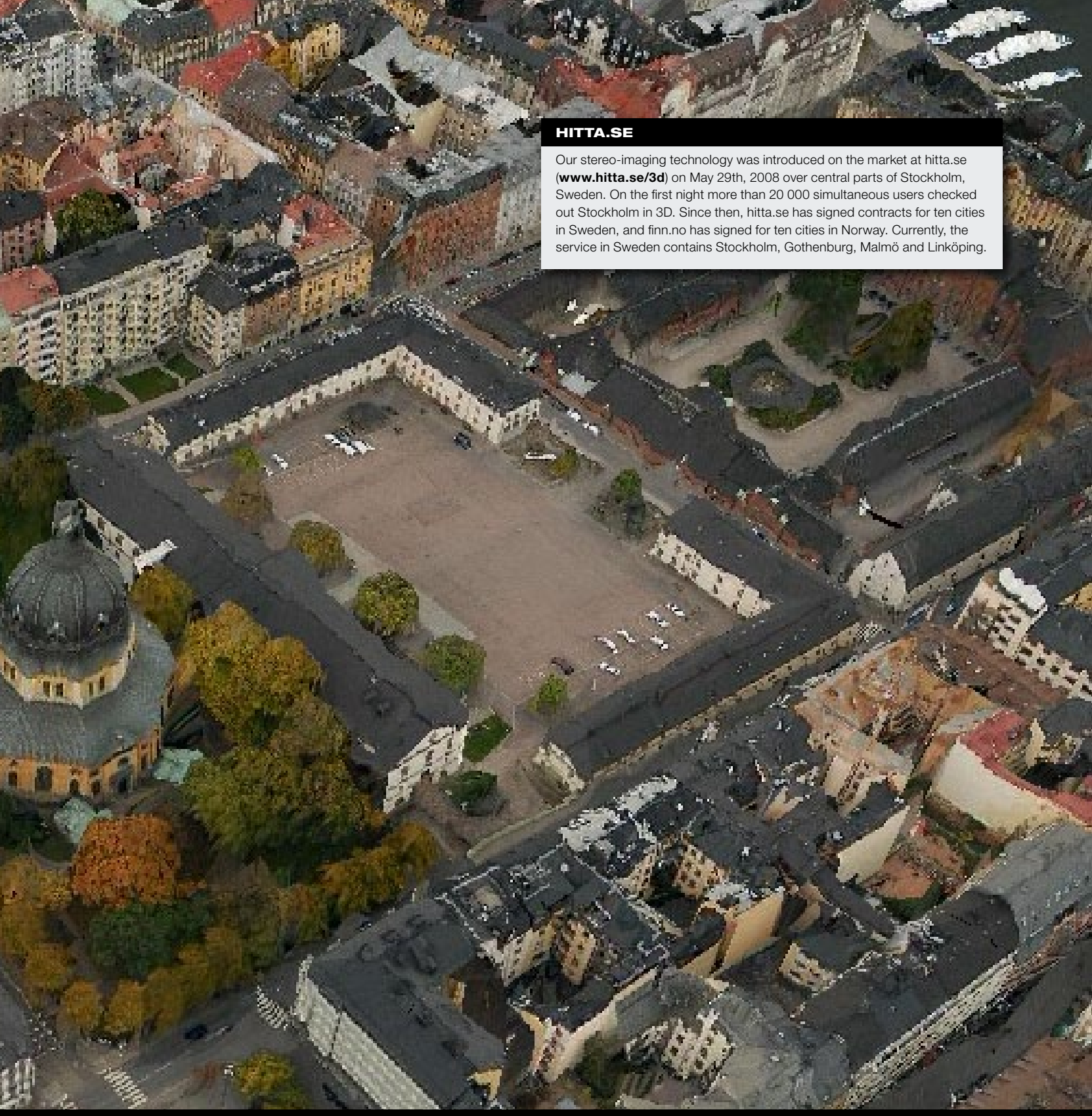
LEIF HAGLUND (text)
GUNNAR LINN (illustration)

IT IS NOW possible to automatically build realistic, geo-referenced and measurable three-dimensional (3D) models in real time, or almost real time, from photogrammetric methods. Saab is the first company to achieve this!

Think about this as a three-dimensional aerial photo, in which you can manoeuvre yourself – for example interactively "fly" around the house you live in. Well, why not try? If you live in any of the three largest cities in Sweden, or in "Saab City" (Linköping), go to **hitta.se/3d** and "fly" home (see separate info box).

This has been possible by combing more than 40 years of experience in image processing, based on the development of target seekers and optronic surveillance systems, with expertise in navigation and positioning techniques and algorithms.

During the system development we found many different applications, and there are many yet to be found. It is, however, clear that the applications span from purely military to everyday consumer products. To this end, Saab has decided to form a spin-out company, named C3technologies (**www.c3technologies.com**), for consumer applications and prod-



HITTA.SE

Our stereo-imaging technology was introduced on the market at hitta.se (**www.hitta.se/3d**) on May 29th, 2008 over central parts of Stockholm, Sweden. On the first night more than 20 000 simultaneous users checked out Stockholm in 3D. Since then, hitta.se has signed contracts for ten cities in Sweden, and finn.no has signed for ten cities in Norway. Currently, the service in Sweden contains Stockholm, Gothenburg, Malmö and Linköping.

ucts. Saab Bofors Dynamics will continue developing the technique and algorithms and, together with other Saab companies, develop the military and civil security markets.

THERE ARE MANY different applications where the utilization of stereo technique solves problems in image processing by adding distance information. Applications can be run on a standard PC in real time, or close to real time, depending on resolution and detection/tracking algorithms used.

The following example is taken from flight trials where an aircraft is flying with a downward-looking camera and a positioning system keeping track of locations and attitudes of the camera. Only one moving camera is thus used in the stereo estimation – so called motion stereo (see separate info box).

To be able to quantitatively estimate the stereo disparity, we will need not only the image but also to know the position and attitudes of the camera. Moreover, this is necessary for each pixel in the image as we are measuring disparity differences with subpixel accuracy. We therefore need calibrated cameras, wherein all aspects in the imaging process from the scene to the CCD-array are taken

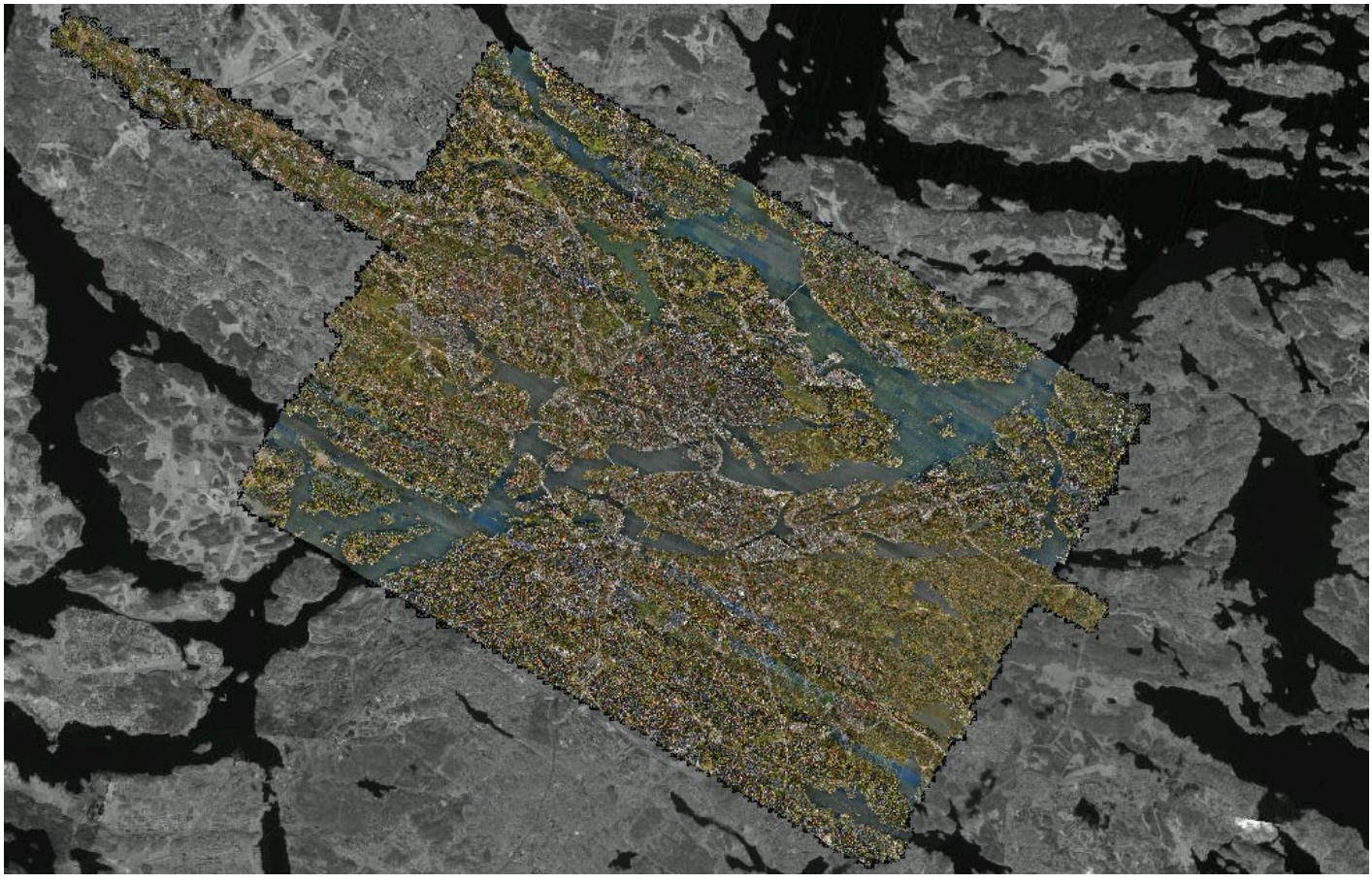
into account. Conveniently we can achieve this by using images from a static scene – no complicated calibration procedure is necessary.

Once the calibrated equipment is in place, it is time to fly over the area to be covered by the 3D map, register the images and calculate the 3D models.

SINCE THE MODELS are created automatically based on the airborne pictures, large areas, for instance cities, can be modelled in a quick and cost-efficient manner. All models will also receive correct geo-referenced data in longitude, latitude and also a correct height value in every pixel. The information can be used as a precise and updated map for immediate situational awareness.

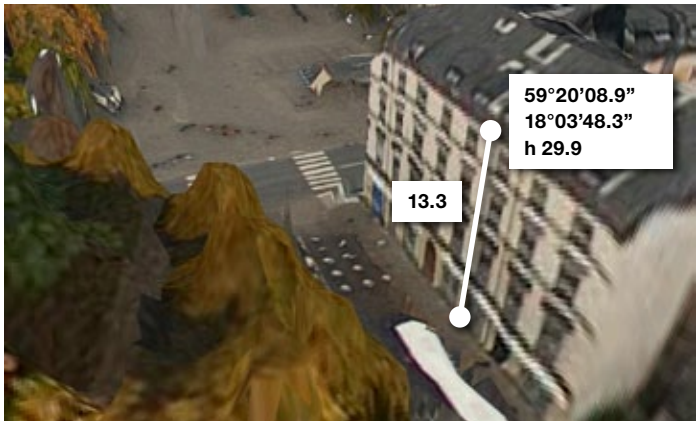
With a flight altitude of 500 metres and a speed of 100 m/s, we

So, how was the Stockholm picture on the previous spread generated? Easy. Data was collected from an altitude of 600 metres and the pixel size is 12 cm, while height values (z-values) are estimated to have an accuracy of about 20 cm. Approximately five hours of flight time were needed, and the automated generation of the model took something like 48 hours – which is possible to shorten by parallelising the computations.



This i the area covered by the mapping flight, 14X18 kilometres. The image on the previous spread is an example of generated 3D model.

We can easily take a closer look at a specific region – in this case the Hedvig Eleonora church.



All positions are given in a coordinate system – in this case latitude, longitude and height – and parameters such as length, area or volume are measurable.

LINE OF SIGHT

It is straightforward to implement line-of-sight calculations based on the orthographically adjusted 3D map. The areas marked in red are what can be seen from a camera at a specific position in the terrain.

Line-of-sight estimates, sensor at 0.2 metres height, field of view 90°.

Line-of-sight estimates, sensor at 2.2 metres height, field of view 90°.

will be able to create a 3D model of maximum 180 km² per hour, but due to the time required to turn the aeroplane, the effective area coverage is between 100 and 150 km² per hour. At this flight altitude, the resolution in the picture is approximately 10 centimetres.

A flight altitude of 2 000 metres will give a resolution of approximately 0.4–0.5 metres, but additionally an area coverage that is four times as large, 400–600 km² per hour.

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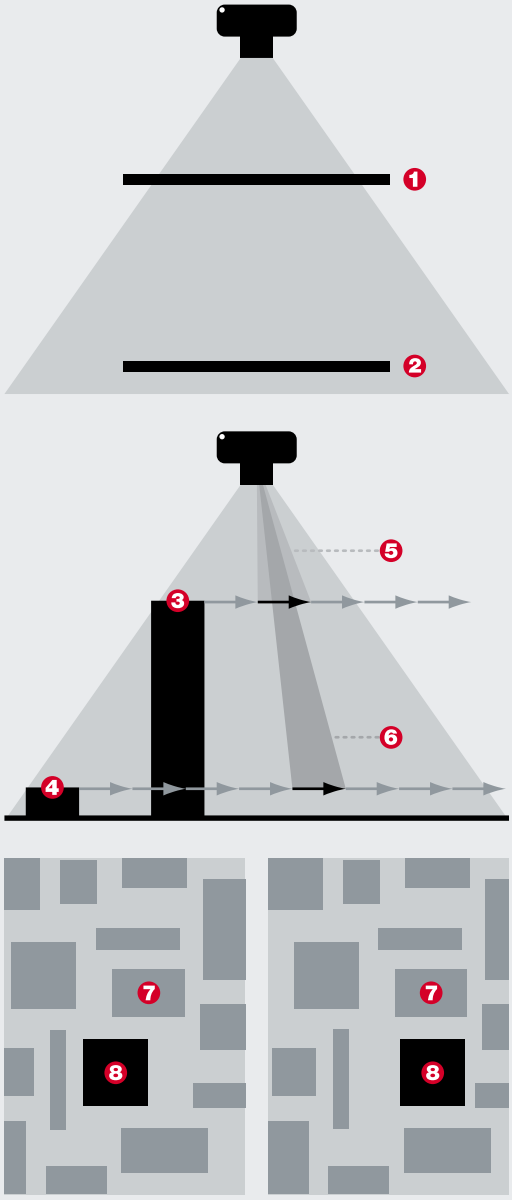
MOTION-STEREO – A DEMONSTRATION



With few exceptions, cameras have cone-shaped fields of view; narrower close to the camera, wider at a greater distance. This means that the same object will take up more of the image at close range 1 than at long range 2. Your spouse will not fit into the picture unless you take a few steps back, right?

This also means that an object, moving before the camera at a certain translational velocity relative to the camera, will take less time to pass the camera's field of vision at short range than at long range. You will have more time snapping a passing car at a distance than from the kerb.

The camera used for rapid mapping is no different. It is mounted on an aircraft, flying above the ground at constant speed, with a cone-shaped field of vision. Now, to make things easier, consider the camera to be still, and the ground to be moving past the camera instead.

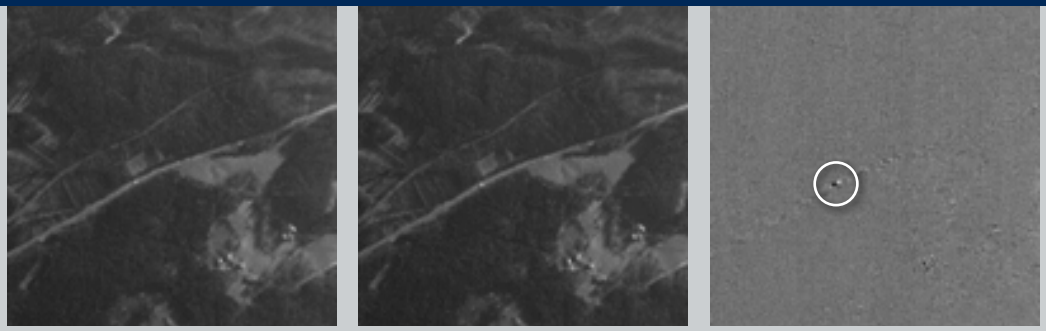
Objects on the ground will take a certain time to pass the camera's field of vision – just as we agreed. The roof of a tall building, for example, will be closer to the camera, and will pass the camera's field of vision in less time 3 than, say, a shed on the ground 4, although they both pass the camera at the same translational speed.

So, if the camera takes repeated snapshots at constant intervals, the rooftop will, between photos, move through a larger portion of the camera's field of view 5 than the shed 6.

And this is just how the system works. Image processing identifies and follows contrasts in consecutive photos. An object on the ground, to which the distance is known by means of the aircraft's altitude-measuring equipment, will move a certain amount of pixels 7 (all grey boxes) from one photo to the next. Objects moving more pixels than that 8 (the black box) will have to be closer to the camera, meaning that they are at a certain height above the ground. The relationship is linear; the amount of pixels that an object is offset for each new image, related to the pixel offset of ground-level objects, is, through pure trigonometry, a direct measure of the object's height above the ground. (And it works negatively as well; "slower-moving" objects are below ground level.)

The image processing system is capable of understanding very complex images, and to follow numerous objects moving at different paces between the images. This renders a complex 3D image of the covered area, with no other input than a set of consecutive photos taken from a steady-pace aircraft flying at known altitude.

ALSO: DETECTION OF MOVING OBJECTS



In the process of generating 3D models many images taken at different time instances are used. Moving objects will stand out as inconsistent data. This inconsistency is easily detected as illustrated in these figures.

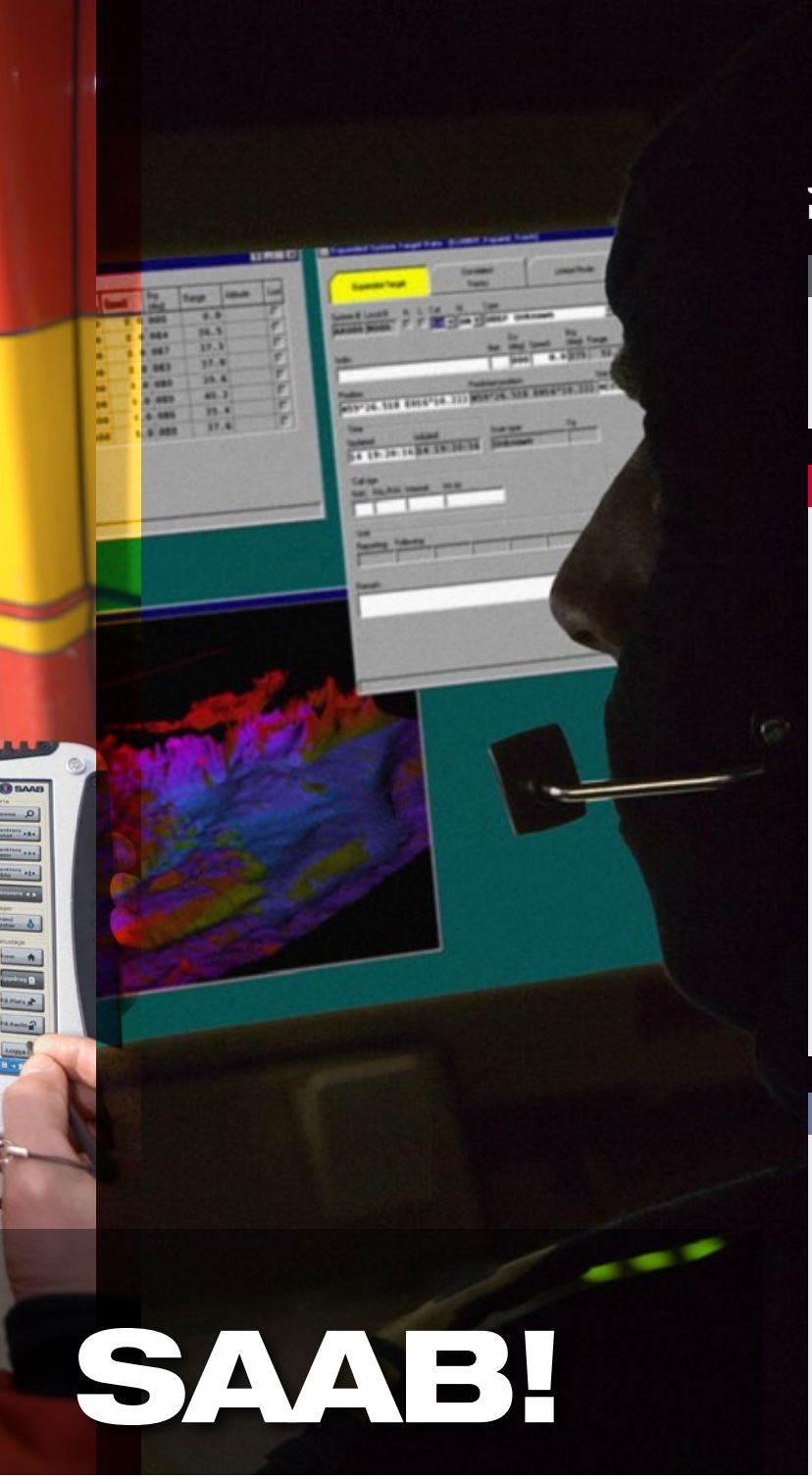
Saab is now a player in NCOIC – these are the benefits.

NCOIC: ADVANTAGE

SINCE IT STARTED in 2004, Saab has been an active member in the global Network-Centric Operations Industry Consortium (NCOIC). Interest in the consortium continues to grow steadily with the current membership standing at 102 companies from 17 countries. Membership is not restricted to commercial ventures; authorities and administrations – both civilian and military – from different countries have joined the consortium. This makes NCOIC unique as organisations go – a world-class forum for network-centric interoperability, providing opportunities for a common industry to test and evaluate, and then make widespread recommendations for agreed standard solutions in a way that no single company could. Experience shows that no agency or administration, regardless of size, could do so either.

The singularly most important reason for industry as a whole to participate in this strategic alliance is that, as long as customers are not aware of what is meant by net-centricity, how to create the solutions that are required, how to integrate existing systems into them and how to use them, the same customers are going to buy less. This is as readily apparent in Sweden as it is in other nations. Once they receive the required knowledge they will spend more – which will benefit the industry as a whole.

IN ORDER TO achieve the intended operational advantage in a live situation, the different actors' systems must be able to interact at once, even if the requirement for this had not been foreseen when developing the systems in question. In order to identify and satisfy different integration-related requirements, NCOIC produces and agrees upon concrete, general recommendations regarding how to satisfy the technical requirements concerned. This takes the form of the technical standards to be used as well as guidelines for the practical application of the selected standards. In cases where it is discovered that standards are missing for a certain area, NCOIC will work in cooperation with established standardisation agencies (see separate info box) in order to get them to pro-



SAAB!

JAN WIBERG, EVA WILLSTRAND (text)
PER KUSTVIK (photo) GUNNAR LINN (illustration)

NCOIC'S MISSION

NCIOC's mission is to support nations and companies in the design of both military and civilian management systems, in order to facilitate their interoperability over administrative and legal borders within particular nations, in addition to across national borders.

MEMBERS

NCOIC members represent world-leading suppliers of defence and integration, leading IT companies (hardware and software), military and civilian authorities from a number of nations, academia and different NGAs (Non-Governmental Agencies). Other examples apart from Saab are Boeing, Thales, Lockheed Martin, BAE Systems, Raytheon, EADS, General Dynamics, Northrup Grumman, Rockwell Collins, Finmeccanica, IBM, Microsoft, Intel, Oracle, HP, Sun, Cisco, US Red Cross and The Johns Hopkins University. Examples of authorities and agencies that are represented are the US Department of Defense (DoD) with DISA (Department of Information Standardisation), DHS (Department of Homeland Security), US Federal Aviation Agency (FAA), Australian Defence Organisation and Euro Control, the Air Traffic Control Agency. Swedish military and civilian authorities are also discussing membership. LFV, the Swedish Civil Aviation Authority, intends to become a NCOIC member.
In addition to NCOIC's members, the integrated project team comprises other important user organisations, for example NATO (NC3A, ACT, C2 Centre of Excellence Netherlands among others), US DoD (Navy, Joint Force Command, Airforce, Army), US NextGen (USA's programme for the next generation of civil aviation), EuroControl/SESAR (the European equivalent to NextGen), the Swedish Armed Forces and LFV.

IPT

The work that NCOIC does is conducted in integrated project teams; IPTs. At the time of writing there are four IPTs in existence, focussed on the interoperability within the following areas:

- network-enabled emergency response – concentrating on collaboration needs resulting from significant catastrophes;
- sense-and-response logistics – concentrating on military and non-military logistics that are integrated into the operational processes in order to improve efficiency and speed, as well as reduce costs;
- aviation – addressing the integration requirements for the next generation of commercial aviation, with less impact on the environment.
- NATO interoperability – focussing on military and non-military requirements in connection with coalition operations.

duce a new standard that NCOIC subsequently can recommend.

THE GUIDELINES AND other results produced by NCOIC up to now can be sorted into four main deliverables (groups of documents, see separate info box). The deliverable containing the concrete recommendations is contained in what is called NCOIC interoperability framework (NIF). NIF is to a large extent based on the results achieved from the Swedish military net-centric programme LedSysT. This came about through FMV's (The Swedish Defence Materiel Administration) donation of the majority of their design regulations to NCOIC, and through employees of Saab having designed the bulk of the NIF. NIF harmonises very well with NATO's NAF and NEC which is very much in line with the Swedish Armed Forces' forward-looking strategy. Read more about NCOIC's deliverables in a separate info box.

Participation in the different NCOIC projects has opened NATO's doors to Saab in a manner that would have been impossible through other channels. Saab employees have for example been able to participate in classified NATO activities and gain access to NATO-classified documentation; something that is normally only granted to citizens of NATO member nations. An example of direct commercial benefit from this are consultant assignment orders of upwards of 50 000 man-hours from FMV where Saab's NATO experience has been of great value to the customer and could not have been matched by any other supplier.

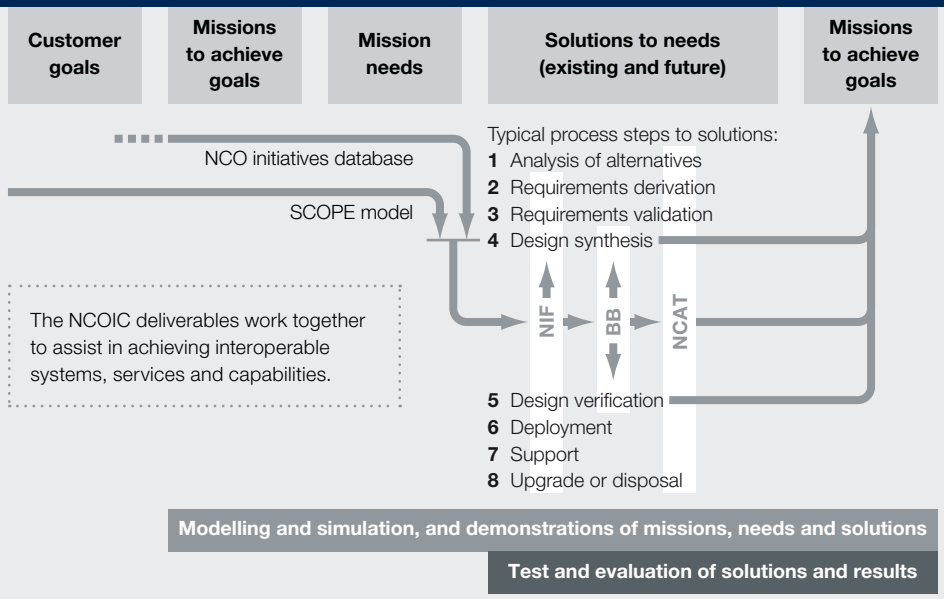
Saab has received several other orders that, to a greater or lesser extent, can be connected to NCOIC membership. One such example is the "Net-Centric" concept currently offered by Saab – with a great deal of success – to airports, harbours, correction facilities, nuclear power facilities and the security sector, which builds on the basic ideas and guidelines which in their turn are the fruits of the work within the consortium.

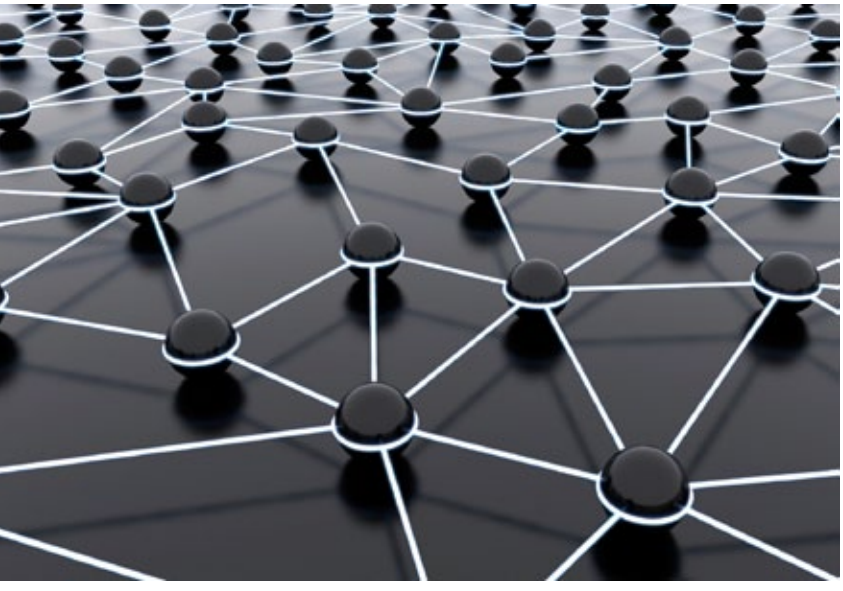
THERE ARE EXCELLENT opportunities for Saab business units to take initiatives and to drive

NCOIC'S DELIVERABLES

NCOIC helps our customers, both government agencies and commercial enterprises, to create interoperable systems, systems of systems, network services and capabilities. In the customers' overall process, when producing technical support for their business operations (the grey boxes in the diagram), NCOIC comes in at the "solutions to needs" level, which involves the design and production of technical solutions that meet the users' requirements. NCOIC has developed a number of deliverables (the blue text in the diagram), supporting the development of network centric interoperable solutions. The deliverables, which are freely accessible for use by anyone, are as follows:

- NCO Database – identifies all important customer initiatives and programmes for network-centric operations, network-centric warfare (NCW) or net-enabled capabilities (NEC) from smaller local initiatives to global wide-area networks. This is a deliverable primarily directed towards the member companies in NCOIC, and is used to identify areas that ought to be addressed by NCOIC.
- SCOPE Model (that stands for systems, capabilities, operations, programs & enterprises) – an evaluation model providing support in order to characterise organisations and systems with the purpose of creating detailed understanding of the strengths in the current systems environments, as well as identifying gaps that must be eliminated. The model is mainly used by customers in early phases of development, for example when creating the strategic roadmap for technical development. It can be used to great advantage in connection with procurement in the form of requirements that tenders are described in accordance with SCOPE's dimensions.
- NIF – contains the overall architectural framework of the NCOIC; it defines the structure and provides guidelines for how the detailed technical recommendations are to be formed in so-called patterns. For different concrete requirements, patterns are created with guidelines regarding the recommendation of standards and the terms of application for the development of solutions complying with the requirements. For each pattern, typical basic causes of failure are described for the production of the type of solution required, in addition to the definition of relevant parameters whose success can be measured in terms of infrastructure for communication and information, service-orientated architecture, semantic interoperability, information security, amongst others. NIF harmonises well with similar models produced by influential user-groups, for example NATO, DoD and civilian equivalents. When developed NIF has been greatly influenced by the results from the LedSysT program run by Saab for the Swedish Armed Forces.
- Building blocks (BB) database – a catalogue of NIF-compliant standard products that the supplier has certified (as being compliant with NCOIC's model), in relation to patterns in NIF. Here both users and companies are able to seek out products that satisfy different types of requirements.
- NCAT (which stands for network-centric analysis tool) – provides support for the evaluation of interoperability target fulfilment. Through using a large number of questions related to SCOPE and NIF, concrete targets/requirements for network-centric interoperability levels can be defined and subsequently evaluated against existing and/or suggested solutions. The tool can be used by both users and suppliers. Suppliers can use it as a requirement tool. Requirements can alternatively be placed through offers stating the level of the offered solution in NCAT terms.





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STANDARDISATION ORGANISATIONS

Examples of standardisation organisations collaborating with NCOIC:

- Institute of Electrical and Electronics Engineers (IEEE);
- International Organisation for Standardisation (ISO);
- Object Management Group (OMG);
- Open Geospatial Consortium (OGC).

the "standardisation" process in a direction that suits the units from a purely commercial point-of-view, for example by producing guidelines that dovetail with existing or planned Saab products, and thereafter coordinating ones' own product development so that the product is actually in the marketplace at the time of determining the guidelines.

EVA WILLSTRAND

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MR. FIBUA

**You have probably heard his epithet.
Maybe you have heard his name.
He is one of the pillars of Saab.**

GUNNAR LINN (text and photo)

The year is 1975. A guy steps into his boss's office, and is asked: "What will our customers' needs be in 20 years?". The guy sets to work, and eventually comes up with four aspects of tomorrow's market for his company, FFV (which in those days stood for Förenade Fabriksverken, producer of defence materiel). He has been scrutinising the development of technology, tactics, threats and competition.

The results of the guy's work lead FFV to become spot-on in the development of defence materiel. By first knowing the needs, FFV soon find the concepts to fulfil them. So, what are the needs, then? Well, the guy and his team are of the conviction that the wars of the future will predominantly be set in urban terrain.

The guy moves on to Bofors in 1991, who follow suit on the method: first know the needs, then develop the concepts. And the needs are still tied to fight in built-up areas (FIBUA).

Around the time of Bofors's fusion with Saab in 2000, the guy finds himself holding numerous lectures for the new organisation on tomorrow's combat. His ideas on what the organisation should aim at to stay in business get widely accepted, and today they more or less form the base for many of Saab's activities.

The guy's name is Christer Regebro, but due to his successful analyses and well-received lectures, you might know him by the epithet Mr. Fight In Built-Up Areas.

ALTHOUGH CHRISTER IS not entirely a strategist – he also has several hands-on technology concepts in his portfolio, for example STRIX, the first-ever terminal-guidance mortar; confined-space capability as in AT4CS; ATARC (which later became NLAW); high-velocity rocket-mine systems; tandem warheads; CG M4; directed-fragment warhead as in Abraham (BAE systems); ACORN sensor hand grenade; totally some hundred ideas boiling down to more than 20 patents – his strategical side makes him quite a freak for strategy games.

For his son's eleventh birthday, Christer bought a copy of the well-known game Dragons and Demons, but both he and his son were disappointed by the fact that the game was all rules. So Christer wrote his own adventures for the game. Marsklandet, Enhörningshornet, parts of Ereb Altor and several others which were later published as stand-alone adventures – they are all Christer's products.

THIS GREAT INTEREST in combining problem and solution, combining technology and tactics, will always be Christer's guiding star. Always asking "Why did this happen? Where are we going?". For a guy like that, being asked "What will our customers' needs be in 20 years?" will never be intimidating at all.

QUICK FACTS

Name: Christer Regebro
Age: 64
Profession: Product planner, new products
Site: Saab Bofors Dynamics, Eskilstuna
Extras: Into cosmology, anthropology, warfare history – and nice cars. Also likes steam engines and old swords. Plus his wife and son.

Since the early nineties, Saab has been using open-source code in systems for both civilian and military customers. Now Saab is taking a further step in the same direction by offering parts of the Safir product as open-source code.

OPENING UP WITH OPEN-SOURCE CODE

DANIEL WENGELIN (text)
PER KUSTVIK (photo)
GUNNAR LINN (illustration)

SAAB, AS A SIGNIFICANT and to an extent traditional supplier of defence materiel, for a long time regarded programming as an integral part of a wider system – something that "comes in the box" when the customer purchases materiel, such as a radar system or an aircraft. Software that may possibly have been utilised in other contexts was kept secret and in negotiations with customers limitations had to be agreed upon regarding the rights and legal aspects of the software concerned.

During the nineties, the conditions for the development of software-based systems were changed through the constantly growing accessibility of software through the internet. A growing mass of software, both open and closed, also found its way into embedded systems. This brought about a change in attitude as to how command-and-control (C2) systems should be developed.

AFTER HAVING FOCUSED initially on development tools at different levels, for example GNU Compiler Collection (GCC) and GNU Ada Translator (GNAT), interest in the next step fell on the introduction of products using open-source code in the target systems. From operating systems, through portability layers, databases and communications, to map management, graphics and other user interaction; open source has made its entrance across the board. One example of this is Corona (see diagram), a C2 system that Saab supplied to the US Army, where an extensive refactoring of the program code led to radically changed proportions between own and open-source code.

By means of dialogue between internal experts and evangelists for open-source code, all development projects benefit from these experiences, eradicating any attitude of "not invented here" and opening up to the possibility of replacing in-house sub-systems with third-party solutions.

QUALIFIED MILITARY (and civilian) C2 systems are seldom developed by one supplier in isolation, but are generally speaking a result of multi-national collaboration between agencies and industries. The majority of industries in the sector wanted to be able to dictate the rules of the game themselves and make other industries their underlings. "King of the hill" was their battle-cry.

In producing the 9LV system family Saab have chosen an entirely different approach. The development strategy has in all respects been to focus on openness.

Openness comes in the form of protecting and favouring local industry in the development, production and service fields. An entirely new architecture based on open industry standards, preferably from OMG, enable partners to take an active part in the development process, and also allow active participation in international standardisation.

Open types of business models that allow traditional purchase, lease or so-called public-private partnerships (PPP) are also a part of the concept.

In a chronological perspective the openness exists towards both historical as well as future aspects. Through extensive R&D investments towards a future network-based defence, with the emphasis on a gradual adjustment, Saab contributes with its unique ability to support the future ability already with today's systems at the same time as it can establish a clear roadmap for future developments.

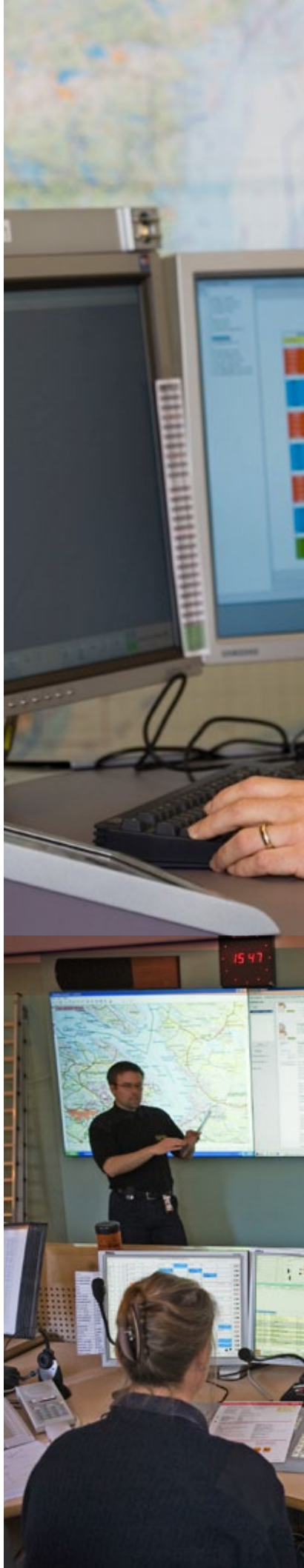
WHEN THE DECISION to take the step towards offering parts of the C2 system itself as open-source code, an evaluation of ten strategic questions was undertaken.

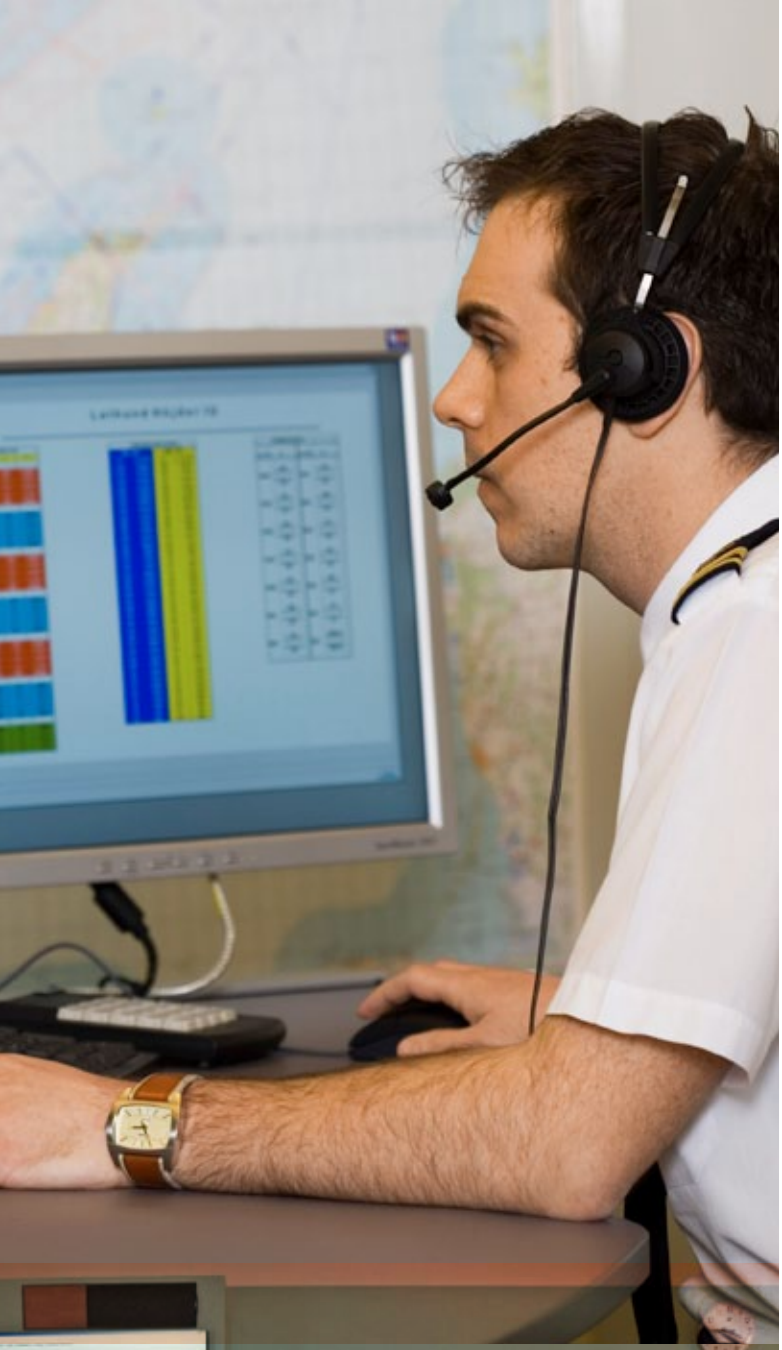
The object for the evaluation was Safir SDK, where SDK stands for software development kit, a software package developed specifically to optimise, in a cost-efficient manner, the development of high-performance, high-availability and long-lived distributed systems with extensive interfaces, both for data exchange and between the operators and the systems concerned.

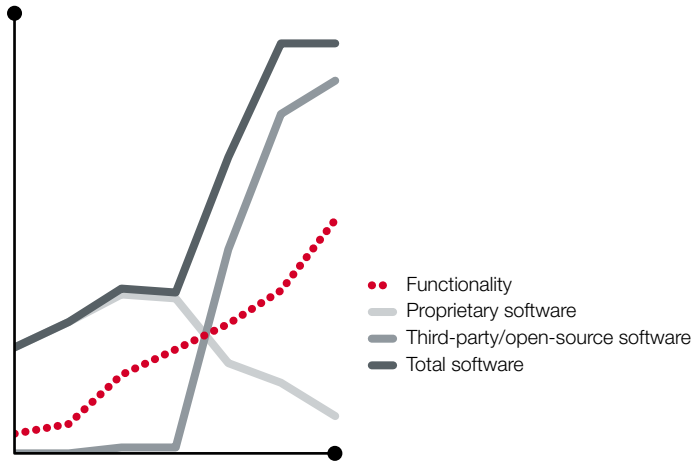
One question concerns export control of military equipment, which naturally would limit the opportunities of providing the entire military C2 system as open-source code. Clarifying that Safir SDK is a demarcated part of a C2 system and having this general-purpose software specially classified under

WWW

www.safirsdk.com
www.opensource.org







For the Corona system, dramatic software changes have occured over the years.

export control legislation has created the conditions under which Safir SDK can be offered as open-source code.

Another aspect has been the possible influence on industrial collaboration with other nations. The opinion is that through having Safir SDK at its disposal, opportunities are created for companies in other nations to value Saab as a collaboration partner and to be able to position oneself as a participant in the industrial collaboration programme prior to any formal agreement being made.

The question of how Saab is seen in the marketplace has also been discussed. The opinion is that Saab's position and credibility as a leading advocate of openness in an otherwise conservative industry would be strengthened. There are risks, however. The conditions for open-source code do not allow for any discrimination in the areas of application, such as terrorism or other criminality. This is, thus, a risk that Saab unintentionally might contribute to improving the C2 system of a terrorist organisation. Such a risk is, however, considered to be minimal; terrorist organisations do not have a command tradition equalling the qualified C2 systems supported by Safir SDK. Another risk that has been examined and found to be minimal, is that a competitor might identify defects or flaws in the software and then use these against Saab.

These aspects were naturally analysed in relation to their compliance with the company's strategic plan, quality aspects, IT security plans etcetera. Finally all the questions were evaluated in a single strategic commercial summary prior to the business-unit management making a decision.

DETAILED PLANNING FOR the implementation of the effort was still in progress at the time of writing. The main outlines are simple; making Safir SDK accessible via a suitable website and packaging the software; ensuring there are personnel available who can handle questions and suggestions that may arise as a result; and to prepare the offer for customers requiring commercial support for the product. The longer-term strategy will involve the provision for more active marketing, to train sales personnel in the new customer benefits that the provision of Safir SDK as open-source code will entail, and handling and product management if or when partners wish to contribute and a number of other, hopefully pleasurable problems.

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SPECIAL FEATURE:
GRIPEN DEMO

IN THE AIR TON

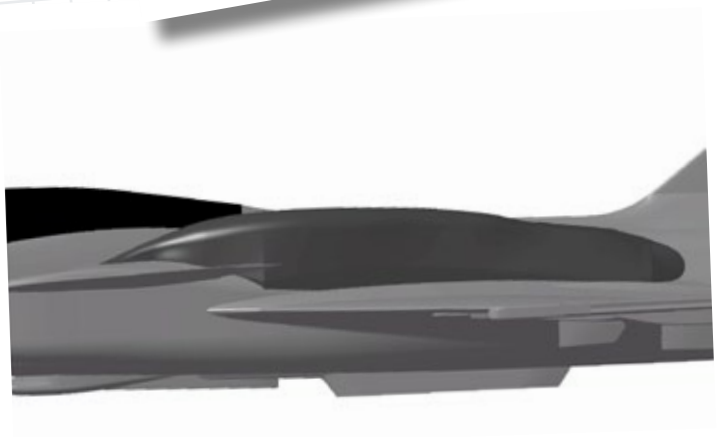
NIGHT

Photo: Peter Karlsson

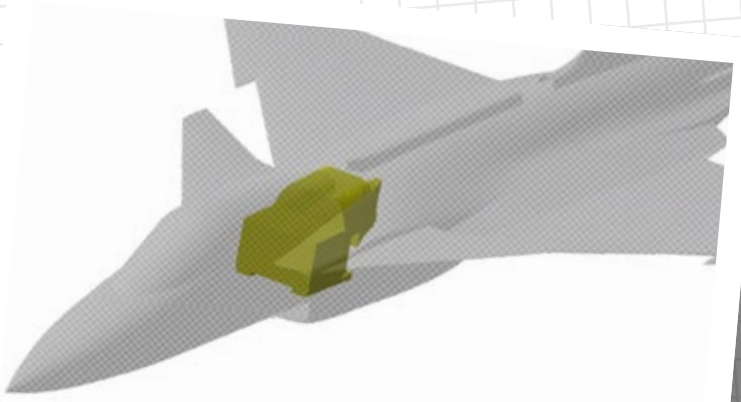
TAKING YOU FURTHER

One of the primary aims for the Gripen Demonstrator programme has been to boost the aircraft's range. But which way should it be done? Come take a look through our decision-making process.

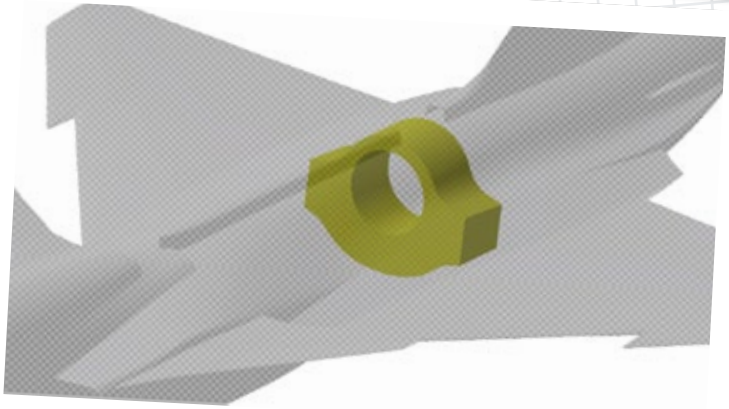
1 The "bathtub" concept.



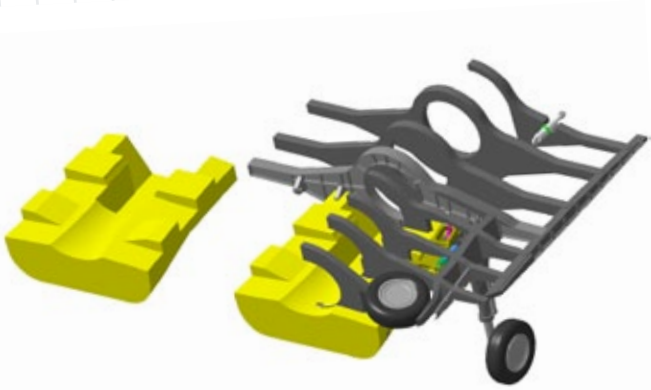
2 The dorsal conformal tank concept, low-speed proposal.



3 Version a: the forward fuselage section of the two-seater mounted on a single-seat aircraft, and with the aft seat replaced with a fuel tank.

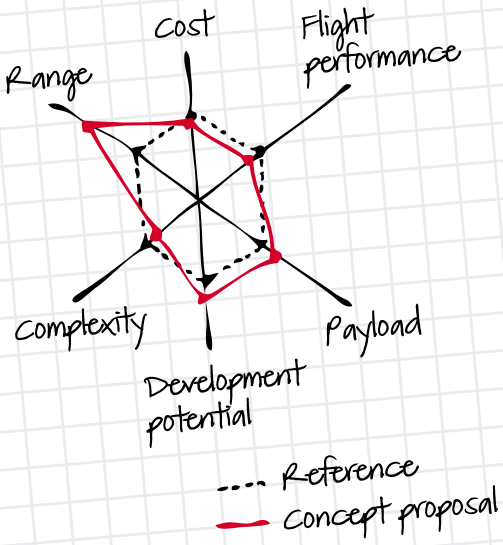


3 Version b: a new fuselage section added aft of the CG, getting the CG back in place and also adding more fuel.



4 The landing-gear bay converted into a fuel tank, and a new landing gear with mounting integrated into the wing structure.

HAMPUS GAVEL (text)
ARNE AXELSSON, GUNNAR LINN (illustration)



DURING THE WORK on the Gripen Demonstrator we had several concept proposals for range increase, including enlargement of the existing fuel tanks, addition of new fuel tanks – both external and internal –, a new engine with better fuel economy, and combinations of these.

Let us begin with an overview of the most promising concept proposals, after which we move on to a description of the concept evaluation, and we end up by looking at why the winning concept was selected for further development.

1 New conformal tank – ventral position

Nicknamed "the bathtub", this concept proposal included a ventral (belly-side) conformal fuel tank (see figure 1), detachable but lacking in-flight separation capability. The main objective was to free the wing pylons for tactical loads rather than utilise drop tanks.

The fuel tank forward limit was the nose gear door, the aft limit was the engine access door, and the cross section was governed by the kinematics of the main-landing-gear doors and ground clearance.

This proposal was economically attractive, but suffered from major drawbacks in the form of reduction in static directional stability and an increase in drag giving a relatively small net gain considering the significant amount of fuel added.

2 New conformal tank – dorsal position

Two versions of dorsal (back-side) conformal tanks were studied; one without speed requirements and one with supersonic capability. The low-speed version (see figure 2) had roughly twice the fuel capability of the supersonic version. Wave drag was the limiting factor for size in the supersonic alternative; directional stability and pitch moment were problems common to both alternatives.

However, it turned out that the version with the larger tank was just as capable of reaching supersonic speed as the specially designed alternative.

The greatest benefit from this proposal, apart from increased weapon-load capability if drop tanks were not needed, was its inherent potential for low supersonic drag increase, assuming the cross-section-area distribution was properly designed to minimize the wave-drag increment.

Potential problem areas were high-angle-of-attack directional stability, exacerbated transonic (around Mach 1) pitch-up causing greater load-factor transients, and canopy jettison. Fuel-tank venting might also prove problematic since the new tank would be a "high point". This could cause an uncommanded fuel transfer and fuel drainage through the vent system when performing zooming climbs and steep dives.

3 New internal tanks – extended fuselage

The initial idea was to fit a double-seat forward fuselage to a single-seat aircraft. The aft seat would then be replaced with a fuel tank (see figure 3a). However, a forward-fuselage stretch like this would in itself cause problems with the centre of gravity (CG) positioned too far forward. The proposed cure for this was to also stretch the aft body by adding fuselage sections aft of the CG (see figure 3b). This would not only put the CG back in place, but more fuel tank volume would also be added.

Possible problem areas were that the forward-section modification would interfere with the ram-air-intake ducting of the environmental-control system. It would also lead to a longer gun release recession which might prove problematic. As for the aft body stretch, this would reduce the ground and tail clearance on take-off and landing. An extended fuselage would also increase fuselage bending momentum and thereby increase weight – meaning the need for beefed-up main landing gear, which unfortunately would not fit within the dimensions of the current housing.

4 New internal tanks – relocated main gear

All the concepts mentioned above resulted in major modifications to the external shape of the aircraft. Being concerned not to change too much in a winning concept, which to its credit the basic Gripen concept already is, other ways of solving the range problem had to be considered. There are two huge "cavities" in the fuselage where the main landing gear currently is housed when retracted, eminently suitable for housing fuel tanks. The volume is large and well placed, very close to the aircraft's CG. The problem would then be where to relocate the main gear, and could the layout of the main gear remain the same? The answer was no; since more fuel would now be carried inside, with the payload requirement unchanged, basically only an increase in maximum take-off weight (MTOW) would be necessary. An increase in MTOW would require the use of larger brakes with more energy-absorption capability. In order to house larger brakes, larger-diameter rims would be necessary. This would increase the overall dimensions of wheels and tires. Since both gear and housing would need to be relocated to the wing, it was obvious that the layout and kinematics of the gear must also change.

INFERIOR CONCEPTS had already been screened during the ongoing conceptual design process. In the final analysis only the most promising remained, as listed above. At this point, the approach was switched from screening to active selection. Important criteria in the selection process were:

- future development potential;
- range;
- payload capability and flexibility;
- simplicity in structural and system design;
- performance;
- weight.

The fulfilment of all the different criteria was assessed as a whole to give a complete picture of concept performance. The web diagram in figure 5 is an attempt to visualize this way of thinking.

AND THE WINNER IS ...

... the proposal including a relocation of the main landing gear to the wings. All the competing proposals suffered from the same drawback: the present landing gear did not allow an increase in MTOW, and the additional fuel would therefore decrease the payload capability. The winning concept design features the following advantages:

- increased range due to the increased fuel capability;
- increased maximum allowed takeoff weight due to beefed-up landing gear;
- increased weapons capability and flexibility due to twin ventral stores.

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As we just read, one of the main drivers for a future Gripen platform is extended range and endurance. But more fuel capacity increases the aircraft's operational mass. This calls for additional thrust, which will be provided by a more powerful engine.

PEDAL TO THE METAL

MÅRTEN STAAF (text)
STEFAN KALM,
WILHELM NORÉN,
GENERAL ELECTRIC,
AIR-ATTACK.COM (photo)

THE ENGINE SELECTED for the demonstrator aircraft, the General Electric F414G, fulfils the requirements for a future Gripen platform. The F414 is the successor of the F404 engine family, of which the current Gripen engine RM12 is one version. Even though thrust is 20–25% higher, the engine size is similar to the RM12. Length is identical, but fan diameter is increased by approximately three inches, and the engine mounts are moved aft. Engine gearbox, oil tank, fuel control, pumps and other components are positioned slightly lower than on the RM12.

The engine is a low-bypass-ratio afterburning turbofan in the 98 kN (22 000 lbf) thrust class. The three-stage fan and the seven-stage high-pressure compressor, both incorporating blisk technology (see separate info box), are each driven by a single-stage turbine. The engine is controlled by a dual-channel full-authority digital engine-control (FADEC) unit.

GE supports the Gripen Demonstrator program with two engines. Both fully flightworthy.

BLISK

Blisk (bladed disk) means that the rotor disc and the turbine blades are solidly connected. Disc and blades are machined together from the same piece of material.

THE GEOMETRICAL difference of the F414G relative to the RM12 engine has resulted in modifications in certain areas of the airframe structure. The engine-bay walls, most of the frames and the engine-bay door have been redesigned for clearance reasons. The engine mounts are new to fit the new engine mount positions. The cross-sectional area in the forward part of the air-intake channel is increased. Also the final part of the intake channel has been modified to accommodate the larger engine fan.

System hardware interfaces such as fuel feed, power take-off and bleed air are geometrically identical to the RM12, although the positions are slightly changed. Parts of the engine bleed ducts to the environmental-control system (ECS) have had to be redesigned due to the limited space available as a result of the airframe modifications necessary to accommodate the engine. The fuel-feed line from the aircraft boost pump to the engine fuel inlet is new. The aircraft

Arrival of the first engine.

Engine in place.

Modifications of engine bay completed.

gearbox is moved down to meet the new power-take-off position. The FADEC unit is cooled by fuel and both the fuel feed and return lines are new.

The F414G has a dual-channel FADEC. The standby channel provides full redundancy in case of malfunction in the in- control channel. The throttle-control interface has been redesigned and in the demonstrator aircraft the throttle control is completely electronic.

An emergency throttle-control function is added in the cockpit for additional redundancy reasons. Except for primary throttle control, which is hardwired directly to the FADEC, the FADEC communicates with the aircraft over the 1553 data bus. The aircraft-interface-unit (AIU) and the aircraft-system-computer (SC) software interfaces and engine-related algorithms have been updated to communicate with the F414G FADEC.

SOFTWARE-INTEGRATION tests and system-maturity tests were performed in a system simulator (SYSIM). The purpose was to verify updated aircraft-bus traffic and software functionality related to the new engine. To represent the engine, a real-time software model from GE was implemented in the simulator representing both the FADEC functionality and the

Setup in the hush house facility before engine runs. A hush house is a generic term for engine-testing facilities designed to reduce the jet-engine noise. The hush house at the Saab Linköping site is an indoor facility for complete engine testing with the engine fully installed in the aircraft.

BROTHERS IN ENGINES

The original F414-GE-400 has been operational in the Boeing F/A-18 E/F Super Hornet since 1998 and has logged more than 900 000 engine flight hours. For the Gripen Demonstrator aircraft, GE has derived an engine version denoted F414G including necessary modifications for a single-engine application.

The most significant modifications relative to the -400 version are:

- FADEC software single-engine logic and functionality;
- FADEC software emergency throttle functionality;
- alternator modified with an additional winding for aircraft flight-control system (FCS) primary power supply.

engine turbo-machinery.

All testing of aircraft or engine hardware was performed in the demonstrator aircraft. The first tests were conducted during the run-up tests in the hangar. These were performed with aircraft power on, and the new FADEC software loaded but without the engine running. During the run-up tests, aircraft-to-FADEC communication was tested for the first time with the real hardware in the loop. Feedback from the tests performed resulted in minor updates to both FADEC software and AIU/SC software.

THE FIRST ENGINE run in the hush house (see caption above) was performed less than five months after the first SYSIM session. In the hush house the aircraft is fixed by use of wires fitted to the landing gear. These engine runs are the most important tests from an engine-integration perspective before first flight. Power settings from idle to maximum afterburner were tested including abrupt power transients. The testing in the hush house was very successful and no software updates or hardware changes were needed before first ground rolls and first flight. Currently flight tests are ongoing including some 20–30 dedicated engine flights aiming to verify the propulsion system functionality and to clear the demonstrator aircraft for flight throughout the complete flight envelope.

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LOOK OUT!

The missile-approach warning system (MAWS) for the Gripen Demonstrator aircraft will in the future protect the aircraft system against missile threats. The MAWS declaration of a threat is intended to trigger countermeasures actions such as dispensing flares.

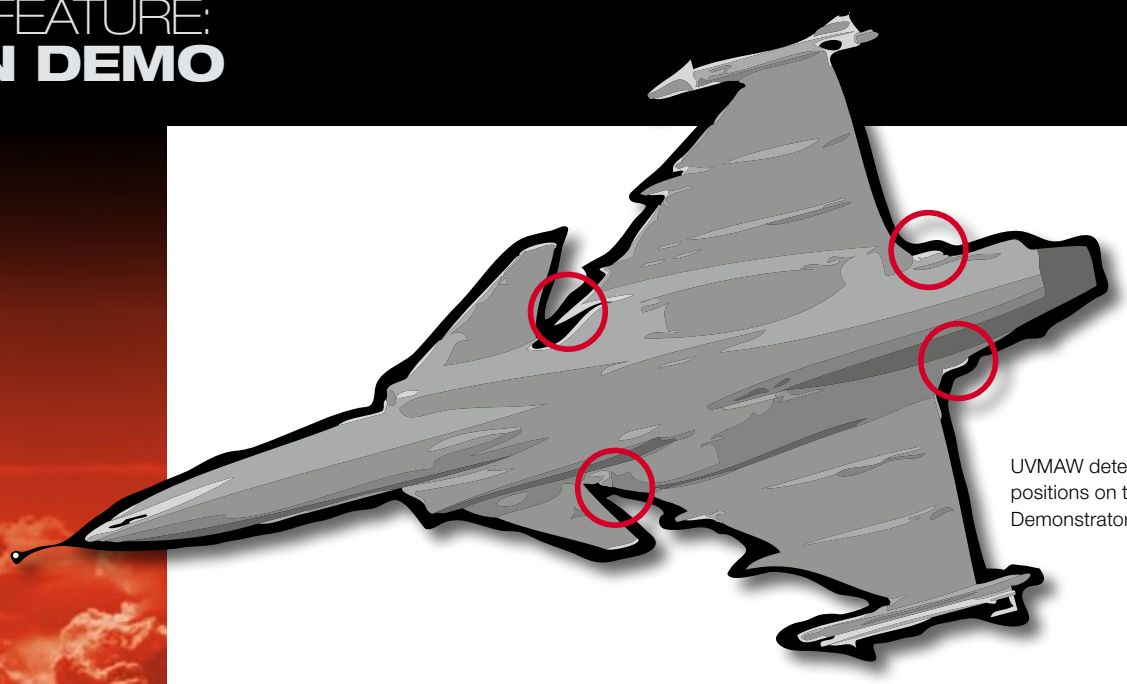
STEFAN RINGBERG, JOS STRYDOM, JOHAN VILJOEN (text)
MWS39 GRIPEN DEMO (photo)
GUNNAR LINN (illustration)

IN THE GRIPEN Demonstrator programme, enhanced electronic warfare is introduced by means of an electrooptical missile-approach warning system (MAWS). The currently available sensor configurations suited to be installed in the demonstrator aircraft are limited. Therefore, as a first step, the threat taken in regard for the Gripen Demonstrator missile-warning system is the man-portable air defense (MANPAD) threat. The chosen sensor configuration mainly covers the lower hemisphere. Typical range performance operating in the ultraviolet (UV) part of the electromagnetic spectrum is approximately five kilometres to detect a missile threat, and later in the missile-approaching phase, to declare the missile threat against the aircraft in question as a threat which needs urgent attention from the aircraft system – by means of automatical dispensing of countermeasures. The countermeasures today consist of flares or chaff, or a mixture of these, to protect the system from missiles with electrooptical or radar seekers.

SAAB'S UV MISSILE Approach Warning System uses up to six solar-blind sensors to detect radiation from the motor plume of incoming missiles. With six sensors optimally positioned on an airframe, it is possible to attain full spherical coverage. Solar-blind sensors operate in that part of the optical spectrum where the ozone layer is strongly absorbing, thereby completely eliminating any interference from direct or reflected sunlight. The UVMAW sensors are suitably sensitive to detect single photons from any source sufficiently hot to radiate UV energy. A tracking-and-classification algorithm then operates on the data to rapidly decide whether a detected source looks and acts like an oncoming missile.

IN THE FUTURE, the countermeasures could consist of a directed infrared countermeasures (DIRCM) system which is effective against electrooptical seekers – infrared seekers – by means that the DIRCM system is directed to the actual threat direction with help from the electro-optical missile-warning system. The DIRCM system then activates a search laser in this sector to find the missile by means of laser retro reflection. The retro reflection gives the DIRCM system aid to track the threat missile and even investigate the missile seeker characteristics due to modulation of the retro reflection from

The MAWS for the Gripen Demonstartor aircraft consists of four ultraviolet detectors and one central unit.



UVMAW detector positions on the Gripen Demonstrator aircraft.

the seeker. The last action from the DIRCM system is to active the jamming laser in such way that the jamming laser action is maximized with help of the information from the modulated retro-reflection signal. Other DIRCM systems utilize a more brute-force approach by simply delivering enough optical energy to damage the seeker detector or optics.

In parallel with the ultraviolet missile-warning system integration on the Gripen Demonstrator, a trade-off study is performed to investigate infrared (IR) missile-warning-system technology. This study is performed by Saab Aerosystems and Saab Avitronics, the integrator partners for the missile-warning system on the Gripen Demonstrator.

DUE TO THE problems caused by direct and reflected solar energy, research on IR missile warning faces a number of technical challenges. In an attempt to distinguish solar energy from missile-plume radiation, two-color detectors are investigated, on the theory that the effective radiating temperature of a missile plume is lower than that of the surface of the sun, resulting in a different ratio of energy in the two chosen bands. However, this only works when the optical resolution of a sensor is sufficiently high to detect the sources as extended sources – meaning that the optical resolution is better than the size of the source to be detected. Due to the small effective radiating size of an oncoming missile, this currently limits the usable range to very short distances, due to the low resolution of available detectors and wide-angle IR optics. Research continues in an effort to overcome these limitations, as well as to package such sensors with cooling, optics and data processing into a unit suitable for airborne use.

Testing of a missile-warning system involves verification of the three primary performance parameters:

- probability of warning (PoW) – a number which should be essentially 100%;
- false-alarm rate (FAR);
- time to impact (TTI) – which is the time left after declaration of a threat until it will reach its target if no countermeasures are taken.

In general, the easiest one to test is the FAR, which involves flying a system under conditions as representative as possible of the intended operational environment, and simply taking note of all issued alarms not caused by missile threats. More challenging is testing the POW and the TTI, for which long-range optical simulators are used, with final testing done by live missile firings. Saab Avitronics regularly participates in such exercises, to demonstrate performance, as well as to ensure that sensors and algorithms remain optimized for protection of aircrew and aircraft.

A FUTURE MISSILE-WARNING integration in the Gripen aircraft system shall hopefully give the Gripen customer the freedom to choose between an ultraviolet missile warning system or an infrared one – or a combination of these.

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WIDE-BAND DATA LINK

Gripen, being part of a network, must be able to communicate via cutting-edge solutions. Here are the details.

JOSEPH ROLLO (text)
PETER KARLSSON, THALES (photo)

WITH THE EMERGING network-centric operational concepts, the current challenge for a fighter communication system is to introduce advanced high-data-rate networking capabilities, while maintaining full interoperability with existing V/UHF communication systems.

Facing this challenge implies an extension of the multi-band/multi-mode capabilities of V/UHF transceivers, and the introduction of wide-band data transmission and networking capabilities.

The development work to integrate a new radio system equipped with these features into the Gripen Demonstrator aircraft is a joint operation between Saab and Thales Norway.

The new wide-band terminal developed by Thales Communications France adds these capabilities to the Gripen and takes advantage of the flexibility offered by software-defined radio (SDR) technology. The Gripen Demonstrator provides the opportunity to demonstrate the high flexibility of the SDR, which allows the development of the Gripen data services in just six months.

THE RADIO WILL provide the data-transmission services required to coordinate close-air-support operation between the Gripen aircraft and a forward air controller. In addition to a "low-rate" data service, interfaced with an improved data modem (IDM), to transmit targeting information, the terminal will also be used in its "high-data-rate" mode to exchange, in real time, images of the target and its environment. This image transmission proves to be particularly important to secure close-air-support operation in urban and peri-urban areas.

Image transmission will be supported by the so-called wide-band data-link (WBDL) waveform, operated in a configurable time-division multiple-access (TDMA) mode. WBDL provides 250 kbps raw data rate, within a 250 kHz channel; it is further secured by encryption and protected against jamming by fast-frequency-hopping (FH) technology.

TDMA mode provides an efficient method to share the available data rate between downlink and uplink, using a TDMA cycle alternating receive and transmit slots, with configurable slot duration in order to adapt to the up-and-down traffic variation during successive phases of the mission.

THE ETHERNET DATA interface with the host computer supports standard IP protocols; the radio network is perceived from the host as a subnet relay. The radio embeds the IP gateway processing that mainly controls the routing/distribution of IP packets in the TDMA frame according to time slots allocated to the network participating units; it also performs IP packet segmentation and reassembly.

After deduction of all waveform "overheads" due to protection mechanism (frequency hopping), channel access (TDMA), channel coding (error detection and correction), the WBDL offers a user data rate at the IP interface in the range of 50–100 kbps, depending on the TDMA cycle configuration.

Thanks to the SDR technology, it will be possible to increase the waveform capabilities through pure software upgrade, in the lower layers (bandwidth efficient modulations, digital channel filtering etcetera) as well in the upper layers (channel access, ad-hoc networking, IP gateway).

The radio also covers conventional voice-and-data services over the full V/UHF frequency range (30–400 MHz/600 MHz), such as PR4G, HQ, SATURN, and includes an embedded multi-guard receiver, which makes it a suitable "multi-purpose" V/UHF terminal, to build a flexible and high-performance multi-channel communication system.

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GRIPEN GOES AESA

The Gripen AESA radar demonstrator is a very important part of the multi-stage Gripen Demonstrator programme, showing that the next generation of the Gripen uses the most advanced technology for its most important sensor: the AESA radar.

JONAS BRANZELL (text)
THALES (photo)
ESKIL NYHOLM,
GUNNAR LINN,
SAAB AEROSYSTEMS
(illustration)

THE AESA RADAR (see separate info box) in the Gripen Demonstrator shows, as a step towards the next-generation Gripen (Gripen NG), a modern combat aircraft taking advantage of AESA benefits. For example, capabilities such as enhanced target detection and tracking in dense target scenarios will be shown. Also, enhanced search-while-track capabilities and modes for long-range detection and tracking will be shown. Qualities such as low probability of intercept and graceful degradation are built in the system.

The Gripen Demonstrator radar consists of three major parts:

- active antenna (AESA) from the French development programme mechanically reshaped to fit the Gripen aircraft fuselage/radome;
- PS05/A – signal/data processor (SDP) upgraded with AESA control capabilities and radar software adapted for AESA-specific modes and functions;
- PS05/A – exciter/receiver (EXR) upgraded to interface the AESA.

GOING FROM CLASSICAL radar systems with passive mechanically scanned antennas towards AESA radar systems is one of the major trends for different applications for land-, naval- and airborne platforms. The use of AESA antennas improves the classical performance figures, but more importantly it provides greater flexibility and enables the implementation of new radar modes and features and makes the radar more time-efficient.

The AESA radar features qualities that make the aircraft more difficult to detect by an enemy and thereby increases the aircraft's survivability. Some of these qualities are the lower radar cross section of an AESA and the fact that an AESA can operate with various output power levels and tapers. Others are the agile beam used for adaptive search and track patterns in combination with flexible waveforms.

WITH THE AESA beam agility target tracking can be more adaptive and time-efficient. This will increase tracking performance in a dense target situation, facilitating the ability to select the right target for weapons engagement and to prepare weaponry with more accurate data – enhance the fire control capability.

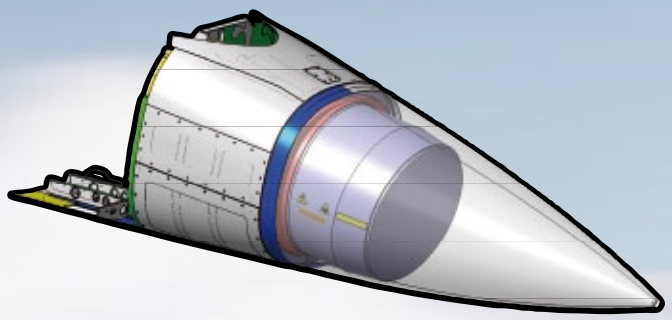
The beam agility will also increase the capability to perform searches for new targets within a larger search volume while retaining the target track updates for current tracks. This will increase the pilot's situational awareness.

Moreover, the beam agility also makes it possible to interleave different modes. This capability further increases the pilot's situational awareness. It is possible, for example, to perform air-to-ground tracking in parallel to air-to-air search-and-track modes.

Generally, by using adaptive beam forming and multichannel processing in AESA radars, better ground-return "clutter" rejection can be achieved. Hence improved detection performance against small and slow-moving targets is obtained. Adaptive beam forming also facilitates improved target detection in the presence of several jammer signals. Situational aware-

MODIFICATIONS TO THE AIRCRAFT

To prepare the installation of the AESA radar in the Gripen Demonstrator aircraft, some modifications like strengthening and reshaping of the forward bulkhead has been carried out. The radome required no modifications. The cooling system was also adapted to handle changes in cooling requirements, such as temperature and flow of cooling liquid. These changes allow Saab to be well prepared in order to provide the Gripen NG with the capability to accommodate the future multifunctional AESA radar.



ness is then maintained even in a dense RF environment. This is important for the survivability of the aircraft.

Flexible beam and waveform control makes it possible to optimize modes for long- and short-range target acquisition.

All-in-all, this will increase the pilot's situational awareness, and facilitate an earlier action/reaction.

THE MODULAR DESIGN of the antenna, where roughly 1 000 elements are used for both transmission and reception, implies graceful degradation, which means that regardless of a number of failed elements, the antenna will retain excellent performance for many years. This will lead to increased reliability for the radar system and result in a lower life-cycle cost for the user.

DEVELOPMENT OF THE Gripen AESA radar demonstrator is a joint effort by Saab and Thales. The antenna is developed by Thales in synergy with the French AESA radar program for Rafale. The Gripen Demonstrator radar-system capabilities are developed by Saab Microwave Systems, and Saab Aerosystems install and integrate the radar into the aircraft.

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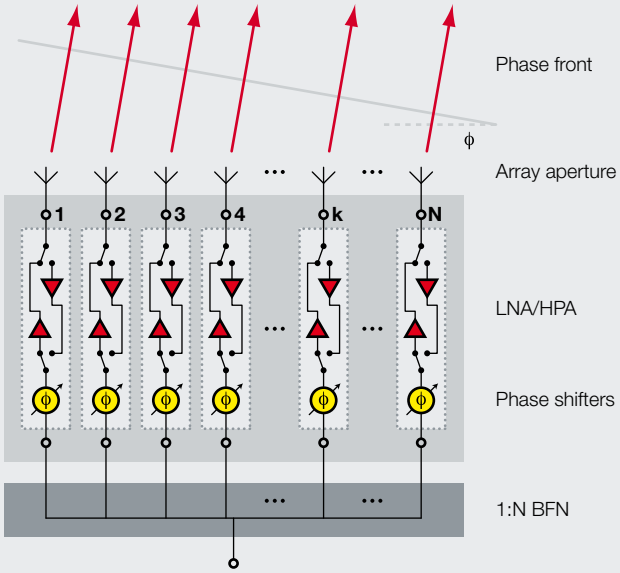
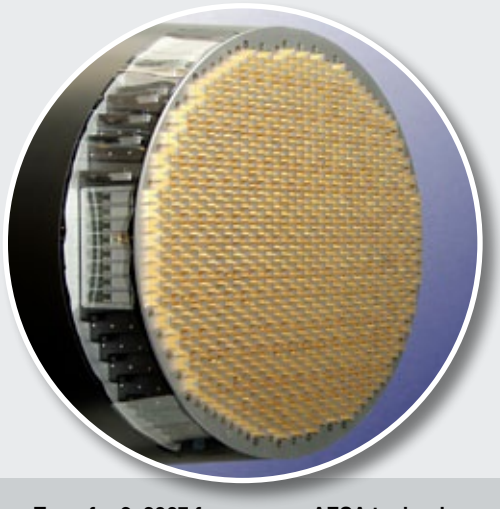
AESA

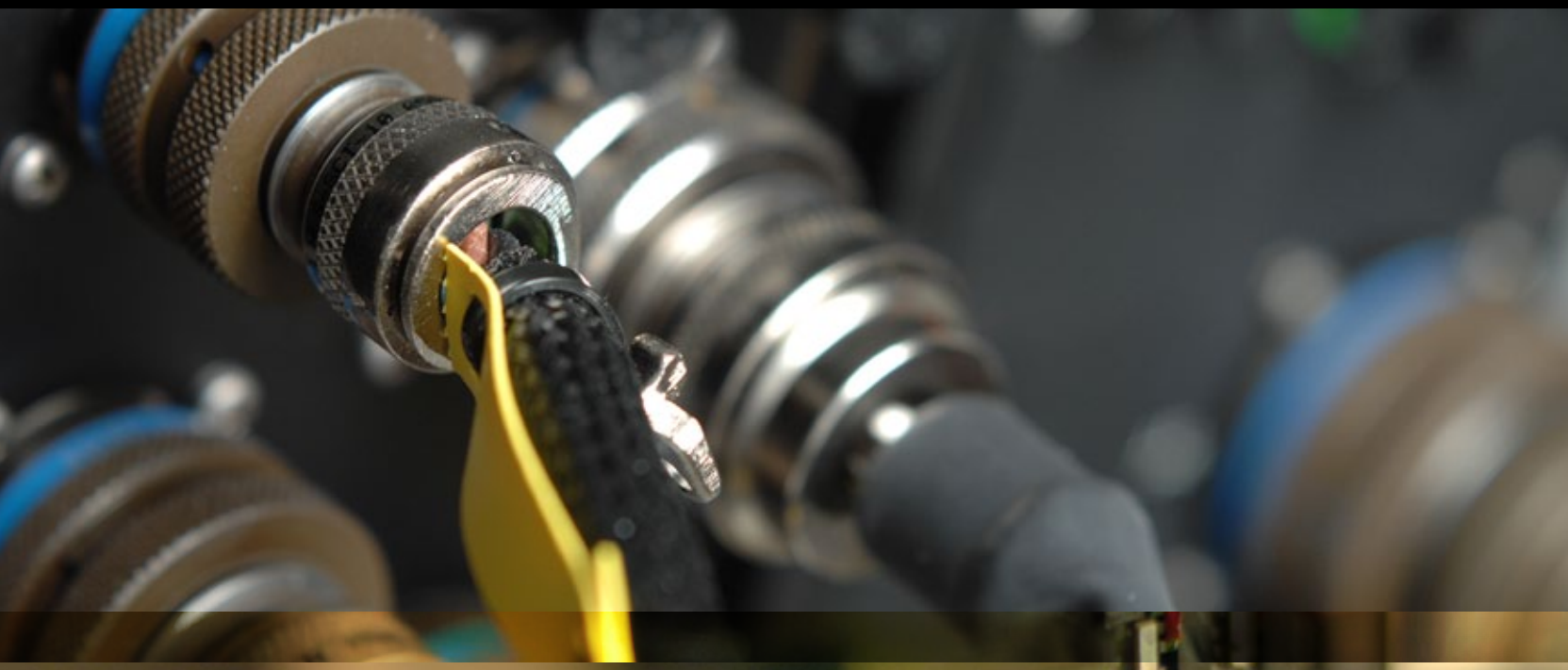
An active electronically-scanned array (AESA) antenna consists of a large number of active elements, transmit/receive modules (TRM). For a typical fighter application, here are in the region of 700–1 500 TRMs depending on the size of the aircraft. Each TRM consists of an antenna element, a power amplifier (HPA), a low-noise amplifier (LNA) and RF control circuits. The beam pointing and beam shape are controlled by changing the insertion phase (phase shifting) and amplitude of each TRM in both transmit and receive mode. The beam pointing is defined by the phase gradient between the elements over the antenna array, and for a two-dimensional array, it can be scanned in both azimuth ("horizontal" angle) and elevation ("vertical" angle).



The agile beam pointing is controlled by changing the signal within each element in the array. The most common device is a phase shifter in order to apply a phase gradient over the array, which forms the energy/field propagation in the desired direction.
This means of beam-pointing is fast and inertia-free compared to a mechanical gimbal. As the beam is controlled digitally, it can be changed within microseconds and therefore gives the radar a high degree of beam agility and a beam-shape flexibility optimised for different scenarios and modes.



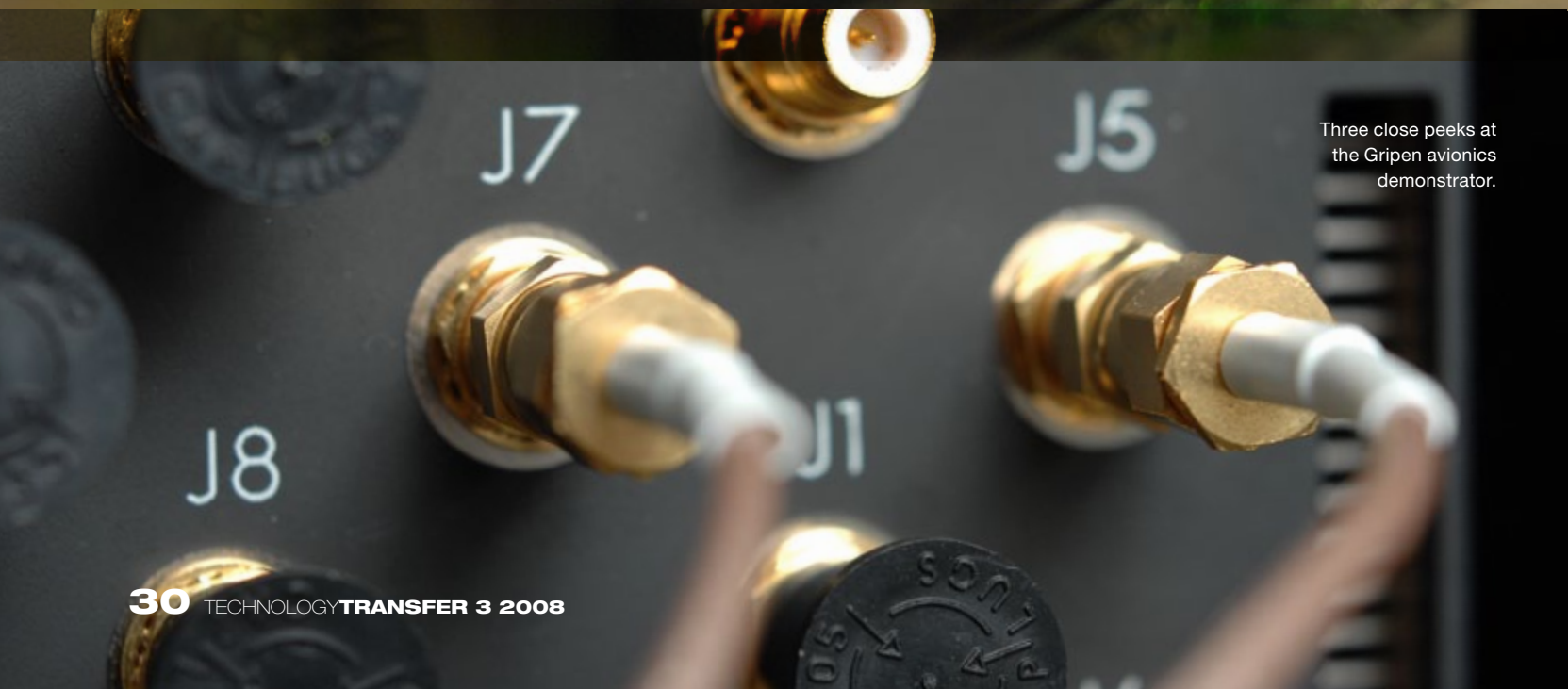
Also see Transfer 3, 2007 for more on AESA technology.



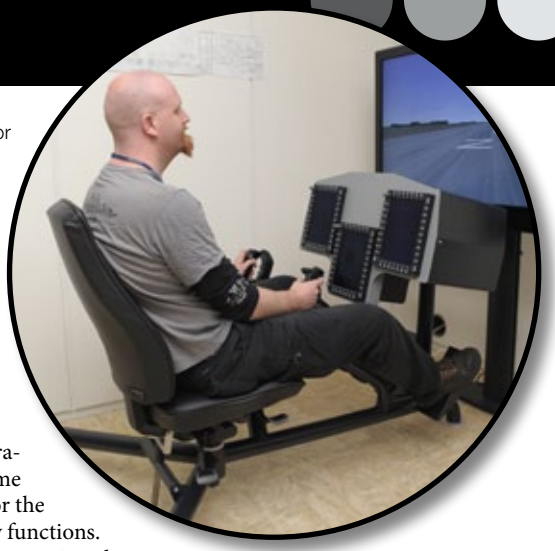
One of the reasons for Gripen's competitiveness is its avionics architecture, in which new functions are easily integrated. Here are the updates.

OVERHAULED AVIONICS

LARS KARLSSON (text)
FRANCIS GÖRMARKER (photo)
GUNNAR LINN (illustration)



Three close peeks at the Gripen avionics demonstrator.



A simple cockpit for testing the avionics architecture.

THE GRIPEN Demonstrator project also has a subproject for which the goal is to research and develop a next-generation avionics architecture. The project is to run from summer 2006 to summer 2009. The architecture is constructed in a systems rig with the core avionics operational in an environment of models consisting of aircraft subsystems, physical and a tactical environment.

The challenges we face in the avionics demonstrator project are to:

- reduce total cost of ownership (TCO);
- reduce costs of avionics development;
- easily and expeditiously adopt the avionics to new operational requirements;
- reduce development lead time of new functions;
- create conditions for customers, partners and subcontractors whereby their subsystem functions development contribution does not require their physical presence on site;
- actively pursue the satisfaction of customers' demands;
- further improve the tactical systems' accessibility.

The project has decided to meet these challenges by addressing the following three areas:

- technology;
- methods/processes;
- tools.

THE ARCHITECTURE in the avionics demonstrator (see figure) will separate system-safety-critical functions from tactical functions. There is one separation in software according to the ARINC-653 standard (see separate info box) and another in hardware where the current Gripen systems computer is subdivided into two further computers: the flight-management computer and the tactical-management computer.

This split is to enable less complex testing for future updates. A future update will consist either of a systems-safety-critical update, or more frequently, a tactical functions update. The cost of updating safety-critical functions is higher due to the cost of affirming that all critical systems are working. Update testing for tactical functions is directly related to the availability of mission-related functions. The separation entails a welcome reduction of time for the introduction of new functions.

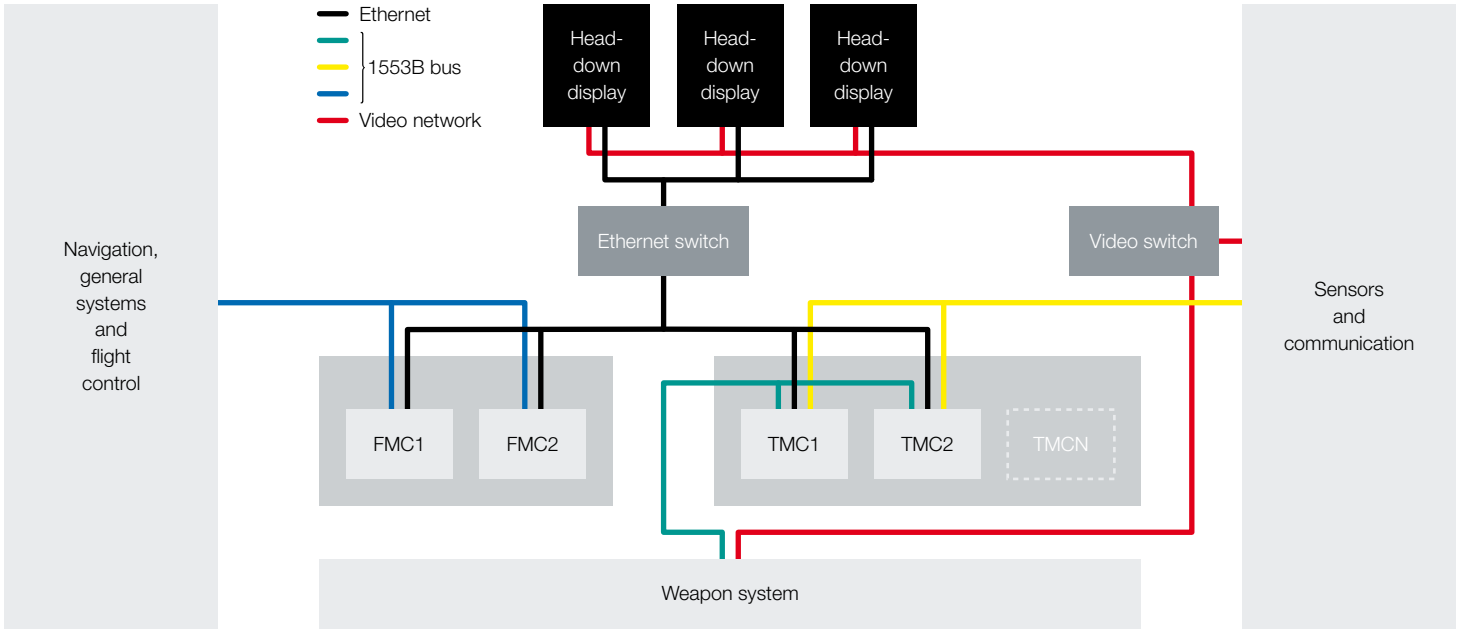
The systems safety requires the flight-management computer to have two redundant processors to achieve high reliability. One of the processors is constantly standing by to take over system-safety-critical functions if the other processor fails for any reason.

The requirements of the real-time operating system (RTOS) are high due to the implementation of the ARINC-653 standard, and therefore two commercial RTOSs are evaluated in the avionics system: Lynyx Works-178 and Green-Hills Integrity-178. The purpose is to show that partitions can execute functions on different operating systems supporting ARINC-653.

DURING THE PROJECT, some functions are and will be developed using model-based system engineering (MBSE). The MBSE tools generate documentation and code which constitute the foundation for review and certification. The generated documentation is always up to date. MBSE methods entail the time for development can be cut by up to 50%, with increased quality as a spin-off.

Rhapsody, a tool based on unified modelling language (UML), defines architecture, interfaces and data flows. A subset of the UML language is selected to be used in modelling of the design. Parts of the emerging system-modelling languager (SysML) are also used.

In designing new functions, Simulink is used. It is an all-round tool capable of managing different areas of design, from control loops to data-logical solutions. Simulink



The architecture in the avionics demonstrator.

PARTITIONING SOFTWARE – ARINC-653

The separation of software into partitions is governed by the ARINC-653 standard. The partitions are isolated in such way that an error in one partition will not affect any other partition other than partitions dependant on the failing partition through data flow. New tactical functions can be added without having negative impact on safety-critical functions.

COTS

The Gripen avionics system of today consists of computers that in many cases are unique and designed especially for Gripen. The demo project strives to use commercial off-the-shelf (COTS) parts. When using COTS parts the risk and cost of development is mainly a matter for the supplier, who in turn has other customers and therefore has an efficient production capacity.

For more on COTS, see Transfer 1, 2008.

PARTITIONING DISPLAYS – ARINC-661

ARINC-661 is an industry standard for the communication and partitioning of displays. It enables the isolation of information of different criticality levels on one display surface. Presentation of, for instance, airspeed, altitude, attitude and heading are critical to the pilot's ability to keep the aircraft airborne. Other functions that are lower in criticality due to systems safety will not affect displayed information of higher criticality. Applying the ARINC-661 standard to the display system is useful in many aspects, for instance for function development where the engineers have access to the actual display software enabling them to really see what they are doing to the system.

enables early understanding of new or modified functions due to its simulation capability. The tool also enables the developers to test their models instantly, and it generates documentation and code.

The human-machine interaction (HMI) design tool VAPS has been employed extensively for prototyping Gripen's new functions. VAPS XT -661 Gripen HMI will be utilised from the prototyping stages to final delivery.

ALLOWING DEVELOPER ACCESS to a soft system simulator during all development phases has so far sounded like utopia in the Gripen avionics development projects. In the avionics demonstrator project this has become reality through MysimNG, a desktop simulator which is already running and producing important results. MysimNG enables customers and subcontractors to take part in early development phases at their own desks in local offices. The partitioning of MysimNG enables the set up of the simulator so that no unintentional information leakage between customers and subcontractors will take place.

THE GRIPEN AVIONIC demonstrator project meets all specified challenges and will ensure that Gripen remains competitive many years from now.

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WHAT'S GOING ON IN YOUR TTG?

● This page is where you can find information about what happens in the TTGs. Here, you will also find an updated list of TTG contact persons.

TTG

SEPTEMBER

30 TTG DIAGNOSTICS AND PROGNOSTICS MEETING. Saab Aerotech, Växjö.

(NO DATE SET) TTG VERIFICATION AND VALIDATION MEETING. Topic: Unification of verification and validation.

OCTOBER

15 TTG ENVIRONMENTAL ENGINEERING MEETING. Saab Bofors Dynamics, Karlskoga. Topic: The environmental engineering process. A course in environmental engineering will be held in November 2009.

15 TTG ILS TECHNICAL PUBLICATIONS MEETING. Saab Training Systems, Huskvarna.

15 TTG ROHS MEETING. Villa Fridhem, Åby. The meeting is held in conjunction with Saab Environmental Days.

15–16 TTG ILS CUSTOMER TRAINING MEETING. WTC, Stockholm.

16–17 TTG ILS DAY. Saab Systems, Järfälla. Topic: Customer experience – can we use it?

(NO DATE SET) TTG MODEL-DRIVEN ENGINEERING MEETING.

NOVEMBER

19 (PRELIMINARY) TTG ELECTROMAGNETIC ENVIRONMENTAL ENGINEERING MEETING. Saab Aerotech, Östersund. Topic: Usage of reverberation chambers for testing and measuring electro-environmental characteristics of electronics.

(NO DATE SET) TTG DIAGNOSTICS AND PROGNOSTICS MEETING. Saab Avitronics, Jönköping.

DECEMBER

10 TTG MECHANICAL DESIGN AND MATERIALS TECHNOLOGY MEETING. Saab Training Systems, Huskvarna. Topic: Rapid manufacturing.

CONFERENCES ON PROGNOSTICS

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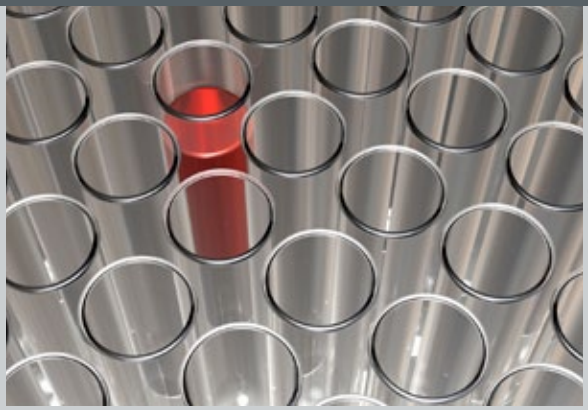
● The first-ever conference dedicated to prognostics and health management (PHM), the IEEE PHM2008, was held in Denver, USA, on September 6–9, 2008. TTG Diagnostics and Prognostics attended, of course, just as they will on March 7–14, 2009, at the IEEE Aerospace Conference at the Big Sky resort, Montana, USA, where approximately 45 papers will be presented covering prognostics and health management.

ELECTROMAGNETIC TERRORISM

● At the EUROEM2008 conference in July, 2008, Mats Bäckström, leader of TTG Electromagnetic Environmental Engineering, was one of six invited plenary speakers on the subject of electromagnetic terrorism. An audience of 500 heard Mats's lecture called "Some Recent Work on Intentional EMI in Sweden". EUROEM, which is called AMEREM every second year as it is held alternately in Europe and the USA, is the main open international conference within the area of electromagnetic environmental engineering, regarding defence and civil security. The five other plenary speakers came from the USA (×2), China, Russia and Switzerland/Belgium.

WANNA LEAD TTG ROHS?



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● Johan Sihlbom, present leader of TTG RoHS, will be leaving his post following the sale of Saab Space to Swiss RUAG. Would you like to be the new leader? Please Contact Johan Sihlbom, **johan.sihlbom@space.se**

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BETTER TOGETHER?

At lunch with the old mates lately, people could not pass behind us since the table was too close to the wall. The symptom was obvious to everyone, but it took a long while until we were able to identify the problem and figure out how to solve it – by simply moving the table. Why did our lunch-mate collective act more dimly than the arguably more intelligent individuals?

A similar problem seems to arise in emergency management. The more unexpected the situation to deal with, the worse the interaction between different actors involved in the crisis. How many of us thought that we could have done better than the Swedish government after the 2006 Tsunami?

How can we then benefit from the individuals' collective abilities on a large scale? Maybe the answer is to inter-connect people and technology so that they together may act more intelligently than any individuals, groups, or computers have ever done before?

THIS IS THE challenge for the Center for Collective Intelligence at the Massachusetts Institute of Technology (MIT), a challenge that is more interesting than ever.

Why is this? Because the Internet has changed the world. The Internet has given the world brand-new ways of acting collectively. Consider Google, where you can get a surprisingly correct answer thanks to millions of people writing about favourite things on their home pages, or Wikipedia

Collective intelligence might be the answer if you think that problems around you cannot be solved quickly enough.

ANNIKA FORSLUND, KLAS WALLENIUS (text)

where anyone can be an expert and encyclopaedia writer.

But Google and Wikipedia are passive sources of collective intelligence, where only old questions are answered.

There are other projects like Innocentive, where companies can easily tap the talents of the global scientific community for innovative solutions to tough research-and-development problems. Today, more than 145 000 researchers are connected to this site. The idea of Innocentive is to post difficult problems to challenge experienced researchers. When a problem is solved, the solver gets a gratification.

One of the really interesting things in MIT's research concerns the so-called prediction markets (see separate info box). It is a kind of stock market in which participants buy and sell predictions about uncertain future events – and are paid only if their predictions are correct. Such prediction markets have been found to be surprisingly accurate over a wide range of situations, including forecasting product sales, project finishing dates and election results.

Another interesting topic MIT are working on is how to harness collective intelligence of thousands of people to help solve the problems of global climate change.

ENOUGH SAID ABOUT MIT. So, how can Saab benefit from this? In the future, we will most probably use collective intelligence in many ways. Just count the times you have read the words "open source" in Saab publications lately. For the five of you who have not met the words: "open source" is a way of freely distributing and exchanging software. Go to page 16, where we have published a dedicated article on the subject.

BACK TO THE beginning. A state of emergency in Sweden potentially involves 290 municipalities, 18 county councils and 2 regions, 21 counties, around 300 other authorities, 260 000 companies and 9 142 817 citizens. Could novel concepts for collective intelligence be developed to lever the experiences and the cognitive capacity that all these actors represent in order to manage crises more efficiently? What do you think?

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READ MORE

- Prediction markets – read Robin Hansson's MIT article on **www.mitpressjournals.org/doi/pdf/10.1162/itgg.2007.2.3.73**
- Solving global climate change by collective intelligence – read Thomas W. Malone's and Mark Klein's article on **www.mitpressjournals.org/doi/pdf/10.1162/itgg.2007.2.3.15**

THE OPEN SOURCE INITIATIVE

The Open Source Initiative was founded in 1998 by Bruce Perens and Eric S. Raymond. The former was largely responsible for the Debian free-software guidelines (DFSG) that have become the ten commandments of open source:

1. Free redistribution.
2. Inclusion of source code.
3. Allowing for modifications and derived works.
4. Integrity of the author's source code.
5. No discrimination against persons or groups.
6. No discrimination against fields of endeavour, like commercial use.
7. The license needs to apply to all to whom the program is redistributed.
8. License must not be specific to Debian, basically a reiteration of the last point.
9. License must not contaminate other software.
10. The GPL, BSD, and Artistic licenses are examples of licenses considered free.

Sourceforge.net is today the largest open-source page on the internet with more than 179 000 projects and more than 1.8 million active users and about 250 million passive users.

ANNIKA FORSLUND ABOUT OUR ATTITUDES TOWARDS TECHNOLOGY

ANTI-TECH TALK

Photo: Per Kustvik

HERE I SIT working on technological strategies, and at home my husband says I'm the most technologically-hostile engineer ever to have passed an exam in the whole country.

Yes, I may well be technologically hostile: I admit I don't like the use of technology just for technology's sake. I can't get excited about new radar technology, or about chip technology has reached new minimalistic "heights".

An everyday example: once upon a time we had a cooker in the kitchen that had cast-iron hotplates, which my husband thought was old-fashioned. Now, I couldn't for the life of me understand why we'd need a new cooker – before the oven door fell off the current one. We discussed the matter and the choice fell between a cooker with two ovens and a traditional electric hob unit, and a cooker with one oven and an induction hob. I said that I felt we needed two ovens as I frequently used both on the old cooker. My husband wanted to choose the most up-to-date technology instead.

YOU DON'T NEED to be a technology nerd just because you happen to be an engineer. In actual fact I'm not technologically-hostile either, I just happen to believe I regard technology in a more holistic manner; I need to see the wider picture. In my job, however, I all too seldom get to meet people who share the same attitude. For far too long Saab has been a company where technology has been invested in for the sake of technology itself – just take a look at our previous business concept:

"Saab is a high-technology company that offers world-leading system solutions, services and products in defence, aviation, space and civil security. Saab has technology for a changing world."

Those like-minded colleagues who share my point of view are most often female technicians. The holistic viewpoint seems to be something of a female way of working with technology. This is maybe why you meet more females within the chemical sector where there is a more direct means of using their expertise in the pharmaceutical industry. Even within Saab I believe I can see a more significant representation of females within requirement-steered operations, for example human-machine interaction (HMI) where the intention is to make the technology more understandable to more people.

HOW, THEN, ARE we to attract more females and other non-nerdy technicians to Saab? I'm of the opinion that we have to communicate new signals. To kick-off with, Saab's business idea has been updated – read more about it on saabgroup.com if you don't already know it by heart. I caught myself thinking about an advertisement that I was unfortunately involved in writing a few years ago:

"… The tasks involve object-oriented programming in C++ and Open GL Performer for real-time visualisation of 3D databases and models. Currently the software is driven on the PC platform with Linux and on SGI with IRIX using Open GL Performer as stage designer. The tasks also involve documentation in addition to design descriptions and test protocols. Finally there is also involvement in testing and validation of the software products …"

THIS FAILED TO attract one single female applicant. I can't help wondering if more – if any – women would have applied if we had instead formulated our message in this way:

"… The tasks involve the further development of our software in order to more efficiently manage sizeable geographical databases. Functions will be forthcoming which will allow us to further develop our ability to visually demonstrate certain training effects in our flight simulations in order to improve their usability. Listed below are the current programming languages and operative systems …"

IN ANY CASE we need to focus on what we do, and why, rather than in what way and with which tools and technologies. And, by the way, how did it go with the cooker? Well, this time I won, to my husband's great annoyance – he wastes no opportunity to keep commenting about how we ought to have invested more money and benefitted from both functionality and technology.

ANNIKA FORSLUND
Director of Technology Strategy
Saab Corporate
– who rather talks to users than reads fact sheets