Gripen
Presentation för NTVA

2007-02-27

Gripen International
Eddy de la Motte
Program Director

Agenda

- Saab Introduction
  - Saab R&T
- Gripen Background
  - Program
  - Design Goals
  - Tactical requirements
  - System aspects
- Operational Aspects
- Next Generation Gripen
- Questions

A history of high technology

1941
First B17 delivered

1948
Tunnan – first flight

1979
First order for RBS 15

1990
First laser simulator BT46

1993
First Gripen delivered

2002
First contract for NLAW

2003
First delivery for A380

2005
Contract for Neuron

2006
Saab 2000 ERIEYE™ AEW&C

SAAB

1937 Saab is founded

1990 Saab Automobile independent company

2000 Saab acquires Celsius

2005 Saab acquires Grintek

2006 Saab acquires EMW

1646
Bofors Järnbruk is founded

1894
Alfred Nobel acquire Bofors

1948
First order for Carl Gustaf

1998
StriC in operation

1950–
Development of fighter radar

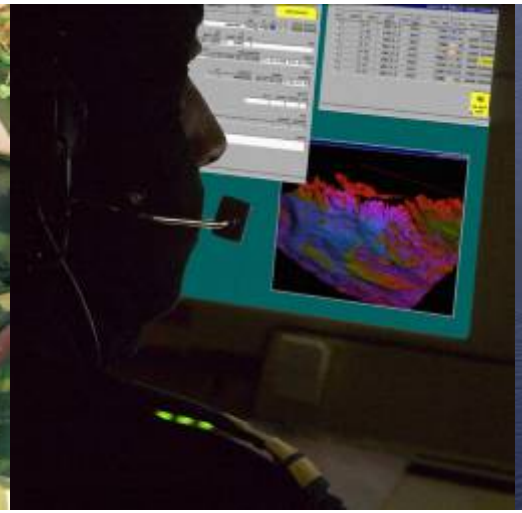
1970–
Development of GIRAFFE

1980–
Development of ARTHUR

1990–
Sea Giraffe AMB is launched

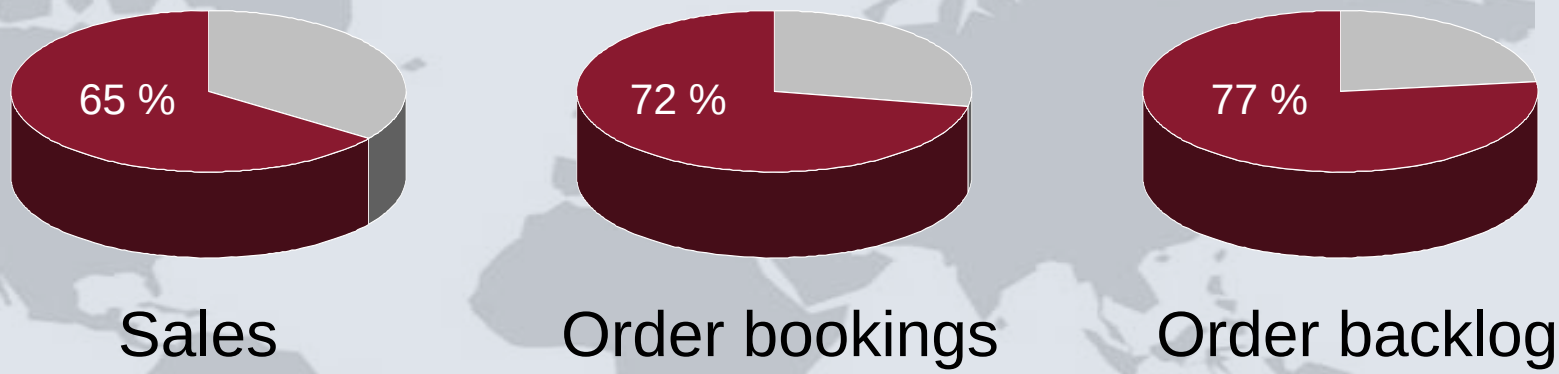
SAAB

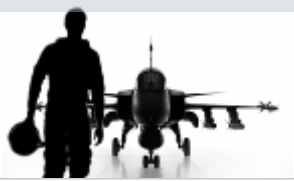
Saab in brief


	2006	2005
Sales US$ m	2,854	2,582
Operating income US$ m	236	221
Operating margin %	8.3	8.6
Number of employees	13,577	12,830

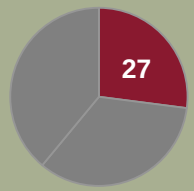
International business





Three segments – 17 business units

Defence and security solutions

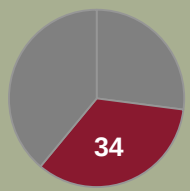


Percent of sales 2005

Saab Systems
Saab Aerotech
Combitech

Saab Grintek
Saab Communication
Saab Surveillance Systems

Systems and products

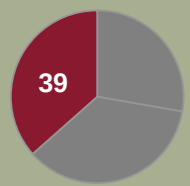


Percent of sales 2005

Saab Bofors Dynamics
Saab Space
Saab Avitronics
Saab Barracuda

Saab Underwater Systems
Saab Training Systems
Saab Microwave Systems

Aeronautics



Percent of sales 2005

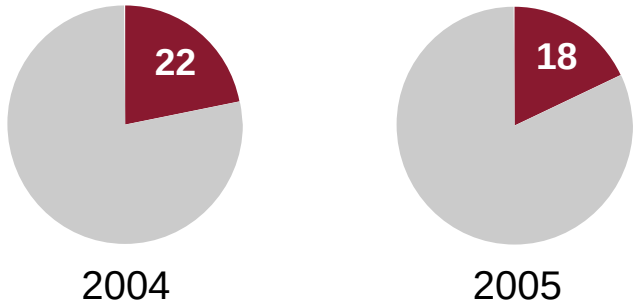
Saab Aerosystems
Saab Aerostructures
Gripen International

Saab Aircraft Leasing

Unique focus on research & development

- The number one R&D company in Sweden

R&D as a percentage of sales



Saab Aeronautics

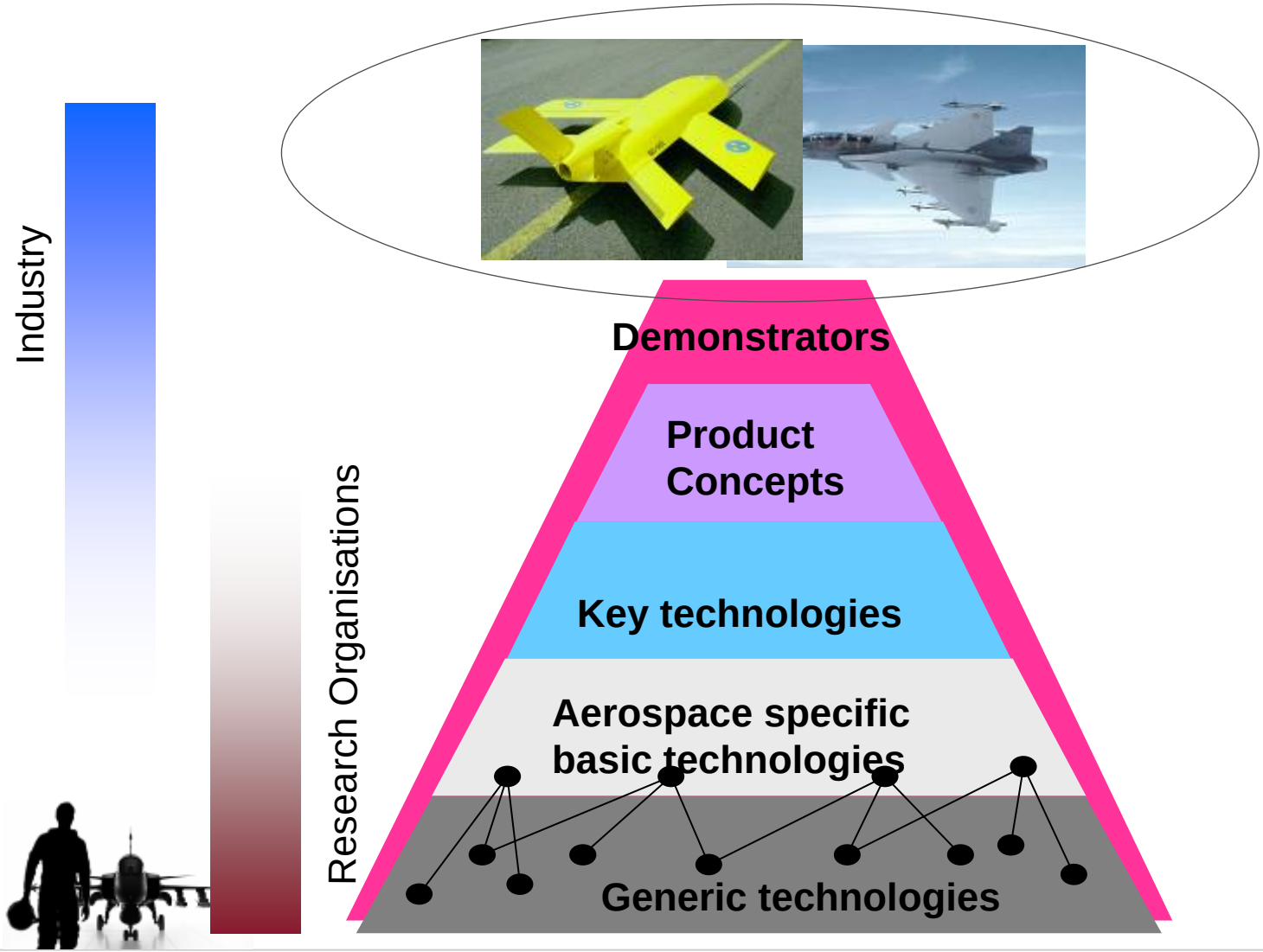
Focus on 3 market segments:

•Fighter Aircraft Systems

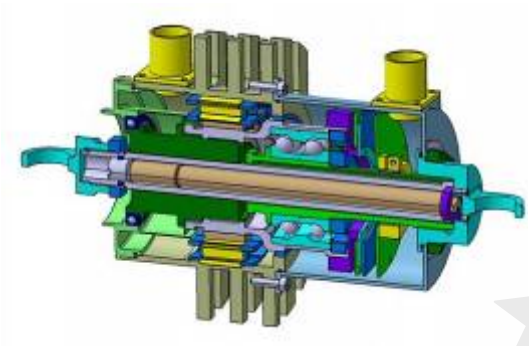
•Unmanned Air Vehicles, UAV

•Supplier to manufacturers of large civil aircraft

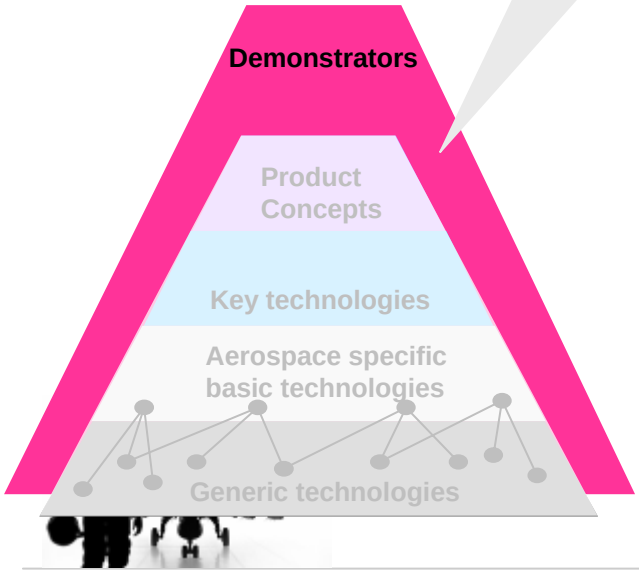
Saab R&T

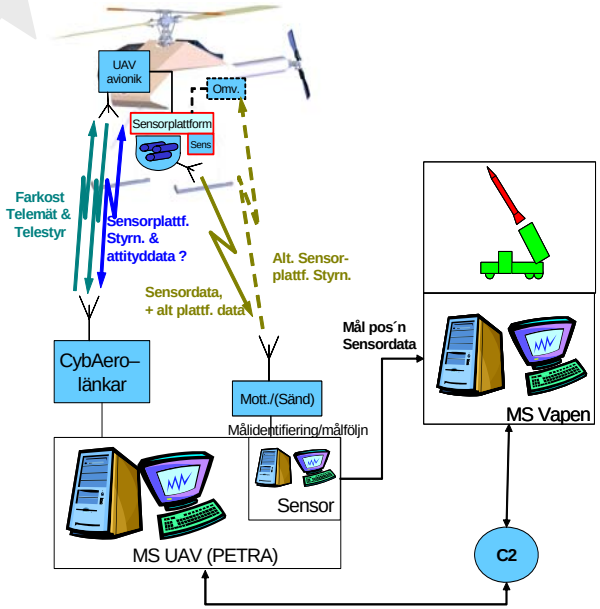

Industry
Research Organisations
Demonstrators
Product Concepts
Key technologies
Aerospace specific basic technologies
Generic technologies

Demonstrators, examples



Electromechanical actuator



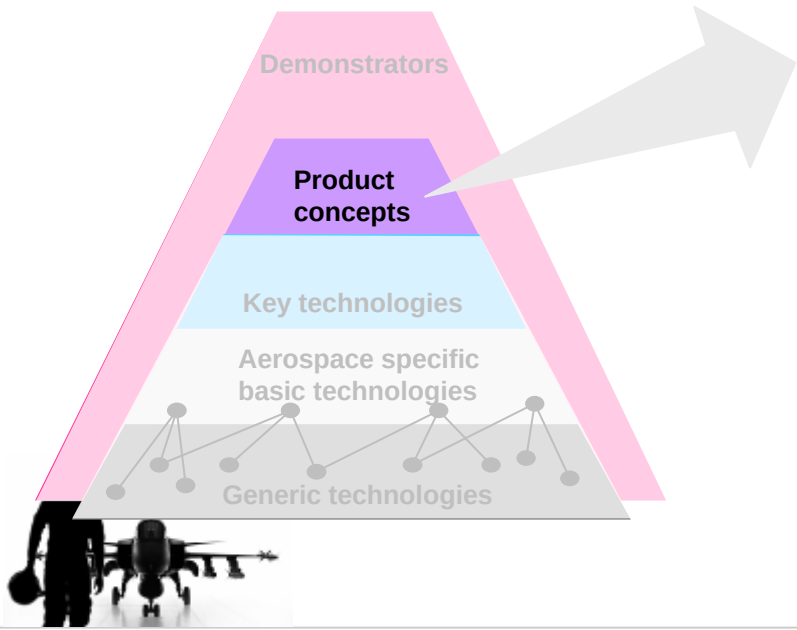


Integrated functional chains

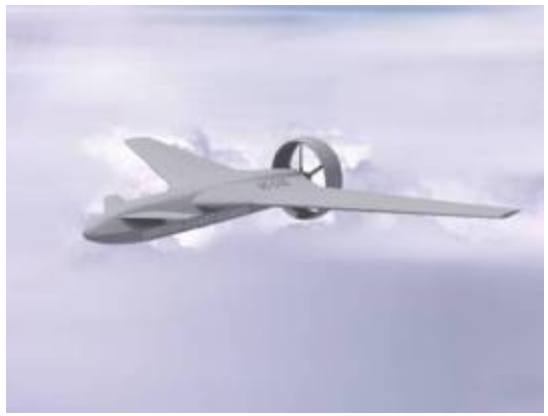
FILUR (Flying Innovative Low-observable Unmanned Research vehicle)

MERA (More Electric Research Aircraft)

Product concepts, examples



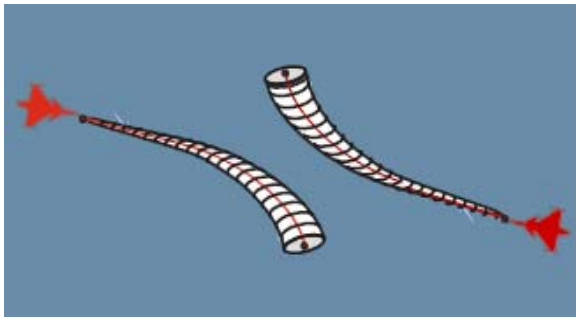
TUMAV



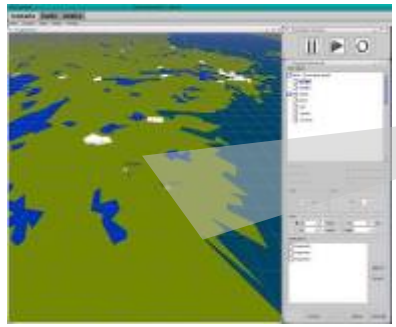
Gripen future development

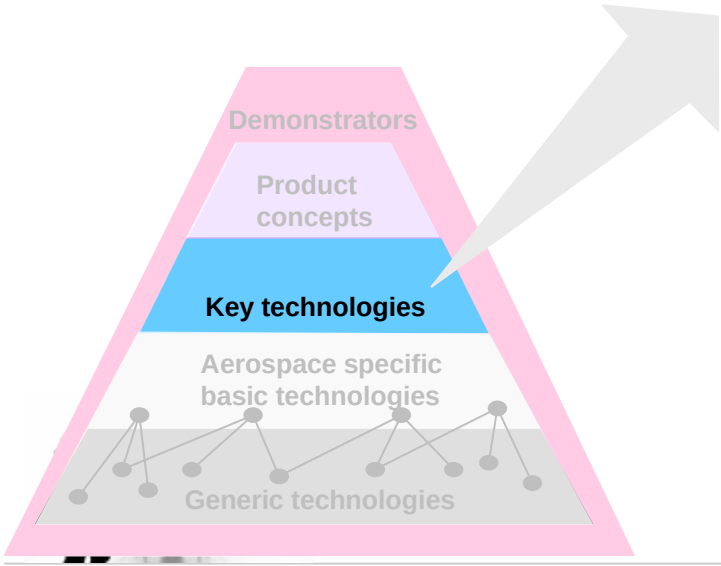
Key technologies, examples

Sense and avoid technology

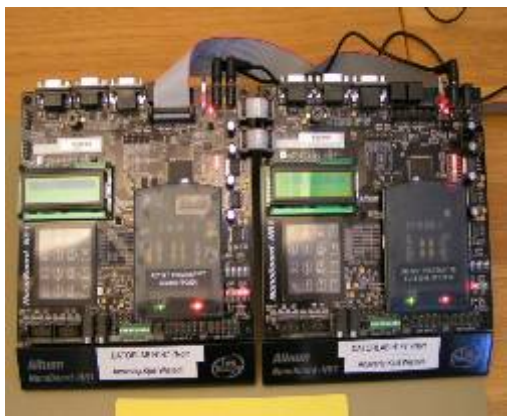


Autonomy and decision support





System Architecture



SAAB Venture Capital Council

Leveraging R&D by bringing competitive technologies to non-core markets in win-win arrangements

SAAB

Our heritage – close to 70 years of experience

SAAB

Gripen program in the rear view mirror…

- **1988**
First flight with JAS 39 Gripen prototype.
- **1992**
Swedish Parliament decision, followed on June 26 by a contract between FMV and IG JAS, to develop a dual-seater, to purchase a second lot of **110 JAS 39 Gripen** including 14 dual seaters and some additional support systems.
- **1996**
Parliament decision to purchase lot three consisting of **64 JAS 39 Gripen** including 14 dual seaters and some additional support contract
- **1997**
Gripen declared operational by CAF Gen Harrskog
- **1999**
Export starts…

JAS 39/Gripen Program

- Order book 246 aircraft
- ~190 Gripen currently delivered
- Contracted by South Africa December 1999
- Contracted by Hungary December 2001 and February 2003
- Contracted by Czech Republic in June 2004
- UK Empire Test Pilots' School, ETPS… April 2005

Czech Republic
14 aircraft (12C & 2D)

Hungary
14 aircraft (12C & 2D)

South Africa
28 aircraft (19C & 9D)

Swedish Air Force
120 aircraft
106 JAS 39A and 14 JAS 39B

84 aircraft
70 JAS 39C
14 JAS 39D

Continuous development

'90 '95 '00 '05 '10 '15 '20

Single seat – General layout

Dimensions

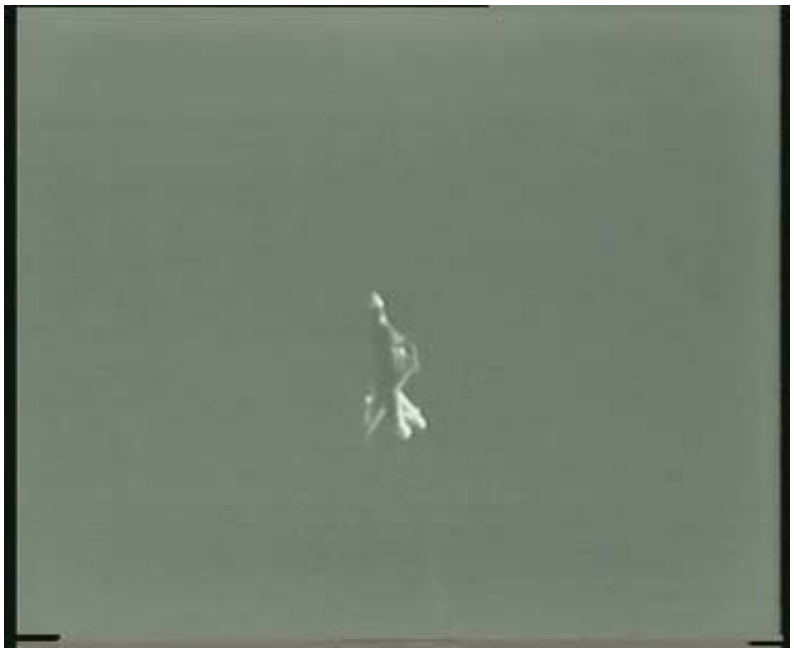
Wing span incl. launchers	8.4 m
Length excl. pitot tube	14.1 m
Height overall	4.5 m
Wheel track	2.4 m
Wheel base	5.2 m
Empty weight	6.8 tonnes
Max Take-off weight	14 tonnes

Dual seat – General layout

Dimensions

Wing span incl. launchers	8.4 m
Length excl. pitot tube	14.8 m
Height overall	4.5 m
Wheel track	2.4 m
Wheel base	5.9 m
Empty weight	7.1 tonnes
Max Take-off weight	14 tonnes

Gripen baseline features



Gripen Inherent Features – Baseline A/B

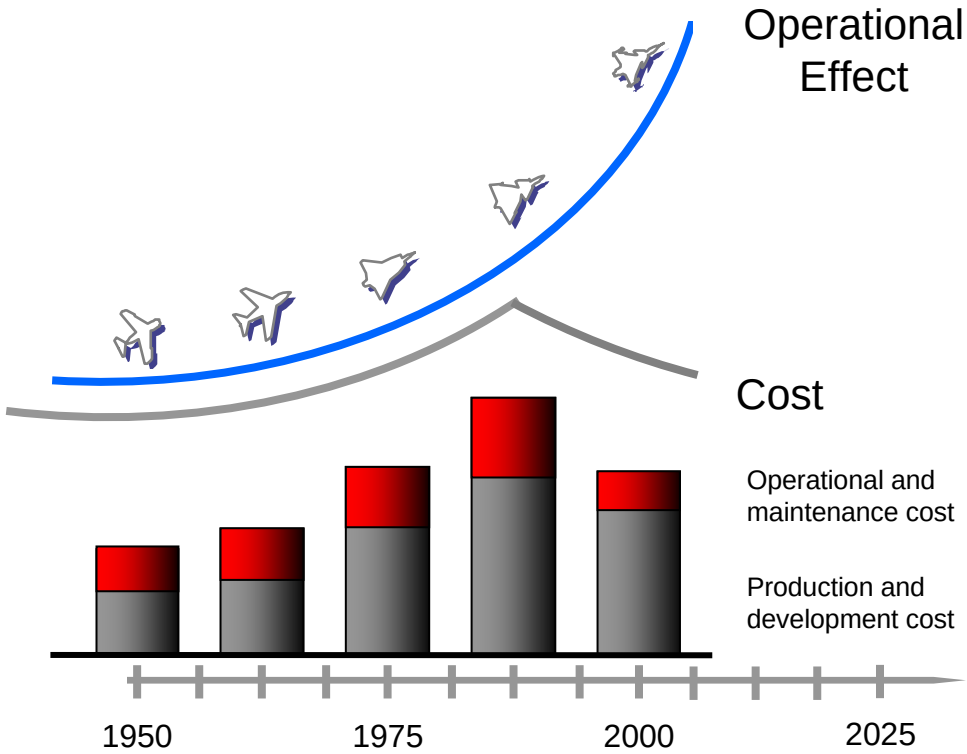
- Worlds most advanced Data Link System
- Swing Role Capacity
- Advanced multi-mode radar
- Fly-By-Wire
- High agility, speed & autonomous
- Auxiliary Power Unit (APU)
- Low radar and visual signature
- Advanced cockpit layout
- Embedded training
- Rapid reaction & turn around time
- Advanced Built In Test system
- Fully Integrated Avionics System
- Designed for a low cost of ownership

Design Goals

Design goals

Break the cost increase curve

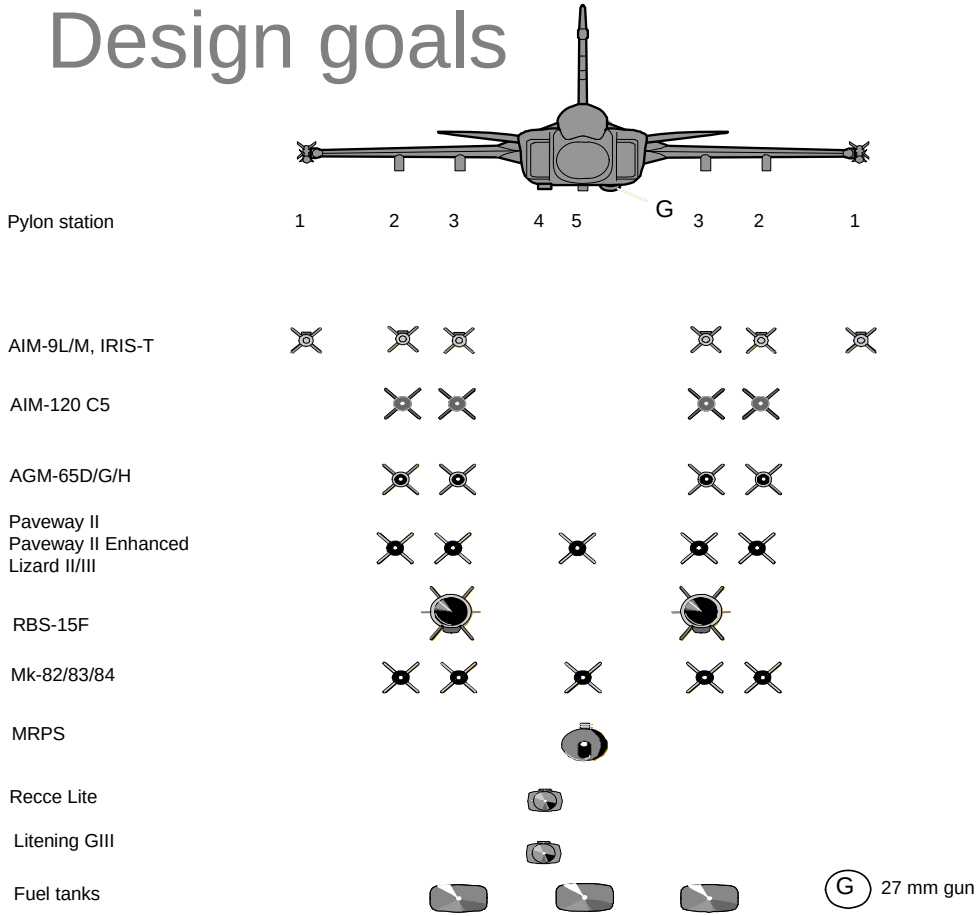
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC



Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC

Design goals



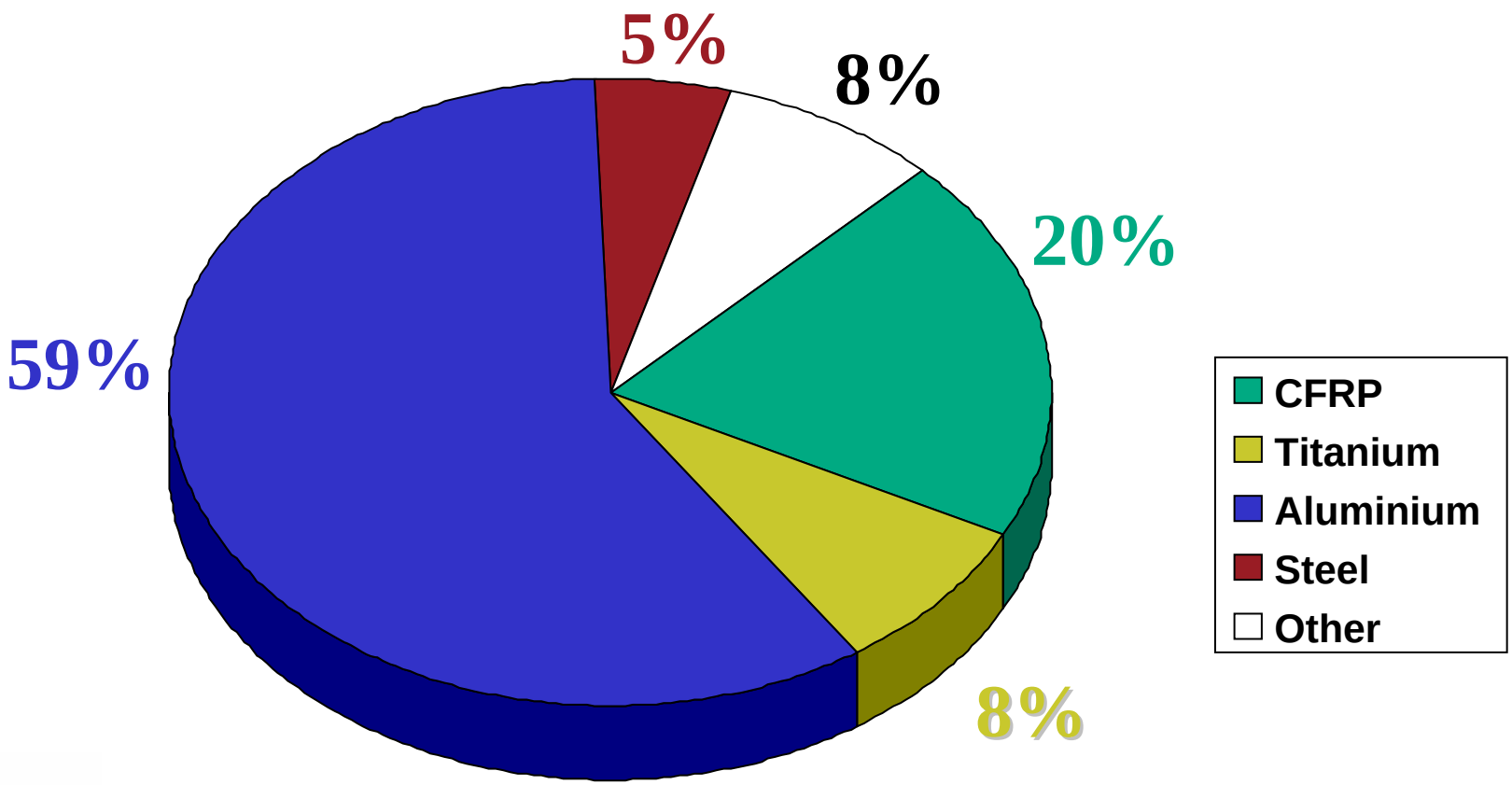
- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC

Design Goals. New materials

Composites

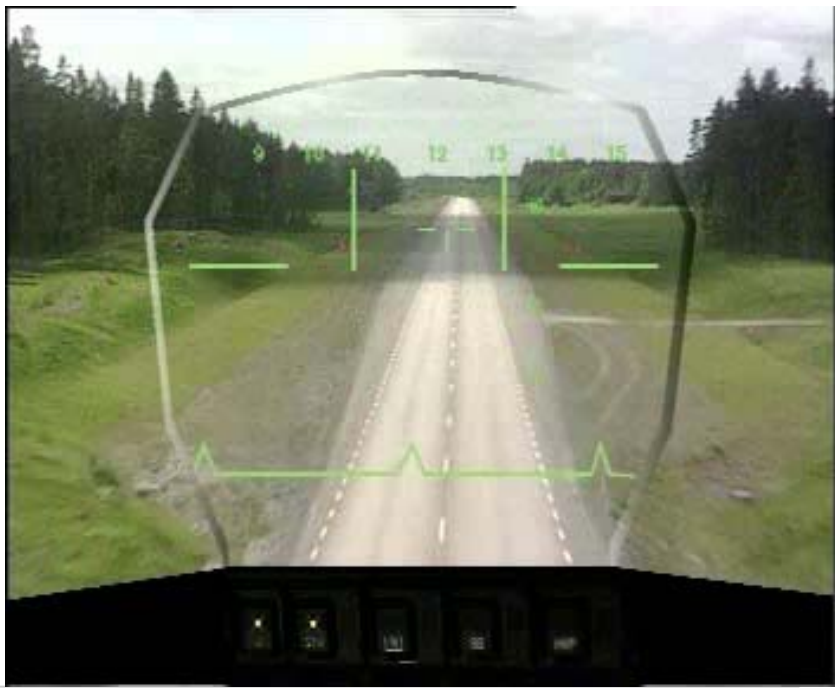
- Carbon-Fiber Composite (CFRP)
- Glass-Fiber Composite (GFRP)
- Aramid-Fiber Composite (AFRP)

Design Goals. Material by weight



Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC



Brake system

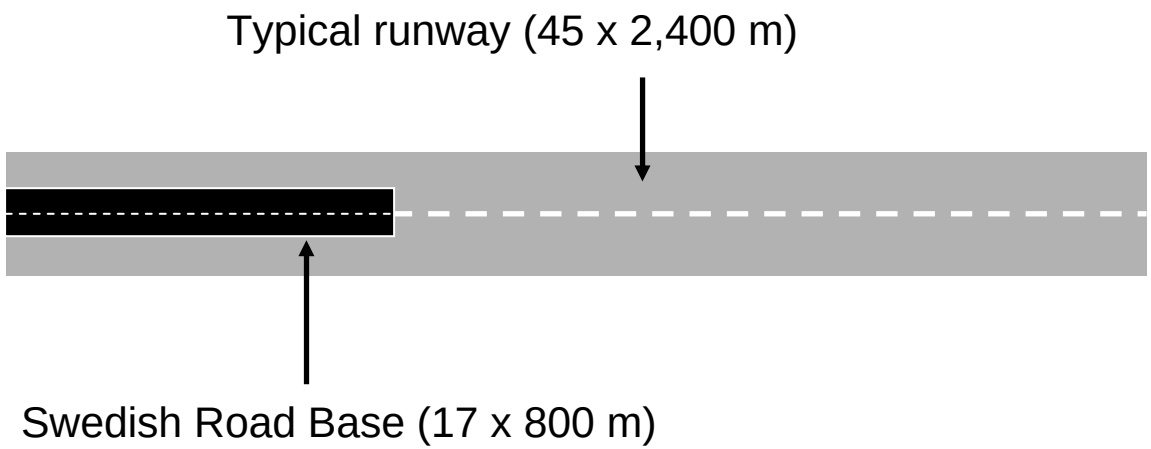
- Brakes on all wheels
- Anti skid protection
- Touchdown protection
- Spin down control
- Brake energy control (Nose wheel)
- Pulse mode, emergency
- Isolation of supply during flight (gear up)
- Fault Monitoring

Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
  A-to-A 10 min, A-To-G 20 min
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC

Gripen – Easy and quick turnaround

Survivability & Flexibility for Autonomous Operations

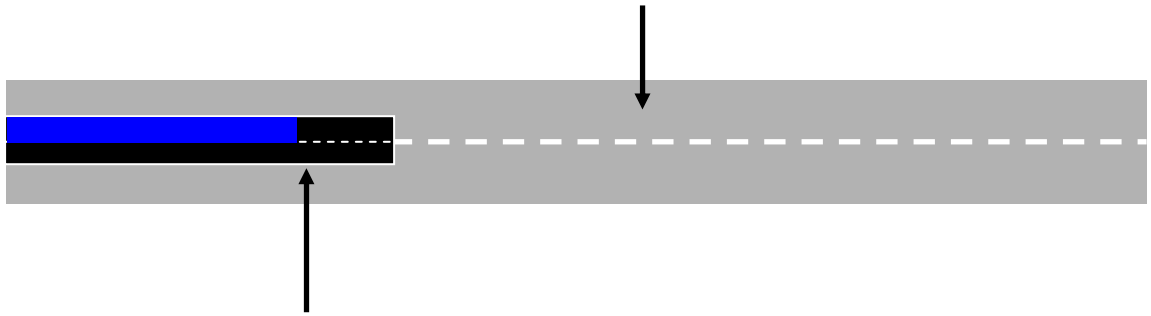


- **Dispersed operations**
  - Short take-off/landing
  - Side mounted engine intakes
  - APU
  - Minimum GSE and crew
- **Rapid turnaround**
  - Air-to-Air < 10 min
  - Air-to-Sea/Ground < 20 min
- **Scramble**
  - Airborne < 1 min

Gripen – Easy and quick turnaround

Survivability & Flexibility for Autonomous Operations

Typical runway (45 x 2,400 m)

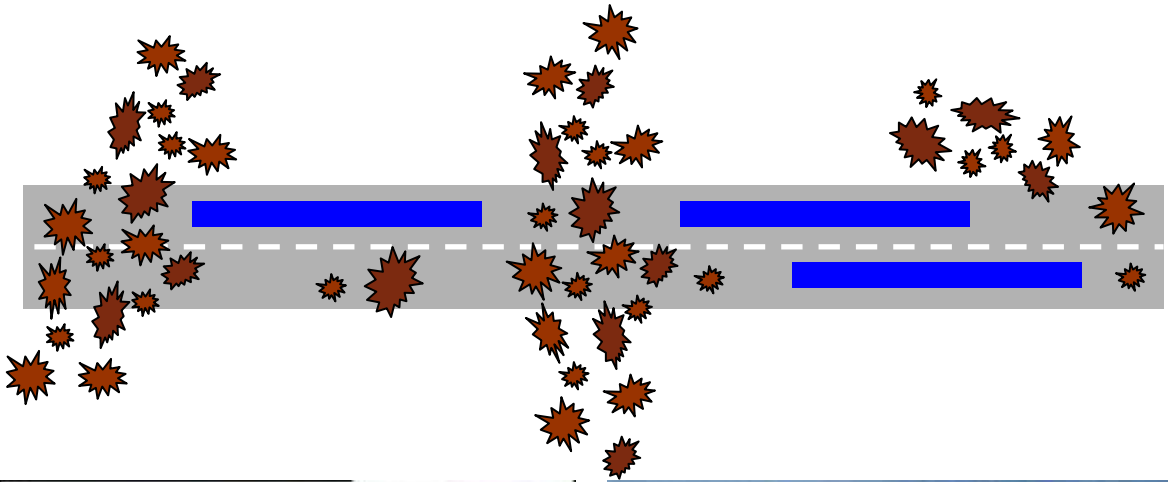


Swedish Road Base (17 x 800 m)

Gripen requires (9 x 600 m)

Gripen – Easy and quick turnaround

Survivability & Flexibility for Autonomous Operations



Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around, performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC

Secondary power system

Allows start of aircraft without external power.
The built in APU provides power to:

Auxiliary gearbox (Hydraulic/Electrical)
ECS, when engine bleed air not available
Air Turbine Starter, for engine start

As backup thermal batteries for hydraulic and electrical power.

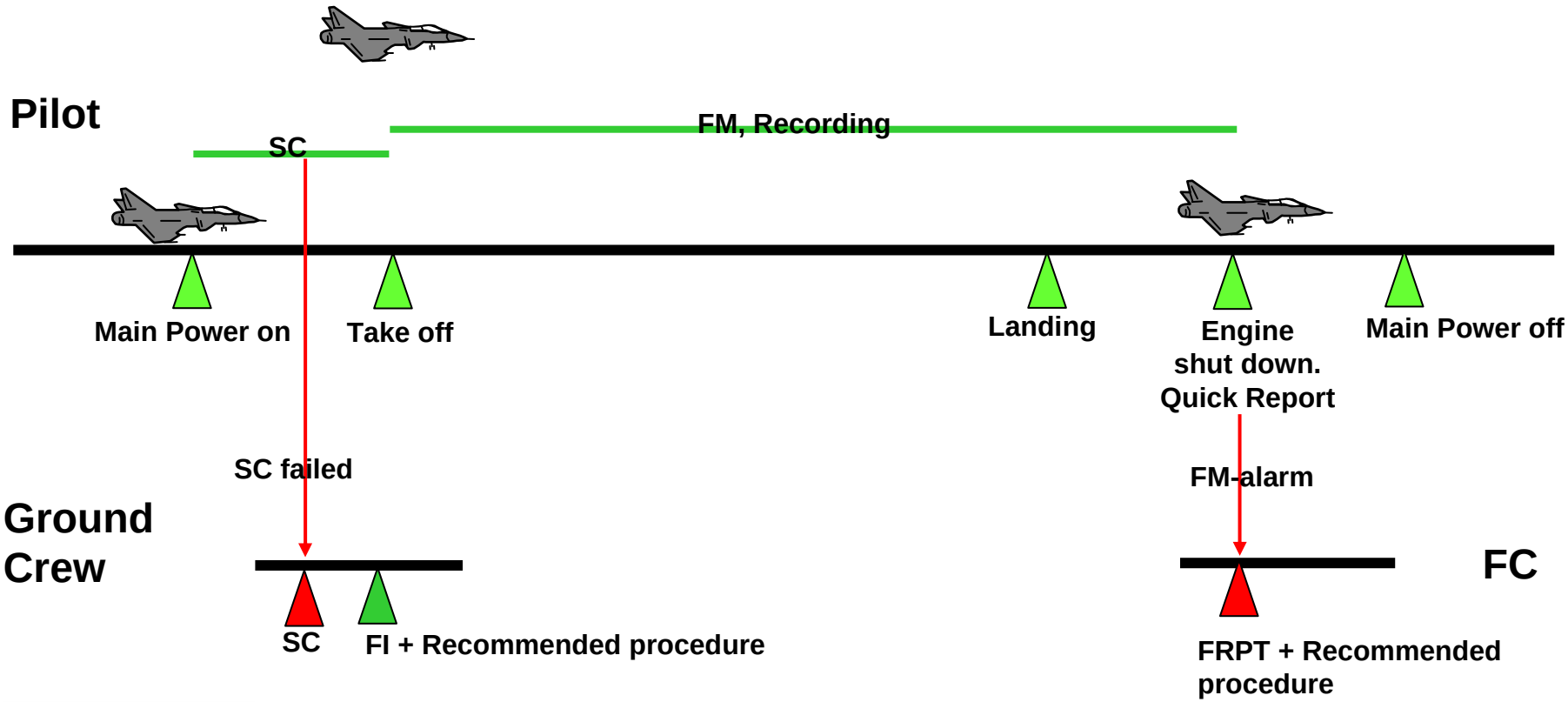
Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC

Design goals

- Break the cost increase curve
- Replace all versions of Viggen
- Reduce empty weight by half with maintained stores capability
- Able to operate from Swedish AF dispersed road base system
- Easy and quick turn-around performed by conscripts
- Minimized requirement for ground support equipment
- Small footprint to the base-system
- Built in growth potential
- Low LCC

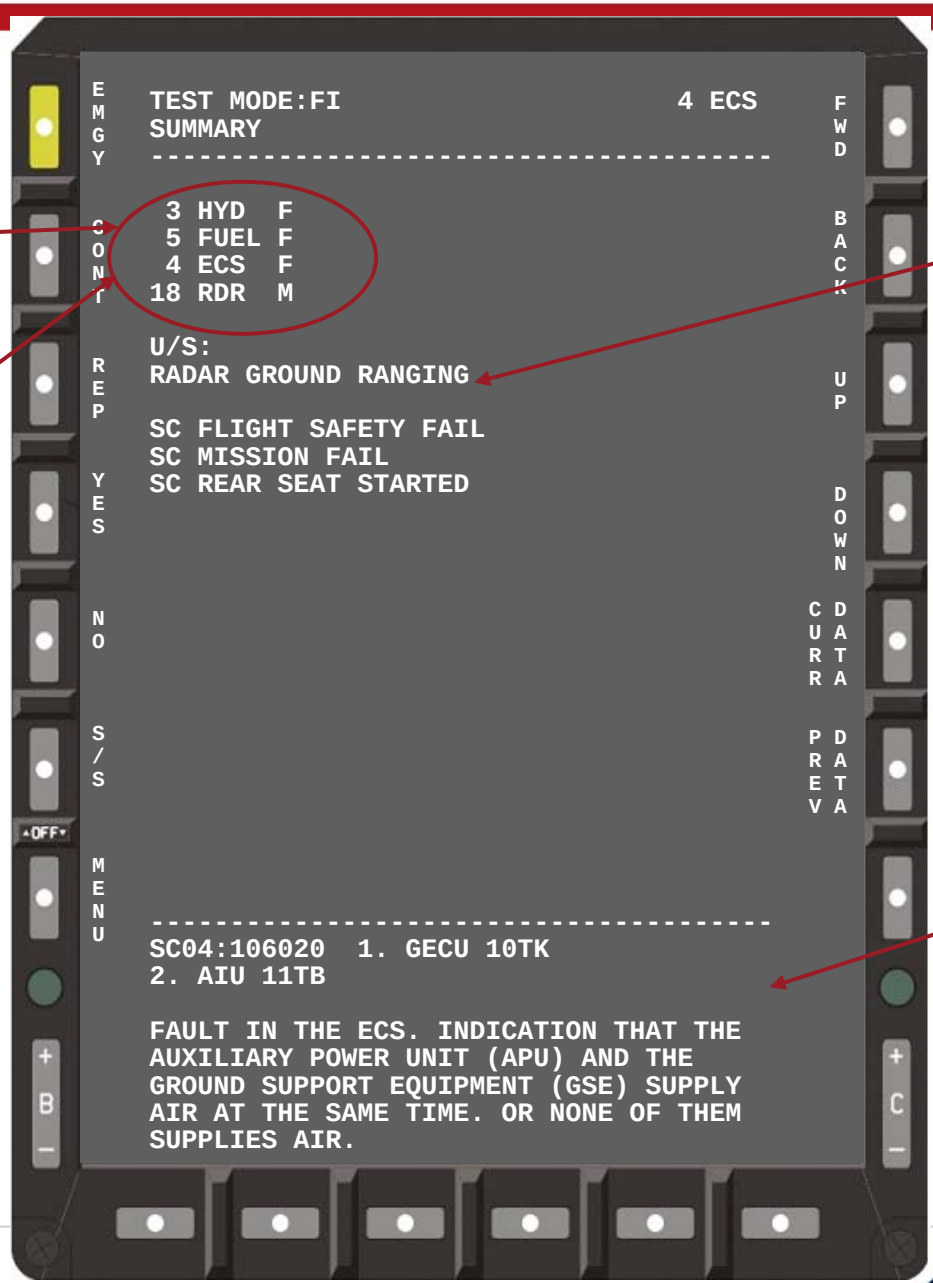
Built In Test Functions



Test status summary after Safety Check.

Only failed tests are shown.

Display in order of Fault Isolation Priority.



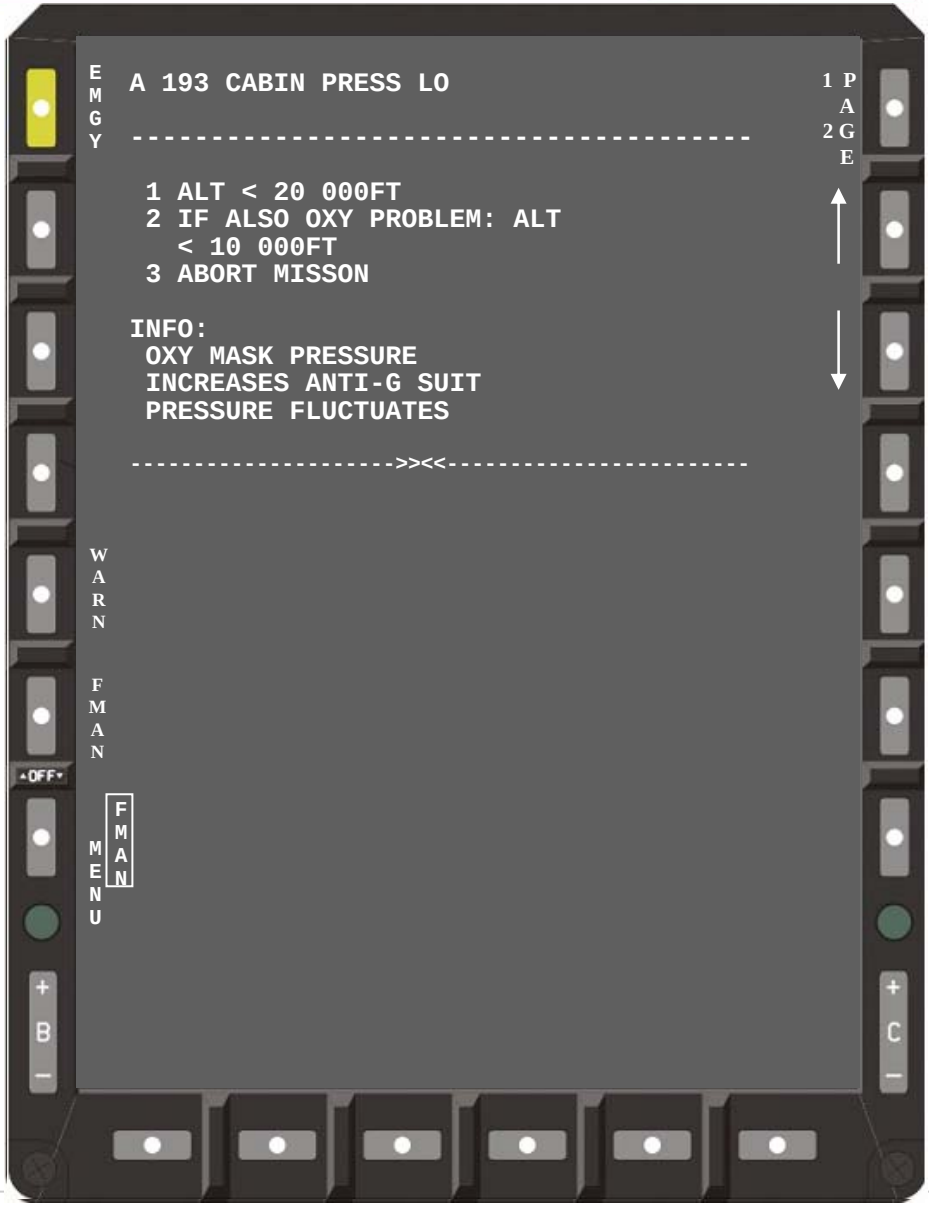
SC degradation info will provide information to the pilot about what causes a degradation of the aircraft in terms of mission capabilities .
(Even at FMAN-page).

Information to ground crew.

<u>Central or Right Display</u>
Manual selection of Warning presentation.

Flight manual display Shows

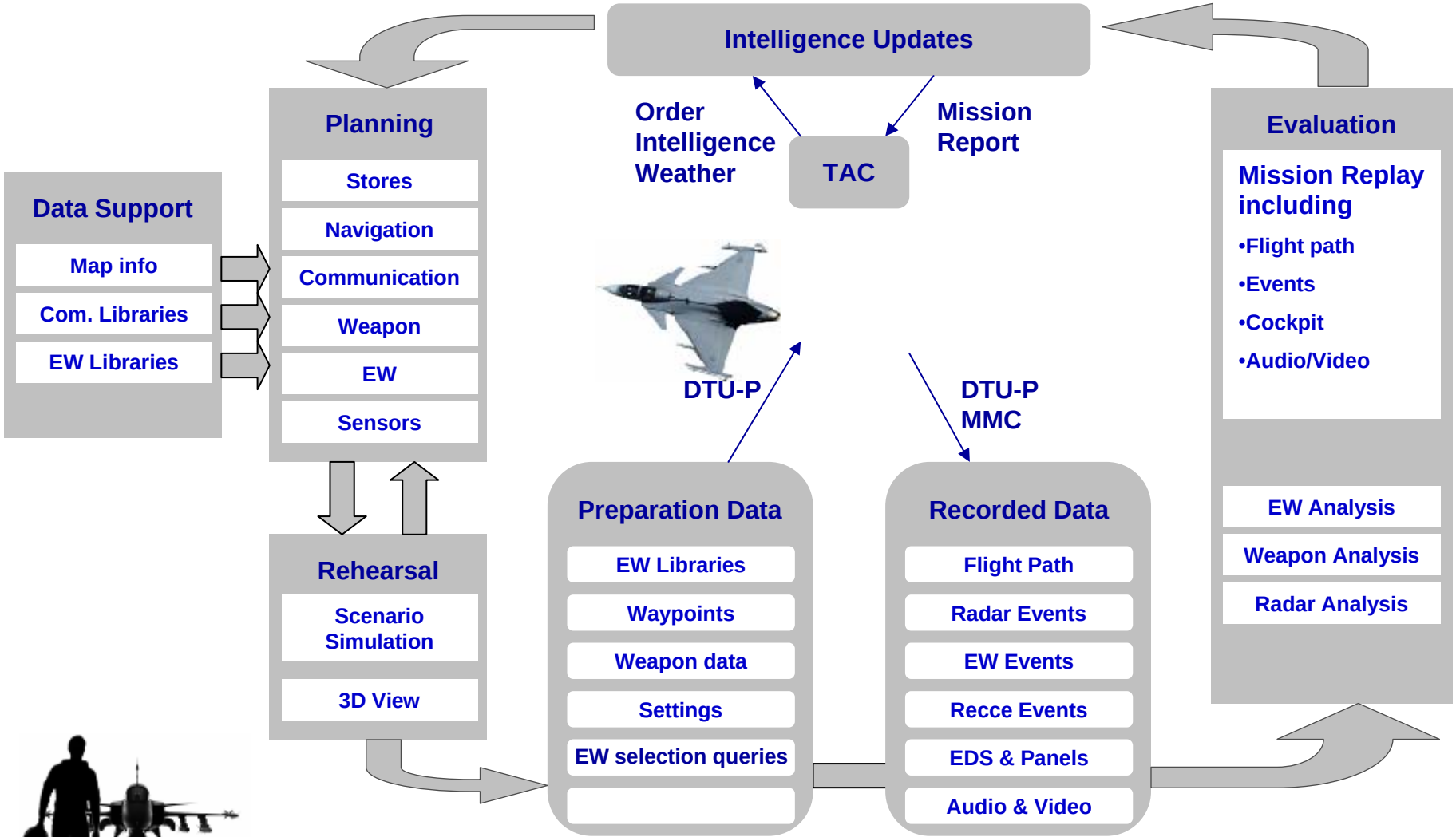
- Failure
- Recommended pilot actions
- Information about
- degradations



Tactical requirements

- Possible for a pilot to fly all types of missions
- Autonomous operations, shared information, superior situational awareness
- Able to change mission type during flight
- Quick response time
- System for mission planning, evaluation and training
- Tools for enhancements to the electronic map and EWS-system library

Mission Support System



Aerodynamic layout and design

- Requirements asked for:
  - Good turn performance
  - Excellent handling qualities
  - Low buffeting level, gust alleviation (low level operations)
  - Supersonic speed at all levels
  - Good acceleration performance
  - High external stores capability
  - Long range performance
  - Short field operations
  - Stable weapons platform

Aerodynamic layout and design

Requirements resulted in:

- Modified delta wing with canard
- Relaxed static stability in pitch
- Fly-by-wire flight control system
- Feathered canards resulted in stable aircraft, gave time for safe ejection

Why an Electronic Flight Control System, EFCS?

- Improved performance
- Advantage in installation (space and weight)
- Easy to create redundancy,
  battle damage resistance
- Possible to make advanced calculations
  (load factor limits, auto recovery etc.)
- Reduced pilot workload
- Easy to monitor
- Flexibility with potential to enhance software
- Low-cost mass produced components

FCS Handling qualities

Flying qualities optimized depending on:

- External stores, altitude, speed
- Op. mode: Taxi, Ground roll, Lift off, Combat, PAL, Aiming

Drag minimized through trimmed lift between canard and main wing

- Cuts through the air

Leading edge flaps to reduce buffeting level and drag

Automatic gust alleviation

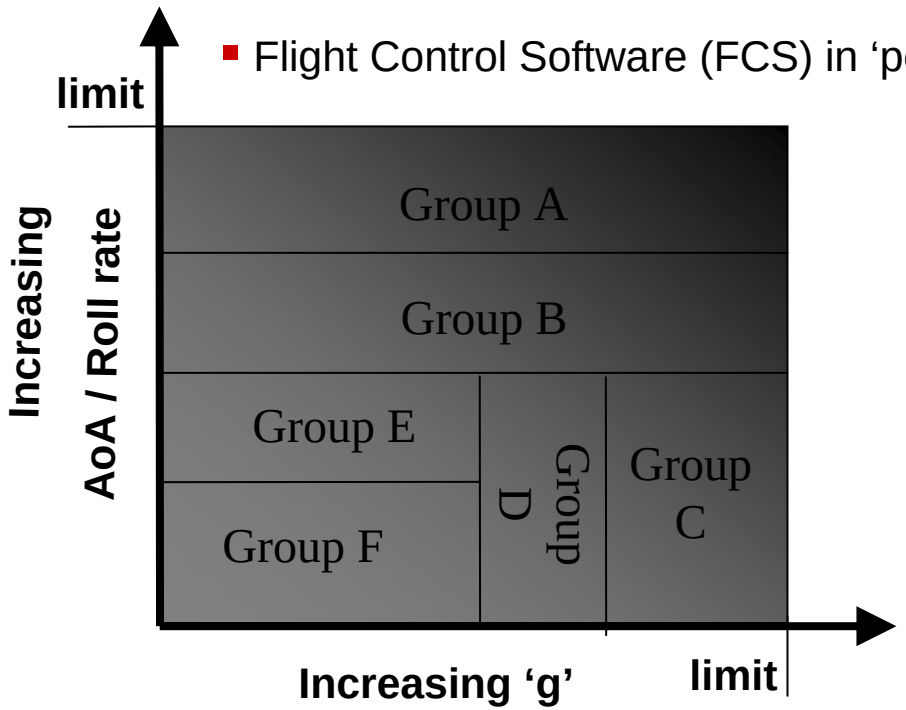
Precise response easy to fly formation, land and handle on ground

Very small effect of external stores

Outer loop functions can easily be developed

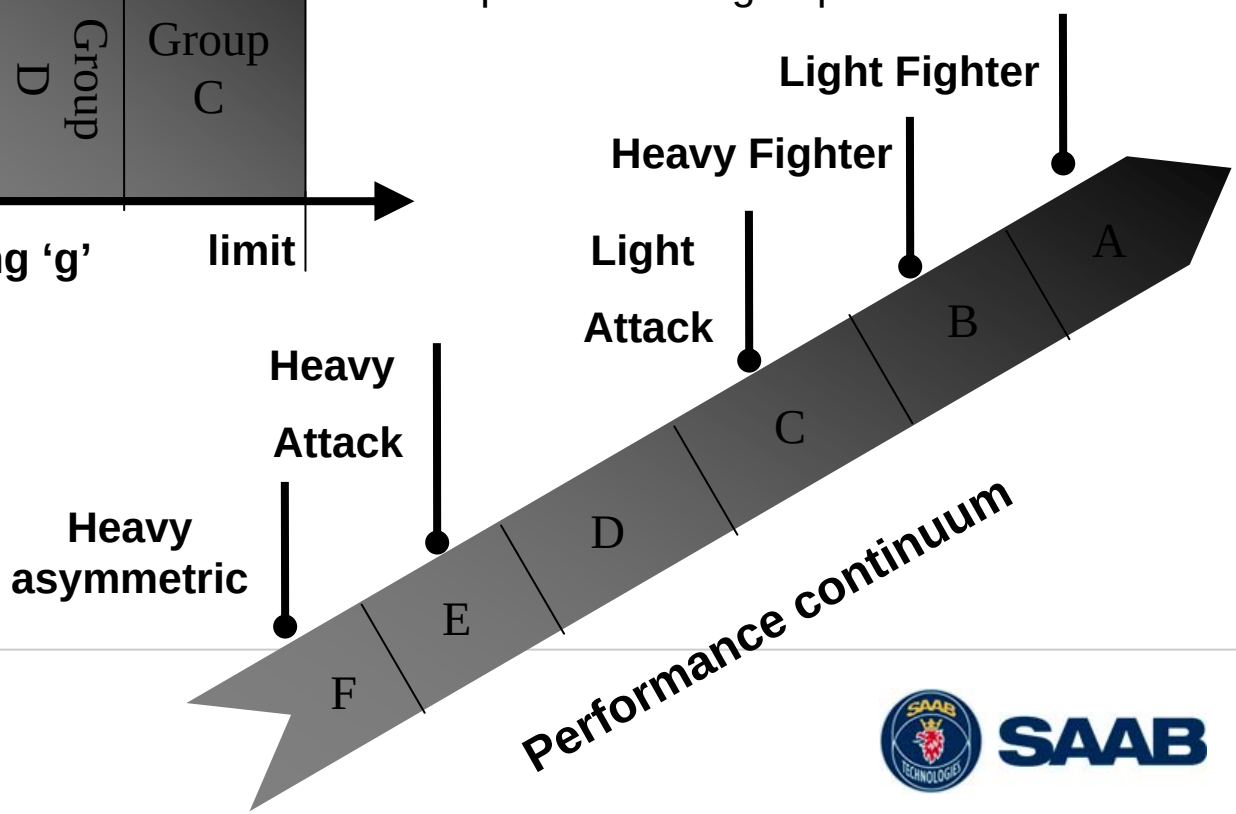
FCS-Performance Groups

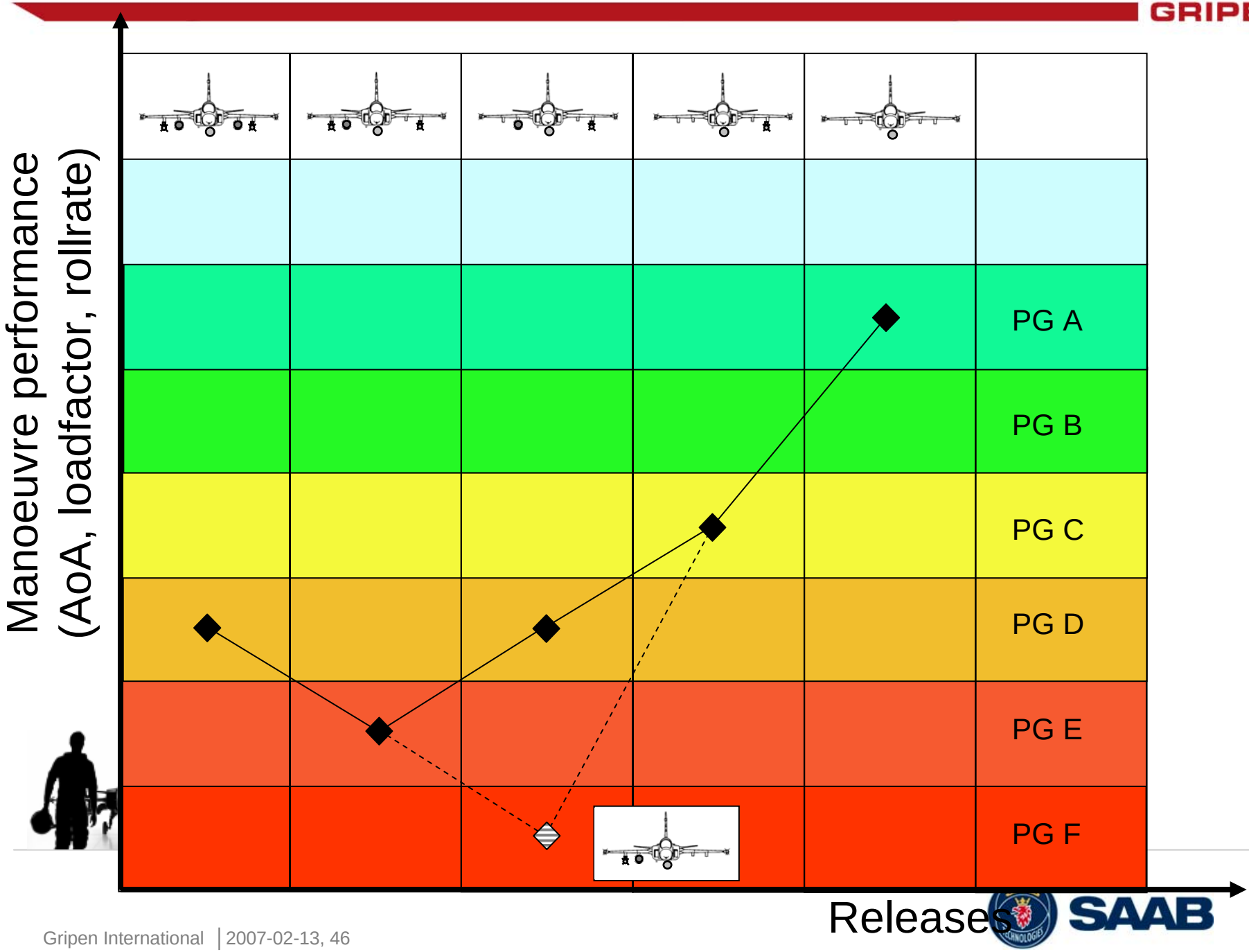
- Flight Control Software (FCS) in ‘performance groups’



Carefree maneuvering

- Each configuration assigned to a ‘performance group’ PG




Manoeuvre performance
(AoA, loadfactor, rollrate)
PG A
PG B
PG C
PG D
PG E
PG F
Releases

We picked the Best!

GE Aircraft Engines

VOLVO

Kitron

Honeywell

Martin-Baker

Hamilton Sundstrand
A United Technologies Company

.....!

SAAB

Gripen export features

Gripen Enhanced Features – Export & C/D

- Multi-national/NATO interoperability
- Fully integrated electronic warfare system
- Additional weapons clearances
- Helmet Mounted Display
- Higher payload & increased MTOW
- Recce Pod
- Advanced Mission Support Equipment
- 3 Colour MFD (8” by 6”)
- English language displays and publications
- World-wide climate clearance
- Air-to-Air Refuelling
- OBOGS
- ....

Day and Night HMI Adaptation

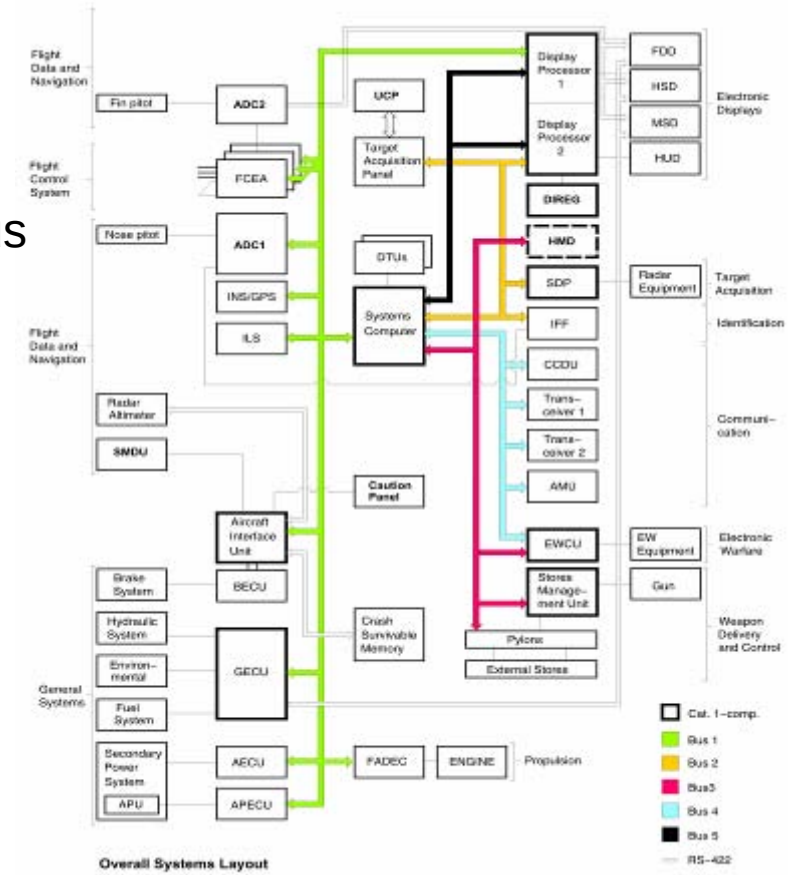
Gripen Architecture – Major Functionality

Centralized system built around:

- Five MIL-STD-1553B data buses
- SC (Systems Computer), acts as bus controller
- AIU (Aircraft Interface Unit), as backup bus controller

High grade of functional Integration within Core System:

- SC (Systems Computer)
- AIU (Aircraft Interface Unit)
- GECU (General Systems Control Unit)
- SMU (Stores Management Unit)



Overall Systems Layout

Data-links

User Controlled Encrypted Datalink

- Tactical info
- Positions
- A/c to a/c
- A/c to ground
- Ground to a/c
- Image transfer
- Auto messages
- Etc

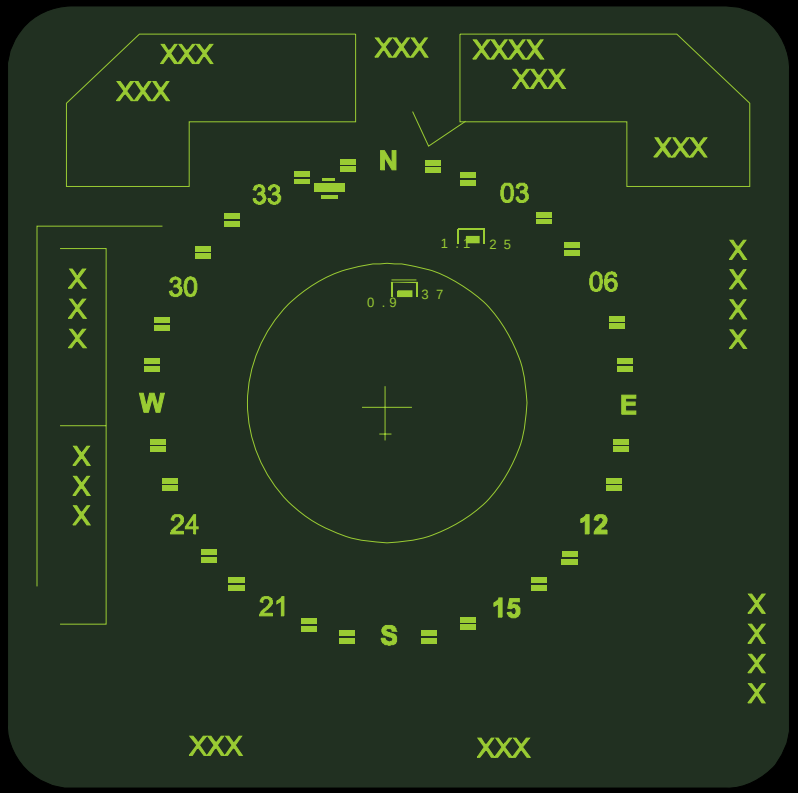
Link 16

- Optional level of integration

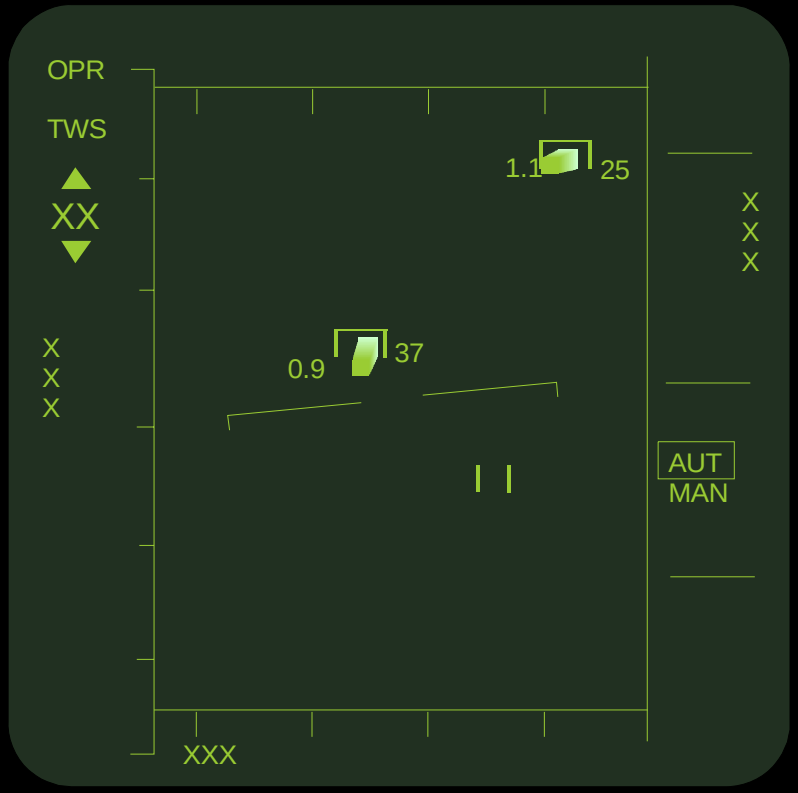
“Generic Third generation fighter”
Head-down display

Radar detection: 2 targets at medium range.

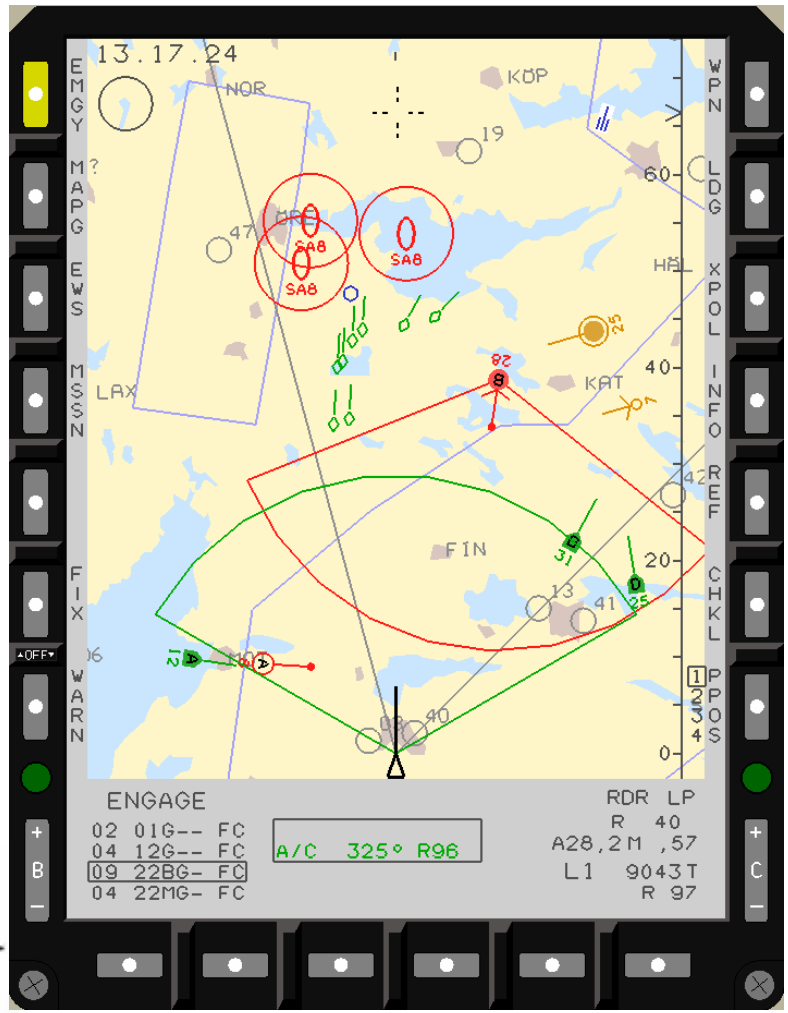
SA-Display

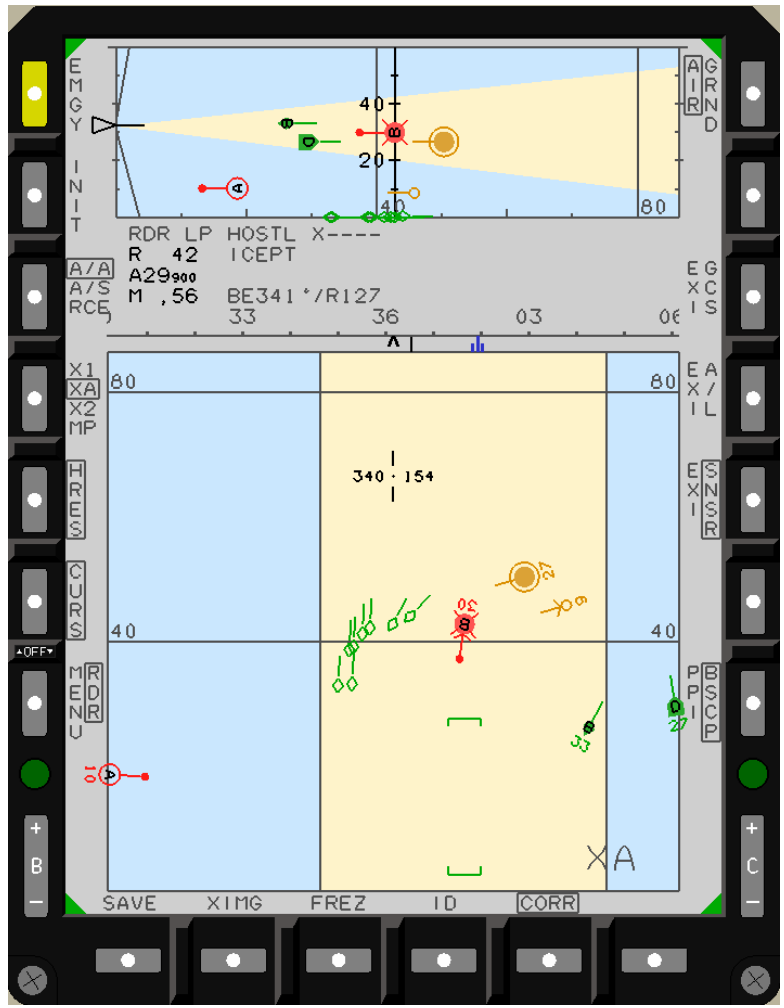


Radar-display



Tactical scenario, example





‘Cobra’ Helmet Mounted Display (HMD)

The Gripen ‘Cobra’ HMD system is the latest version of the ‘Striker’ family

- Includes Night Vision Cameras and day camera on the helmet
- Electro Optical trackers

In 2004 centrifuge tests were carried out in UK and Sweden

In May 2004 the ‘Cobra’ HMD System was flown for the first time in the Gripen - This was the first flight with a modern binocular HMD system in the –3g to +9g envelope

In service date planned for 2008

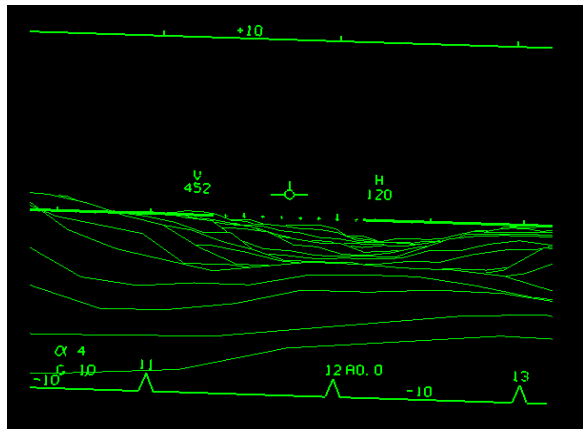
+

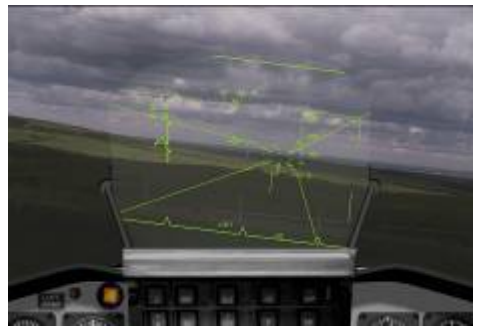
=

Multimodal Display Techniques
Perspective Displays

Experience Perspective Displays

- Synthetic Terrain Head-up
- Pathway-in-the-sky (a.k.a. Highway-in-the-sky) Head-up.
- 2,5D- and 3D- presentations.





Multimodal Display Techniques Tactile Indications

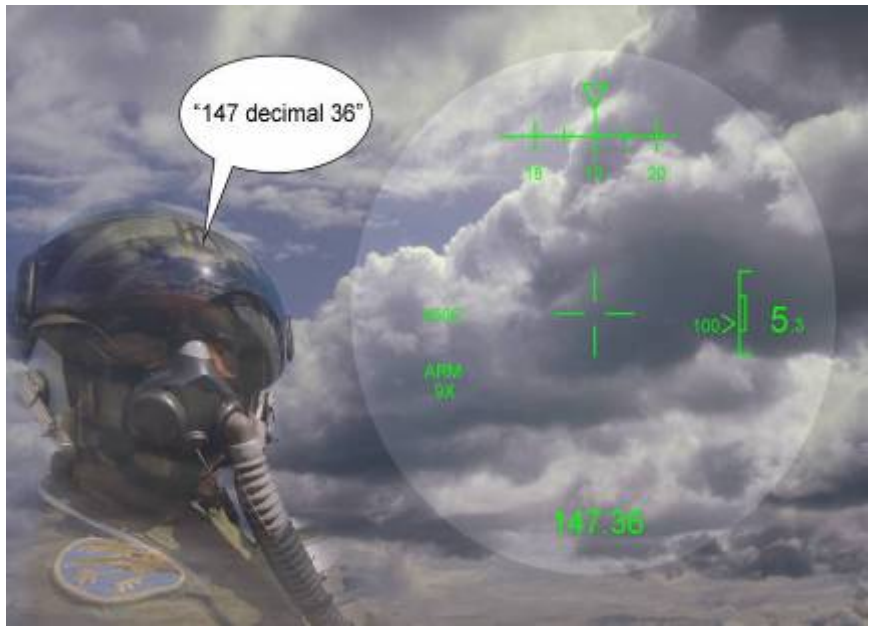
Experience Tactile Indications

- Evaluated the use of tactile indications as navigational aid in a ground based scenario
- Tested with, and without, 3D-audio as a complement.
- Preliminary results are very promising regarding spatial awareness and the ability to discriminate the indications.

Multimodal Interaction Techniques
Direct Voice Input

Experience Direct Voice Input

- Direct Voice Input has been tested and evaluated during different kind of scenarios
- Advantages were found regarding High Level Commands, in other words: One voice command replaced a chain of ordinary keyboard and marker selections



Operational Aspects

Experience gained…

- First SwAF sqn operational 1997
- Logged some 85.000 flt. hours
- Proven logistics concept
- Participation International Exercises
  - Battle Griffin
  - Nordic Air Meet
  - Frisian Flag
  - NOAM (Nordic Air Meet)
  - COOP Jaguar
  - Joint Winter
  - Red Flag Alaska
  - …
- Successful dissimilar ACM training
  - F16, F18, MIG 21, MIG 29, Tornado F3, L39, Mirage III…

Gripen on a spiral development path!

DEMO!

Gripen A/B

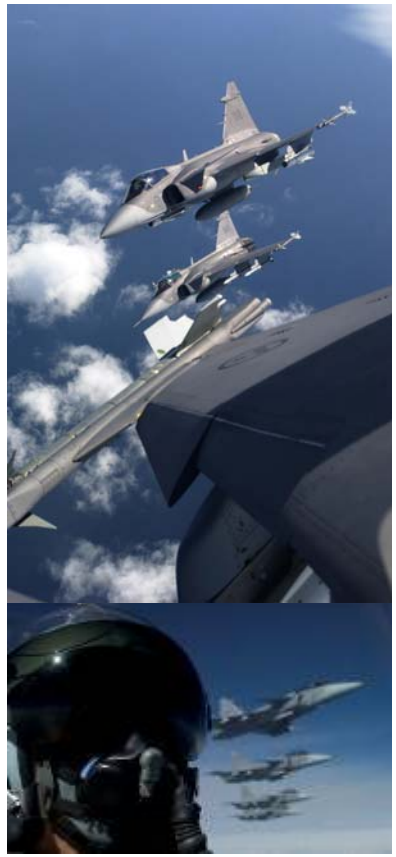
- Digital Fighter Link Swing-role fighter
- Rapid reaction & turn around time
- Advanced BIT
- Designed for low cost of ownership
- Glass cockpit
- AMRAAM
- Fly by wire
- APU
- …

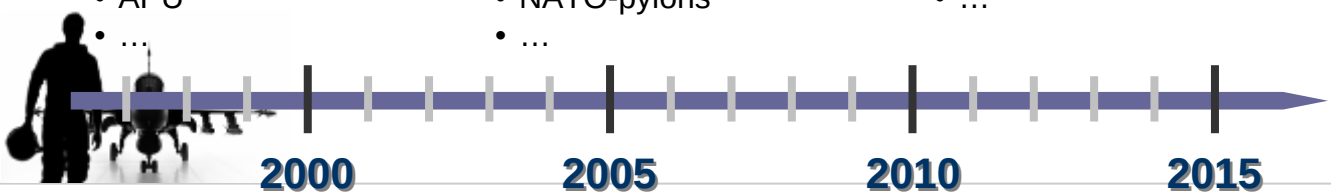
Gripen C/D

- NATO interoperability/LINK 16
- Air to Air refueling
- Increased MTOW
- OBOGS
- Color displays
- Fully integrated EWS
- HMD
- World Wide Climate Clearance
- Increased survivability/lethality
- NATO-pylons
- …

Gripen N

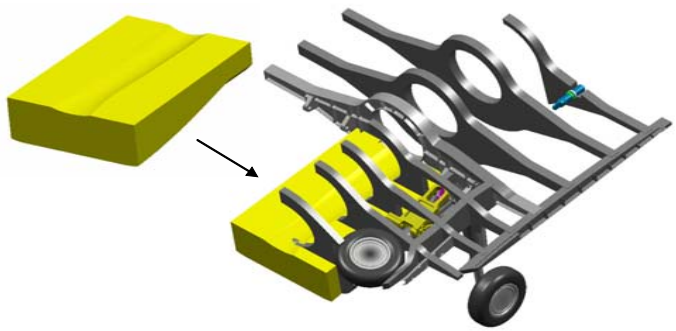
- Increased range
- Increased MTOW
- Added weapons stores
- Increased thrust
- AESA
- Enhanced EWS
- Advanced rear cockpit
- Enhanced NCW
- Full capability HMD
- GCAS
- Satellite Comms
- Jammer Pod Integration
- Improved LCC
- Overall increased basic performance
- …





SAAB

Example - Structural

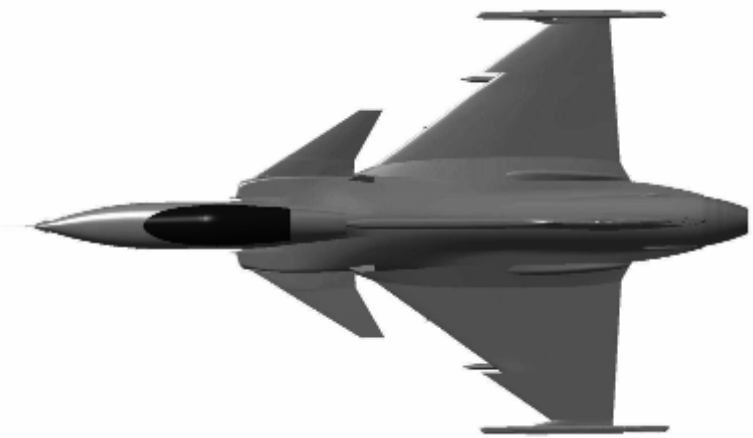


New fuel tank 6, in existing landing gear compartment

New main landing gear, repositioned

Gripen Next Generation

Basic data	Gripen C	Gripen N
• Length excl. pitot tube	14.1 m	14.1 m
• Wing span incl. launchers	8.4 m	8.4 m
• Number of Stations	8	10
• Empty weight	6 800 kg	7 100 kg
• Internal Fuel	100%	138%
• Engine Thrust	18 000 Lbs	> 22 000 Lbs
• Max Take-off weight	14 000 kg	16 000 kg
• Payload	5 000 kg	6 000 kg



New/Upgraded Avionic Structure

- Increase overall capability:
  - Better computer and bus performance
  - Reduce time to integrate new systems and functions (hours rather than months)
  - More efficient distributed development
- Increase mission availability
- Meet new (unknown) operational requirements
- Easy Start-Up
- Common avionic development for all flying Saab products
- ....

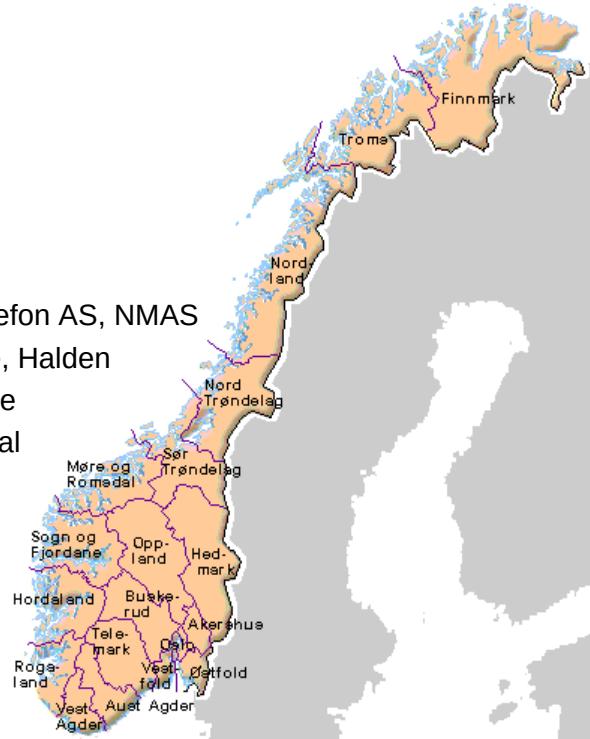
Existing Saab industrial network in Norway:

Nordtro A.S	Sörkjosen
Natech NSV A/S	Narvik
ASTI	Selbu
Capro AS	Melhus
Trelleborg Viking A.S	Mjondalen
Capinor A/S	Gjövik
Nammo Raufoss A.S	Raufoss
Nortek AS	Rud
Eltek Energy AS	Drammen
L3 Communications Navigation AS	Drammen
Det Norske Veritas AS	Hövik
Vikato Consulting A/S	Slemmested
Park Air Systems AS	Oslo
Simrad Optronics A/S	Oslo
Syberg A/S	Oslo
THALES Norway AS	Oslo
Visma Services	Oslo
Vinghog A/S	Tonsberg
Keytouch A.S	Horten
Hydro Polymers A/S	Porsgrunn
Engelsrud Fyrverkerifabrikk A/S	Sarpsborg
Heli-One Norway AS	Stavanger Lufthavn
Kitron Arendal A.S	Staubö
Hydal A/S	Kopervik
Jakob Hatteland Display A.S	Nedre Vats
Corena Norge AS	Kongsberg
Kongsberg Defence & Aerospace AS	Kongsberg
Seaprof Solutions AS	Bergen
Aanderaa Instruments A/S	Bergen
Ingeniör Harald Benestad A.S	Lierskogen
West Mekan Produksjon A/S	Nordfjordeid

New partners and suppliers:

Applica AS
Datarespons Norge AS
DYNO Nobel ASA
Flextronics International Norway AS
Josab International AS
Karotek AS
Keytos AS
Mesanin AS
Motec AS
NCE Systems Engineering Kongsberg
Norsk Hydro ASA
OPRA
SCALI AS
SH Produkter AS
T&G ELEKTRO
TECHNI AS
TINEX AS
UMOE AS
VMETRO ASA
Jotne/EPM Consultants
PRESENS AS
EIDEL Eidsvoll Electronics
Kongsberg Devotek

N-Tec
Tisics
Aktiv Styrning
Heli-One
Teleplan
Ergo Group
Nordisk Mobiltelefon AS, NMAS
Saab Microwave, Halden
Volvo Aero Norge
Fjord International
Semcon



..and many more to come...

QUESTIONS ?