Manned Unmanned Cooperation

Agenda

- Cooperation Sweden USA
- Project
- 6th generation fighter aircraft and loyal wingmen
- Result

FMV

Presentation

- Hans Einerth
- Ret Lt Col, M Sc Engineering Physics
- JA 37 Viggen 600 fh
- JAS 39 Gripen 1400 fh
- SK 60 400 fh
- Gripen Operational Test and Evaluation unit
- SAAB Test pilot 2013-2019
- Displaypilot SAAB B17
- SAAB Gripen Product Management 2018-2019
- FMV Test Pilot since 2019
- Besides test pilot working with FCASC

Project

Background

- Sweden and USA in a valuable project with Ground Collision Avoidance System GCAS
- GCAS now implemented in JAS 39 Gripen and F-16
- MUMCM is a continuation of this successful collaboration
- Manned Unmanned Contingency Management

- Partners
  - AFRL
  - Lockheed Martin contracted by AFRL
  - FMV
  - FOI
  - SAAB contracted by FMV

PROJECT AGREEMENT NO. RDTE-US-SW-AF-19-01

TO THE

MEMORANDUM OF AGREEMENT

BETWEEN

THE DEPARTMENT OF DEFENSE OF THE UNITED STATES OF AMERICA

AND

THE GOVERNMENT OF THE KINGDOM OF SWEDEN

FOR

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

PROJECTS

DATED

APRIL 18, 2011

CONCERNING

MANNED UNMANNED CONTINGENCY MANAGEMENT (MUMCM)

The project

- Lockheed Martin coded a Contingency Manager
- Errors in the LW trigger the CM, that suggests actions to Gripen pilot
- Gripen simulator

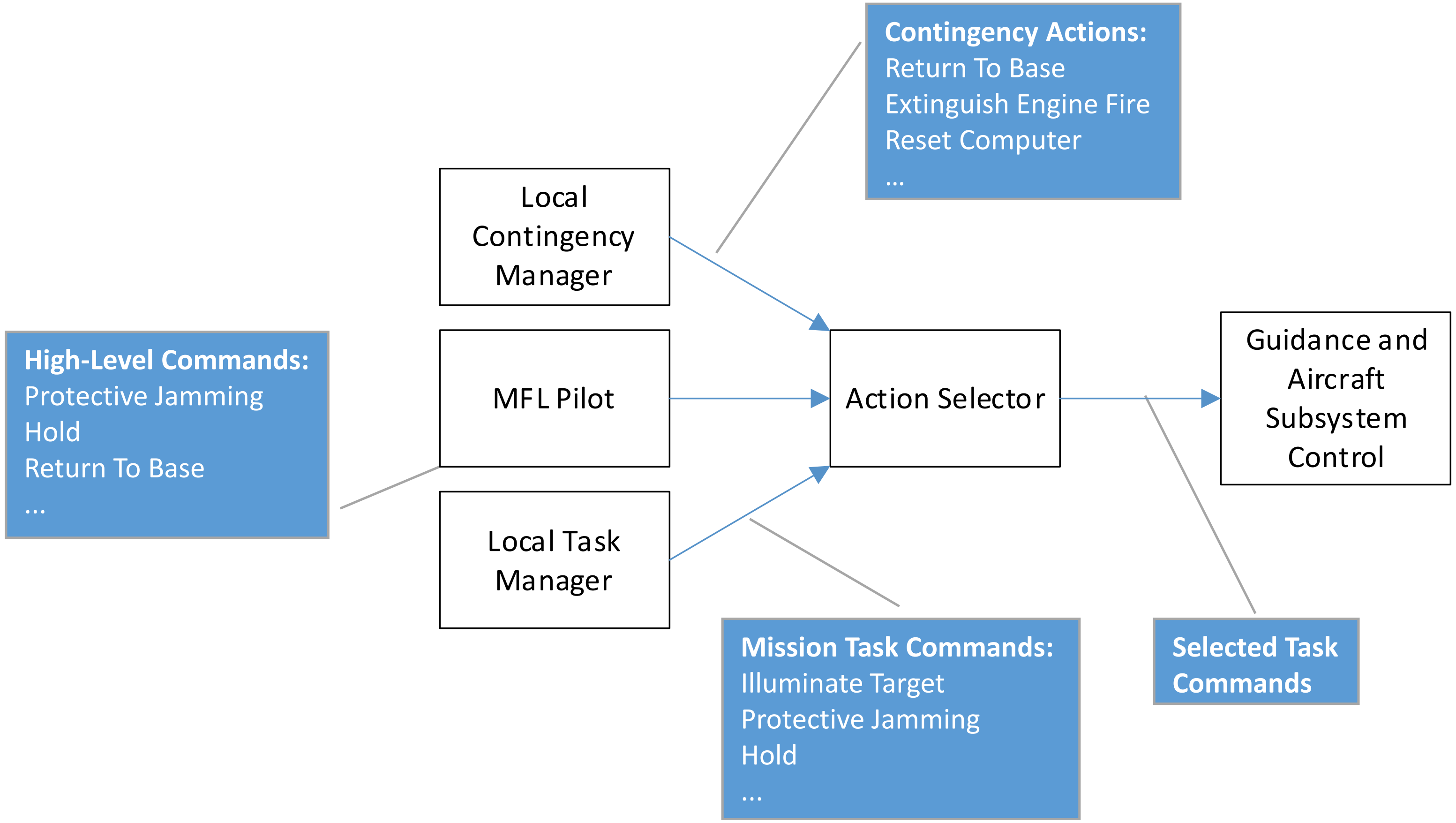
SAAB:Simulator Environment

LM: Contingency Manager

SAAB: Gripen Simulators (6 manned)

Error Introduced → Contingency Manager → Required Actions → Pilot reaction

The Action Selector: manages aircraft control from multiple sources

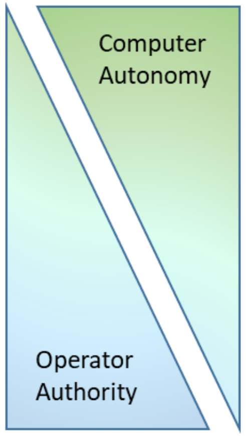


Chosen Local CM Conditions and Actions

Index	Local CM Condition
1	Engine Fire
2	Engine Degraded
3	Lost Electrical Gen
4	Low Fuel
5	GPS Hardware Failure
6	Datalink Dropout Rate Exceeded
7	Bad Weather
8	Loss of Lead MF
9	Internal Flight Control Failure
10	Mission Manager Failure
11	Off Route
12	Target (Video) Sensor Failure
13	Weapon Manager Failure
14	Icing Detected
15	Angle Of Attack Fail
16	Avionics Computer Failure
17	Mission Updates

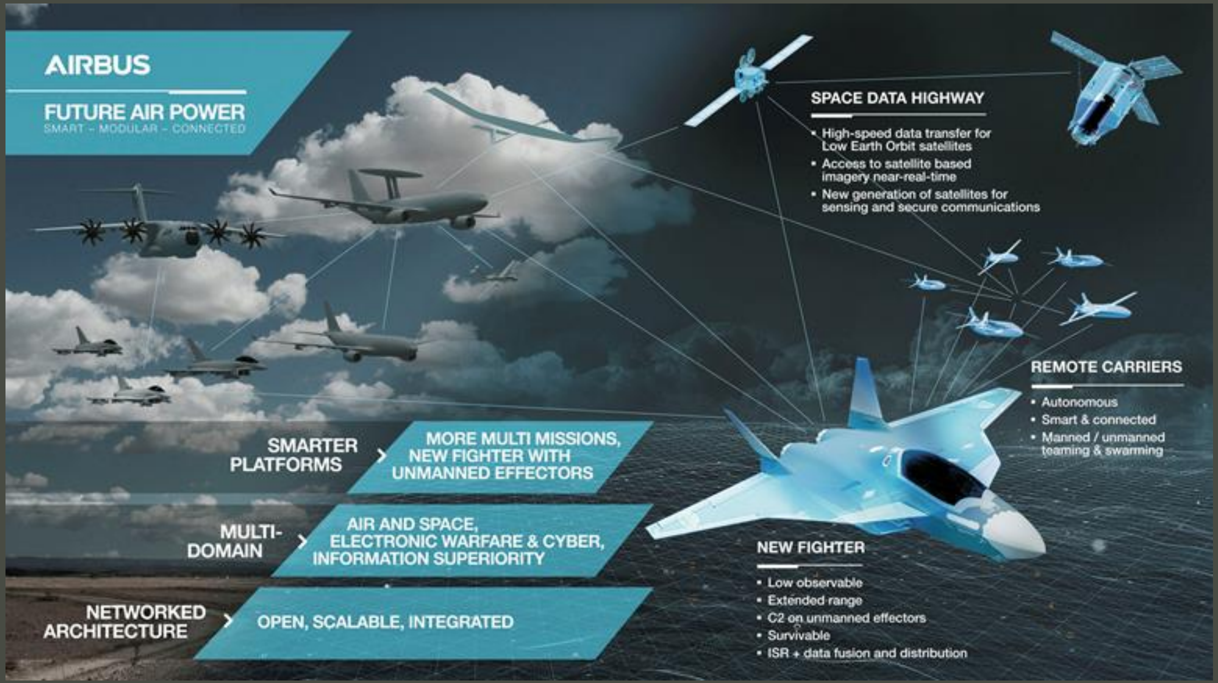
Index	Local CM Contingency Action
1	Return to base
2	Land ASAP
3	Controlled crash
3	Self destruct
4	Increase safety distance to group
5	Extinguish Fire
7	Reset subsystem
8	Activate backup power
9	Check for GPS jamming
10	Request coordinates for new route
11	Evaluate mission
12	Request addition of mission task
13	Request removal of mission task
14	Request weather route change (coordinates)
15	Go to new altitude to clear icing
16	Request confirmation of engine fire from pilot
17	Handover to secondary MF as Lead
18	Handover to GCS as Lead

Definition of Autonomy levels used

Name	Autonomy Level	Operator Authority		Computer Autonomy	Computer Autonomy Indication	Abbreviation
Automatic	5	Interrupt		Full Autonomy	FULL_AUTO	5:FULL_A
Direct Support	4	Revoke action		Action unless revoked	ACTION_UNLESS	4:ACT_UN
In Support	3	Accept advice Authorize action		Advice and if authorized: action	AUTHORIZE_ACTION	3:AUT_AC
Advisory	2	Acceptance of advice		Advice	ADVICE	2:ADVICE
At Call	1	Advice only on request		Advice only if requested	ADVICE_ON _REQ	1:AD_ORQ
Commanded	0	Operator full authority (Action)		Support action	COMMANDED	0:COMMAN

- In the MUMCM project, the autonomy levels 3-5 and 0 was used. 1 and 2 was omitted to reduce the scope, but they should also be included in a complete implementation
- Note that an autonomy-level is not assigned to an aircraft, but is assigned to each *task.* I.e. some tasks may be executed autonomously, while others require the pilot permission to proceed (applies to autonomy level 0, 3-5)

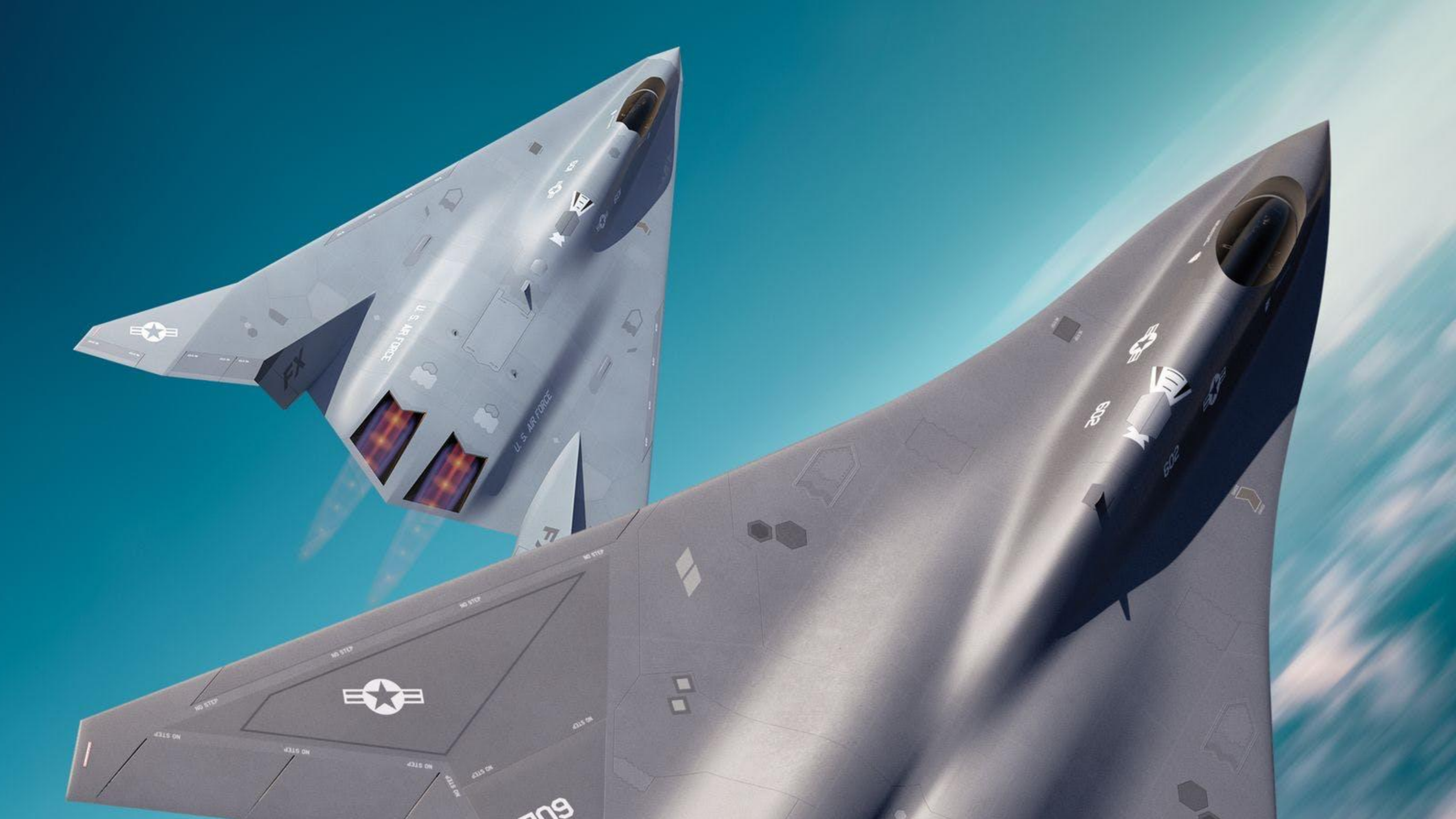
Cockpit Gripen

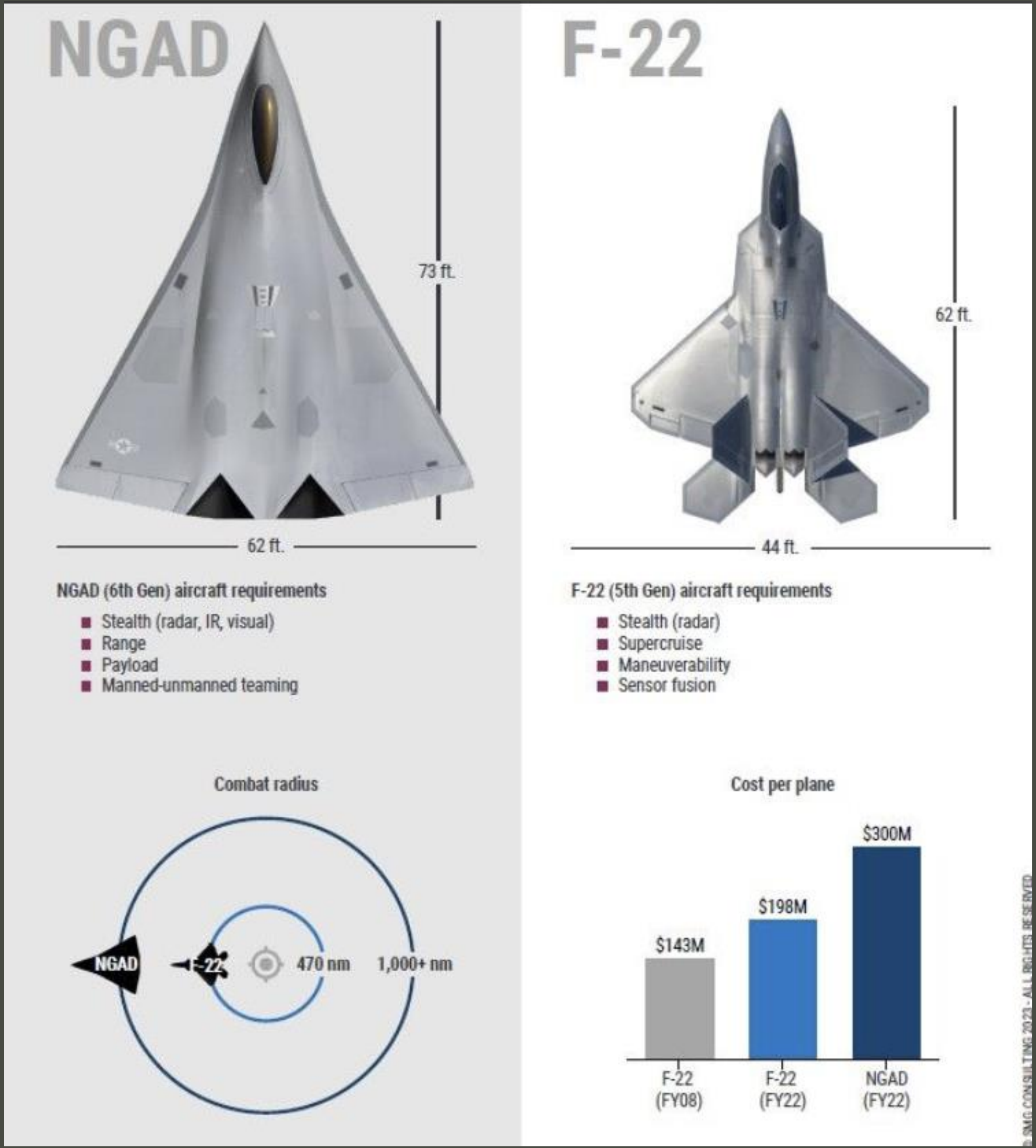


FCASC
UK, Italy, Japan, Saudi

SCAF
France, Germany, Spain

FMV


U.S. AIR FORCE
NO STEP


NGAD
73 ft.
62 ft.
F-22
62 ft.
44 ft.
NGAD (6th Gen) aircraft requirements
Stealth (radar, IR, visual)
Range
Payload
Manned-unmanned teaming
F-22 (5th Gen) aircraft requirements
Stealth (radar)
Supercruise
Maneuverability
Sensor fusion
Combat radius
NGAD
F-22
470 nm
1,000+ nm
Cost per plane
$143M
$198M
$300M
F-22 (FY08)
F-22 (FY22)
NGAD (FY22)
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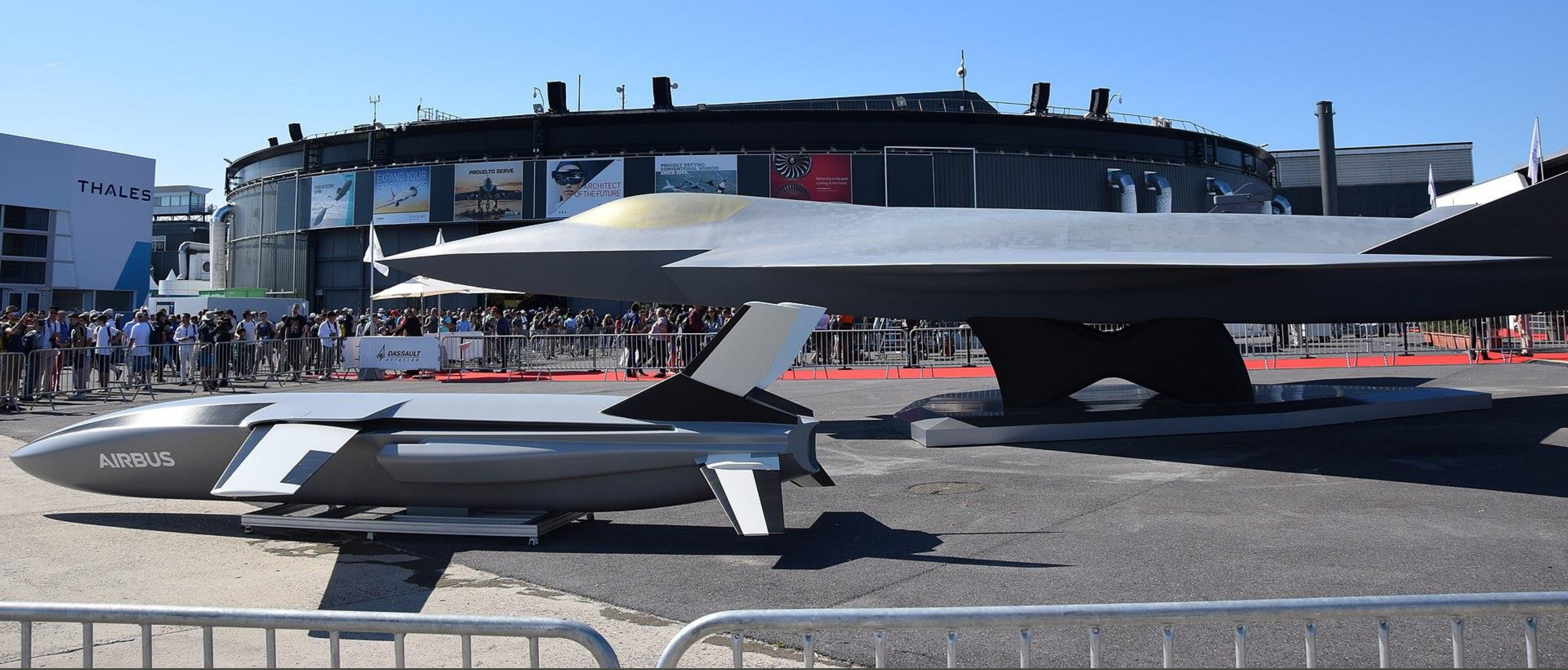
THALES
EXPAND YOUR
PROUD TO SERVE
ARCHITECT
OF THE FUTURE
DASSAULT
AIRBUS

USAF
2 CCA per 300 F-35 and 200 NGAD
= 1000 CCA (Collaborative Combat Aircraft)

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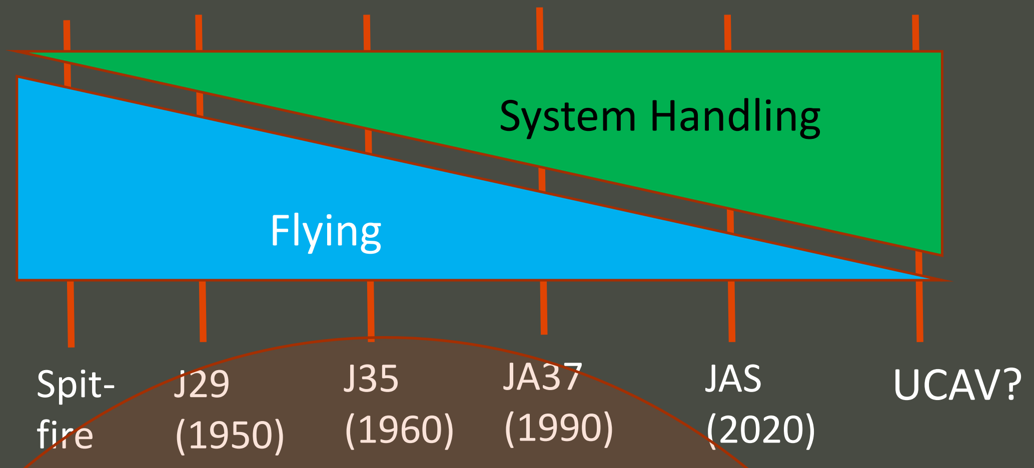
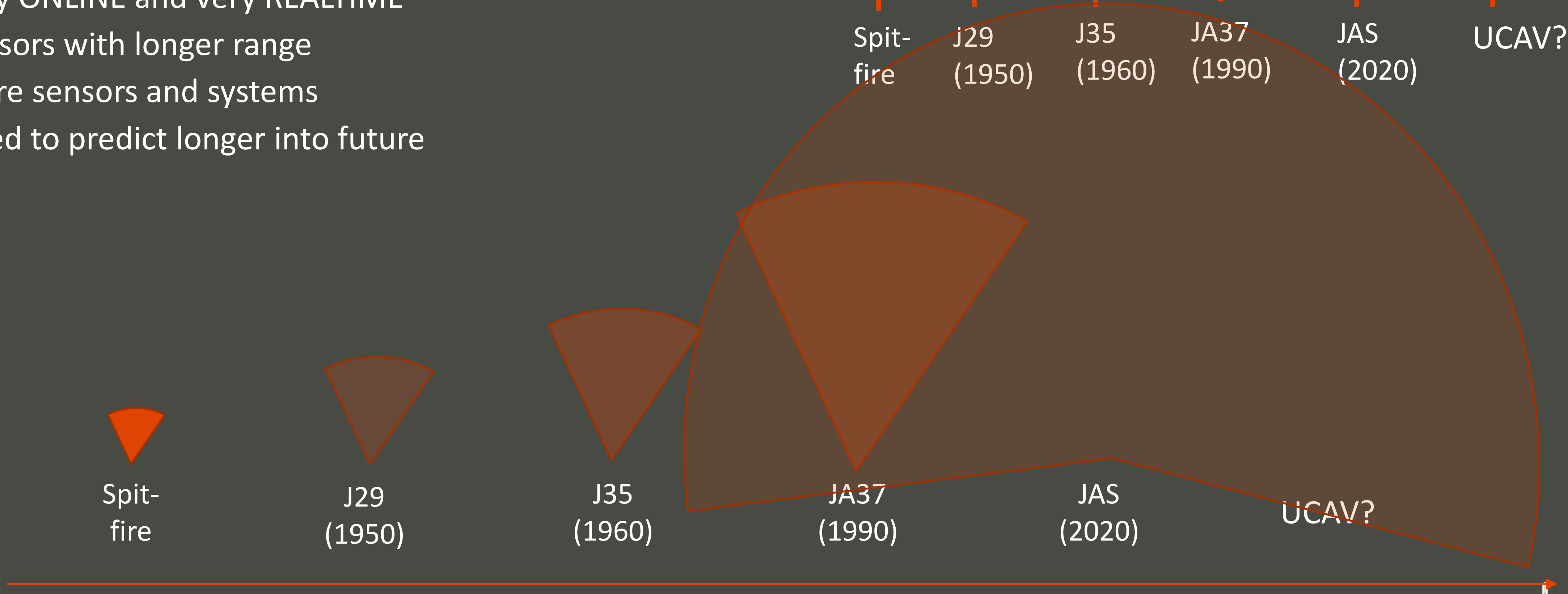
Being a fighter pilot…

- Today: 90 % system handling, 10 % flying
- Very ONLINE and very REALTIME
- Sensors with longer range
- More sensors and systems
- Need to predict longer into future





Why loyal wingman?

- Not enough platforms
- Platforms too expensive
- Education and training prohibits fast growth in numbers
- Many missions dangerous (requires CSAR etc)
- Many long (dull) missions (fighter pilot environment is not suited for long missions)
- In a defensive operation under existential threat and very permissive ROE an autonomous LW is acceptable

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Why crewed fighters

- Still has best flexibility
  - Can perform a variety of roles all over the world without tailoring equipment or software
  - Can be deployed globally without special arrangements around uncrewed aircraft
- Forward deployed human decision-making, without need of broad band datalinks
  - In offensive operations under strict ROE it is desirable to have humans physical in the attacking force
  - In peacetime QRA only crewed platforms are acceptable

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6th gen fighter

- Full data-to-decision environment in high-traffic, with drones, ground sensors, AI, combat cloud
- Optionally manned
- Variable-cycle engines (high thrust, cruise fuel efficient)
- Engine supplies significant more electricity and cooling than 5 th gen
- Directed Energy Weapons
- Stealth airframe and avionics
- Long range weapons – Not a Close In Fighter
- Long range platform – Large aircraft
- Virtual Cockpits

Large aircraft → 2 engines → Small series → Expensive a/c → Not for small nations…?

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UF-23 A/B Technical overview

UF-23 Data sheet

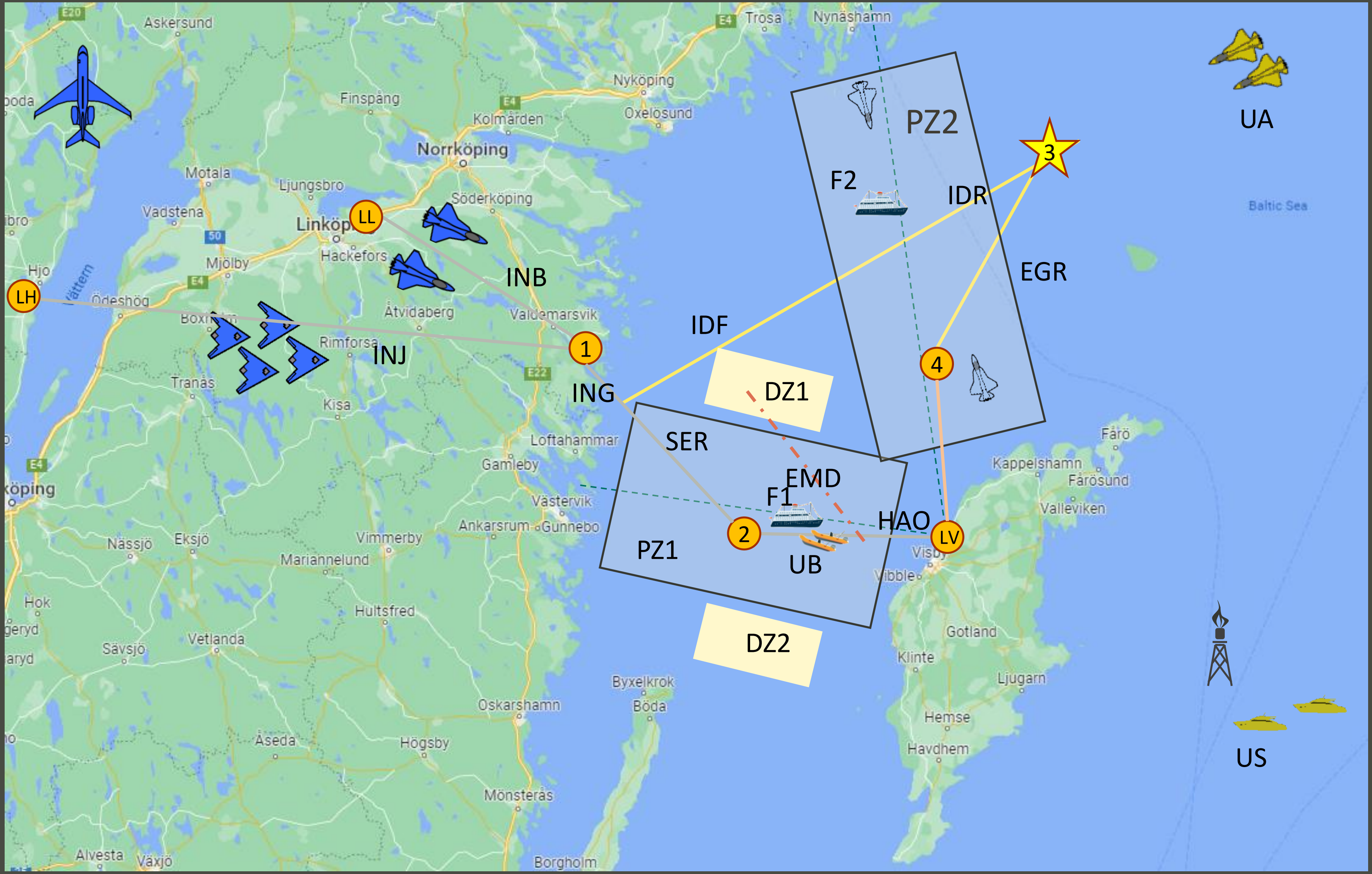
UF-23A Hydra

Length	27ft
Wingspan	36ft
Empty weight	5500kg
MTOW	9500kg
Thrust	36KN
Maximum speed:	M0.92
Service Ceiling:	45 000ft
Combat radius:	200nmi
Max Nz:	7G
Eco :	M0.5/ 28 000ft
Rwy length:	1500m

UF-23B Super Hydra

Length	31ft
Wingspan	38ft
Empty weight	6000kg
MTOW	11 500kg
Thrust	40KN
Maximum speed:	M0.92
Service Ceiling:	45 000ft
Combat radius:	250nmi
Max Nz:	7G
Eco :	M0.55/ 28 000ft
Rwy length:	1700m

Mission/Scenario SimEval#1c/#2 (with variations)



Name	Phase-tag
INB	Inbound
ING	Ingress
SER	Search
HAO	Hand over
INJ	Inbound Join, Flight over land
EMD	Emergency Ditch
	New mission phase
IDF	Ingress A2A
IDR	Identify and Repulse
EGR	Egress
3	Intercept point
4	WP 4
	Object
PZ1-2	Protected Zones
F1	Ferry 1
F2	Ferry 2
UA	Unknown Aircraft
UB	Unknown Boats
US	Unknown Ships

Cockpit Gripen

Conclusions

- To begin: The workload in modern fighter is high
- The workload to control Loyal Wingman (especially when things starts to go wrong) was unaccaptable high
- We need new ways to communicate with uncrewed aircraft
  - Voice, touch displays
- A high level of autonomy of the uncrewed aircraft is essential
- The overall concept requires a thorough planning process
- Who is Pilot-In-Command of the Loyal Wingman?