Research and Education in Aircraft Design

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A New Approach to the Unresolved European Air Force Training Problem:

High Energy at Lowest Cost

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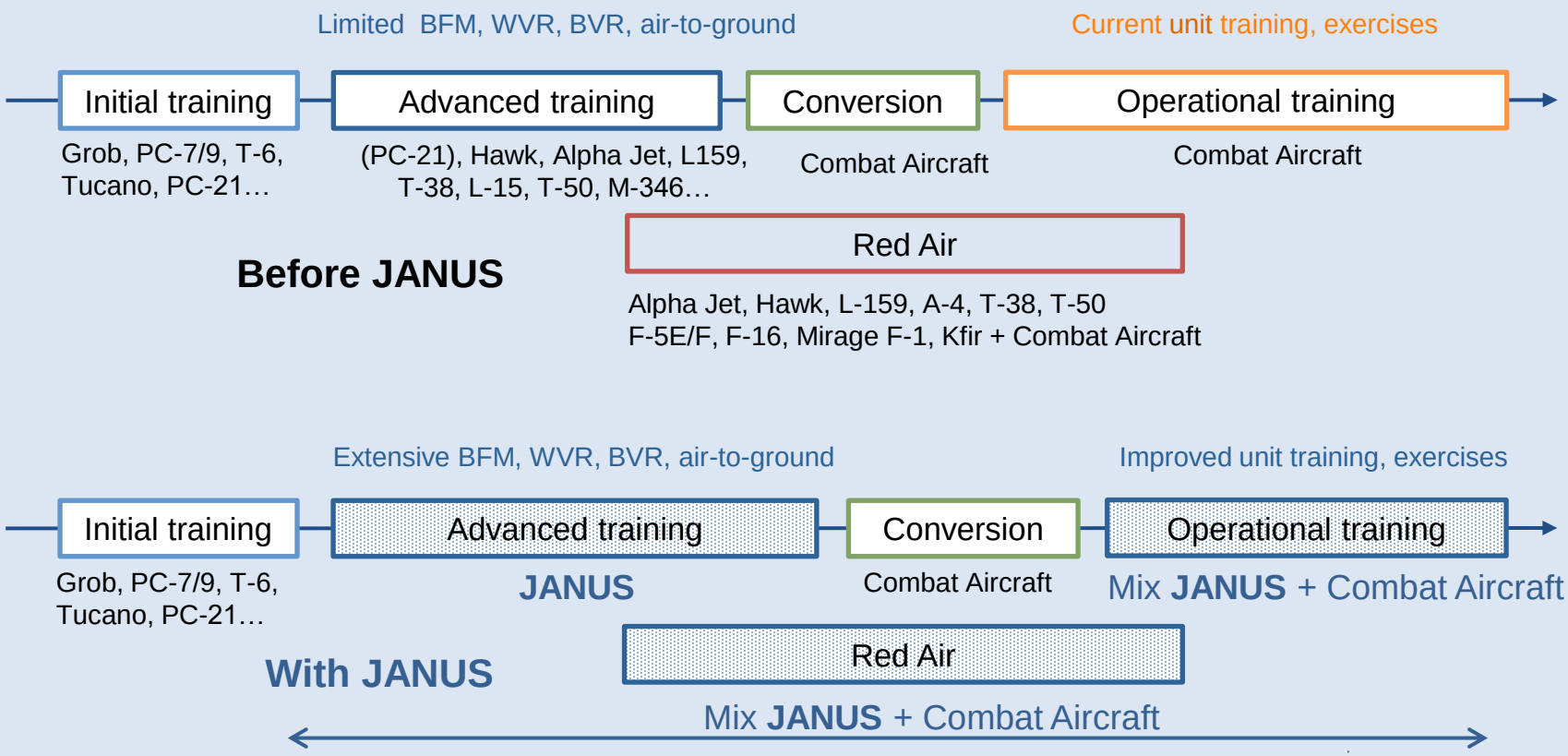
‚Janus' is from Roman mythology and describes the duality in all kinds of expressions. In our case consisting of two elements: „ body and mind", or „air vehicle and avionics"

Advanced Training & RedAir: Solution Still Missing

- **Main Training problem** for the next generation combat aircraft (FCAS):
  - Advanced Training (AT): based on legacy or new, expensive aircraft
  - ADAIR/„Red Air“ (Aggressor Squadrons): based on outdated aircraft or front-line fighters: not adequate or much too expensive (LCC)
- Urgent: move to a **new Concept of Aircraft & System Combination:**
  - **High energy** is an essential capability
  - AT and ADAIR/„Red Air“: **one system based on common requirements**
  - **Delete unnecessary requirements**: no lightweight fighter compromise and on-board weapons system replaced by **data-link avionics emulation**
  - Consistent with future air combat training system concepts such as “Live Virtual Constructive (**LVC**)” and “Distributed Mission Operation Centre (**DMOC**)”
  - **Advanced Technologies** in the AT air vehicle :
    - Composite airframe 50%+, low weight & integrated manufacturing
    - Advanced data links: real-time operations, on-line software maintenance
    - Virtual / augmented reality restitution system
    - All mission avionics to ground and to on-board embedded simulation capabilities
    - Artificial intelligence for simulated targets

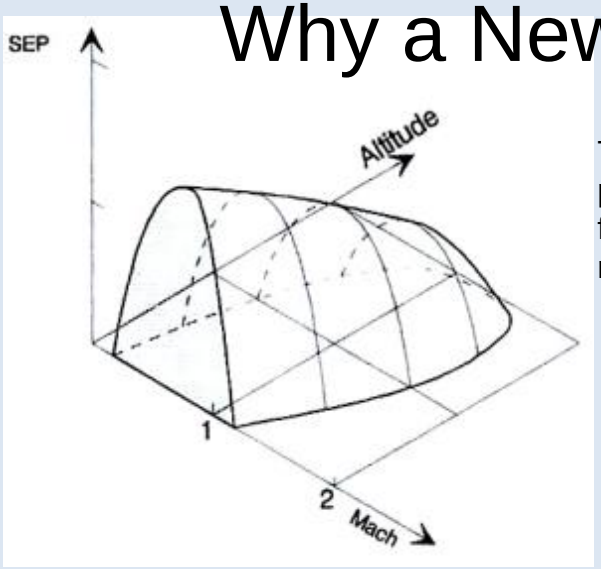
Broad Training Range based on Janus Concept



BFM: Basic Fighter Manœuvre
WVR: Within Visual Range
BVR: Beyond Visual Range

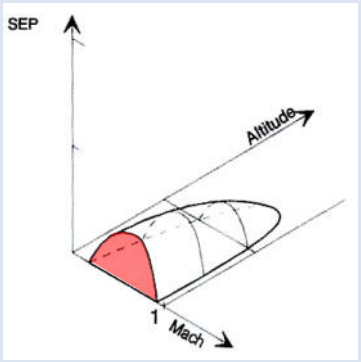
Operations with Janus

Why a New Supersonic Light Trainer? (I)

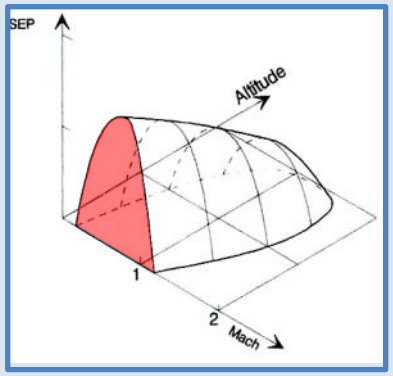


The volume inside the envelope shows the available Specific Excess Power SEP potential depending of Mach number and Altitude: SEP is directly representative for climb rate and acceleration or a combination of both. The surface of the volume represents steady-state conditions i.e. at 1 g (no turns).

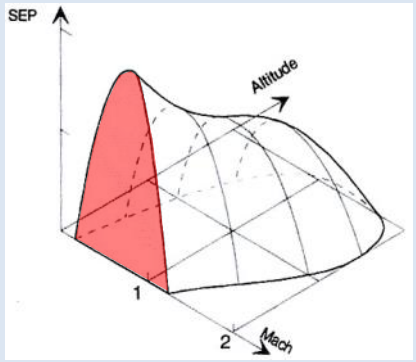
- **Supersonic trainer and fighter: high energy potentials (SEP) required in air combat manoeuvres**
- **Subsonic trainer does not match these capabilities & does not fulfil advanced trainer requirements**



Subsonic Trainer
(engine without reheat subsonic configuration)



Supersonic Trainer „light“
(engine with reheat, supersonic configuration)

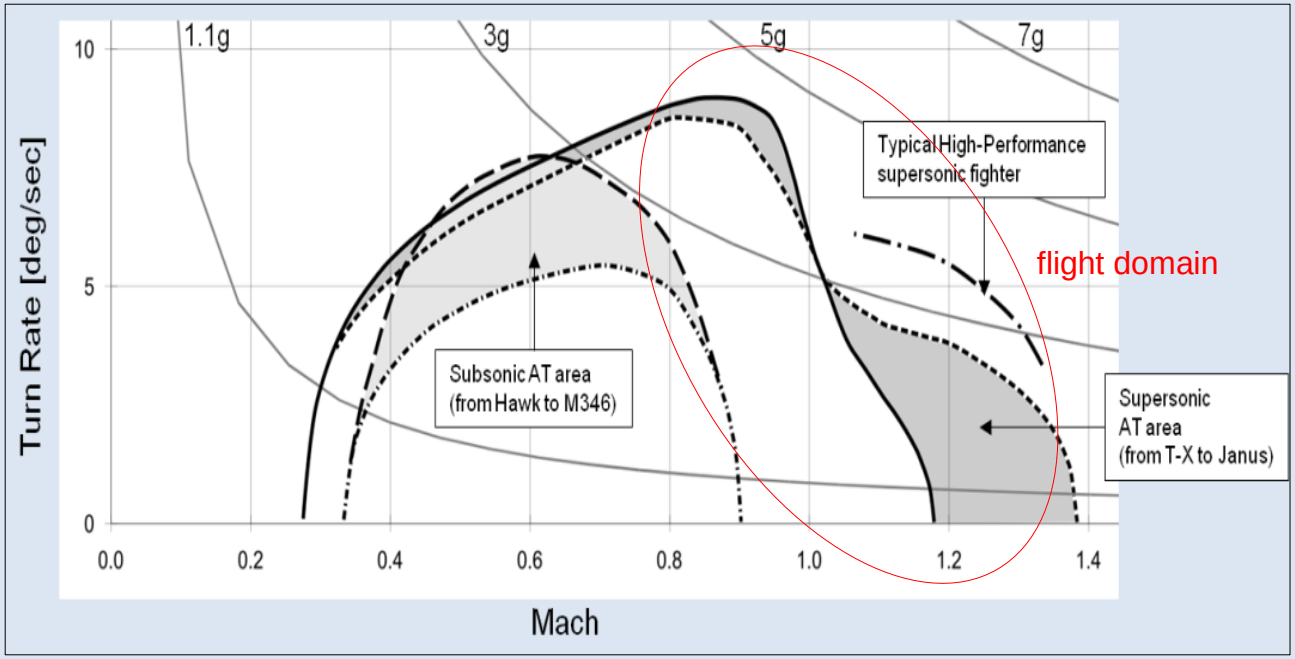


Supersonic Fighter
(engine with reheat, supersonic configuration, F-16 type)

Why a New Supersonic Light Trainer? (II)

Janus ——— > wing area, < W/L
Subsonic – – – – > thrust, > T/W
Janus ····· < wing area, > W/L
Subsonic –·–·– < thrust, < T/W

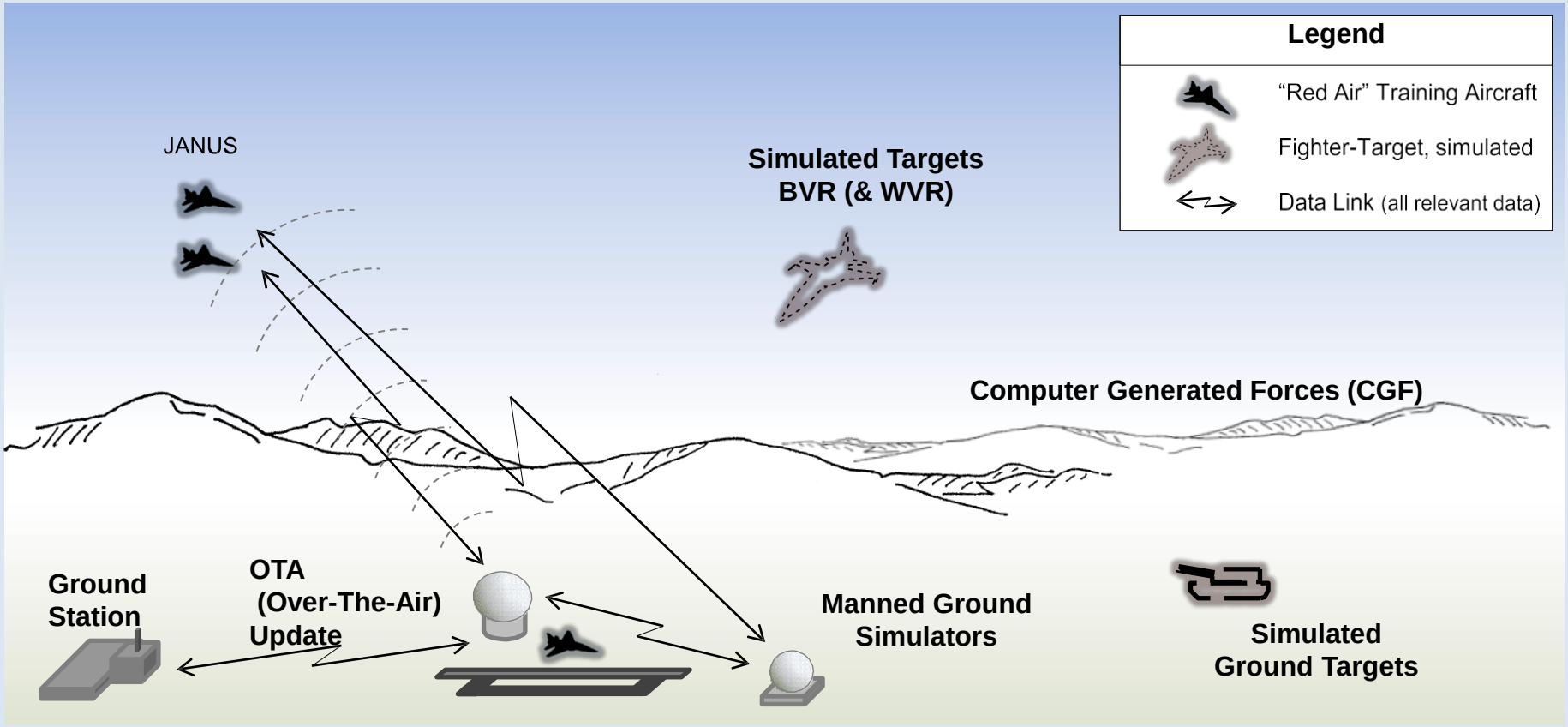
at 30 kft, 50% internal fuel



- **High sustained Turn-Rates between Mach 0.9 and 1.3: a flight domain not accessible to subsonic trainers**
- **Initial BVR at higher Mach degenerates rapidly to low supersonic & transonic manoeuvres: superior perfomance required**
- **Mach 0.9 to 1.3: the essential domain for BFM**
- **Phase 3-4 Advanced Training as well as „Red-Air“ (USAF Categories A-C)**

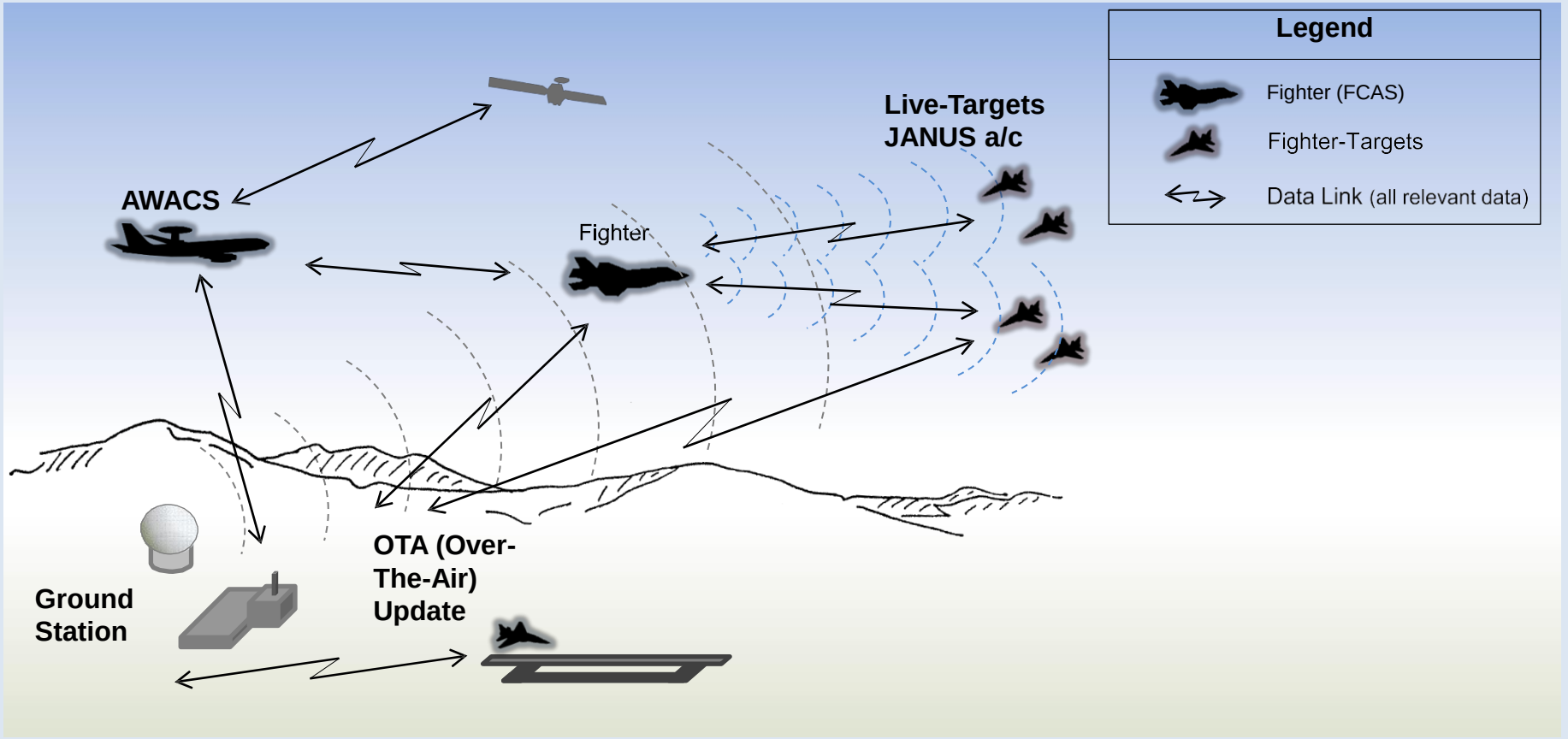
Air Combat & Ground Attack Training

- JANUS aircraft vs. simulated targets
- Target simulation embedded or via datalink
- Manned Ground Simulators option



ADAIR/“Red Air” Operational Fighter Training

- Multiple JANUS aircraft in the air (against 5th gen., e.g. FCAS, F-35)
- 5th generation fighters need multiple real targets (cost!)



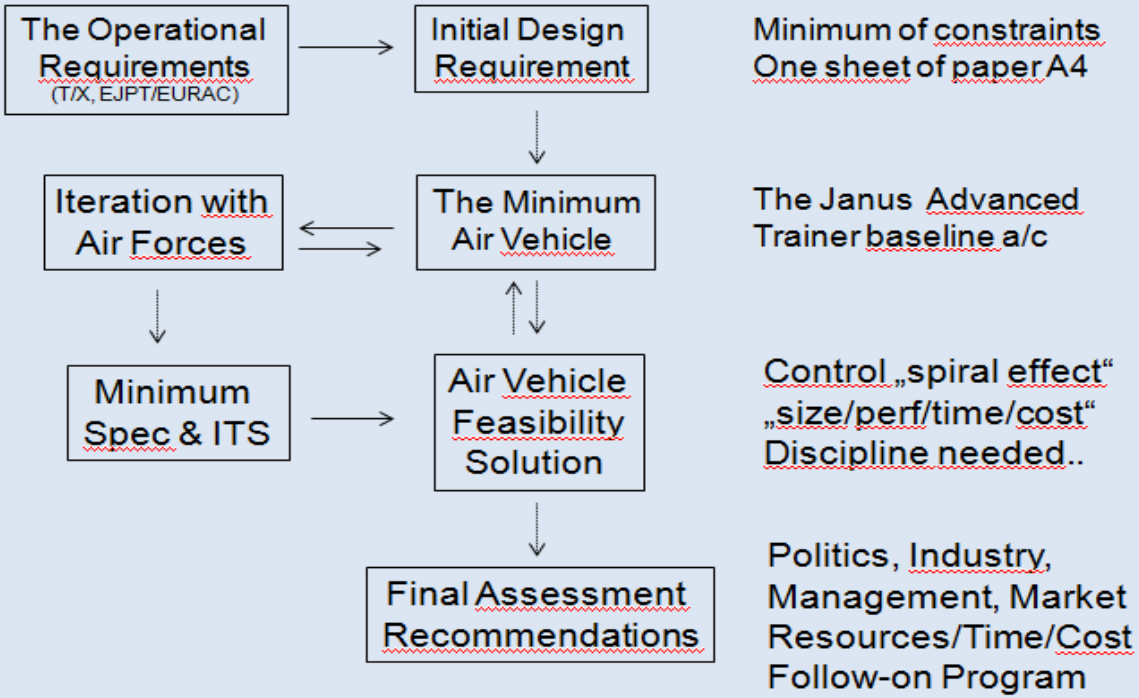
Essentials in Advanced Training and Red-Air

- Two fundamental areas for ITS:
  - **High-energy** aircraft **manoeuver performance** (real, p.5&6)
  - High capabilites in **sensors & system simulations** (virtual)
  - Lower environmental impact
- Required manoeuvre performance:
  - BFM Phase 3-4* Advanced Training with dedicated performance close to operational fighters
  - Advanced Training as well as in Red-Air (USAF CAF-ADAIR**)
- Required simulation (sensor and simulation)
  - Hardware replaced by simulated equipment (on-board and via datalink, LVC).
  - Agile, open Integrated Training System (ITS)
  - Connected to DMOC

* Contains BFM, Basic Fighter Manoeuvres
** US Air Force Combat Air Force Adversary Air

The Janus Consortium Proposing a Feasibility Study
(NOT the Industrial Consortium for FSD)

AT/Red-Air Feasibility Assessment Process EFD



- Start with the Minimum Air Vehicle
- Iterate with European A/F needs and requirements
- lowest-cost / high energy solution & lowest environmental impact (fuel, noise)

Industrial Considerations

- The smaller European industries: have full Feasibility Study capability as well as know how in training a/c (POL, CZ, RO, Swiss).
- Participation of main industries in the Feasibility Study t.b.d.
- The Feasibility Study: must address also innovative organisations and management procedures.
- LCC Life-Cycle-Cost reduction potential: 30-50% (depending requirements)
- Step-by-step: with main system industries: Demonstrator development (TRL 6+), rapid transition to FSD, gradual build-up of ITS (on the ground)

Environmental Impact

- Lower fuel consumption, 50% compared to new AT: environmental benefit
- Engine with 50% lower (reheat) thrust: less noise compared to new AT (lowest for high energy a/c)

Janus Baseline, T-X/T-7, legacy T-38, AFJT

- T/W: Thrust-to-Weight ratio (at T/O-weight, and thrust)
- W/L: T/O Weight/Wing area (Wing Loading)

* Janus baseline design

	Units	Janus	T-7/ Red Hawk	T-38	AFJT
Length	m	11.0	14.15	14.1	14.0
Span	m	8.0	10.0	7.7	10.0
Wing Area (ref)	m^2	18.08*	24.0 (est)	15.8	20.0 (est)
T/O Weight (normal)	kg	4800*-5200	7000 (est)	5451	7000 (est)
Thrust Reheat	kN	42*- 48	78.7	38.5	75-89
W/L(1)	kg/m^2	265*- 287	291	340	357
T/W(1)	kN/kg	0.88* - 1.0	1.15	0.71	1.09-1.28
Structure	-	50% Composite	Metal only	Metal only	Metal only
Propulsion origins	-	1995* or 2025	1980	1960	1990
Weapon Potential	kg	0	3000	0	3000

Conclusions: Future Advanced Training & “Red-Air”

- Neither todays Advanced Trainers nor the (known) future AT (with Integrated Training Systems ITS) offer solutions
- European solutions & proposals:
  - not high energy
  - unnecessary LCA capacities
  - individual national solutions, no European integration
- US T-X Program Boeing T-7 (supersonic T-38 successor) and T-50:
  - meet high energy requirements
  - size offers unnecessary LCA potential, expensive
  - dependence from US, not meeting European requirement (F-35)

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The Situation Update 201206 (1): Future Advanced Training & “Red-Air”

- Needs regarding H.E. flying element:

  - still required (50% AT, 50% simulator) or in full expansion (Red-Air)
  - between Basic-Trainer (e.g. PC-21, M-345) and Fighter

  Needs regarding ITS: based on LVC combined with simulators and DMOC

- AT&Red-Air todays solutions:

  - USA (T-7) and Asia (T-50): High Energy HE at high cost
  - Europe/RoW: M-346, L-39 and legacy : Low Energy at medium-low cost
    AFJT Spain HE: identical to T-7, 10 years later, very high cost, no market
  - All have LCA potential but for export reasons only (there is no European Operational Requirement)

The Situation Update 201206 (2): Future Advanced Training & “Red-Air”

- Future of AT&Red-Air:
  - USAF “Reforge”, complete rebuild from scratch Ref.
  - Europe: split between H.E./L.E. solutions, no integrated concept, no European initiative yet visible, funding limitation

The Window-of-Opportunity today:

- Janus potential: LCC reduction between 30 to 50% (compared to T-7)
- Reduction of enivronmental impact (fuel 50% & noise)
- New ITS must start now, in parallel to new combat a/c (FCAS)
- If not, European A/F will procure US T-7, similar to F-35 with strong dependencies, economic loss

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Appendix: JANUS Concept Requirements

Advanced Training (airborne element)

- High energy and reheat fuel management
- Fighter-like maneuverability, Trade-off between T/R & SEP/Mach: the Operators choice. Agility
- Supersonic speed is fall-out from high SEP
- Multiple mission sequences and swing role
- Embedded and ground-based simulation & broad use of datalink

ADAIR/„Red Air“ Support Missions

- „Red-Air“ missions in ADAIR Aggressor Squadrons
- Virtual weapons, sensor and systems via latest data transfer technology
- DMOC & Virtual Reality
- Unarmed Air Policing, „cooperative“ targets“

Technical Specifications, Requirements

- Max. sustained g-load of 6.5 g at 10 kft, 80% internal fuel (US T-X req.)
- Ferry mission requirement of 2000km (AEJPT/EURAC)
- Supersonic speed M 1.3+ at altitude (Advanced Training & „Red-Air“)
- Minimum on-board avionics, simulation off-board + datalink
- Requirements and performance: trade-off : between SEP and turn-rates (T/R), depending of wing-loading and thrust-to-weight ratio

Air Combat & Ground Attack Training (1)

- Energy & Maneuverability close to operational fighters
- Real JANUS aircraft to represent operational fighters and opponents