EUROCONTROL
AVAL Project

AVAL Phase 1 findings

(presented by Thierry Arino)

Presentation content

- **Introduction**
- **Safety benefits of ACAS**
- **VLJs and LJs below 5,700 kg: what are they?**
- **What are the safety implications?**
  - ✓ **If VLJs & LJs are not equipped with ACAS**
  - ✓ **If VLJs & LJs are equipped with ACAS**
- **Conclusion & Recommendations**

Introduction (1/2)

- **ACAS II (TCAS II) reduces risk of mid-air collisions**
- **Mandated in 2 phases**
  - ✓ **1st January 2000: MTOM > 15,000 kg or more than 30 passengers**
  - ✓ **1st January 2005: MTOM > 5,700 kg or more than 19 passengers**
- **Would there be safety benefits from extending use of ACAS to lighter jets?**
  - ✓ **VLJs & LJs with MTOM < 5,700 kg**

Introduction (2/2)

AVAL Project

- ✓ **Assess the impact of VLJ and LJ operations on the safety benefits delivered by ACAS in the European environment**
- ✓ **Divided in two phases**

Phase 1

- ✓ **Determine if there is a need for further investigation**

Phase 2

- ✓ **Full safety study**
- ✓ **Determine the best approach for ACAS equipage on VLJs and LJs**
- ✓ **Phase 2 to be completed in 2009**

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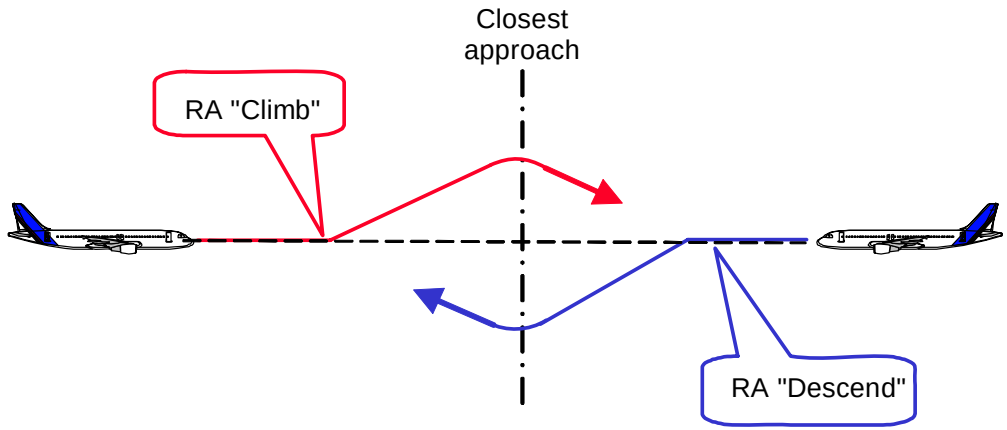
ACAS

- **Last resort safety net independent from the means of separation provision**
- **Interrogates adjacent SSR transponders**
- **Provides two levels of alert: TA & RA to prevent risk of imminent mid-air collision**
- **ICAO PANS-OPS**
  - ✓ **“Pilots shall respond immediately by following the RAs”**



Safety performance measurement

- **No specific requirements on ACAS to achieve a Target Level of Safety**
- **Safety benefits of ACAS quantified through a safety metric**

$$\text{risk ratio} = \frac{\text{risk of collision with ACAS}}{\text{risk of collision without ACAS}}$$

- **For typical IFR operations as observed in the European airspace, risk ratio = 22%**
  - ✓ **Indicates a reduction in the risk of collision by a factor of 5**

Factors influencing the safety benefits of ACAS

- **Characteristics of the airspace**
  - ✓ **Any change in ATM operations and airspace design has an effect on the ACAS performance**
- **Level of ACAS equipage and operating mode**
  - ✓ **Unequipped < TA mode < RA mode**
- **Pilot behaviour**
  - ✓ **RAs must be followed promptly for maximum benefits**
- **Possible interaction between ACAS and other lines of defence against the risk of mid-air collision**
  - ✓ **Pilot must report RAs to ATC as soon as possible**

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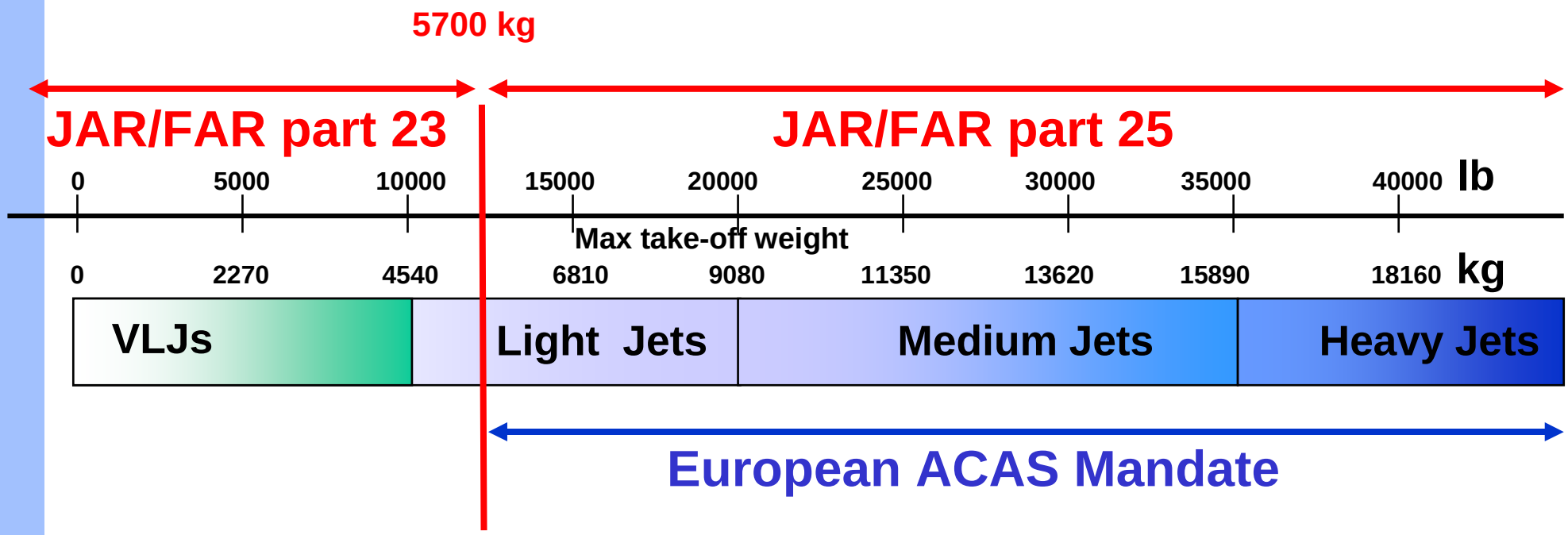
Definition of VLJs & LJs (1/2)

- **No internationally agreed definition of a VLJ category**
- **Definition used in the AVAL study**
  - ✓ **VLJs = turbofan-powered aircraft with MTOM < 4,540 kg (10,000 lbs) certified for single pilot operation**
  - ✓ **LJs = MTOM between 4,540 kg (10,000 lbs) and 9,080 kg (20,000 lbs)**

    Small LJs = LJs with MTOM < 5,700kg

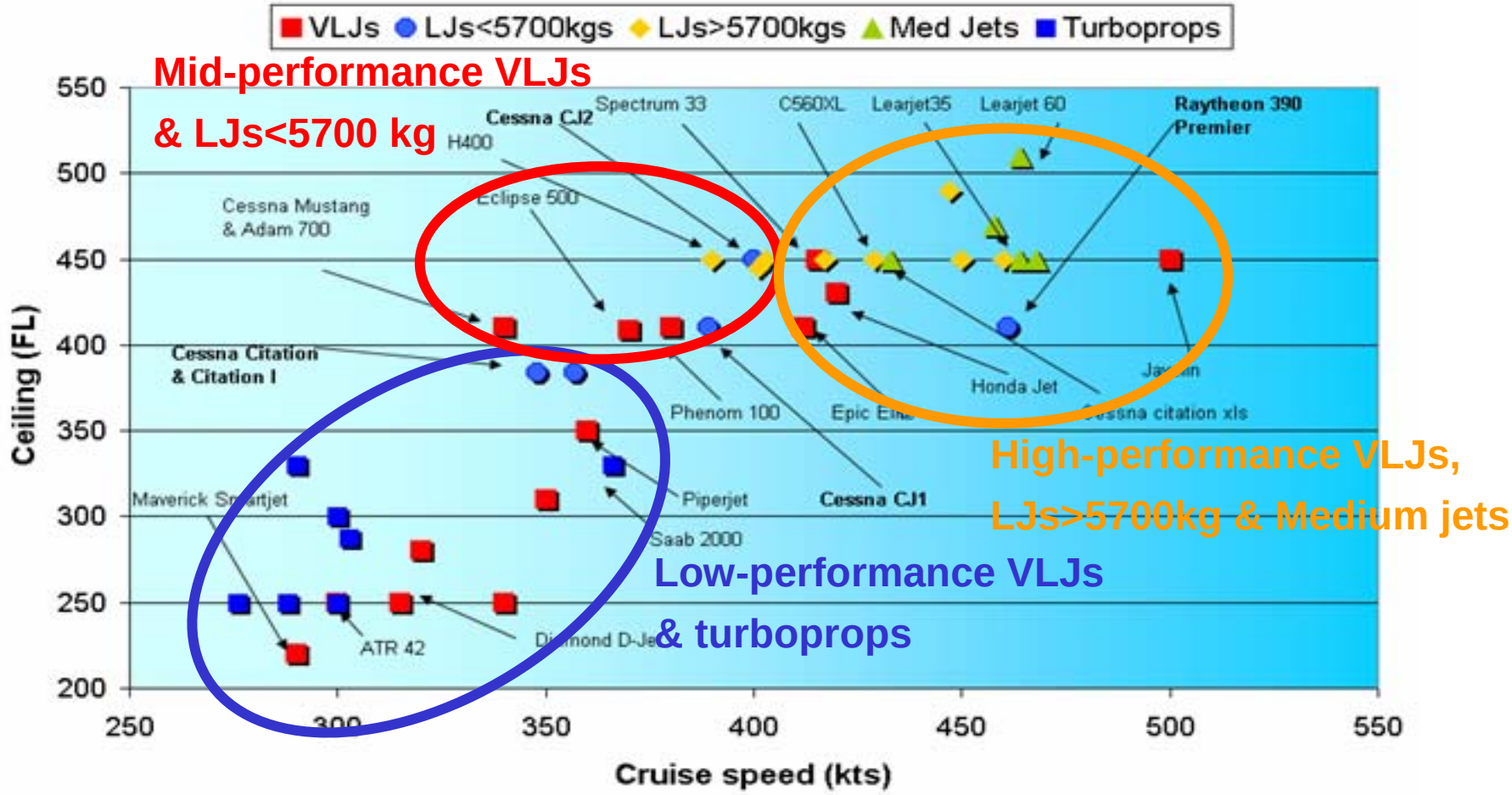
Definition of VLJs & LJs (2/2)



European sales and growth

- **European VLJs = 12 to 15% of the VLJ world fleet**
- **25 to 33% of current business fleet replaced by VLJs over the next decade**
- **Between 2007 and 2016, sales of VLJs and LJs should be similar**
- **~200 VLJs and LJs to be sold per year in the next decade**
- **110,000 to 170,000 additional flights each year until 2015**

Ceiling versus cruise speed



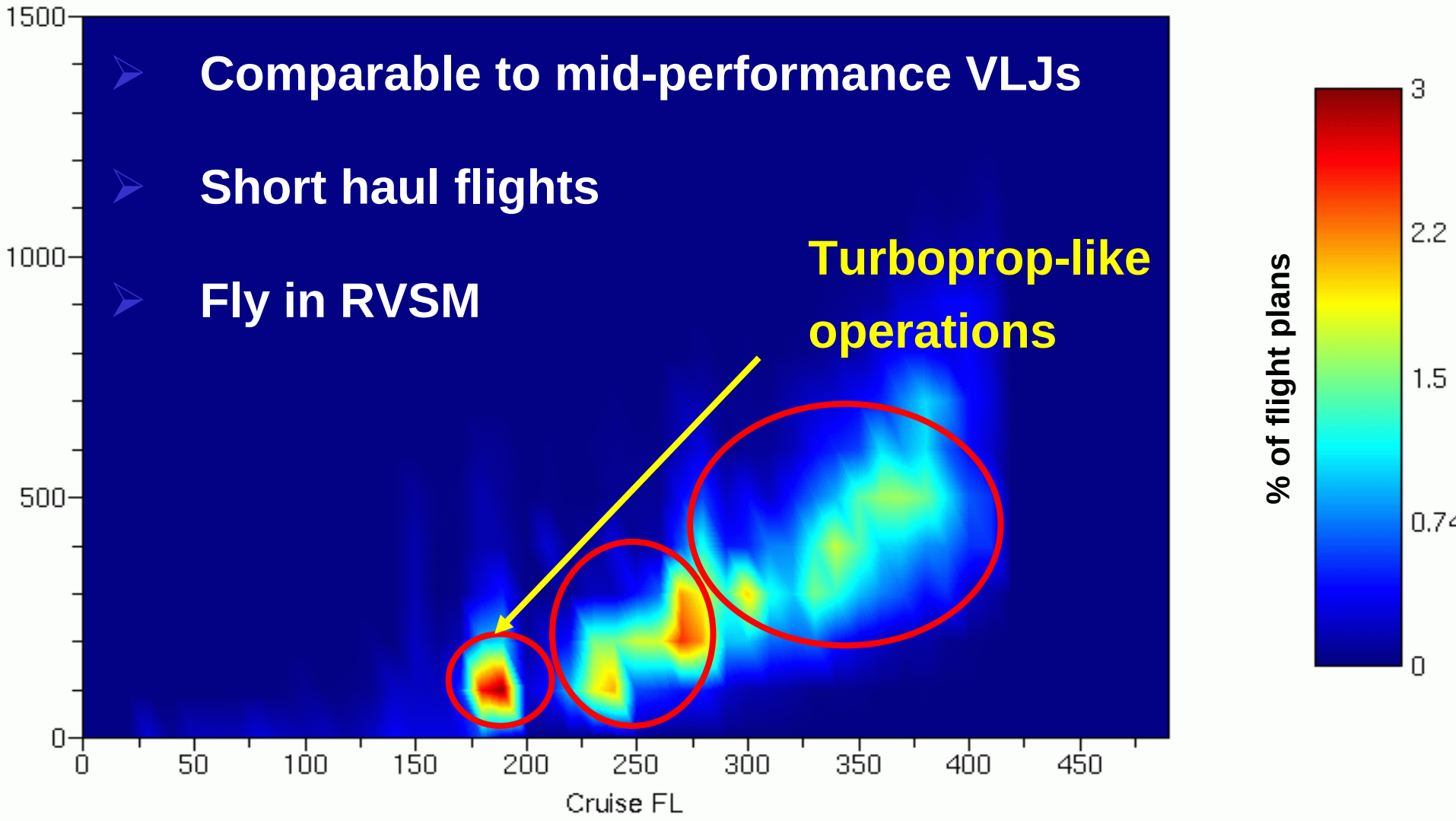
VLJ Performance

3 categories of VLJs

- ✓ **Low-performance VLJs**
  - **Similar to turboprops**
- ✓ **Mid-performance VLJs**
  - **Most common**
  - **Similar to small LJs**
- ✓ **High-performance VLJs**
  - **Similar to medium jets and LJs with MTOM > 5,700kg**

Mid-performance VLJs will fly in RVSM with lower performance than other RVSM aircraft

Distances and cruise FLs of small LJs



Small LJ operations

- **Fly routes on demand**
- **Fly to secondary airports**
- **Many of these airports share TMAs with major airports**

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Safety implications

Perspective for aircraft already equipped

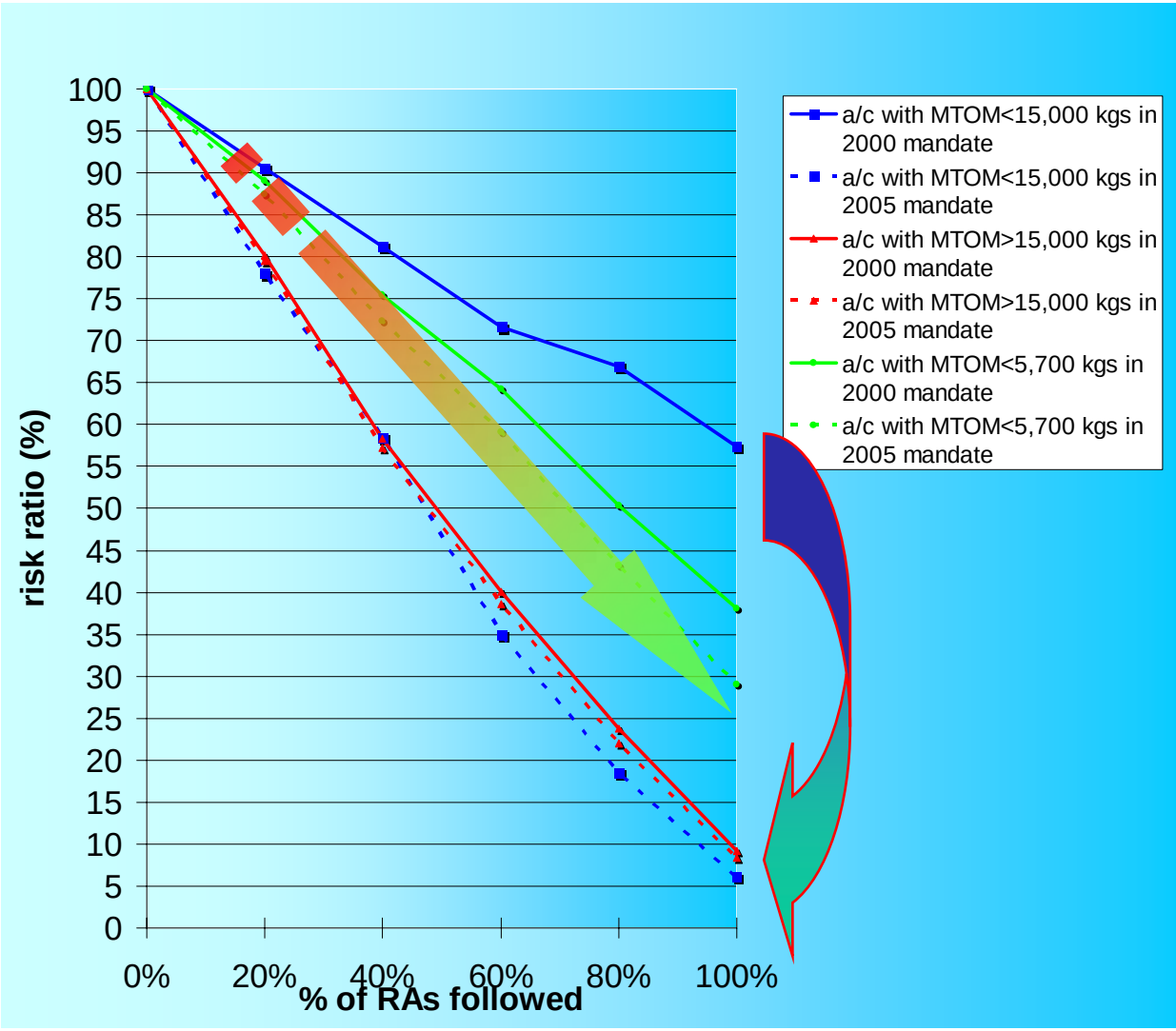
- ACAS provides safety benefits to the equipped aircraft and to the whole airspace
- ACAS works better when both aircraft are equipped
- Reduction of the safety benefits delivered by ACAS

Perspective for VLJs and LJs

- No benefit from own ACAS
- If separation provision fails, only “see and avoid” remains
  - Inadequacy of “see and avoid” for jet aircraft

An example: ACAS mandate Phase II

- **Aircraft with MTOM between 5,700kg & 15,000kg**
  - ✓ **~10% of the fleet**
- **Fleet perspective**
  - ✓ **Huge benefits for small aircraft**
- **RA response rate**
  - ✓ **Significant factor**



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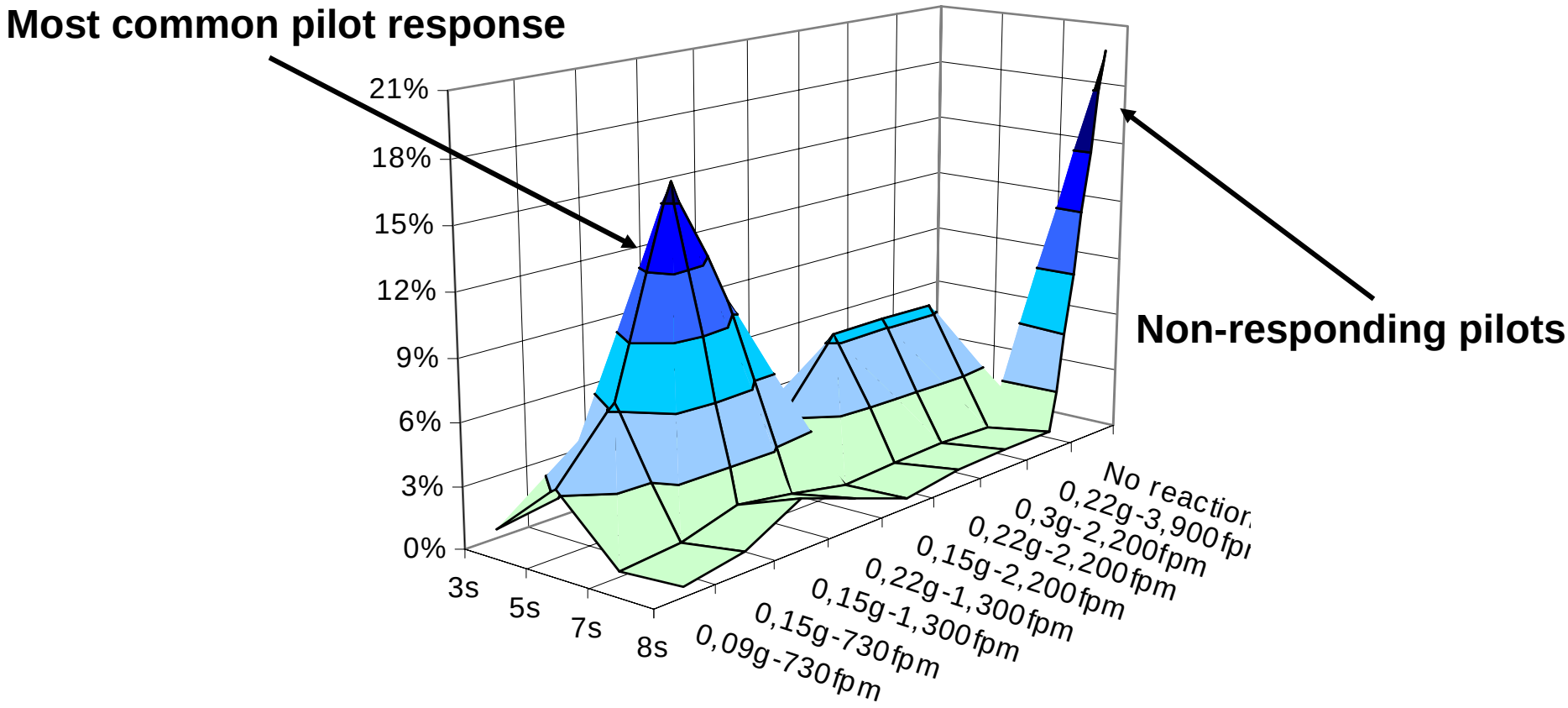
Benefits & risks

- **Risk reduction afforded by the carriage and operation of ACAS demonstrated by safety studies and observed operationally**
  - ✓ **Extent of benefit to be quantified taking into account key influencing factors**
- **Pilot response to RAs is critical**
  - ✓ **Maximum safety benefits obtained when all pilots respond to RAs**
  - ✓ **Poor pilot responses degrades ACAS safety benefits**

Pilot response to RAs (1/2)

- **Non responding, slow and aggressive pilots observed in mid-90s**
- **Current pilot response = Continuum around standard response**



Pilot response to RAs (2/2)

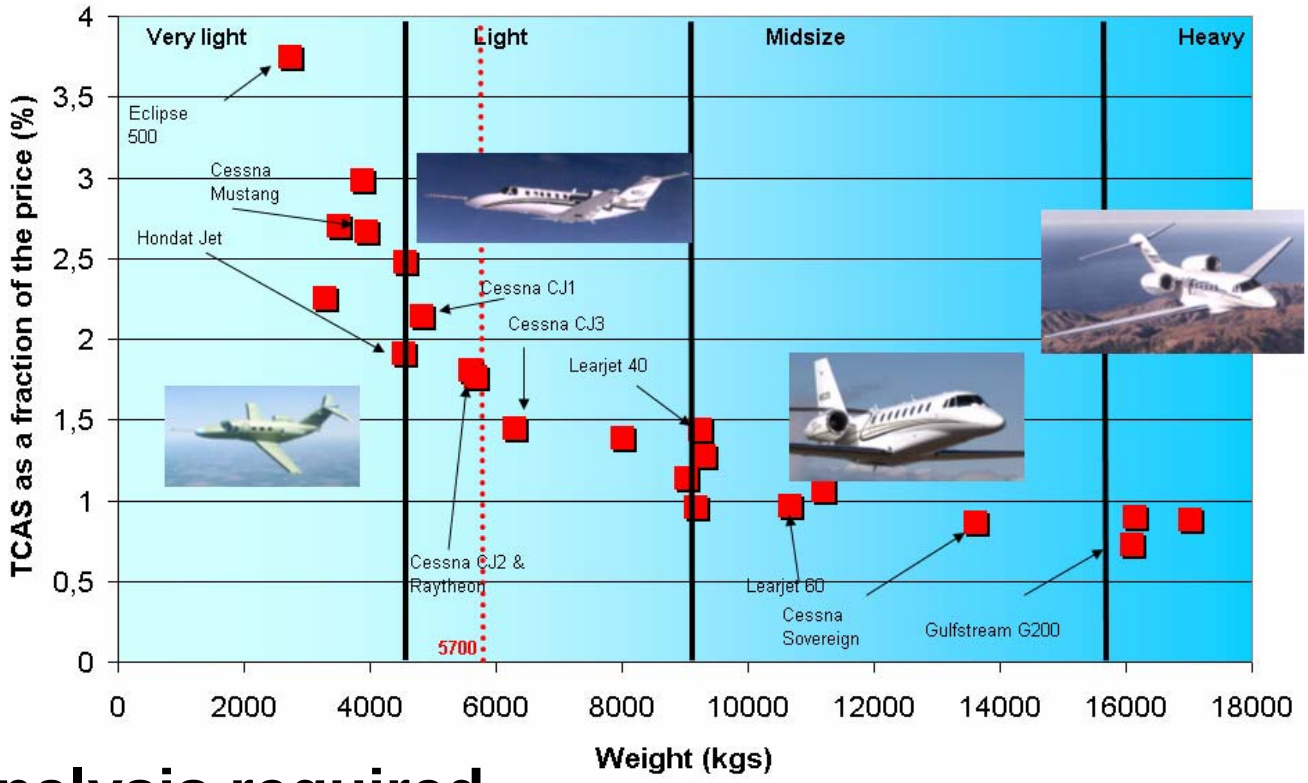
Single Pilot Operation for VLJs and small LJs

- ✓ Higher non-response rate?
- ✓ Increased risk of opposite response?
- ✓ Increased probability of “last moment” response?
- ✓ Increased likelihood that the pilot will report the RA late to ATC?

New population of pilots operating ACAS

- ✓ Professional with ACAS experience
  - Would behave as other airline pilots?
- ✓ Professional without ACAS experience
  - Would behave as other airline pilots at the time of ACAS introduction (slow or aggressive response)?
- ✓ Non-professional
  - Increased rate of non-response and non-standard manoeuvres?

Cost & technical aspects



- **Cost Benefit Analysis required**
- **Technical considerations**
  - ✓ **Fitting antennas on small aircraft**
  - ✓ **Interference issues**
  - ✓ **Avionics architecture**

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Conclusion

- **There is evidence that the new VLJs and small LJs will have an effect on the overall performance of ACAS as a safety net**
- **If not equipped with ACAS, they will not benefit from the safety provided by this system**
  - ✓ **May also influence the safety of aircraft equipped with ACAS**
- **Safety benefits derived from an extended ACAS mandate need to be quantified**
  - ✓ **Pilot response to RAs will be an important consideration**
  - ✓ **Pilots need to be trained carefully in the operation of ACAS**

Recommendations

- **Quantify implications of VLJ introduction in the European airspace on the performance of ACAS**
  - ✓ **For VLJs and small LJs**
  - ✓ **Other aircraft already equipped with ACAS**
- **Investigate the use of speed along with MTOM as a determinant for requiring ACAS carriage**
- **Proceed with Phase 2**

Proposed Phase 2 work

- **In-depth investigation using the established encounter model approach**
- **Adapt model to reflect operation of VLJs and small LJs in the European ATM system**
- **Define a set of operationally realistic scenarios**
  - ✓ **Possible scenario target date = 2015**
- **Sensitivity study on influential factors**
  - ✓ **Pilot reaction to RAs**
  - ✓ **TCAS equipage**
- **Provide elements for future ACAS policy decisions regarding VLJs and small LJs**