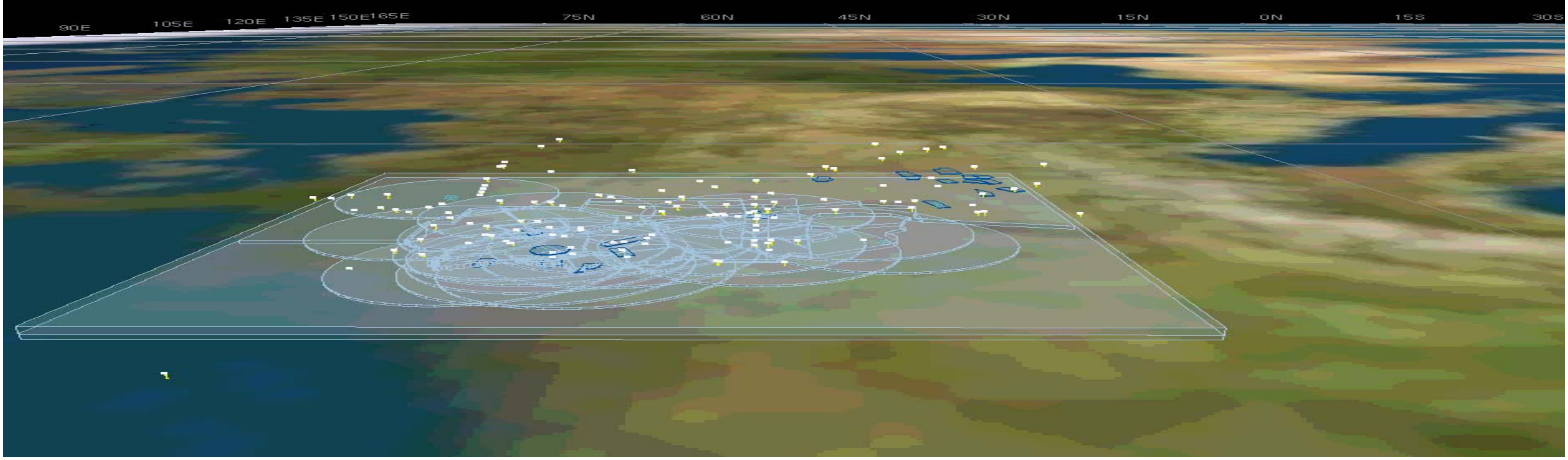
PBN AIRSPACE DESIGN

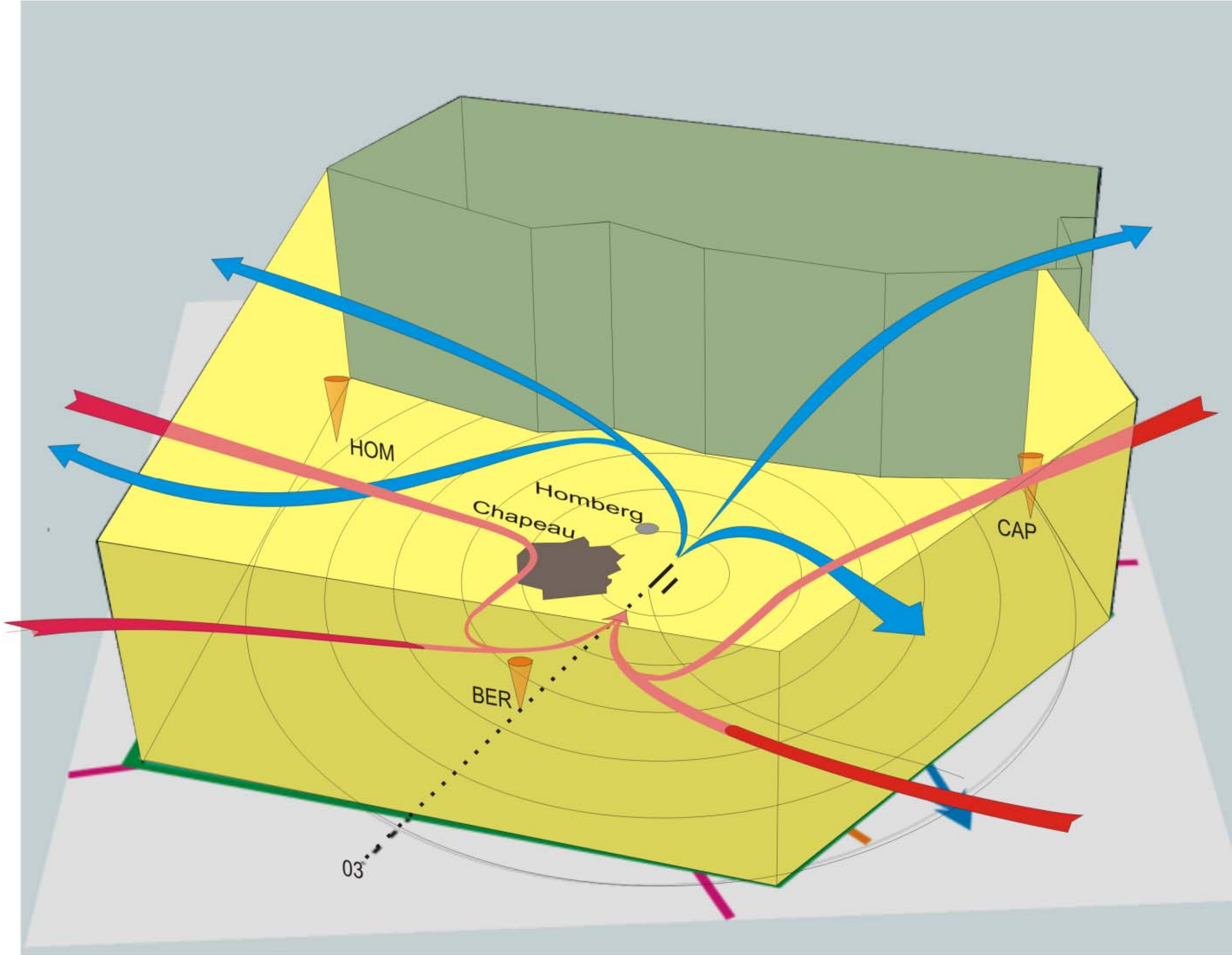
Victor Hernandez

RO ATM/SAR

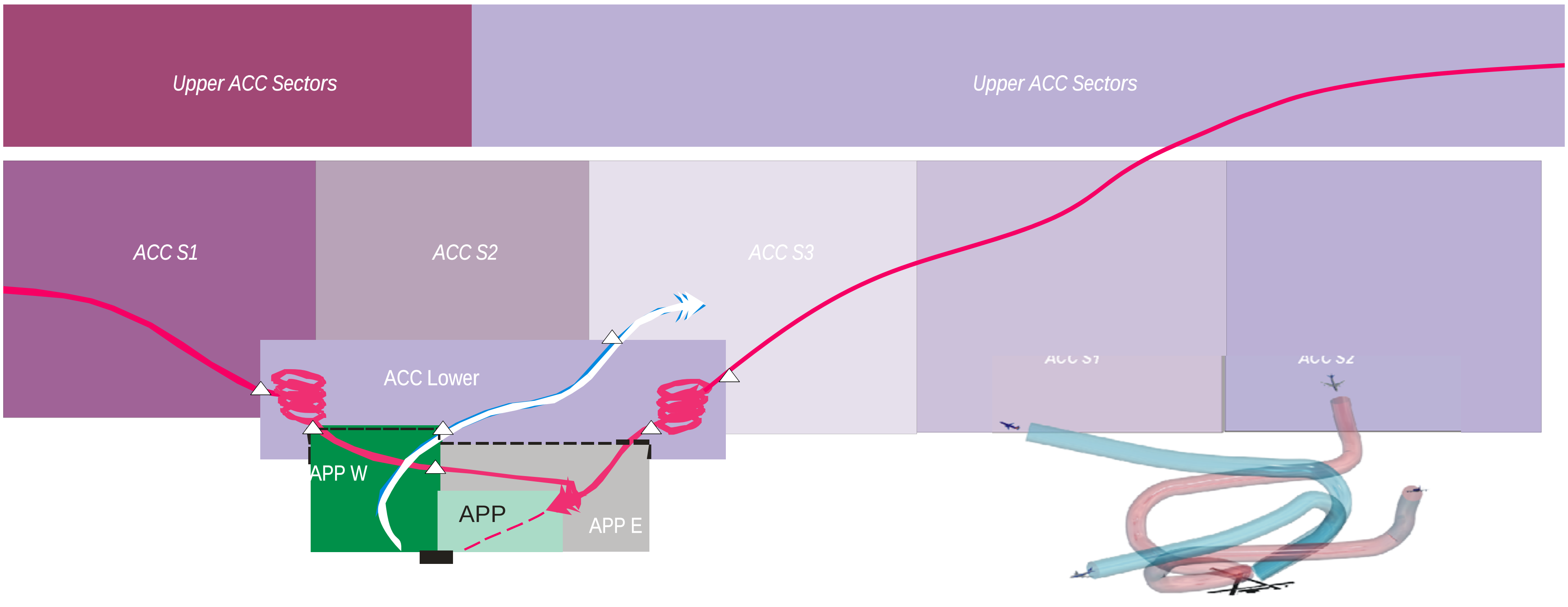
International Civil Aviation Organization



PBN Airspace Redesign



ATC Sectorization



GEOGRAFICA

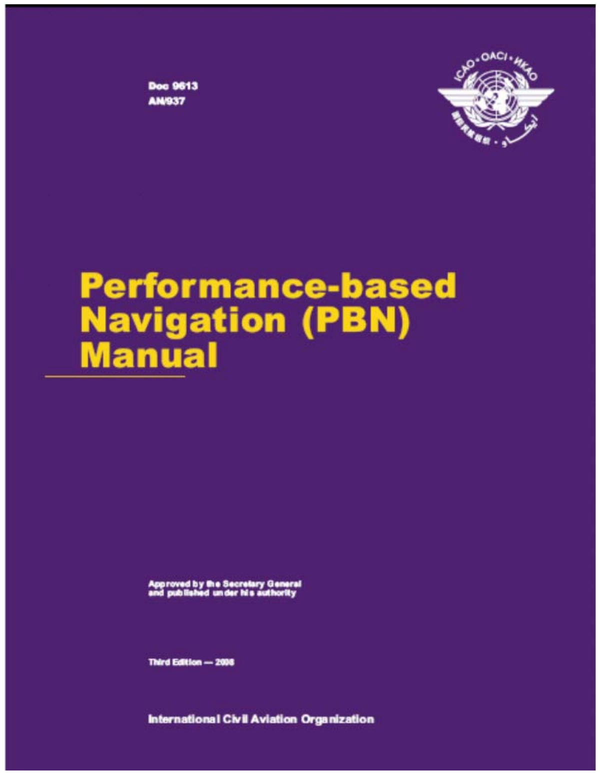
FUNCIONAL

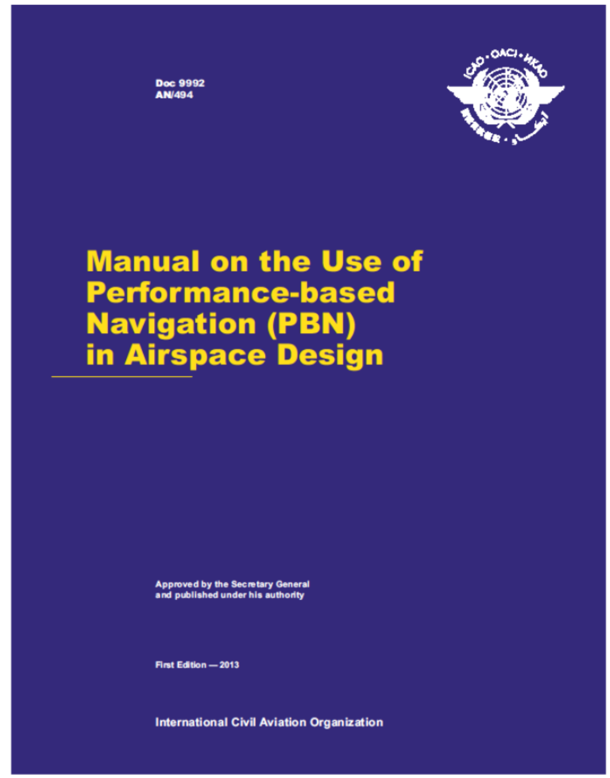
PBN Airspace Design

Doc 9613 Manual PBN

Volumen I
Parte A - Airspace Concept
Parte B – Implementation Procceses

Volumen II – Navigation Specifications





Doc 9902, PBN in Airspace Design

PBN Airspace Design

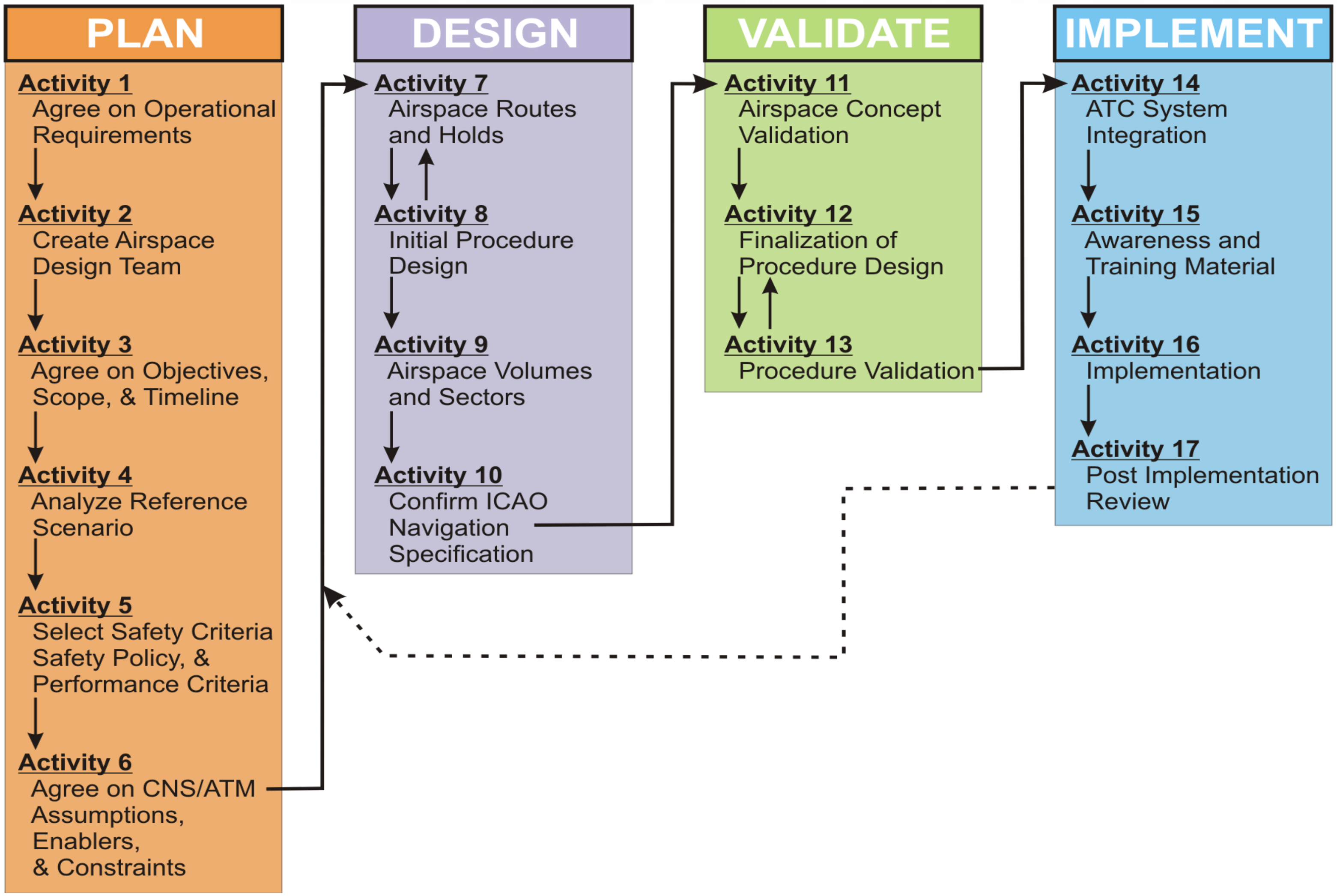
PLAN

DESIGN

VALIDATE

IMPLEMENT

PBN Airspace Design



Activity 1

Agree on Operational Objectives

- Capacity
- Environment
- Accessibility
- Safety
- Efficiency

Activity 2

Airspace Design Multidisciplinary Team

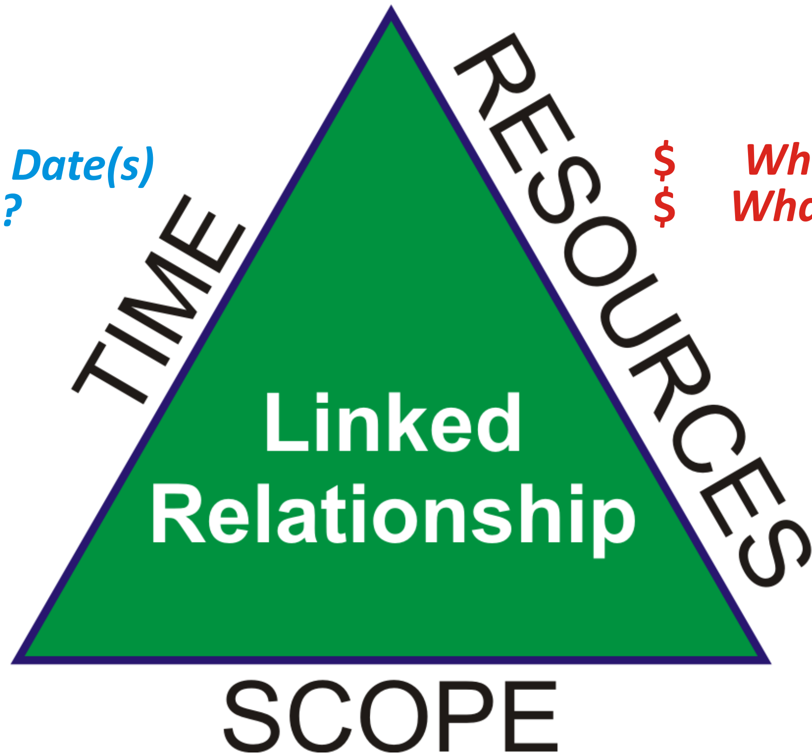
- Lead by ATM / airspace specialist
- ATCOs (Air Traffic controllers)
- ATM & CNS specialist
- Procedure designers
- Technical pilots
- ……

Activity 3

3 – Project objectives, scope and timescales

- $ *Implementation Date(s)*
- $ *Phases of Work?*

- $ *Which Human Resources?*
- $ *What about the budget?*



- *What is the Objective ?*
- *How much can be done?*
- *What cannot be done?*

PLANNING EXAMPLE

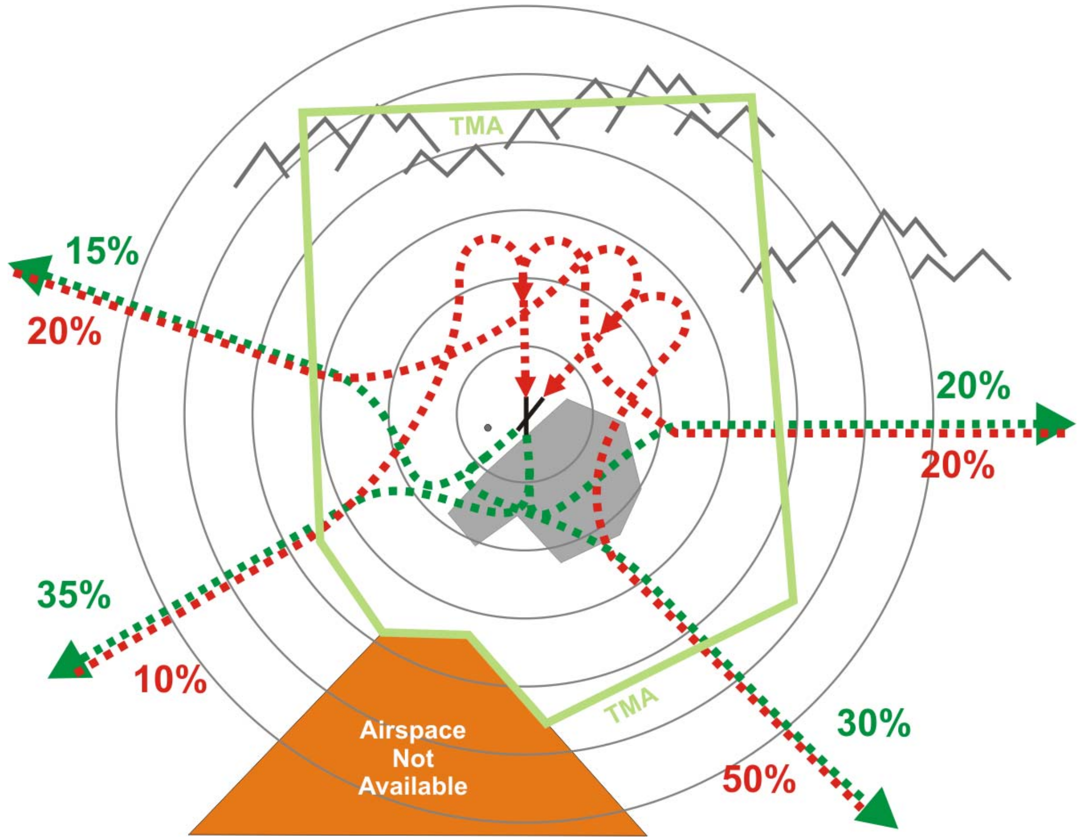
EXAMPLE PROJECT PLAN

Phase	#	ACTIVITY	Number of Days
PLAN	1	Agree on Operational Requirements	10
	2	Create Airspace Design Team	5
	3	Agree on Objectives, Scope & Timeline	15
	4	Analyze Reference Scenario	15
	5	Select Safety Criteria, Safety Policy, & Performance Criteria	10
	6	Agree on CBS/ATM Assumptions	12
DESIGN	7	Design Airspace Routes and Holds	14
	8	Initial Procedure Design	20
	9	Design Airspace Volumes and Sectors	20
	10	Confirm ICAO Navigation Specification	5
VALIDATE	11	Airspace Concept Validation	20
	12	Finalize Procedure Design	22
	13	Procedure Validation	20
IMPLEMENT	14	ATC System Integration	30
	15	Awareness and Training Material	30
	16	Implementation	1
	17	Post Implementation Review	30
		TOTAL DAYS REQUIRED	279

Activity 4

Analysis of the reference scenario

- Assessment of present operations
- Identification of positive and negative
- Benchmark
- Avoids repeats of design flaws



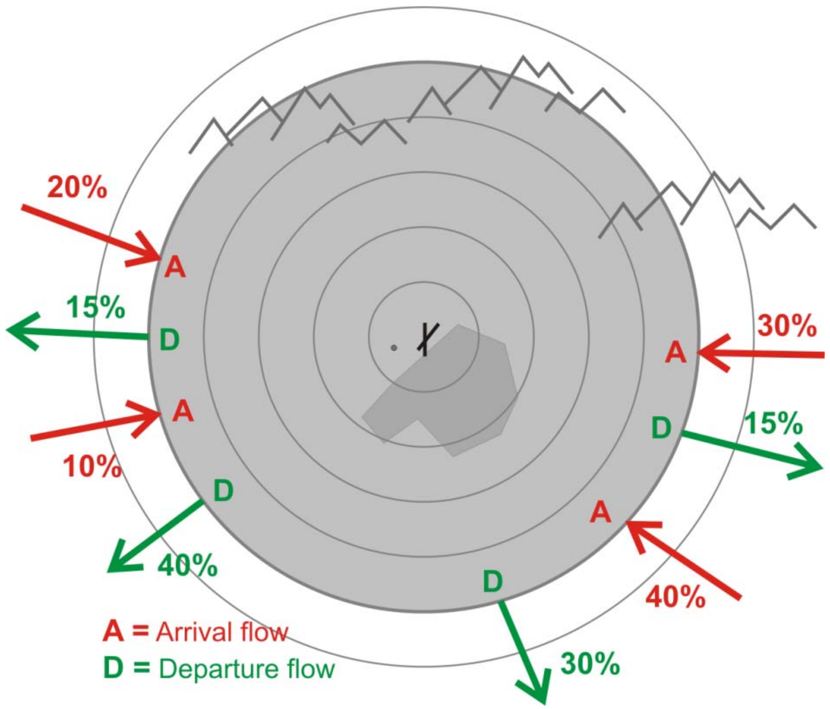
Activity 5

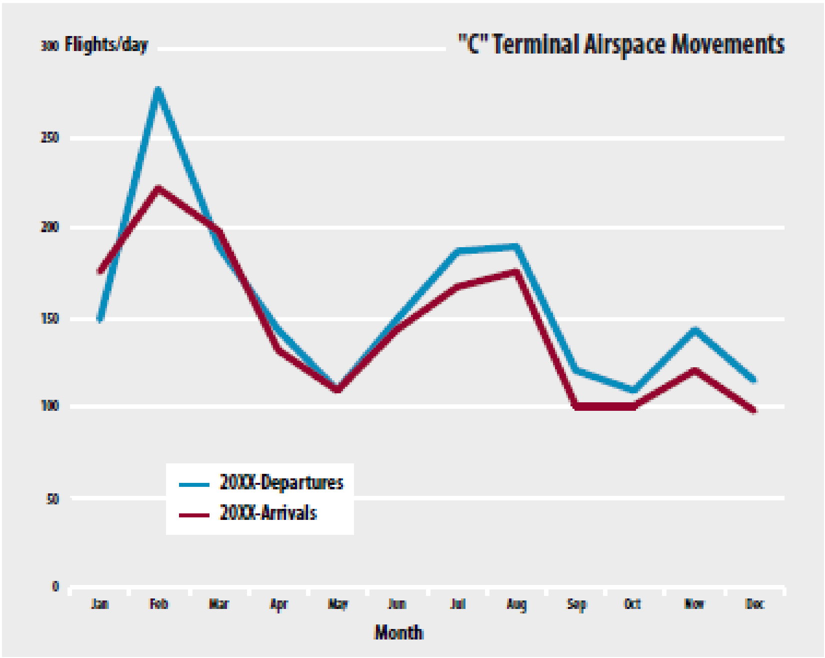
Select Safety Criteria, Safety Policy and Performance Criteria

- Select Safety Management system
- Select Safety Assessment Methodology
- What evidence is needed to prove safety of design
- Set success criteria

Activity 6

Agree on ATM/CNS assumptions



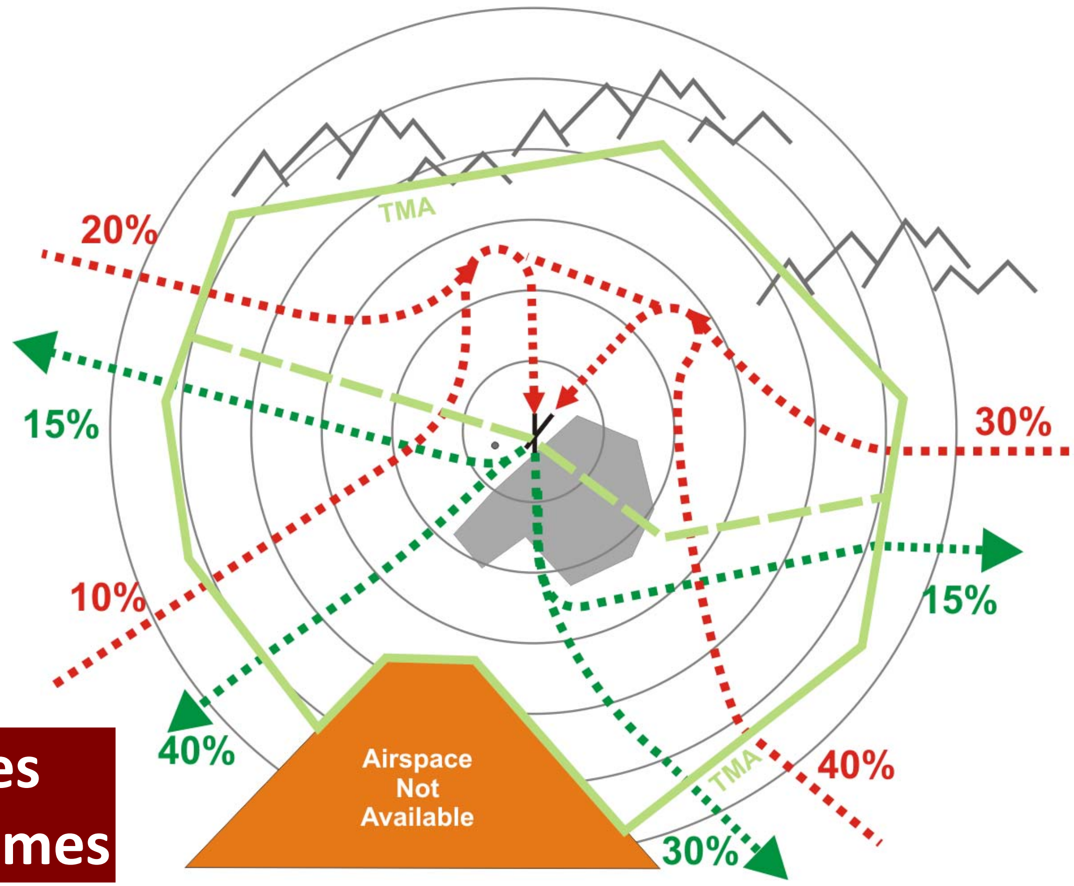


Activity 7

Design the Airspace

- Arrivals
- Departures
- Transit
- VFR
- Military

AVOID trying to fit the routes into the existing airspace volumes



Activity 8

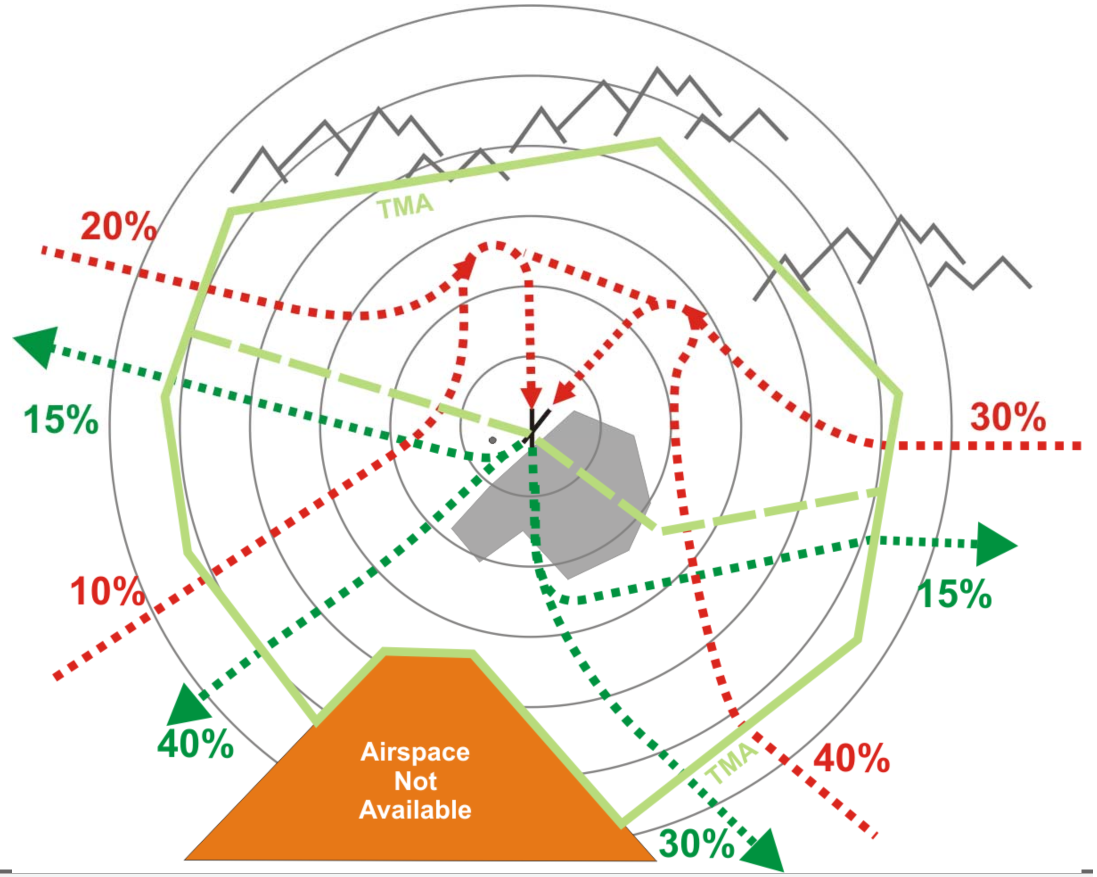
Initial Procedural Design

- Capability/functionality needed?
- Fleet capability/functionality available?
- Coverage provided by available Navaid infrastructure?
- Design according to ICAO Doc 8168 and Doc 9905
  - Initiation
  - Collect & Validate Data
  - Create Conceptual Design
  - Review by Stakeholders

Activity 9

Design Airspace Volumes and Sectors

- Sectorisation
- Airspace volume
- Iterations possible



Activity 10

Confirm ICAO Navigation specification

- Review NAV specs
- Identify appropriate spec
- Go to Validation and Implementation
- If no appropriate spec
  - Apply Trade off

Activity 11

Airspace Concept Validation

- Prove ATM operability & validity
- Assess objectives
- Identify possible weak points
- Provide evidence and proof to support Safety Assessment

Activity 12

Finalization of procedure design

- Design according to ICAO Doc 8168 and Doc 9905
  - Apply Criteria
  - Document and Store
  - Support Safety Assessment
- Output:
  - Draft procedure layouts
  - Calculation outputs
  - Textual description of procedure

Activity 13

Procedure validation

- Verification of terrain, obstacle and aeronautical data used to support design
- Validate intended use of procedure (match to conceptual design)
- Validate correct application of criteria
- Validate fly ability and human factors (charting)
- Flight Inspection (if required)

Activity 14

ATC System Integration

- Changes to ATC system interfaces and displays to ensure controllers have the necessary information on aircraft capabilities and the appropriate displays to support the new routings. Such system changes could include modifications to:
  - Air Traffic Flight Data Processor (FDP)
  - Air Traffic Radar Data Processor (RDP)
  - ATC situation display
  - ATC support tools

Activity 15

Awareness and Training Material

- The introduction of PBN can involve considerable investment in terms of training, education and awareness material for both flight crew and controllers.
  - Printed training packages
  - Computer based training
  - NOTAMS
  - ICAO provides additional training material and seminars.

Activity 16

Implementation

- Have the Safety and Performance Criteria been satisfied;
- Have the required changes been made to the ATM system;
- Have the required changes been made to the ground navigation systems;
- Do the assumptions and conditions upon which the Airspace Concept has been developed still pertain. (are traffic flows as forecast, is the fleet suitably equipped and approved etc);
- Are the critical enablers all in place.;
- Have the pilots and controllers received appropriate training.

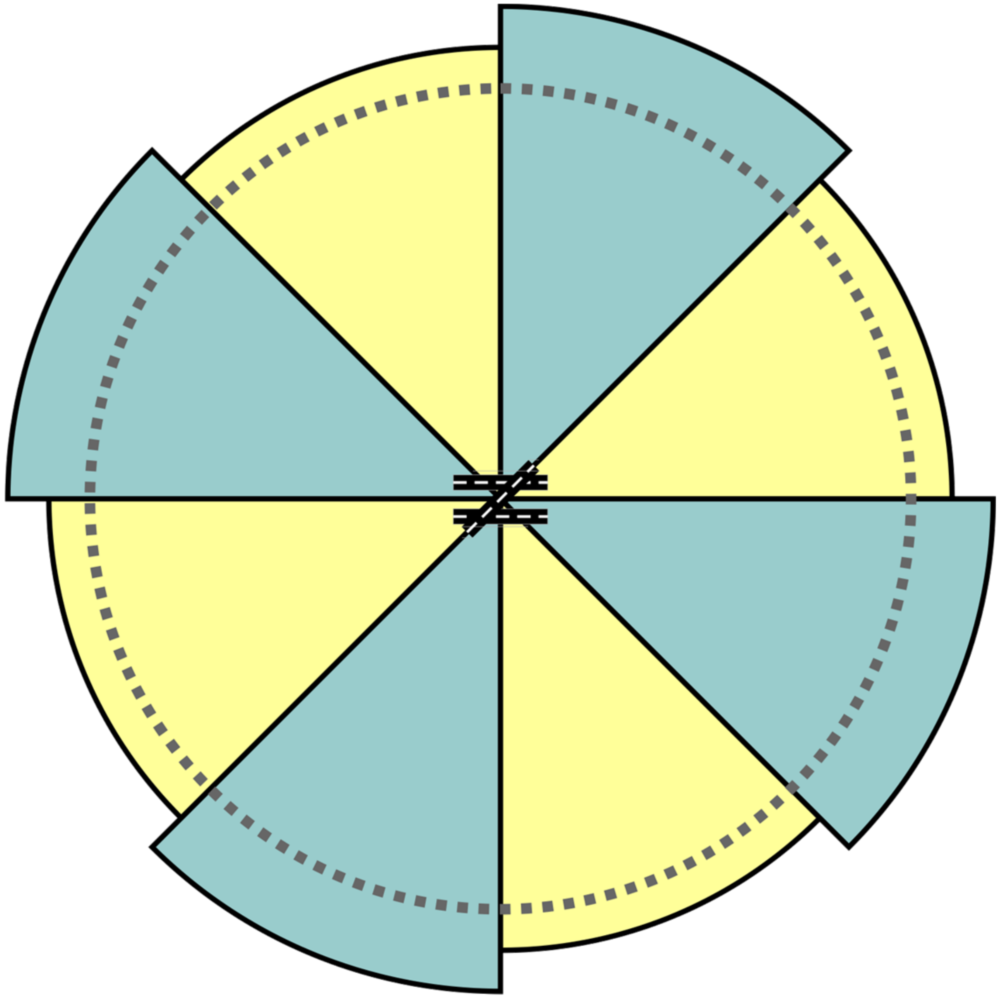
Activity 17

Post Implementation Monitoring

- Keep LOG
  - Assess if objectives are met
  - Measurement Programme
  - SMS safety assessment – collect evidence

Good Design Practice

Segregate Arrivals laterally and vertically from Departures



Good Design Practice

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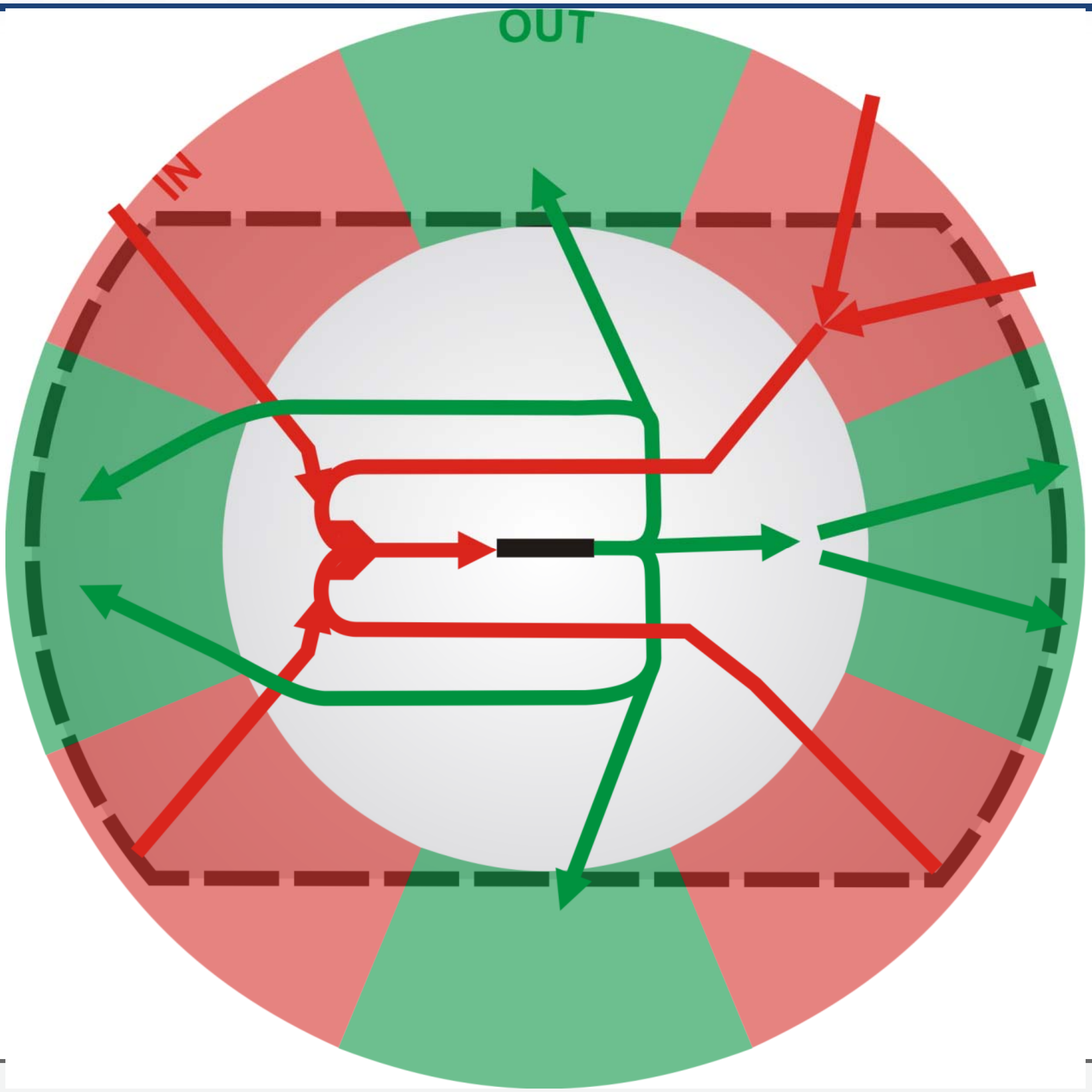
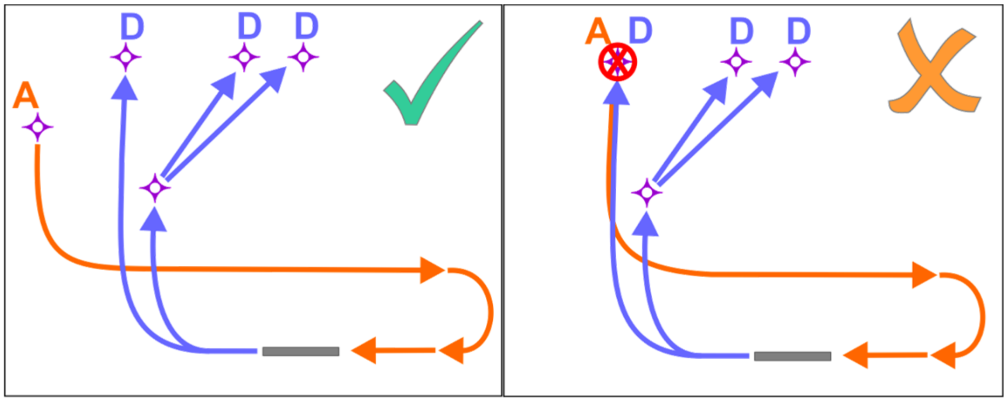
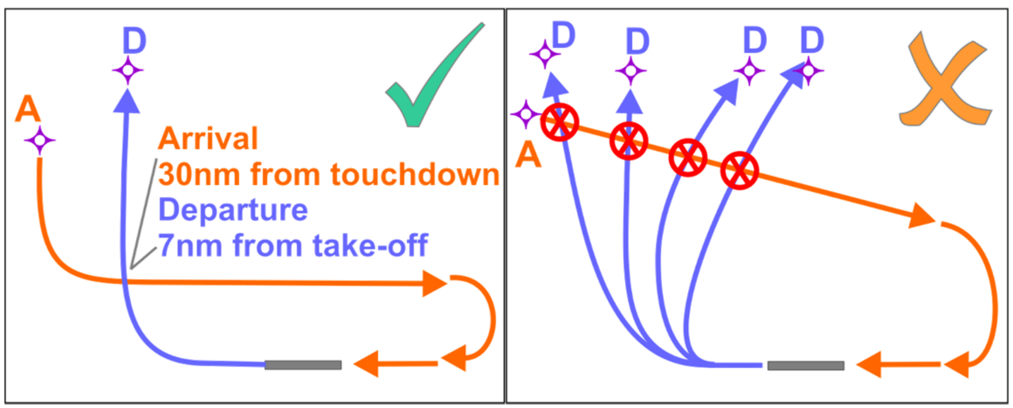


Good Design Practice



- Segregation of routes and entry/exit points

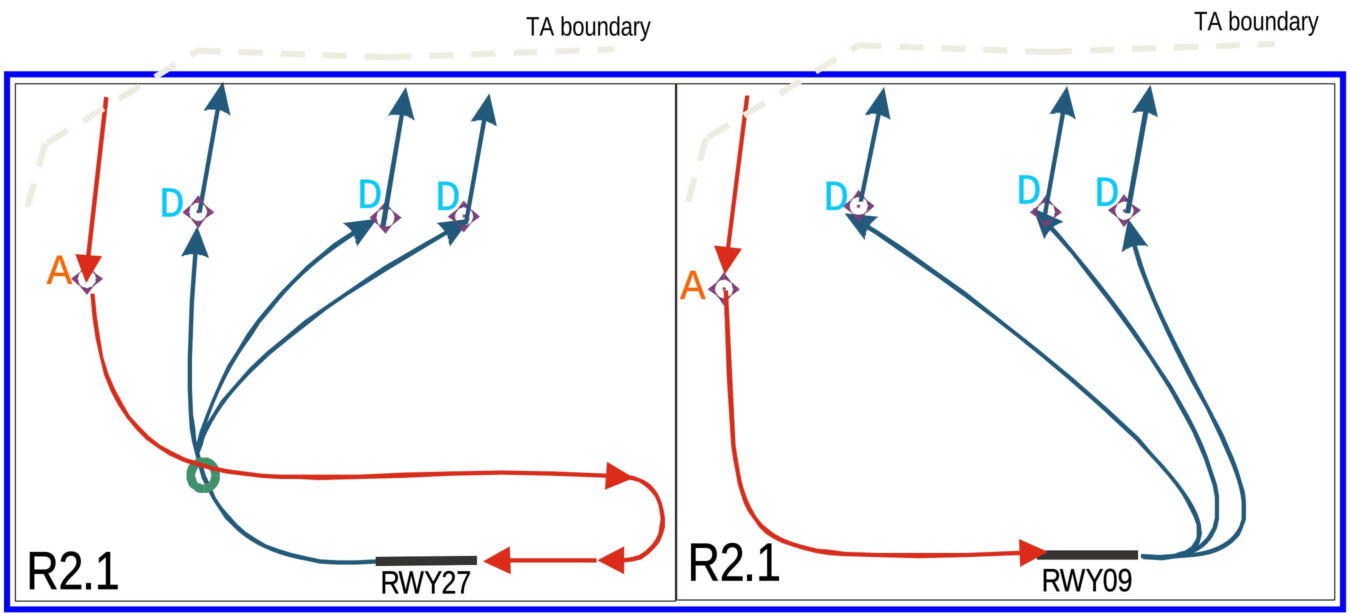


- Plan for vertical separation

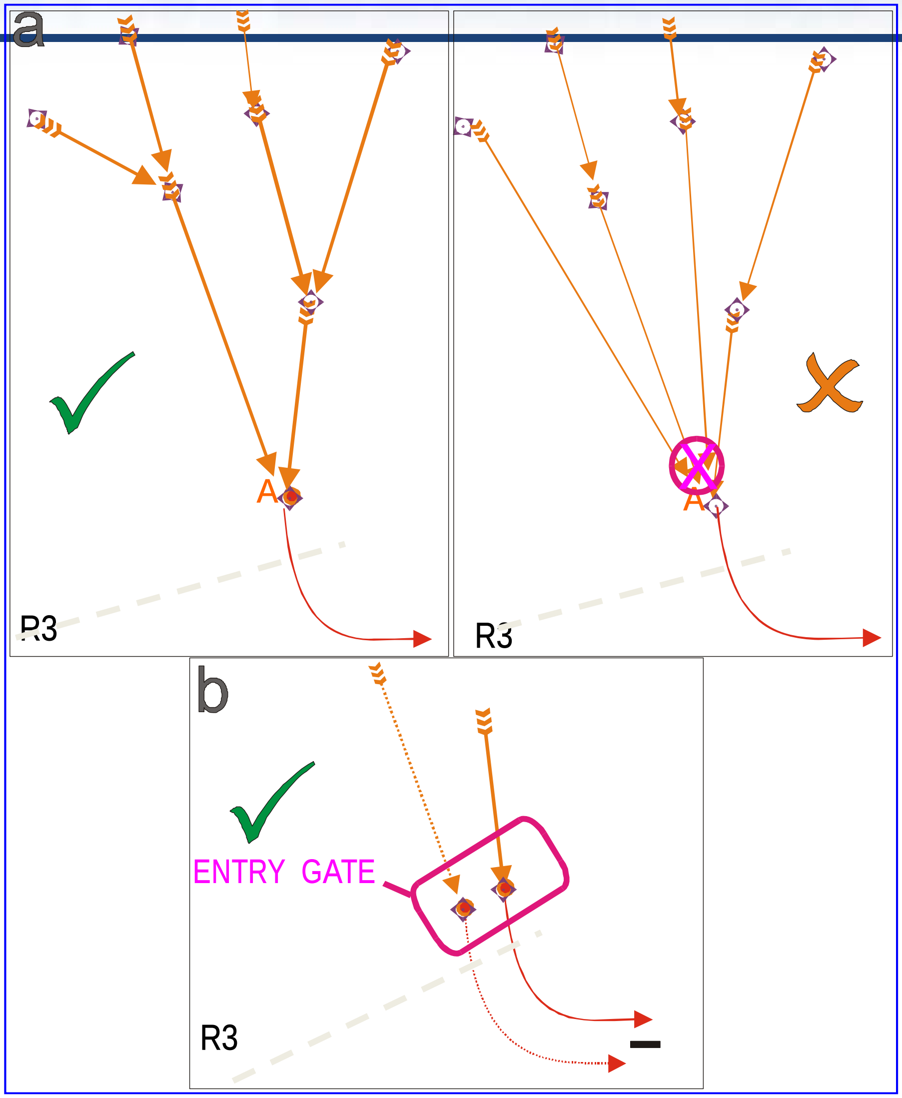
Good Design Practice

Fix the same Exit/Entry points for different RWY configurations

Handoff between ACC and APP should not change with RWY configuration



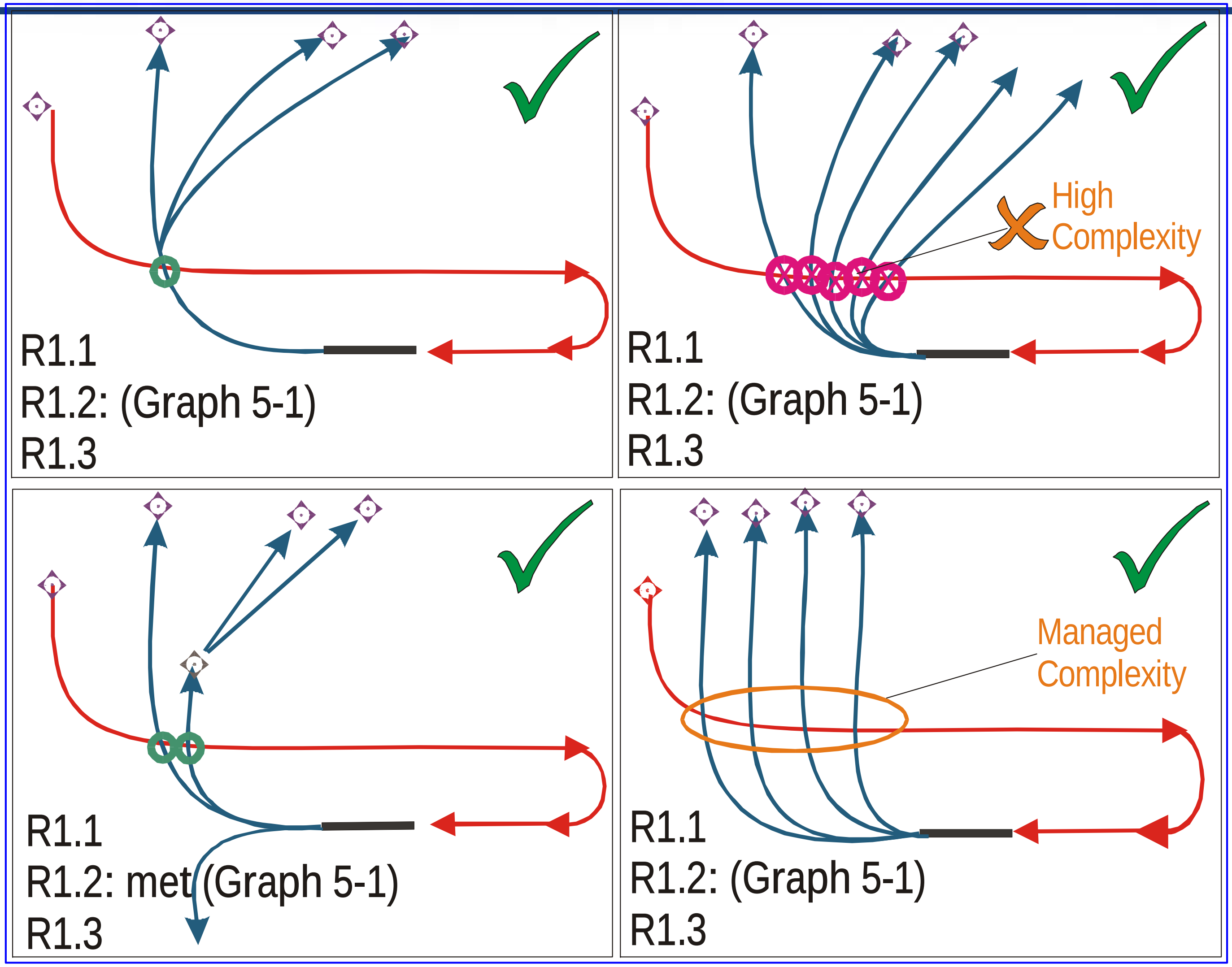
Good Design Practice



- Gradually converge inbound flows
- Group similar inbound flows in entry gates

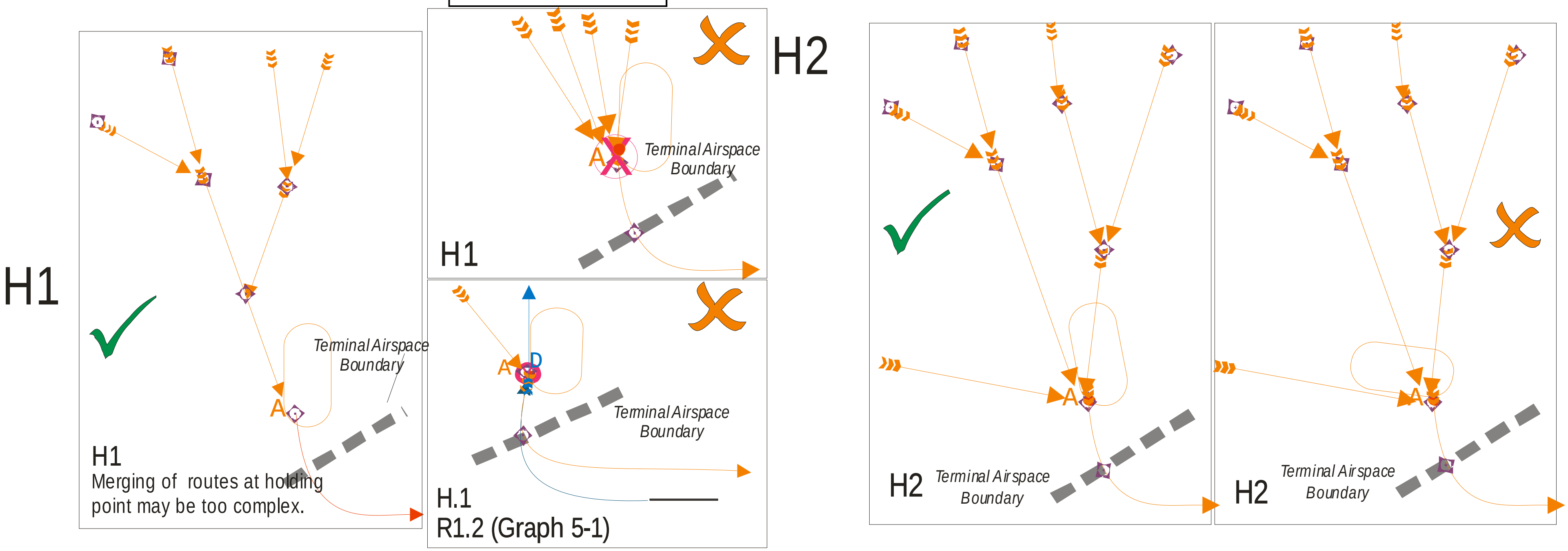
Good Design Practice

Minimise Crossing Complexity



Good design practice

Holds



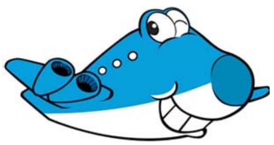
Continuous Descent Operations

(CDO)

Design Methods

CDO Design Methods

- Design to select the shortest path



CDO Design Methods

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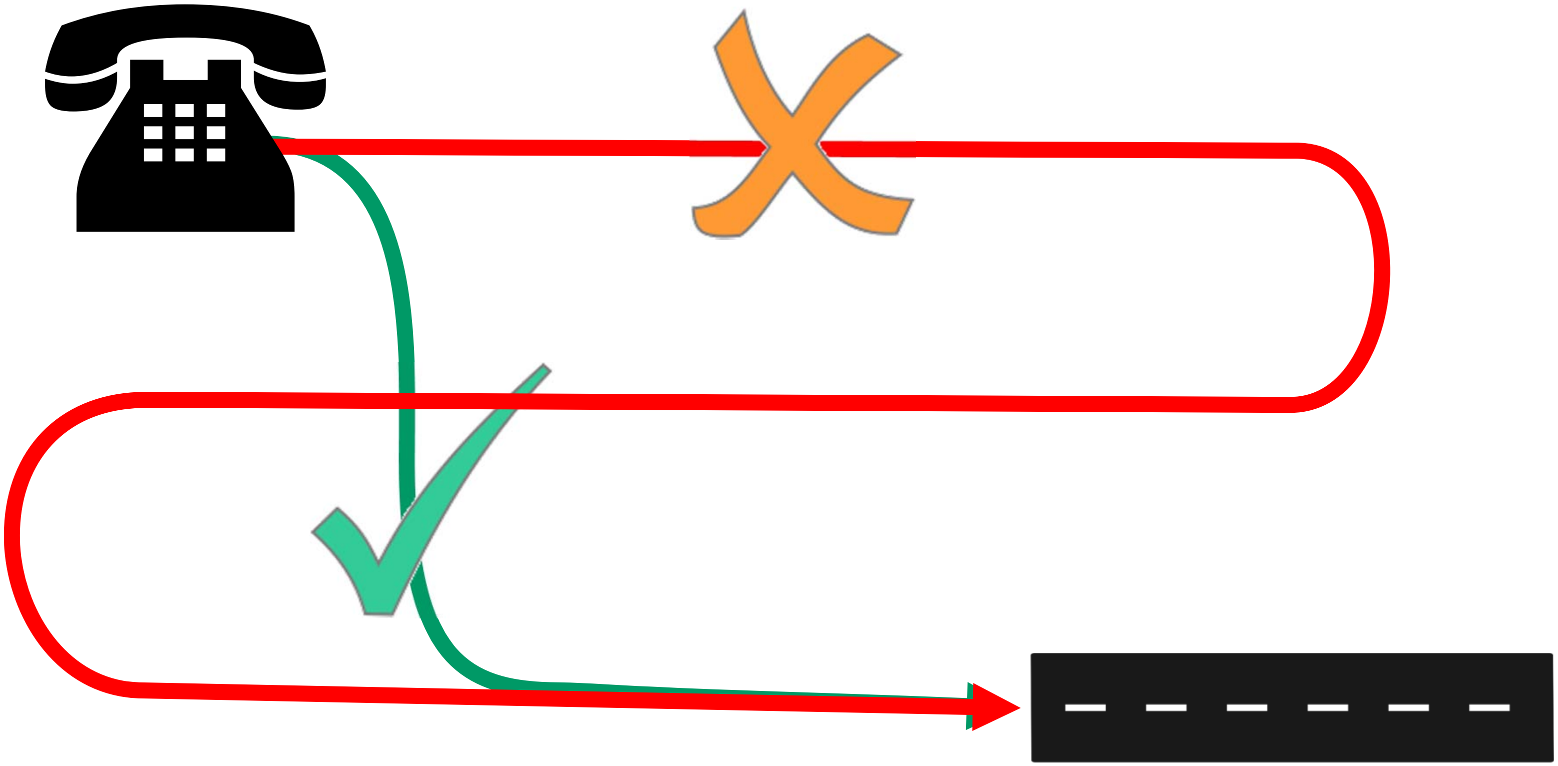
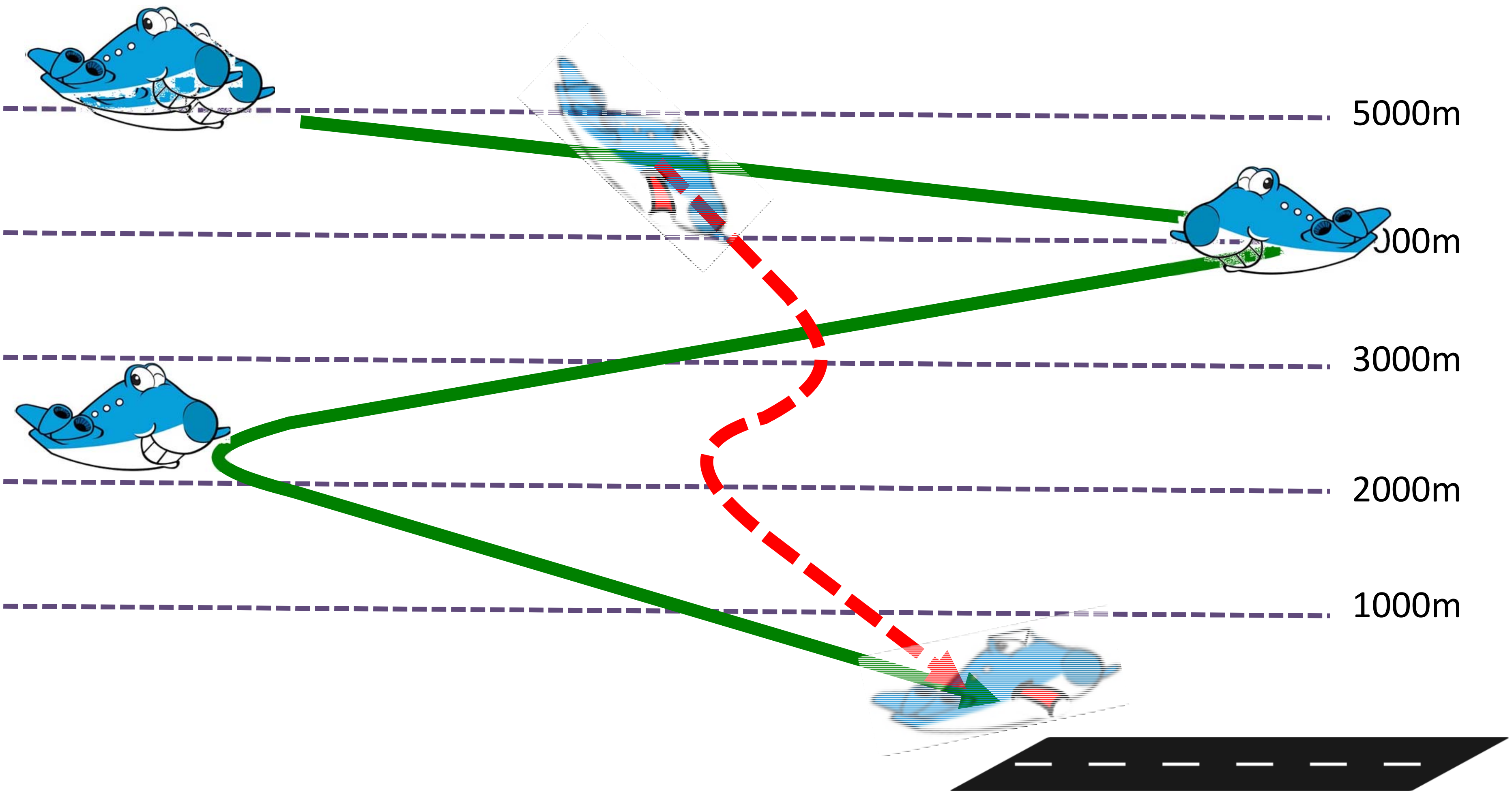


CDO Design Methods

- Long path plus "shortcuts" are inefficient



CDO Design Methods

1. Select the shortest path.
2. Modify path as necessary in response to:
   - airspace,
   - terrain,
   - departure paths,
   - other traffic.
3. Apply required speeds and or altitude profiles.
4. Review and modify as necessary.

CDO Design Methods

CDO STAR waypoints may contain:

1. Speed restrictions
2. Altitude restrictions

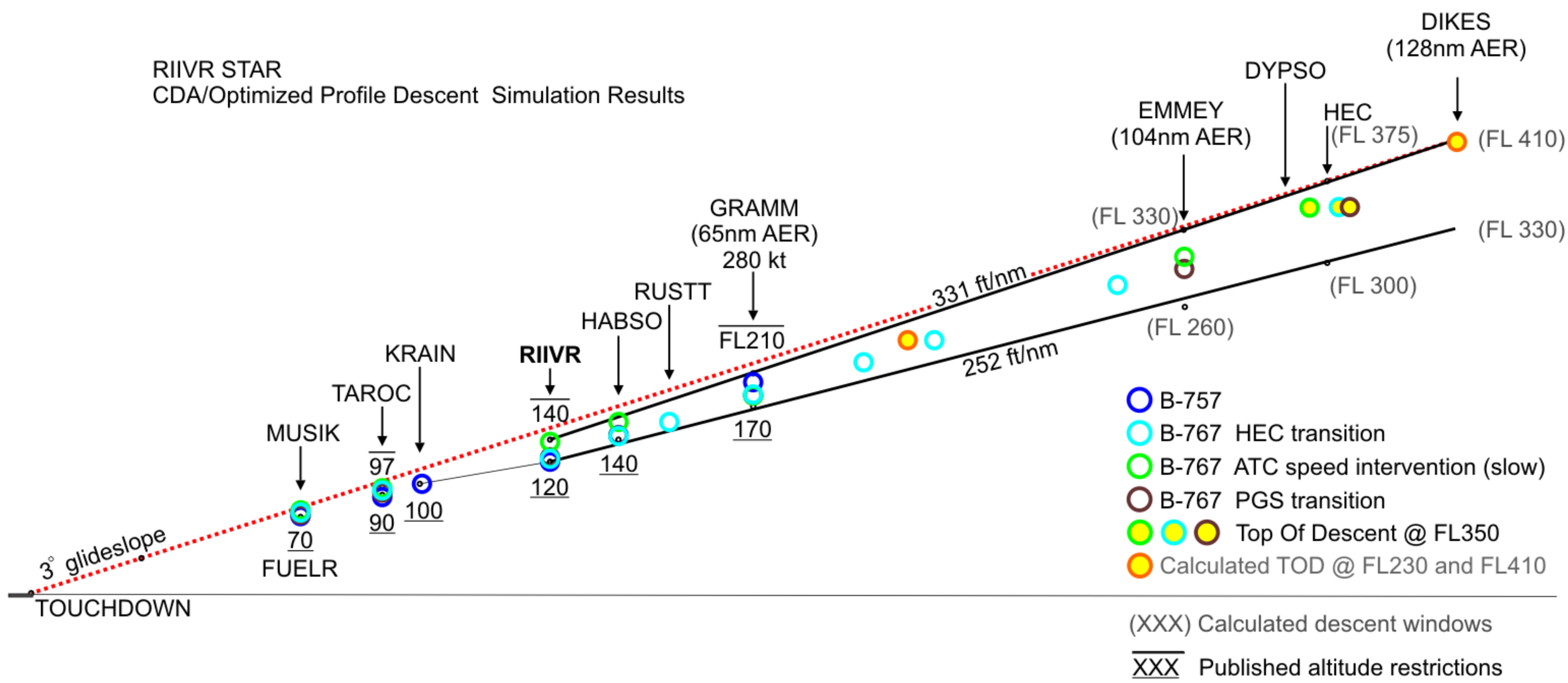
Altitudes restrictions may be

- "At",
- "At or above",
- "At or below",
- or a window of both "At or above and at or below"

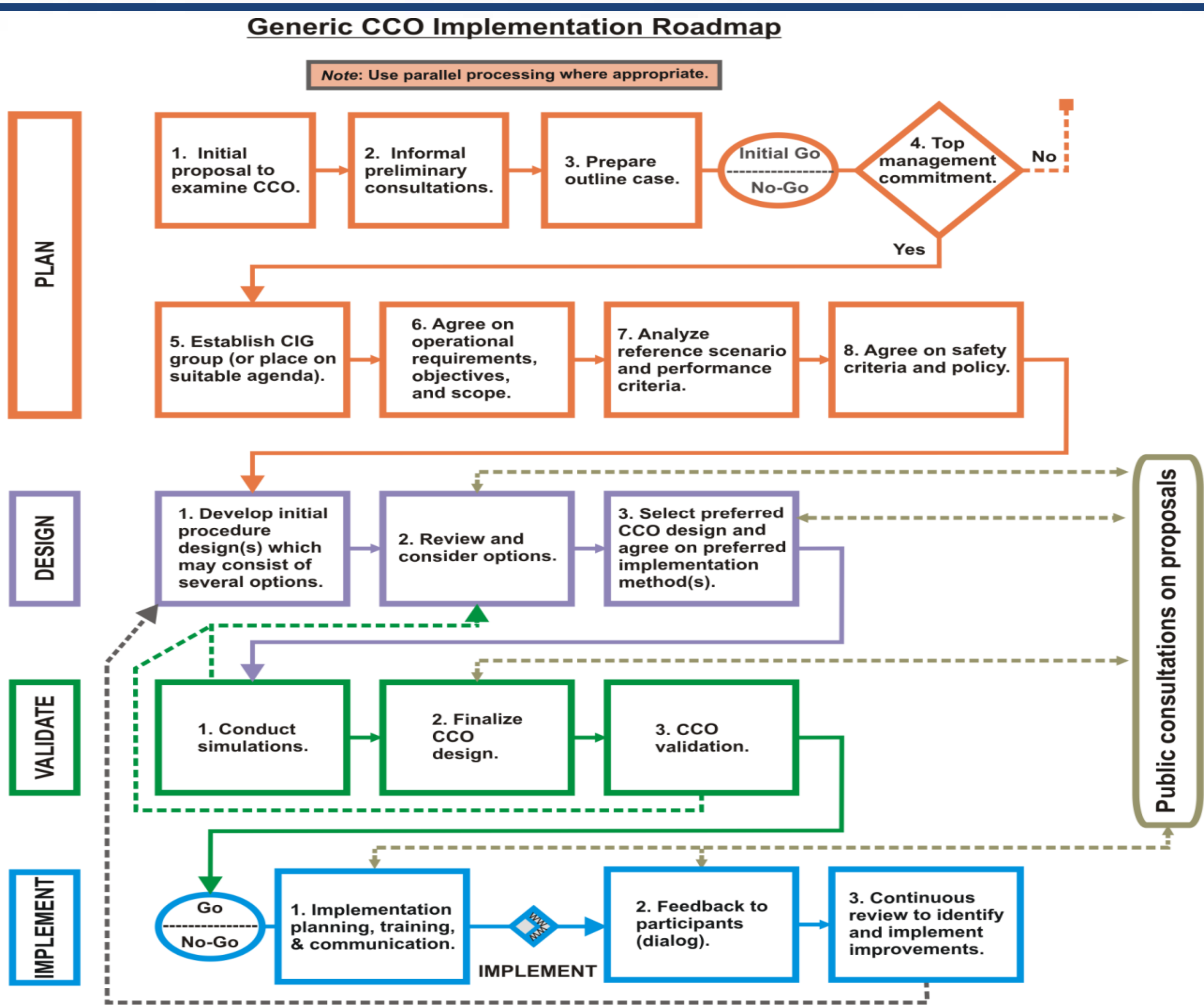
Limit speed and altitude restrictions to the minimum necessary.

- In general speed restrictions should not be less than 280kt above 10,000 msl.
- Speed restrictions must have an associated altitude restriction (FMS requirement)

Closed Path CDO Calculations Example - refined with simulation



CCO Roadmap



Generic CCO Implementation Roadmap
Note: Use parallel processing where appropriate.
PLAN
1. Initial proposal to examine CCO.
2. Informal preliminary consultations.
3. Prepare outline case.
Initial Go
No-Go
4. Top management commitment.
No
Yes
5. Establish CIG group (or place on suitable agenda).
6. Agree on operational requirements, objectives, and scope.
7. Analyze reference scenario and performance criteria.
8. Agree on safety criteria and policy.
DESIGN
1. Develop initial procedure design(s) which may consist of several options.
2. Review and consider options.
3. Select preferred CCO design and agree on preferred implementation method(s).
VALIDATE
1. Conduct simulations.
2. Finalize CCO design.
3. CCO validation.
IMPLEMENT
Go
No-Go
1. Implementation planning, training, & communication.
IMPLEMENT
2. Feedback to participants (dialog).
3. Continuous review to identify and implement improvements.
Public consultations on proposals

CCO Defined

CCO is an aircraft operating technique made possible by

1. appropriate airspace and procedure design
2. appropriate ATC clearances

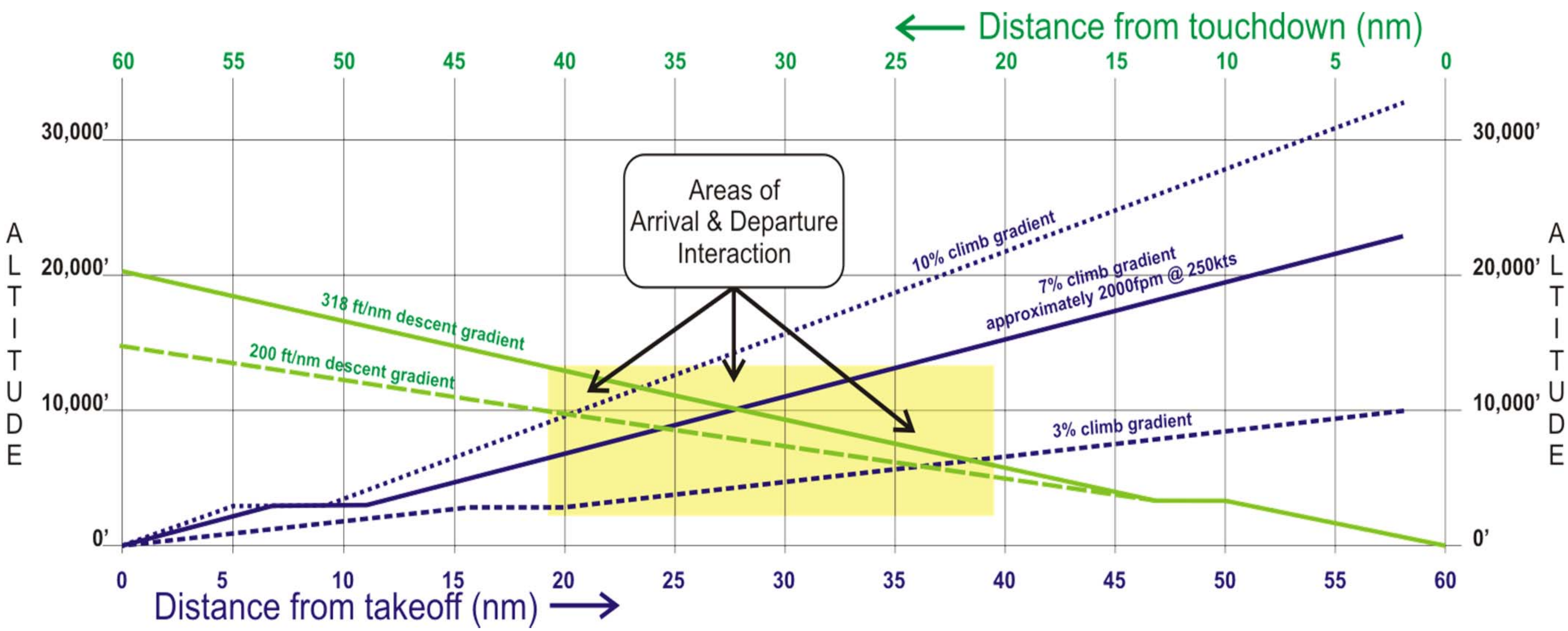
enabling the execution of a flight profile optimized to the performance of the aircraft, allowing the aircraft to attain initial cruise flight level at optimum air speed with climb engine thrust settings set throughout the climb, thereby reducing total fuel burn and emissions during the whole flight.

CCO & CDO Design Methods

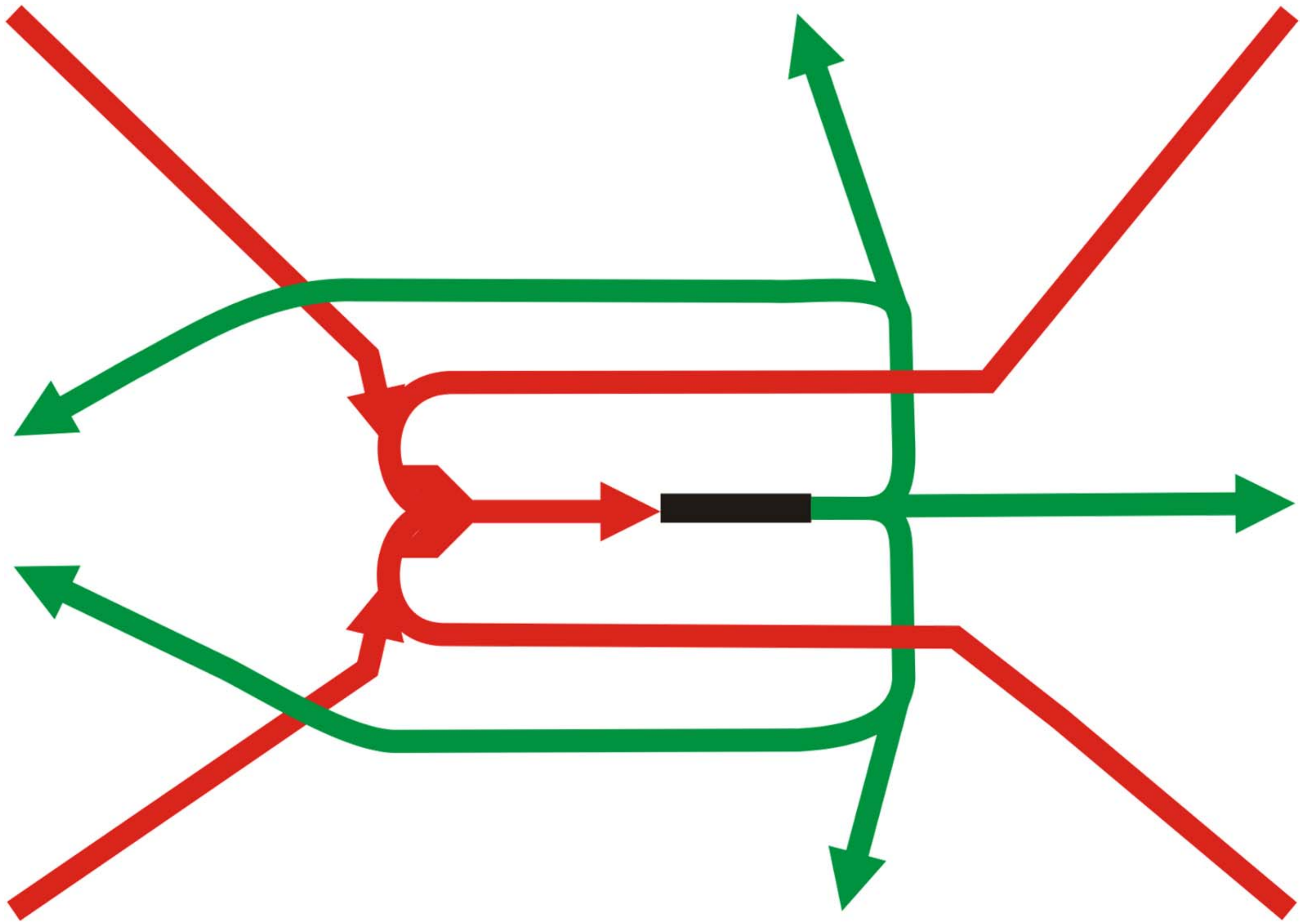
BALANCE:

- Where a trade-off between CCO and CDO is unavoidable, the local analysis and decision making should take into account that a level segment for an aircraft in descent would normally burn less fuel than for the same duration of level segment for an equivalent aircraft in climb.
- Often there is far more unnecessary level flight in the descent phase than in the climb phase.
- The balance will depend on local characteristics such as the extent of level flight in both phases, the significance of noise in the areas affected etc.

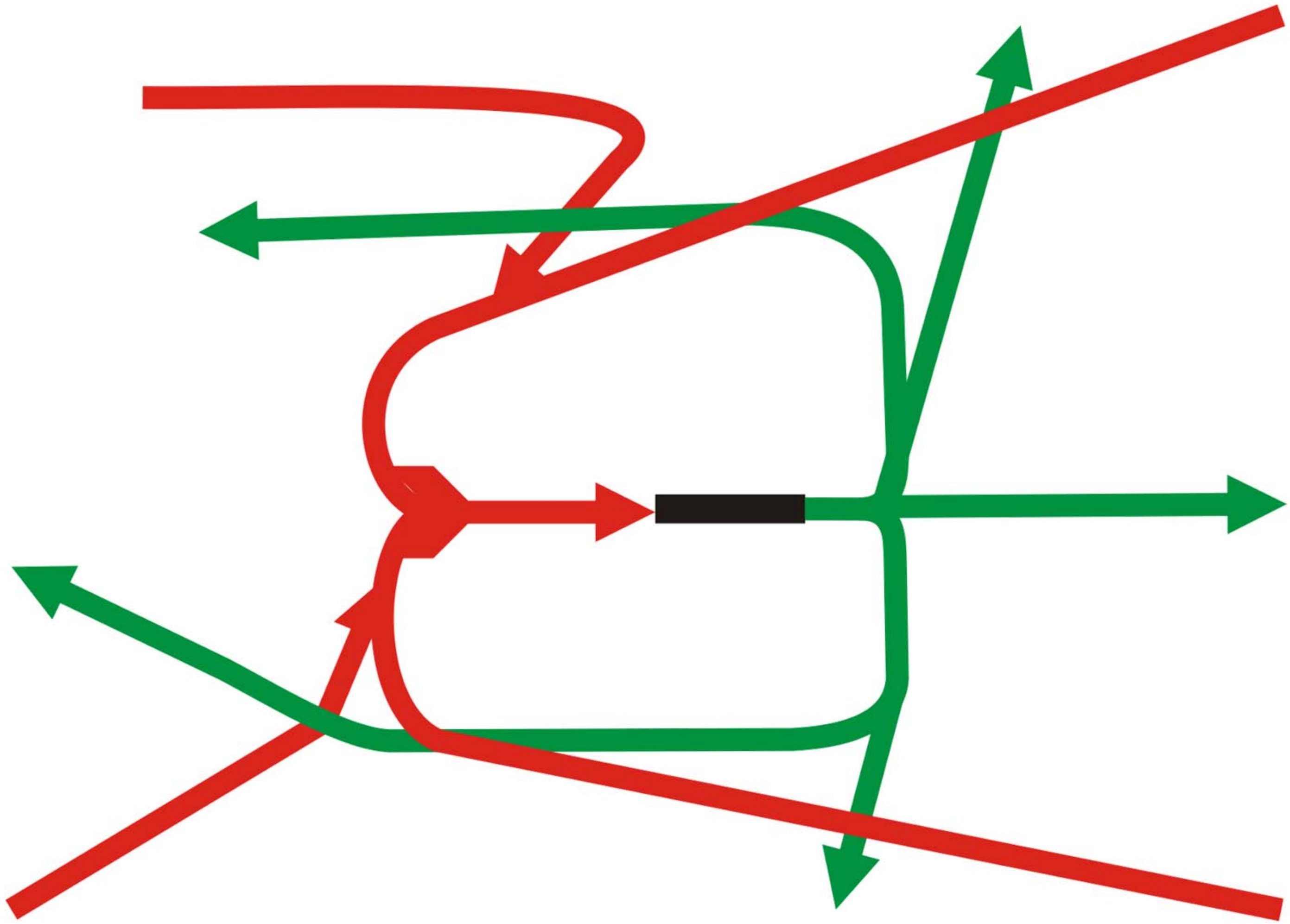
Profile Interaction



Profile Interaction



Profile Interaction



QUESTIONS?

Thank You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