Safety / Performance Criteria Agreeing Assumptions

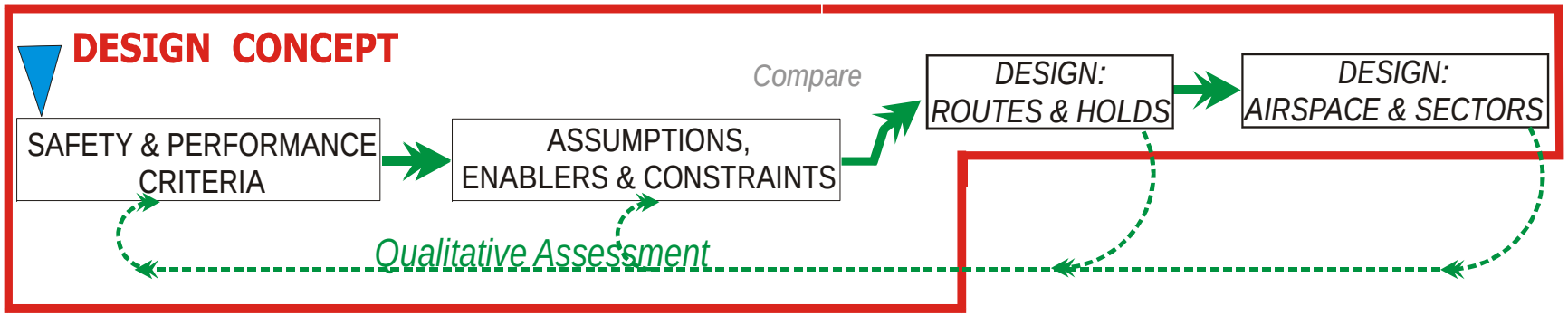
Module 10 - Activities 5 & 6

European Airspace Concept Workshops
for PBN Implementation

Why have safety and performance criteria?

- Measure performance
- Measure safety
- Determine success of implementation
- Other …

Interconnections

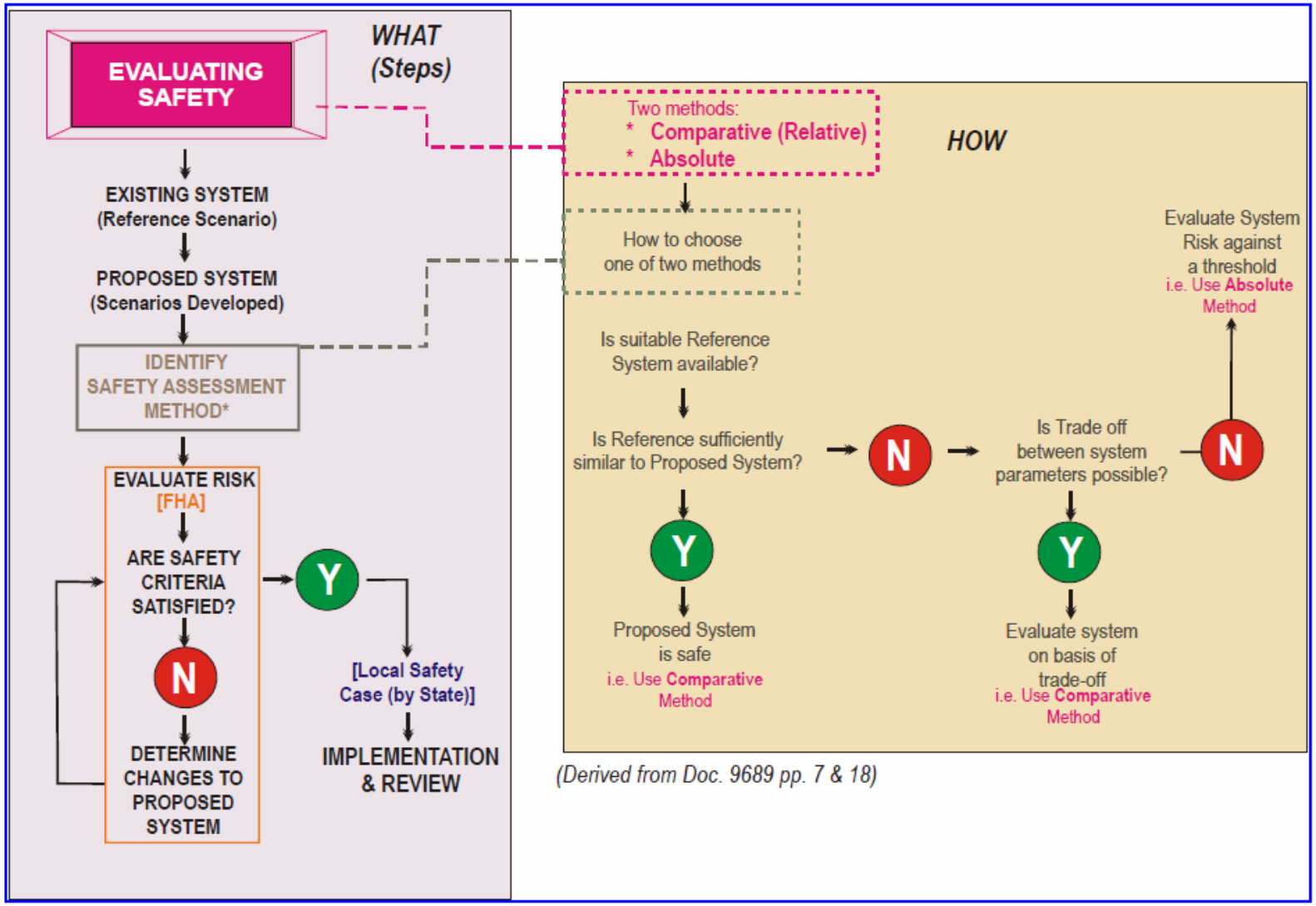


Assessment

- Qualitative Assessment
  - Expert judgement used to assess the design based on ICAO SARPs and Procedures
- Quantitative Assessment
  - Quantified results produced in the form of numerical data e.g. capacity increased by 20%

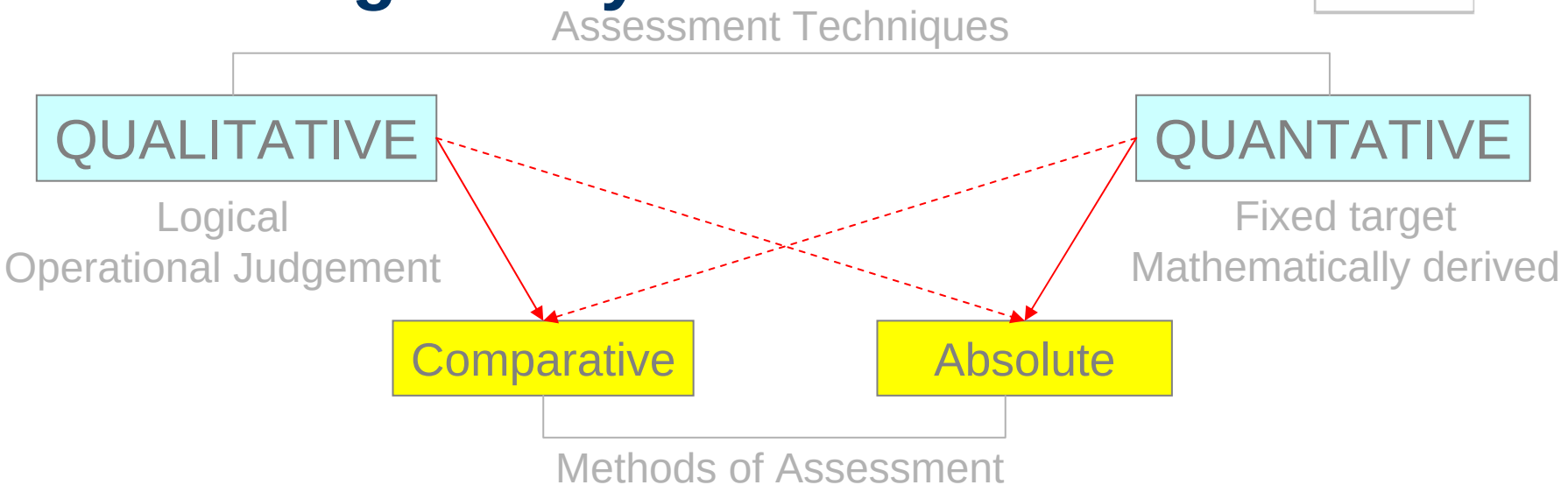
Both Qualitative and Quantitative assessment are crucial to safety and performance assessment

Evaluating Safety



(Derived from Doc. 9689 pp. 7 & 18)

Evaluating Safety 1/2



Comparative:

Base Case — Compare and Analyse → New Environment

Reference Scenario

Is operation as safe or safer than current ops?

Absolute:

Modelling — Mathematical Computation → TLS (5×10^{-9})

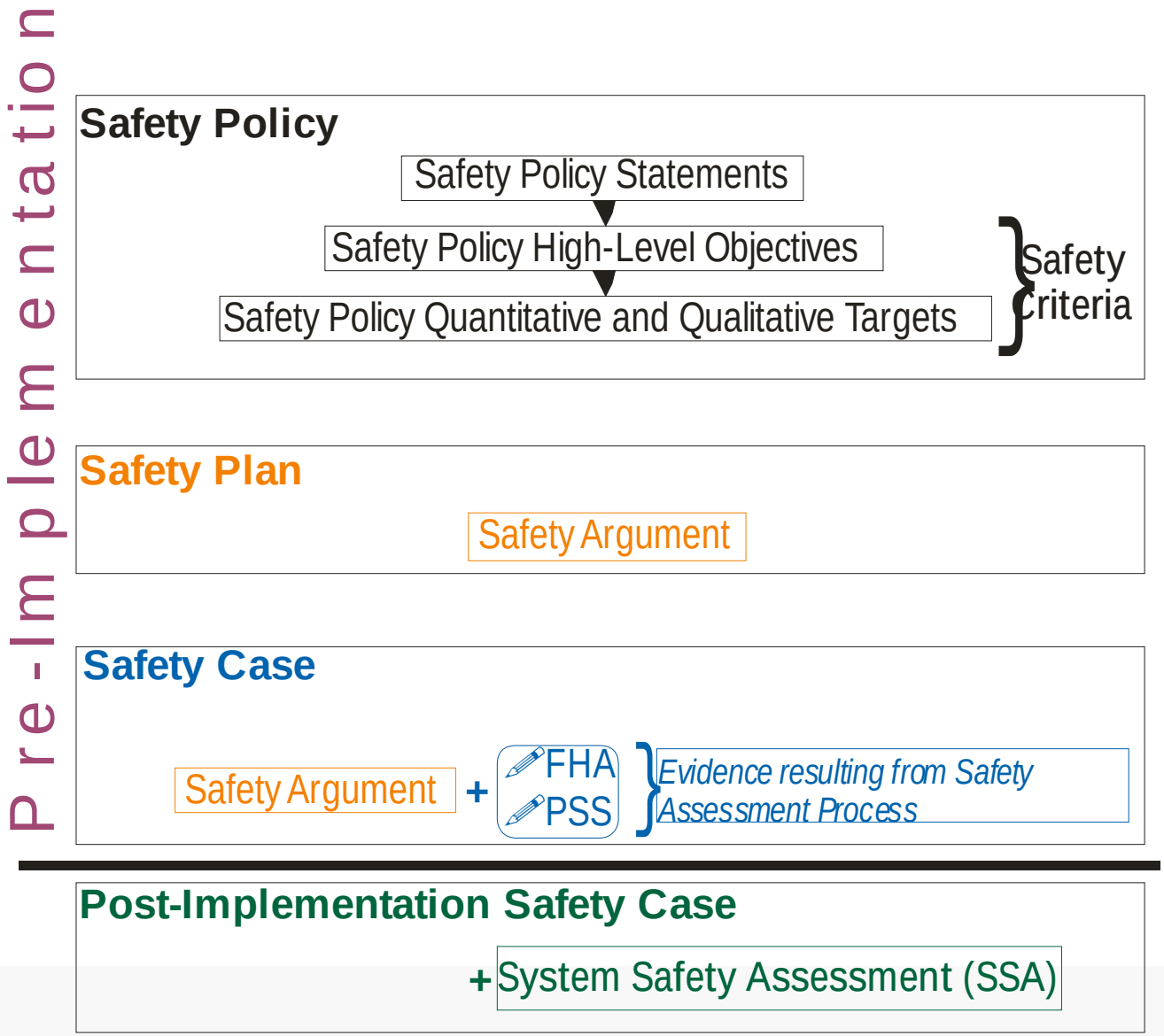
e.g. Reich Model

Does output meet the set target?

Evaluating Safety 2/2

- Comparative Assessment
  - Reference system must sufficiently resemble the new system to be introduced (typically the case with airspace changes).
  - Comparative *does not* automatically mean ‘qualitative’: Comparisons can be made between two TLS.
- Absolute method often used for route spacing or determination of separation minima (ICAO)
- Professional judgement/common sense is a good synonym for ‘Qualitative’

Safety & Performance Criteria



Performance Criteria

1a. an airport capacity increase of 20% is demonstrated; and	
2a. no increase in noise pollution is experienced by the residents of Suburb *Y* between 22:00 and 05:00 UTC;	
3a. track mileage flown by arriving aircraft is not extended by more than 5%;	
1b. TARGET airport capacity = 43 movements per hour	
2b. noise emitted by each ACFT does not exceed 65dB at the noise monitoring point.	
3b. track mileage flown by arriving aircraft does not exceed 32 NM from Terminal Airspace Entry point.	

Sample Checklist: Safety and Performance Criteria

Checklist: PERFORMANCE CRITERIA (ref. Part , Ch.3)	
ASSESSMENT AND MEASUREMENT (ref. Part C 3.2)	
	• Is the chosen Assessment methodology (qualitative vs. quantitative) the correct methodology for the required measurement? • Do the people that are assigned to the assessment have the suitable background and support tools to do the assessment? • Is the assessment done by people from the project team or by external parties? • Is the assessment done repetitive during the design process?
SAFETY CRITERIA (ref. Part C 3.3)	
	• What has been the motivation to decide on either relative or absolute measurement of safety? • What is the chosen frequency approach on safety assessment (phased vs. once-only) and why was this approach chosen? • What is the chosen support to substantiate the safety assessment; simulations (fast- real-time), analysis and/or expert judgement? • What is the "benchmark" used in the determination of safety criteria?
PERFORMANCE CRITERIA (ref. Part C 3.4, 3.5)	
	• Are the design objectives met? • Depending on the objectives were quality and or quantity measured in order to determine if the objectives are met? • Are there measurement tools used, that would normally be outside the scope of the design project, to measure if the objectives are met (e.g. noise modelling tools)?

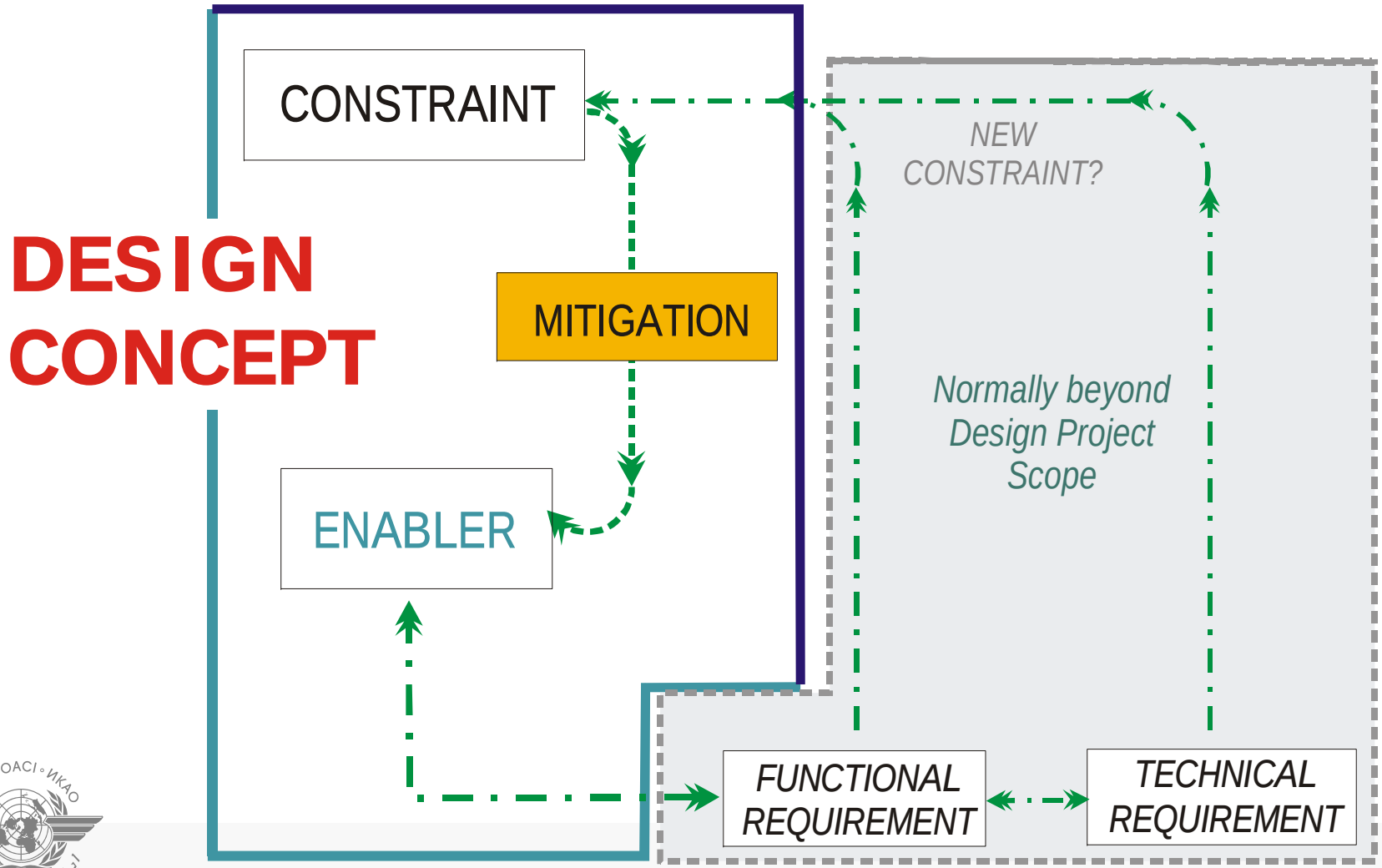
Outstanding Actions/Issues

Action	Due date	Responsible

Reports

REPORT TYPE	DUE DATE	RESPONSIBLE	CONSULTATION PERIOD
DRAFT REPORT			
REVIEW			
FINAL REPORT			

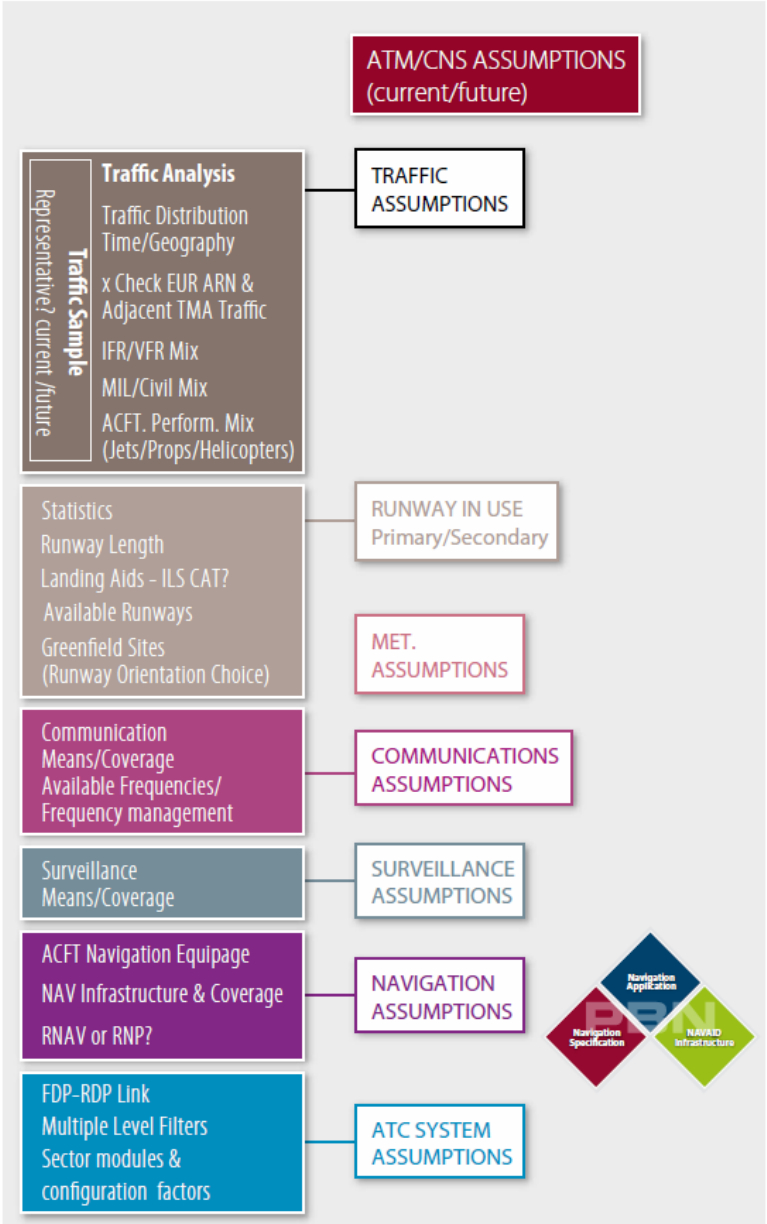
Assumptions / Enablers & Constraints



Assumptions / Enablers & Constraints

CONSTRAINTS	*MITIGATION*	ENABLERS
High Terrain on final approach RWY X	Increase ILS angle by 1°?	Specification change for ILS
Multiple airports within close proximity with poor co-ordination agreement	Letter of Agrrement	EUROCONTROL DOC The Cross-Border Common Format Letter of Agreement
Aircraft Performance Mix limits capacity	Design different SIDs for high and low performance aircraft.	Airspace Design
Aircraft Navigation Performance Mix limits capacity by increasing ATC workload	ATC system modification to allow FDPS/RDPS to show aircraft navigation capability	Software Application Change
Inadequate Navigation infrastructure	New DME at Location A	Enhance NAV infrastructure
High mix of IFR-VFR movements limits capacity	SEGREGATED VFR/IFR ROUTES	Airspace Design
Fixed-wing/Rotor craft mix increases approach workload and complexity	Separated routes based on aircraft category	Airspace design
TSA which adversely affects traffic patterns	Airspace sharing arrangements	Flexible Use of Airspace Concept and EUROCONTROL DOC The Cross-Border Common Format Letter of Agreement
Poor Radar Coverage prevents route placement in part of the Terminal Airspace	Improve Surveillance capability	Enhance Radar infrastructure
Poor Radio Coverage adversely affects route placement in part of the Terminal Airspace	Improve Radio Coverage	Enhance communications infrastructure
Severe weather disrupts traffic, especially at peak times	Create 'contingency' routes for poor weather operations; re-locate holding patterns	Airspace design
No flights permitted over Village X	Diverge departure routes as soon as possible after take-off	Airspace design
Flights over City Y not permitted below 10,000 feet	Continuous Descent Approach	Airspace design and Level constraints in procedures

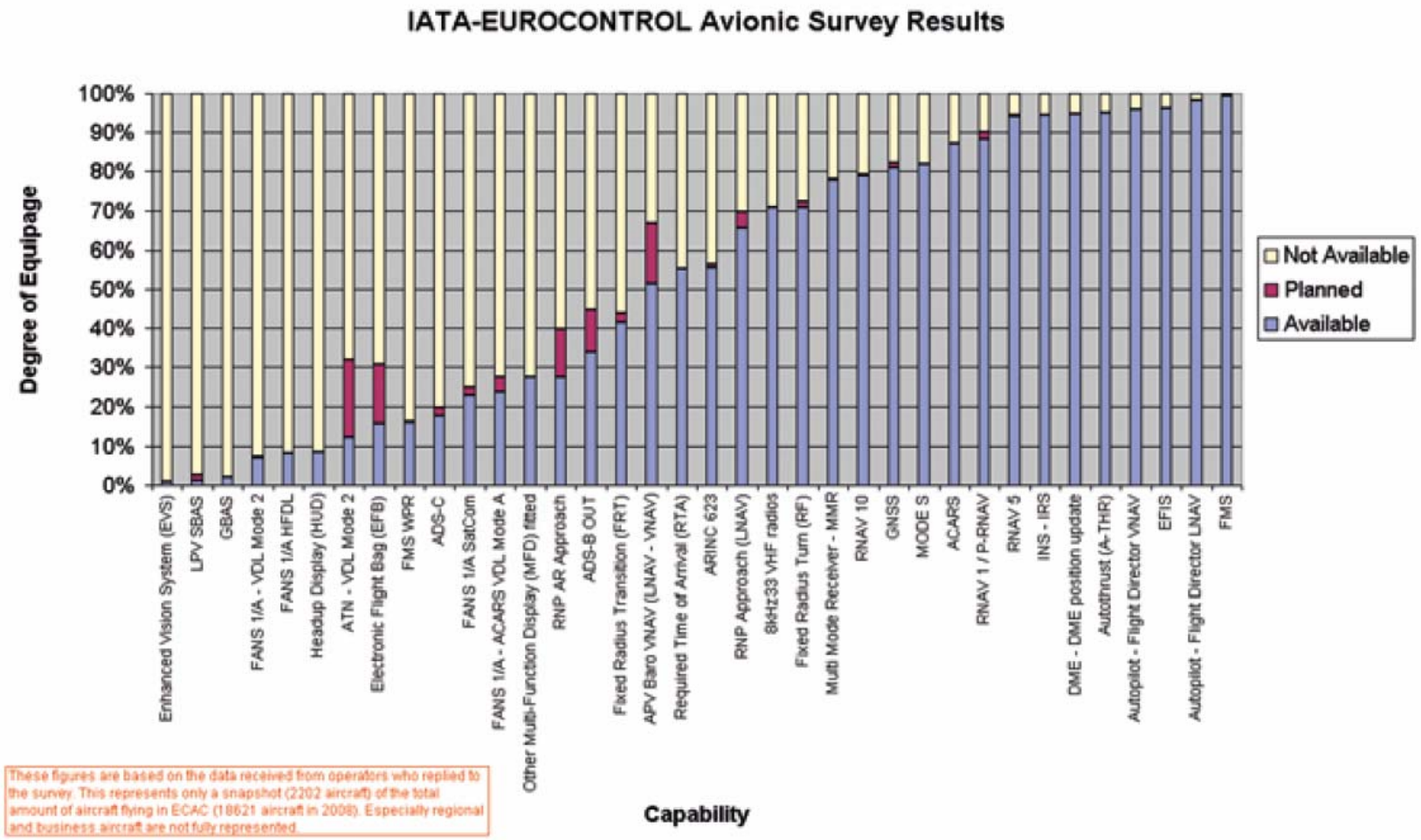
Assumptions



Fleet Assumptions

- What's in my fleet?
  - Jets
  - Turbo props
  - Piston
- What level of navigation qualification?
  - What certification?
- Upgrading a fleet costs €. Retrofits must be *worth* the cost. > CBA

Fleet Capability and Trends



Select Nav spec based on fleet capability

Navigation Specification	Flight phase								Additional Functionalities (Required or Optional)			
				Approach								
	En route oceanic/ remote	En route continental	Arrival	Initial	Intermediate	Final	Missed[1]	DEP	RF	FRT	TOAC	Baro VNAV
RNAV 10	10											
RNAV 5[2] *AMC 20-4*		5	5									
RNAV 2		2	2					2				
RNAV 1 *Rev 1* *JAA TGL 10*		1	1	1	1		1	1				O
RNP 4	4									O		
RNP 2	2	2								O		
RNP 1[3]			1	1	1		1	1	O[8]			O
Advanced RNP[4]	2[5]	2 or 1	1	1	1	0.3	1	1	R[8]	O	O	O
RNP APCH[6] *AMC 20-27* *AMC 20-28*				1	1	0.3	1		O[8]			O
RNP AR APCH *AMC 20-26*				1-0.1	1-0.1	0.3-0.1	1-0.1		*Specific requirements for RF & VNAV*			
RNP 0.3[7]		0.3	0.3	0.3	0.3		0.3	0.3	O[8]			O

Cost vs. Benefit (1/5)

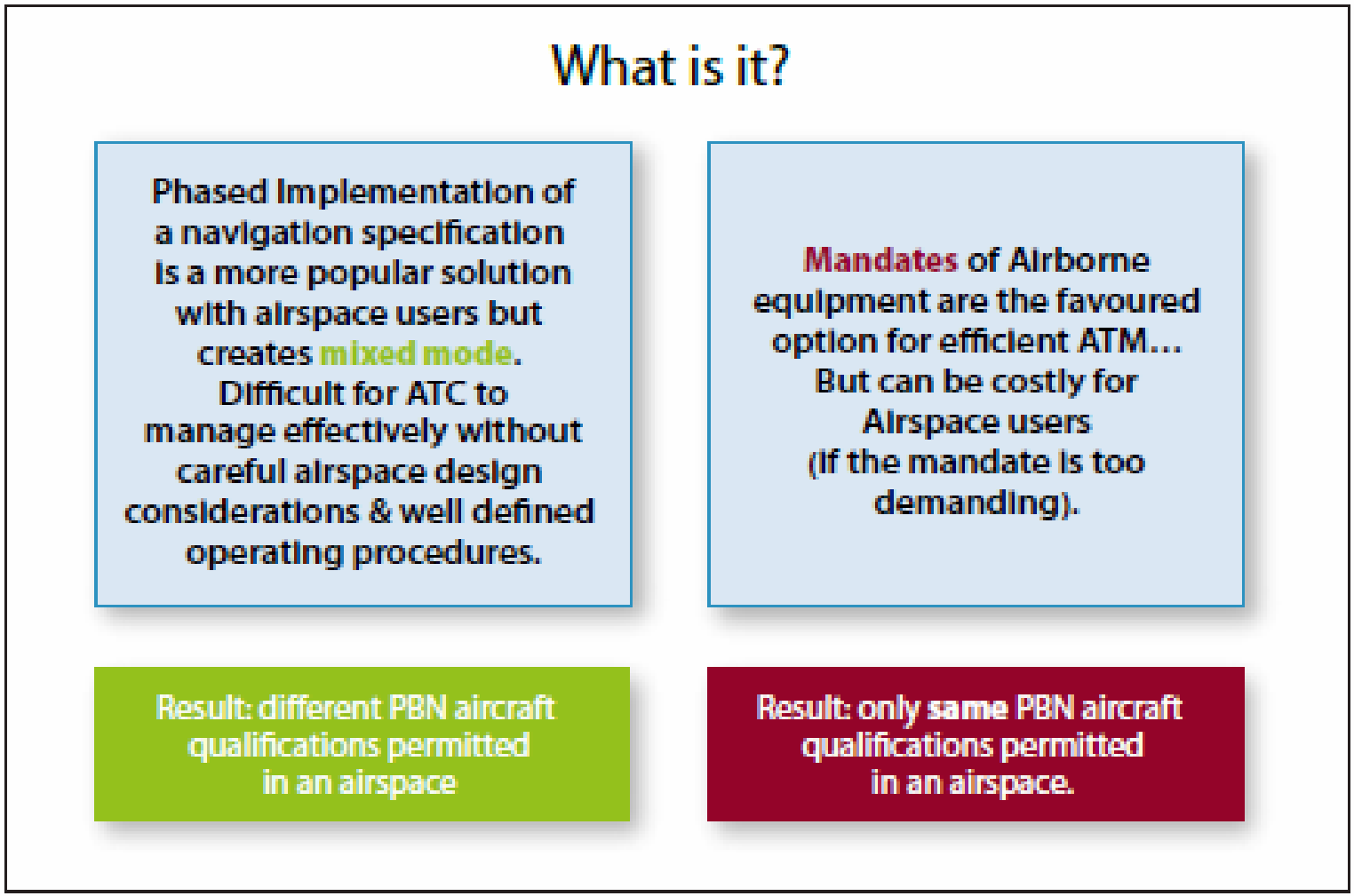
Mixed mode or Mandate?

- PBN raises the important questions: Is it necessary to **mandate** PBN aircraft equipage for operation along PBN ATS routes and/or SIDs/STARs?
- The alternative of a mandate is allowing a mix of navigation qualifications to operate in an airspace and having dedicated ATS Routes (incl. SIDs/STARs) for particular PBN qualifications. This is called ' **mixed mode**'.
- Evidence repeatedly shows that mixed mode difficult to manage in en route and terminal operations. Controllers usually end up radar vectoring everyone

Cost vs. Benefit (2/5)

Mixed mode or Mandate?

MIXED MODE



AU preference

ATM preference

Cost vs. Benefit (3/5)

Why have mixed mode?

- Mixed mode is typically used because
  - Keeps down aircraft operator costs: retrofits may be costly.
  - It may be physically impossible to retrofit old aircraft;
  - Physical/cost limitations of certain aircraft types.
- Consequences of mixed mode ..
  - No incentive for aircraft to obtain ops approval
  - Fleet retains mixed flavour
  - Navaid infrastructure evolution slowed
  - CBAs difficult to quantify.

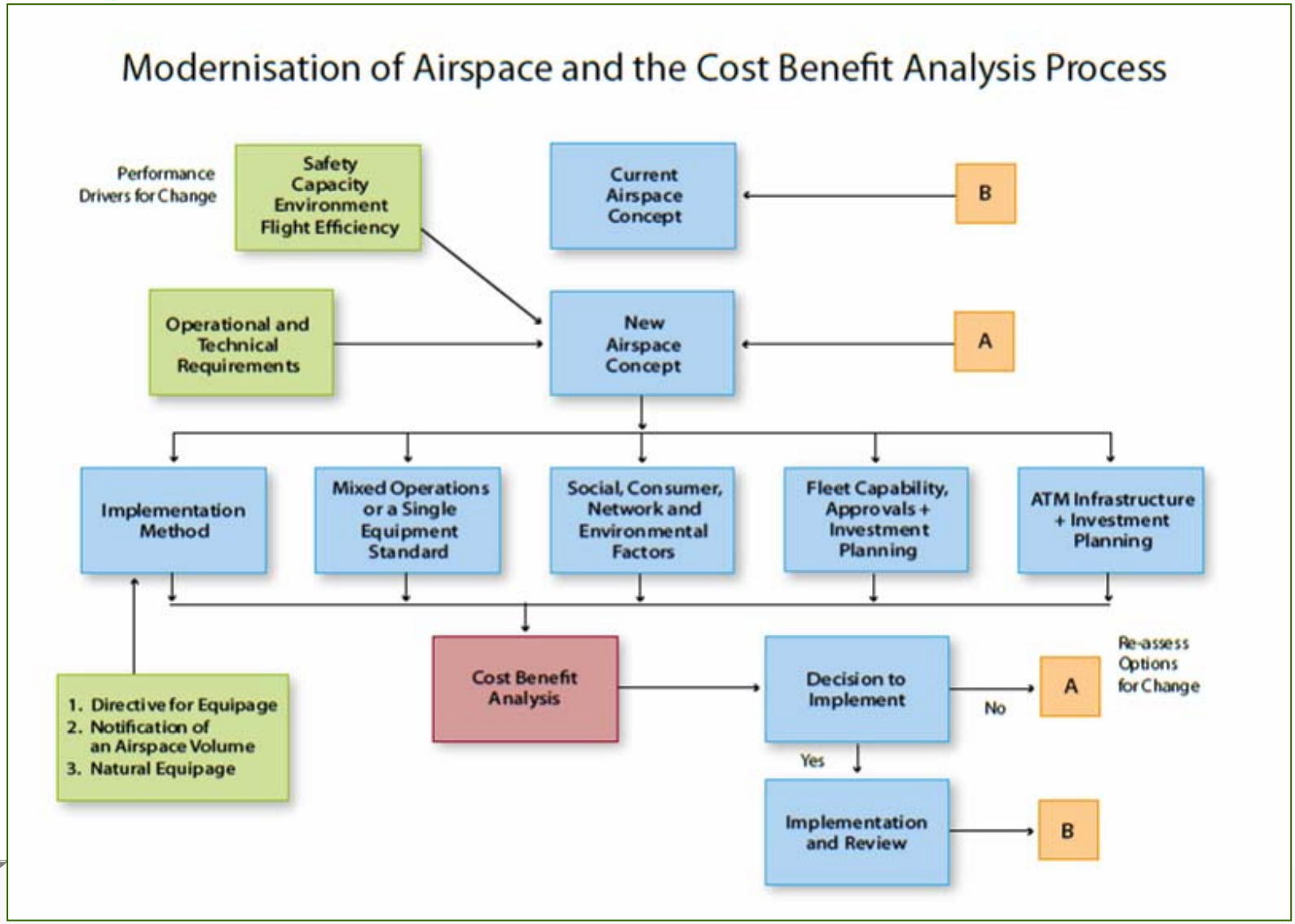
Analysing Cost Vs. Benefit (4/5)

CBAs needed to justify mandates

- CBAs – demanding and exacting process
- Need to know the cost of the proposed change
  - FMS upgrades
  - STC/Certification costs for manufacturer, passed on to the aircraft operator.
- Upgrades cost money. They need to be worth it.

Analysing Cost Vs. Benefit (5/5)

State Sample



Navaid Infrastructure

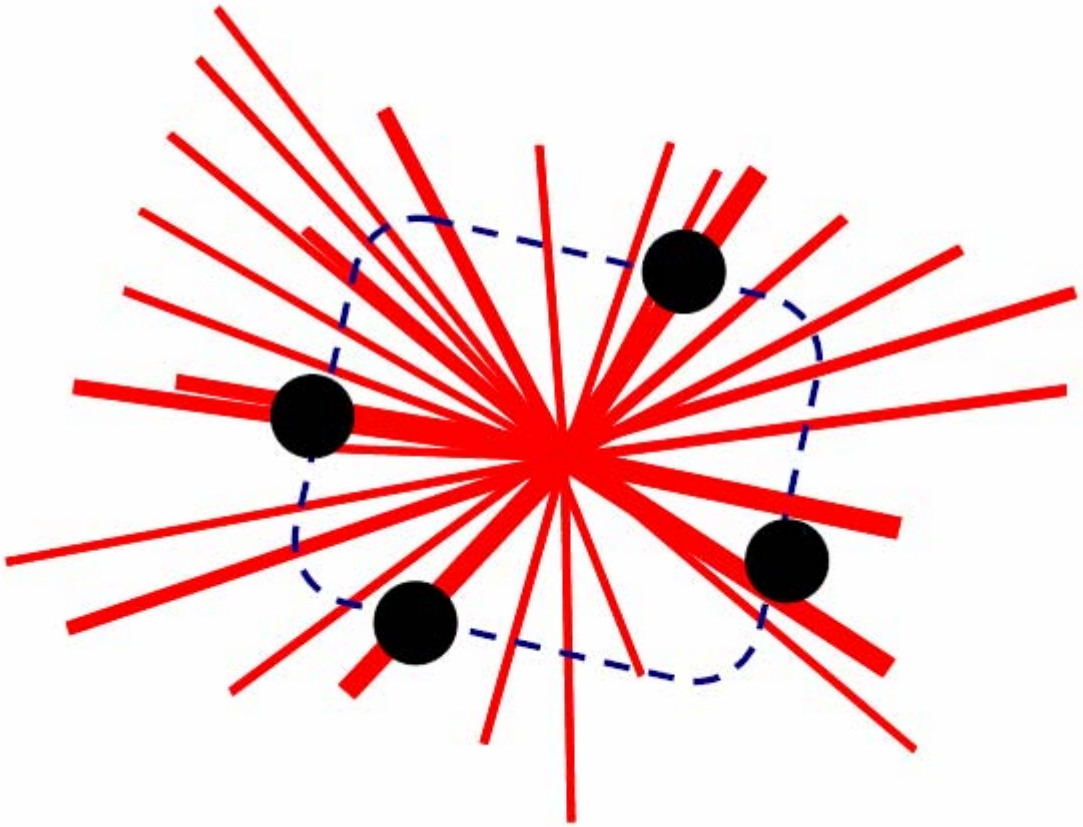
(also has cost implications)

- What is available?
  - GPS (can we use it?)
  - Augmentation (SBAS/EGNOS?)
  - DME (coverage?)
- Are the aircraft equipped?
  - Navaid Infrastructure availability must match fleet equipage.

Navaid Infrastructure > Nav Specs

NAV SPEC	NAVAID				
	GNSS	IRU	DME/ DME	DME/ DME/ IRU	VOR/ DME
RNAV 10	✓	✓			
RNAV 5	✓	✓	✓		✓
RNAV 2 & 1	✓		✓	✓	
RNP 4	✓				
RNP 2	✓		✓	✓	
RNP 1	✓		✓	✓	
Advanced RNP	✓		✓	✓	
RNP APCH APV Baro	✓				
RNP APCH APV SBAS	✓ + SBAS				
RNP AR APCH	✓				
RNP 0.3	✓				

Assumptions



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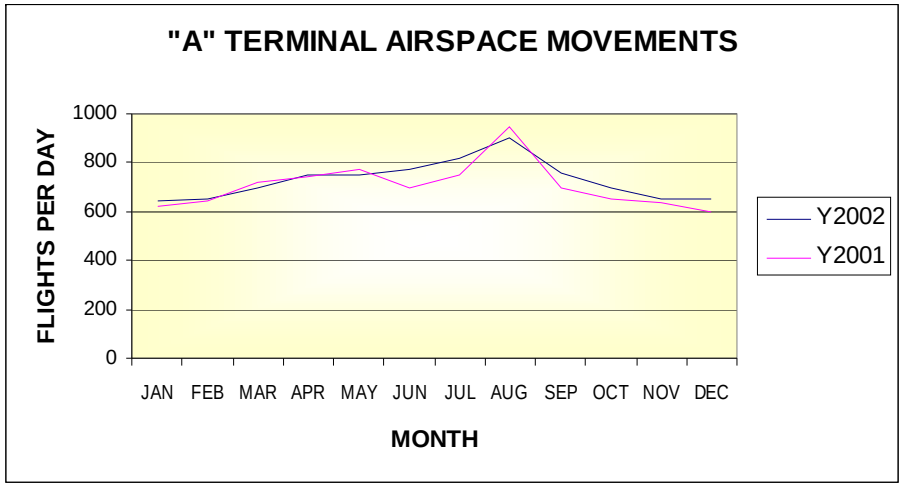
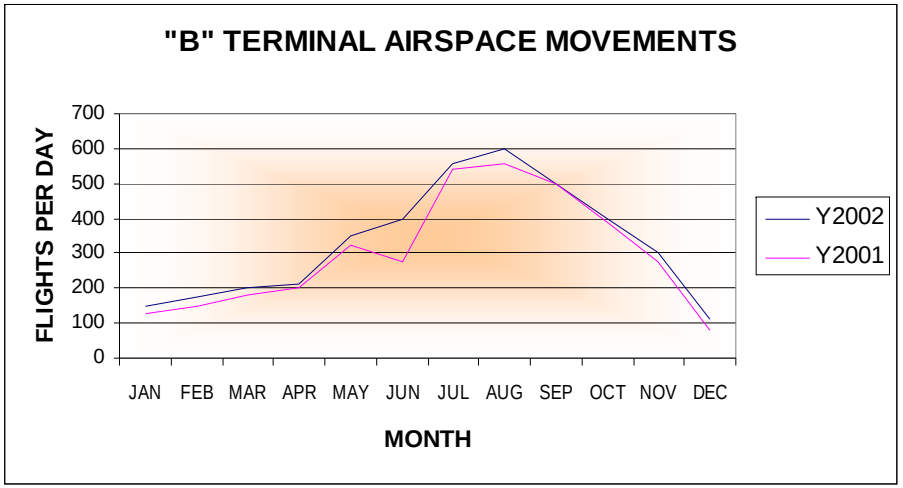
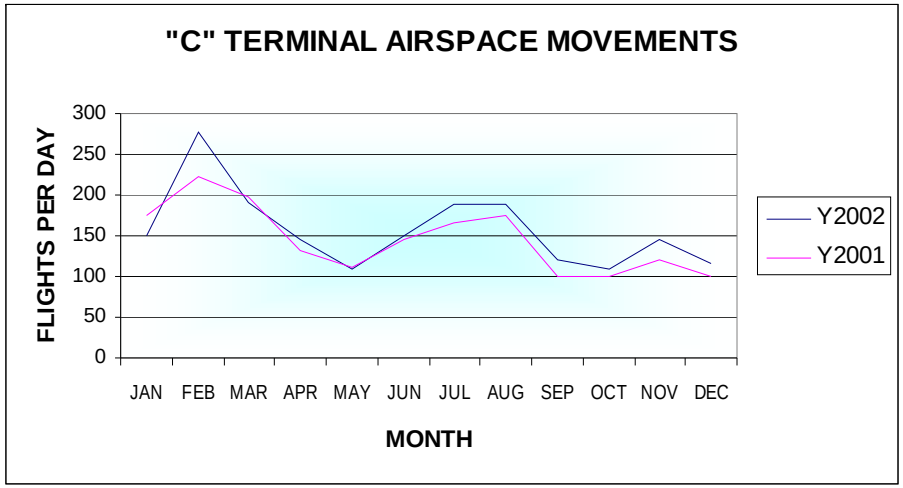
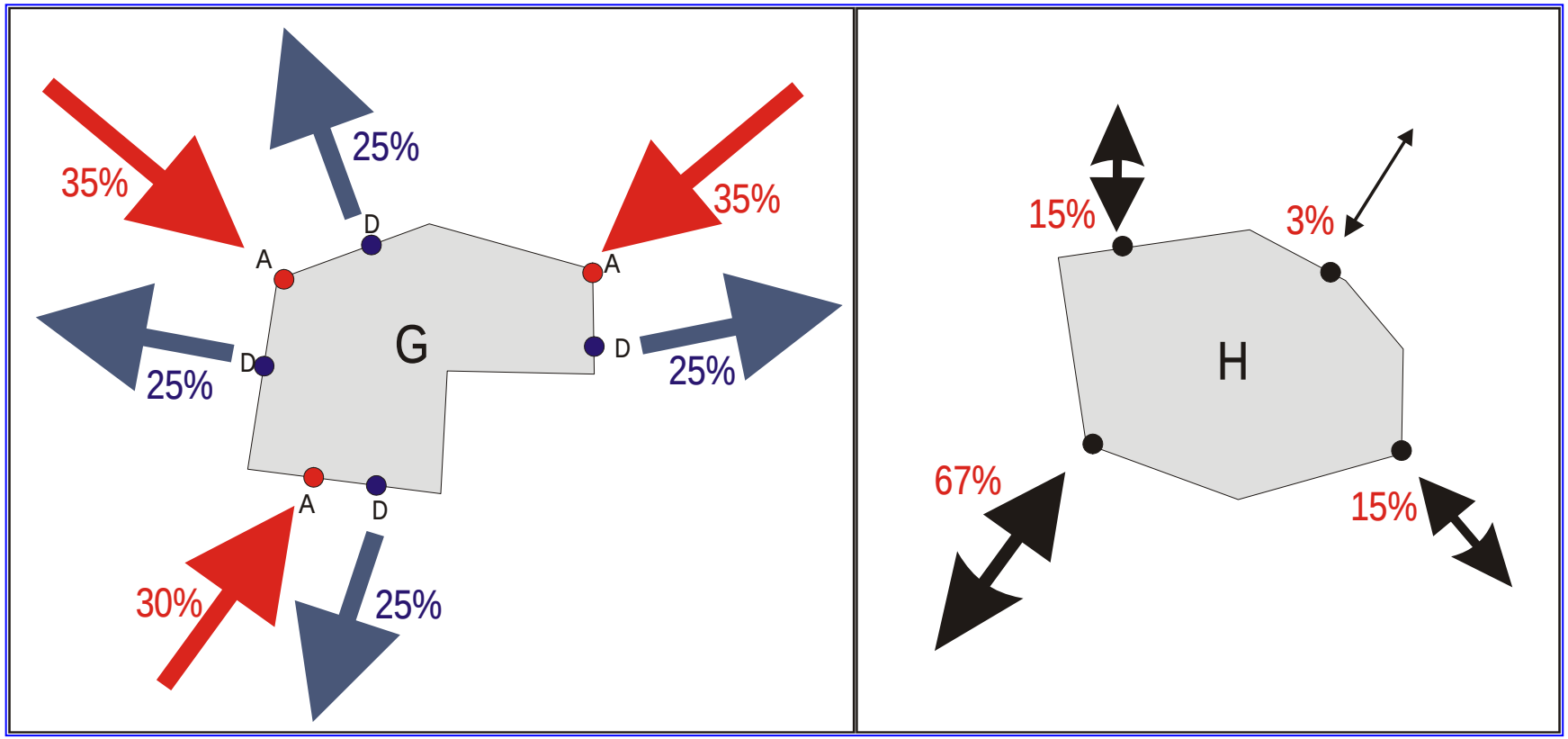






Assumptions



Kapitali Assumptions: Fleet Characteristics

- 75 % GPS/DME equipped
- 95 % DME
- **ALL** RNAV 5 approved
- 65% RNAV 1 approved
- 25% Retro-fittable
- 10 % too old

Kapitali Assumptions: Infrastructure and Technical

- Two radar (APP and feed from ACC) full coverage as from 2000ft update rate
- 10 revolutions per min
- Full RADAR and Flight plan Data Processing (FDP)
- Approach Capabilities:
  - RWY 04 ILS CAT III
  - RWY 22 NPA - discuss
- DME coverage over whole TMA from 2000 ft
- NDB for NPA

Which Nav Spec for Kapitali?

Navigation Specification	Flight phase								Additional Functionalities (Required or Optional)			
				Approach								
	En route oceanic/ remote	En route continental	Arrival	Initial	Intermediate	Final	Missed[1]	DEP	RF	FRT	TOAC	Baro VNAV
~~RNAV 10~~	~~10~~											
~~RNAV 5[2] AMC 20-4~~		~~5~~	~~5~~									
SID/STARs RNAV 2		2	2					2				
SID/STARs RNAV 1 *Rev 1* *JAA TGL 10*		1	1	1	1		1	1				O
~~RNP 4~~	~~4~~									O		
~~RNP 2~~	~~2~~	~~2~~								O		
SID/STARs RNP 1[3]			1	1	1		1	1	O[8]			O
SID/STARs Advanced RNP[4]	2[5]	2 or 1	1	1	1	0.3	1	1	R[8]	O	O	O
FA RNP APCH[6] *AMC 20-27* *AMC 20-28*				1	1	0.3	1		O[8]			O
~~RNP AR APCH~~ *AMC 20-26*				1-0.1	1-0.1	0.3-0.1	1-0.1		*Specific requirements for RF & VNAV*			
~~RNP 0.3[7]~~		~~0.3~~	~~0.3~~	~~0.3~~	~~0.3~~		~~0.3~~	~~0.3~~	~~O[8]~~			~~O~~

A few examples ….

- Changing a Radar for approach
- Blocked military airspace – that wasn't
- Changing planned Runway orientation
- Change to the number of runways available

It's *really* cheaper getting the assumptions/enablers/constraints RIGHT

THANK YOU