RECAT Phase II Updates

Presented by DOT Volpe Center in support of FAA

WakeNet3-Europe: 4th Major & Final Workshop
Wake Turbulence in Current Operations and Beyond
28th & 29th February 2012 - DFS Headquarters in Langen, Germany

Acknowledgement

- RECAT Phase I Team
- RECAT Phase I Reviewers

Disclaimer

- This brief presents a snapshot of a work in progress!

RECAT

- Phase I is static six category separation
- Phase II is static pair-wise separation
- Phase III is dynamic pair-wise separation
- All three phases directly support NextGen and SESAR capacity enhancement goals

RECAT Phase I

- Joint effort led by FAA-EUROCONTROL
  - Moves away from the take-off weight based standard
  - Uses vortex physics related parameters such as wingspan, circulation, etc.
- Static six category separation
  - Used ½ NM increments
- Phase I RECAT study completed in 2011
  - ICAO level implementation currently not possible
  - However, some ANSPs are interested in implementing it
  - RECAT team welcomes the opportunity in working with various interested partners
- Meanwhile, Phase II activity is underway

Current ICAO Separation

		Follower			
		A380	Heavy	Medium	Light
Leader	A380		6NM	7NM	8NM
	Heavy		4NM	5NM	6NM
	Medium				5NM
	Light				

RECAT I Separation

RECAT Separation Matrix

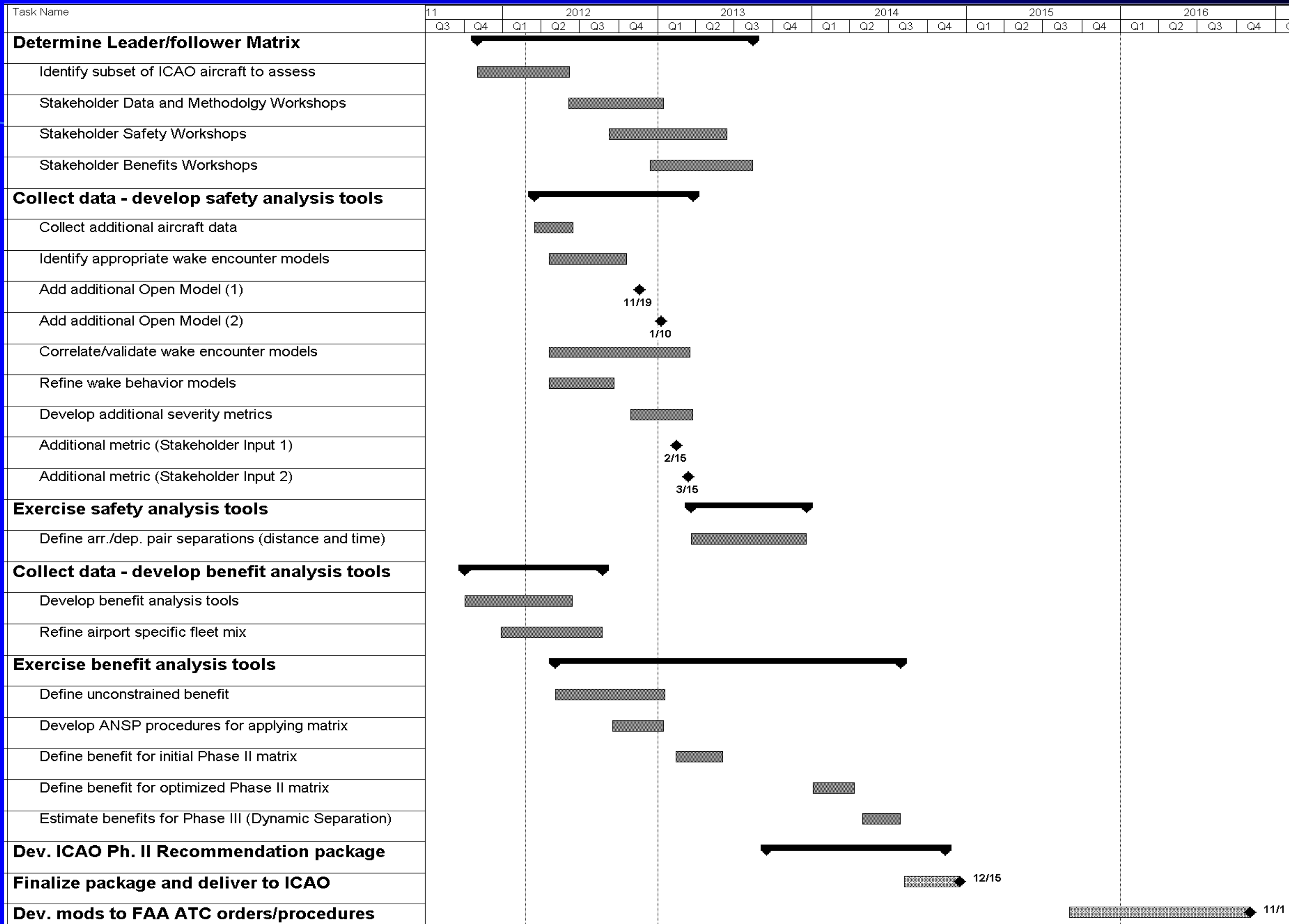
		Follower					
		A	**B**	**C**	**D**	**E**	**F**
Leader	**A**	MRS	5.0	6.0	7.0	7.0	8.0
	B	MRS	3.0	4.0	5.0	5.0	7.0
	C	MRS	MRS	MRS	3.5	3.5	6.0
	D	MRS	MRS	MRS	MRS	MRS	5.0
	E	MRS	MRS	MRS	MRS	MRS	4.0
	F	MRS	MRS	MRS	MRS	MRS	MRS

(green)	Separation was increased for some or all aircraft pairs
(blue)	Separation was decreased for some or all aircraft pairs
(white)	Separation remained the same for some or all aircraft pairs
MRS	Minimum Radar Separation (3NM, or 2.5 NM when existing requirements are met)

RECAT Phase II Team

- At the time of this brief, envisioned to be similar to Phase I
- Joint effort led by FAA and EUROCONTROL
  - Federal Aviation Administration
    - FAA ATO Air Traffic Operations
    - AVS Aviation Safety
  - EUROCONTROL
    - Airspace Department
    - Performance and Methods/Safety Assessment
    - Performance and Methods/Validation
  - Supporting Organizations
    - US Department of Transportation Volpe Center
    - MITRE CAASD Corporation
    - Northwest Research Associates, Inc.
    - International Subject Matter Experts / Consultants
- Enlargement of the team to include additional stakeholders is also under discussions

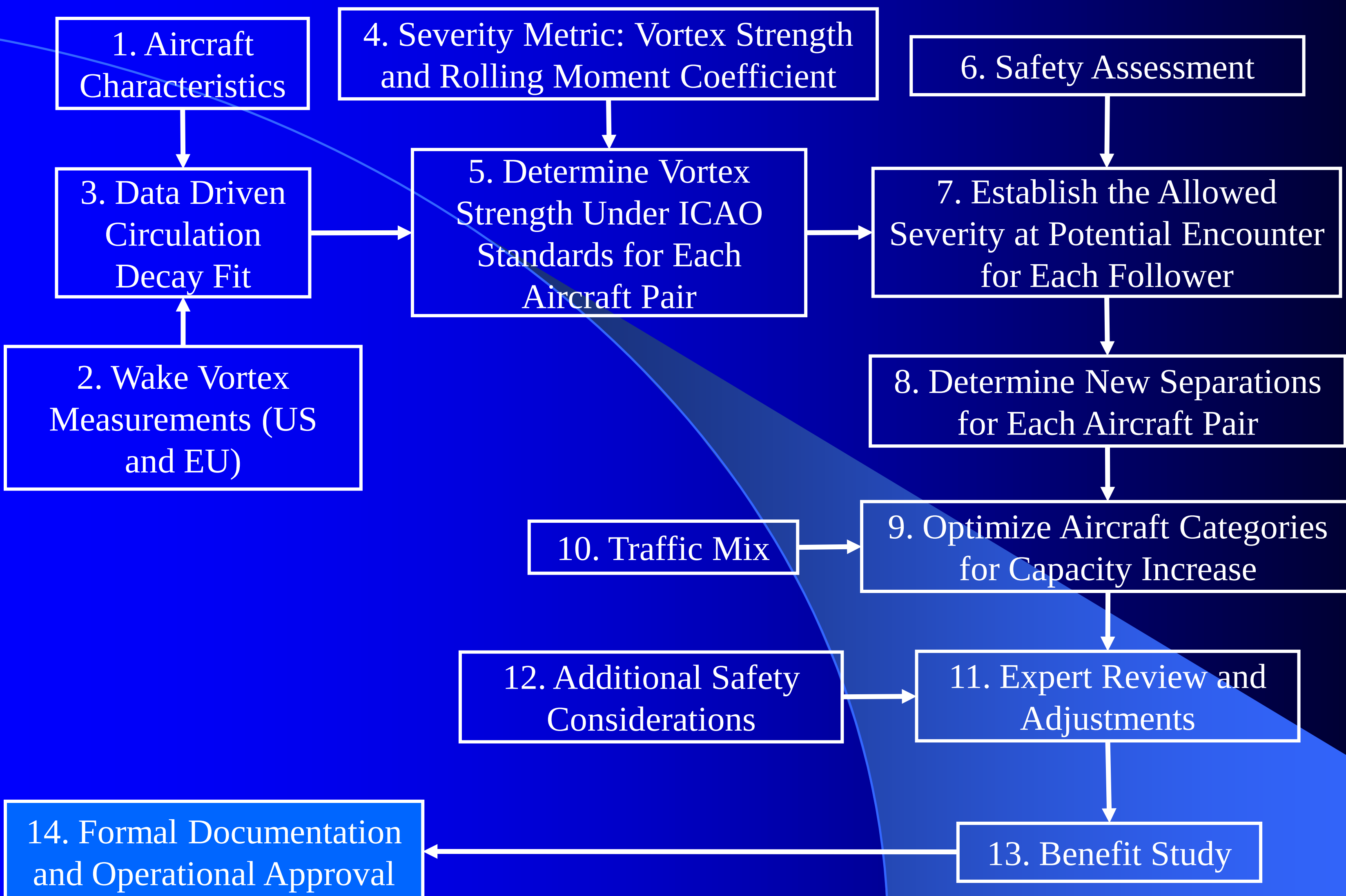
RECAT Phase II Schedule



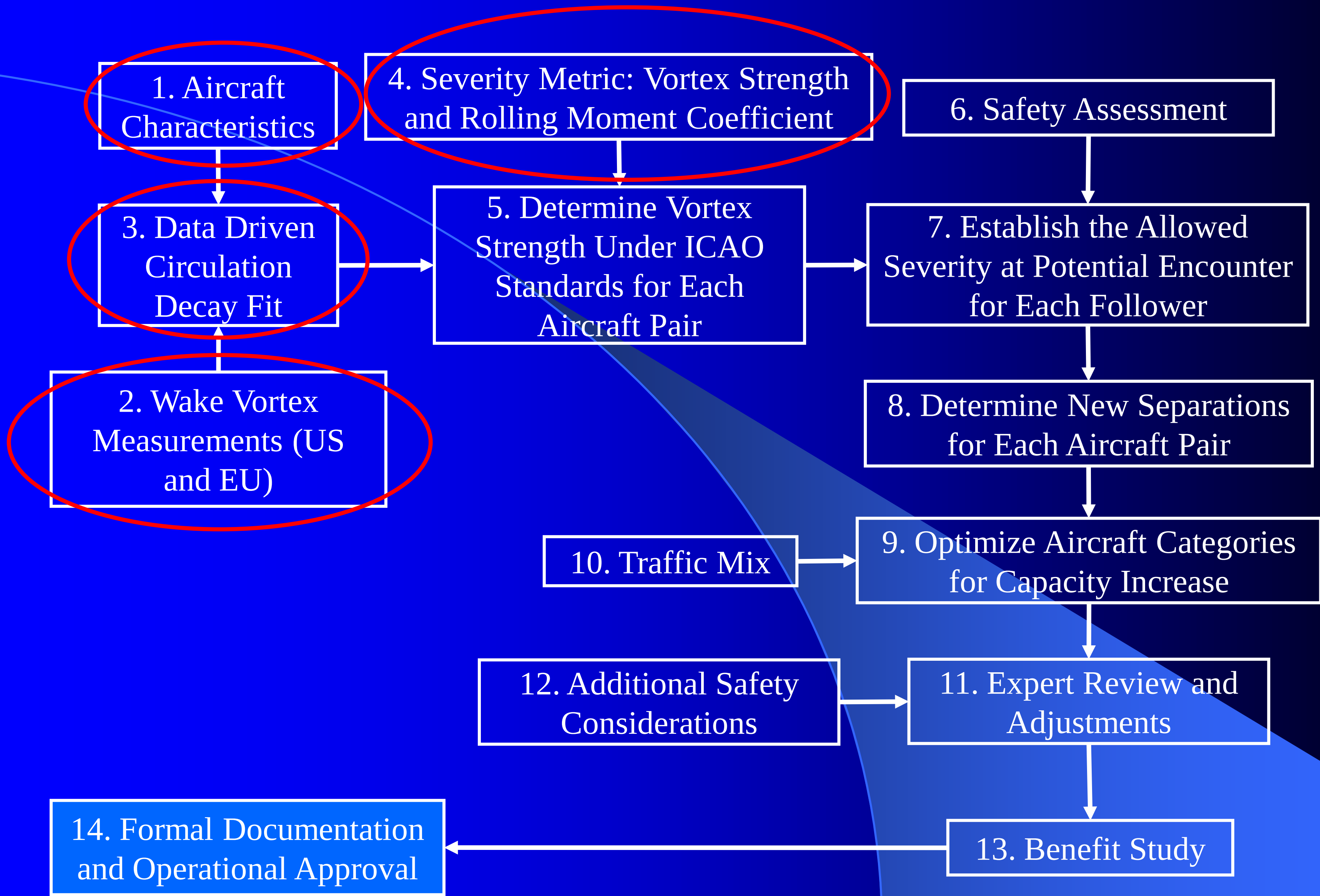
RECAT Phase II Methodology

- Higher level philosophy remains the same as Phase I
  - Incorporating various feedback from Phase I
  - Relative safety assessment : As safe or safer than today’s ICAO
  - Focusing on NGE/IGE regime
  - Transparency: Openly available tools and data, with the exception in the event that manufactures, airlines, etc. would like to contribute to the database
  - Optimization: Static Pair-Wise separation essentially ensures that capacity is automatically optimized for each airport
  - May provide separation minima in less than ½ NM increments

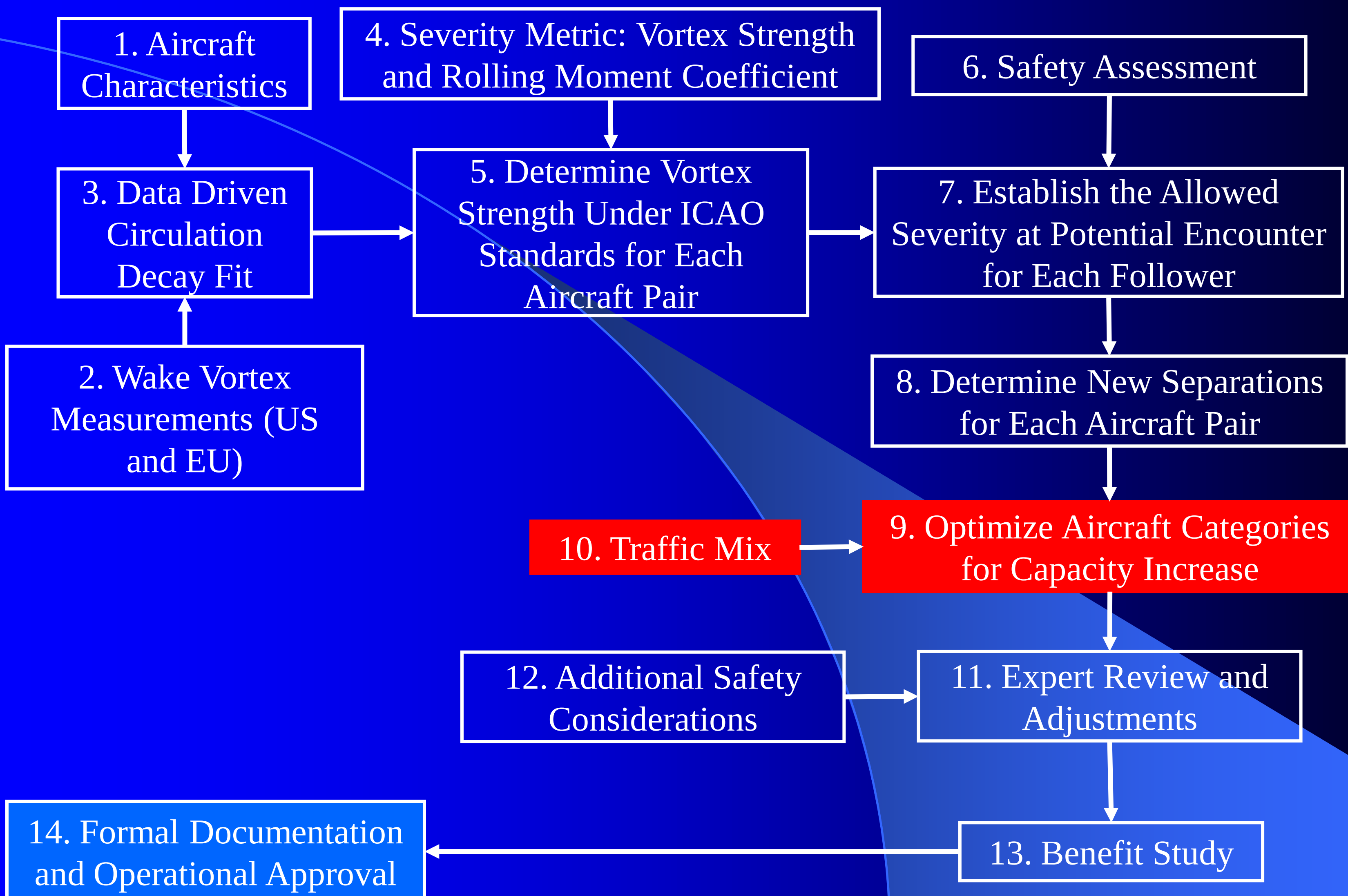
Overview of RECAT I Methodology



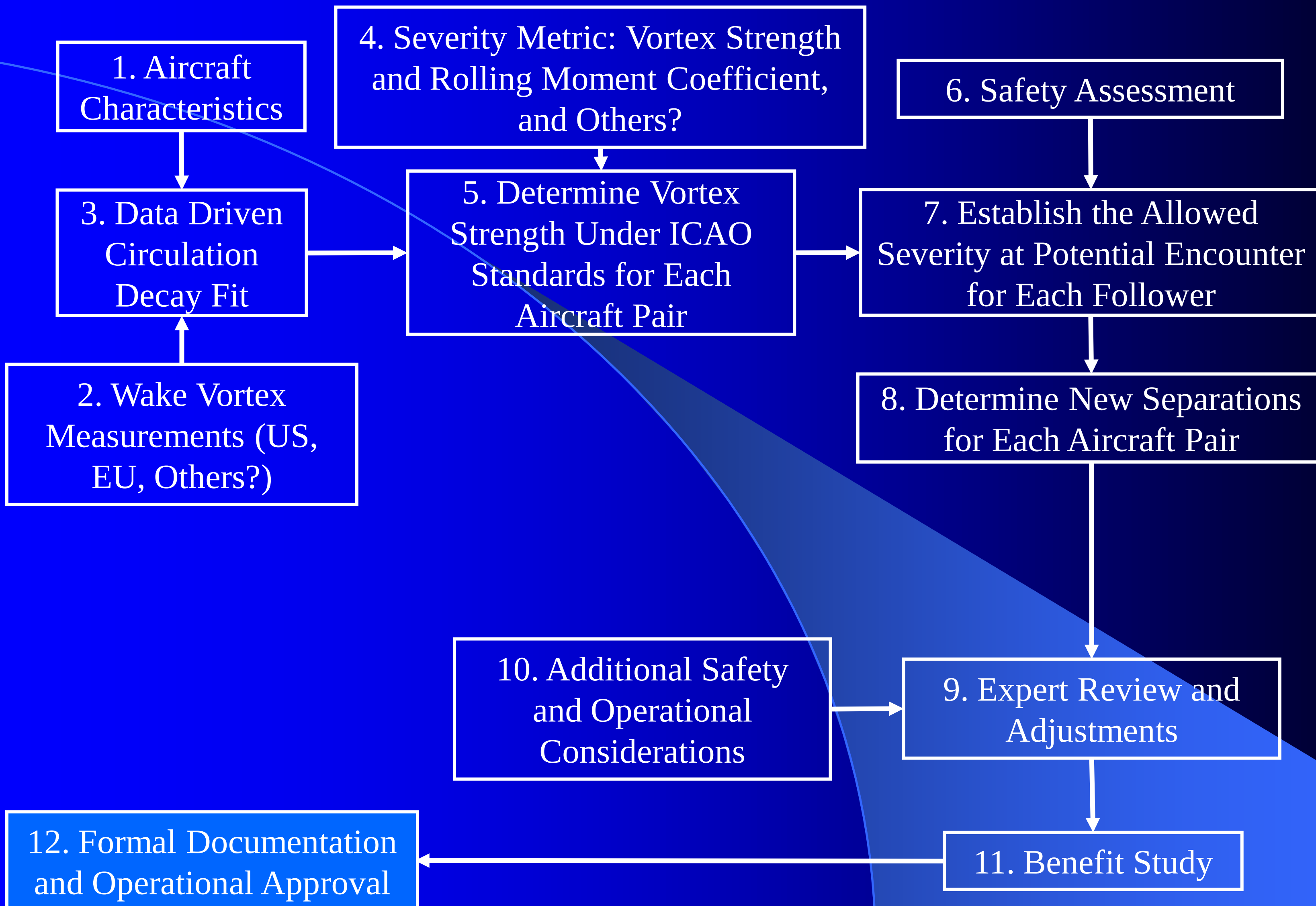
Enhancement Areas in RECAT II Methodology



Blocks Unnecessary in RECAT II Methodology



Revised RECAT II Methodology - Preliminary



Examples of the Component Enhancements

Representative but Not Exhaustive

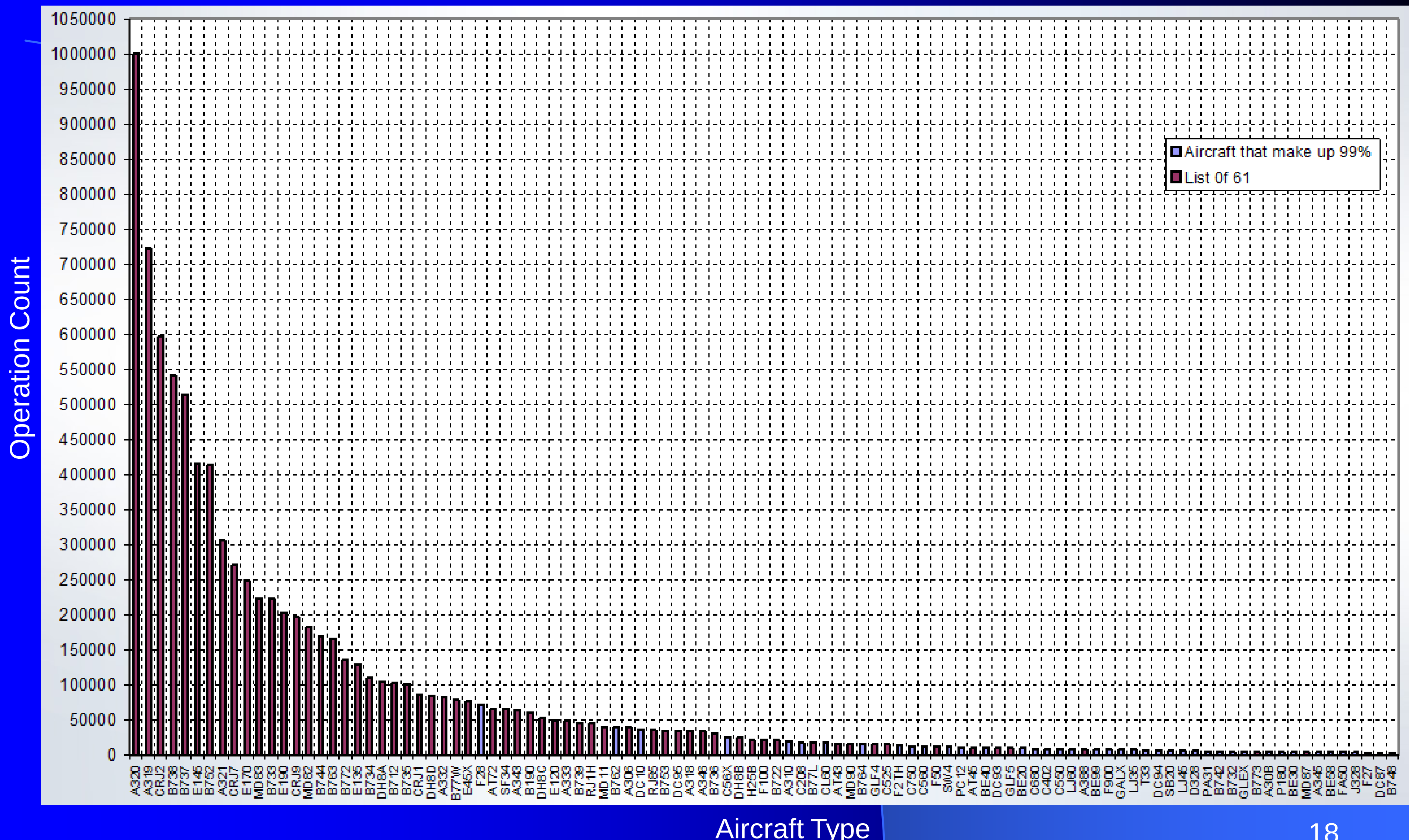
Aircraft Fleet Mix Characterization

- Using a more recent traffic dataset (2010)
  - Examine the number of aircraft types needed to comprise 99 percent of the global traffic/movement
  - Will examine the model-make-series details to ensure aircraft sub-types are properly represented
  - Add new aircraft that have not yet met the 99 percent threshold
  - Solicit comments from ANSPs

Aircraft Fleet Mix Characterization

- The number of airports examined expands from 9 in RECAT 1 to at least 87 in Phase II
  - Phase I selected 61 aircraft types that comprised 85 percent of the movements in 9 US and EU airports
  - Phase II is currently examining the number of aircraft types needed to represent 99 percent of the movement globally in 2010
  - 87 airports so far have been selected to represent the global airport list
- Next slides illustrate that the number of aircraft to be included from a global perspective is very manageable
  - At the regional level, the number of aircraft types needed to comprise 99 percent of the local movement is actually far less than the global value

103 ICAO Aircraft Designators to Make Up 99% Movement in 87 Airports Globally – 2010 Data



Wake Decay Curves

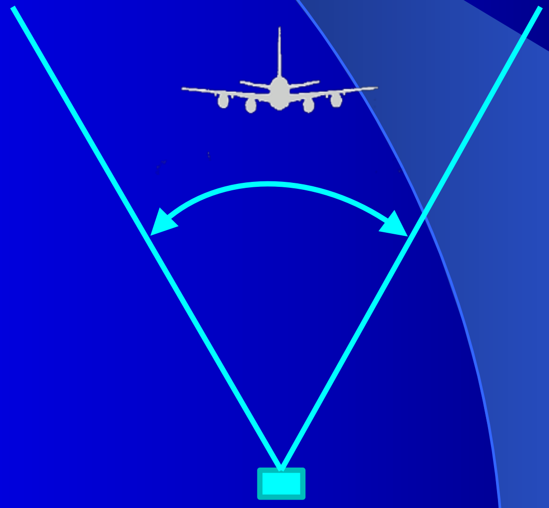
- Continuation of wake data collection by FAA since the RECAT I effort permits refinement opportunities of the decay curves
  - Not necessary to use 95 percent confidence interval around the median of the median decay curve (due to the level of data sharing possible in Phase I)
  - The recent / ongoing FAA data collections also include EDR
  - Allows a more direct path to construct the conservative decay curves that even better captures the near worse conditions
  - Expect the decay curves to be similar, but removes the communication difficulties experienced in RECAT I
- Decay curves also involve “non-wake” parameters
  - An opportunity for individual airlines, airports and ANSPs to possibly contribute (for example, aircraft performance data)

Vortex Spacing

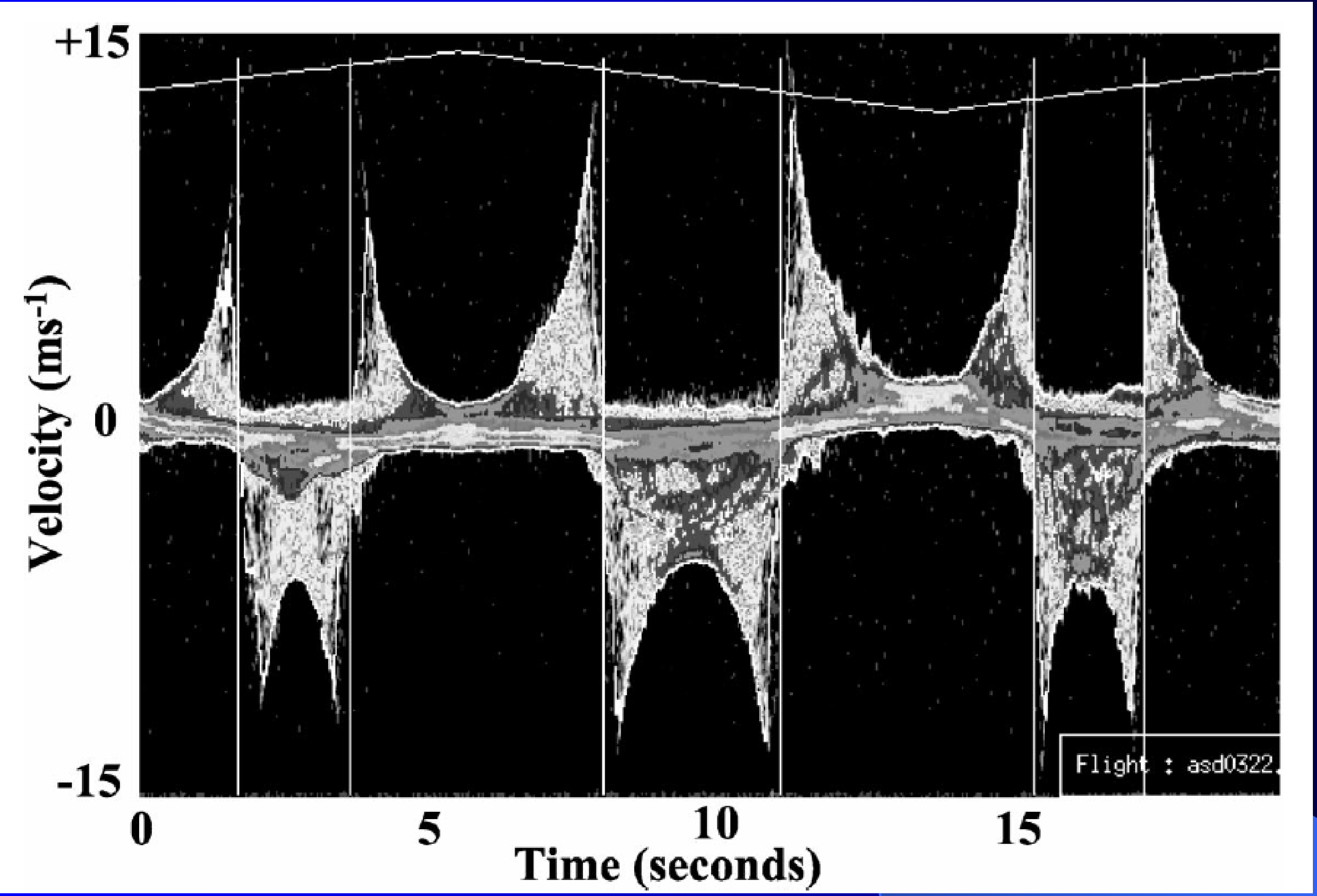
- A fundamental parameter associated with wake decay of individual aircraft
- Standard assumption is that airplanes have elliptic wing loading leading to vortex spacing as pi/4 of the wingspan
- Although recognized as a fundamental parameter, it is often difficult to obtain (measurement perspective) this parameter and aircraft manufacturers as a rule, do not release information that would lead to the estimate of this parameter

Vortex Spacing

- Continuous-Wave LIDAR situated under the flight path scanning upward traditionally has been considered as the optimal configuration to obtain vortex spacing
  - High range resolution of CW LIDARs at close range
  - High angular resolution
  - Both factors are advantageous to vortex spacing measurements



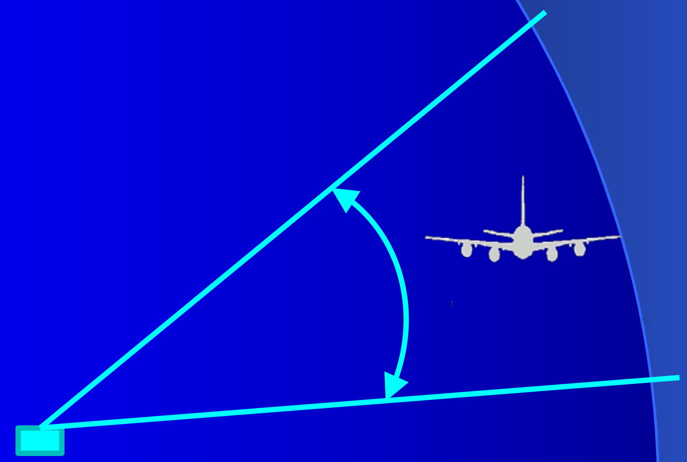
CW LIDAR Example on the Measurable Details of Wake Vortices



Aerosp. Sci. Technol. 4 (2000) pp. 363-370 : Example of a CW LIDAR Measurement Under the Flight Path of an A321 on Arrival. Note the Level of Vortex Structure Details Being Revealed – bo Can be Converted from Scan Information

Vortex Spacing

- Pulsed LIDARs (such as the LMCT WindTracers) are however becoming the standard form of LIDAR for wake vortex measurements due to its far superior range capability over CW LIDARs
  - Significant stand-off distance required
  - Scan geometry therefore typically is “side viewing”
  - Range resolution is less ideal for vortex spacing measurements
  - But still has high angular resolution
  - Consequently Pulsed LIDARs track wake descent well



Vortex Spacing

- A brief survey of the recent techniques used for obtaining vortex spacing
  - Inferred Method
  - Direct Methods

Vortex Spacing

- Inferred Method
  - Pulsed LIDAR measurements have good angular resolution thereby ensuring high altitude resolution of the measurements
  - Therefore these measurements track wake descent well
  - For a short post roll-up period, circulation and wake descent data can be combined to provide estimates on vortex spacing
  - Has been used in prior safety assessments

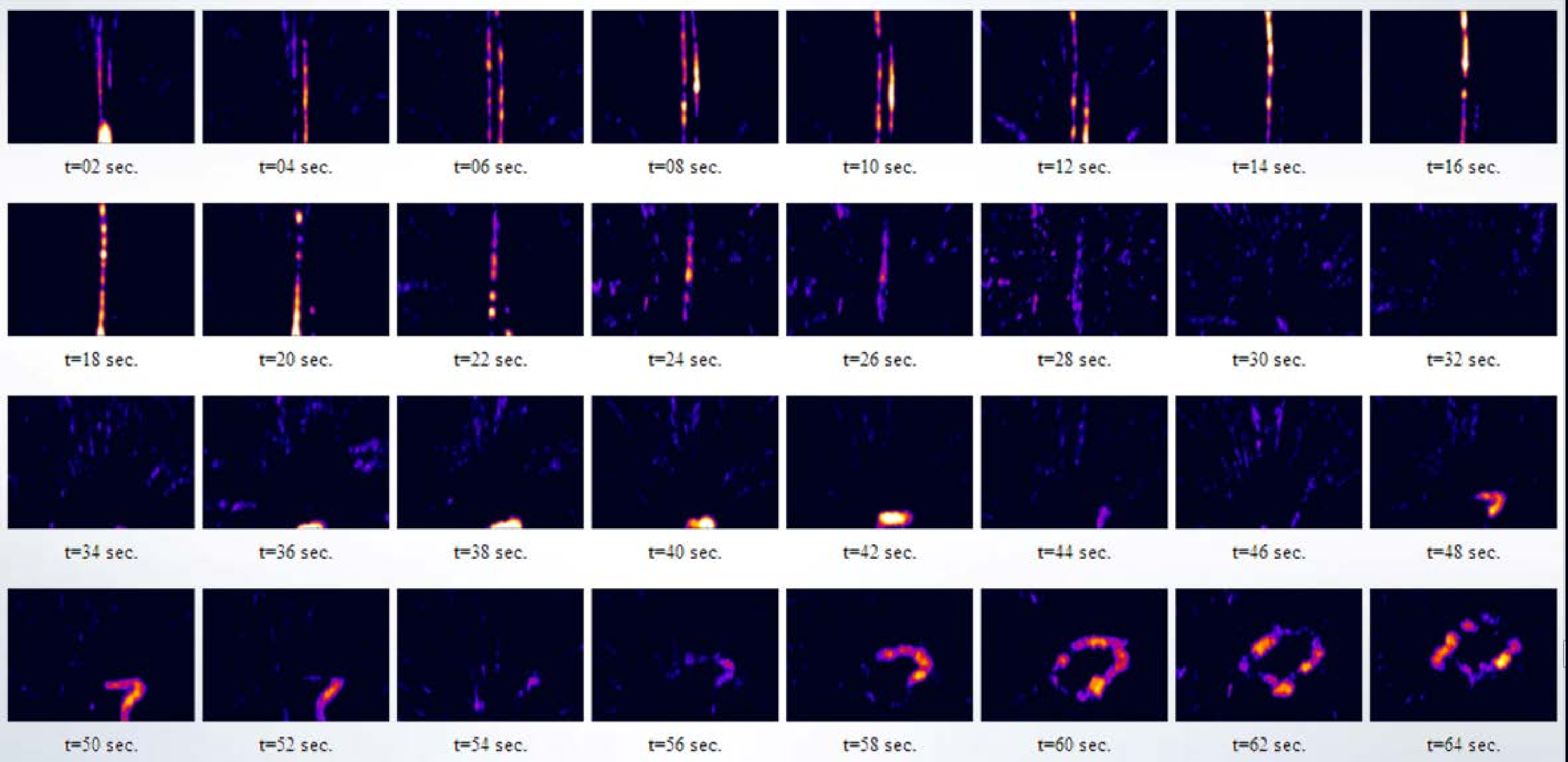
Vortex Spacing

- Direct Method 1
  - CW LIDAR measurements from historical tests in US and EU
  - Difficulty may be that most of the data no longer exist in raw form for this specific examination

Vortex Spacing

- Direct Method 2
  - Phased Microphone Array
  - DOT Volpe, NASA LaRC and TU-Berlin represent the institutional memories of these efforts back in 2003
  - Data and processing infrastructure from US still exist

Vortex Spacing from Phased Microphone Array



AIAA 2005-4849: 200-400 Hz Band, 10 ft by 10 ft Beamforming Grid at 500 Feet AGL - 1500 ft by 1000 ft Space ; B735

Vortex Spacing

- Direct Method 3
  - A new generation of compact pulsed LIDARs are now commercially available with shorter pulse widths than the LMCT WindTracers
  - Marketed for wind energy industry
  - But adaptable for wake vortex measurements – at least for bo
  - These compact LIDARs also require much shorter stand-off distances relative to the LMCT WindTracers, therefore can be fielded under the flight path with aircraft approaching altitude at around 200 m or less (the traditional CW LIDAR measurement altitudes)
  - FAA has recently tasked DOT Volpe Center to acquire two of these compact LIDARs
    - First unit arrived in February 2012
    - Second unit will arrive in March 2012
  - Will prioritize with FAA on the use of these assets (crosswind data for other aspects of the wake turbulence program vs. vortex spacing collection for RECAT)

Additional Severity Metric

- RECAT I uses a combination of circulation and rolling moment coefficient
- Phase II will explore additional static metric such as roll control authority
  - Data collection represents a challenge (opportunity for manufacturer input)
  - Pilot input / acceptability requires additional dedicated communication – opportunity for additional stakeholder input
- May explore others (e.g., dynamic metric) and factor in their associated validation and acceptability in the international end-user community – suggestions welcomed

Summary – 1/2

- RECAT Phase I Completed
  - ICAO level implementation not possible at this time
  - Specific ANSPs have however expressed interest in implementing it as is
- RECAT Phase II Effort Started
  - This brief provides some snapshots of the activities and areas of focus
  - Two year R&D program
- Phase II builds on the analytical infrastructure and feedback from various international stakeholders from Phase I

Summary – 2/2

- An additional desire of the overall RECAT effort, via active engagement, would be to provide information for airframe manufacturers allowing them to make informed design decisions in the future with wake vortex considerations. For example,
  - Wing loading
  - Roll control
  - Others
- Project continues to welcome constructive feedback from various stakeholders and research groups, and meaningful partnership sought