Upper E Traffic Management

February 19, 2020

Pre-decisional

Agenda

- Roll Call
- Looking back
- Updates
- Plans ahead
- Level setting
- Concepts

Roll call

Who's on the line?

- Company/Organization
- Vehicle type (if applicable)
- Brief background

Looking back

- Initial Table Top at NASA Ames (April) 2019
- ICAO Drone Enable 2019
- Second Table Top at NASA Ames (December) 2019

Updates

- Summary from Table Top almost complete
- Internal engineering work underway
  - Simulation platforms
  - Services
- Project planning

Plans ahead

- Meetings
  - Every ~3 weeks
  - Mix of NASA-led and AIA meetings
  - Targeting face-to-face in July
- ConOps development
- Agreements
- Simulation work
- Future testing
- Performance characteristics (homework)

Performance Characteristics Input (Part 1)

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Item	Description	Values
Model Name	Aircraft Name	
Model Type	Aircraft Type	
Default Weight class	Weight Class	
Max Climb Rate	Maximum Climb Rate	
Max Descent Rate	Maximum Descent Rate	
Eng Type	Engine Type	
Max Mach	Maximum Mach	
Min IAS	Minimum Indicated Air Speed	
Max IAS	Maximum Indicated Air Speed	
Max Alt	Maximum Altitude	
Default Climb Speed	Nominal Climb Speed	
Default Descent Speed	Nominal Descent Speed	
Default Climb Mach	Nominal Climb Mach	
Default Descent Mach	Nominal Descent Mach	
Max Apprch speed	Maximum Approach Speed	
Minimum CAS	Minimum Calibrated Air Speed	
Maximum CAS	Maximum Calibrated Air Speed	
Minimum Cruise CAS	Minimum Cruise Calibrated Air Speed	
Maximum Cruise CAS	Maximum Cruise Calibrated Air Speed	

Item	Description	Values
Maximum Takeoff	Maximum Takeoff Weight	
Operating Weight	Operating Weight Empty	
Typical Descent	Typical Descent Weight	
Approach Speed	Approach Speed Slope	
Max Approach Weight	Maximum Approach Weight Speed	
Max Weight FLAP	Maximum Weight Deflect Calibrated Air Speed	
Min Weight FLAP	Minimum Weight Deflect Calibrated Air Speed	
Gross Wing	Gross Wing Area	
Engine Name	Engine Name	
Engine Thrust	Engine Thrust Model	
Airframe Drag	Airframe Drag Model	
Number Of Engines	Number Of Engines	
Effective Number	Effective Number Of Engines	
Descent Drag	Descent Drag Scale Factor	
Decel Factor	Decel Factor (0.5-1.5)	
Descent Ratio Scale	Descent Ratio Scale	

Performance Characteristics Input (Part 2)

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Operations performance parameters

Model Category	Symbols	Units	Description
Aircraft type (3 values)	n_{eng}	Dimensionless	Number of engines
	engine type	String	Either Jet, Turboprop or Piston
	wake category	string	H (heavy), M (medium), or L (light)
Mass (4 values)	m_{ref}	tonnes	Reference mass
	m_{min}	tonnes	Minimum mass
	m_{max}	tonnes	Maximum mass
	m_{pyld}	tonnes	Maximum payload mass
Flight envelope (6 values)	V_{MO}	knots	Maximum operating speed
	M_{MO}	dimensionless	Maximum operating Mach number
	h_{MO}	Feet	Maximum operating altitude
	h_{max}	Feet	Maximum altitude at MTOW
	G_w	Feet/kg	ISA weight gradient on maximum altitude
	G_t	Feet/C	Temperature gradient on maximum altitude
Aerodynamics (14 values Or 16 values for jet	S	m^2	Reference wing surface area
	$C_{D0,CR}$	dimensionless	Parasitic drag coefficient (cruise)
	$C_{D2,CR}$	dimensionless	Induced drag coefficient (cruise)
	$C_{D0,AP}$	dimensionless	Parasitic drag coefficient (approach)
	$C_{D2,AP}$	dimensionless	Induced drag coefficient (approach)
	$C_{D0,LD}$	dimensionless	Parasitic drag coefficient (landing)
	$C_{D2,LD}$	dimensionless	Induced drag coefficient (landing)
	$C_{D0,\Delta LDG}$	dimensionless	Parasitic drag coef. (landing gear)
	C_{M16}	dimensionless	Mach drag coefficient
	$V_{stall,TO}$	knots(CAS)	Stall speed [TO]
	$V_{stall,IC}$	knots(CAS)	Stall speed [IC]
	$V_{stall,CR}$	knots(CAS)	Stall speed [CR]
	$V_{stall,AP}$	knots(CAS)	Stall speed [AP]
	$V_{stall,LD}$	knots(CAS)	Stall speed [LD]
	$C_{Lbo(M=0)}$	dimensionless	Buffet onset lift coefficient (jet only)
	K	[1/M]	Buffeting gradient (jet only)
Engine thrust (12 values)	$C_{Tc,1}$	Newton (jet/piston)	1st max. climb thrust coeff.
	$C_{Tc,2}$	Knot-Newton(turboprop)	2nd max. climb thrust coeff.
	$C_{Tc,3}$	Feet	3rd max. climb thrust coeff.
	$C_{Tc,4}$	1/feet^2(jet), N(turboprop), kN (piston)	1st thrust temperature coeff.
	$C_{Tc,5}$	deg.C	2nd thrust temperature coeff.
	$C_{Tdes,low}$	1/deg.C	Low altitude descent thrust coeff.
	$C_{Tdes,high}$	Dimensionless	High altitude descent thrust coeff.
	h_{des}	Feet	Transition altitude for calculation of descent thrust
	$C_{Tdes,app}$	Dimensionless	Approach thrust coeff.
	$C_{Tdes,ld}$	Deimensionless	Landing thrust coeff.
	$V_{des,ref}$	Knots	Reference descent speed (CAS)
	$M_{des,ref}$	dimensionless	Reference descent Mach number

Model Category	Symbols	Units	Description
Fuel flow (5 values)	C_{f1}	Kg/min/kN(jet), kg/min/KN/knot (turboprop), Kg/min (piston)	1st thrust specific fuel consumption coeff.
	C_{f2}	knots	2nd thrust specific fuel consumption coeff.
	C_{f3}	Kg/min	1st descent fuel flow coeff.
	C_{f4}	feet	2nd descent fuel flow coefficient
	C_{fcr}	dimensionless	Cruise fuel flow correction
Ground movement (4 values)	TOL	m	Take-off length
	LDL	m	Landing length
	Span	m	Wingspan
	length	m	length

- What's realistic for a return date?
- Targeted discussion on parameters beforehand?
- Additional information on flight characteristics

Level Setting/Concept Development

- FAA initial focus is on further iterating on what we went over during the December tabletop:
  - Transition
  - Operations straddling Upper E
  - Contingency management
- Will likely solicit additional input for targeted topics
- Our initial focus will be on operations at altitude and development of the concept as it applies to a cooperative environment

Topic Areas

- Cooperative paradigm
- Approach to conflict management
- Intent sharing
- Information exchanges
- Services
- Architecture
- Special considerations
- Accountability
- Risk management
- How the system learns
- Airspace structures
- ANSP interaction
- …

Initial Approach

- Nominal operations
- Strategic deconfliction
- Architecture
- Intent sharing and updating
- Conflict Management
  - Detection
  - Resolution
  - Rules

Initial Simulations

- Initial fast time simulations will focus on growth in uncertainty as a function of time
- Will provide insight into:
  - Intent sharing and the appropriate time horizons for communication and updates
  - Airspace Efficiency
  - Conflict management

Scenario Input

- Mix of aircraft
- Density
- Encounters
- …

Framing from UTM

Technical Capability Levels (TCL) Progression for System Development and Testing

TCL1	TCL 2	TCL 3	TCL 4
Remote Population	Sparse Population	Moderate Population	Dense Population
Low Traffic Density	Low-Mod Traffic Density	Moderate Traffic Density	High Traffic Density
Rural Applications	Rural / Industrial Applications	Suburban Applications	Urban Applications
Multiple VLOS Operations	Multiple BVLOS Operations	Mixed Operations	Dense BVLOS Operations
Notification-based Operations	Tracking and Operational Procedures	Vehicle to Vehicle Communication	Large Scale Contingency Management
		Public Safety Operations	

Framing: TCL Equivalent

DRAFT: For Discussion Purposes

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Level 1	Level 2	Level 3	Level 4
Low Traffic Density	Low-Mod Traffic Density	Moderate Traffic Density	High Traffic Density
Mostly slow moving operations	Supersonics present	Vehicle to Vehicle Communication	Large Scale Contingency Management
Mix of cooperative and non-participating	Greater level of cooperative	Contingency Management	Hypersonics (?)
	Conflict management service	Space Launches (?)	

Next Steps

- Performance information
- Adaptation
- Follow-on meetings
- Outreach events

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Questions?

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