



Mission Planning Systems

Systems Certification and Integrity
Directorate of Aviation Engineering
Directorate General Technical Airworthiness

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Directorate General Technical Airworthiness (DGTA-ADF)



Overview

- What is a mission planning system?
- Technical Airworthiness Aspects of Mission Planning Systems
- Integrity Requirements for Mission Planning Systems

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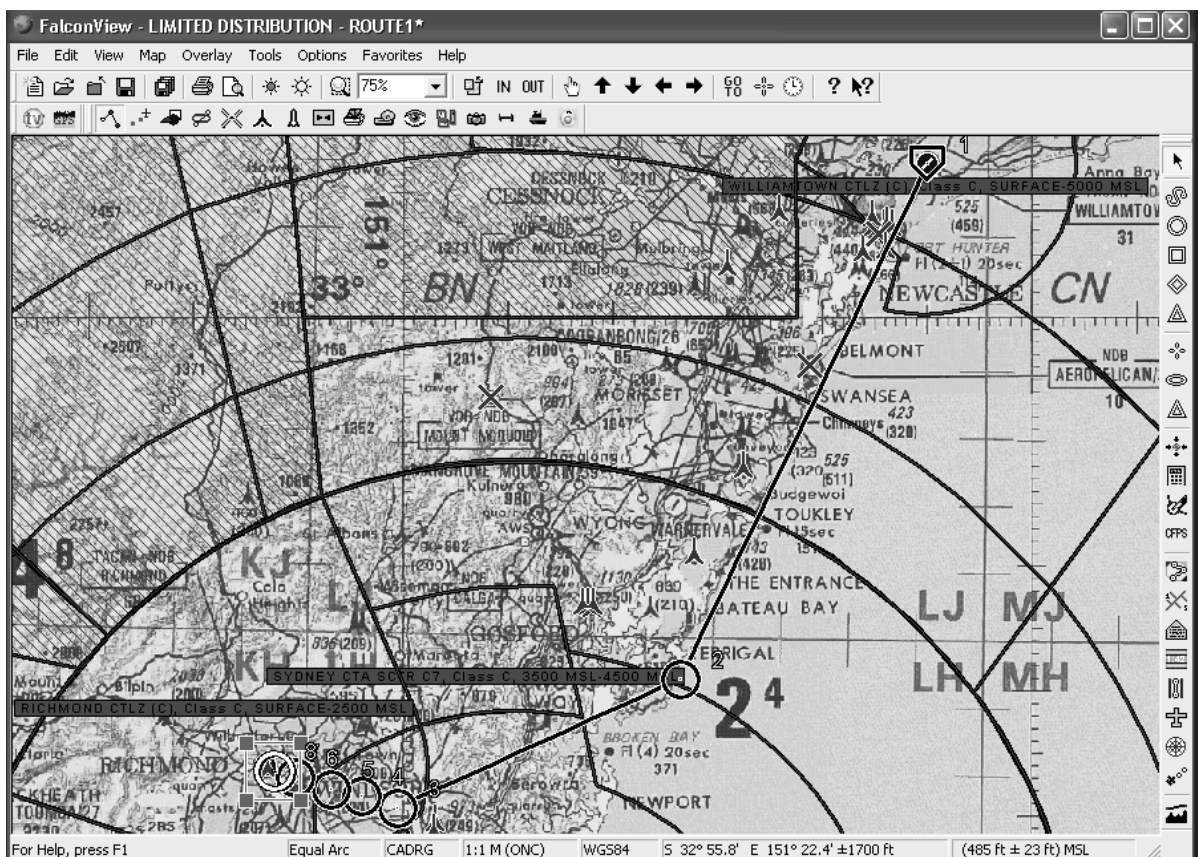


What is a mission planning system?

- A suite of software applications and associated hardware that allow maps, charts, weather, intelligence and aircraft performance data to be used in developing navigation solutions, communication settings, flight/mission calculations, etc.
- **Examples:**
 - Portable Flight Planning System
 - Joint Mission Planning System
 - Ground Mission Management System
- **Functions performed (generally):**
 - Aircrew enter flight details (waypoints, aircraft loading, etc).
 - MPS performs calculations to validate mission plan.
 - e.g. Is weight and balance within limits?
 - MPS produces data to be loaded to the aircraft.
 - e.g. sequence of waypoints, TOLD, digital maps

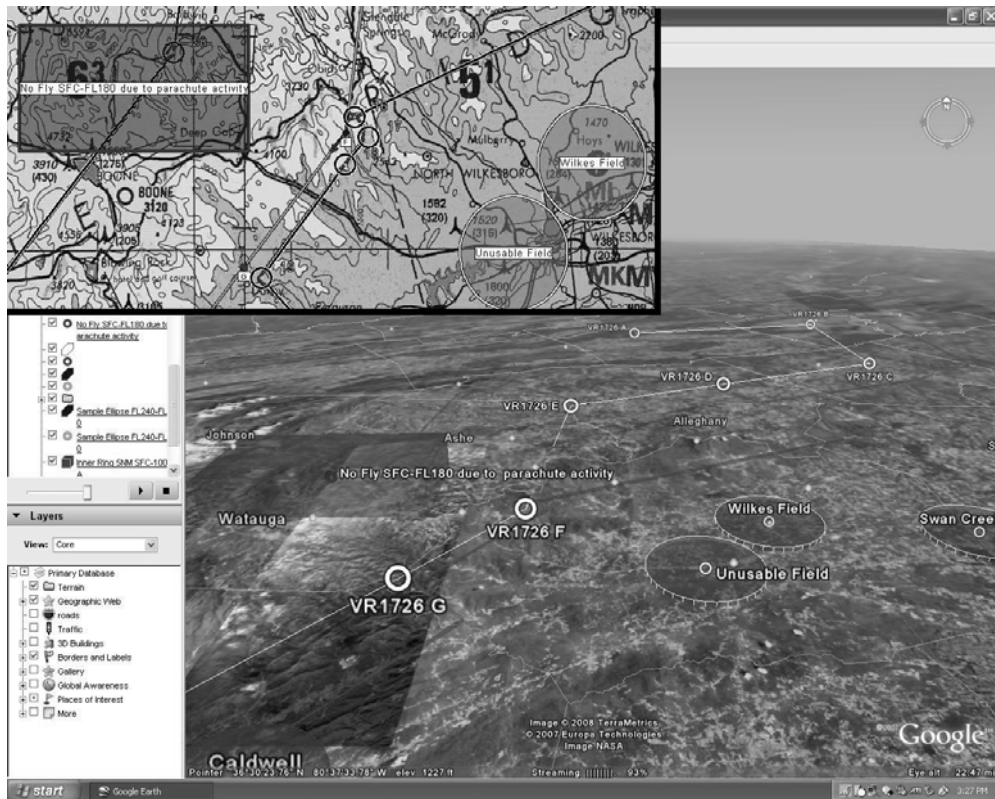


PFPS/JMPS





Is this a good idea?



Mission Planning and Google Earth?

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Technical Airworthiness Aspects of MPS

- There are hazards associated with MPS:
 - Errors can be introduced into databases.
 - Calculations can be incorrect.
- MPS must be assured commensurate with the severity of associated hazards.
 - No different to any other system with safety implications.
- Knowledge of operational processes is required to determine how severe the hazards are.
- ADF policy is based on FAA policy, with some changes to account for ADF use of MPS.

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Common MPS Hazards

- Erroneous Weight and Balance Calculations
- Erroneous Take Off and Landing Data Calculations
- Erroneous Fuel Usage Calculations
- Incorrect Translation of Waypoint Map Coordinates
- Erroneous Data Packages for Guided Weapons
- Introduction of Errors into Aeronautical Data
 - Transfer, Formatting or Translation
 - Digital Maps
 - Navigation Databases
 - Airfield Databases
 - Digital Terrain Elevation Data



Background – FAA Policy

- MPS are not directly considered by FAA policy.
- FAA look at:
 - Electronic Flight Bags (EFBs)
 - Aeronautical Data Processing
- ADF use of MPS incorporates both EFB and aeronautical data considerations from the FAA system.
- ADF has a system focus (i.e. we look at Design Acceptance of an MPS).
- FAA has a data focus, approve aeronautical data for use.
 - This approval considers all systems that interact with the aeronautical data.





Technical Airworthiness Policy for MPS

- Technical Airworthiness Policy for MPS incorporates two considerations:
 - Data produced or calculations made by an MPS are correct.
 - Aeronautical data processing does not introduce errors.
- The policy is currently in draft (see NPRM DGTA 03-09)
- Assuring the correctness of data produced or calculations made by an MPS is a readily apparent consideration.
 - No difference to the assurance of other safety related systems.
- Aeronautical data processing may not be so simple.



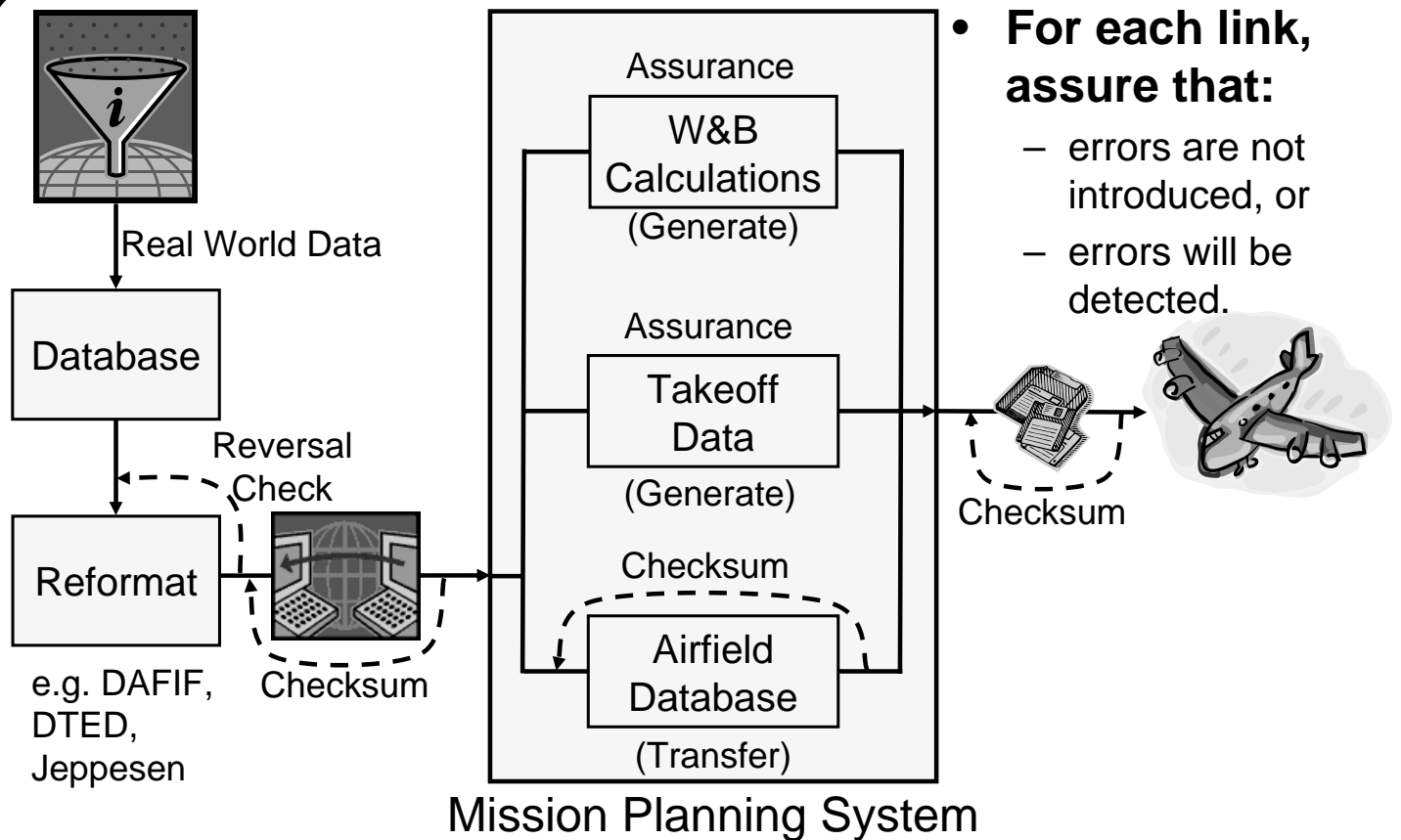
Aeronautical Data Processing

- For each step of the aeronautical data processing chain, must assure that either:
 - errors are not introduced, or
 - introduced errors are detected and handled.
- A Mission Planning System is a step in the aeronautical data processing chain.
- To achieve the above, must either:
 - assure the correct function of the MPS, or
 - implement (and assure) detection and handling mechanisms.





Aeronautical Data Processing



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The Process

- Identify the data processed by the MPS.
- Identify the data criticality and data assurance level.
- Identify each MPS component that processes each data element.
- Identify what function the each MPS component performs for each data element.
 - Transfer, Format, Manipulation, Generation
- Define and Implement Treatments to assure the detection and handling or absence of errors.

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Criticality

Severity	DAL	Data Criticality	Definition	Data Assurance Level
Catastrophic	A	Critical	The data, if erroneous, would prevent continued safe flight and landing or would reduce the ability to cope with adverse operating conditions to the extent that there is a large reduction in safety margins or functional capabilities. There is a high probability when trying to use corrupted critical data that an aircraft would be placed in a life threatening situation.	1
Hazardous	B	Critical		1
Major	C	Essential	The data, if erroneous, would reduce the ability to cope with adverse operating conditions to the extent that there is a significant reduction in safety margins. There is a low probability when trying to use corrupted essential data that an aircraft would be placed in a life threatening situation.	2
Minor	D	Essential		2
No Safety Effect	E	Routine	The data, if erroneous, would not significantly reduce aircraft safety. There is a very low probability when trying to use corrupted routine data that an aircraft would be placed in a life threatening situation.	3



Criticality Considerations

- Care should be taken to clearly identify the hazard associated with MPS use.
 - This may be different to the aircraft level hazard.
- Example: Weight and Balance
 - Attempting to fly an overweight aircraft, or with an out of range CoG, could be Catastrophic.
 - Does this mean that the severity of weight and balance calculation errors is Catastrophic?
 - Possibly, but not necessarily.
 - What if the variables to the calculation can only have a limited effect on W&B?
 - Is an obscure load required to produce the worst effects?
 - How is the data used?
 - To validate the flight plan? Or as in input to TOLD calculations?





Treatment Options

Function	Data Assurance Level	Detection and Handling	OR	Absence
Transfer	Critical	Digital Error Detection	OR	Level A or B
	Essential	Feedback / Read Back Verify	OR	Level C or D
	Routine	No requirements.		
Format	Critical	Feedback / Reversibility Check	OR	Level A or B
	Essential	Independent Redundancy	OR	Level C or D
	Routine	No requirements.		
Manipulate/ Generate	Critical	Feedback / Reversibility Check	OR	Level A or B
	Essential	Independent Redundancy	OR	Level C or D
		AND Logical Consistency Checks OR Semantic Consistency Checks		
	Routine	No requirements.		

See notes in Table 3 AAP 7001.054 S2 C24 (DGTA NPRM 03-09) for additional information on assurance levels.



Definitions

- **Logical Consistency**
 - Logical consistency validates by comparing the relationship between two different data sets.
 - Example: Translate two maps: same location, different scale.
 - Landmark appears in the same place on both maps.
- **Semantic Consistency**
 - Semantic consistency validates by comparing data to an expected value or range of values.
 - Example:
 - Calculated aircraft weight should be less than max weight.
- Neither technique is perfect.





Example – Weight and Balance Calculations

- Data: aircraft weight, centre of gravity.
- Criticality: depends on aircraft type, but usually “Essential”.
- MPS Components:
 - W&B Calculation Component: Generation
 - Data Transfer Module: Transfer
- Treatments:
 - W&B Calculation: Function assured to Level C or D and semantic consistency check (within expected range)
 - Data Transfer Device: Digital Error Detection assured to Level C or D



Example – DTED Transfer

- Data: Digital Terrain Elevation Data
- Criticality: Critical (used in TAWS)
- MPS Components:
 - Import DTED: Transfer
 - Export DTED to Data Transfer Device: Transfer
- Treatment Options
 - Digital Error Detection assured to Level A or B
 - for each MPS component, or
 - calculated at source, checked on aircraft.
- Note: other treatments would be required if the MPS manipulates the database (i.e. where digital error detection could not be applied).





Example – Digital Map Formatting

- Data: digital maps
- Criticality:
 - Essential or Critical if used in a moving map display
 - Essential if static display
- MPS Components
 - Import Function: Transfer
 - Formatting Function: Format
 - Data Transfer Device: Transfer
- Treatments
 - Input Device: Digital Error Detection assured to appropriate level
 - Formatting Function: Reversibility check assured to appropriate level
 - Data Transfer Device: Digital Error Detection assured to appropriate level



Example - Waypoints

- Data: Flight Path Waypoints, may include:
 - Mission Flight Path, Weapon Release Points, Terminal Approach Data, or Flight Path through Controlled Air Space
- Criticality: depends on type of waypoint
 - Mission Flight Path: Routine
 - Others: Essential or Critical
- MPS Components
 - User Interface: Generation
 - Data Transfer Device: Transfer
- Treatments:
 - User Interface: assured to appropriate level (depends on type) and semantic consistency checks (in range, distance from departure, etc)
 - Data Transfer Device: Digital Error Detection assured to appropriate level.





Example - Summary

- Level of Assurance depends on criticality of the data.
- Scope of assurance depends on function performed:
 - Generation: assure entire function and some fault tolerance
 - Transfer: generally only need to assure digital error detection
 - Formatting: generally only need to assure readback/verify
- Many common requirements will emerge:
 - e.g. data transfer device almost always needs digital error detection



Other Factors

- Above analysis only considers the introduction of errors or erroneous calculations.
- There are other, important characteristics of aeronautical data that the MPS may negatively affect:
 - accuracy
 - resolution
 - timeliness
 - completeness
 - format
- These considerations may result in additional requirements being placed on the MPS.
 - e.g. When translating the navigation database, the input resolution shall be maintained.





What does DGTA expect to see?

- A List of Functions
 - What is the MPS used for?
- Assignment of Severity
 - How critical is the data?
- Allocation of Treatment
 - Assurance of absence
 - Detection and Handling
- Evidence of Implementation
 - Standard software assurance artefacts.



A Good Format

Data Element	Criticality	MPS Components and Functions		Treatment
		Component	Function	
A	Critical	X	Transfer	CRC Check assured to Level A
		Y	Format	Reversibility Check
		Z	Manipulation	Assured to Level B and Semantic Consistency
B	Essential	P	Transfer	None = Risk
		Q	Manipulation	Independent Redundancy with Component R and Logical Consistency
etc...				

See Table 4 of AAP 7001.054 S2 C24 for more details.





Summary

- MPS may contain safety-related software.
 - Erroneous calculation of safety-related data.
 - Introducing errors into safety-related databases.
- Like any safety-related item, an MPS needs to be appropriately assured.
 - Errors are not introduced, or
 - Errors are detected and handled.
- An assessment should be conducted to determine:
 - which components of the MPS perform safety-related functions, and
 - how critical each function is.



Further Reading

- AAP 7001.054 Section 2 Chapter 24 Mission Planning Systems
- AAP 7001.054 Section 2 Chapter 22 Electronic Flight Bags
 - May be useful in determining criticalities
- RTCA DO-200A Standards for Processing Aeronautical Data
- RTCA DO-201A Standards for Aeronautical Information





Questions

