COGNITIVE WORK AIDS FOR C2 PLANNING

Actionable Information to Support Operational Decision Making

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Topical Area: Decisionmaking and Cognitive Science

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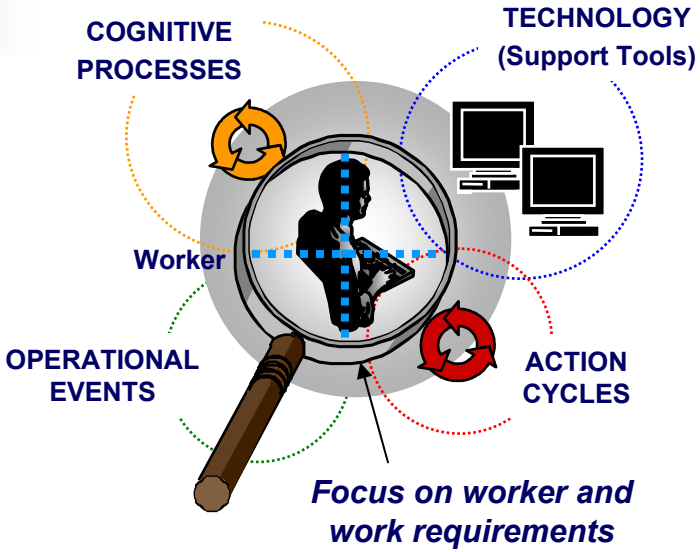
OUTLINE

- Work- Centered Support Technology
- WIDE Advanced Technology Demonstration (ATD) for AMC's Tanker Airlift Control Center (TACC)
- WIDE Spiral 1 Timeline Concept
- Illustrative Scenario: Tanker Airlift Control Center (TACC) Mission Re-planning

WORK-CENTERED SUPPORT SYSTEMS (WCSS)

• WCSS AS WORK AIDING TECHNOLOGY

- A WCSS is a net-centric (enterprise) application
- Computer support for work as practiced through:
  - Cognitive-based analysis and design
  - Visualizations tailored to work domain
  - Automation embedded in work visualizations



• RIGHT INFO AT THE RIGHT TIME

- Intuitive "actionable" displays
- Explicit support for anticipated AND unanticipated events
- Automatic info monitoring, retrieval & fusion

Effective situation awareness
+ Proactive problem identification

Better / faster decisions / actions

KEEP THE USER FOCUSED ON WORK SUBJECT MATTER AND ACTIVITIES

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- Work- Centered Support Technology
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- **WIDE Spiral 1 Timeline Concept**
- **Illustrative Scenario: Tanker Airlift Control Center (TACC) Mission Re-planning**

WORK-CENTERED INTERFACE DISTRIBUTED ENVIRONMENT (WIDE)

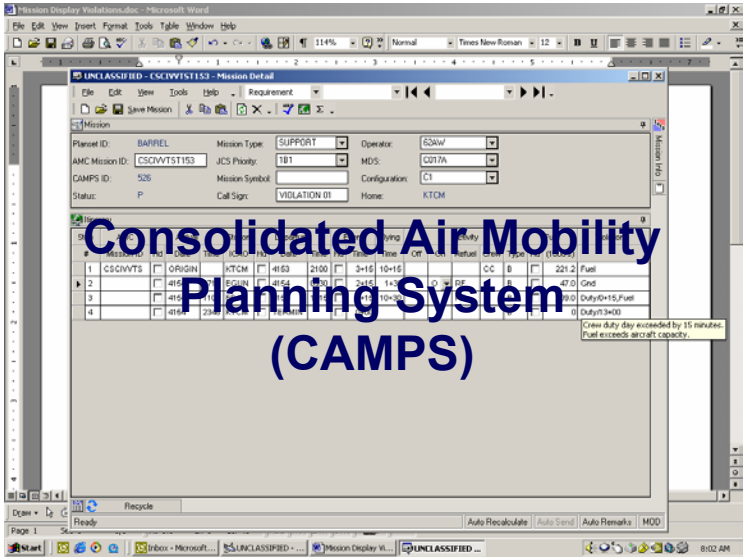
CLIENT ORGANIZATION:
Air Mobility Command (AMC)
Tanker Airlift Control Center (TACC)

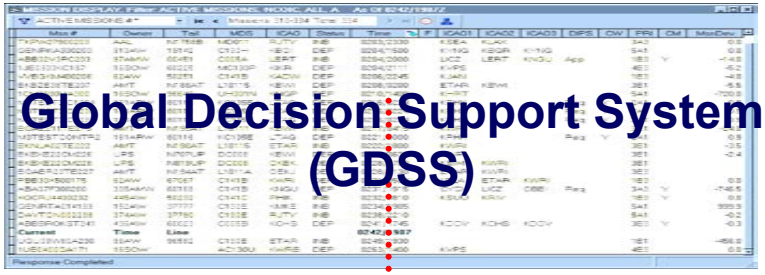
PROJECT OBJECTIVE:
Create WCSS to improve mission planning and execution C2

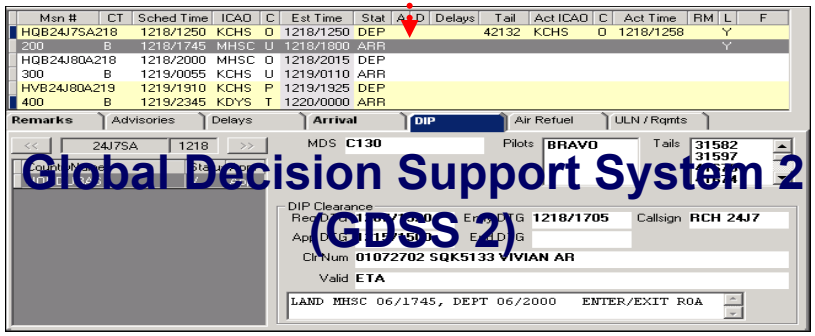
BENEFITS TO THE WAR FIGHTER

- Actionable decision quality C2 information ready at hand at all times
- Improved situation awareness (SA) on missions and mission issues
- Improved team operational continuity, communications and coordination
- More effective and efficient planning of increasingly complex missions
- More effective recognition of mission deficiencies and problems
- More efficient C2 decision making in addressing mission problems and exploiting operational opportunities

CURRENT TACC WORK AIDS







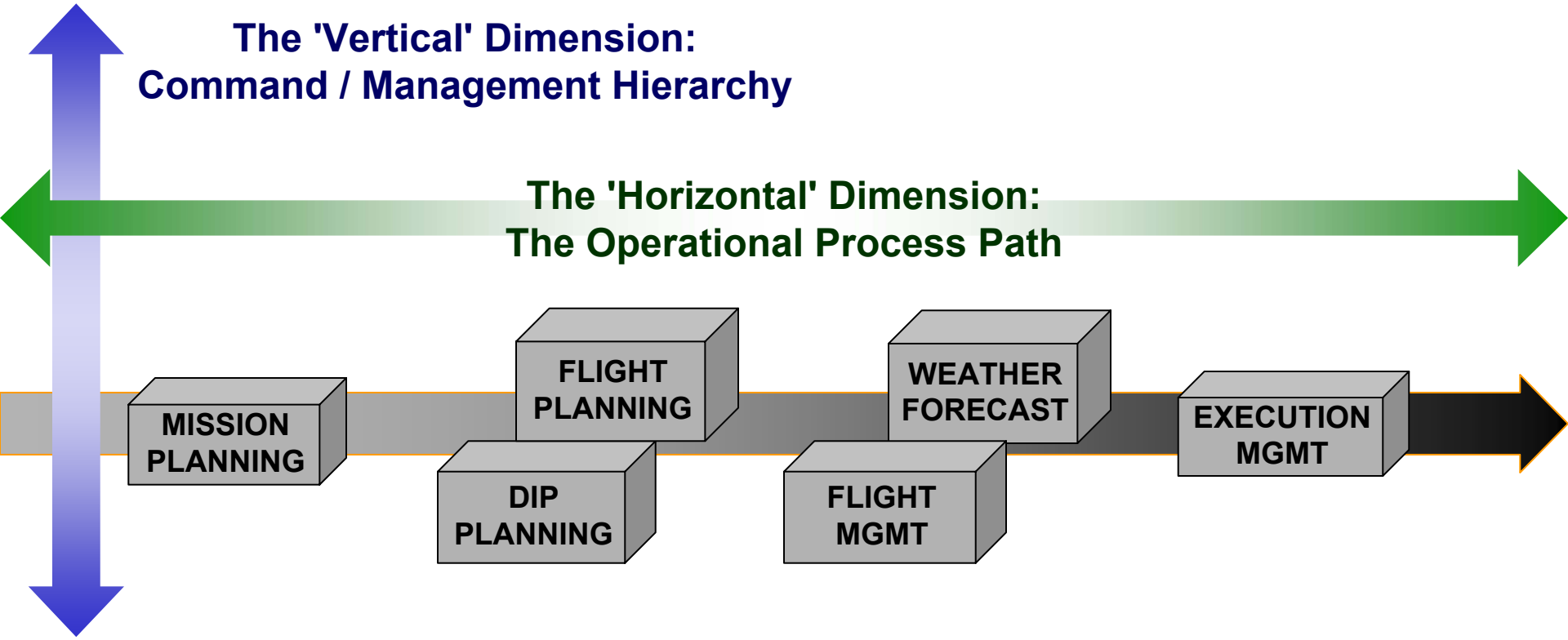
Good systems, but...

- 'Old School' format - i.e., heavy reliance on textual data and textual displays
- Compartmentalization between legacy systems and among subunits of each legacy system
- These factors induce high cognitive and procedural 'overhead costs' for employment in C2

WIDE RESEARCH AND DEVELOPMENT GOALS

- **Improve the mission planning process:**
  - Facilitate generation of more ‘robust’ plans on the first attempt
  - Facilitate more effective resource utilization via better decision making
- **Bridge the ‘seam’ between mission planning and execution**
  - More effectively communicate mission intentions and constraints to execution-phase staff
  - Provide automated support for prelaunch ‘scrubs’ of mission plans
- **Improve the ability to detect and respond to emerging problems during execution**
  - Identify and flag emerging problems (exception reports; alerts)
  - Facilitate the ability to assess repercussions of mission changes (e.g., delays, alternative COA's)
- **Improve supervisory staffers’ ability to maintain the ‘big picture’ and anticipate and address problems.**
  - Enable the supervisor to (e.g.) anticipate conditions 24 – 48 hours out.

HORIZONTAL AND VERTICAL INTEGRATION



- **VERTICAL INTEGRATION WILL:**
  - Improve commanders' / supervisors' situation awareness (SA)
  - Minimize lead time for problem detection
  - Minimize time on task to analyze problems that arise

- **HORIZONTAL INTEGRATION WILL:**
  - Improve situation awareness among diverse roles / positions
  - Minimize time and effort to understand state of mission / plan
  - Minimize time on task to analyze problems and / or deficiencies

OUR PROGRESS ON HORIZONTAL INTEGRATION

The 'Horizontal' Dimension: The Operational Process Path

MISSION PLANNING

FLIGHT PLANNING

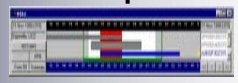
DIP PLANNING

FLIGHT MGMT

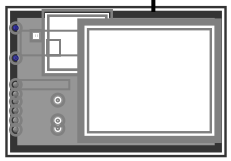
WEATHER FORECAST

EXECUTION MGMT

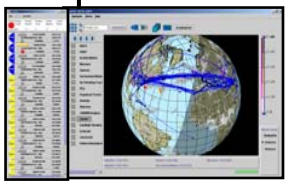
PRIOR YEARS



MOG Viewer



Sortie Manager



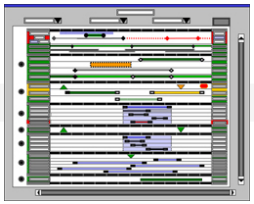
GAMAT Weather Tool

CURRENT AND ONGOING...

Flight Visualization Tool (FVT)

Comprehensive Geo-Spatial SA For Individual Missions

Timeline Tool



Comprehensive Temporal SA For Individual Missions

OUR PROGRESS ON VERTICAL INTEGRATION

The 'Vertical' Dimension: Command / Management Hierarchy

Flight Visualization Tool (FVT)

Comprehensive Geo-Spatial SA For Sets ofl Missions

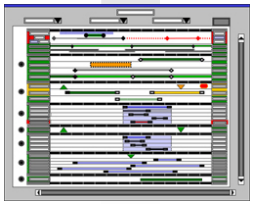
Director of Operations
("The Senior")

Deputy Dir Operations

Mission Area Rep

Duty Officer

Timeline Tool

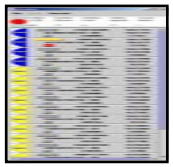


Comprehensive Temporal SA For Multiple Missions

TACC WCSS SUITE: NAVIGATION CONCEPT

A COHERENT FRAMEWORK FOR C2 VISUALIZATION

Situation Awareness on Overall Workstream



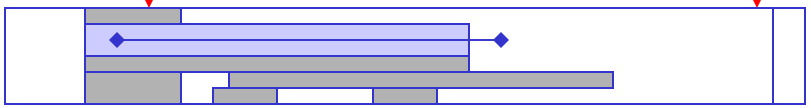
Workstream Overview Summary

Drilldown from complete set of missions to selected subset - relative to time

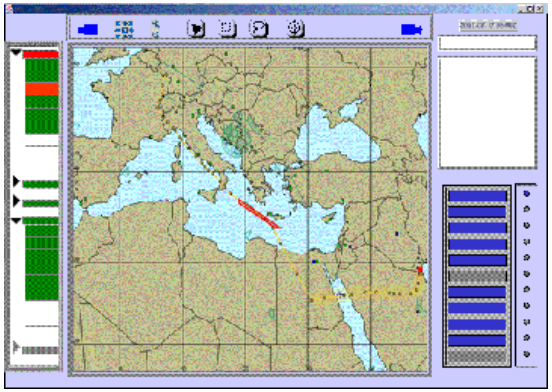
Drilldown from complete set of missions to selected subset - relative to space

Multi-Mission Timeline Display

Drilldown from set of missions / flights to just one.



Individual Mission Timeline Display



Flight Visualization Display (FVT)

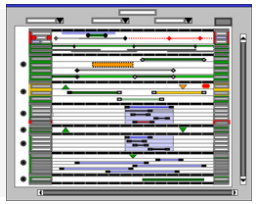
Situation Awareness on Case(s) with Respect to Time

Situation Awareness on Case(s) with Respect to Space

SPIRAL ITINERARY IN THE WIDE PROJECT

FY05:
MISSION PLANNING
TEMPORAL VISUALIZATION

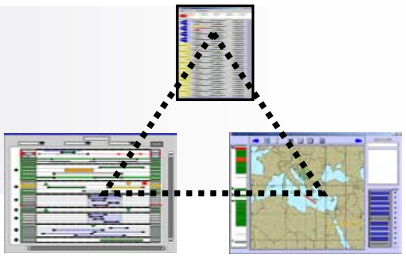
- Multi-mission timeline
- Single mission timeline



Evaluation & Refinement

FY06:
MISSION MANAGEMENT
WCSS SUITE COMPONENTS

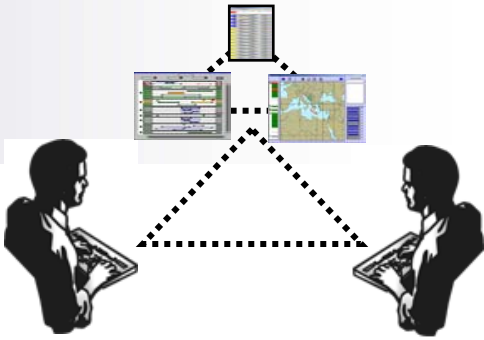
- Initial WCSS suite integration
- Mission management views



Evaluation & Refinement

FY07:
TACC TEAM SUPPORT
INTEGRATED WCSS SUITE

- More mission views
- Increased team work support



Evaluation

OUTLINE

- Work- Centered Support Technology
- WIDE Advanced Technology Demonstration (ATD) for AMC's Tanker Airlift Control Center (TACC)
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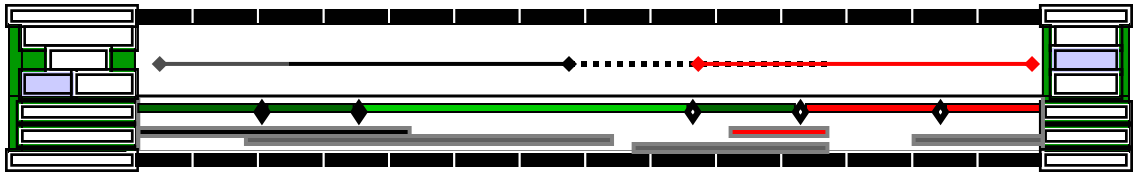
INDIVIDUAL MISSION TIMELINE DISPLAY: GENERAL ORGANIZATION

‘Core’ (Primary; Summary Component)

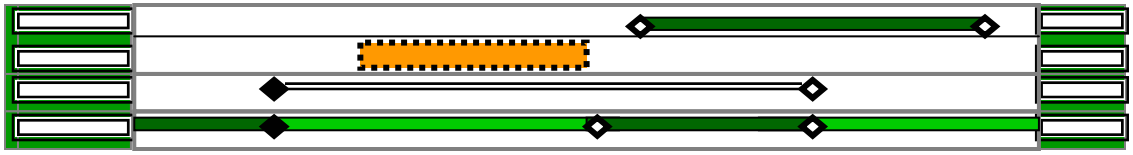
CORE



A concise summary ‘picture’ of the most critical flight-related information
The ‘top level’ abstract for basic flight information

Additional / Auxiliary ‘Clusters’ Defined by More Specific Subject Matter

CLUSTER A

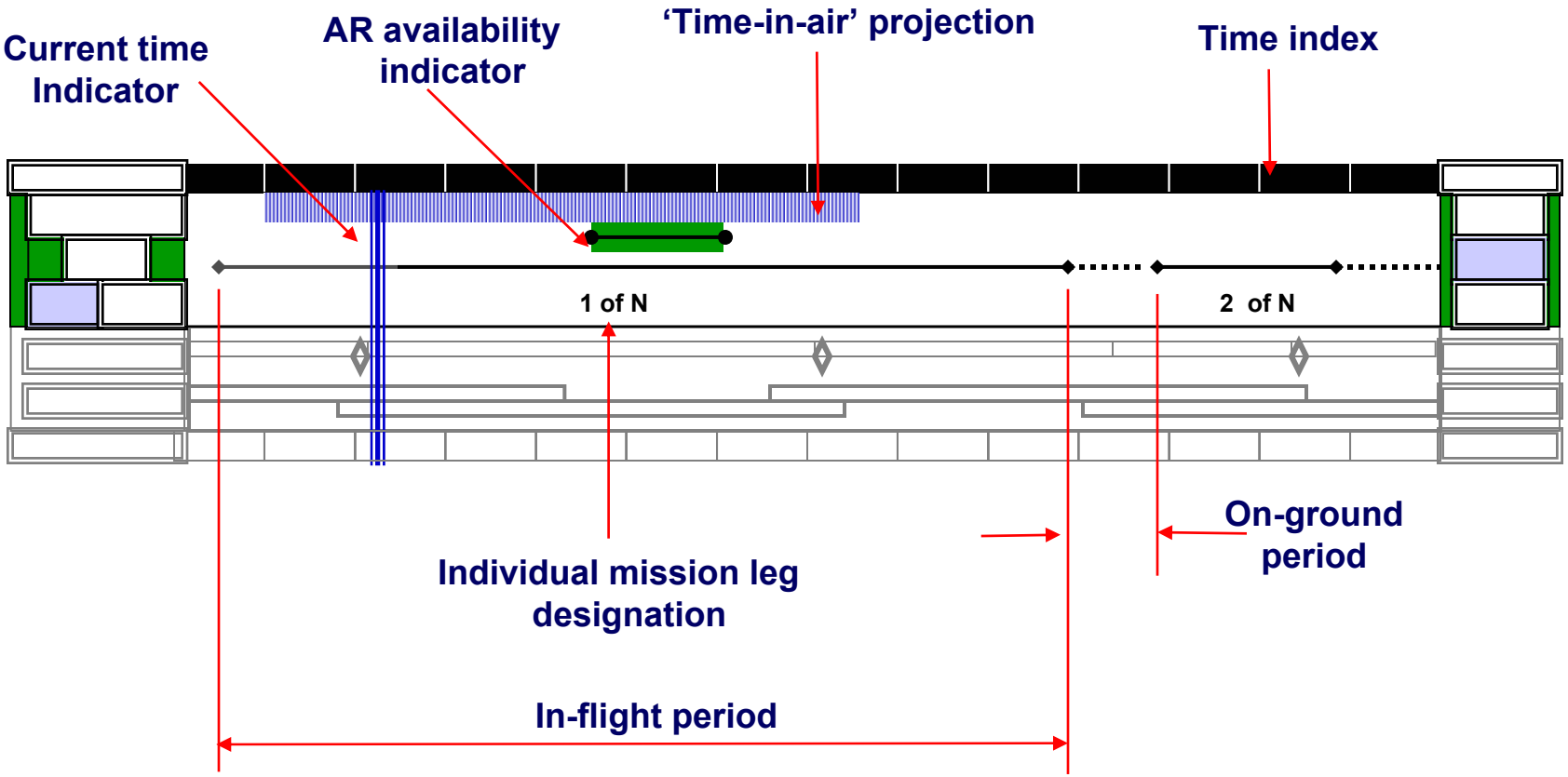


CLUSTER B

Topically-organized sets of time-correlated data
Provide modular ‘sub-windows’ on the mission’s key elements

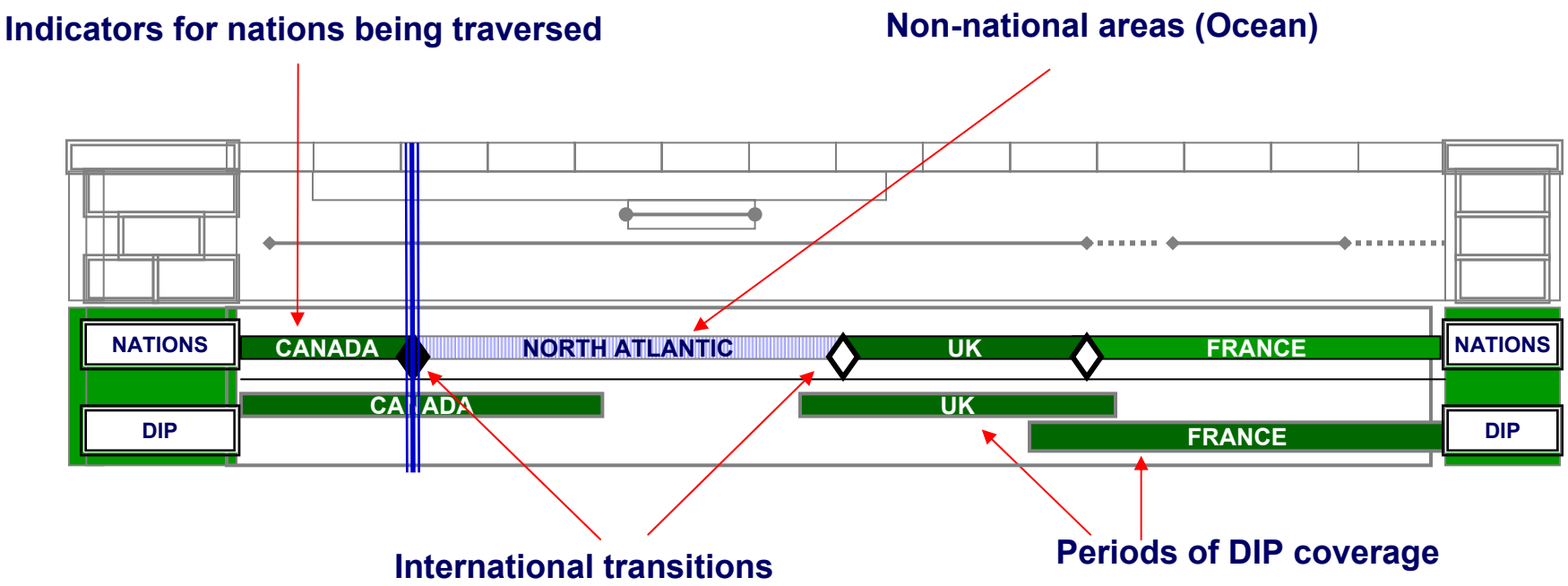
SINGLE MISSION DISPLAY : 'CORE': 1 OF 2

FLIGHT DATA DEPICTION
(Top Portion of Core Representation)



SINGLE MISSION DISPLAY : 'CORE': 2 OF 2

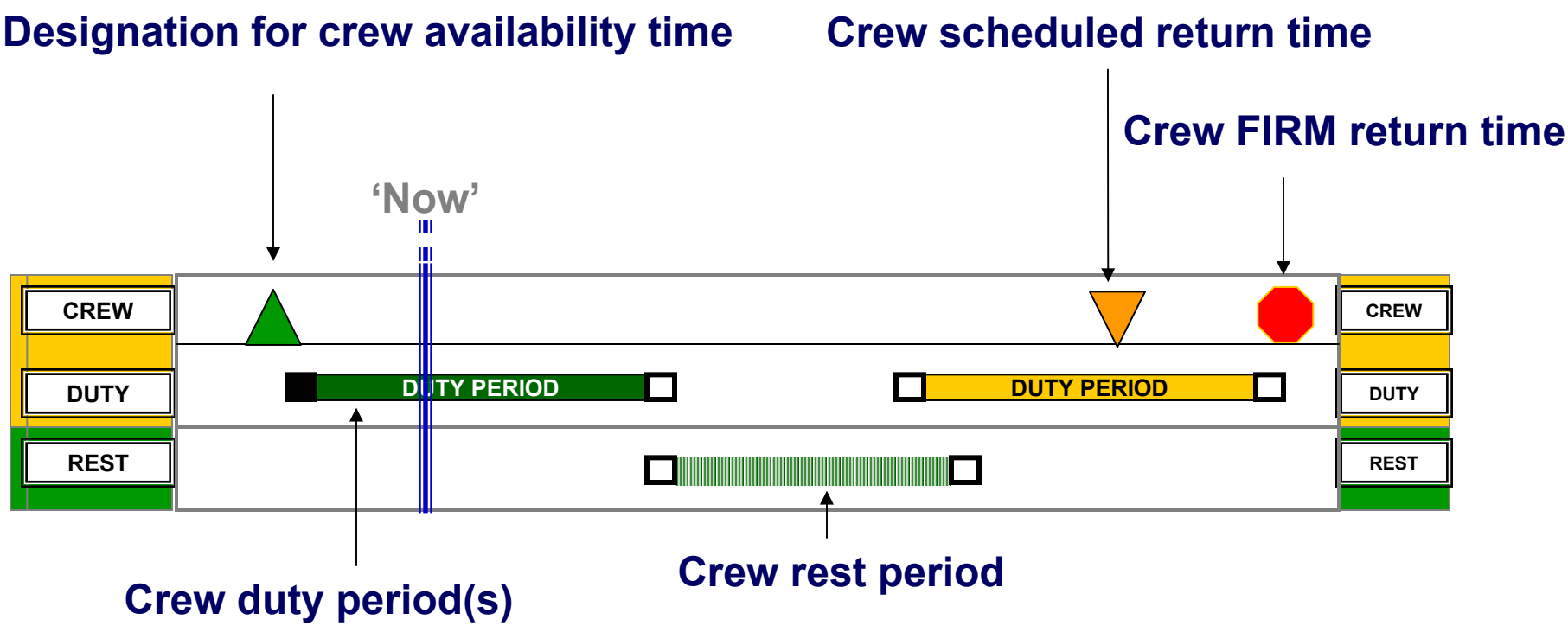
AUXILIARY DATA DEPICTION
(Lower Portion of Core Representation)



MISSION FEATURES: 'CLUSTERS'

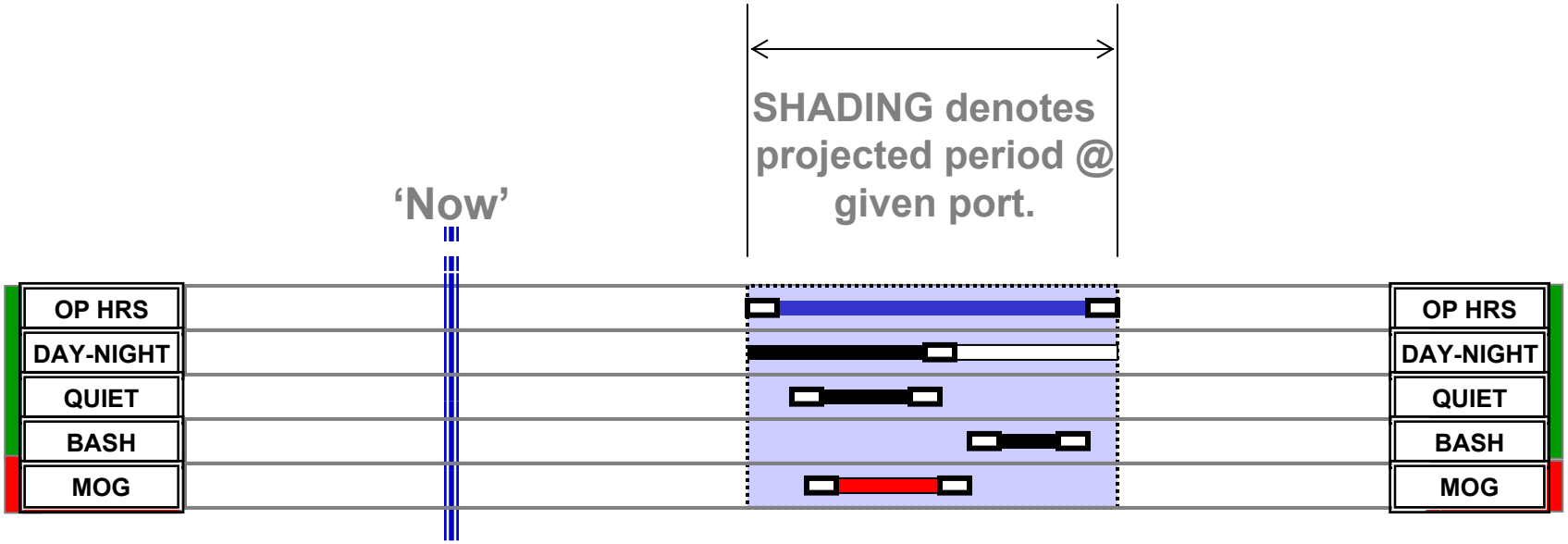
Geographical Features	•Theaters •WX Watch Areas •Nations being overflown	•Route / nav waypoints •Reporting waypoints (planned)
Aircrew	•Scheduled crew availability •Link to previous / next mission •Duty day cycle(s)	•Required rest periods •Scheduled crew return time •Firm crew return time
Port (Airfield)	• Arrival / Departure Times • Operating hours • Day / night hours	• Quiet hours • BASH hours • MOG periods
Aircraft	• Availability of tail number • Link to previous mission • Link to next mission	• Scheduled MX periods • Projected time horizon for remaining in the air 'as is'*
Ground Events	• Standard on-ground turnaround time periods	• Availability / on-board time(s) for PAX, cargo
Load / Cargo	• Scheduled air drop • Period PAX on board • Period Hazmat on board	• Human remains on board • Med evac patients on board • Nuclear material on board
Aerial Refueling	• Planned AR rendezvous timeframe • Projected / actual AR rendezvous timeframe	
Permissions	• DIP's (validity period) • PPR's (validity period)	

CLUSTER CLOSEUP: AIRCREW ELEMENTS



NOT TO SCALE

CLUSTER CLOSEUP: PORT (AIRFIELD) ELEMENTS



- Unlike other clusters, Port elements are portrayed only for period during which the mission is projected to be at the given airfield.

NOT TO SCALE

COMPLETE SINGLE MISSION TIMELINE DISPLAY

‘Core’ + ‘Clusters’ = Complete Single Mission Timeline Display

CORE

GEO CLUSTER

CREW CLUSTER

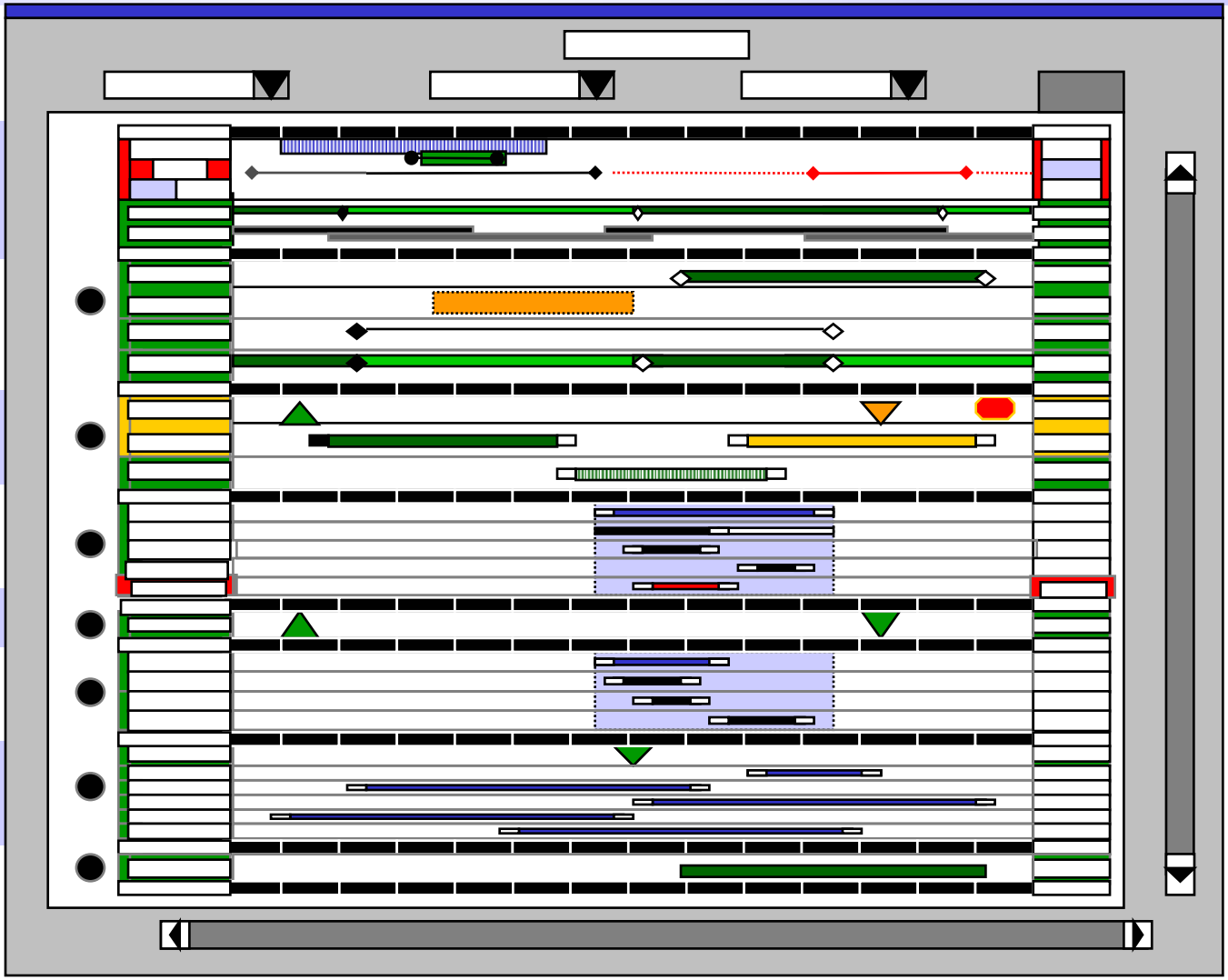
AIRFIELD CLUSTER

AIRCRAFT CLUSTER

GROUND CLUSTER

LOAD CLUSTER

PERMISSIONS CLUSTER

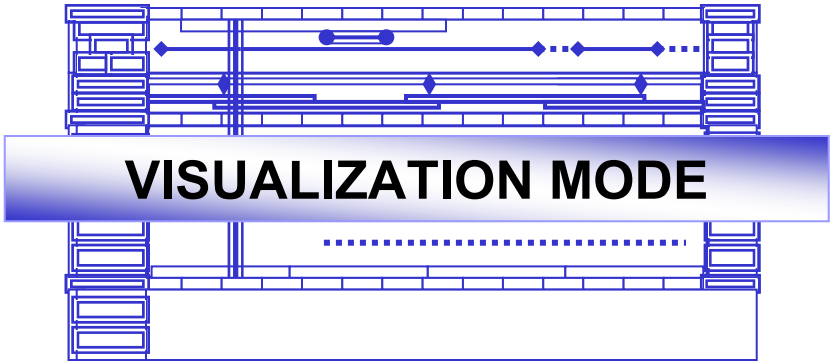


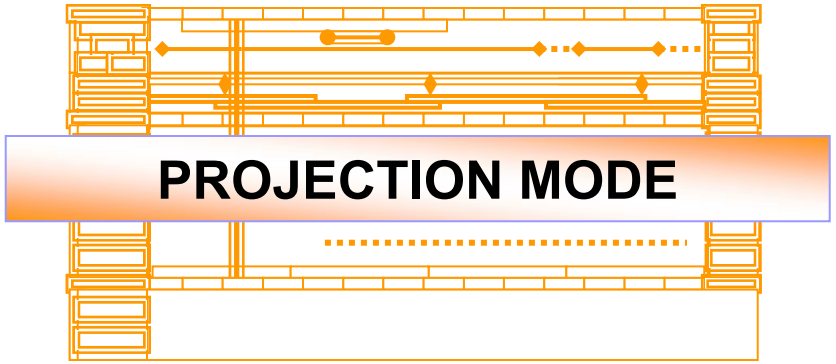
NOT TO SCALE

TWO 'MODES' FOR THE INDIVIDUAL MISSION DISPLAY

The Individual Mission Display can be Used for Either

Passive Visualization or Proactive 'What-If' Simulation



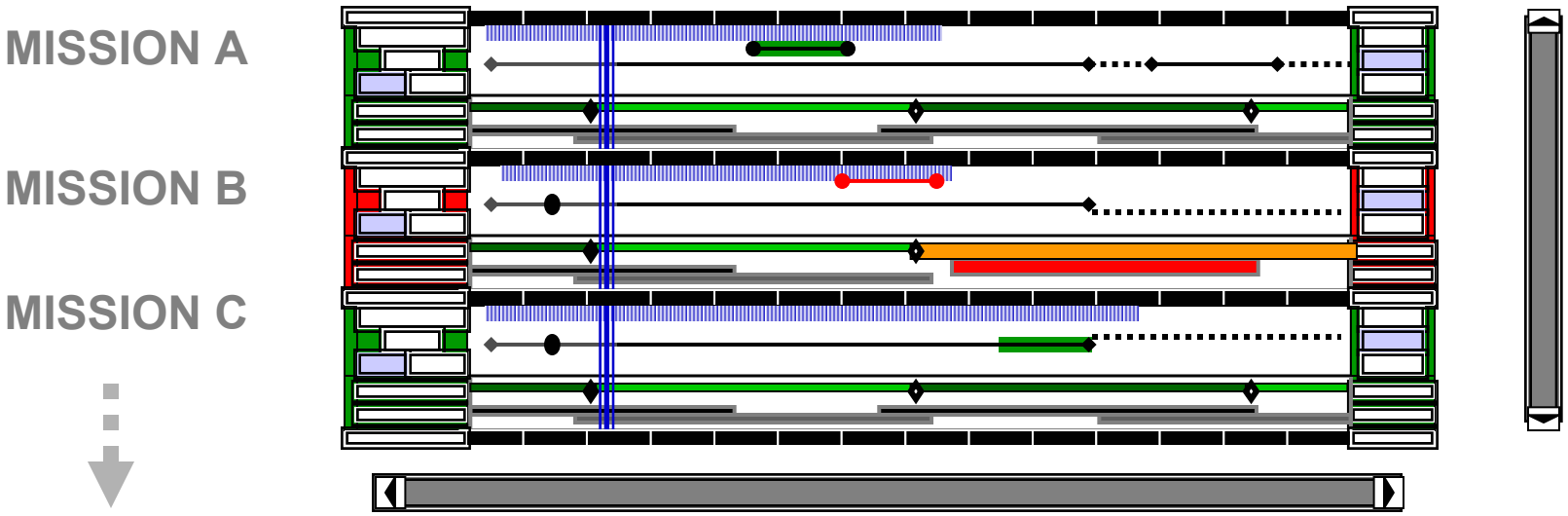


- This is the default mode (automatically in this mode upon invocation).
- In this mode, the Individual Mission Timeline is passively observed / monitored.

- This is the optional mode (only available upon manual invocation).
- In this mode, the Individual Mission Timeline elements may be modified using direct manipulation tactics.

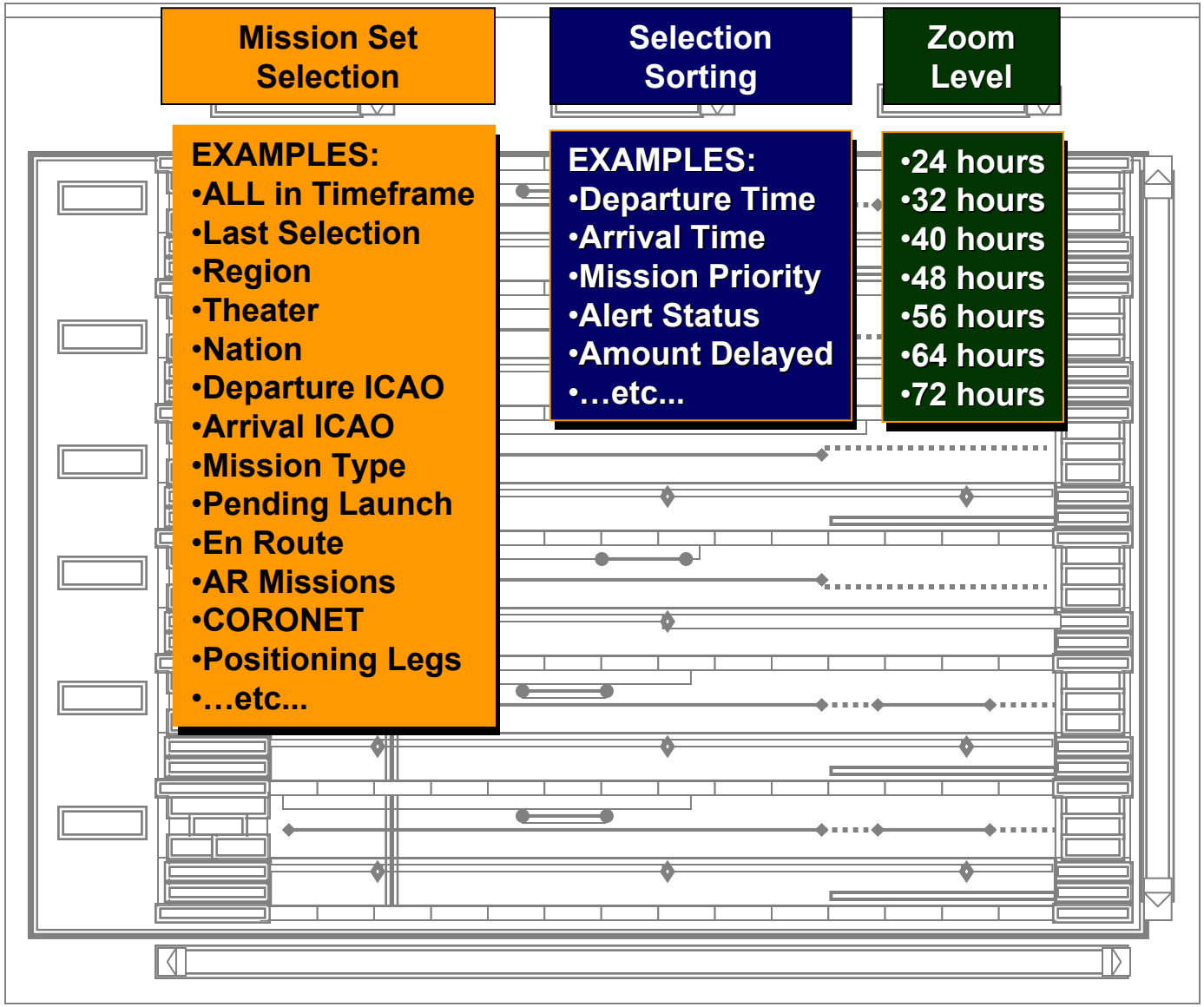
MULTI-MISSION TIMELINE DISPLAY: GENERAL ORGANIZATION

Set of 'Core' Representations = Coherent Multi-Mission Overview



- This collection of mission representations provides a supervisory overview capability across a set of missions.
- Each mission's 'core' representation serves as its entry in the set.
- Consistency between 'core' usage in single- and multi-mission displays facilitates user situation awareness and reduces cognitive burden.

MULTI-MISSION TIMELINE DISPLAY: PRESENTATION OPTIONS AVAILABLE



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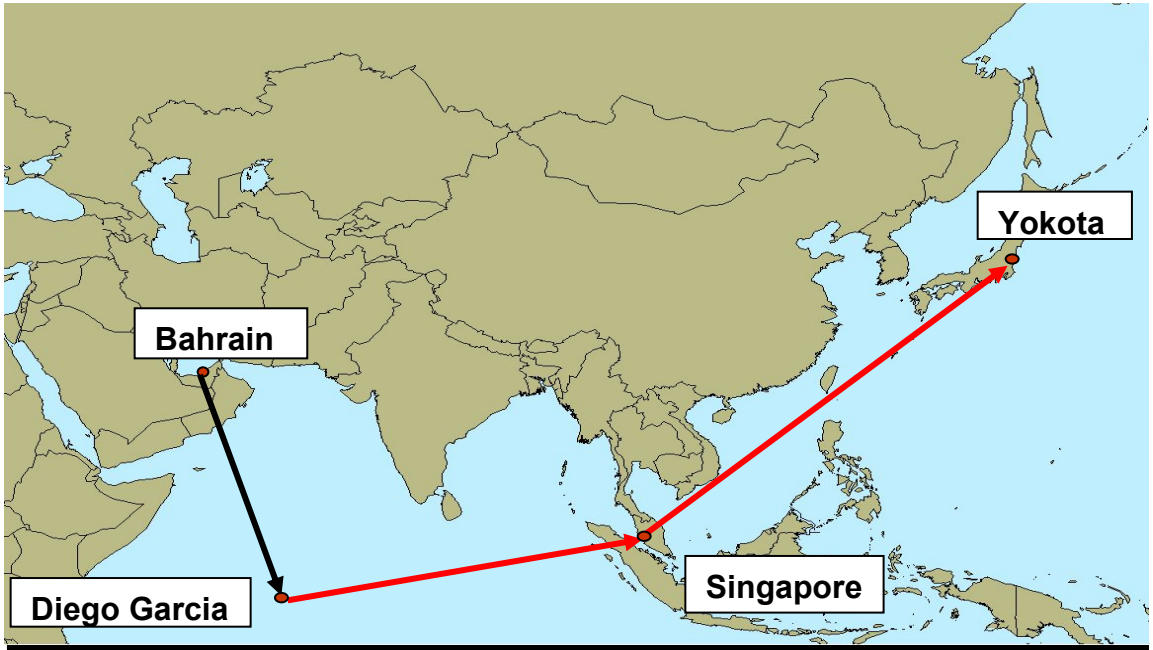
OVERVIEW: A "ROUTINE" CHANNEL MISSION

A MULTI-LEG MISSION ORIGINALLY SCHEDULED TO RUN FOR 3 DAYS FROM YOKOTA TO BAHRAIN AND BACK...

Mission ID: TQRJZF300053
Mission Type: CHANNEL
Aircraft: DC008
Tail: N799ALC
Priority: 1B1



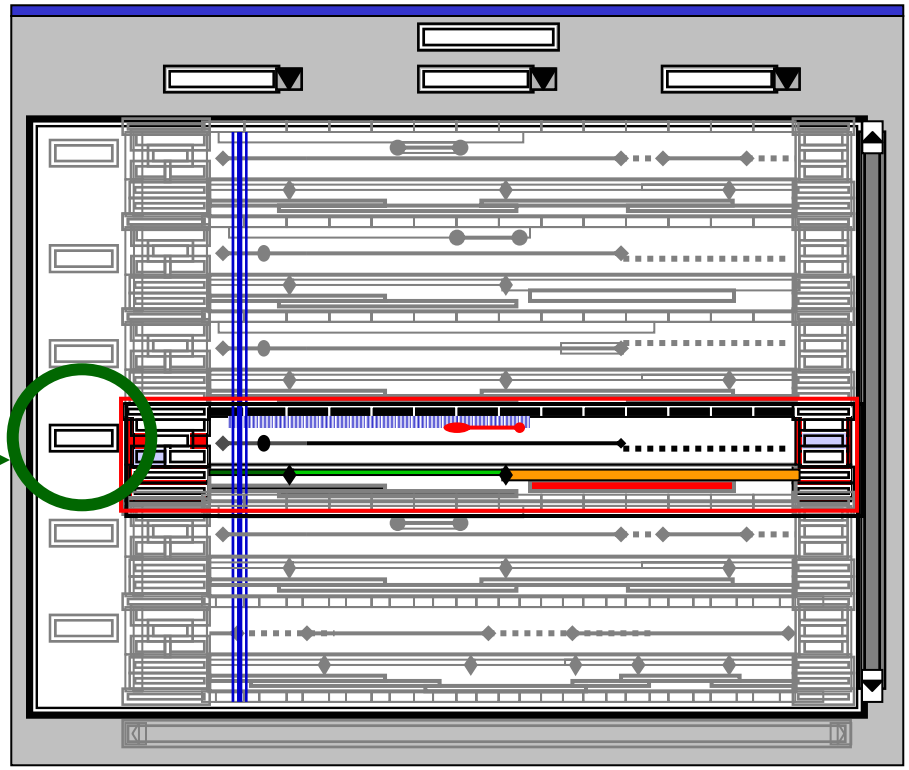
SORTIE	ETD	ETA	DEP	ARR	PORTS
100	4053:2135	4054:0435	RJTY	WSAP	(Yokota - Singapore)
200	4054:2320	4055:0400	WSAP	FJDG	(Singapore - Diego Garcia)
300	4055:0703	4055:1302	FJDG	OBBI	(Diego Garcia - Bahrain)
400	4055:1525	4055:2115	OBBI	FJDG	(Bahrain - Diego Garcia)
500	4055:2335	4056:0440	FJDG	WSAP	(Diego Garcia - Singapore)
600	4056:0700	4056:1315	WSAP	RJTY	(Singapore - Yokota)

Our scenario focuses on Murphy's Law as applied to the final (return) legs of this mission ...

AUTOMATED ALERTING ON MISSION ISSUE(S)

- A TACC duty officer (DO) is monitoring a set of missions operating in the South Asian region.
- An automated alert cues the DO to a problem with our subject mission

MULTI-MISSION TIMELINE DISPLAY

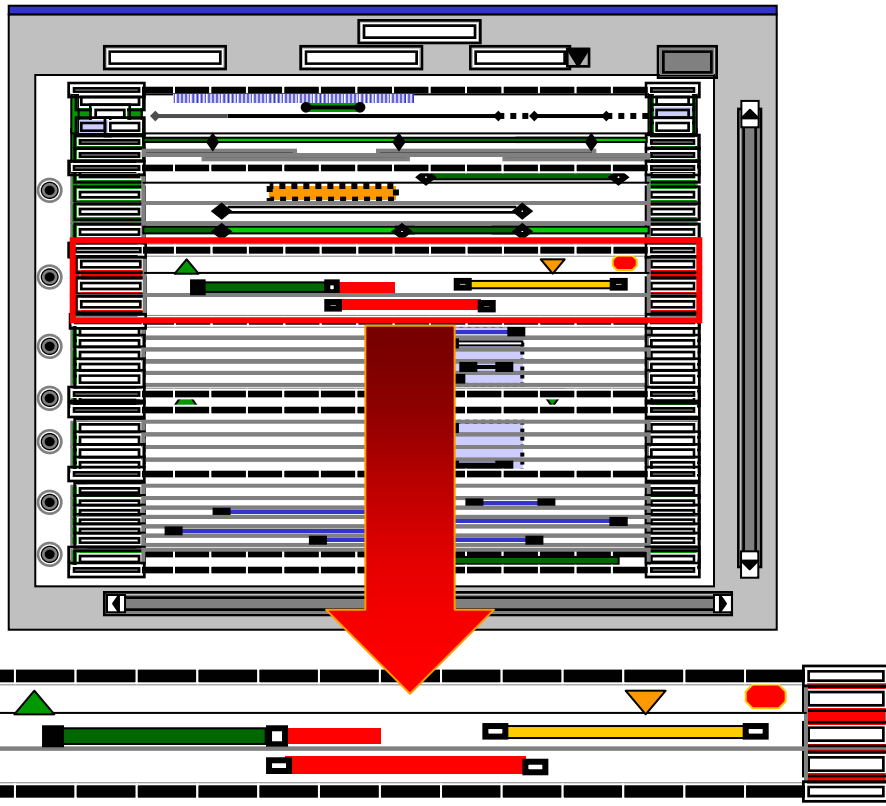


- The DO drills down on the subject mission by invoking an Individual Mission Timeline Display

AND THEN ...

DRILLDOWN TO FOCUS ON CRITICAL ISSUES

- On the Individual Mission Timeline Display, the DO sees that the alert relates to the Crew Cluster...



- Arrival into Diego Garcia overlaps a required crew rest period.
- The crew must be given an additional 8 hours on-ground for crew rest.

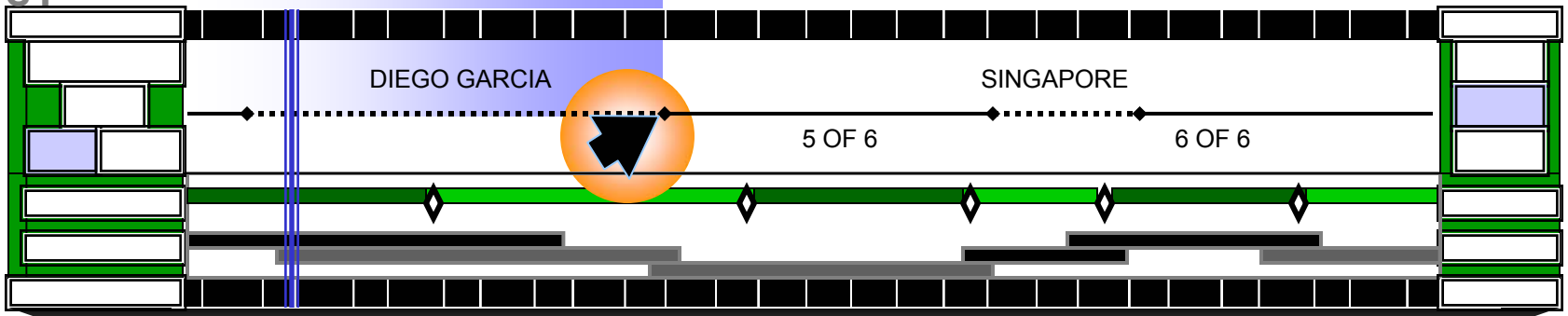
- The DO toggles the Individual Mission Display into 'Projection Mode' to do some 'what-if' simulation of a modified mission itinerary.

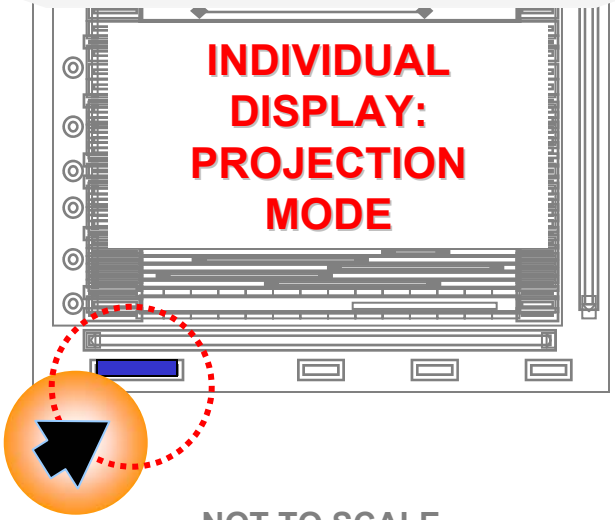
AND THEN ...

DIRECT MANIPULATION TO EXPLORE RAMIFICATIONS AND POSSIBILITIES

WHAT-IF: Diego Garcia departure slides by 8 hours?

- Using 'grab and drag', DO shifts Diego Garcia departure time 8 hours later.





- Then he / she triggers the simulation process to project the ramifications...

- Capability for modifying state of the data.
- Capability for automated inference / projection of ramifications of this change.

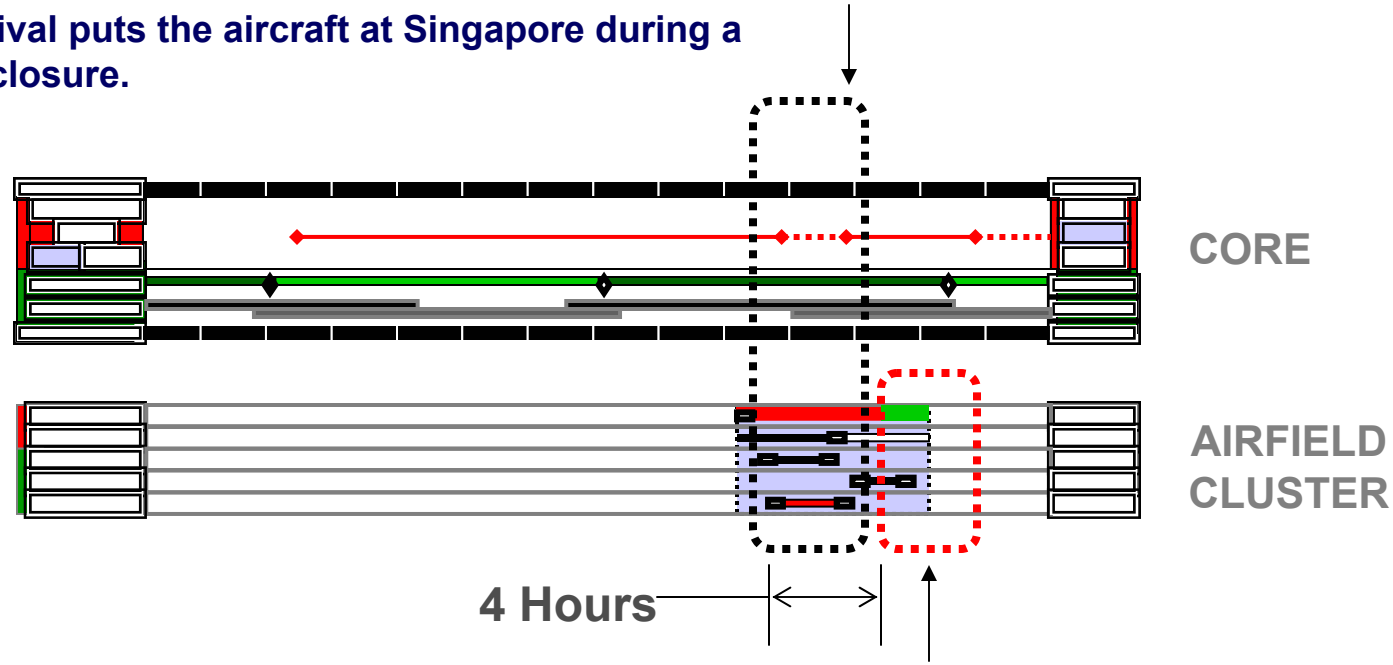
AND THEN ...

NOT TO SCALE

CASCADING PROBLEMS DURING RE-PLANNING

- The modified itinerary causes a problem at the next airfield (Singapore).
- An 8-hour delay in arrival puts the aircraft at Singapore during a midday construction closure.

Updated arrival time in Singapore correlates with no-ops period portrayed on Airfield cluster.



- The DO notes when Singapore re-opens.
- He / she determines an additional 4 hour delay will get the aircraft into Singapore after it's re-opened.

- Automated alerting on the new set of circumstances…
- Visualization for decision support.

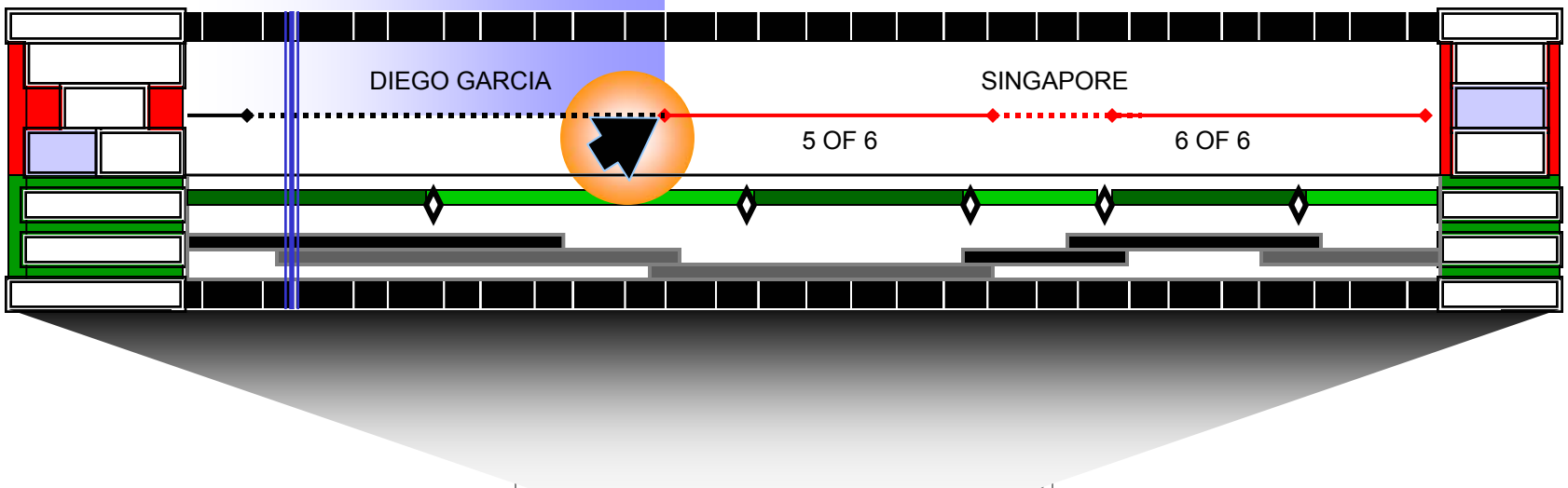
AND THEN …

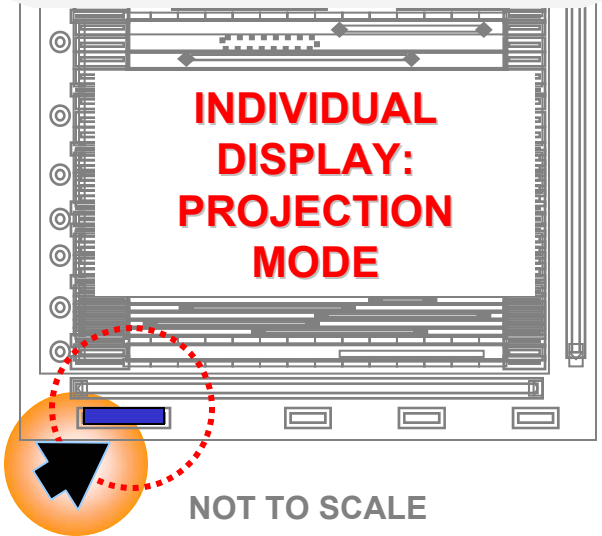
NOT TO SCALE

MISSION RE-PLANNING: TAKE 2

WHAT-IF: Diego Garcia departure slides by another 4 hours?

- Using 'grab and drag', user shifts Diego Garcia departure time another 4 hours later (12 hours total)





- Capability for recurrent experimentation in search for corrective / viable COA.

- Then he / she triggers the simulation / inference process to project the ramifications...

Which leads to...

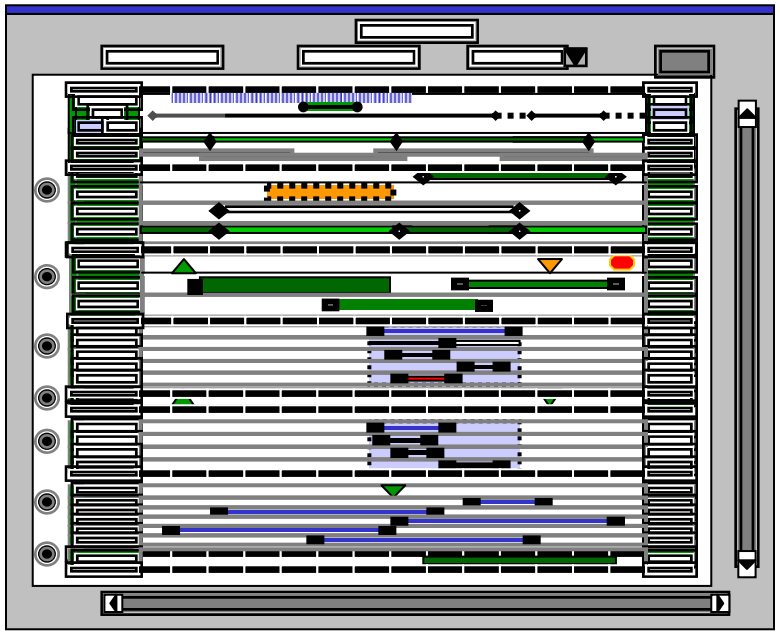
… AND THE MISSION IS 'FIXED'...

- A new itinerary (now shifted 12 hours later than originally planned) is computed...

SORTIE	ETD	ETA	DEP	ARR	PORTS
500	4056:1135	4056:1640	FJDG	WSAP	(Diego Garcia - Singapore)
600	4056:1900	4057:0115	WSAP	RJTY	(Singapore - Yokota)

(example)

- The Individual Display simulation is updated to reflect this new itinerary...



- Automated updating of the Timeline Display to reflect the new state.
- Automated alerting on the new set of circumstances...

All alert indicators now show the mission is 'GREEN' / 'GO'

PAYOFFS ILLUSTRATED BY THE SCENARIO

- A single coherent display for representing mission features and interrelationships among them.
- Automated alerting to cue user on problems in work context.
- Interactive ability to experiment with modified or alternative conditions.
- Automated support for identifying and assessing ramifications of mission changes.
- Capability for progressively ‘testing and refining’ alternative Courses of Action (COA’s) in replanning.

SUMMARY

- AFRL is demonstrating advanced cognitive work aids at AMC
  - Enhance decision making, situation awareness and work support
  - Could be extended to other USAF C2 application venues.
- Spiral development is underway to achieve both vertical and horizontal integration across TACC
- Spiral evaluations will assess value added capabilities to be nominated for transition into AMC / TACC operations.

QUESTIONS?