Human Performance Factors in OPCON Evaluation & Assessment

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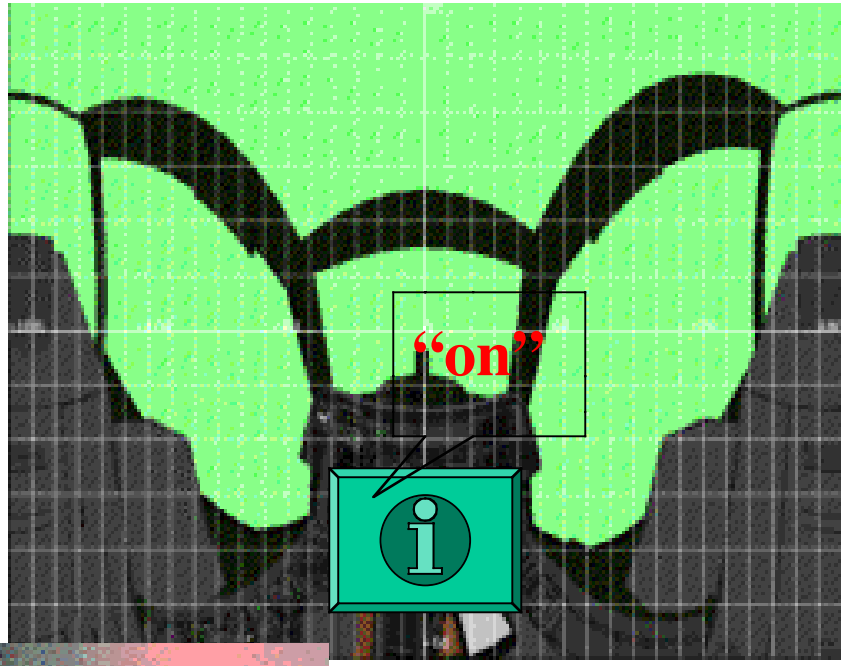

“on”


ON
ON
STILL
ON

Matters of Consequence in Human Performance in Operations

- Impact multiple operational entities in the airport/airspace
- Noticeable change in schedule, staffing, roles and responsibilities
- Change in scope of the range & span of decision making
- Change in fundamental informational characteristics of the system (displays, alerts, controls, communications, etc.)
- Changes in, or development of, new certification standards, MELs, etc
- Fundamental changes in airspace structure or use (segregated airspaces etc.)

Operational Concepts Community Evaluated

- **AAC (1993)**
- **Data Link Communications CPDLC Oceanic Trails (1979, 1994)**
- **Terminal Productivity Concepts (PRM & TAP AILS) (1991, 1993)**
- **Reduced Vertical Separation Minima (1994)**
- **National Route Program (FAA 1994)**
- **Programe for Harmonized Air Transport Research in Europe (PHARE Demonstrations 1,2,3) (1995-2000)**
- **Free Flight RTCA (1995), FAA Response Action Plan (1996)**
- **Collaborative Decision Making (FAA, ATA, NASA, 1998)**
- **AATT Operational Concept Development (Boeing, Honeywell, Lockheed Martin, NASA LaRC, DAG) (1994-present)**
- **Surface Movement Advisor System (1997-8)**
- **ADS-B/CDTI Ohio Valley trials >> Safe Flight 21 (2000-2001)**
- **CAPSTONE (2001- present)**
- **CTAS TMA- Time-based Metering, PFAST (1995-present)**
- **URET (1995 – present)**
- **Free Flight Phase 1 (ancillary technologies)**
- **OEP (2001- present)**

Dimensions of study for OPCONS

- **Reliability/Consistency/Predictability**
- **Coverage (range of operations, airspaces, operational characteristics—efficiency, safety, observability, predictability)**
- **Technical Complexity (what sensors, boxes, software, CNS requirements)**
- **Procedural Complexity (what selection, training, dynamic, memorial, documentation footprint)**
- **Cultural (national, corporate, practice) variability**
- **Information Flow**
  - **Timeliness, density, relevance, degree of interpretation, transformation, and integration**
- **Recoverability**
  - **Levels of safety**

Dependent Variables

- Airport/Airspace/Aircraft Variables
  - # of A/c per unit volume/unit time
  - Fuel use, aircraft life-cycle costs
  - Conflicts & configurations
  - Schedule deviations/million operations…
  - Number Operations
- System Level Variability
  - Stability
  - Predictability
  - Robustness
  - Environmental (noise, air, etc)
  - Distance of the proposed concept from the current …

Dependent Variables

- Human Variables
  - Reaction Time
  - Performance Time
  - Performance Sequences
  - Training Footprint
  - Errors & performance profiles
  - Communication (frequency, duration, content analysis)
  - Eye Movement
  - Physiological Correlates o Behavior (EEG, Cardiac Arrhythmia, Pupillary Diameter, GSR, Blink Rate…
  - Subjective workload, Situation awareness
  - Cooper-Harper Ratings (handling qualities of the opcon)
  - Usability assessments
  - (t)required/(t)available

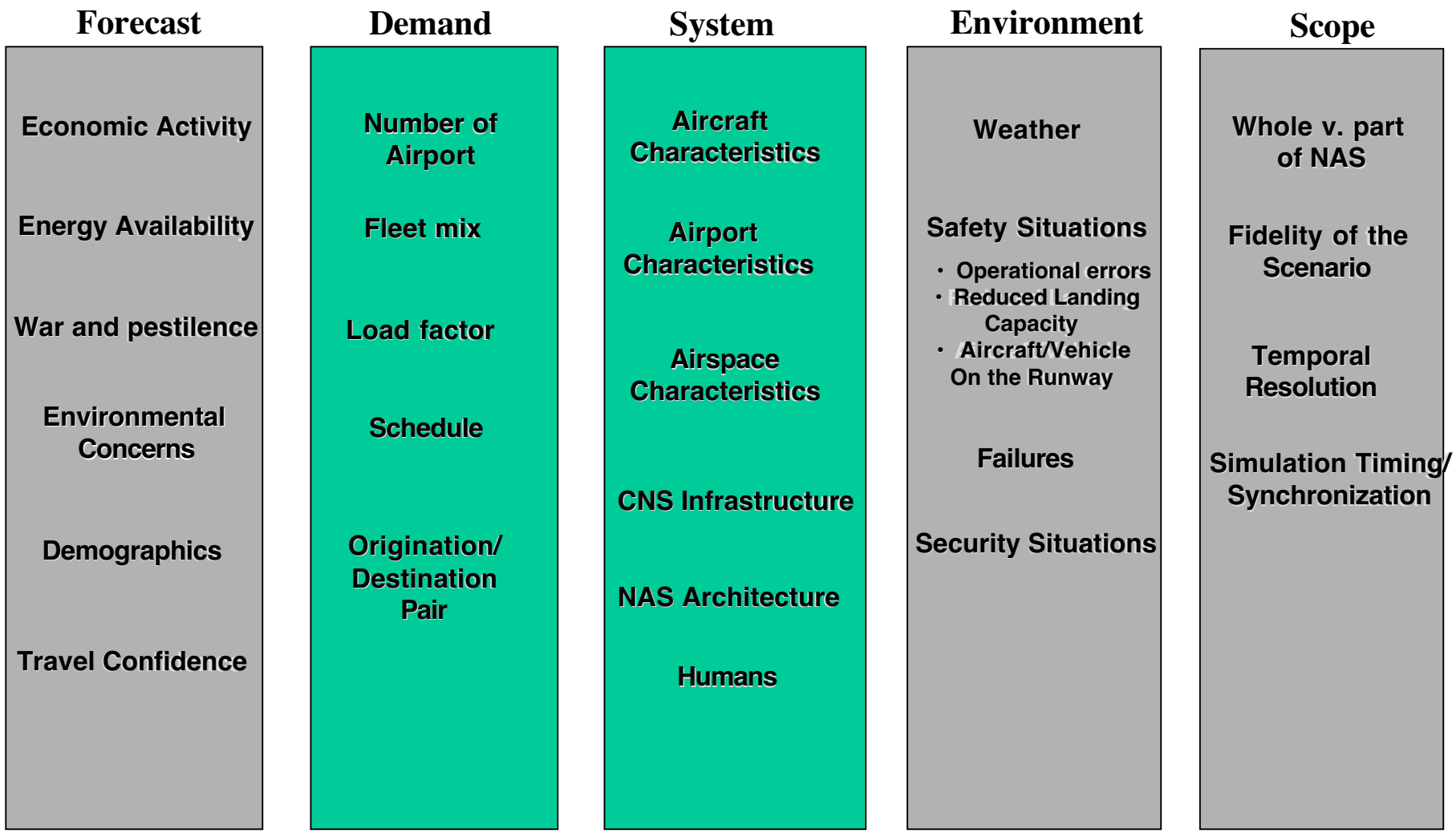
Scenario Development & Metrics Issues: Human Performance Perspective

- **Normal Operations occur at stable routinized level**
  - ***OPCON's susceptibility to disruption needs to be measured at that operating point, and at transition to non-routine***
- **Level Of Specificity & Definition**
  - ***All components, or many critical elements of an Operational Concept may be at a level of specificity wherein the measurable variables are not available***
- **Dependent and Response Variables**
  - ***Those that are measurable are not the relevant diagnostic of system performance***
- **Scalability**
  - ***Predictive performance scaling in fast time & real time simulations is unvalidated***

Possible Solution Paths

- Characteristic Response Method
  - Translate prior experience in joint human-artifact complex dynamic systems to current OPCON
    - Control by exception design for DST
    - Reversion for failure modes assuming a supervisory control paradigm
    - Gaming in operating modes governed by a minimax rule
- Define units of the OPCON
  - Analysis following the fault lines of human-system performance
- Cognitive Process and Information topology analysis
  - Bottlenecks and optimization opportunities based on state of system, control opportunity and distributed knowledge
  - Minimum information requirements and control requirements: Requisite Variety
- Models at varied and matched levels of aggregation

Scenario/Metric Parameters



Concept Independent (stipulated by the SEA/VAMS)

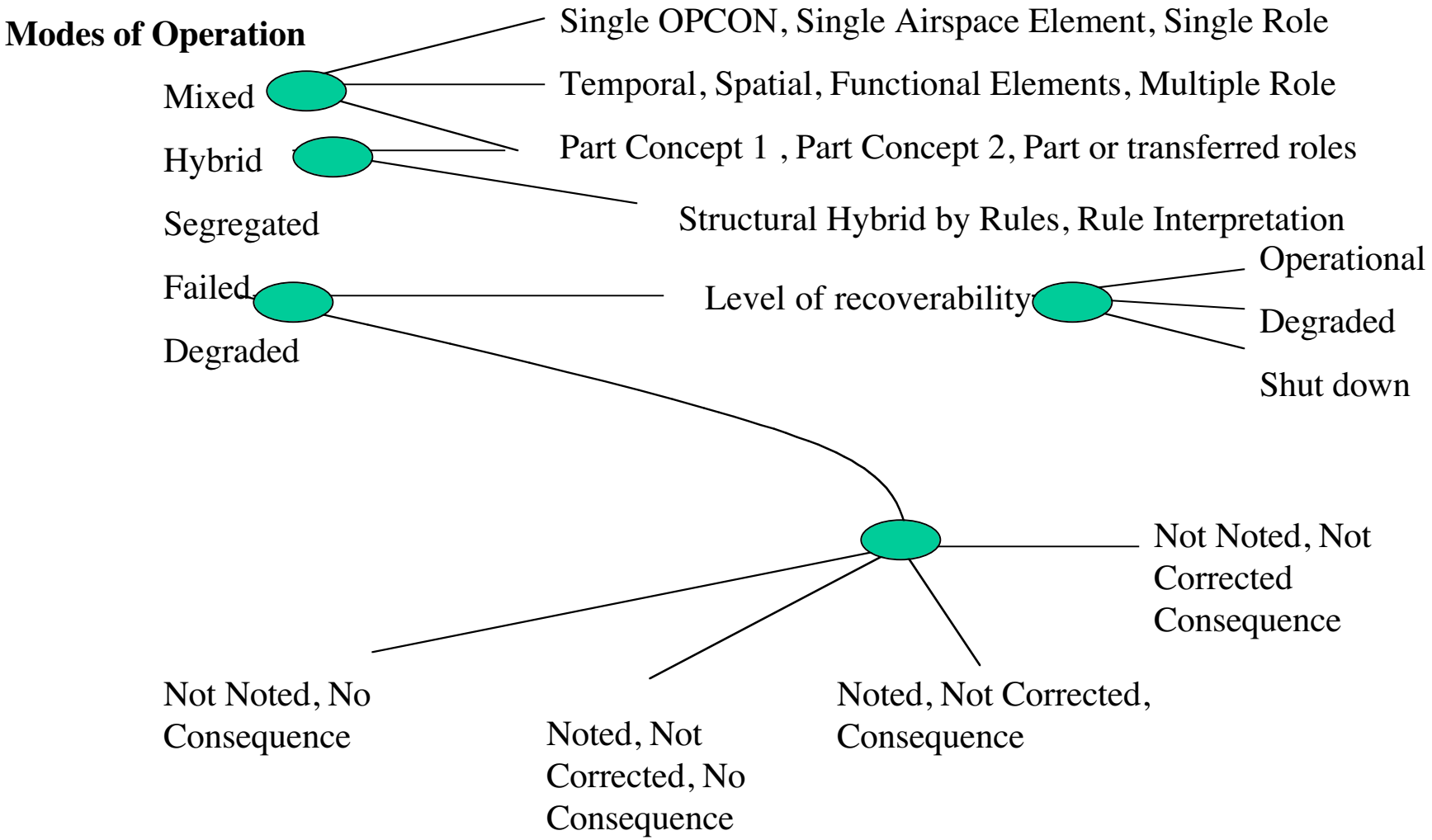
Concept Dependent

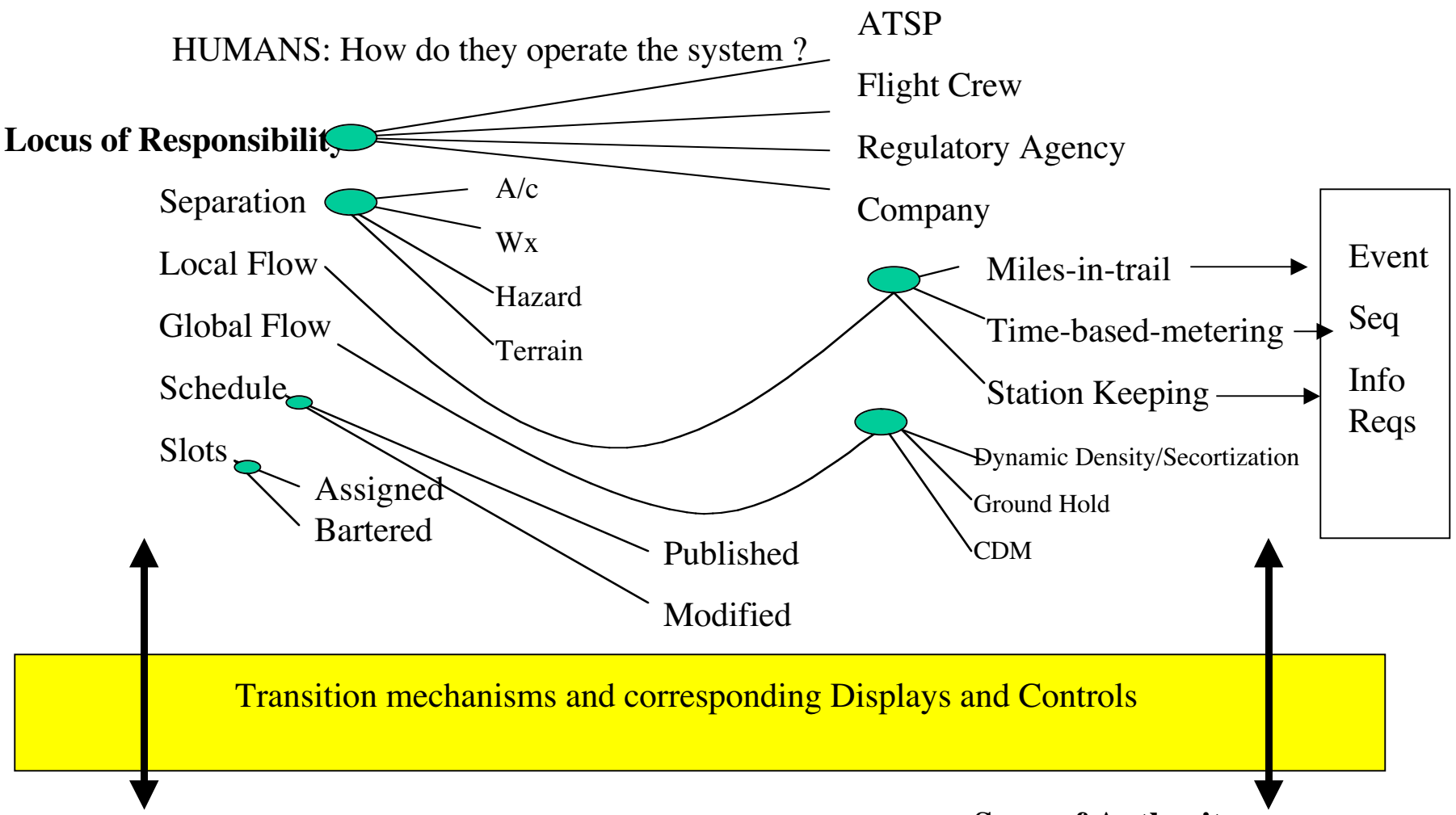
Note: Assume a multiple-day schedule of flights for these scenarios

Chsaractersitic Response Matrix of Measures and Perturbations

OPCON	Roles, Responsibilities & Information	Problem Solving Strategy Processes	System Constraints
Ambiguity			
Dynamicall y Changing Risk			
Organizatio nal & Social Pressures			

Defining Units of the OPCON and Derivative Study Foci





Locus of Authority

Separation

Local Flow

Schedule

Slots

Issues of dynamic criteria

Issues of ambiguity

Variability in response

Bias

Adaptation

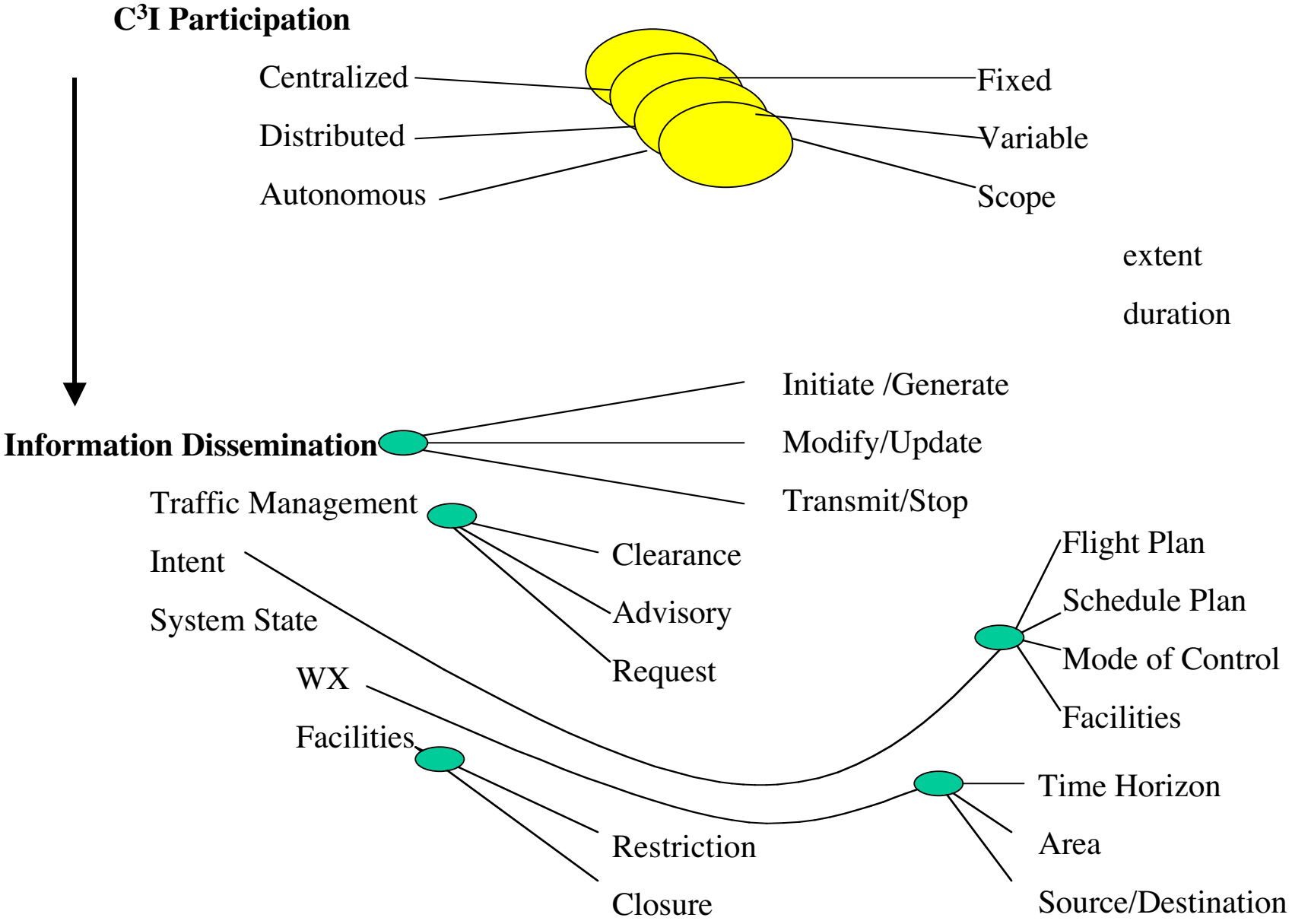
Span of Authority

Separation

Local Flow

Schedule

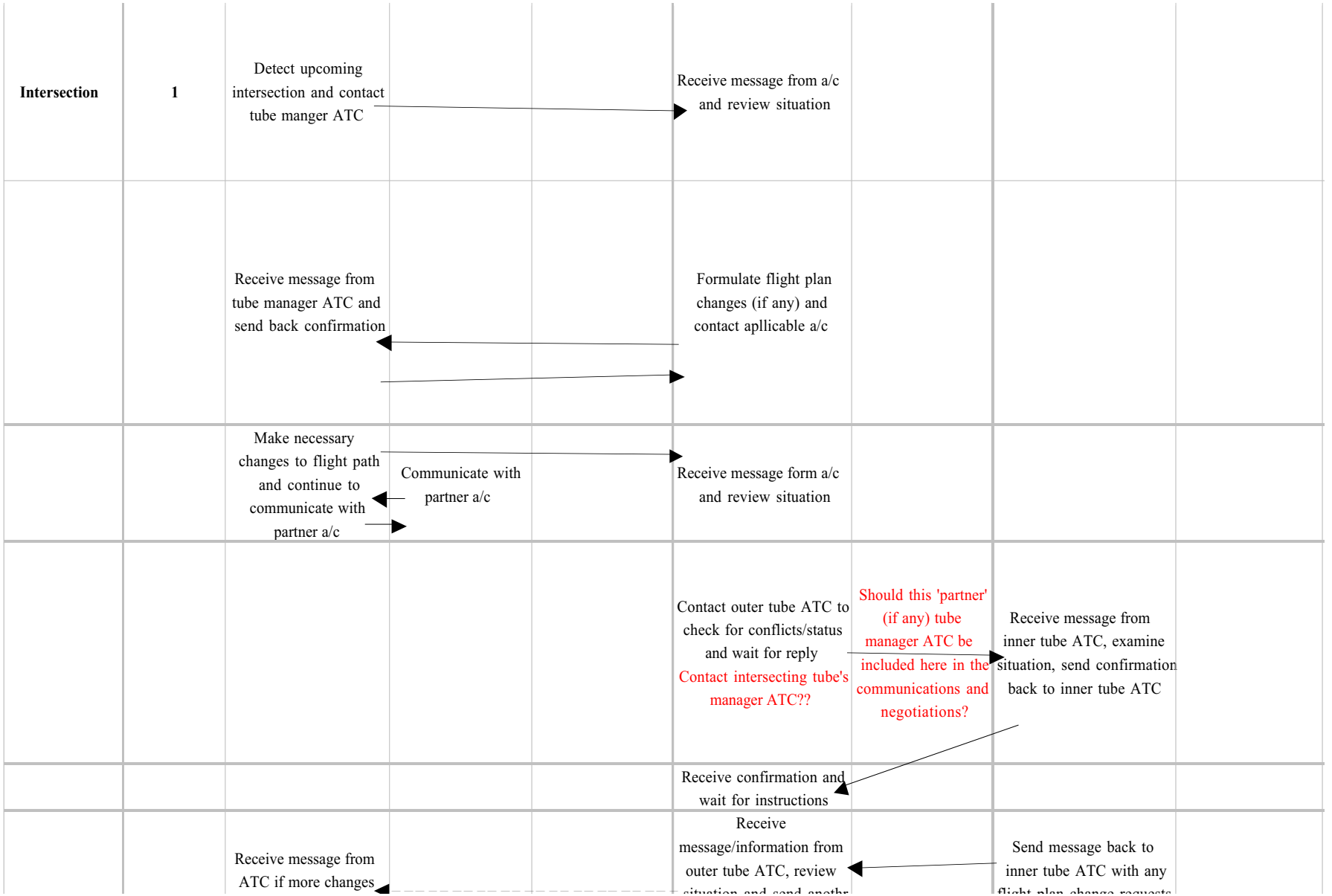
Slots

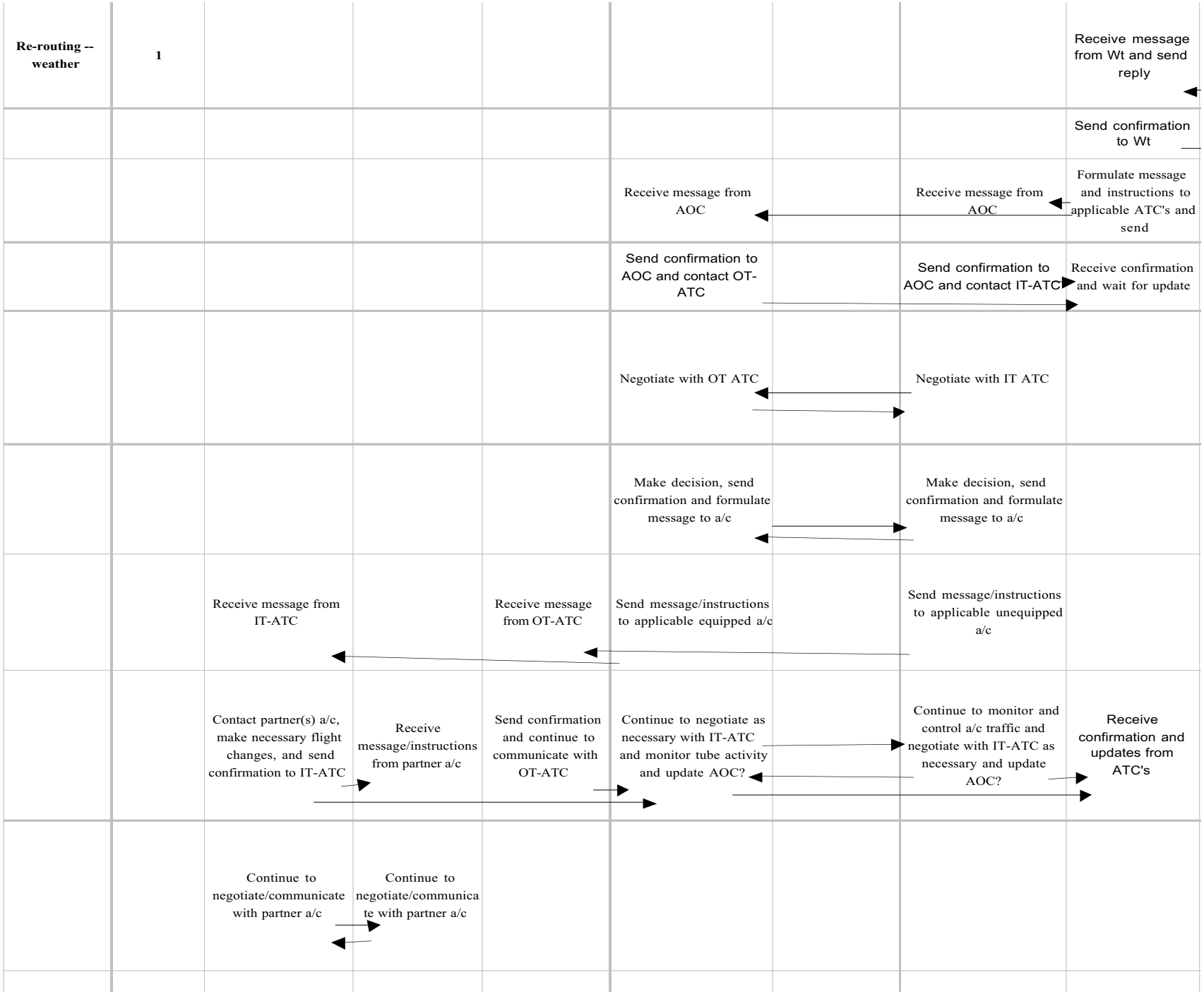

C3I Participation
Centralized
Distributed
Autonomous
Fixed
Variable
Scope
extent
duration
Information Dissemination
Initiate /Generate
Modify/Update
Transmit/Stop
Traffic Management
Intent
System State
WX
Facilities
Clearance
Advisory
Request
Flight Plan
Schedule Plan
Mode of Control
Facilities
Restriction
Closure
Time Horizon
Area
Source/Destination

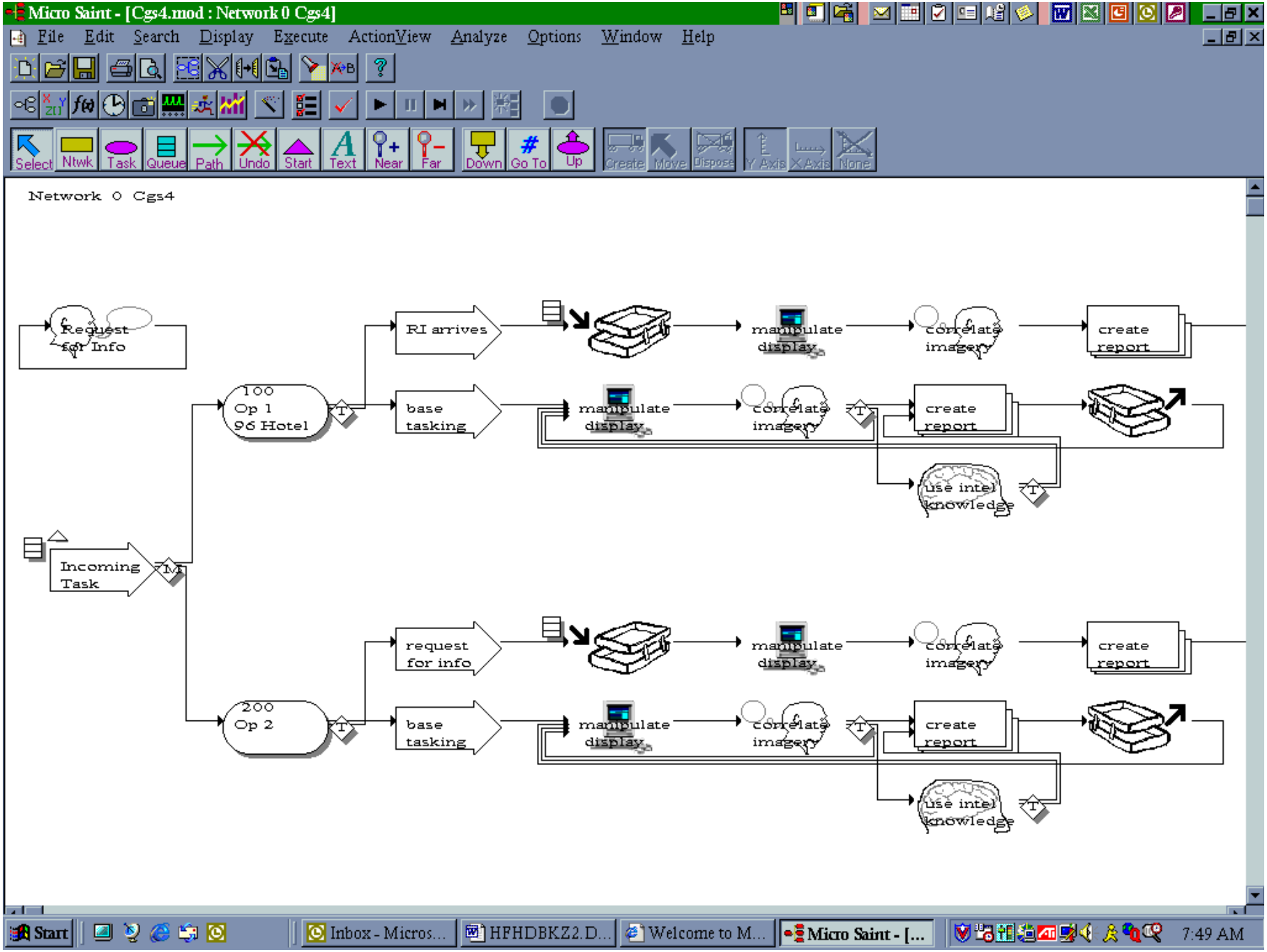
Cognitive Process and Information Topology Analysis

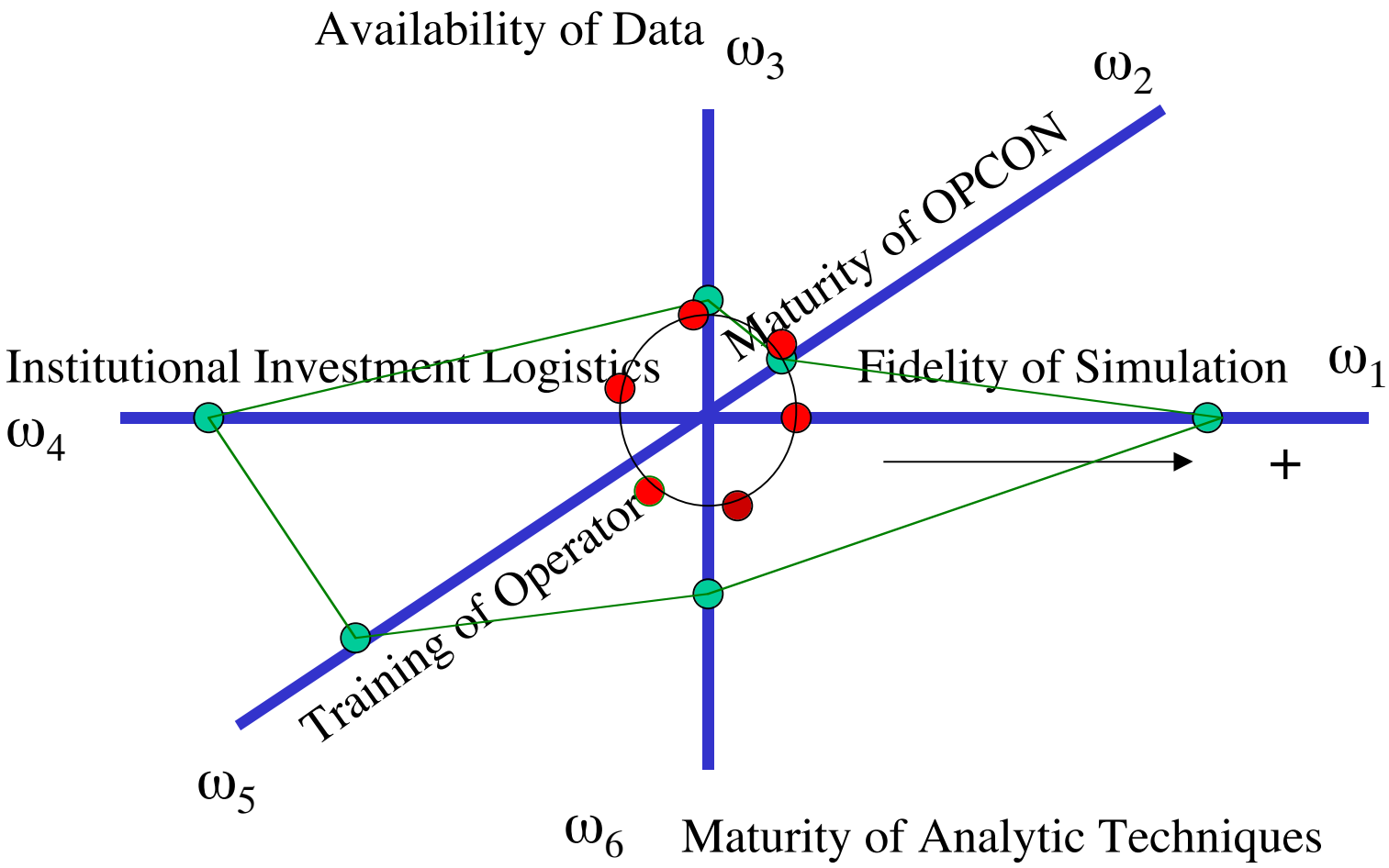
University Tube Operations

					Key Players			
		AIRCRAFT EQUIPPED	**PARTNER A/C (do we need this too?)**	**AIRCRAFT UNEQUIPPED**	**ATC INNER TUBE MANAGER**	**ATC *partner* TUBE MANAGER (do we need this too?)**	**ATC OUTER TUBE MANAGER**	**AOC**
Conflicts								
	Modeling Priority							
Merge into tube	**1**						Receive flight schedule and sequence information	Set flight schedule and sequence and send to OT-ATC
		Receive flight information					Formulate message to a/c and send	
		Confirm flight plan to ATC and record information					Receive confirmation from a/c and give confirmation/update to AOC	Receive confirmation from OT-ATC
		Formulate message to IT-ATC and send flight information			Receive flight information/status from a/c entering tube			
		Receive confirmation/insturctions and partner a/c frequency from inner tube ATC			Formulate message to a/c and send confirmation and any applicable instructions/flight plans and partner a/c flight information (radio frequency)			
		Formulate message to partner a/c and inner tube ATC and send flight information	Receive message from partner a/c and send confirmation					
		Send confirmation to			Receive confirmation from a/c and wait for next a/c			

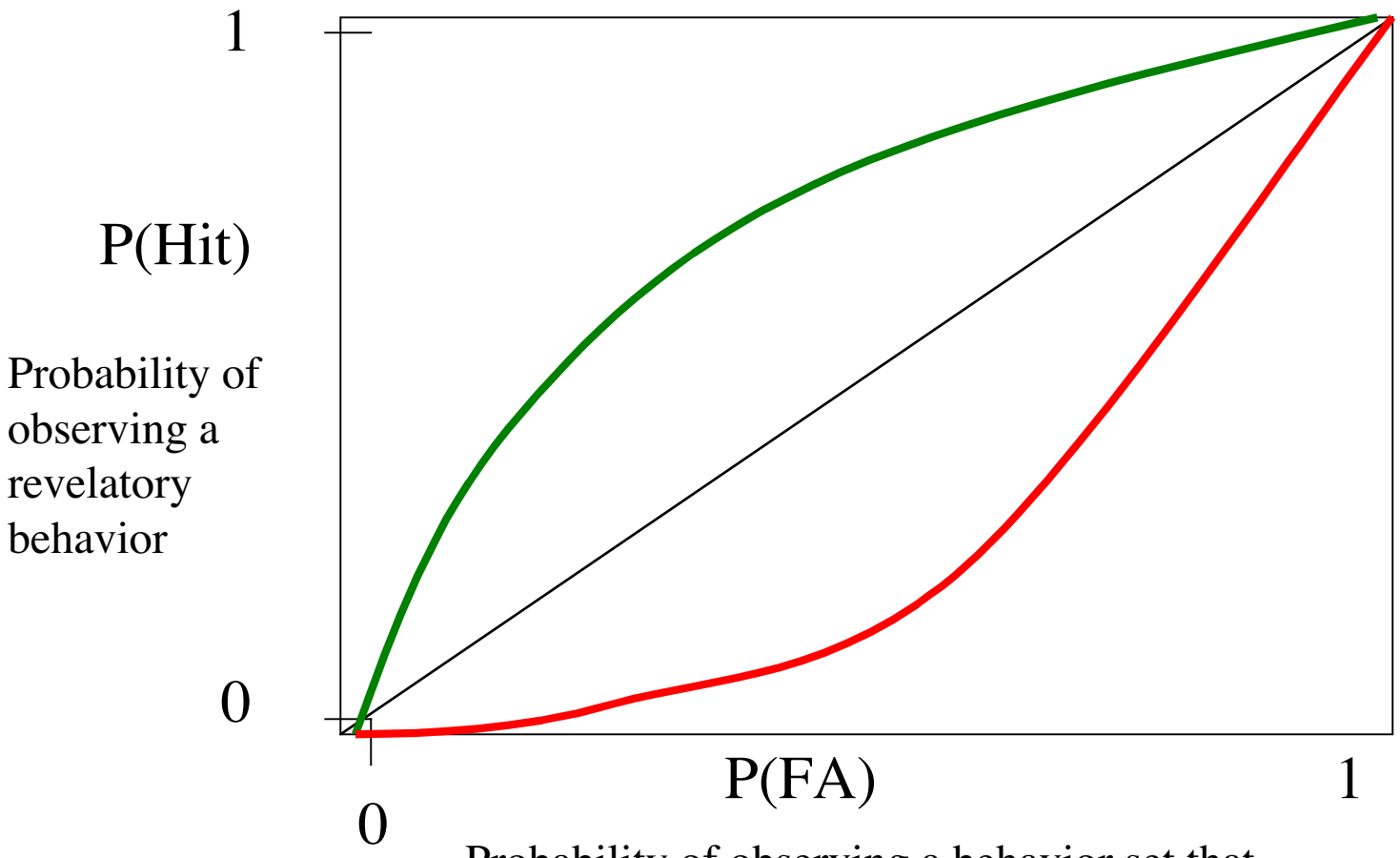

Intersection
1
Detect upcoming intersection and contact tube manger ATC
Receive message from a/c and review situation
Receive message from tube manager ATC and send back confirmation
Formulate flight plan changes (if any) and contact apllicable a/c
Make necessary changes to flight path and continue to communicate with partner a/c
Communicate with partner a/c
Receive message form a/c and review situation
Contact outer tube ATC to check for conflicts/status and wait for reply
Contact intersecting tube's manager ATC??
Should this 'partner' (if any) tube manager ATC be included here in the communications and negotiations?
Receive message from inner tube ATC, examine situation, send confirmation back to inner tube ATC
Receive confirmation and wait for instructions
Receive message/information from outer tube ATC, review
Send message back to inner tube ATC with any
Receive message from ATC if more changes


Re-routing -- weather
1
Receive message from Wt and send reply
Send confirmation to Wt
Receive message from AOC
Receive message from AOC
Formulate message and instructions to applicable ATC's and send
Send confirmation to AOC and contact OT-ATC
Send confirmation to AOC and contact IT-ATC
Receive confirmation and wait for update
Negotiate with OT ATC
Negotiate with IT ATC
Make decision, send confirmation and formulate message to a/c
Make decision, send confirmation and formulate message to a/c
Receive message from IT-ATC
Receive message from OT-ATC
Send message/instructions to applicable equipped a/c
Send message/instructions to applicable unequipped a/c
Contact partner(s) a/c, make necessary flight changes, and send confirmation to IT-ATC
Receive message/instructions from partner a/c
Send confirmation and continue to communicate with OT-ATC
Continue to negotiate as necessary with IT-ATC and monitor tube activity and update AOC?
Continue to monitor and control a/c traffic and negotiate with IT-ATC as necessary and update AOC?
Receive confirmation and updates from ATC's
Continue to negotiate/communicate with partner a/c
Continue to negotiate/communicate with partner a/c


Micro Saint - [Cgs4.mod : Network 0 Cgs4]
File Edit Search Display Execute ActionView Analyze Options Window Help
Select Ntwk Task Queue Path Undo Start Text Near Far Down Go To Up Create Move Dispose Y Axis X Axis None
Network 0 Cgs4
Request for Info
RI arrives
manipulate display
correlate imagery
create report
100 Op 1 96 Hotel
base tasking
manipulate display
correlate imagery
create report
use intel knowledge
Incoming Task
request for info
manipulate display
correlate imagery
create report
200 Op 2
base tasking
manipulate display
correlate imagery
create report
use intel knowledge
Start
Inbox - Micros...
HFHDBKZ2.D...
Welcome to M...
Micro Saint - [...
7:49 AM


Availability of Data
ω_3
ω_2
Maturity of OPCON
Institutional Investment Logistics
Fidelity of Simulation
ω_1
ω_4
+
Training of Operator
ω_5
ω_6
Maturity of Analytic Techniques

Data Operating Curve (DOC)



Fidelity of the analysis/simulation sets the lower limit of discriminability of significant behavior

Summary Perspective on OPCOn Evaluation and Assessment

- **Assertion:**
  - Safety and Capacity of airspace operations is limited by the cognitive, perceptual, or attentive characteristics of the managers, controllers, operators in that airspace.
  - Technical aiding systems (&/or procedures) can be designed to assist the human operators and offset the limitation(s)
    - Identified what and how the limit is manifest
    - Develop technologies that work to remove that limitation(s)

      And don't impose others,

      Only alter the limitation & otherwise don't change the airspace operation,

      Enhancement will not be exploited to reach a new level of human constraint ,

      Can revert to safe operations in case of all foreseeable failure modes