
NextGEN
FAA Research & Development
Systems Thinking
Presented for: V&V Summit
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Manager, Research and Development Management Division
September 20, 2018
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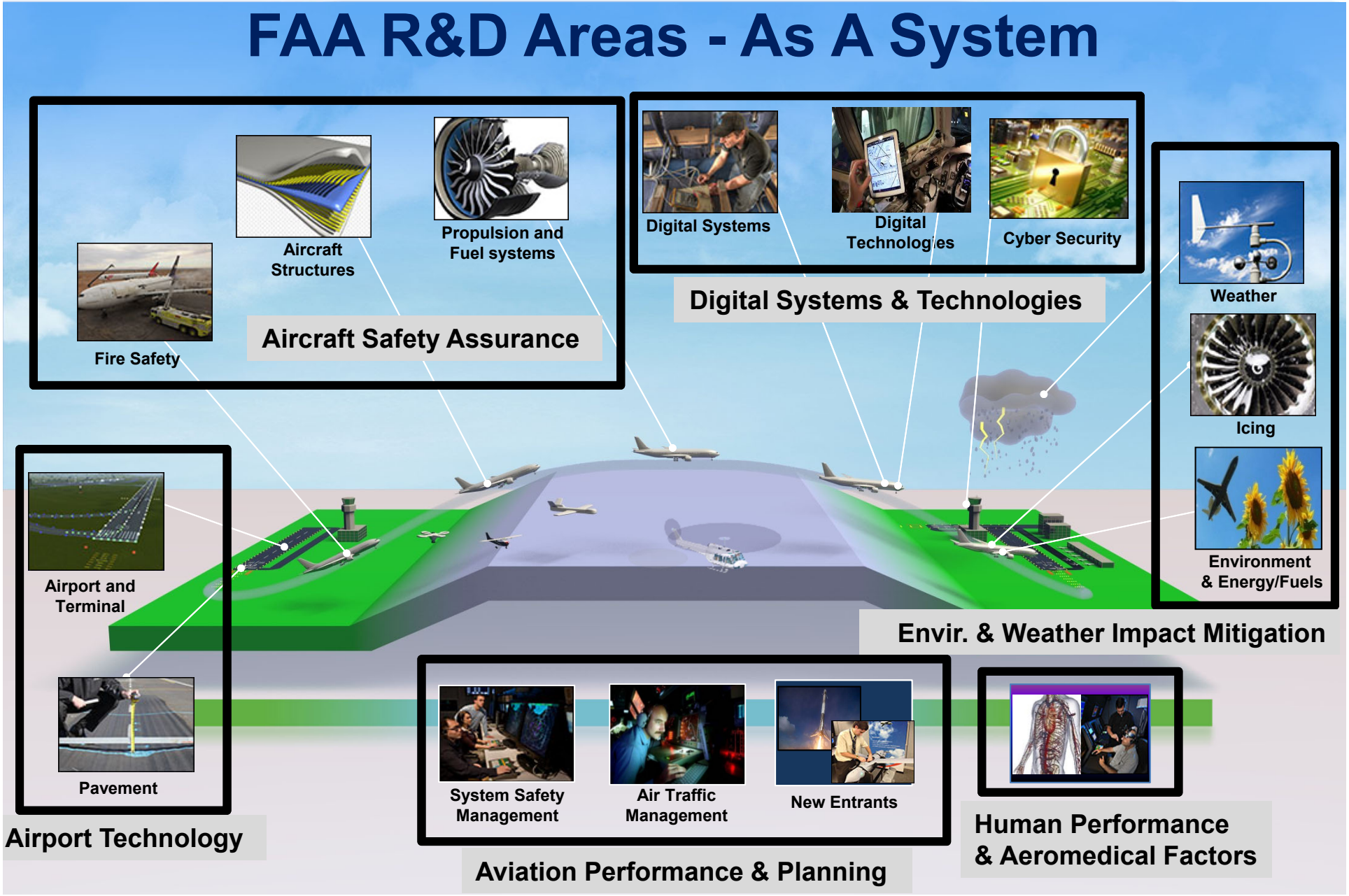
FAA R&D Areas - As A System



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Nature of FAA R&D

Applied Research

To analyze information and identify, develop, establish, improve, accelerate and/or enhance practicable methods, procedures and new technologies

Statute: US Code Titles 42, 49

RE&D

Funds programs that improve the NAS, by increasing its:

- Safety
- Security
- Productivity
- Capacity

F&E

Funds capital investments for developing and validating technology and systems that support air traffic services and safety/capacity improvements:

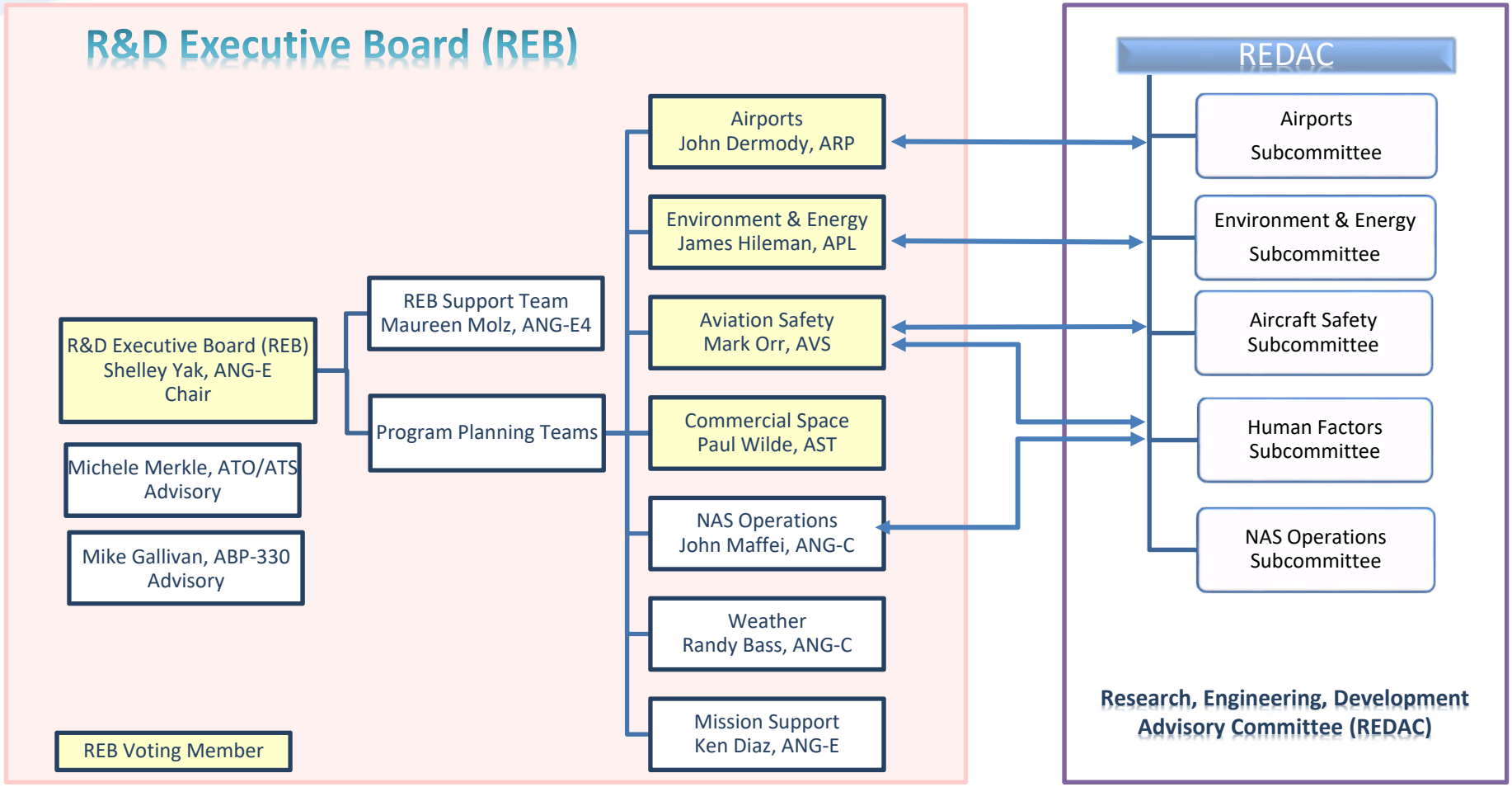
- Advanced Technology Development and prototyping NextGen Portfolios (Pre-implementation)
- Center for Advanced Aviation System Development (CAASD)

AIP

Funds the discovery and evaluation of new technologies and methods to enhance safety and efficiency of airport operations and the durability of its infrastructure:

- Airport Cooperative Research
- Airport Technology Research

FAA R&D Governance and External Advisory System



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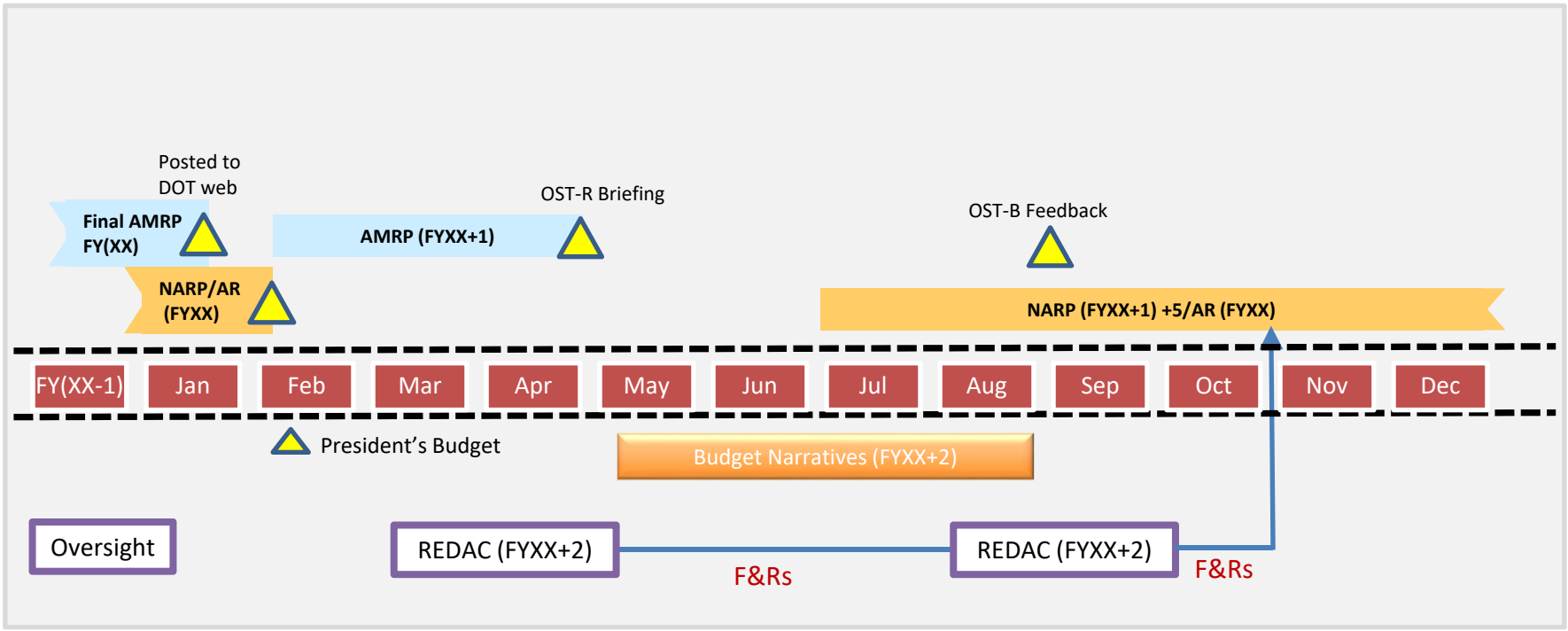
R&D Planning and Reporting Cycle

R&D Planning and Reporting Cycle



Reporting Products

- *National Aviation Research Plan (NARP)*
- *Annual Review (AR)*
- *Annual Modal Research Plan (AMRP)*

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Current R&D Planning Frameworks

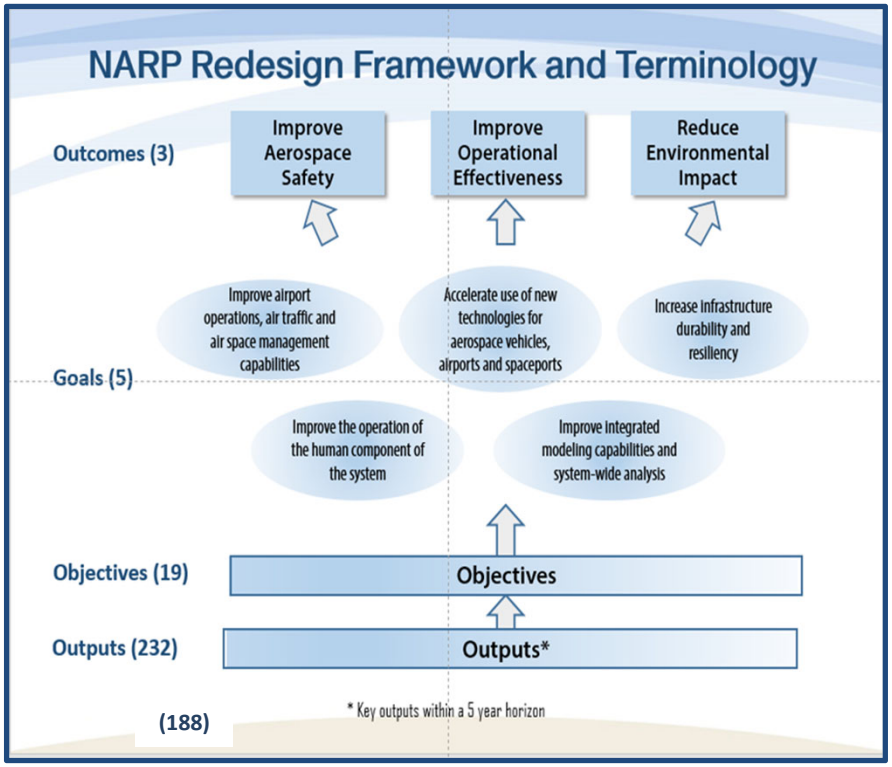
AMRP Framework by Research Area and BLI

Approp.	Research Program
Airport Technology	
AIP	Airports Cooperative Research
AIP	Airports Technology Research
Aircraft Safety Assurance	
RE&D	Fire Research and Safety
RE&D	Unmanned Aircraft Systems
RE&D	Advanced Materials/Structural Safety
RE&D	Aircraft Catastrophic Failure Prevention
RE&D	Continued Airworthiness
RE&D	Propulsion and Fuel Systems
RE&D	System Safety Management/Terminal Area Safety
Digital Systems and Technologies	
RE&D	Aircraft Icing/Digital System Safety
RE&D	NextGen – Information Security
RE&D	NextGen – Flight deck Data Exchange Requirements
Environment and Weather Impact Mitigation	
RE&D	Weather Program
RE&D	NextGen – Weather Technology in The Cockpit
RE&D	Aircraft Icing/Digital System Safety
RE&D	Environment and Energy
RE&D	NextGen – Environmental Research – Aircraft Technologies and Fuels
RE&D	NextGen – Alternative Fuels for General Aviation

Approp.	Research Program
Human Performance and Aeromedical Factors	
RE&D	Flight deck/Maintenance/Systems Integration Human Factors
RE&D	Air Traffic Control/Technical Operations Human Factors
RE&D	NextGen – Air Ground Integration Human Factors
RE&D	Aeromedical Research
Aviation Performance and Planning	
RE&D	System Safety Management/Terminal Area Safety
RE&D	Commercial Space Transportation
RE&D	NextGen – Wake Turbulence
F&E	Advanced Technology Development and Prototyping
F&E	NextGen – Separation Management Portfolio
F&E	NextGen – Traffic Flow Management Portfolio
F&E	NextGen – On Demand NAS Portfolio
F&E	NextGen – NAS Infrastructure Portfolio
F&E	NextGen Support Portfolio
F&E	NextGen – Enterprise, Concept Development, Human Factors, and Demonstrations Portfolio
F&E	NextGen transportation System – Unmanned Airspace Systems (UAS)
RE&D	System Planning and Resource Management

BLIs included in multiple research areas

NARP Framework



TWO PERSPECTIVES OF THE SAME WORK

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NARP Research Goals/Objectives at a Glance

Goal 1. Improve airport operations, air traffic and air space management capabilities

- 1a. Separation Management
- 1b. Air/Surface Traffic Management
- 1c. Integrated Weather Information
- 1d. Collaborative Decision Making
- 1e. Airport/Spaceport Systems
- 1f. Aerospace Vehicle Operation
- 1g. Noise and Emission Management

Gate to Gate Separation/ ATM

Goal 2. Accelerate use of new technologies for aerospace vehicles, airports and spaceports

- 2a. Applied Innovation
- 2b. Certification/Licensing
- 2c. Alternative Fuels
- 2d. Data Analysis

Widgets

Goal 3. Increase infrastructure durability and resiliency

- 3a. Durability – NAS, Airport & Spaceport Infrastructure
- 3b. Resiliency – NAS, Airport & Spaceport Infrastructure
- 3b. Cybersecurity – Aviation Ecosystem

Enterprise

Goal 4. Improve the operation of the human component of the system

- 4a. Human Performance
- 4b. Aeromedical Factors

Human

Goal 5. Improve integrated modeling capabilities and system-wide analysis

- 5a. Aerospace System
- 5b. Data Engineering
- 5c. System Performance

System-wide tools & analysis

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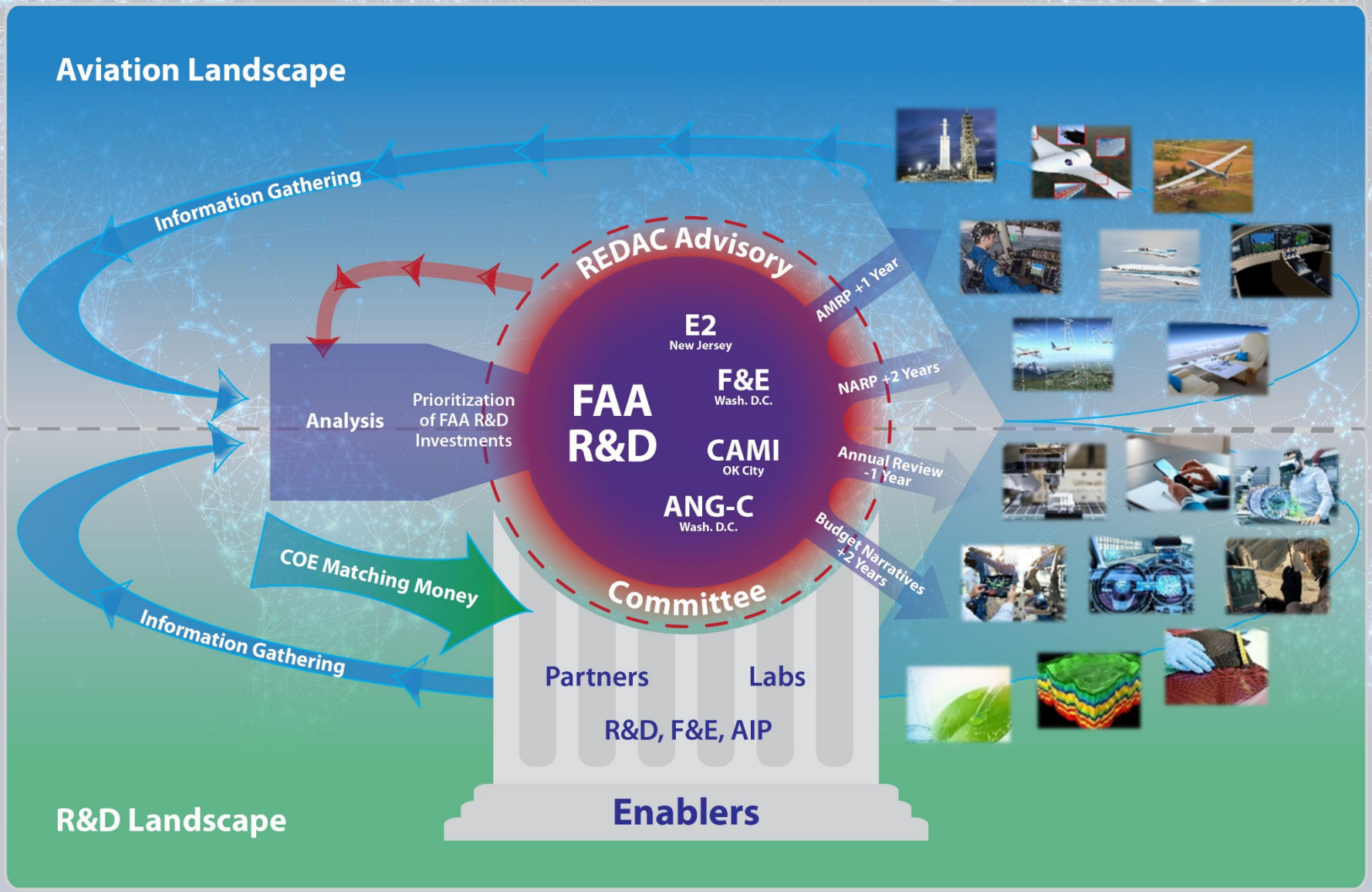
NARP Objectives

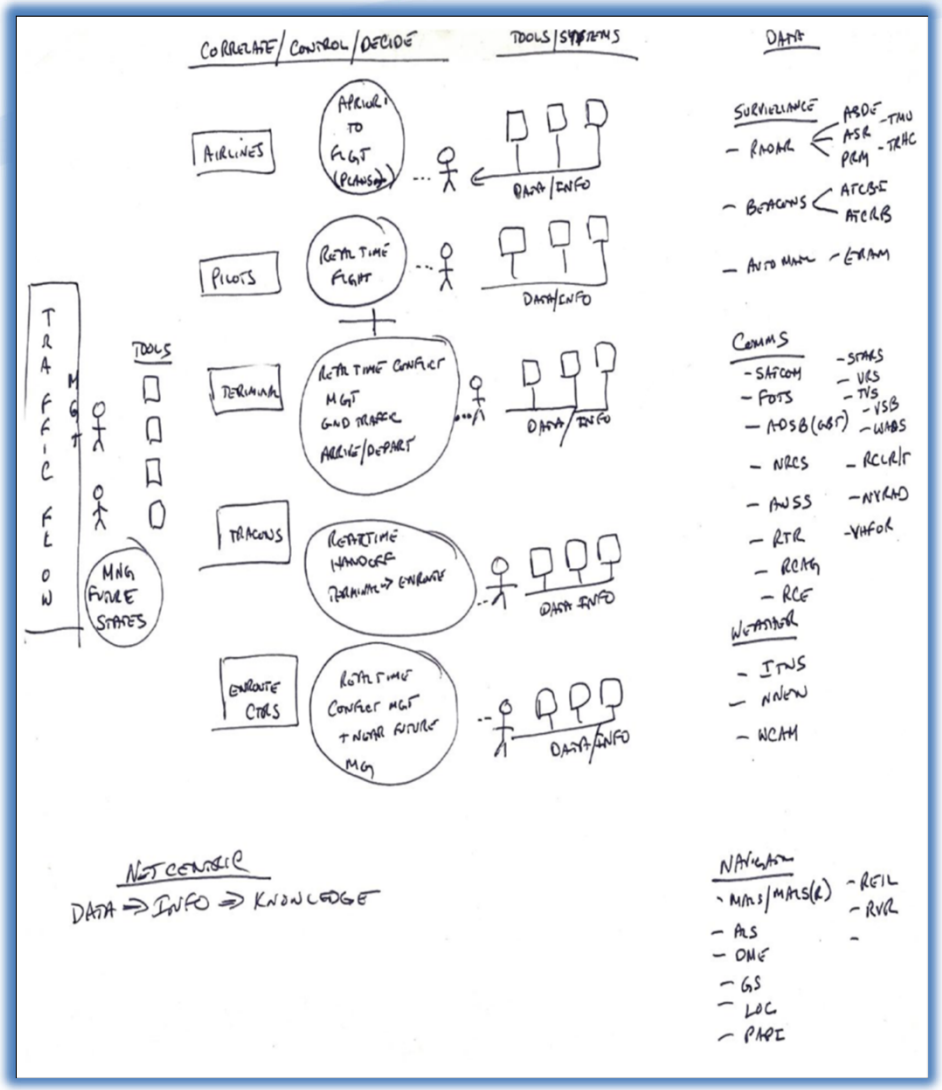
- Communicate driving forces for research (Vision)
- Communicate big picture (Strategy)
- Prioritize research that is results focused and properly positions the FAA
- Communicate costs and align investments
  - Include in-house/other resources (i.e. agencies, COEs, etc.)
  - Communicate strategy for leveraging other resources
- Communicate impacts/mitigations/alternatives of budget decisions on research
- REDAC review and advise on planned R&D
  - Share insights on research activities occurring within industry/academia
  - Identify future/long-term R&D requirements, emerging technologies, and knowledge gaps

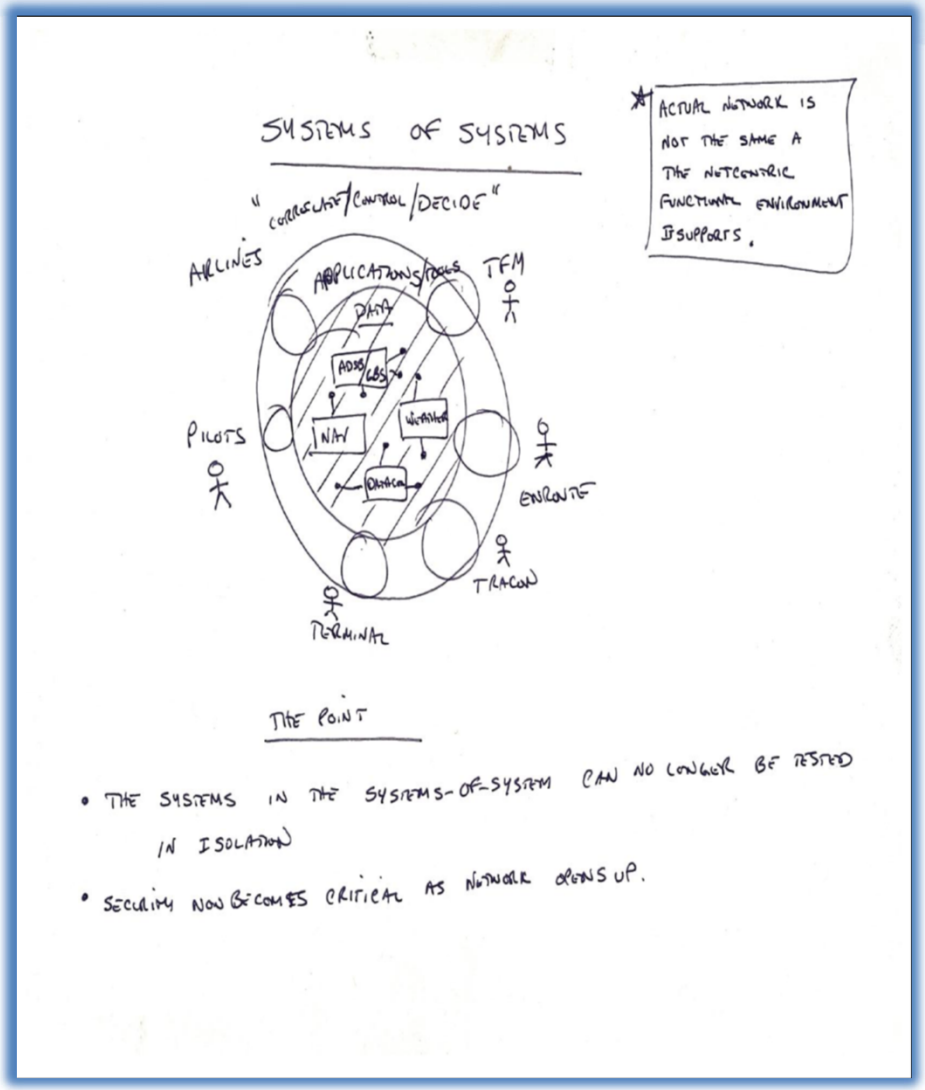
Growing and Technologically Advancing World



Systems Thinking?

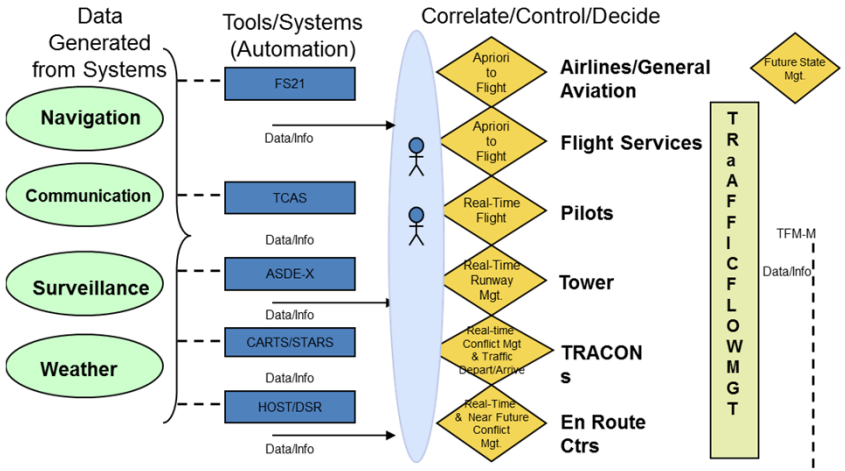
What is this?


CORRELATE/CONTROL/DECIDE
TOOLS/SYSTEMS
DATA
AIRLINES
PILOTS
TERMINAL
TRACONS
ENROUTE CTRS
TRAFFIC FLOW MGT
TOOLS
MNG FUTURE STATES
DATA/INFO
SURVEILLANCE
- RNAV
- BEACONS
- AUTO MAN
COMMS
- SATCOM
- FOTS
- NRCS
- AWSS
- RTR
WEATHER
- ITWS
- WNEW
- WCAM
NAVIGATION
- PRNAV
- RNP
- GPS
- LOC
NETCENTRIC
DATA ⇒ INFO ⇒ KNOWLEDGE


SYSTEMS OF SYSTEMS
"CORRELATE/CONTROL/DECIDE"
AIRLINES
APPLICATIONS/TOOLS
TFM
DATA
ADS-B
GBSS
NAV
WEATHER
DATACOM
PILOTS
ENROUTE
TRACON
TERMINAL
ACTUAL NETWORK IS NOT THE SAME AS THE NETCENTRIC FUNCTIONAL ENVIRONMENT IT SUPPORTS.
THE POINT
• THE SYSTEMS IN THE SYSTEMS-OF-SYSTEM CAN NO LONGER BE TESTED IN ISOLATION
• SECURITY NOW BECOMES CRITICAL AS NETWORK OPENS UP.

Formalization of Systems Views

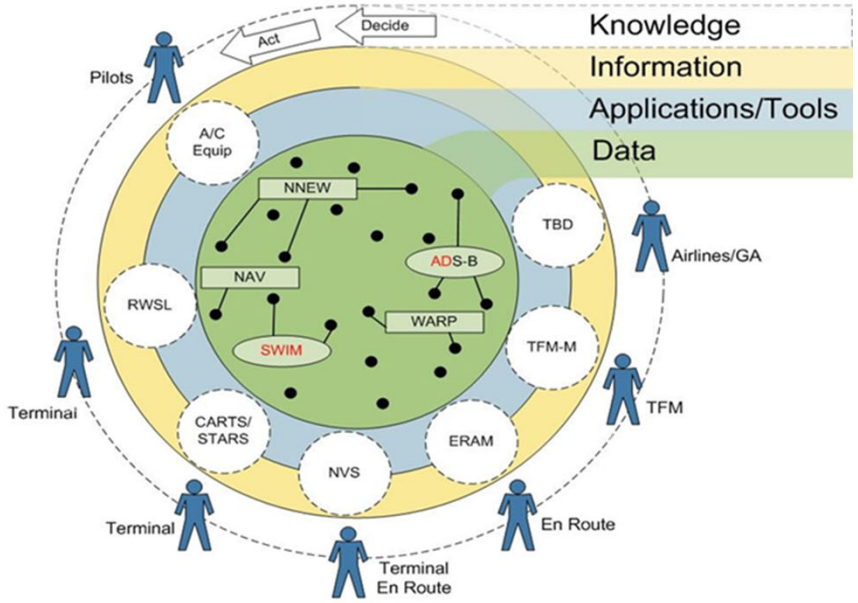
Conceptual View of Current NAS



Interoperable systems that exchange data in a point-to-point manner with human intensive manual processes

Conceptual View of a Net-Centric NAS: NextGen

Net-centric systems that gather, fuse and analyze multiple pieces of data from multiple sources to meet unique user needs



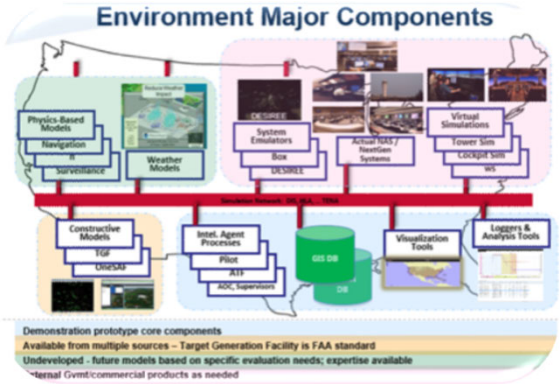
NetCentric has 2 components:
The transport layers and
The information layers.
This is about the information layers

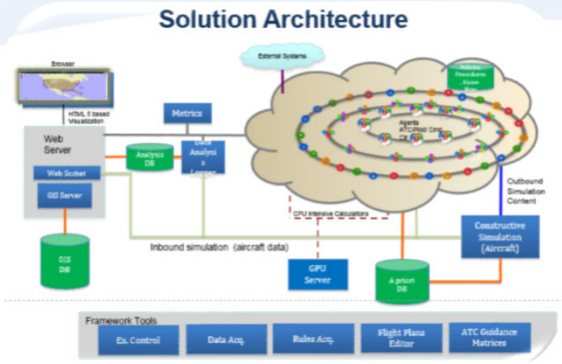
Data: Individual facts, measurements or observations which may or may not be sufficient to make a particular decision

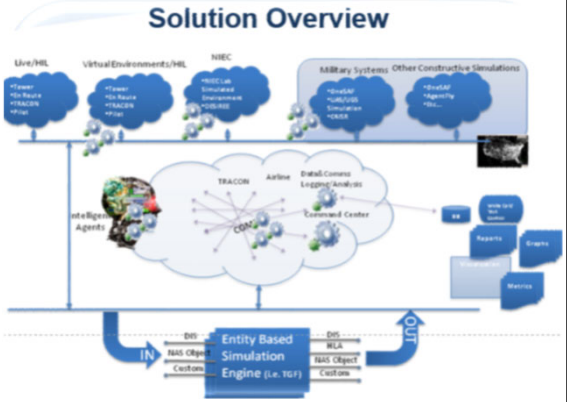
Information: Obtained when elements of data are assembled, reconciled, fused and placed in operational context

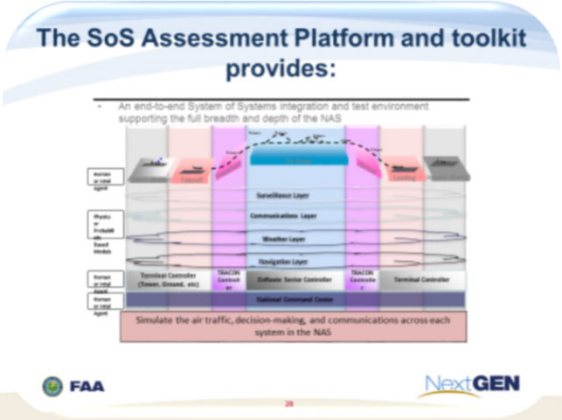
Knowledge: Derived from being able to use information to construct and use an exploratory model based on understanding of the situation or phenomenon

Do you remember this?









Benefits

- Test ***entire*** NAS as a system-of systems
- Influence concept evaluation and ***test***
- Evaluation in realistic/***intended environment***
- Simulate the air traffic, decision-making, and communications across each system in the NAS

Provides

- An end-to-end System of Systems integration and test environment supporting the full breadth and depth of the NAS

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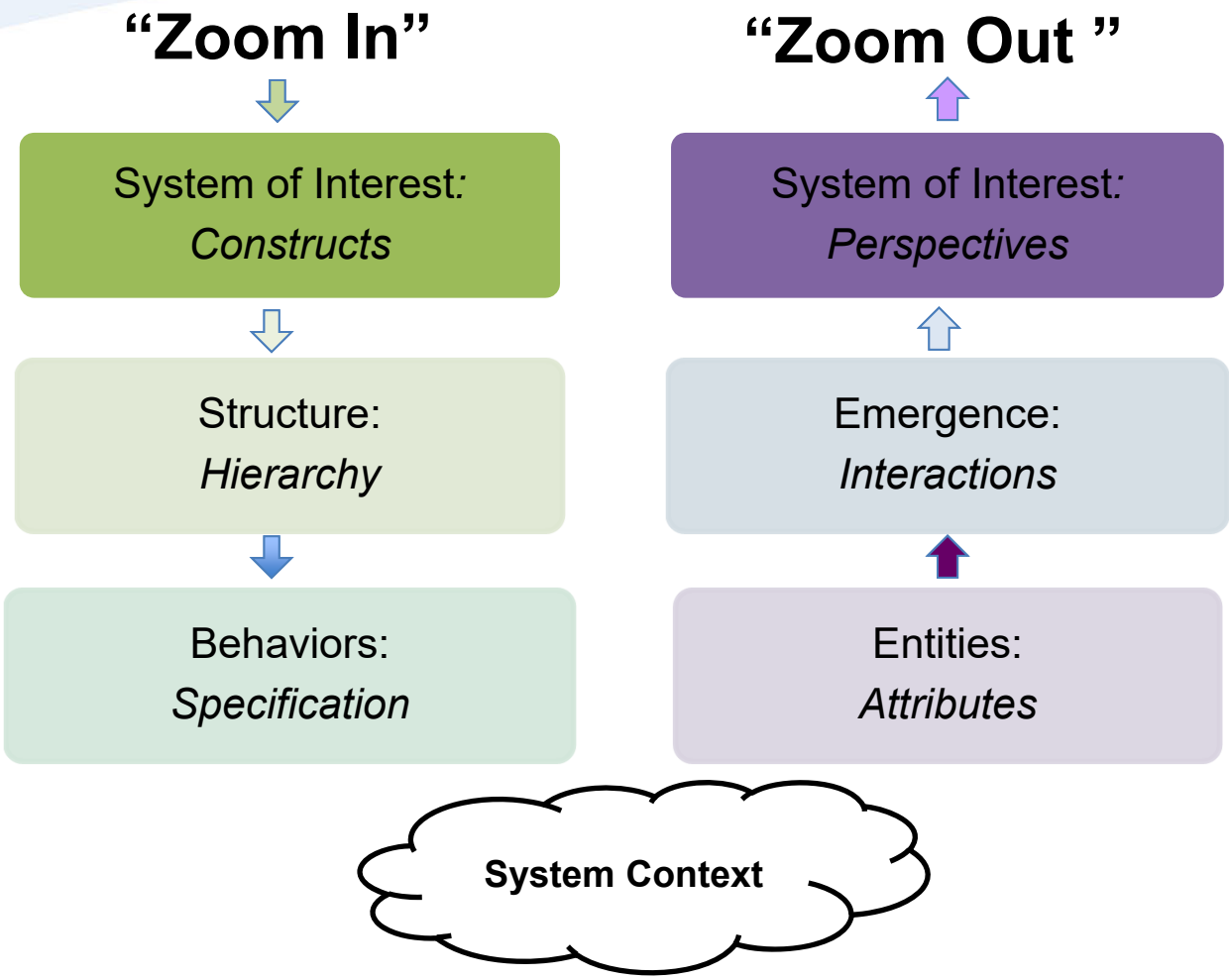
Holism – The Big Picture



Zoom Out

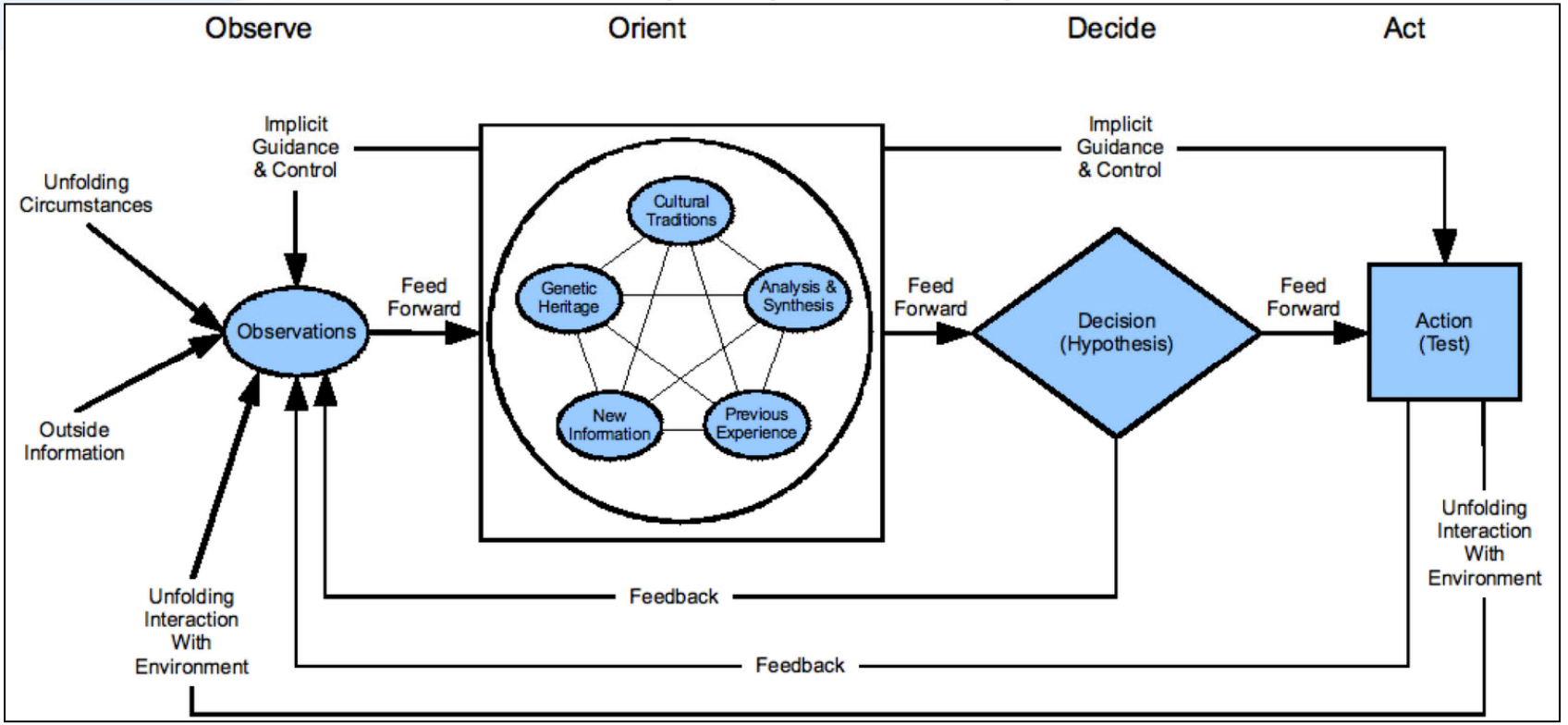
- Sense a change in conditions
- Assess the time frame: How much time before the risk profile changes?
- Assess with rigor: Do the new conditions call for disrupting plans? If so, how?

Then Zoom In

- Focus on supreme execution of plans and objectives

Quoted from Jim Collins & Morten Hansen, Great By Choice, HarperCollins, 2011

Boyd's OODA Loop as a Tool for Managing Change



Note how orientation shapes observation, shapes decision, shapes action, and in turn is shaped by the feedback and other phenomena coming into our sensing or observing window.

Also not how the entire "loop" (not just orientation) is an ongoing many-sided implicit cross-referencing process of projection, empathy, correlation, and rejection.

From "The Essence of Winning and Losing" John R. Boyd. January 1996

What are Mental Models?

"Mental models are deeply held internal images of how the world works, images that limit us to familiar ways of thinking and acting. Very often, we are not consciously aware of our mental models or the effects they have on our behavior."

- Peter Senge

Georgia Tech – FAA Applied System Thinking Course
August 18-19, 2015

These are critical for communication complex information for the purpose of problem solving and decision making

Bias and Errors

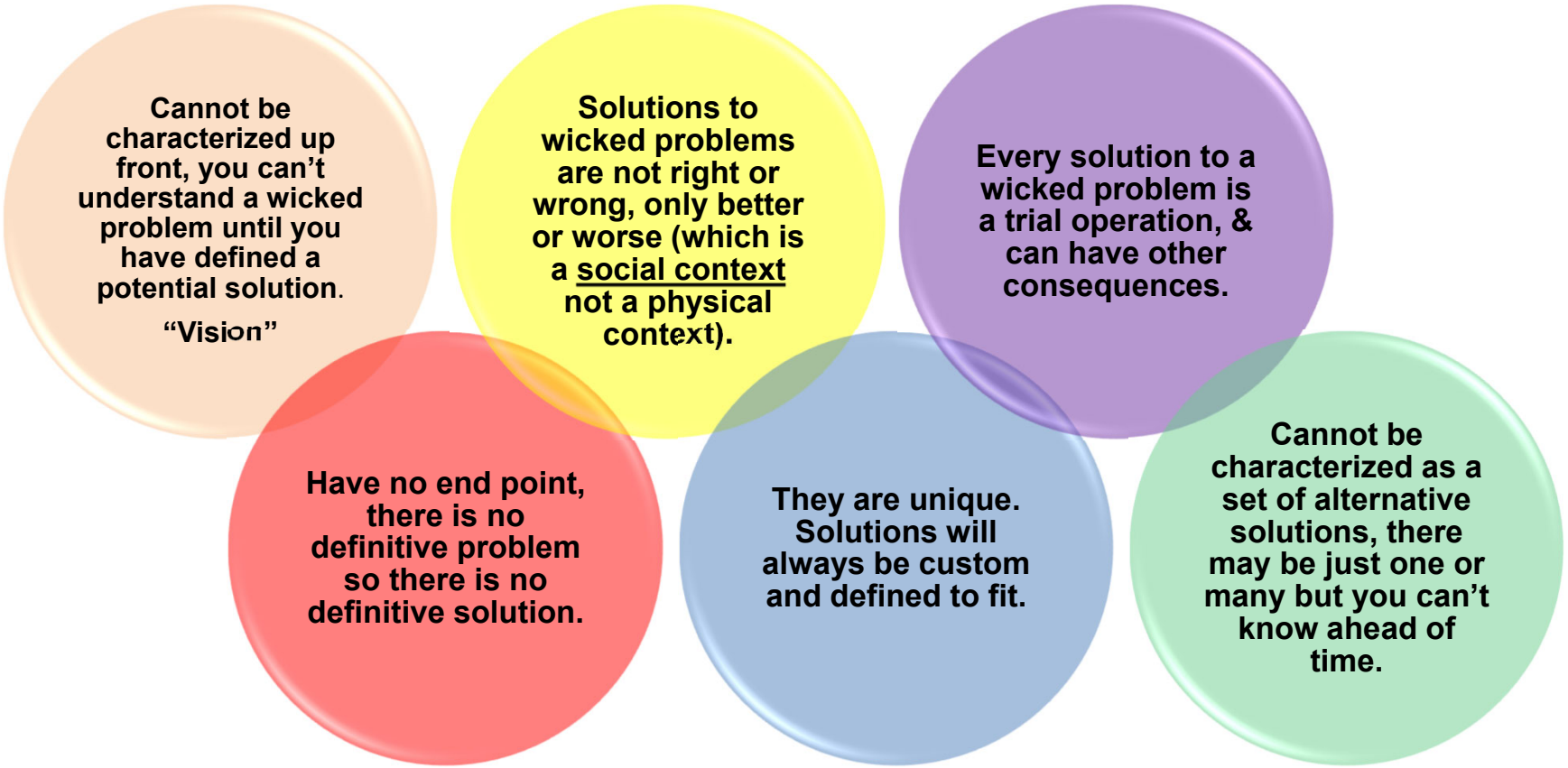
- Bias – tendency to use information in making decisions in a way that does not conform to rules of logic, and has no rational basis
- Characteristic error – a common decision making error that arises from a bias

Biased decisions are not necessarily errors; erroneous decisions are not necessarily biased.

Common Biases

- Errors of formal logic (examples)
  - Conjunction Bias
  - Inappropriate Generalization
  - Affirming the Null
- Interpolation and Extrapolation of Trends

A Wicked Problem…
depends on how you look at it



If you can't answer these you don't understand your problem.

Conclusion

- Everything is a system.
- In the end its all about THINKING.
- We all have unique perspectives and all these should be used in solving tough problems, but consensus management does not work quickly. So how do we do this? “Vision” and “Planning”.
- We all have bias’ that shape our thought.

Biases are only as powerful as our inability to hear another approach.

The trick to solving tough systems problems might be to:

- Envision what you (the community) wants the future to look like.
- Be able to create a mental model to ensure understanding and debate.
- Plan to that vision then adjust the vision depending on the constraints of the program execution (technical barriers, resources, heavy community resistance).
- Don’t give up.

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Innovation Technical Advisory Council (ITAC)

- Bringing new innovative ideas that support the ANG/William J. Hughes Technical Center Mission(s)
- Facilitate a culture of technological innovation and advancement at the WJHTC where the workforce is empowered to develop new ideas, utilize its expertise, and influence the direction of the Center's future technological capabilities.
- Guide research and development into new technology innovations.

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