National Aeronautics and Space Administration

Application of Human-Autonomy Teaming (HAT) Patterns to Reduced Crew Operations (RCO)

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Human-Autonomy Teaming

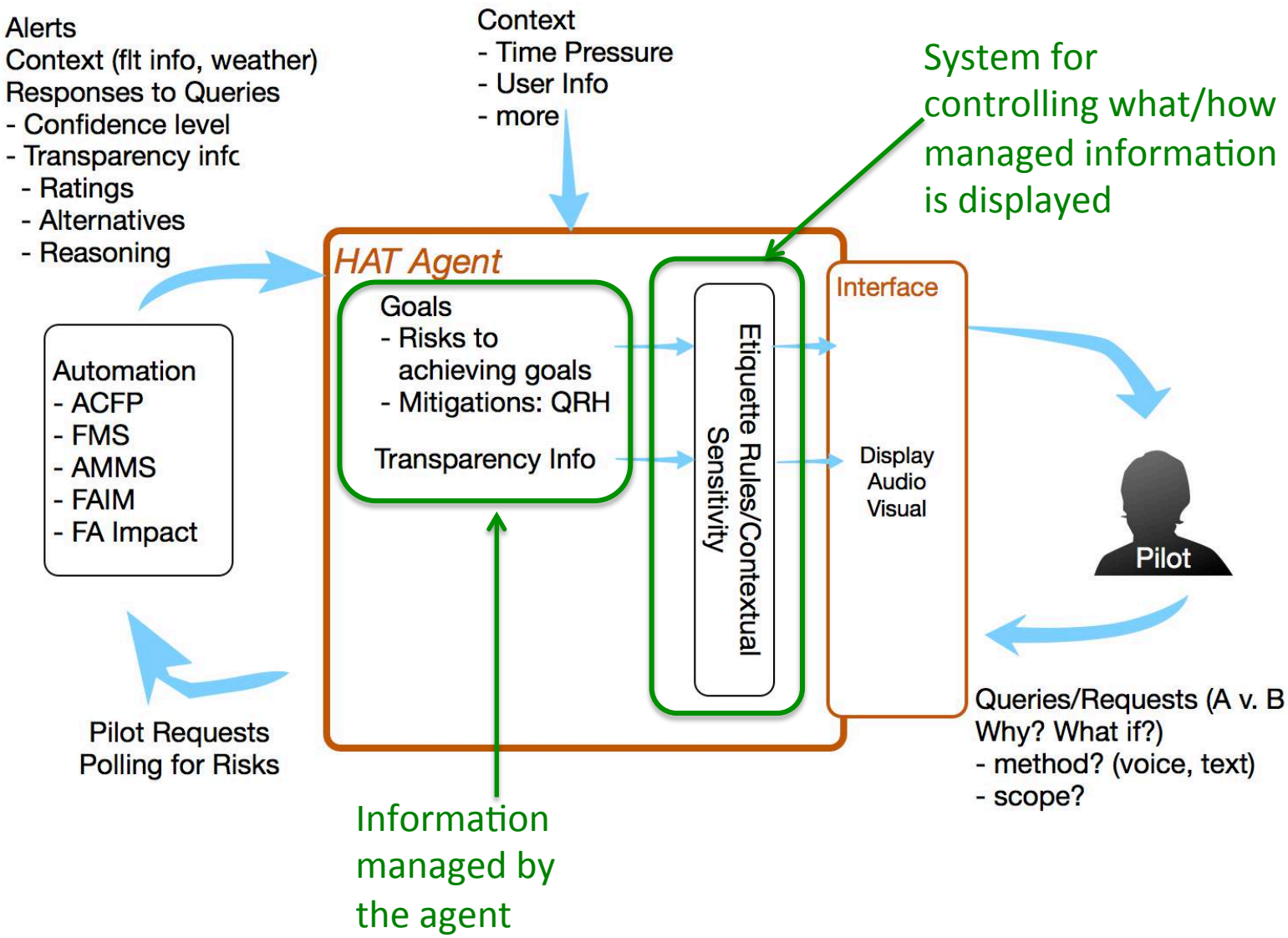
Characteristics of HAT

- Bi-directional dialogue
- Shared goals
- Communication – shared language
- Trust
- Separate information that makes it sub-optimal to make decisions separately
- Shared (but not completely) Info/SA
- Flexibility/Robust/Resilient
- Shared fate ?

Critical Aspects of HAT

- Collaboration
- Pilot directed dynamic interface
- Contextually driven levels of automation and interaction

HAT Agent Architecture



Legend

Human Operator

Intelligent / Cognitive Agent

Automated Tools

Communication Only

Supervisory Relationship

Cooperative Relationship

Both imply ***bi-directional information flow****, usually using automated tools*

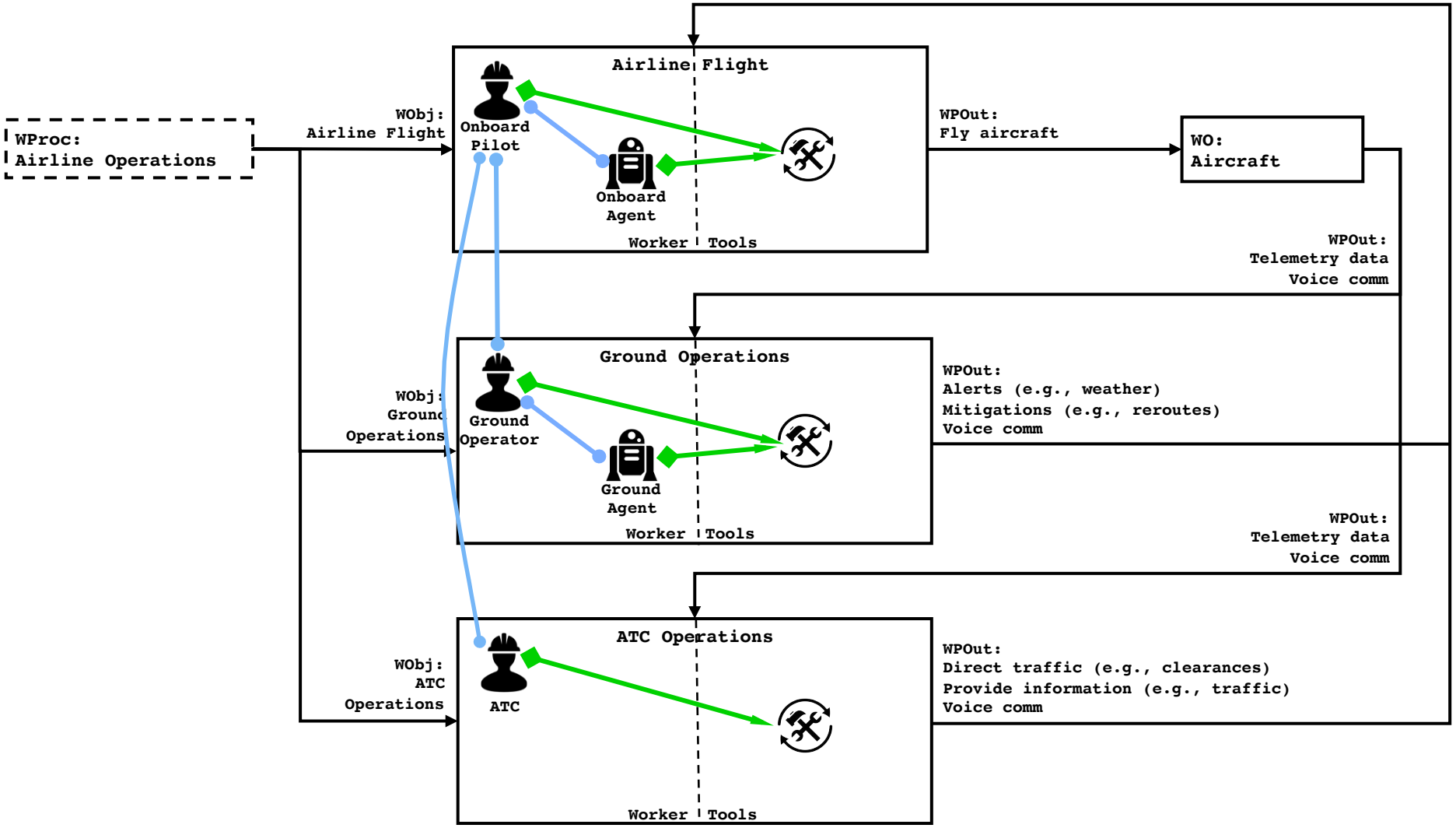
Co-location *(e.g., onboard an airplane, in ground station)*

RCO Use-Case

FLYSKY12 is en route from SFO to BOS. There is one POB and a dispatcher flight following.

- Onboard automation detects fuel imbalance and alerts POB and dispatcher.
- POB requests automation diagnose fuel imbalance. Automation reports to POB a leak in left tank.
- POB requests that agent manage fuel. Agent opens the cross feed and turns off the pumps in the right side to draw fuel from the left.
- POB contacts dispatch about need to divert.
- Dispatcher requests divert planning from dispatch automation.
- Dispatcher uplinks flight plan to POB. POB inspects the flight plan and agrees.
- POB requests agent coordinate divert with ATC. Agent reports divert is approved. POB tells agent to execute.

Top-Level System Work



Dialog/Bi-Directional Communication Pattern

Both the automation and human operators may have information or know of constraints the other is unaware of. Sharing this information is important to making plans that are acceptable and implementable

- Transparency
  - In order to evaluate a recommendation, it is necessary to understand how that recommendation was arrived at
- Shared Language
  - Human and computer reasoning systems often take very different forms (e.g., humans categorize and satisfice; computers are more quantitative). Dialog and Transparency require an interface that bridges such differences
- Human Directed
  - Ultimate responsibility needs to fall somewhere. We believe that is going to be the human. It follows that the human should be giving explicit direction to the automation.