



EXPLORE FLIGHT

WE'RE WITH YOU WHEN YOU FLY

Provider of Services to UAM

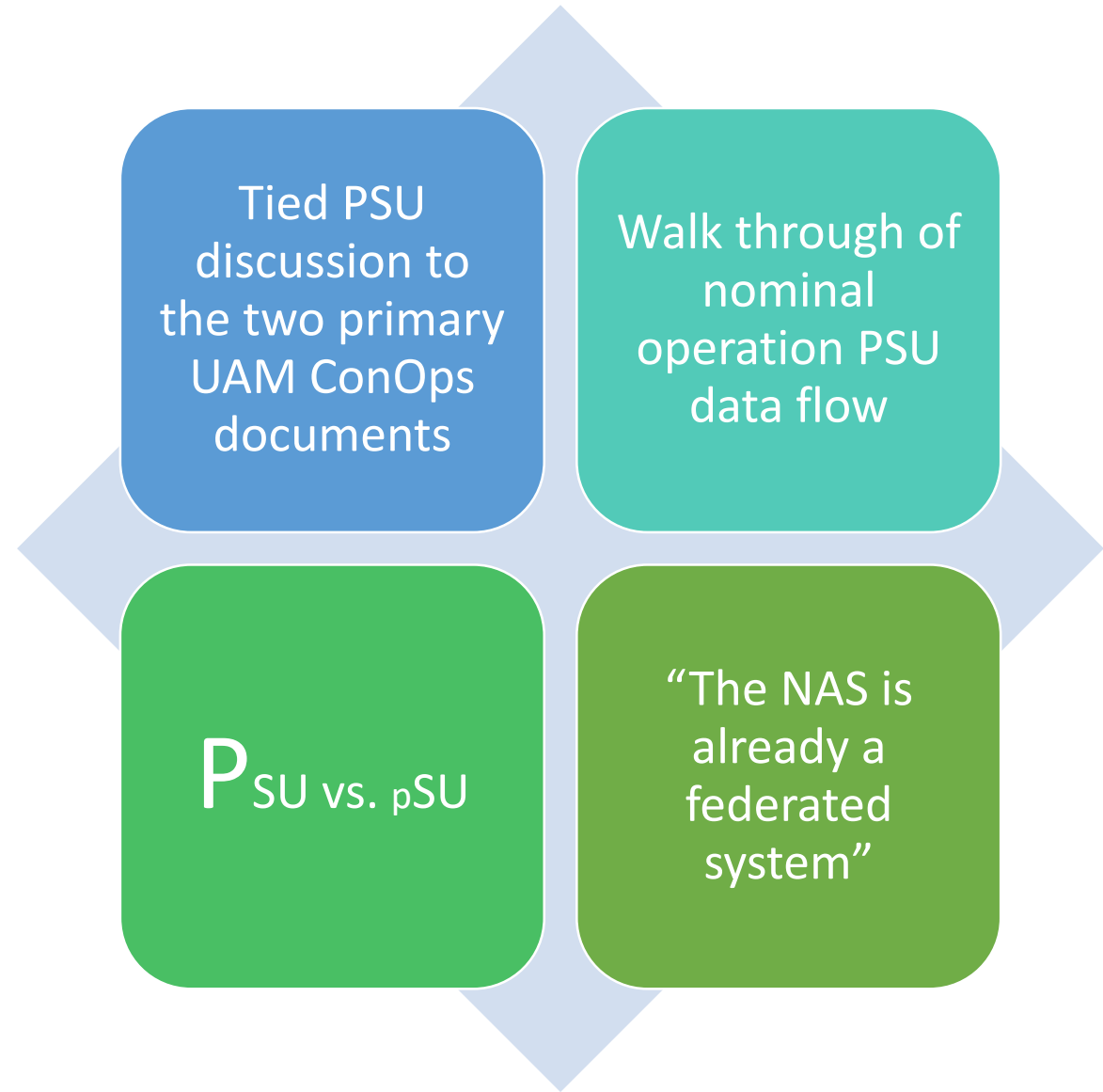
An overview and initial use case discussion

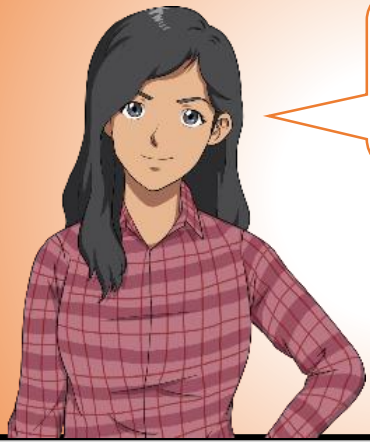
Joseph Rios
Chief Technologist, Aviation Systems Division
NASA Ames Research Center
18 May and 15 June 2021

Session 2

15 June 2021

Review from last session

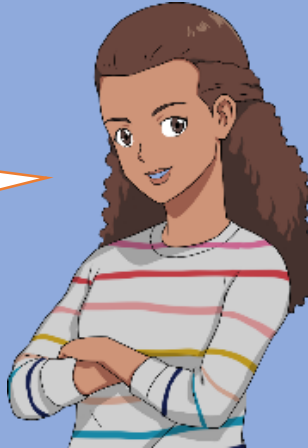




How you should react if you agree with the stuff Joey says...

I might say some things in today's meeting that are not necessarily community-vetted. Here is how you should take my statements today...

How you should react if Joey says things that seem off to you...



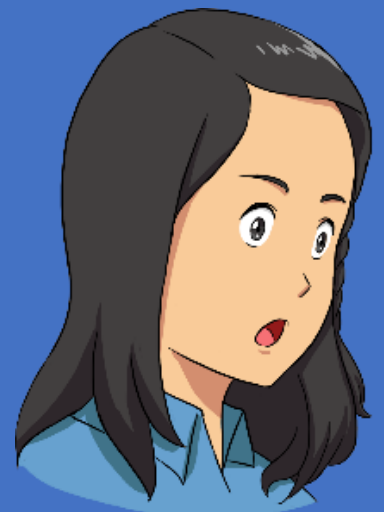
Everything Joey said was super correct!

Indeed! Very insightful!



Joey said some weird stuff today.

He was just playing devil's advocate to spur conversation! So wise!



Simple Questions from Last Session

- Will there be a FIMS? Yes. But it may have a different name and may supply data/services that are not the same as those in UTM.
- What is a USS? UAS Service Supplier, as defined in the UTM world
- Are there any identified PSUs out there? pSU maybe. PSU is for a future UML.
- Joey says Strategic deconfliction not equal to most safety critical; will you all discuss then what is the most safety critical way? I said that the word “primary” in discussing strategic deconfliction doesn’t equal/imply most safety critical.
- What is the role/interaction of PSU with a highly autonomous aircraft? What is the role of ATM with highly skilled pilots today? PSUs manage information flow about operations. On the scale of “management to control” they are more toward the management end. They help ensure that more tactical systems do not get overwhelmed. That is why ICAO has three layers for conflict management that still apply in a more autonomous environment like UAM.

Less Simple Questions from Last Session

- Who owns or provides DSS? Open question. In UTM it is likely that industry provides an “accepted” implementation of DSS that meets some blessed standard. Likely the same in UAM, perhaps even the same DSS. PSUs need to prove the “SLA” of the DSS is true and appropriate and there needs to be mitigations to loss of DSS. Many open questions.
- Discuss how COP will be developed and role of PSU? The PSU Network is the primary source for UAM operational data. USS Network is primary source of UTM operational data. FIMS/FAA likely primary source for airspace data. An authorized entity like a PSU or USS would have access to these sources at the appropriate fidelity and could develop a COP along with other data sources. I don’t know that there is some unified GUI that is blessed as THE COP, if that is the question.
- Who funds the PSUs and to whom will they be accountable? A PSU would self-fund based on their individual business cases. They are Certified by the FAA (at least according to our poll last time) and are accountable for the set of services they provide. As a community, we need an overarching RACI chart with rows for specific features/actions.
- What is the underlying network of system that the PSUs will operate on? Current wisdom says the Internet is the underlying network. That could change, but I have not seen alternatives proposed or requested.
- What is the plan for cybersecurity architecture for PSUs? Ongoing work growing out of UTM. NASA UTM Project put in significant effort in this direction, FAA UPP2 pushed the envelope further. UAM building on those efforts. Some acronyms: NIST, IATF, IETF



The slide most likely to get Joey in trouble with every single person and organization.

While the concepts of external systems and external service providers are not new, the current pervasiveness and frequency of their invocation can present organizations with significant, new challenges. There are instances where system elements, subsystems, or perhaps the entire system may be outside of the direct control of the organization that authorizes its operation.... FISMA and OMB policy require external providers that process, store, or transmit federal information or operate information systems on behalf of the federal government to meet the same security and privacy requirements as federal agencies. Federal security and privacy requirements also apply to external systems storing, processing, or transmitting federal information and any services provided by or associated with the external system.



D.11.3 Air Transportation Information Type

Air Transportation involves the activities related to the safe passage of passengers or goods through the air. It also includes command and control activities related to the safe movement of aircraft through all phases of flight for commercial and military operations. Note: The protection of air transportation from deliberate attack is included in the Transportation Security information type under the Homeland Security mission area. The general recommended security categorization for the air transportation information type is as follows:

Security Category = {(confidentiality, Low), (integrity, Low), (availability, Low)}

Above quote from From NIST 800-37, Left quote from 800-60v2

Joey's view of a PSU "Authority to Operate" likely harsher than industry's view and maybe harsher than the FAA's as well.

Since PSUs are managing the airspace, and ATM is a function of the FAA that the FAA is not abdicating, the PSUs may be considered acting on behalf of the FAA for some functions (open area of research and concept development).

All of this equates to PSUs likely needing to follow the NIST Risk Management Framework to become authorized to operate.

[NIST RMF](#), [NASA USS Auth](#), [NASA USS Spec](#), [UPP2 Report](#), [UPP2 Security Analysis](#), [NIST 800-60v2](#)

Operator vs. Pilot

- Operator is the person or organization responsible for operational control of the flight
 - See [8900.1](#) for more info
 - Examples of operational control functions include: preflight planning, canceling a flight due to unsafe conditions, crewmember qualifications, designating PIC/SIC, providing other personnel for dispatch, etc.
 - Often called a “Fleet Operator” in the AAM domain.
- Pilot in Command – The pilot responsible for the operation and safety of an aircraft during flight time. ([pilot/controller glossary](#), [CFR 14 91.3](#))
- In UAM (and UTM) it is the Operator is the one that communicates with the PSU (USS). Communications are assumed to be primarily digital in nature, facilitated by machine-to-machine protocols.
- *Note: a “Vertiport Operator” is yet another role with responsibilities related to managing a vertiport. This is distinct from the “Operator” above.*

Use Case Assumptions

PLEASE NOTE: These are assumptions for the Use Case... not 'universal' assumptions about UAM.

Airspace construct and procedures exist to facilitate UAM operations.

UAM Operations are in and around DFW.

Up to 100 operations may be airborne at any given time.

Several vertiports are in operation to support UAM.

UAM Operations are capable of VFR flight in uncontrolled airspace.

UAM Operations stay within defined UAM airspace structures when in controlled airspace.

Nothing bad or unexpected happens during the lifespan of our use cases today. Bad stuff is bad.

Use Case

Three operators using three different PSUs plan to depart an operation from three different vertiports.

No other operations departing those vertiports.

All three operations plan to land at the same vertiport at roughly the same time.

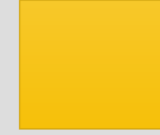
The operations are all reasonably spaced and sequenced in the air leading to the vertiport (“en route”) per protocols (rules, CBRs, etc.) and using structured procedural routes to the vertiport.

The vertiport has 5 FATOs (final approach and takeoff areas) available and the vertiport operator has provided a landing reservation to each of the operations at 3 different FATO.

Which description best fits my current role?

FAA civil servant or contractor

16%



NASA civil servant or contractor

36%



Other government employee

3%



Industry stakeholder for UAM

38%



General Interest

7%



When planning to operate in a designated UAM airspace construct, a UAM Operator _____ use a PSU to announce intent to other stakeholders.

SHALL

76%



SHOULD

17%



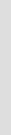
MAY

7%



WOULD NEVER EVER

0%



When expected capacity for 2 hours from now changes at a Vertiport, a UAM Operator with a planned landing around that time at that Vertiport would PRIMARILY learn about this change via _____.

its PSU

61%



the Vertiport Operator

31%



the FAA

4%



a status announcement on a webpage

1%



some other means than those noted above

3%



If an operator submits an operation plan to its PSU that conflicts with at least one other announced UAM operation, that PSU _____ assist its operator in deconflicting that operation plan.

SHALL

48%



SHOULD

19%



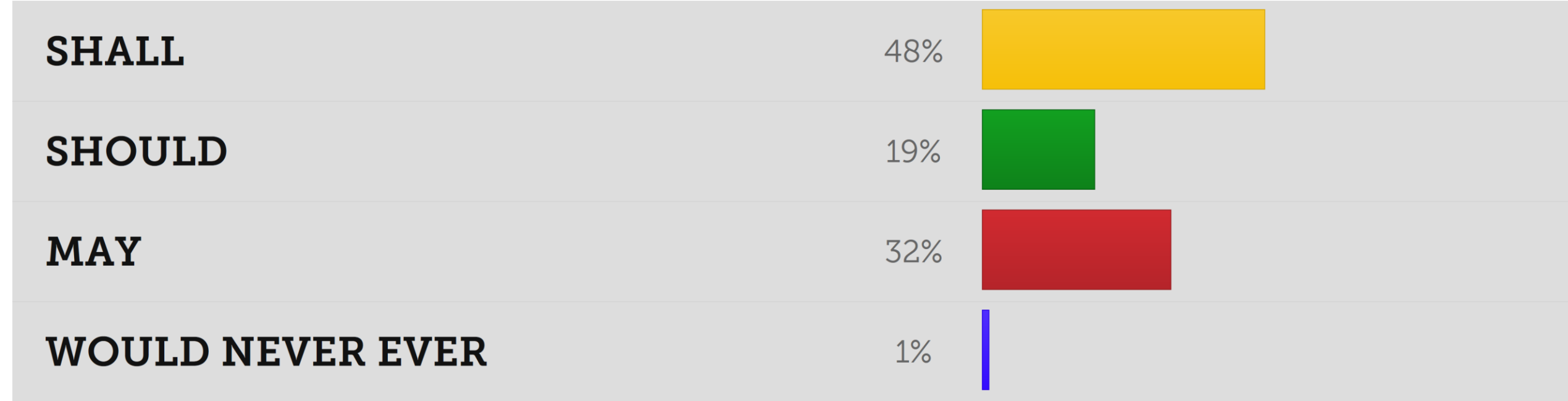
MAY

32%



WOULD NEVER EVER

1%



Where/when does the responsibility for conformance monitoring of an operation's 4D Trajectory end for a PSU?

At the arrival fix for a vertiport

25%



At the FATO

54%



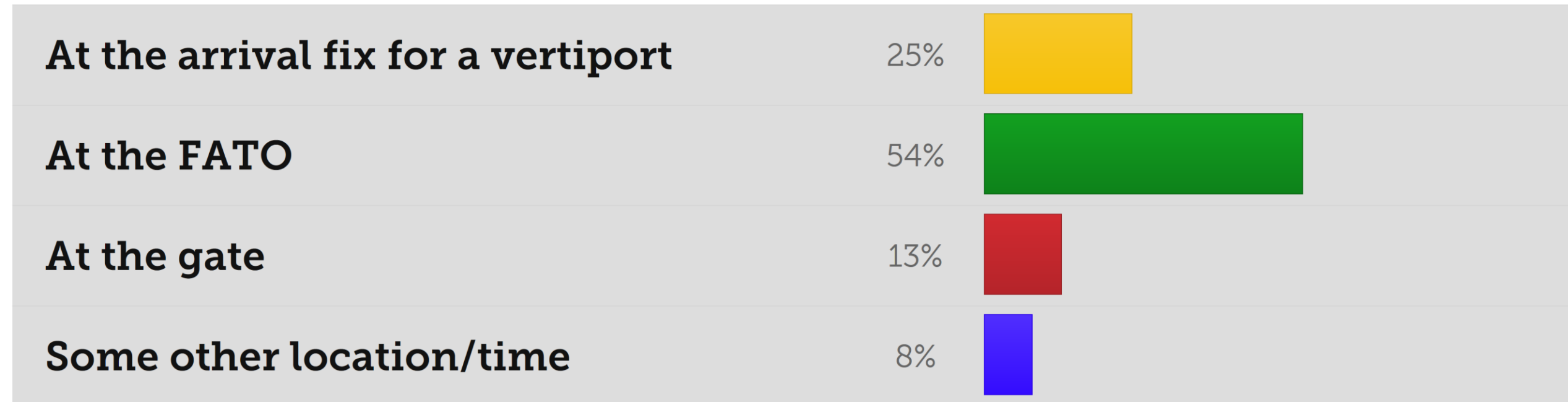
At the gate

13%



Some other location/time

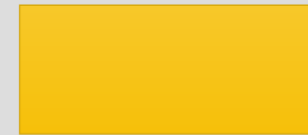
8%



If an Operator submits an operation plan (Operation Alpha) to its PSU that conflicts with at least one other announced UAM operation (Operation Beta) but meets all other UAM operational requirements, that PSU _____ announce Operation Alpha to the PSU Network as provided by the Operator. (bonus discussion question: what should this PSU tell the operator of Operation Alpha?)

SHALL

32%



SHOULD

7%



MAY

9%



SHALL NOT

51%



If a UAM Operation needs to perform a tactical maneuver for safety purposes, the Operator must communicate the maneuver to the PSU _____.

prior to executing that maneuver to ensure deconfliction with all elements of the airspace

6%



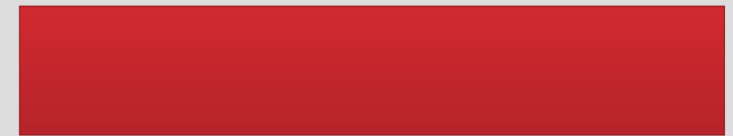
as soon as practical

19%



as soon as practical and only if the maneuver takes the operation out of conformance with its plan

74%



after landing and closing out the plan

0%



never

1%



A PSU _____ subscribe to other services (like weather, route optimization, battery prognostics, etc.) to provide value to its supported Operators.

SHALL

18%



SHOULD

19%



MAY

61%



SHALL NOT

2%



A RADAR surveillance service is a PSU.

TRUE

11%



FALSE

82%



EVERYTHING EVERYWHERE IS A PSU

7%



A Vertiport Operator is a PSU.

TRUE

11%



FALSE

88%



EVERYTHING EVERYWHERE IS A PSU

2%



If an approach fix to a vertiport has an in-trail spacing requirement, for a given operation it is the responsibility of the _____ to ensure that in-trail spacing requirement is met.

Individual Operator

8%



Vertiport Operator

5%



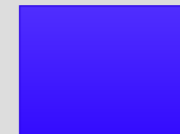
Supporting PSU

18%



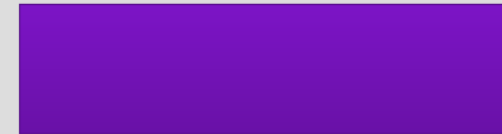
Vehicle automation

18%



Pilot-in-command (remote or otherwise)

52%



An Operator _____ implement and provide its own PSU services.

SHALL

2%



SHOULD

2%



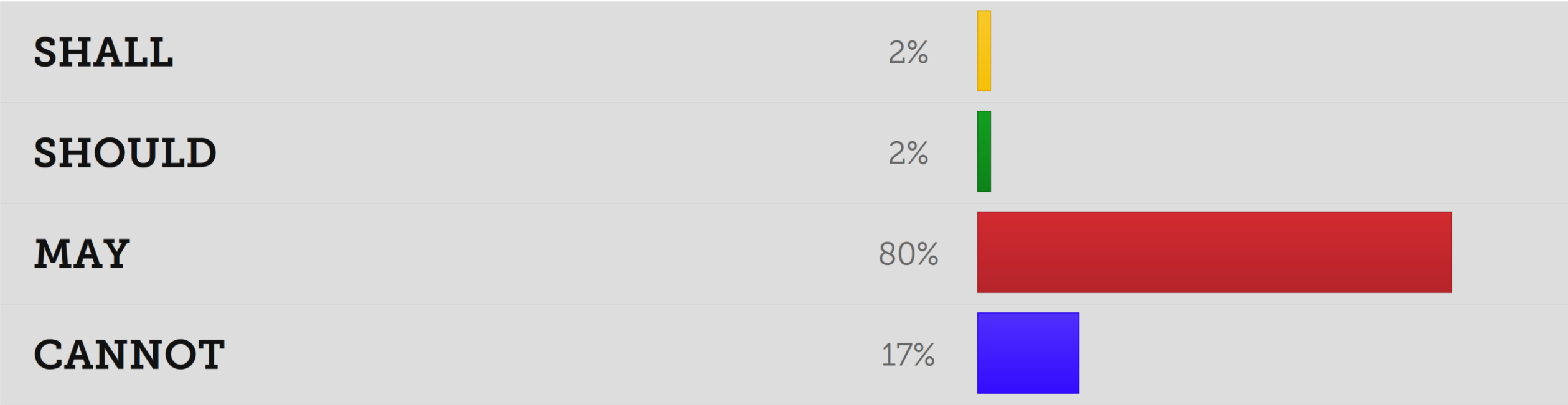
MAY

80%



CANNOT

17%



Non-exhaustive, non-official list. Will evolve with rules and standards.

Other services will be necessary to fully enable UAM operations, but that doesn't mean they are PSU services.

Key PSU services/features



Checking plan versus airspace constructs and accepted rules/protocols

Is plan using airspace constructs appropriately?
Any other required checks performed by operator (wx, etc.)?



Bridging operator-FAA strategic, digital communications

Airspace authorizations
Notification of off-nominal events or encroachment on controlled, non-UAM airspace



Sharing intent and state with other PSUs per CBRs

Ensure that initially shared plans are deconflicted
Provide position/state reports to other PSUs as appropriate



Monitoring conformance of an operation with its plan

Alert operator in case of non-conformance or potentially nearly non-conformant
Update PSU Network in cases of contingency

Key PSU services/features

Proposal: A entity CANNOT be a PSU unless it meets the following draft requirements



Checking plan versus airspace constructs and accepted rules/protocols

A PSU SHALL ensure that operation plans that it supports appropriately use airspace constructs

A PSU MAY assist an operator in meeting the operators non-PSU related requirements



Bridging operator-FAA strategic, digital communications

A PSU SHALL notify the FAA of an authorized operation

A PSU SHALL notify the FAA of off-nominal events or encroachment on controlled, non-UAM airspace for operations that the PSU is supporting



Sharing intent and state with other PSUs per CBRs

A PSU SHALL ensure that operation plans are appropriate deconflicted per "rules" prior to sharing with the PSU Network

A PSU SHALL share operation state with the PSU Network per "rules"



Monitoring conformance of an operation with its plan

A PSU SHALL alert an operator that it is supporting when that operator's operation is non-conforming with its plan

A PSU SHALL alert the PSU Network when an operation it is supporting enters a Contingent state

Detailed Use Case

Use Case ConOps Driver

- *The interactions between UAM aerodromes and PSUs is a key research area that will define the domains of the UAM aerodrome operator and PSUs with respect to scheduling and sequencing operations into and departing from aerodromes, how contingencies requiring alternate landing locations are managed, and the level of trajectory precision required to support operations on high-density routes between high-demand aerodromes.*

Use Case ConOps Driver

- The *interactions between UAM aerodromes and PSUs* is a key research area that will define the domains of the UAM aerodrome operator and PSUs with respect to *scheduling and sequencing operations into and departing from aerodromes*, how contingencies requiring alternate landing locations are managed, and the level of trajectory precision required to support operations on high-density routes between high-demand aerodromes.

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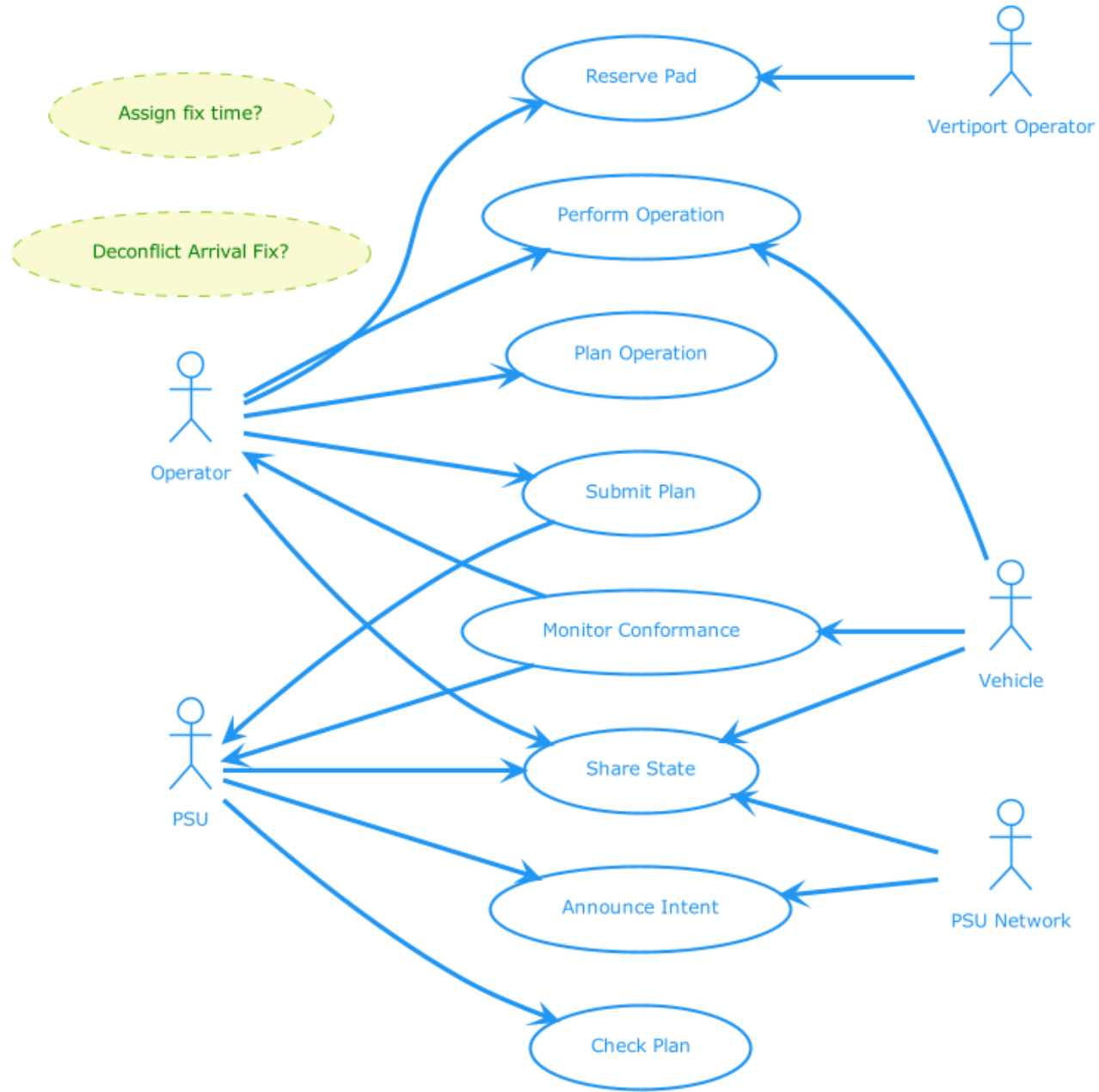
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Nominal Operations with Vertiport





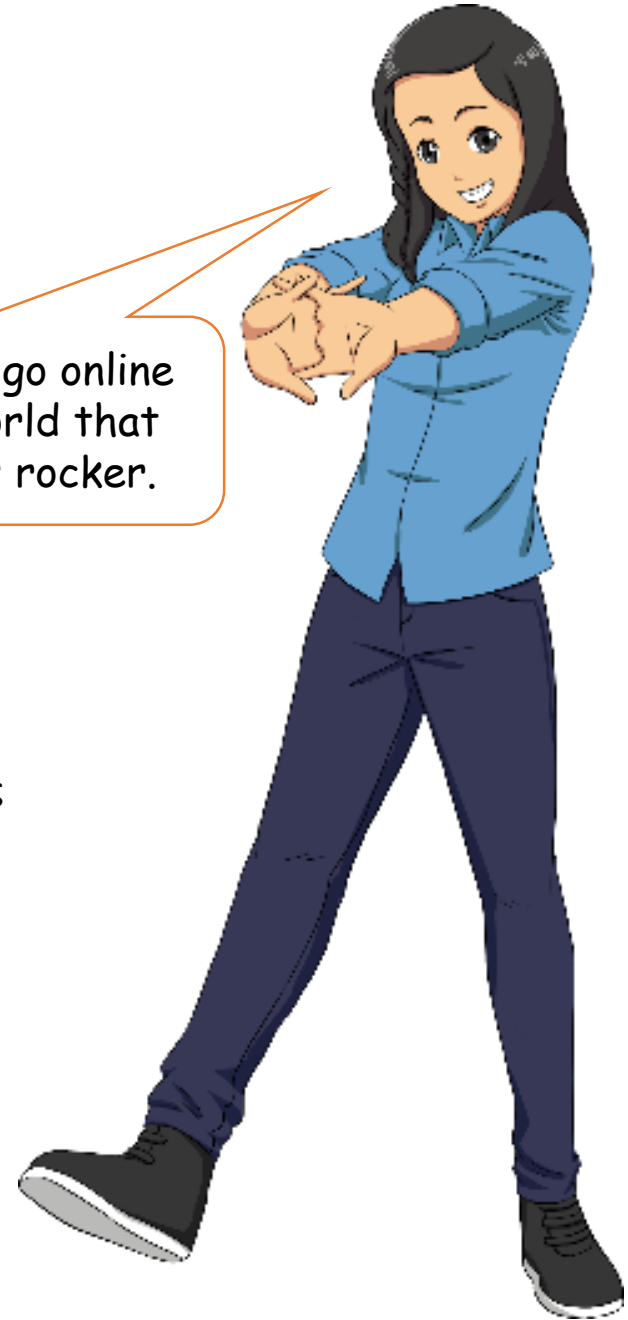
Questions

- Whose task is it to ensure orderly and safe landing sequence at the vertiport?
- When is this task supposed to be completed? Or is it continuous? If continuous does the responsibility shift between entities at any time?
- When does conformance monitoring via PSU end? Approach fix? Wheels-down? On the pad? Later?
- Can this task of deconflicting three operations to the same vertiport be effectively managed by the operator, PSU, and/or vertiport operator or is some other entity/service needed?
- Does voice comm play a role in the management of this nominal scenario? If so, who is talking to whom and when?



That was super great, I totally get PSUs now. I think we may have completely solved UAM!

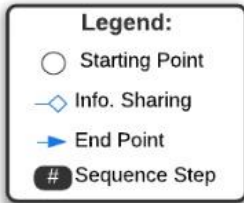
Whelp, time to go online and tell the world that Joey is off his rocker.



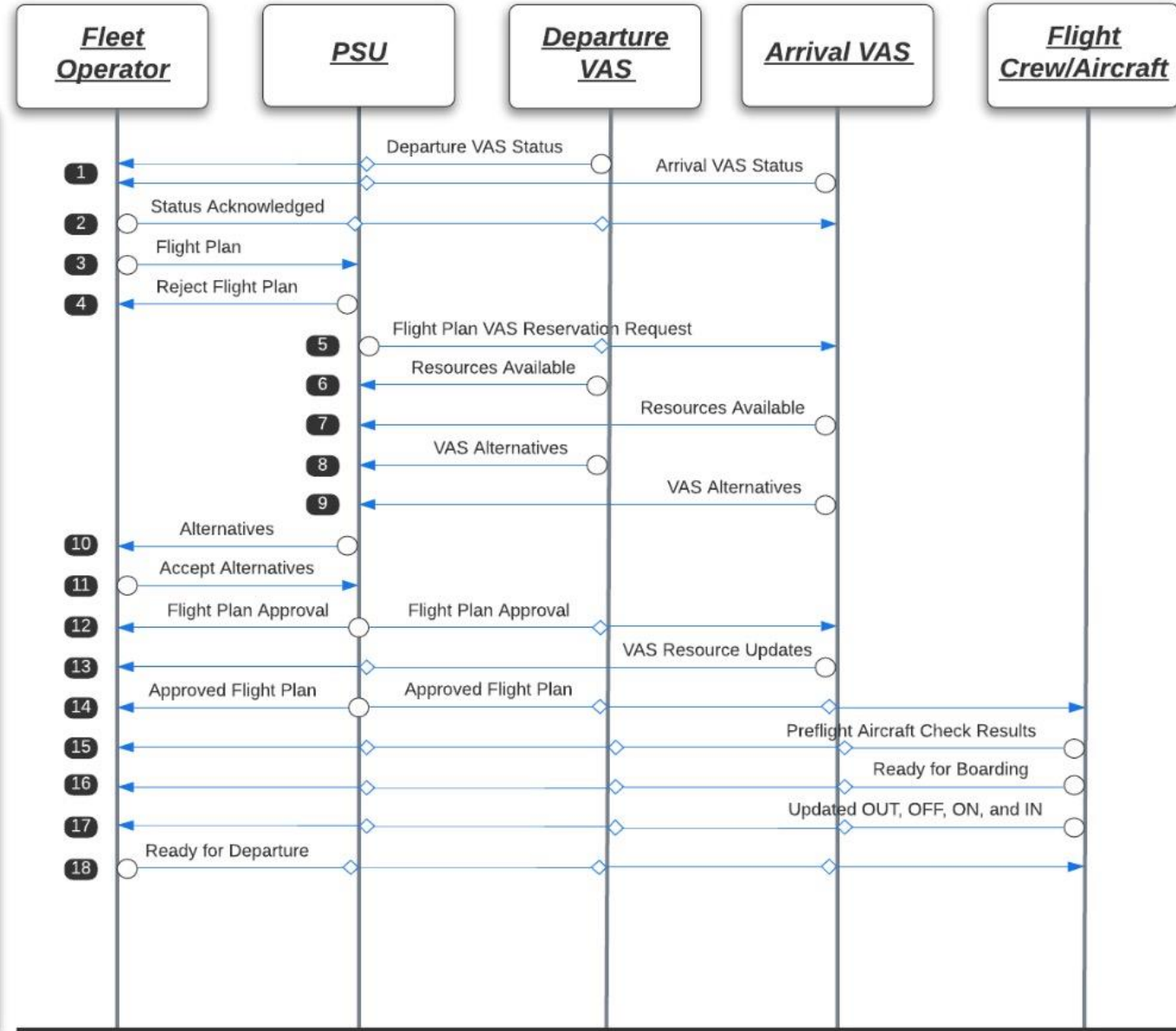
Thanks! I'm assuming everyone is in one of these two camps. Feel free to reach out:

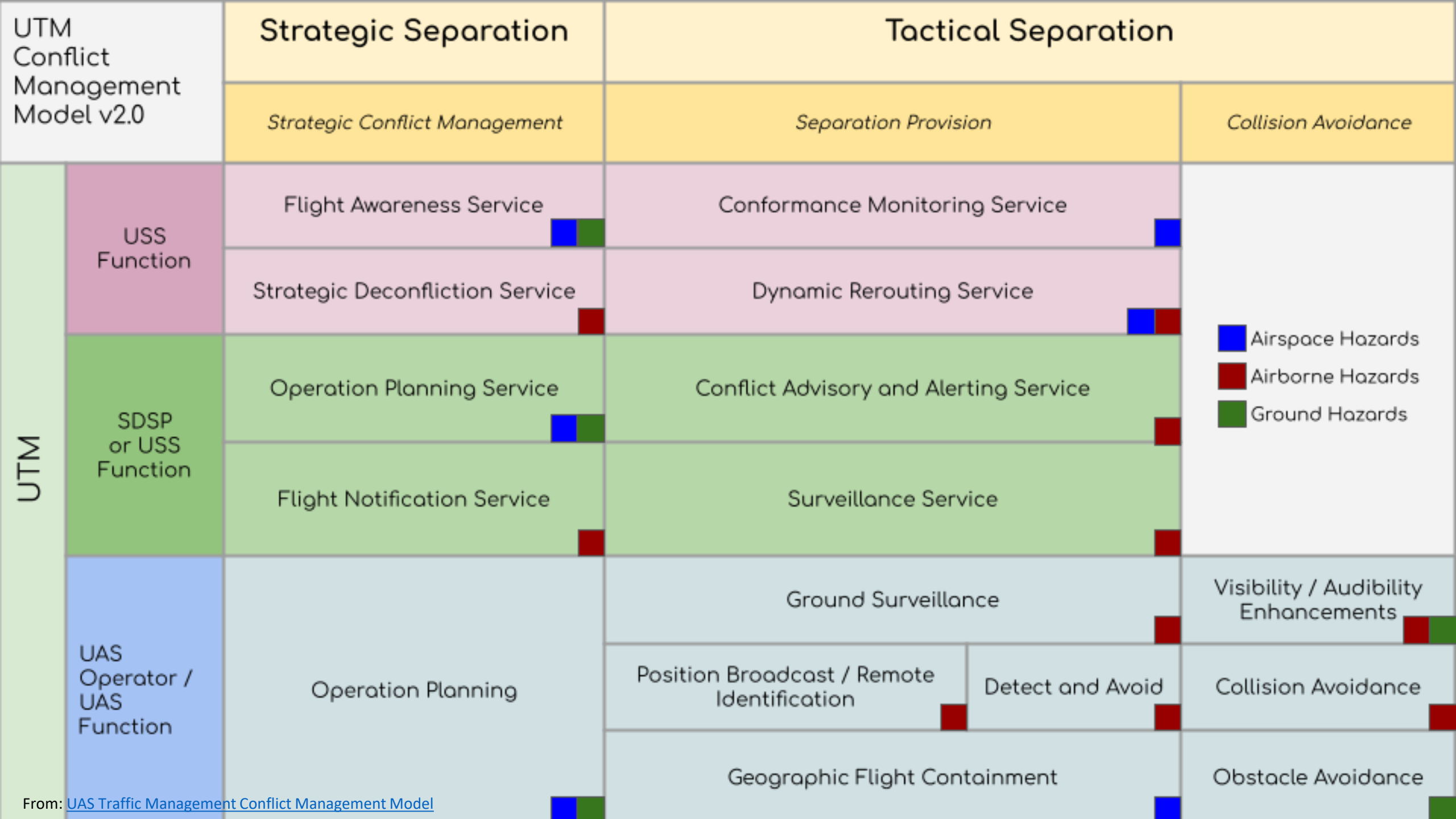
Joseph.L.Rios@nasa.gov

Backup



1. VAS broadcast status and resource availability
2. Acknowledge receipt of VAS message
3. Fleet Operator files Flight Plan
4. PSU checks Flight Plan and rejects if not correct
5. PSU submits flight plan to Departure and Arrival VAS
6. Departure VAS Resources Available
7. Arrival VAS Resources available
8. Departure VAS Resources NOT Available, sends alternatives
9. Arrival VAS Resources NOT Available, sends alternatives
10. PSU sends alternatives to Fleet Operator
11. Fleet Operator accepts alternatives
12. PSU accepts Flight Plan
13. VAS secures reservations and updates resource availability
14. PSU distributes Flight Plan
15. Aircraft preflight check results distributed
16. Aircraft final check successful, ready for boarding released
17. Aircraft updates OUT, OFF, ON, IN times
18. Fleet Operator dispatches aircraft ready for departure





From: [UAS Traffic Management Conflict Management Model](#)