Future Communications for MCNA and SWIM
ACAST Workshop Breakout Session

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ACAST Workshop

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Session Overview

- Overview of Potential Discussion Topics (~15 min)
- For each discussion topic (~ 45 min each)
  - Background on selected issues
  - Group discussion on selected issues
- General discussion and wrap up (~ 30 min)

Breakout Session Goal

- The session goal is develop a sense of the key challenges to implementation of mobile extension of SWIM (aka MCNA) and the key benefits of that extension
  - To facilitate this, several key issues have been identified and background material prepared to “prime the pump” and elicit group feedback

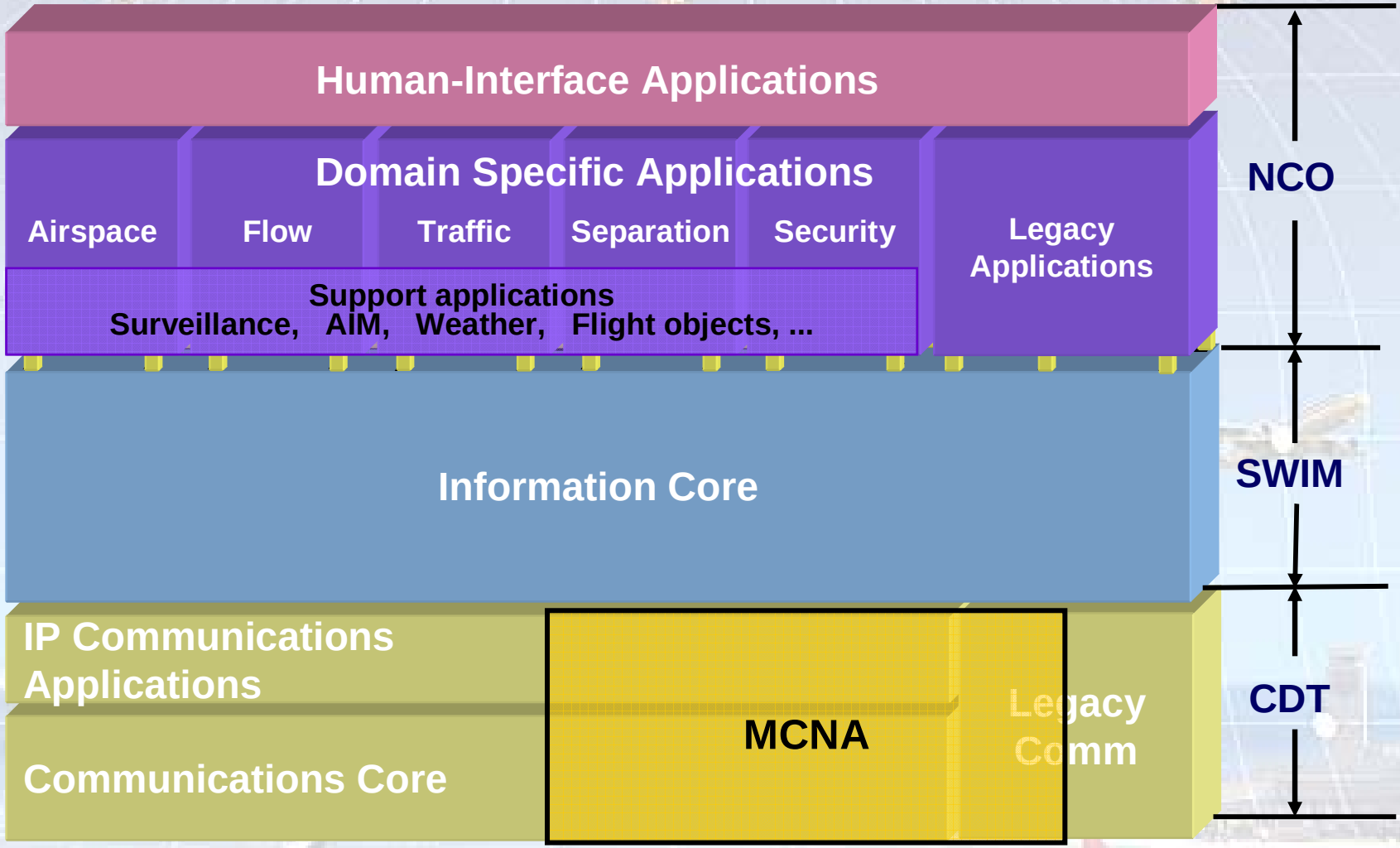
Proposed Discussion Topics

1. MCNA Alternative Architectures

2. If technology isn't the problem, then what is?

3. Key benefits of mobile extension of SWIM

Architecture Reference Model



Discussion Topic 1
MCNA Alternative Architectures

Topic 1 MCNA Alternative Architectures

- The notion of integrated communications for ATS, AOC, AAC and APC is frequently touted as a cost saving mechanism. However, the more rigorous requirements of certification that accompany certain ATS communications make an equally strong argument for separation of services. This seems to indicate two potential MCNA architectures:
  - An architecture "A," that can accommodate all classes of traffic by rigorous enforcement of traffic classes of service over a common A/G link and avionics?
    - Key tenet: ***Integrated*** Avionics and Communications service
  - An architecture "B," that provides for APC, AAC, AOC and ATS advisory services on common links and ATS tactical communications on a different link?
    - Key tenet: Avionics and link may share structure and hardware, but services are provided over ***physically separate*** instances

Topic 1 Proposed Questions

- MCNA Alternative Architectures Associated Questions
  - Common IPv6 Links:
    - What obstacles will prevent the sharing of IP links between safety of life and non safety of life services
      - How can we overcome these obstacles?
      - Do we want to overcome these obstacles?
  - Certification:
    - Should links and/or systems be certified to level-C or just applications?
      - Is it time to revisit the requirement for AM(R)S and AMS(R)S?
    - What obstacles will prevent the use of service history to achieve higher level certification?
      - How can we overcome these obstacles?
  - Commercial Services for ATS:
    - Which infrastructure should the FAA own versus lease?

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- What is the level of maturity for running different services over IPv6?
- ATS and AOC are both safety critical – have we broken those apart?
  - ATMAC desires separation of ATS and AOC to reduce cost
  - What is included in tactical ATS? Positive control of airspace, safety separation services.
  - Another qualifier for separating services – the C in CNS. C for ADS-B would be considered tactical. VDB (differential GPS corrections) is also tactical. C carries S&N data to applications. Cost-performance issue.
  - Where do we view FANS CPDLC, ATN implementation of CPDLC, FANS addressable, ATS tactical?
  - Where do we segregate the stack? We have systems today carrying multiple classes of services (e.g. architecture "A.")

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- What are the certification challenges of architecture "A," and what are the performance requirements? Until we know these, we can't assess the partitioning.
- It all comes back to RCP.
  - We may need to challenge the ICAO rules for ATC and AOC. Dividing ATC and AOC may be achieved differently in the future, for example, by defining RCP correctly for those services. As long as everyone on the shared media can get their job done with required performance, ATC and AOC can share the links.
- ATS magnitude is small in comparison with AOC, AAC, APC.
  - ATS imposes a higher level of certification requirements. Have to look at business case for entire aircraft, and understand that a cheaper communications service cost might be offset by increased certification costs, because we still have to provide ATS at the higher level of certification. Compare cost of complex systems.

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- There are standards processes we need to consider other than RCP.
  - RTCA SC 189/WG-53 provides requirements for safety critical services. SPR should be technology independent.
  - DO-264 describes end-to-end chain, allocation, airborne piece, leading to guidance on aircraft certification.
  - PARC CWG datalink roadmap and RCP roadmap – how to apply those?
  - ICAO has also been addressing RCP documentation. Not clear that RCP is actually a logical approach to take.
- At PARC CWG, consensus emerged that we have multiple types of communications and we have to aggregate those (e.g. terminal enroute…)
  - Application service provider will have to specify what level is required.

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- Next generation SatCOM MOPS were very generic.
- Let individual service providers declare what they will actually provide. DO-262 and 270 provide rigorous model for these to be addressed.
- There should be a catalog of services – if you want to fly in terminal airspace for example, here are the services that meet this particular performance capability.
- Availability – MCNA provides a more robust communications architecture. Forcing availability across ensemble of links seems reasonable.
  - Availability from NAS perspective is different from perspective of aircraft. DO-270 does this, through multi-user about and single-user availability.
  - How does the aircraft meet combined requirements of SatCOM and VHF? One of the cost-benefits will come from looking at the aircraft as an integrated system.

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- Part of RCP also looks at latency – SatCOM services may be a backup only. "Some comm is better than No comm." May not be able to have all aircraft in a sector cut over to SatCOM service if VHF is lost. This is really just a lower level of RCP.
- Think about the horizontal view of the stack as well as the vertical. RCP is based on the top layer. IPv6 is at the bottom layers of MCNA. The only issue for MCNA is how to interface to the SWIM layer.
  - Where does RCP apply? Some at lowest layer, some at higher layers. End-through-end tradeoffs.
  - Requirements on the applications are allocated down the stack in order to be certified. Or we can over-provision, but that drives up costs.
  - The need to standardize will penalize some technologies, but does force us through the process to decide on standards. The trade will be how open the standard versus how usable the technology.

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- Who carries the certification burden, the aircraft or the ground?
  - Operator and service providers have to share the cost.
  - What is the cost of meeting RCP with SatCOM to an A/C that already has VHF? This is different issue from system certification. In some cases, the system was certified merely by the fact that it is government owned.
- There is another model. FANS over ACARS is already out there. Needs a detailed analysis of models for safety.

Discussion Topic 2
Technology isn't the problem

Topic 2 – Technology isn't the problem

- The current NAS is a massively complex system of systems, and includes equipment, platforms, facilities and users, each having a broad spectrum of requirements.
- Technology insertion into the NAS is a painstakingly slow and laborious process that *introduces complexity*.
  - It is virtually impossible to introduce COTS into the NAS
  - Legacy interfaces and specialty engineering (Security, Human Factors, Safety) introduce unique requirements that result in COTS solutions quickly becoming stove-piped NAS specific implementations
  - The need for certification significantly hampers technology refresh in the NAS

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- If these statements are true (that it is virtually impossible to introduce COTS into the NAS), and there are good reasons that this is a good thing, then we don't have anything to do. However, if it is true, then we can't get to the vision state.
- Consider 3G-based systems example
  - A 3G system includes many things beyond just the air interface most of which would not be applicable to aviation. Proponents for using this standard have indicated that what they really are interested in is the air interface component of the standard. However, modifications will be required to adapt the air interface to A/G communications, and as a consequence, it is no longer just a COTS solution. Further, there is no feedback mechanism to incorporate those changes to the COTS solution.

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- Maybe we need a policy on “mechanism for getting rid of old legacy systems”.
  - The issue is more so about having trust that an investment in a technology today is sound and will be the technology of the future as well. The FAA has to keep up its side of the deal. Two-way commitment to infusion of technology is necessary.
- The Refresh cycle for aviation is very different from COTS products.
  - Aircraft carriers are able to be upgraded over time; same is true for B-52. But can’t use COTS alone for upgrades, and COTS is never used in upgrades at no additional cost.
  - Boeing found that requirements and refresh cycles are different. Need to make use of commercial and military technology, design system to be open to take advantage of pieces of architecture for upgrades.

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- The Refresh cycle for aviation is very different from COTS products. (continued)
  - Consider 1553 example; it is upgraded over time, when it is cost-effective; it remained viable for a long time.
  - The “Commercial” part of COTS is desired for cost effectiveness, but the “OTS” part is not. Consider Electronic Flight Bag example.
- Associated question: What is the target window of opportunity for a mobile extension of SWIM (MCNA)? Has the train left the station?
  - If we are building systems for 2015, we need to start now. Something else will always come along over time. Take a piece of MCNA and show value-added capability now.
  - However, CPDLC trails showed this approach might not be sufficient. Need to get an airline involved. Ask the airline what problem they have at an airport and how can we solve it with SWIM and MCNA.

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- Associated question: What is the target window of opportunity for a mobile extension of SWIM (MCNA)? Has the train left the station? (continued)
  - The NAS is a complex system of system – we have to introduce a concept at some point and see if it grows or dies. SWIM and MCNA are setting a framework for transformation. There may be some concept that will survive.
- The Need to grow capacity by 3X may not have a market case behind it
- The requirement for ATN only was a detriment to CPDLC

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- Four factors accelerate introduction of innovation (Reference: Everett Rodgers)
  - relative advantage (more benefits enables faster adoption);
  - simplicity (break into pieces, then introduce in pieces);
  - compatibility (be aware of how introduction of innovation modifies procedures and behaviors; more compatible, the faster);
  - trial ability (check it out first, get comfortable, then invest)
- Trials as a way to introduce change
  - When change is introduced, make sure all stakeholders are have incentives to adopt the change.
  - Start the simpler parts of MCNA first. Shield the customer from the front-end work. All the customer should see is the benefits at the trials.

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- Trials as a way to introduce change (continued)
  - Do we need policy trials or certification trials? Consider MMDA prototype as a certification pathfinder as an example.
  - Trail path in a carefully controlled environment can change political positions. If some integrated services are tried, and those trials meet the availability and other requirements, can those data be used in certification of an integrated system solution?
  - How do you perform a policy trial without a disastrous outcome? One way is to operate the trial system in parallel to the operational system. You can cut over if desired.
  - Can't even think about the magnitude of what 10^{-6} means, nor craft a trial long enough to verify that level of performance.
  - New generation of aircraft have not been lost; no accidents at all. The system has been tuned over time to get to this level of performance. We can't possibly test as long as needed, if we could, it might cost as much.

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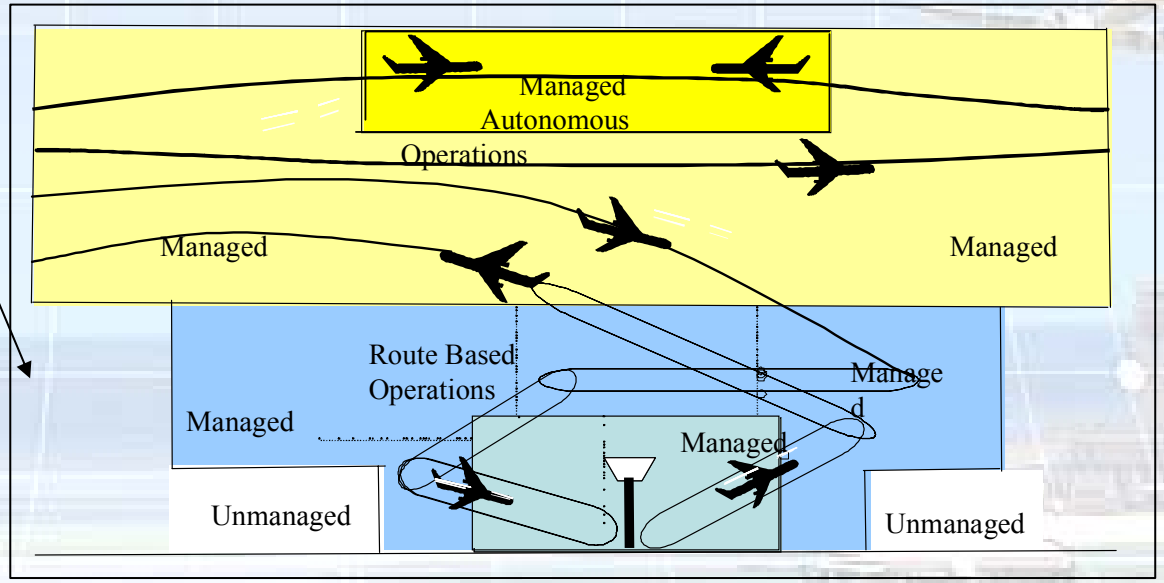
- From the Air Force perspective, the train has already left the station.
  - Commitment have been made to RNP, Mode S, ADS-B, 8.33 kHz, VDL-2, FANS, and SatCOM. Now, AF hands are tied for infusion of anything new until at least 2015.
  - The commercial transport is behind this timeline. VDL-2 is a key piece for moving to 4-D trajectory. Deciding on MCNA makes a commitment to next 10 years beyond that.

Discussion Item 3
Key Benefits of SWIM and MCNA

Topic 3 – "Phase II" ConOps

- Concept of operations in this phase are described by
  - Time frame (~ transition in 2020 to 2025 time frame)
  - Describing the airspace structure
  - Describing the composition of users
  - Describing the overall ATM philosophy
  - Defining the required ATM services, and associated messages

Notional 2025 Airspace Structure



Topic 3 Proposed Questions

- In the future, 4D trajectories are enabled by a predefined set of services, each having a predefined set of messages. Help us define benefits of a mobile extension of SWIM in the context of the future operations concept
  - What is the role of these technologies in autonomous airspace?
  - What is the role in managed, 4-D trajectory airspace?
  - Is there a role/need in unmanaged airspace?
  - Does the concept of SWIM extend across all types of A/G communications (including ATS tactical)? Why?

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- The year we are talking about matters.
  - In 2015 SWIM looks different in 2020 and 2025. CPDLC will eventually evolve from a “controller-to-pilot” datalink to an “automation-to-automation” datalink. At some point in time, controllers become air traffic managers.
- MCNA as an architecture includes transition states. What is the definition of those transition states?
  - NAS is not network centric now. The hardest part of deploying network centric operations will be the transition.
  - If the MCNA or network centric operations are too complicated – then they will be dead. Any transition into the system is extremely difficult. Simplicity of transition is important to make it successful. How do we get people involved to see MCNA as their system?
  - Need to create a framework within which simple transition steps can be introduced and tried. Some steps will die and others will thrive.

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- MCNA as an architecture includes transition states. What is the definition of those transition states? (continued)
  - Can't tell what the success criteria for transition steps will be in advance. We can only bound the outcome states. Some things that appear to be needed before they were introduced, but then not after.
  - How can the FAA afford something that can die shortly after introduction? FAA is always short on funding. We have to try to introduce something.
- SWIM provides a mechanism for changing schema over time within the operational system.
  - Cost savings are possible from a system wide architecture, with interfaces developed and introduced once for each application, then available to all applications.

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- SWIM is often described in terms of information anywhere at any time. Why is this notion of information communities of interest (a.k.a. “infosphere”) approach being applied to ATM?
  - ATC tactical requires peer-to-peer capability with no time for publish-subscribe at all
  - Yes, but this is also part of SWIM. Once a connection is established the first time (which could be a lengthy process), then it is available for use in real time.
  - For example, ATS tactical information sent to a specific aircraft is of interest to others in the NAS (e.g. flow control).

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- Only when we reach the “control by exception” state is ATS tactical information over SWIM required.
  - ATS strategic is currently envisioned within SWIM; ATS tactical (for control by exception) is not.
  - Communications load needs to be modeled. Design for steady state, but need to accommodate tactical change in the shared communication capacity
  - Tactical control means control the aircraft only. Should ICAO address what it defined to be tactical? Consider routine, non-routine, tactical, strategic as discriminators
  - More granularity under the definition of ATC may be required
  - FAA needs a policy for control by exception, time frame for tactical. Consider past SatCOM work for guidance – emergency, medical, other categories, to see if they fit.

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- Is the PARC CWG considering these?
  - Airspace designers would specify what class is needed for each service. Controller tools will have an effect on how traffic is handled.
- Considering the "C" in "CNS" (that carries S&N too), and NGATS vision, what is the theme of the ACAST subprojects? MCNA may be in a position to architect those other sub-projects.
  - Mike Harrison provided a guiding theme: 4D trajectory to/from the aircraft as the air traffic management approach of future. 4D trajectory – Pilot files plan, with input from dispatcher. 4D trajectory negotiation includes pilot approval of machine-to-machine updates into FMS.
  - How do we do that? Get that 4D information to the aircraft and other stakeholders.
  - MCNA effort can help guide the work of other subprojects.

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- Considering the “C” in “CNS” (that carries S&N too), and NGATS vision, what is the theme of the ACAST subprojects? MCNA may be in a position to architect those other sub-projects. (continued)
  - Caution: A system engineering approach is needed to evolve the transitional CNS architecture to global architecture. There are still architecture tasks that need to be performed.
  - From pilot or controller perspective, the C is the picture, N is brush, S is paint.

Additional issue identification
General discussion and wrap up

Open Discussion

- Workshop was successful
- FAA has no R&D funds – look to NASA to do that
  - Need stakeholder feedback. Would like input from airlines and service providers.
  - First draft of datalink roadmap being circulated to PARC and ATMAC; included a long list of research topics that could be provided to ACAST for potential investment.
- Is there agreement at the FAA on what SWIM is?
  - Growing at different levels. Right information to the right people at the right cost. SDN is an application.
  - The architecture for SWIM ought to encompass ATS tactical even if not done through publish-subscribe

Open Discussion Concluded

- Customer is the one with the money; the client has the interest; the customer uses the product; the caretaker keeps it working. Who are the 4 C's for SWIM?
  - OMB-Exhibit 300 for SWIM makes an attempt to answer this.
- What becomes of these workshop notes?
  - Posted and impacts the ACAST project direction.
- Finally, we encourage feedback on this breakout session.