SC186 WG4 Meeting Notes, November 19-21, 2002
Rockwell Collins Arling Offices

Attendees:

Jonathan Hammer (MITRE CAASD)

Joel Wichgers (Rockwell Collins)

Steve Koczo (Rockwell Collins)

Jim Maynard (UPS-AT)

Tom Foster (TRIOS)

Michael Petri (FAA WJHTC)

Bob Hilb (UPS)

Randy Bone (MITRE CAASD)

Rick Stead (ARINC)

Ann Drumm (MIT LL)

Stan Jones (MITRE CAASD)

Lynn Martin (San Jose St University / NASA Ames)

Tim Rand (Rockwell Collins)

Bill Petruzel (FAA)

Gene Wong (FAA)

Jerry Anderson (FAA)

Paul Gross (CSF Consulting)

Shahar Ledecky (Air Traffic Simulation)

Tuesday 11-19-02

0. Agenda Discussion

Jonathan provided an overview of the agenda.

Bob Hilb noted to WG1 and ACM Subgroup members that ACM, CD, and CDTI table topics will be discussed in the joint meeting with WG4. ACM subgroup will then break off to discuss additional ACM application development.

1. Action Item Review

WG1-WG4 Action Items. Jonathan updated action items electronically.

Discussion about whether one can de-select situational awareness applications. As long as CDTI is enabled, one cannot turn off the situational awareness application.

2. ACM Review – Tim Rand, Martin Eby (via phone)

Review started with Table 5 in Section 2.4.4 (page 81).

NIC - ACM can support any NIC from a safety perspective, but the size of the NIC is more of a practicality / user acceptability issue (i.e., too large a NIC begins to impact aircraft movements were unnecessary flight path changes may be needed due to an excessively large NIC). A NIC of 0.2 NM was selected (NIC of 7 or greater).

SIL of 10-5 was selected based on the Ownship and target aircraft navigation integrity in the fault trees.

Tom – what type of airspace are we dealing with (e.g., remote, oceanic)? Tim indicated that it did not matter and that the NIC of 7 is used for all regions. Bob Hilb indicated that when we certify the system, it will be done based on safety.

Tim to add appropriate footnotes to Table 5. Add a footnote to the table to the effect that a "NIC of 7 is the 'required nominal performance' based on engineering judgement. Ultimately a 'minimum' NIC will be established by airspace designers / service providers for the type of airspace that the ACM system operates in".

Differentiate between 'requirement to commence an operation' and 'requirement to be able to continue an operation'.

Jonathan recommended to Tim to consider adopting the table format used by Joel Wichgers in ASSA to cover the distinctions among performance requirements (e.g., desired, minimum, degraded categories). Tim to rename columns of the table (nominal, minimum, etc).

Some discussion concerning the need for additional requirements, e.g., latency, etc.

Discussion about altitude performance and associated integrity: Joel – how will we specify altimetry error? Tom – altitude is problematic, do we use standard baro corrected altitude or geometric altitude.

Tim recommended an altitude quality of 10-5 (analogous to lateral SIL). There was concern that this is too stringent based on current achievable avionics.

Actions (Tim and Joel) – Understand the entire issue of the use of altitude for ACM. 1) how does RVSM achieve 1,000 ft separation with integrity. Can ACM leverage RVSM altitude management? Explore the role of geometric altitude as a crosscheck on barometric altitude.

Comment / observation – a NIC of 9 would provide the needed integrity for geometric altitude.

Joel – As far as he knows, without augmentations to GPS (e.g., WAAS and LAAS), there is not an equivalent of HPL for VPL to provide integrity bounds on vertical performance. Joel action – investigate the extent to which VPL is available for non-augmented and augmented GPS performance. Tom recommended that SC-186 should request SC-159 to support some of these 'surveillance-based' 3-D PVT performance issues. This may require a change in the TOR of SC-159 to address these issues in a timely manner, i.e., to add focus of the role of Nav for surveillance use. Jonathan action – add the topic of SC-159 to support some of SC-186's surveillance performance needs to the SC-186 leadership telecon agenda.

Actions for Tim and Martin based on Jonathan's inputs: We need to address some additional requirements for the ACM analysis: 1) subsystem integrity from the safety analysis for ASSAP and CDTI subsystems, 2) nominal processing requirements for ASA sub-systems (e.g., flow-down of requirements to ASSAP MOPS). Tom – at a minimum, we need a function diagram, and if there is an algorithm that needs to be referenced. Parametrically specifying the ACM algorithm requirements, either a black box approach or using the actual algorithm (e.g., missed detection, nuisance/false alarms, number of

alert levels, time to alert, ACM response to flight crew / maneuvers, flight crew performance assumptions / response times).

Discussion about how to provide / summarize the ACM top-level requirements that will be used to flow down requirements to the various MOPS, e.g., ASSAP / CDTI MOPS. Tom – Cliff Notes type summary of application MASPS requirements.

For the application appendices, the final section of these documents should be an application requirements summary section. Tom – summary requires function diagrams for each sub-system, roles of guidance, alerting, etc.; information elements.

3. Continued with action item review – Jonathan

We reviewed action items and Jonathan updated action item table electronically.

4. Results of Action item 10-24-02 #7 concerning use of NAC as a surrogate for NIC – Joel Wichgers

Joel reviewed his paper for this action item. (The reason for this action item was the concern WG4 had at the October meeting that typical TSO-C129 GPS receivers do not provide sufficient 99% SIL / NIC outputs for use in EVAcquisition). The results of his analysis (for GPS Standard Positioning Service navigation only at this time, and not necessarily applicable to other navigation sources) suggest that one cannot in general use NACp as a "surrogate" for NIC. NIC is an integrity performance measure for faulted and fault-free performance while NACp is a typical performance indicator for fault-free performance. However, NACp can be used to describe the typical performance region of GPS position accuracy (out to about 99.9% of the navigation error curve). Beyond 99.9%, as one gets into the tails of the distribution (which are not well specified / known), one can no longer scale NACp to NIC (i.e., integrity is not scalable). Joel also noted that GPS position errors are not independent from PVT sample to sample, but instead have correlation times on the order of several minutes or more. Joel referenced GPS navigation recorded data from the FAA WJHTC as an indication of typical performance / position error distribution.

Another viewpoint - faulted performance (detected or undetected) typically occurs much less frequently (more rarely) than at the 99% or 99.9% rate, which is the region where we are scaling NACp to be used as NIC. Any impact of integrity failures on position bounds would occur towards the tails of the distribution (many 9's).

5. Results of Action item 10-25-02 #1 concerning a GPS Position & Velocity Model

Joel indicated that there is not a recognized industry model for GPS position and velocity. He offered a potential model (that would need to be validated by GNSS standards organizations such as RTCA SC-159, etc). He noted that SC-186 WG4 needs to note the long correlation times (lack of independent sample-to-sample outputs) associated with GPS, which are on the order of minutes or more. Joel indicated that WG4 does not need to wait for these models at this time, but should encourage SC-159 to develop and validate these models for analysis work for future ASA applications.

Tom – should we (WG4) use / recommend / adopt a preferred GPS position and velocity models for analysis work on ASA applications? Jonathan agreed that we may want to do that for future work, but not to impact current or already complete application analyses.

Since not all navigation sources may be GPS-based, we may need to consider the potential impact of non-GPS navigation. Use of conservative position and velocity model assumptions could obviate the need of including detailed navigation models in our analyses.

6. Results of Action item 8-27-02 #4 concerning lack of reliable "on-ground" indication

Joel presented his work concerning the need for reliable "on-ground" indication for the ASSA and FAROA applications. He indicated that it is acceptable (but not desirable) to lack a "reliable" on-ground indication for some aircraft for the ASSA and FAROA applications, since there are other ways to determine whether or not an aircraft is a potential hazard for surface operations (methods include assessing altitude and velocity reports, combined with knowledge of position and a surface map database). While not desirable, the application can deal with a lack of reliable on-ground indications.

7. Issue Paper #3 on ASA Own-ship Data Processing by Stu Searight

WG4 reviewed Stu's issue paper #3. Stu raised the issue that data items / information elements that are transmitted by ADS-B (e.g, NIC, NAC, etc) require some processing function to collect the data, interpret it, and formulate a final output for transmission via ADS-B. Where this processing occurs functionally has not been fully addressed to this point. This processing is currently not covered in the ADS-B MASPS.

Issues: What MASPS and MOPS will be the home for this additional transmit processing function? This question is more critical at the MOPS level, since this is closer to physical implementations being developed. Incorporating this into the Data Link MOPS will likely be a problem since systems are already being developed. Thus we have the option to require a new MOPS, or incorporate it into the ASSAP/CDTI MOPS. A new MOPS for strictly this function seems overkill and requires going to the PMC.

A proposal was made that this function should be included in the ASSAP / CDTI MOPS (as a catch all). However, WG4 could not reach consensus. It is recommended that this be taken up by SC-186 leadership to determine a recommendation to be discussed at the next SC-186 plenary.

Wednesday 11-20-02

8. EVAcquistion Review with Bob Grappel / Dave Spencer - MIT LL

Bob and Dave participated via telecon to provide an update on their EVAcquisition analysis.

Extrapolation of position and velocity data to determine future traffic position was discussed. Bob indicated that extrapolation of greater than 6 sec with velocity uncertainty would degrade the error of position too much. If update rate and error bounds are exceeded, then the target can / should be shown as degraded.

We discussed the scaling of NAC from 95% to 99% to address the need for NIC with a SIL = 0.01. Due to the relatively modest (low integrity requirement) the 99% number represents more typical performance rather than dealing with the tails of distributions where SIL/integrity is a greater issue. The group agreed that for the EVAcquistion application, NAC (95%) can be scaled to 99% and be used as an effective NIC. There

was additional discussion on how to treat the velocity aspects, NACv, from 95% to 99%. The group agreed that NACv is also scaleable from 95% to 99%.

Dave emphasized that to complete the analysis, he needs to be able to put performance bounds on velocity, etc. He and Bob will assume the following in completing the analysis: 1) NACv can be scaled similar to NACp to determine 99% velocity bounds; 2) NACp can be scaled to 99% to obtain horizontal position bound for NIC; to the 99% number, 3) instead of assuming a worst case velocity of 600 kts, it was decided to use the reported / measured velocity in assessing the extent of position extrapolation error (use of 600 kts was deemed too pessimistic).

Bob Grappel / Dave Spencer Action – Update the text of the EVAcquistion analysis document to make it read consistent based on the recent discussion concerning NACp, NIC, NACv, data extrapolotion, position error budget, etc.

Jonathan action – create a standard table of application requirements to be used by the application analyses documents, including definition of requirements parameters.

Concerning "maximum time to alert to indicate integrity changes", the group decided that this parameter was 'not applicable' to EVAcquistion. Instead, a new consideration for "maximum time to alert to indicate a change in accuracy (new NACp)" will be included in a note in the text {Requirement that reported accuracy should be to the same time as that used for position data}.

Discussion about AC 23-1309 (which suggest a collision risk of 10-6 for small aircraft). Jerry Anderson asked whether EVAcquisition is only intended for small GA aircraft, or if not, how do we deal with using EVAcquisition for large / air transport category aircraft. A discussion ensued about how to handle this case for the fault tree analysis. We discussed VFR versus IFR operation, (does IFR add 3 '9's' of safety?). Tom Foster noted that use of EVAcquisition in air transport category aircraft should be treated similar to how TCAS display of traffic is currently being addressed. Jonathan took the action (and volunteered Stan to assist) to help provide a strawman answer for the issue of how to achieve the necessary increased safety (better than 10-6) for the use of EVAcquisition in air transport category aircraft.

9. Review of CDTI Features Requirements for ASA Applications –Randy Bone

Randy presented the table that allocates CDTI Requirements / Features for ASA Applications.

WG1 Action – Clarify / restate definition of 'extended display range' and 'reduced display range' limits. Be more specific on ranges / steps; is there a standard set of display range steps for CDTI? Consider ADS-B equipage class ranges.

WG1 Action – Re-check definition of "aerodrome runway" (specific runway or the whole map with all runways?)

Discussion on how to capture display features – at the top level, a list of CDTI display features is identified and defined with sufficient clarity as required by the various ASA applications. This seems appropriate for the MASPS level. Later on, more specific details can be provided on display features in the ASSAP/CDTI MOPS.

These are definitions of features. The requirements for the features that flow down to the MOPS are then captured later in the table / text. The group did some real time edits to the display feature definitions.

Additional WG1 actions were captured by Jonathan in the Action Item table based on the groups discussion of display feature definitions (refer to the WG4-WG1 action item list).

It was noted that the display feature definitions should be followed immediately by the specific MASPS requirements. The definitions and requirements will then be referenced in the "CDTI Requirements for Applications" table. Randy will update the table based on the revised definitions before it is further reviewed.

10. Suggestions for organizing Chapter 2 – Group Discussion led by Michael Petri

Michael offered some proposals concerning the organization of Chapter 2. His concern is that much / most of the application related material is in appendices and is not represented sufficiently in Chapter 2. His recommendation is to move an appropriate high-level description of each application and their respective performance requirements forward into Chapter 2.

Considerable discussion ensued concerning how best to organize the document. The group discussed various outline options, and several members volunteered to work on strawman recommendations overnight, with discussion to continue on Thursday.

Discussion was tabled until Thursday. Now discussing CSPA.

11. CSPA Review – Presented by Shahar Ladecky

Shahar reviewed his CSPA analysis material. He walked the group through his document and demonstrated how he performs the Monte Carlo simulations to evaluate TCV / NMAC performance and also to determine false alarm performance.

Shahar has not yet simulated the effects of NACv and will incorporate it in the next simulations.

Thursday 11-21-02

12. Discussion of Future Meetings / Schedule

Plan on editing telecons for December 17-19 (probably 4 hours in the morning).

January 14-16 editing sessions (via internet or meeting)

January 27-29 WG4 (Rockwell Collins DC office), January 30-31 plenary DC (RTCA)

February 11-12 editing session (via internet, possibly meeting)

March 4-6 West Coast (tentatively in Salem, OR at UPS-AT)

Tentative: April 24 Plenary (WG meetings 21-23)

13. CSPA Review continued from Wed PM

Shahar continued with the review of CSPA.

There was considerable discussion of how to model NIC in the simulation. Some good discussion, but unable to resolve the issue. A subgroup will address this offline. The NIC subgroup (Joel, Jim, Stan, Jonathan, Bill) has the action to clarify the use of NIC,

NAC, and SIL. The action includes clarification of the definitions of these terms, and should result in a short appendix to be added to the MASPS to ensure that this topic is document for future use (and to prevent this issue form being revisited again at a later time due to lack of documentation).

CSPA Fault Tree Review :

Top Level TCV / NMAC probability is ~2.3e-8. The two factors that affect this number are 1) TCV probability (due to an at risk blunder) with CSPA system working normally, and 2) TCV simultaneous with a CSPA system failure, or an induced TCV by a CSPA system failure. These main events were further decomposed into more detailed fault trees.

Shahar action – to add the "induced TCV due to system failure" sub-tree into the document.

Bob – we need to document the rate of occurrence of failures that are found in our fault trees, and where possible, tie it to know systems, e.g., PRM, nav failures that result in blunders, etc. This traceability is needed to avoid surprises later. Where we make assumptions on failure rates, we should state them explicitly.

14. Review of ASA MASPS Outline Strawmen

Jim Maynard and Tom Foster offered strawmen updates to the current ASA MASPS outline. These were discussed by the group.

A revised outline was developed and working assignments were made (see below):

1.1 Introduction Michael & Steve
1.2 System overview
1.3 Key definitions
Own ship, traffic ads-b, tis-b, background & coupled applications
1.4 airborne surveillance applications
definition of application categories
1.4.1 application category 1
1.4.1.1 application 1.1
1.4.1.2 application 1.2 etc.
1.4.2 application category 2
1.4.3 etc.
1.5 Key concepts of operation - anticipated operational use of applications (interactions, background and coupled applications)
1.6 application assessment process
2 ASA System Requirements Jim Maynard
2.1 ASA System Functions
Include historical background of system functions, e.g., ADS-B, TIS-B etc. (Michael Petri)
2.2 Category 1 application requirements
2.2.1 Common requirements for application category 1
2.2.1.1 Information requirements
2.2.1.1.1 Information elements & characteristics
2.2.1.2 Performance requirements

2.2.1.3 Functional requirements
2.2.2 Additional requirements for application 1.1
2.2.2.1 Information requirements
2.2.2.1.1 Information elements & characteristics
2.2.2.2 Performance requirements
2.2.2.3 Functional requirements
2.2.3 Additional requirements for application 1.2
2.2.4 Etc.
2.3 Category 2 application requirements
2.4 Etc.
3 Jonathan & Tom F, Stan Jones

Writing Assignment Summary:

Chapter 1 – Michael, (Steve - secondary partner)

Chapter 2 – ASA System Requirements – Jim

Chapter 3 – Jonathan, Tom, Stan

Jonathan action – get Michael Petri the latest ASA MASPS document(s) for document control purposes.

The group decided to keep the ASA MASPS Appendices as separate documents with version control. The main body of the ASA MASPS will be a separate document with version control.

It was suggested to Use R-numbers for 'requirements', A-numbers for 'assumptions' made in the ASA MASPS document.

Editorial Subgroup Members: Jonathan, Michael, Jim, Tom, Joel, Stan, Steve.

Goal to complete this by the December Telethon.

Action Item for Jim Maynard – Provide document outline and formatting guidelines to the group.

Summary of Action Items for October 23-25 WG4 Meeting

1) Tim Rand on ACM:
    a) Tim to add appropriate footnotes to Table 5. Add a footnote to the table to the effect that a "NIC of 7 is the 'required nominal performance' based on engineering judgement. Ultimately a 'minimum' NIC will be established by airspace designers / service providers for the type of airspace that the ACM system operates in".
    b) Tim to rename columns of the table (nominal, minimum, etc).
    c) Some discussion concerning the need for additional requirements, e.g., latency, etc.

d) Understand how RVSM achieves 1000 ft altitude with integrity? ACM should be able to operate to 1000 ft type levels. Concern about altitude integrity of 10-5 being too stringent for existing systems.

e) Action – Understand the entire issue of the use of altitude for ACM. How does RVSM achieve 1,000 ft separation with integrity. Explore the role of geometric altitude as a crosscheck on barometric altitude. ACM should consider operation to the RVSM altitude separation (1000 ft) or today's 2000 ft vertical separation.

f) Actions (Tim and Joel) – Understand the entire issue of the use of altitude for ACM. 1) how does RVSM achieve 1,000 ft separation with integrity. Can ACM leverage RVSM altitude management? Explore the role of geometric altitude as a crosscheck on barometric altitude.

g) Tim and Martin Actions on ACM analysis - we need to address some additional requirements for the ACM analysis: 1) subsystem integrity from the safety analysis for ASSAP and CDTI subsystems, 2) nominal processing requirements for ASA sub-systems (e.g., flow-down of requirements to ASSAP MOPS). Tom – at a minimum, we need a function diagram, and if there is an algorithm that needs to be referenced. Parametrically specifying the ACM algorithm requirements, either a black box approach or using the actual algorithm (e.g., missed detection, nuisance/false alarms, number of alert levels, time to alert, ACM response to flight crew / maneuvers, flight crew performance assumptions / response times).

2) Joel action – investigate the extent to which VPL is available for non-augmented and augmented GPS performance.

3) Jonathan action – add the topic of SC-159 to support some of SC-186's surveillance performance needs to the SC-186 leadership telecon agenda.

4) Bob Grappel / Dave Spencer Action – Update the text of the EVAcquistion analysis document to make it read consistent based on the recent discussion concerning NACp, NIC, NACv, data extrapolation, position error budget, etc.

5) Jonathan action – create a standard table of application requirements to be used by the application analyses documents, including definition of requirements parameters.

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7) WG1 Action – Clarify / restate definition of 'extended display range' and 'reduced display range' limits. Be more specific on ranges / steps; is there a standard set of display range steps for CDTI? Consider ADS-B equipage class ranges.

8) WG1 Action – Re-check definition of "aerodrome runway" (specific runway or the whole map with all runways?)

9) Additional WG1 actions were captured by Jonathan in the Action Item table based on the groups discussion of display feature definitions (refer to the WG4-WG1 action item list).

10) The NIC subgroup (Joel, Jim, Stan, Jonathan, Bill) has the action to clarify the use of NIC, NAC, and SIL. The action includes clarification of the definitions of these terms, and should result in a short appendix to be added to the MASPS.

11) Shahar action – to add the "induced TCV due to system failure" sub-tree into the CSPA document.

12) Jonathan action – get Michael Petri the latest ASA MASPS document(s) for document control purposes.

13) Writing Assignment for Chapter 1 – Michael, (Steve - secondary partner)

    Writing Assignment for Chapter 2 – ASA System Requirements – Jim

    Writing Assignment for Chapter 3 – Jonathan, Tom, Stan

14) Action Item for Jim Maynard – Provide document outline and formatting guidelines to the group.

Future WG4 Meetings

December 17-19 editing sessions (via internet)

January 14-16 editing sessions (via internet) or possible meeting

January 27-29 WG4 (Rockwell Collins Offices in Arlington, VA), January 30-31 plenary DC (at RTCA)

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End of meeting minutes