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Informal Examination of ASA MASPS End-to-End Latency Requirements
Revision 1

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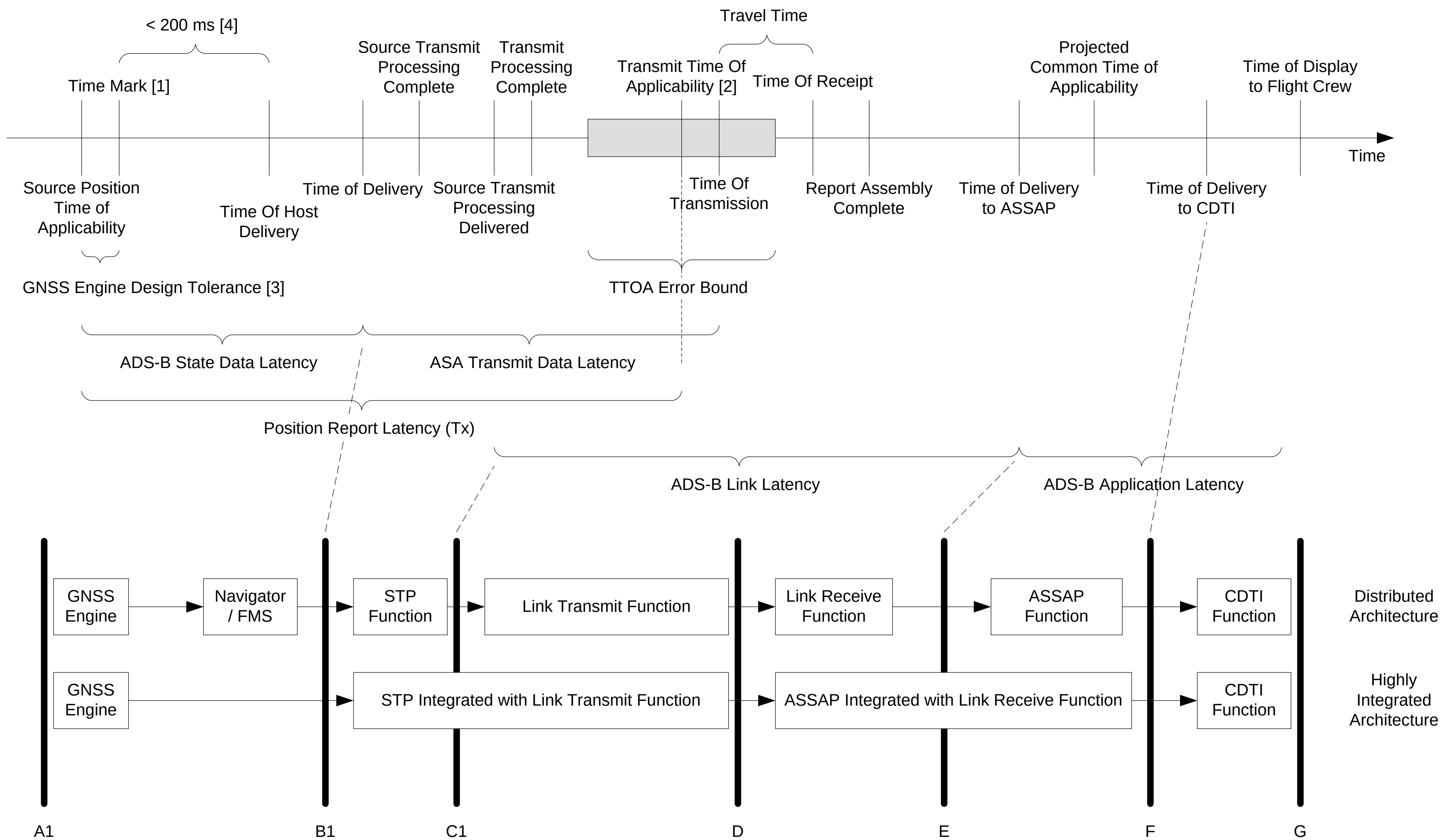
Summary

This paper presents the end-to-end latency requirements from DO-289. The author asserts that the latency allocated to ASSAP should be revisited.



< 200 ms [4]
Time Mark [1]
Source Transmit Processing Complete
Transmit Processing Complete
Travel Time
Transmit Time Of Applicability [2]
Time Of Receipt
Projected Common Time of Applicability
Time of Display to Flight Crew
Time
Source Position Time of Applicability
Time Of Host Delivery
Time of Delivery
Source Transmit Processing Delivered
Time Of Transmission
Report Assembly Complete
Time of Delivery to ASSAP
Time of Delivery to CDTI
GNSS Engine Design Tolerance [3]
TTOA Error Bound
ADS-B State Data Latency
ASA Transmit Data Latency
Position Report Latency (Tx)
ADS-B Link Latency
ADS-B Application Latency
GNSS Engine
Navigator / FMS
STP Function
Link Transmit Function
Link Receive Function
ASSAP Function
CDTI Function
Distributed Architecture
GNSS Engine
STP Integrated with Link Transmit Function
ASSAP Integrated with Link Receive Function
CDTI Function
Highly Integrated Architecture
A1
B1
C1
D
E
F
G

[1] The Time Mark is an implementation detail of an ARINC 743A compliant GNSS. Other position sensors do not typically output a Time Mark.

[2] Transmit Time of Applicability (TTOA) may occur before, after, or coincide with Time of Transmission (TOT) depending on the ADS-B link implementation.

[3] GNSS Engine Design Tolerance is dependent on the implementation of the GNSS engine.

[4] ARINC 743A requires that the digital solution associated with the Time Mark be delivered in 200 ms.

[5] The bold lines match Figure 2-7 in DO-289.

Max Latency	EV Acq	CD	ASSA, FAROA	EV Approach	Advanced Req	DO-289 Reference
End to End A1-G	6 s	3 s	3 s	6 s	2 s	Table 2-3
ASA Transmit Data Latency B1-D	1.1 s	1.1 s	1.1 s	1.1 s	0.3	Table 3-1
ADS-B State Data Latency A1 – B1	1 s	1 s	1 s	1 s	0.2	Table 3-1
ADS-B Link Latency C1 – E	1.2 s	1.2 s	1.2 s	1.2 s	0.4	3.2.3.1.1.2.2 Table 3-12
ADS-B Application Latency E – G	(0.4) 1 s	(0.4) 1 s	(0.4) 1 s	0.4 s	0.4	3.3.2.2

Examine ASSA/FAROA Maximum Latency

Latency Allocation between each of the functional interfaces is examined. DO-289 Values are bold. Derived values are normal text.

A1-B1	B1-C1	C1-D	D-E	E-G
1	0.4	0.7	0.5	**0.4**

So to derive these numbers, you start with the End to End requirement of 3 seconds. So take the **A1-G** number, subtract **A1-B1**, **C1-E**, and **E-G** to get B1-C1. To get C1-D, subtract B1-C1 from **B1-D**. To get D-E, subtract C1-D from **C1-E**.

Ok so what does all this mumbo jumbo mean? According to the MASPS, you get 1 second to get state data into the STP function. Not bad, should be able to do that pretty easily. STP actually cuts that 1 second requirement down to 600 ms. STP gets 400 ms to play with. That's pretty generous. Then the link transmitter gets 700 ms to play with. So the transmit time is ignored and you move onto how much time the link receiver gets to receive data and move it on to ASSAP, 0.5 seconds. This is probably reasonable. Then the last step gives 400 ms to ASSAP and CDTI to process stuff, transfer data, and throw it on the screen. Consider the ASSAP and CDTI are separate units, a likely design, and existing federated bus technology (e.g. 100KBit ARINC 429), this requirement looks tight. Another consideration here is just the process that ASSAP has to carry out. The UAT link allocates 800 ms for aircraft to transmit each second. So your reports from aircraft could span 800 ms for a complete set. Mode S is similar at 600 ms. After they all are received then you carry out your extrapolation to a common time, correlation, priority sorting, etc. It doesn't seem reasonable to implement an ASSAP that meets the E-G number. It seems more reasonable for the ASSAP allocation to be more like 900 ms or more. You could run the algorithm several times per second, but I'm puzzled why you would want to do that knowing you are only going to have a fraction of aircraft updates.

Examine Advanced Requirement Maximum Latency

A1-B1	B1-C1	C1-D	D-E	E-G
0.2	0.1	0.2	0.2	**0.4**

So to derive these numbers I followed the same method. I ran into some snags though. When you look at the B1-D number of 0.3 and the C1 –E number of 0.4, you don't have much room to play with to make B1-C1 work out. Certainly not the simple subtraction I applied before. That would give you B1-C1 of 2 -0.4-0.4-0.2 = 1 second. One second is larger than the entire time allocated to B1-D, so obviously that can't work. I elected to allocate 0.1 second to B1-C1, leaving 0.2 second to C1-D. That then leads to 0.2 second allocated to D-E. Those numbers come in significantly under the end to end time of 2 seconds though. The total time above is 1.1 seconds.

So to meet the latency number, the position source will need to produce measurements at 200 ms intervals and deliver them within 200 ms. WAAS sensors are capable of meeting those requirements today. STP to transmit time gets 300 ms. This can be met by the precision case of both links. So far so good. Two hundred milliseconds is allocated for report generation in the receiver. The ASSAP, CDTI time block has the same problems as before.