

**RTCA Special Committee 186, Working Group 3, Meeting #26  
EUROCAE WG-51, SG-1, Meeting #3  
for  
ADS-B 1090ES MOPS Maintenance**

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**Review of Issues with ADS-B Report Formats  
as  
Specified in RTCA DO-260A**

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<b>Summary</b>
Response to Action Item 25-XX. This Working Paper addresses issues that were discussed during Meeting #25 at Eurocontrol in Brussels regarding the report formats and parameter resolution currently specified in RTCA DO-260A for various ADS-B Reports.

## **1. Introduction**

During discussions during Meeting #25 conducted at Eurocontrol, it was pointed out that the report architecture provided for various ADS-B Reports in RTCA DO-260A does not clearly provide sufficient information to establish the resolution of various parameters in the report. The complaint indicated that there were problems with Table 2-81, 2-88, 2-94, and 2-96. This working paper attempts to address the complaint and concentrates primarily on Table 2-81 which provides structure of the ADS-B State Vector Report.

## **2. Discussion**

### **2.1 General**

During the Meeting #25 discussions, attention was brought to the first paragraph of RTCA DO-260A section 2.2.8. The paragraph specifically states that the report structures provided in DO-260A are EXAMPLE codings of each of the ADS-B reports and that implementations may use alternative report structures provided that the minimum report contents are established.

That being said, this working paper moves on to address the complaint regarding the resolution implied in the report structures.

First, review of Table 2-81, column 10 emphasizes that the data structure for each parameter was established in a manner that would allow parameter breaks to occur on “byte” boundaries as this allows for easier interface design for delivery of the data to an application.

Next, each of the reports structures was reviewed and it was verified the most if not all of the parameters provided in the reports have sufficient resolution. Using Table 2-81 as the reference point, review of the range (column 7), resolution (column 8) and data structure (column 10) indicates that the resolution provided is at least as good as the resolution of the data transmitted via the ADS-B broadcast messages. In most cases, the resolution is much better than that provided in the transmitted data. **However, there are exceptions.**

Review of Table 2-81, line 4 and 5 indicates that position data is encoded to a resolution of 0.0000215 degrees (in true Angular Weighted Binary, the actual resolution is 0.000021457672119128125 degrees). Due to the use of Compact Position Reporting (CPR) to encode latitude and longitude information in the various messages, the real resolution of the transmitted data is governed by the CPR algorithm and not by the data structure indicated in Table 2-81 or other similar tables dealing with position data. With CPR, the resolution of latitude encoding is established by dividing the size of the latitude zone (dlat) by the number of range bins in the zone. Likewise, resolution of longitude encoding is established by dividing the size of the longitude zone (dlon) by the number of range bins in the zone. The resolution remains constant for all dlat\_even encodings and also for all dlat\_odd encodings. The resolution does not remain constant for dlon\_even or dlon\_odd as the circles of latitude decrease in diameter as one moves from the equator to the poles.

### **2.2 Surface Position Message Position Encoding Resolution**

Table 1A and 1B are provided at the end of this paper. Table 1A provides Surface Position Message Latitude Encoding Resolution. Table 1B provides Surface Position Message Longitude Encoding Resolution.

Surface encoding uses **2^19** bins for encoding. That means that there are **2^19** bins or possible encodings for each even and each odd latitude zone. Likewise, there are **2^19** bins or possible encodings for each even and odd longitude zone.

Table-1a shows that the even latitude encoding resolution is 0.00001144 degrees or 4.1486 feet. The odd latitude encoding resolution is 0.00001164 degrees or 4.2189 feet.

Table-1b shows that the even longitude encoding resolution is 0.00001164 degrees or 4.2506 feet at the equator. The even longitude encoding resolution increases to a maximum of 0.00068665 or 13.12523 feet at a latitude of 87.0 degrees. The odd longitude encoding resolution is 0.00001184 degrees or 4.3239 feet at the equator. The odd longitude encoding resolution increases to a maximum of 0.00068665 degrees or 15.1557 feet at a latitude of 86.5354 degrees. As such, the resolution is consistent with the resolution claims made in early CPR presentation materials of 5 meters or 15 feet (actually 16.4042 feet) for the Surface Position Message.

### 2.3 Airborne Position Message Position Encoding Resolution

Table 2A and 2B are provided at the end of this paper. Table 2A provides Airborne Position Message Latitude Encoding Resolution. Table 2B provides Airborne Position Message Longitude Encoding Resolution.

Airborne encoding uses  $2^{17}$  bins for encoding. That means that there are  $2^{17}$  bins or possible encodings for each even and each odd latitude zone. Likewise, there are  $2^{17}$  bins or possible encodings for each even and odd longitude zone.

Table-2a shows that the even latitude encoding resolution is 0.00004578 degrees or 16.5942 feet. The odd latitude encoding resolution is 0.00004655 degrees or 16.8755 feet.

Table-2b shows that the even longitude encoding resolution is 0.00004655 degrees or 17.0026 feet at the equator. The even longitude encoding resolution increases to a maximum of 0.00274658 degrees or 52.5009 feet at a latitude of 87.0 degrees. The odd longitude encoding resolution is 0.00004735 degrees or 17.2957 feet at the equator. The odd longitude encoding resolution increases to a maximum of 0.00274658 degrees or 60.6228 feet at a latitude of 86.5354 degrees. Review of Table 2-b indicates that for the most part, the resolution is consistent with the resolution claims made in early CPR presentation material of 15 meters or 45 feet (actually 49.2126 feet) for the Airborne Position Message

### 2.4 Intent Message Position Encoding Resolution

Table 3A and 3B are provided at the end of this paper. Table 3A provides Intent Message Latitude Encoding Resolution. Table 2B provides Intent Message Longitude Encoding Resolution.

The Intent Message encodings use  $2^{14}$  bins for encoding. Resolution computations proceed similarly to those provided for the Airborne and Surface Position Messages and can be reviewed in Table 3A and 3B.

### 2.5 TIS-B Message Position Encoding Resolution

Table 4A and 4B are provided at the end of this paper. Table 4A provides TIS-B Message Latitude Encoding Resolution. Table 2B provides TIS-B Message Longitude Encoding Resolution.

The TIS-B Message encodings use  $2^{12}$  bins for encoding. Resolution computations proceed similarly to those provided for the Airborne and Surface Position Messages and can be reviewed in Table 4A and 4B.

### 2.6 ARINC-735B DTIF Encoding Resolution

Review of Attachment 20J to ARINC-735B “Display Traffic Information File” characteristics indicates that the latitude and longitude resolution used to transfer position information is actually 0.0000107288360595640625 degrees. Note that this resolution is actually 1 bit better than that provided

for in Table 2-81 of RTCA DO-260A. This brings one to the question if DO-260A needs to be changed to the better resolution used by ARINC-735B.

### **3. Summary**

This working paper has shown that the resolution of position data provided in RTCA DO-260A ADS-B reports is actually established by the CPR encoding. Likewise, the paper has shown that the resolution used in the ADS-B reports may be less than that needed by some applications. As the Report Tables provided in RTCA DO-260A are example report structures, it may not be necessary to make changes to the tables at this time. Rather, it should be the responsibility of the application to establish the needed resolution such that the interface to the application can be designed to provide the appropriate resolution.

In closing, the working group is invited to review the situation and determine if the ADS-B Report tables need to be updated to provide more resolution.

Table-1A: SURFACE POSITION MESSAGE LATITUDE ENCODING RESOLUTION

solution: dlat / (2^19 bins per zone)				even latitude encoding resolution (degrees)	odd latitude encoding resolution (degrees)	even latitude encoding resolution (naut. miles)	odd latitude encoding resolution (naut. miles)	even latitude encoding resolution (feet)	odd latitude encoding resolution (feet)	even latitude encoding resolution (meters)	odd latitude encoding resolution (meters)
Item #	Latitude (degrees)	dlat_even (degrees)	dlat_odd (degrees)								
1	ALL	6.00000000	6.10169492	0.00001144	0.00001164	0.00068277	0.00069434	4.14855425	4.21886873	1.264479296	1.285911149

Table-1B: SURFACE POSITION MESSAGE LONGITUDE ENCODING RESOLUTION

solution: dlon / (2^19 bins per zone)					even longitude encoding resolution (degrees)	odd longitude encoding resolution (degrees)	even longitude encoding resolution (naut. miles)	odd longitude encoding resolution (naut. miles)	even longitude encoding resolution (feet)	odd longitude encoding resolution (feet)	even longitude encoding resolution (meters)	odd longitude encoding resolution (meters)
Item #	Latitude (degrees)	NL Zone	dlon_even (degrees)	dlon_odd (degrees)								
1	89.90000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00007204	0.00007204	0.43770740	0.43770740	0.13341321	0.13341321
2	89.50000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00036018	0.00036018	2.18851032	2.18851032	0.667057924	0.667057924
3	89.00000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00072034	0.00072034	4.37685398	4.37685398	1.334065049	1.334065049
4	88.50000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00108044	0.00108044	6.56486432	6.56486432	2.00097058	2.00097058
5	88.00000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00144046	0.00144046	8.75237472	8.75237472	2.667723729	2.667723729
6	87.50000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00180037	0.00180037	10.93921859	10.93921859	3.33427372	3.33427372
7	87.00000000000000	1	360.000000000	360.000000000	0.00068665	0.00068665	0.00216014	0.00216014	13.12522940	13.12522940	4.000569794	4.000569794
8	86.5353699751210	2	180.000000000	360.000000000	0.00034332	0.00068665	0.00124716	0.00249432	7.57785473	15.15570946	2.309730047	4.619460095
9	85.7554162094442	3	120.000000000	180.000000000	0.00022888	0.00034332	0.00101830	0.00152745	6.18729248	9.28093872	1.885886687	2.82883003
10	84.8916619070208	4	90.000000000	120.000000000	0.00017166	0.00022888	0.00091876	0.00122502	5.58249350	7.44332467	1.701543965	2.268725286
11	83.9917356298056	5	72.000000000	90.000000000	0.00013733	0.00017166	0.00086406	0.00108007	5.25009176	6.56261470	1.600227918	2.000284897
12	83.0719944471981	6	60.000000000	72.000000000	0.00011444	0.00013733	0.00082977	0.00099572	5.04176128	6.05011353	1.536728788	1.844074545
13	82.1395698051060	7	51.42857143	60.000000000	0.00009809	0.00011444	0.00080639	0.00094079	4.89969676	5.71631288	1.493427523	1.74233211
14	81.1980134927195	8	45.000000000	51.42857143	0.00008583	0.00009809	0.00078948	0.00090226	4.79695044	5.48222907	1.462110446	1.670983367
15	80.2492321328051	9	40.000000000	45.000000000	0.00007629	0.00008583	0.00077671	0.00087380	4.71934829	5.30926682	1.438457311	1.618264475
16	79.2942822545692	10	36.000000000	40.000000000	0.00006866	0.00007629	0.00076673	0.00085193	4.65875494	5.17639438	1.41998846	1.577764955
17	78.3337408292275	11	32.72727273	36.000000000	0.00006242	0.00006866	0.00075874	0.00083461	4.61018111	5.07119922	1.405183158	1.545701474
18	77.3678946132819	12	30.000000000	32.72727273	0.00005722	0.00006242	0.00075219	0.00082057	4.57040336	4.98589458	1.393058901	1.519700619
19	76.3968439079447	13	27.69230769	30.000000000	0.00005282	0.00005722	0.00074674	0.00080897	4.53724966	4.91535379	1.382953651	1.498199788
20	75.4205625665336	14	25.71428571	27.69230769	0.00004905	0.00005282	0.00074212	0.00079921	4.50920476	4.85606666	1.374405567	1.480129072
21	74.4389341572514	15	24.000000000	25.71428571	0.00004578	0.00004905	0.00073817	0.00079089	4.48518043	4.80555046	1.36708295	1.464731732
22	73.4517744166786	16	22.500000000	24.000000000	0.00004292	0.00004578	0.00073474	0.00078373	4.46437546	4.76200049	1.360741596	1.451457702
23	72.4588454472895	17	21.17647059	22.500000000	0.00004039	0.00004292	0.00073175	0.00077748	4.44618727	4.72407398	1.355197838	1.439897703
24	71.4598647302898	18	20.000000000	21.17647059	0.00003815	0.00004039	0.00072911	0.00077200	4.43015417	4.69075148	1.350310949	1.429741005
25	70.4545107498760	19	18.94736842	20.000000000	0.00003614	0.00003815	0.00072677	0.00076714	4.41591658	4.66124528	1.34597133	1.420747515
26	69.4424263114402	20	18.000000000	18.94736842	0.00003433	0.00003614	0.00072467	0.00076281	4.40319036	4.63493722	1.34209238	1.412728821
27	68.4322202208333	21	17.14285714	18.000000000	0.00003270	0.00003433	0.00072279	0.00075893	4.39174812	4.61133553	1.338604785	1.405535024
28	67.3964677408467	22	16.36363636	17.14285714	0.00003121	0.00003270	0.00072109	0.00075543	4.38140573	4.59004410	1.335452424	1.399045396
29	66.3617100838262	23	15.65217391	16.36363636	0.00002985	0.00003121	0.00071954	0.00075225	4.37201253	4.57074037	1.332589377	1.393161621
30	65.3184530968209	24	15.000000000	15.65217391	0.00002861	0.00002985	0.00071813	0.00074936	4.36344410	4.55315906	1.329977119	1.387802837
31	64.2661652256744	25	14.400000000	15.000000000	0.00002747	0.00002861	0.00071684	0.00074671	4.35559678	4.53707998	1.327585855	1.382901933
32	63.2042747938193	26	13.84615385	14.400000000	0.00002641	0.00002747	0.00071565	0.00074428	4.34838353	4.52231887	1.325387257	1.378402747
33	62.1321665921037	27	13.33333333	13.84615385	0.00002543	0.00002641	0.00071456	0.00074204	4.34173074	4.50872038	1.323359487	1.374257929
34	61.04917744264635	28	12.85714286	13.33333333	0.00002452	0.00002543	0.00071355	0.00073997	4.33557574	4.49615625	1.321483442	1.370427273
35	59.9545927669403	29	12.41379310	12.85714286	0.00002368	0.00002452	0.00071261	0.00073806	4.32986483	4.48450286	1.319742759	1.366876429
36	58.8476377614846	30	12.000000000	12.41379310	0.00002289	0.00002368	0.00071173	0.00073627	4.32455178	4.47367425	1.31812334	1.363575869
37	57.7274735386611	31	11.61290323	12.000000000	0.00002215	0.00002289	0.00071092	0.00073461	4.31956951	4.46358306	1.316612973	1.360500072
38	56.5931875620592	32	11.250000000	11.61290323	0.00002146	0.00002215	0.00071015	0.00073306	4.31496415	4.45415654	1.31520103	1.35762687
39	55.4437844449504	33	10.90909091	11.250000000	0.00002081	0.00002146	0.00070944	0.00073161	4.31062421	4.44533122	1.313878218	1.354936912
40	54.5278174227290	34	10.58823529	10.90909091	0.00002020	0.00002081	0.00070877	0.00073025	4.30654992	4.43705144	1.312636375	1.352413235
41	53.0951615279600	35	10.28571429	10.58823529	0.00001962	0.00002020	0.00070814	0.00072897	4.30271767	4.42926819	1.311468304	1.350040901
42	51.8934246916877	36	10.000000000	10.28571429	0.00001907	0.00001962	0.00070754	0.00072776	4.29910655	4.42193817	1.310367635	1.347806711
43	45.6715016555384	37	9.72972973	10.000000000	0.00001856	0.00001907	0.00070698	0.00072662	4.29569801	4.41502295	1.309328711	1.345698953
44	49.4277643925659	38	9.47368421	9.72972973	0.00001807	0.00001856	0.00070645	0.00072555	4.29247549	4.40848834	1.308346487	1.343707203
45	48.1603912809662	39	9.23076923	9.47368421	0.00001761	0.00001807	0.00070595	0.00072453	4.28942420	4.40230378	1.307416453	1.341822149
46	46.86732522549874	40	9.000000000	9.23076923	0.00001717	0.00001761	0.00070547	0.00072356	4.28653087	4.39644191	1.306534566	1.340035453
47	45.5462672266024	41	8.78048780	9.000000000	0.00001675	0.00001717	0.00070502	0.00072265	4.28378356	4.39087815	1.305697188	1.338339617
48	44.1945495141927	42	8.57142857	8.78048780	0.00001635	0.00001675	0.00070459	0.00072178	4.28117152	4.38559033	1.304901037	1.336727891
49	42.8091401224355	43	8.37209302	8.57142857	0.00001597	0.00001635	0.00070418	0.00072095	4.27868500	4.38058548	1.304143146	1.335194174
50	41.3865183226024	44	8.18181818	8.37209302	0.00001561	0.00001597	0.00070379	0.00072016	4.27631519	4.37576438	1.303420828	1.33373294
51	39.9225684338386	45	8.000000000	8.18181818	0.00001526	0.00001561	0.00070342	0.00071941	4.27405407	4.37119166	1.302731638	1.332339176

Table-2A: AIRBORNE POSITION MESSAGE LATITUDE ENCODING RESOLUTION

solution: dlat / (2^17 bins per zone)				even latitude encoding resolution (degrees)	odd latitude encoding resolution (degrees)	even latitude encoding resolution (naut. miles)	odd latitude encoding resolution (naut. miles)	even latitude encoding resolution (feet)	odd latitude encoding resolution (feet)	even latitude encoding resolution (meters)	odd latitude encoding resolution (meters)
Item #	Latitude (degrees)	dlat_even (degrees)	dlat_odd (degrees)								
1	ALL	6.00000000	6.10169492	0.00004578	0.00004655	0.00273106	0.00277735	16.59421702	16.87547493	5.057917184	5.143644594

Table-2B: AIRBORNE POSITION MESSAGE LONGITUDE ENCODING RESOLUTION

solution: dlon / (2^17 bins per zone)					even longitude encoding resolution (degrees)	odd longitude encoding resolution (degrees)	even longitude encoding resolution (naut. miles)	odd longitude encoding resolution (naut. miles)	even longitude encoding resolution (feet)	odd longitude encoding resolution (feet)	even longitude encoding resolution (meters)	odd longitude encoding resolution (meters)
Item #	Latitude (degrees)	NL Zone	dlon_even (degrees)	dlon_odd (degrees)								
1	89.90000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00028815	0.00028815	1.75082959	1.75082959	0.533652842	0.533652842
2	89.50000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00144073	0.00144073	8.75404128	8.75404128	2.668231696	2.668231696
3	89.00000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00288136	0.00288136	17.50741590	17.50741590	5.336260196	5.336260196
4	88.50000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00432176	0.00432176	26.25945727	26.25945727	8.003882319	8.003882319
5	88.00000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00576184	0.00576184	35.00949887	35.00949887	10.67089491	10.67089491
6	87.50000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00720147	0.00720147	43.75687437	43.75687437	13.33709488	13.33709488
7	87.00000000000000	1	360.000000000	360.000000000	0.00274658	0.00274658	0.00864056	0.00864056	52.50091761	52.50091761	16.00227918	16.00227918
8	86.5353699751210	2	180.000000000	360.000000000	0.00137329	0.00274658	0.00498863	0.00997726	30.31141892	60.62283783	9.23892019	18.47784038
9	85.7554162094442	3	120.000000000	180.000000000	0.0091553	0.00137329	0.00407320	0.00610980	24.74916991	37.12375486	7.543546746	11.31532012
10	84.8916619072028	4	90.000000000	120.000000000	0.0006865	0.0091553	0.00367505	0.00490007	22.32997400	27.77329867	6.806175858	9.074901144
11	83.9917356298056	5	72.000000000	90.000000000	0.00054932	0.00068665	0.00345622	0.00432028	21.00036704	26.25045881	6.40091167	8.001139588
12	83.0719944471981	6	60.000000000	72.000000000	0.00045776	0.00054932	0.00331908	0.00398289	20.16704510	24.20045412	6.14691515	7.37629818
13	82.1395698051060	7	51.42857143	60.000000000	0.00039237	0.00045776	0.00322555	0.00376315	19.59878702	22.86525152	5.973710093	6.699328442
14	81.1980134927195	8	45.000000000	51.42857143	0.00034332	0.00039237	0.00315791	0.00360904	19.18780174	21.92891628	5.848441783	6.683933467
15	80.4292321238051	9	40.000000000	45.000000000	0.00030518	0.00034332	0.00310683	0.00349518	18.87739314	21.23706728	5.753829245	6.47307901
16	79.2942822545692	10	36.000000000	40.000000000	0.00027466	0.00030518	0.00306694	0.00340771	18.63501975	20.70557750	5.679953838	6.31105982
17	78.3337408292275	11	32.72727273	36.000000000	0.00024969	0.00027466	0.00303496	0.00333846	18.44072445	20.28479689	5.620732631	6.182805894
18	77.3678946132819	12	30.000000000	32.72727273	0.00022888	0.00024969	0.00300877	0.00328230	18.28161345	19.94357831	5.572235602	6.078802475
19	76.3968439079447	13	27.69230769	30.000000000	0.00021128	0.00022888	0.00298695	0.00323586	18.14899862	19.66141517	5.531814603	5.929799154
20	75.4205625665336	14	25.71428571	27.69230769	0.00019618	0.00021128	0.00296849	0.00319683	18.03681904	19.42426666	5.497622686	5.920516288
21	74.4389341572514	15	24.000000000	25.71428571	0.00018311	0.00019618	0.00295267	0.00316358	17.94072170	22.2220182	5.4683318	5.858926928
22	73.4517744166786	16	22.500000000	24.000000000	0.00017166	0.00018311	0.00293897	0.00313491	17.85750183	19.04800195	5.442966384	5.805830809
23	72.4588454472895	17	21.17647059	22.500000000	0.00016156	0.00017166	0.00292700	0.00310994	17.78474910	18.89629592	5.420791352	5.759590811
24	71.4598647302898	18	20.000000000	21.17647059	0.00015259	0.00016156	0.00291645	0.00308800	17.72061670	18.76300592	5.401243797	5.71896402
25	70.4545107498760	19	18.94736842	20.000000000	0.00014456	0.00015259	0.00290707	0.00306858	17.66366631	18.64498111	5.383885319	5.682990059
26	69.4424263114402	20	18.000000000	18.94736842	0.00013733	0.00014456	0.00289870	0.00305126	17.61276145	18.53974890	5.368369519	5.650915283
27	68.4232202208333	21	17.14285714	18.000000000	0.00013079	0.00013733	0.00289116	0.00303572	17.56699249	18.44534212	5.354419141	5.622140098
28	67.3964677408467	22	16.36363636	17.14285714	0.00012484	0.00013079	0.00288435	0.00302170	17.52562292	18.36017639	5.341809694	5.596181584
29	66.3617100838262	23	15.65217391	16.36363636	0.00011942	0.00012484	0.00287817	0.00300900	17.48805012	18.28296149	5.330357507	5.572646484
30	65.3184530968209	24	15.000000000	15.65217391	0.00011444	0.0001942	0.00287253	0.00299742	17.45376740	18.21263624	5.319910876	5.551211349
31	64.2661652256744	25	14.400000000	15.000000000	0.00010986	0.00011444	0.00286736	0.00298684	17.42238711	18.14831991	5.310343421	5.531607731
32	63.2042747938193	26	13.84615385	14.400000000	0.00010564	0.00010986	0.00286261	0.00297172	17.39353411	18.08927548	5.301549028	5.513610989
33	62.1321665921033	27	13.33333333	13.84615385	0.00010173	0.00010564	0.00285824	0.00296817	17.36692295	18.03488153	5.293437947	5.497031714
34	61.04917744449504	28	12.85714286	13.33333333	0.00009809	0.00010173	0.00285418	0.00295989	17.34230295	17.98461046	5.285933769	5.481709094
35	59.9545927669403	29	12.41379310	12.85714286	0.00009471	0.00009809	0.00285042	0.00295222	17.31945934	17.93801146	5.278971038	5.467505718
36	58.8476377161486	30	12.000000000	12.41379310	0.00009155	0.00009471	0.00284693	0.00294510	17.29820711	17.89469701	5.272493359	5.454303475
37	57.7274735386611	31	11.61290323	12.000000000	0.00008860	0.00009155	0.00284366	0.00293845	17.27838602	17.85433222	5.266451891	5.442000288
38	56.5931875620592	32	11.250000000	11.61290323	0.00008583	0.00008860	0.00284061	0.00293225	17.25985659	17.81662616	5.26080412	5.430507479
39	55.44378444449504	33	10.90909091	11.250000000	0.00008323	0.00008583	0.00283776	0.00292644	17.24249685	17.78132488	5.255512871	5.419747649
40	54.2781747227290	34	10.58823529	10.90909091	0.00008078	0.00008323	0.00283508	0.00292099	17.22619969	17.74820575	5.250545499	5.409652938
41	53.0951615279600	35	10.28571429	10.58823529	0.00007847	0.00008078	0.00283255	0.00291586	17.21087068	17.71707276	5.245873215	5.400163604
42	51.8934246916877	36	10.000000000	10.28571429	0.00007629	0.00007847	0.00283017	0.00291104	17.19642621	17.68775267	5.241470542	5.391226843
43	50.6715016555384	37	9.72972973	10.000000000	0.00007423	0.00007629	0.00282793	0.00290648	17.18279203	17.66009181	5.237314843	5.382795811
44	49.42776439255693	38	9.47368421	9.72972973	0.00007228	0.00007423	0.00282581	0.00290218	17.16990195	17.63395335	5.233385947	5.3742881
45	48.1603912809662	39	9.23076923	9.47368421	0.00007043	0.00007228	0.00282380	0.00289811	17.15769679	17.60921512	5.229665813	5.367288598
46	46.8673325249874	40	9.000000000	9.23076923	0.00006866	0.00007043	0.00282190	0.00289425	17.14612347	17.58576766	5.226138265	5.36014181
47	45.5462672266024	41	8.78048780	9.000000000	0.00006699	0.00006866	0.00282009	0.00289059	17.13513424	17.56351260	5.22278875	5.335358469
48	44.1945495141927	42	8.57142857	8.78048780	0.00006539	0.00006699	0.00281837	0.00288711	17.12468607	17.54236134	5.219604146	5.346911564
49	42.8091401224355	43	8.37209302	8.57142857	0.00006387	0.00006539	0.00281673	0.00288380	17.11474000	17.5223381	5.216572585	5.340776695
50	41.3865183226024	44	8.18181818	8.37209302	0.00006242	0.00006387	0.00281517	0.00288064	17.10526076	17.50305752	5.213683312	5.334931761
51	39.9225668433386	45	8.000000000	8.18181818	0.00006104	0.00006242	0.002813					

Table-3A: INTENT MESSAGE LATITUDE ENCODING RESOLUTION

solution: dlat / (2^14 bins per zone)				even latitude encoding resolution (degrees)	odd latitude encoding resolution (degrees)	even latitude encoding resolution (naut. miles)	odd latitude encoding resolution (naut. miles)	even latitude encoding resolution (feet)	odd latitude encoding resolution (feet)	even latitude encoding resolution (meters)	odd latitude encoding resolution (meters)
Item #	Latitude (degrees)	dlat_even (degrees)	dlat_odd (degrees)								
1	ALL	6.00000000	6.10169492	0.00036621	0.00037242	0.02184851	0.02221882	132.75373612	135.00379944	40.46333747	41.14915675

Table-3B: INTENT MESSAGE LONGITUDE ENCODING RESOLUTION

solution: dlon / (2^14 bins per zone)					even longitude encoding resolution (degrees)	odd longitude encoding resolution (degrees)	even longitude encoding resolution (naut. miles)	odd longitude encoding resolution (naut. miles)	even longitude encoding resolution (feet)	odd longitude encoding resolution (feet)	even longitude encoding resolution (meters)	odd longitude encoding resolution (meters)
Item #	Latitude (degrees)	NL Zone	dlon_even (degrees)	dlon_odd (degrees)								
1	89.90000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.00230520	0.00230520	14.00663671	14.00663671	4.26922273	4.26922273
2	89.50000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.01152587	0.01152587	70.03233022	70.03233022	21.34585357	21.34585357
3	89.00000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.02305086	0.02305086	140.05932720	140.05932720	42.6900157	42.6900157
4	88.50000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.03457409	0.03457409	210.07565813	210.07565813	64.03105855	64.03105855
5	88.00000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.04609470	0.04609470	280.07599098	280.07599098	85.36715932	85.36715932
6	87.50000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.05761179	0.05761179	350.05499496	350.05499496	106.69675905	106.69675905
7	87.00000000000000	1	360.000000000	360.000000000	0.02197266	0.02197266	0.06912449	0.06912449	420.00734089	420.00734089	128.01823341	128.01823341
8	86.5353699751210	2	180.000000000	360.000000000	0.01098633	0.02197266	0.03990905	0.07981809	242.49135133	484.98270265	73.91136152	147.82272304
9	85.7554162094442	3	120.000000000	180.000000000	0.00732422	0.01098633	0.03258560	0.04887840	197.99335926	296.99003889	60.34873797	90.52256096
10	84.8916619070208	4	90.000000000	120.000000000	0.00549316	0.00732422	0.02940040	0.03920054	178.63979202	238.18638936	54.44940687	72.59920915
11	83.9917356298056	5	72.000000000	90.000000000	0.00439453	0.00549316	0.02764980	0.03456225	168.00293636	210.00367045	51.20729336	64.00911670
12	83.0719944471981	6	60.000000000	72.000000000	0.00366211	0.00439453	0.02655262	0.03186314	161.33636081	193.60363297	49.17532120	59.01038544
13	82.1395698051060	7	51.42857143	60.000000000	0.00313895	0.00366211	0.02580443	0.03010517	156.79029617	182.92201220	47.78968074	55.75462753
14	81.1980134927195	8	45.000000000	51.42857143	0.00274658	0.00313895	0.02526331	0.02887236	153.50241393	175.43133020	46.78753427	53.47146773
15	80.2492321238051	9	40.000000000	45.000000000	0.00244141	0.00274658	0.02485462	0.02796145	151.01914513	169.89653827	46.03063396	51.78446321
16	79.2942822545692	10	36.000000000	40.000000000	0.00219727	0.00244141	0.02453550	0.02726167	149.08015801	165.64462001	45.43963071	50.48847856
17	78.3337408292275	11	32.72727273	36.000000000	0.00199751	0.00219727	0.02427969	0.02670765	147.52579556	162.27837512	44.96586105	49.46244715
18	77.3678946132819	12	30.000000000	32.72727273	0.00183105	0.00199751	0.02407019	0.02625839	146.25290762	159.54862649	44.57788482	48.63041980
19	76.3968439079447	13	27.69230769	30.000000000	0.00169020	0.00183105	0.02389559	0.02588689	145.19198898	157.29132140	44.25451683	47.94239323
20	75.4205625665336	14	25.71428571	27.69230769	0.00156948	0.00169020	0.02374789	0.02557465	144.29455232	155.39413327	43.98097814	47.36413031
21	74.4389341572514	15	24.000000000	25.71428571	0.00146484	0.00156948	0.02362136	0.02530860	143.52577362	153.77761459	43.74665440	46.87141543
22	73.4517744166786	16	22.500000000	24.000000000	0.00137329	0.00146484	0.02351179	0.02507925	142.86001464	152.38401562	43.54373107	46.44664647
23	72.4588454472895	17	21.17647059	22.500000000	0.00129251	0.00137329	0.02341601	0.02487951	142.27799279	151.17036734	43.36633081	46.07672649
24	71.4598647302898	18	20.000000000	21.17647059	0.00122070	0.00129251	0.02333157	0.02470401	141.76493359	150.10404733	43.20995038	45.75171216
25	70.4545107498760	19	18.94736842	20.000000000	0.00115646	0.00122070	0.02356558	0.02454862	141.30933049	149.15984885	43.07108256	45.46392048
26	69.4424261311402	20	18.000000000	18.94736842	0.00109863	0.00115646	0.02318956	0.02441006	140.90209162	148.31799118	42.94695615	45.20732227
27	68.423202208333	21	17.14285714	18.000000000	0.00104632	0.00109863	0.02312930	0.02428577	140.53559396	147.56273695	42.83535313	44.97712078
28	67.3964677408467	22	16.36363636	17.14285714	0.00099876	0.00104632	0.02307483	0.02417363	140.20498334	146.88141112	42.73447755	44.76945268
29	66.3617100838262	23	15.65217391	16.36363636	0.00095533	0.00099876	0.02302536	0.02407197	139.90440098	146.26369193	42.64286005	44.58117187
30	65.3184530968209	24	15.000000000	15.65217391	0.00091553	0.00095533	0.02298024	0.02397938	139.63021118	145.70108993	42.55928701	44.40969079
31	64.2661652256744	25	14.400000000	15.000000000	0.00087891	0.00091553	0.02293891	0.02389470	139.37909689	145.18655926	44.25286185	44.25286185
32	63.2042747938193	26	13.84615385	14.400000000	0.00084510	0.00087891	0.02290092	0.02381696	139.14827289	144.71420381	42.41239222	44.10888791
33	62.1321665921033	27	13.33333333	13.84615385	0.00081380	0.00084510	0.02286588	0.02374534	138.93538363	144.27905223	42.34750358	43.97625371
34	61.049177424635	28	12.85714286	13.33333333	0.00078474	0.00081380	0.02283347	0.02367915	138.73842358	143.87688371	42.28747015	43.85367275
35	59.9545927669403	29	12.41379310	12.85714286	0.00075768	0.00078474	0.02280339	0.02361780	138.55567471	143.50409167	42.23176830	43.74004574
36	58.8476377614846	30	12.000000000	12.41379310	0.00073242	0.00075768	0.02277541	0.02356077	138.38565691	143.15757611	42.17994688	43.63442780
37	57.7274735386611	31	11.61290323	12.000000000	0.00070880	0.00073242	0.02274931	0.02350762	138.22708818	142.83465779	42.13161513	43.53600230
38	56.5931875620592	32	11.250000000	11.61290323	0.00068665	0.00070880	0.02272491	0.02345798	138.07885271	142.5300925	42.08643296	43.44405983
39	55.44378444449504	33	10.90909091	11.250000000	0.00066584	0.00068665	0.02270206	0.02341150	137.93997479	142.25059091	42.04410297	43.35798119
40	54.2781747227290	34	10.58823529	10.90909091	0.00064625	0.00066584	0.02268060	0.02336789	137.80959755	141.98564597	42.00436399	43.27722351
41	53.0951615279600	35	10.28571429	10.58823529	0.00062779	0.00064625	0.02266042	0.02332690	137.68695444	141.73658207	41.96698572	43.20130883
42	51.8934246916877	36	10.000000000	10.28571429	0.00060135	0.00062779	0.02264140	0.02328830	137.57140969	141.50202140	41.93176433	43.12981474
43	50.6715016555384	37	9.72972973	10.000000000	0.00059386	0.00061035	0.02262345	0.02325188	137.46233624	141.28073447	41.89851875	43.06236649
44	49.4277643925699	38	9.47368421	9.72972973	0.00057823	0.00059386	0.02260648	0.02321746	137.35921559	141.07162682	41.86708757	42.99863048
45	48.1603912809662	39	9.23076923	9.47368421	0.00056340	0.00057823	0.02259041	0.02318489	137.26157429	140.87372099	41.873732651	42.93830878
46	46.8673325249874	40	9.000000000	9.23076923	0.00054932	0.00056340	0.02257517	0.02315402	137.16898772	140.68614125	41.80910612	42.88113448
47	45.5462672266024	41	8.78048780	9.000000000	0.00053592	0.00054932	0.02256070	0.02312472	137.08107395	140.50810080	41.78231000	42.82686775
48	44.1945491541927	42	8.57142857	8.78048780	0.00052316	0.00053592	0.02254694	0.02309687	136.99748853	140.33889069	41.75683317	42.77529251
49	42.8091401224355	43	8.37209302	8.57142857	0.00051099	0.00052316	0.02253385	0.02307037	136.91792001	140.17787049	41.72538068	42.72621356
50	41.3865183226024	44	8.18181818	8.37209302	0.00049938	0.00051099	0.02252137	0.02304512	136.84208607	140.02446016	41.70946650	42.67

Table-4A: TIS-B MESSAGE LATITUDE ENCODING RESOLUTION

solution: dlat / (2^12 bins per zone)				even latitude encoding resolution (degrees)	odd latitude encoding resolution (degrees)	even latitude encoding resolution (naut. miles)	odd latitude encoding resolution (naut. miles)	even latitude encoding resolution (feet)	odd latitude encoding resolution (feet)	even latitude encoding resolution (meters)	odd latitude encoding resolution (meters)
Item #	Latitude (degrees)	dlat_even (degrees)	dlat_odd (degrees)								
1	ALL	6.00000000	6.10169492	0.00146484	0.00148967	0.08739404	0.08887530	531.01494448	540.01519778	161.8533499	164.596627

Table-4B: TIS-B MESSAGE LONGITUDE ENCODING RESOLUTION

solution: dlon / (2^12 bins per zone)					even longitude encoding resolution (degrees)	odd longitude encoding resolution (degrees)	even longitude encoding resolution (naut. miles)	odd longitude encoding resolution (naut. miles)	even longitude encoding resolution (feet)	odd longitude encoding resolution (feet)	even longitude encoding resolution (meters)	odd longitude encoding resolution (meters)
Item #	Latitude (degrees)	NL Zone	dlon_even (degrees)	dlon_odd (degrees)								
1	89.9000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.00922081	0.00922081	56.02654684	56.02654684	17.07689093	17.07689093
2	89.5000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.04610347	0.04610347	280.12932087	280.12932087	85.38341427	85.38341427
3	89.0000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.0920344	0.0920344	560.23730881	560.23730881	170.76032626	170.76032626
4	88.5000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.13829638	0.13829638	840.30263251	840.30263251	256.12423419	256.12423419
5	88.0000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.18437879	0.18437879	1120.30396391	1120.30396391	341.46863727	341.46863727
6	87.5000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.23044716	0.23044716	1400.21997983	1400.21997983	426.78703619	426.78703619
7	87.0000000000000	1	360.000000000	360.000000000	0.08789063	0.08789063	0.27649798	0.27649798	1680.02936357	1680.02936357	512.07293363	512.07293363
8	86.5353699751210	2	180.000000000	360.000000000	0.04394531	0.08789063	0.15963618	0.31927236	969.96540530	1939.93081061	295.64544608	591.29089215
9	85.7554162094442	3	120.000000000	180.000000000	0.02929688	0.04394531	0.13034240	0.19551360	791.97343705	1187.96015557	241.39439589	362.09024383
10	84.8916619070208	4	90.000000000	120.000000000	0.02197266	0.02929688	0.11760161	0.15680215	714.55916809	952.74555745	217.79762746	290.39683662
11	83.9917356298056	5	72.000000000	90.000000000	0.01757813	0.02197266	0.11059919	0.13824899	672.01174543	840.01468178	204.82917345	256.03646681
12	83.0719944471981	6	60.000000000	72.000000000	0.01464844	0.01757813	0.10621047	0.12745257	645.34544322	774.41453187	196.70128480	236.04154176
13	82.1395698051060	7	51.42857143	60.000000000	0.01255580	0.01464844	0.10321772	0.12042067	627.16118467	731.68804878	191.15872297	223.01851013
14	81.1980134927195	8	45.000000000	51.42857143	0.01098633	0.01255580	0.10105325	0.11548943	614.00965570	701.72532080	187.15013707	213.88587094
15	80.2492321328051	9	40.000000000	45.000000000	0.00976563	0.01098633	0.11184578	0.16478502	679.58615309	184.12253585	207.13785283	
16	79.2942822545692	10	36.000000000	40.000000000	0.00878906	0.00976563	0.09814200	0.10904667	596.32063202	662.57848002	181.75852282	201.95391425
17	78.3337408292275	11	32.72727273	36.000000000	0.00799006	0.00878906	0.09711874	0.10683062	590.10318225	649.11350048	179.86344420	197.84978861
18	77.3678946132819	12	30.000000000	32.72727273	0.00732422	0.00799006	0.09628078	0.10503358	585.01163048	638.19450598	178.31153926	194.52167920
19	76.3964839079447	13	27.69230769	30.000000000	0.00676082	0.00732422	0.09558236	0.10354755	580.76975594	629.16528560	177.01806730	191.76957291
20	75.4205625665336	14	25.71428571	27.69230769	0.00627790	0.00676082	0.09499156	0.10229860	577.17820930	621.57653309	175.92391256	189.45652122
21	74.4389341572514	15	24.000000000	25.71428571	0.00585938	0.00627790	0.09448546	0.10123442	574.10309447	615.11045836	174.98661760	187.48566171
22	73.4517744166786	16	22.500000000	24.000000000	0.00549316	0.00585938	0.09404718	0.10031699	571.44005857	609.53606247	174.17492428	185.78658590
23	72.4588454472895	17	21.17647059	22.500000000	0.00517004	0.00549316	0.09366402	0.09951802	569.11197116	604.68146936	173.46532326	184.30690596
24	71.4598647302898	18	20.000000000	21.17647059	0.00488281	0.00517004	0.09332627	0.09881605	567.05973437	600.41618933	172.83980150	183.00684865
25	70.4545107498760	19	18.94736842	20.000000000	0.00462582	0.00488281	0.09302634	0.09819447	565.23732197	596.63939541	172.28430232	181.85568190
26	69.4424263114402	20	18.000000000	18.94736842	0.00439453	0.00462582	0.09275824	0.09764026	563.60836650	593.27196473	171.7872461	180.82928906
27	68.4322020208333	21	17.14285714	18.000000000	0.00418527	0.00439453	0.09251720	0.09714306	562.14375982	590.25094781	171.34141251	179.90848314
28	67.3964677408467	22	16.36363636	17.14285714	0.00395053	0.00418527	0.09229933	0.09669453	560.81993336	587.52564447	170.93791022	179.07781070
29	66.3617100838262	23	15.65217391	16.36363636	0.00382133	0.00395053	0.09210145	0.09628788	559.61760391	585.05476773	170.57144021	178.32468750
30	65.3184530968209	24	15.000000000	15.65217391	0.00366211	0.00382133	0.09192094	0.09591751	558.52084472	582.80435971	170.23714802	177.63876316
31	64.2661652256744	25	14.400000000	15.000000000	0.00351563	0.00366211	0.09175563	0.09557878	557.51638755	580.74623703	169.93098949	177.01144738
32	63.2042747938193	26	13.84615385	14.400000000	0.00338041	0.00351563	0.09163688	0.09526782	556.59309158	578.85681524	169.64568888	176.43555164
33	62.1321665921037	27	13.33333333	13.84615385	0.00325521	0.00338041	0.09146353	0.09498135	555.74153452	577.11620893	169.39001430	176.90501485
34	61.049177424635	28	12.85714286	13.33333333	0.00313895	0.00325521	0.09133386	0.09471660	554.95369430	575.50753483	169.14980601	175.41469100
35	59.9545927669403	29	12.41379310	12.85714286	0.00303071	0.00313895	0.09121356	0.09447118	554.22269886	574.01636667	168.92707321	174.96018296
36	58.8476377614846	30	12.000000000	12.41379310	0.00292969	0.00303071	0.09110163	0.09424307	553.554262763	572.63030444	168.71978750	174.53771121
37	57.7274735386611	31	11.61290323	12.000000000	0.00283518	0.00292969	0.09099724	0.09403049	552.90835273	571.33863116	168.52646052	174.14400920
38	56.5931875620592	32	11.250000000	11.61290323	0.00274658	0.00283518	0.09089966	0.09383190	552.31541085	570.13203701	168.34573184	173.77262392
39	55.44378444449504	33	10.90909091	11.250000000	0.00266335	0.00274658	0.09080823	0.09364599	551.75989917	569.00239602	168.17641189	173.43192476
40	54.2781747227290	34	10.58823529	10.90909091	0.00258502	0.00266335	0.09072240	0.09347157	551.23839022	567.94258386	168.01745596	173.10889402
41	53.0951615279600	35	10.28571429	10.58823529	0.00251116	0.00258502	0.09064167	0.09330760	550.74781677	566.94632829	167.86794290	172.80523533
42	51.8934246916877	36	10.000000000	10.28571429	0.00244141	0.00251116	0.09056560	0.09315319	550.28563877	566.00808559	167.72705733	172.51925897
43	50.6715016555387	37	9.72972973	10.000000000	0.00237542	0.00244141	0.09049379	0.09300751	549.84934496	565.12293788	167.59407498	172.24946595
44	49.4277643925569	38	9.47368421	9.72972973	0.00231291	0.00237542	0.09042591	0.09286985	549.43686237	564.28650730	167.46835029	171.99452192
45	48.1603912809662	39	9.23076923	9.47368421	0.00225361	0.00231291	0.09036163	0.09273957	549.04629717	563.49488394	167.34930602	171.75323513
46	46.86733252498740	40	9.000000000	9.23076923	0.00219727	0.00225361	0.09030068	0.09261608	548.67595088	562.74456501	167.23642448	171.52453792
47	45.546272660024	41	8.78048780	9.000000000	0.00214367	0.00219727	0.09024280	0.09249887	548.32429580	562.03240319	167.12924001	171.30747101
48	44.1945495141927	42	8.57142857	8.78048780	0.00209263	0.00214367	0.09018778	0.09238748	547.98995143	561.35556277	167.02733267	171.10117006
49	42.8091401224355	43	8.37209302	8.57142857	0.00204397	0.00209263	0.09013540	0.09228148	547.67168004	560.71148195	166.93032274	170.90485423
50	41.3865183226024	44	8.18181818	8.37209302	0.00199751	0.00204397	0					