International Civil Aviation Organization

The Thirteenth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/13)

Bangkok, Thailand, 02 – 05 August, 2010

Agenda Item 5: Airspace safety monitoring activities/requirements in the Asia/Pacific Region

MONITORING PROGRESS OF CHINA RMA

(Presented by the China RMA)

SUMMARY

This working paper presents the progress of long term height monitoring program of China RMA, including both the airborne monitoring service and ground-based monitoring system preparation.

1. INTRODUCTION

1.1. China RMA has two sets of EGMUs to conduct the aircraft height keeping performance monitoring. During the first half year of 2010, China RMA has provided height monitoring service to fifty domestic aircraft.

1.2. China RMA is willing to establish the ground-based monitoring system. China RMA has submitted preliminary result for the ground-based monitoring station site selection in China to the fifth RMA Coordination Meeting (RMA CG/5) which was held in Atlantic City, USA from 3 to 7 May 2010. China RMA is also considering the possibility of buying the COTS ground-based monitoring system.

2. PROGRESS OF AIRCRAFT HEIGHT KEEPING PERFORMANCE MONITORING BY EGMU

2.1. After RASMAG/11 meeting, China RMA submitted the Estimated RVSM Monitoring Burden List to complement the APPENDIX D for the *ASIA/PACIFIC REGIONAL IMPACT STATEMENT —— RVSM GLOBAL LONG TERM HEIGHT MONITORING REQUIREMENTS EFFECTIVE FROM NOVEMBER 2010.*

2.2. China RMA is promoting the Long Term Monitoring program. The **Table 1** in Appendix A presented detail information about the monitoring result completed by China RMA from January to June 2010. Since the beginning of 2010, the China RMA has provided monitoring service to up to fifty-four domestic aircraft.

3. ISSUES OF GROUND-BASED MONITORING

3.1. At the RASMAG/12 meeting, China RMA submitted working paper seven to request the ICAO Regional Office to send a State letter to CAAC requesting them to provide China RMA with the necessary support for the establishment of a ground-based monitoring system.. In February

2010, ICAO Asia/Pacific Office sent a formal letter to ATMB of CAAC for this issue. In this State letter China was suggested to consider planning and developing the ground-based monitoring infrastructure in China in the near future.

3.2. In the RASMAG/12 meeting, it is suggested that the initial analysis of possible height monitoring infrastructure should be reviewed by each RMA and State represented at RASMAG to consider further details in the interim before RASMAG/13. Based on the Traffic Sample Data of the second half month of December 2009[1], the China RMA completed an analysis to study the methodology of choosing the preliminary site location of the ground-based monitoring system and submitted working paper thirty three to provide the detail and result to the RMACG/5 meeting, which was included in the attachment of this working paper. Considering the possible influence introduced by the change of route structure, more TSD data will be applied before the determination of site location.

3.3. Considering the high resolution of accuracy requirement of the Multilateration part of the ground-based monitoring system, China RMA is also considering the possibility of purchasing the COTS product. Recently, China RMA has begun to contact with some equipment supplier for the technical and financial detail. The decision will be made after the cost-benefit analysis.

4. ACTION BY THE MEETING

4.1. The meeting is invited to note the content of this working paper.

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[1] Only the second half month (from December 17 to 31) data of Traffic Sample Data were analyzed because the route structure of China was changed on 16 December 2009.

Appendix A Aircraft Monitored By the China RMA

Table 1: Aircraft Monitored by the China RMA from January to June, 2010

	Date of Measurement (dd/mm/yyyy)	Reg_No	ICAO Code	Operator	Callsign	Type	Validity Indicator
1.	04/01/2010	B2869	CXA	CXA8130	B752	-20.00	C
2.	05/01/2010	B2659	CXA	CXA8441	B737	62.36	C
3.	06/01/2010	B5146	CXA	CXA8405	B738	26.58	C
4.	07/01/2010	B2849	CXA	CXA8105	B752	-41.51	C
5.	19/01/2010	B2808	SHQ	SHQ6607	B752	19.61	C
6.	02/03/2010	B3005	CDG	CDG4919	CRJ1	-12.31	C
7.	03/03/2010	B3007	CDG	CDG4920	CRJ1	124.10	C
8.	04/03/2010	B2962	CDG	CDG1175	B733	39.96	C
9.	04/03/2010	B5098	CDG	CDG4672	B733	-47.23	C
10.	6/03/2010	B3079	CDG	CDG4733	CRJ7	10.52	C
11.	7/3/2010	B3080	CDG	CDG4734	CRJ7	80.14	C
12.	8/3/2010	B5352	CDG	CDG4675	B737	-20.28	C
13.	8/3/2010	B5351	CDG	CDG1172	B737	-2.97	C
14.	21/3/2010	B2823	CSN	CSN3503	B752	-12.78	C
15.	22/3/2010	B2267	CSN	CSN6508	MD90	-3.01	C
16.	22/3/2010	B2100	CSN	CSN6501	MD90	-21.14	C
17.	22/3/2010	B2596	CSN	CSN3614	B733	-48.02	C
18.	24/3/2010	B2923	CSN	CSN3609	B733	-35.63	C
19.	24/3/2010	B2822	CSN	CSN3504	B757	39.33	C
20.	25/3/2010	B6058	CSN	CSN3523	A332	103.87	C
21.	25/3/2010	B2622	CSN	CSN3734	B737	-43.77	C
22.	27/3/2010	B5166	CSN	CSN3751	B738	48.31	C
23.	27/3/2010	B6288	CSN	CSN380	A322	58.06	C
24.	27/3/2010	B6220	CSN	CSN3489	A319	-14.37	C
25.	28/3/2010	B6111	CSN	CSN3107	A333	25.52	C
26.	1/4/2010	B2477	CAO	CAO1042	B744	-122.06	C
27.	2/4/2010	B2458	CAO	CAO1041	B744	-25.84	C
28.	5/4/2010	B2476	CAO	CAO1081	B744	-103.98	C
29.	8/4/2010	B2475	CAO	CAO1041	B744	-77.25	C
30.	12/4/2010	B6026	CSC	CSC8832	A320	-36.37	C
31.	13/4/2010	B3043	CSC	CSC8860	E145	-77.15	C
32.	14/4/2010	B3042	CSC	CSC8859	E145	-0.10	C
33.	15/4/2010	B2300	CSC	CSC8633	A319	94.13	A
34.	16/4/2010	B6518	CSC	CSC8887	A332	67.50	C
35.	28/4/2010	B3152	GCR	GS7465	E190	N/A	N/A
36.	28/4/2010	B3037	GCR	GS7427	E145	-11.34	C
37.	29/4/2010	B3081	GCR	GS7428	E145	-9.76	C
38.	30/4/2010	B3162	GCR	GS7465	E190	-44.22	C
39.	30/4/2010	B3159	GCR	GS7466	E190	-27.84	C
40.	12/5/2010	B8120	UNA	UNA8120	G200	-14.50	C
41.	14/5/2010	B8087	UNA	UNA8087	G200	175.83	C
42.	18/5/2010	B6095	CES	CES5714	A333	-10.90	C

	Date of Measurement (dd/mm/yyyy)	Reg_No	ICAO Code	Operator	Callsign	Type	Validity Indicator
43.	18/5/2010	B5074	CES	CES5705	B737	-62.14	C
44.	19/5/2010	B5101	CES	CES5714	B738	-12.47	C
45.	20/5/2010	B2318	CES	CES5323	A306	69.85	C
46.	20/5/2010	B2325	CES	CES5330	A306	48.68	C
47.	21/5/2010	B2568	CES	CES5802	B763	-110.81	C
48.	21/5/2010	B6096	CES	CES5751	A333	38.60	C
49.	24/5/2010	B5001	CES	CES5702	B763	-104.68	C
50.	27/5/2010	B6013	CES	CES5174	A320	54.10	C
51.	27/5/2010	B6009	CES	CES5175	A320	53.32	C
52.	10/6/2010	B2473	CSN	CSN2473	B744	-75.22	C
53.	24/06/2010	B8021	HZX	HZX8021	F900	-116.34	C
54.	26/06/2010	B2461	CSN	CSN2473	B744	-116.53	C

ATTACHMENT A

REGIONAL MONITORING AGENCIES (RMA)

FIFTH SPECIAL COORDINATION MEETING

Atlantic City, USA, 3 to 7 May 2010

Agenda Item 4: Future Monitoring Systems

The Preliminary Analysis on the Ground-based Monitoring System Site Selection in China

(Presented by the China RMA)

SUMMARY

This working paper presents the analyzing process and preliminary result for the ground-based monitoring station site selection in China.

1. INTRODUCTION

1.1 During the Twelfth Meeting of the Regional Airspace Safety Monitoring Advisory Group (RASMAG/12), it is suggested that for the China FIRs several ground-based height monitoring systems essentially to accommodate the large number of Chinese domestic fleet that operate within those FIRs only, and to be available for other international flights that may operate in that airspace. Additionally, monitoring capability is available by EGMU through the China RMA.

1.2 This working paper presents the China RMA's preliminary study of the analyzing process and result for the site selection for the Ground-Based Monitoring Station inside China.

2. DISCUSSION

2.1 Background

2.1.1 In the specific case of the implementation and ongoing operation of RVSM, Annex 11 requires that for all airspace where a RVSM of 300 m (1 000 ft) is applied between FL 290 and FL 410 inclusive, a programme shall be instituted, on a regional basis, for monitoring the height-keeping performance of aircraft operating at these levels, in order to ensure that the implementation and continued application of this reduced vertical separation minimum meets the safety objectives. The Asia Pacific Region has published her Regional Impact Statement – RVSM Global Long Term Height Monitoring Requirements effective from November 2010 submitted by RASMAG to provide general guidance to States.

2.1.2 The China RMA currently has applied two sets of airborne monitoring equipment (Enhance GPS Monitoring Unit, known as EGMU) to support the height monitoring plan for the demotic Chinese operators. With the current monitoring ability, the China RMA is able to the ensure compliance with a basic RVSM Minimum Monitoring Requirement. However, to assess aircraft group performance and long-term ASE stability, large volumes of data are necessary, including results of monitoring of the same airframes over a period of time. Such large volumes of data are only obtainable from ground-based monitoring installations that are regularly overflown by the relevant airframes.

2.1.3 China has a large number of domestic fleet that operate inside China and cannot be captured by ground-based monitoring systems in other countries. For this reason, it is necessary to establish the ground based monitoring system inside China. In 2009, the China RMA has finished the technical research for the necessity of ground-base monitoring system. Based on the December 2009 Traffic Sample Data (TSD), the China RMA finished the primary site selection. This working paper presented the detail description for the process and result of this analysis.

2.2 Considerations for the Ground-based System Site Selection

2.2.1 The aim of the ground-based monitoring system site selection is to cover the largest possible number of aircraft using the airspace situated between FL 290 and FL 410. At the same time, to assess aircraft group performance, the selection proposal is also suggested to cover larger number of flights and more types of aircraft from different operators. For the China area, the choice was rather more complicated. The China RMA carried out a study on the air traffic density established from the December 2009 Traffic Sample Data and tried to obtain distributions of operators and aircraft types within flight levels of interest. Considering the large number of domestic fleet that operate within Chinese domestic airspace, the coverage of domestic aircraft and the domestic operator-type pair are given a priority.

2.2.2 The ground-based monitoring station should be located to cover the en-route airspace where the aircraft can fly over without climbing, descending or making any turns for a period of time when they get monitored. According to the ATC departments, the aircraft will maintain the level flight when they fly over the existing navigation station (or FIX) in the RVSM airspace and the distance is more than the diameter of the coverage area of ground-based monitoring station.

2.2.3 The site selection will also consider the collocation of the established domestic civil aviation infrastructure with the ground-based monitoring system because it is easy to provide power supply and get access.

2.2.4 Geographical condition is another consideration for the sit selection. Mountain area is not a good choice either for the station establishment or for the signal transmission.

2.2.5 To conclude, there are four key factors that China RMA consider in the process of the preliminary site selection for the ground-based monitoring system:

1. Coverage of the largest possible number of aircraft/operator-type pair/proportion of flights in which domestic ones are given a priority;
2. Aircraft can get monitored without climbing, descending or making any turns when it fly over the station;
3. The stations are near by the established civil aviation infrastructure (for instance: VOR, DME, NDB or other existing navigation infrastructure); and
4. Geographic condition is favourable to the establishment of ground-based stations and mountain areas are avoided.

2.3 Process for the Site selection

2.3.1 In this study, the China RMA implemented the December 2009 TSD data[2] (15 days) which contained the 3-letter operator code, aircraft type, registration number and the flight track information.

2.3.2 The half-month TSD sample was analyzed to obtain the count of coverage of individual aircraft, operator-aircraft types, and numbers of flights for every FIX within the domestic Chinese RVSM airspace. The following count of coverage for each FIX was analyzed: (1) the total fight number; (2) the global operator-type pair number; (3) the domestic operator-type pair number; (4) the total operator number. Considering the principles of site selection, the records of flights that flied over FIX of the Compulsory Reporting Points were filtered so that only the FIX indicating the established civil aviation infrastructure was analysed. **Table 2.1** presented the result for the preliminary analysis of coverage with Top 10 FIX and their count of coverage under different queries.

Table 2.1: The Result for the Preliminary Analysis of Coverage with Top 10 FIX

	Flight		Global Aircraft		Domestic Aircraft		Global Operator-Type		Domestic Operator-Type	
1.	**ZHO**	**5061**	**ZHO**	**1134**	**ZHO**	**815**	**ZHO**	**221**	**ZHO**	**109**
2.	*WXI*	*4904*	*HFE*	*970*	*HFE*	*702*	YBL	186	TYN	96
3.	PLT	4491	*WXI*	*916*	*WXI*	*676*	LBN	184	*WXI*	*96*
4.	*HFE*	*3879*	DA	869	DA	665	*WXI*	*177*	DA	93
5.	KWE	3686	LKO	849	DS	631	*HFE*	*175*	WHA	87
6.	LBN	3406	PLT	834	PLT	626	GYA	174	PIX	85
7.	NF	3316	LBN	820	LKO	621	CHW	173	*HFE*	*84*
8.	DS	3262	KWE	777	DO	605	DA	168	AR	81
9.	TYN	3243	TOL	775	ZF	593	GS	167	LBN	81
10.	SHR	3189	ZF	753	LH	574	QNX	164	LH	79

2.3.3 It can be found from the result that the FIX “ZHO” apparently has a maximum value under every situation and “ZHO” is decided for the **primary location** of the ground-based monitoring system. It can also be found from **Table 2.1** that the FIX “WXI” and “HFE” also have much bigger count values than the rest. **Figure 2.1** illustrates the location of the “ZHO”, “WXI” and “HFE”. It can be found from this figure that the “ZHO” is at the intersection of the main route “A461” and “B208”, so it can be inferred that there are a number of flights that can be covered by the FIX pairs (WXI-ZHO, ZHO-HFE or WXI-ZHO-HFE). In another word, the aircraft that flied over WXI may also pass ZHO or HFE. So if ZHO is selected for the location of ground-based monitoring system, the flights/aircraft covered by ZHO should be excluded from the entire traffic sample before choosing the second site.

[2] The data of December 17 to 31 were analyzed because the route structure was changed on 16 December 2009.

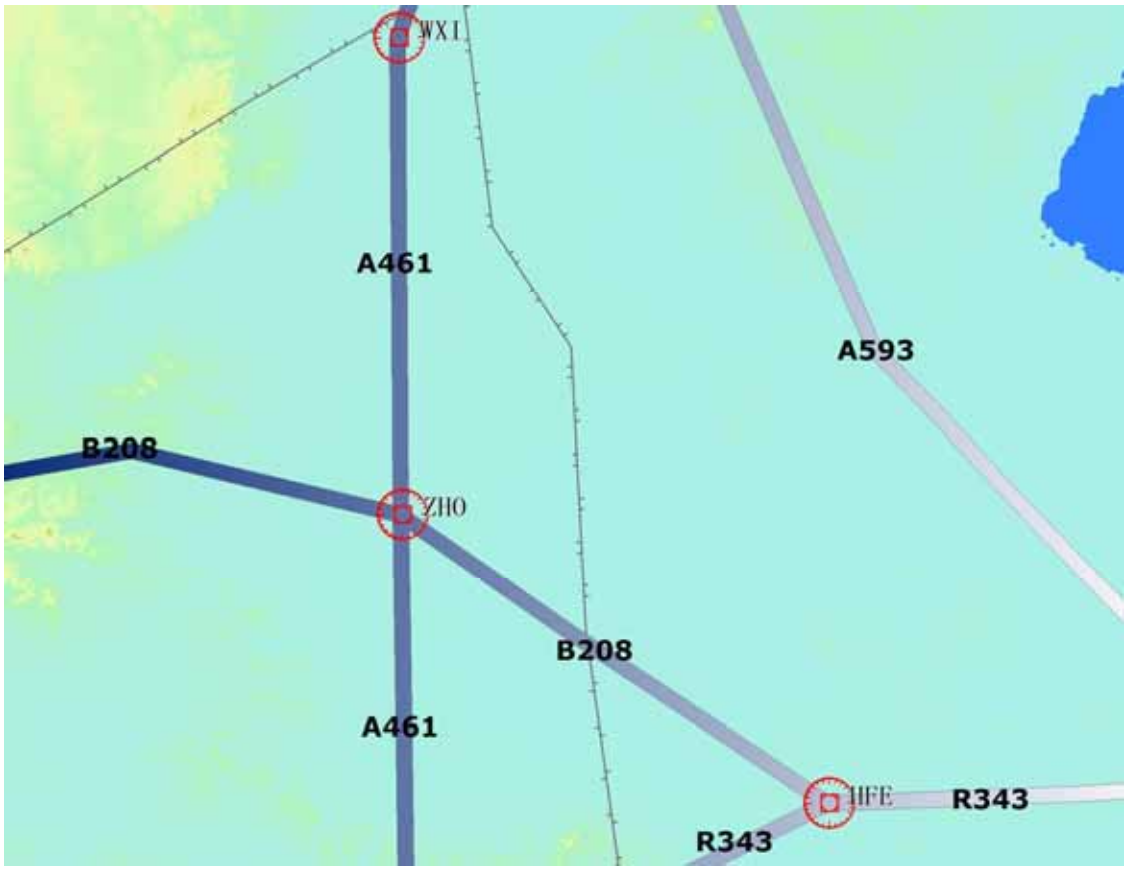

Figure 2.1: The Location of “ZHO”, “WXI” and “HFE”

2.3.4 Based on the TSD data with exclusion of flights over ZHO, we re-select the FIXes following the five key principles. Eleven FIXes which have higher ranking for the coverage of both domestic operator-type pair number and individual aircraft are chosen for further study. The eleven FIXes are: “QNX”, “HFE”, “PLT”, “KN”, “AR”, “TYN”, “TOL”, “KWE”, “NF”, “SHR”, and “LBN”. **Figure 2.2** presents the location of these FIXes. It can be found from this figure that most of these FIXes locate at the Eastern China which is the busiest area of Chinese airspace.

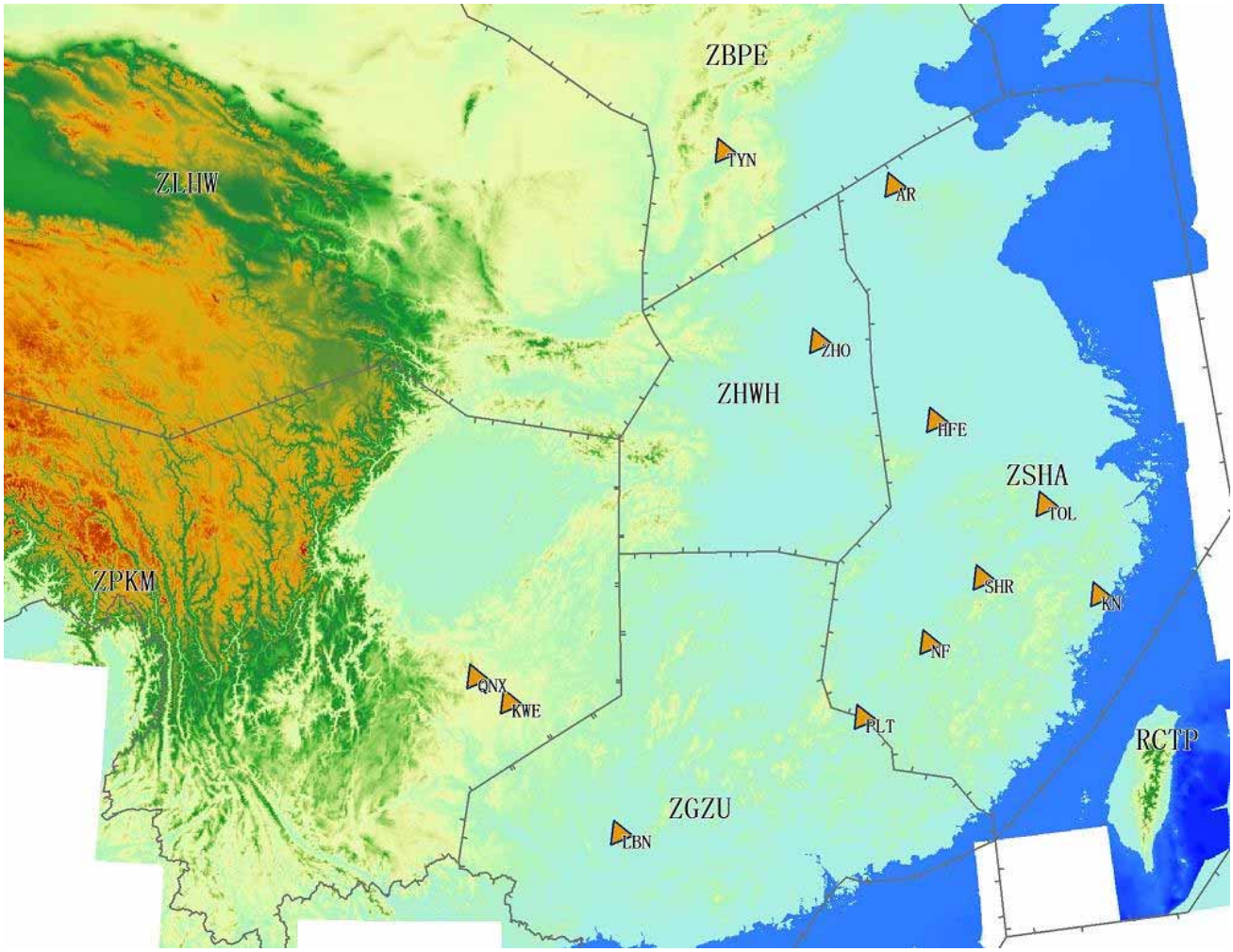

Figure 2.2: Location of the Eleven FIXes

2.3.5 China RMA has a preliminary plan to establish five ground-based monitoring stations. Based on the analysis, the first selection is "ZHO". The following step is to choose another four stations from the eleven alternatives which are presented in section 2.3.4. In this process we tested all the combination of four out of eleven: there are 330 different combinations. Then we counted all the coverage under different queries for these combinations (with the inclusion of the 'ZHO' records). **Table 2.2** presents the minimum value and maximum value for all the combinations under each query, where:

1. The first query is : the total number of flights that fly over the FIX;

2. The Second query is: the total number of aircraft (including both domestic flights and foreign flights) that fly over the FIX;

3. The Third query is: the total number of domestic aircraft that fly over the FIX;

4. The Forth query is: the total number of operator-aircraft type pair (including both domestic flights and foreign flights) that fly over the FIX;

5. The Fifth query is: the total number of domestic operator-aircraft type pair that fly over the FIX;

Table 2.2: Count of Coverage for All the Combinations of Four out of Eleven

	Flight	Global Aircraft	Domestic Aircraft	Global Operator-Type Pair	Domestic Operator-Type Pair
Maximum	19068	2291	1345	417	154
Minimum	10884	1665	1114	283	129
Difference	8184	626	231	134	25

2.3.6 Then the uniformization method was implemented to determine the other four sites. For each query result of the combination, we calculated the weighted factor by equation 2.1 (A). The final weighted factor for a combination is the mean value of every weighted factor indicated by equation 2.1 (B).

$$s_{ij} = \frac{x_{ij} - \min_j}{\max_j - \min_j} \quad \text{(A)}; \qquad S_i = \frac{1}{5}\sum_{j=1}^{5} s_{ij} \quad \text{(B)} \tag{2.1}$$

i = 1, 2, …, n where n is the total number of the combination result (in this case, n=330); x_{ij} is the value of the count of coverage for the ith combination result, jth query where j = 1, 2, …, 5; $\min_j$, and $\max_j$ is the minimum value for the x_{ij} under jth query respectively. The minimum and maximum values were presented in **Table 2.2**; s_{ij} is the weighted factor for x_{ij}; S_i is the final weighted factor for each combination result. Table 2.3 presents an instance for the above equations:

Table 2.3: An example for the Uniformization Method

Fix	Query	x_{ij}	s_{ij}	S_i
ZHOARWENFLBN	Flight	17615	0.822458	0.872536419
	Global Aircraft	2198	0.851438	
	Domestic Aircraft	1314	0.865801	
	Global Operator-Type	404	0.902985	
	Domestic Operator-Type	152	0.92	

After we get all the S_i values, **the combination which has the maximum value of S_i will be the best site selection proposal.**

2.4 Result for the Site Selection of Five Stations

2.4.1 **Table 2.4** presented the result of five station site selection proposal using the above methodology:

Table 2.4: Site Selection Result

Fix	Query	x_{ij}	s_{ij}	$Max(S_i)$
ZHOPLTARKWELBN	Flight	18787	0.965664712	0.91086435
	Global Aircraft	2210	0.870607029	
	Domestic Aircraft	1330	0.935064935	
	Global	404	0.902985075	

Fix	Query	x_{ij}	s_{ij}	$Max(S_i)$
	Operator-Type			
	Domestic Operator-Type	151	0.88	

2.4.2 **Table 2.5** presented the x_{ij} for this five-station combination, the total number and the proportion for each query:

Table 2.5: Count of Coverage and Proportion under Five Queries

Fix	Query	x_{ij}	Total Number	Proportion
ZHO PLT AR KWE LBN	Flight	18787	69242	0.271324
	Global Aircraft	2210	3571	0.618874
	Domestic Aircraft	1330	1540	0.863636
	Global Operator-Type	404	779	0.518614
	Domestic Operator-Type	151	201	0.751244

It can be found from the **Table 2.5** that the number of domestic Chinese aircraft and domestic operator-type pair are more than 80% and 75% respectively. These proportions demonstrate that the preliminary ground-based monitoring stations in China can cover the possible large domestic fleet that operates within China, and it is also available for quite a number of international aircraft that operate in the Chinese airspace.

2.4.3 **Figure 2.3** presented the breakdown of domestic operators whose aircraft can be monitored by the five stations. It can be found from this figure that the top six operators occupies more than 75% of the total number of monitored aircraft. **Figure 2.4** presented the total number of aircraft compared with the number of aircraft monitored by the five stations for the top six operators until Dec. 2009.

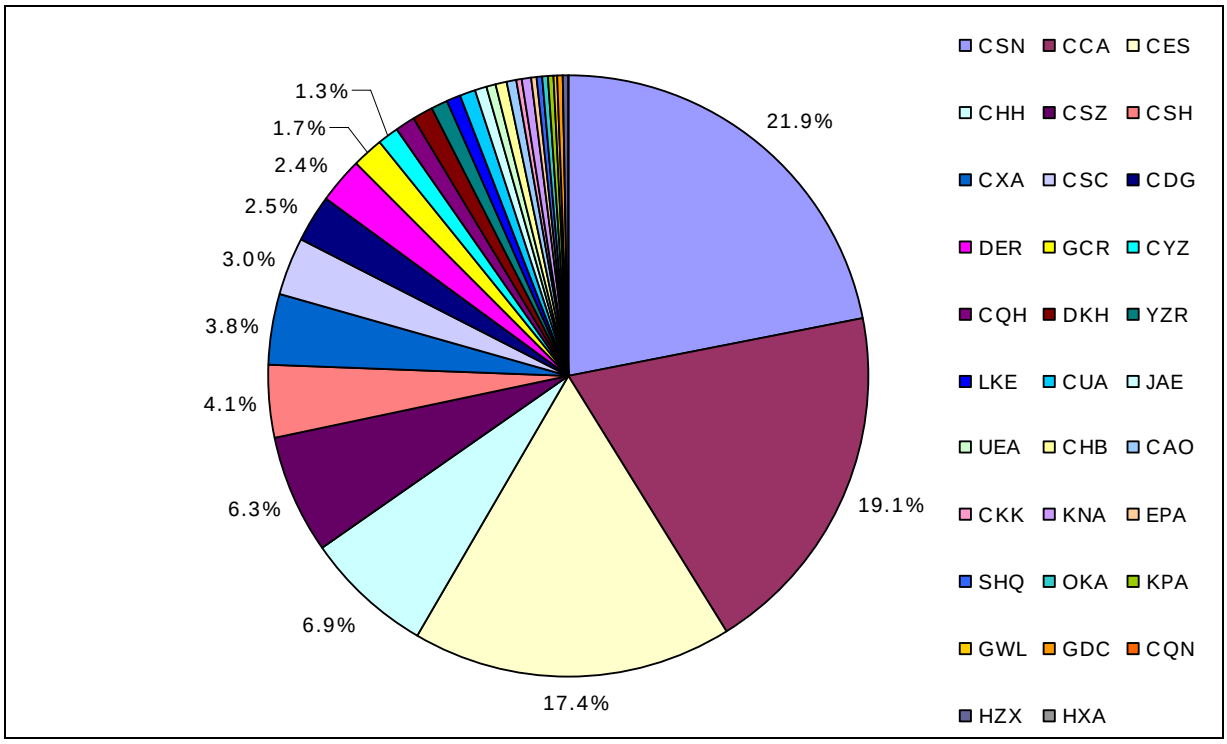

Figure 2.3: Breakdown of aircraft number for the different operator

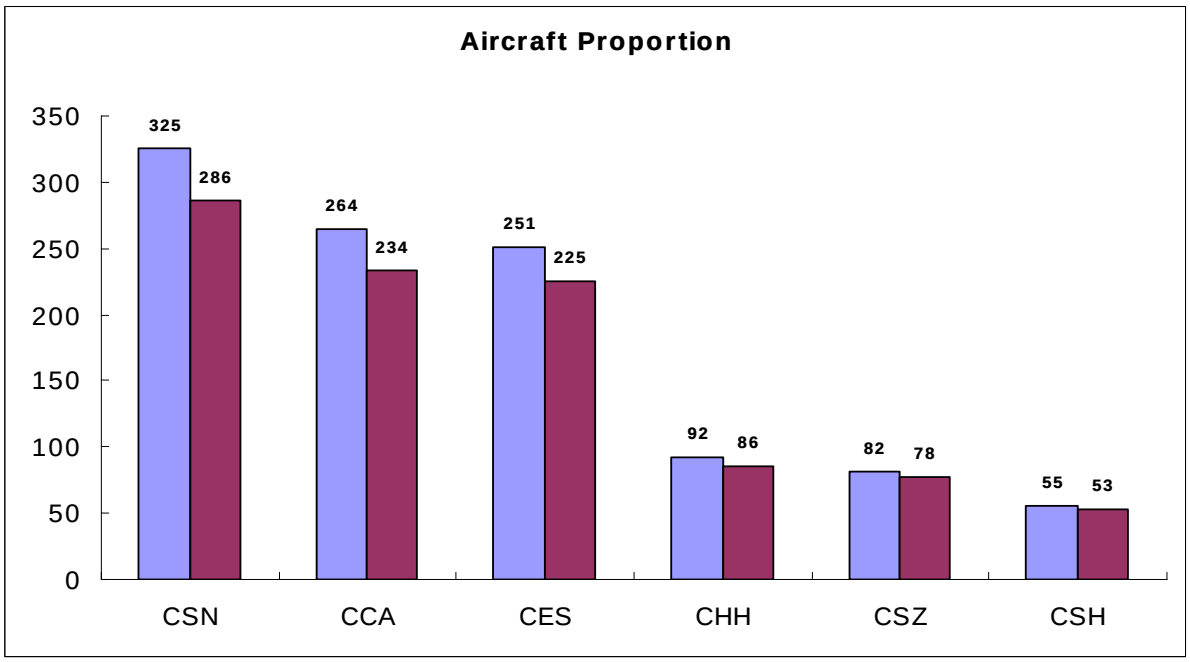

Figure 2.4: Breakdown of Total Aircraft Number Compared with the Number of Aircraft Monitored by the Five stations for the Top Six Operators

2.4.4 **Figure A.1** to **Figure A.5** in attachment A presented the geographical information for the five selected FIXes. These data will be studied in the further analysis to establish the optimum architecture and particularly the geographical layout, of each of the measurement stations. **Figure 2.4** presented the location for these five stations. The specifications for each of the stations were fixed

as follows: 1) Coverage area: circle with a radius of 50 NM; 2) The sections of air routes monitored by the station must have a minimum length of 25 NM

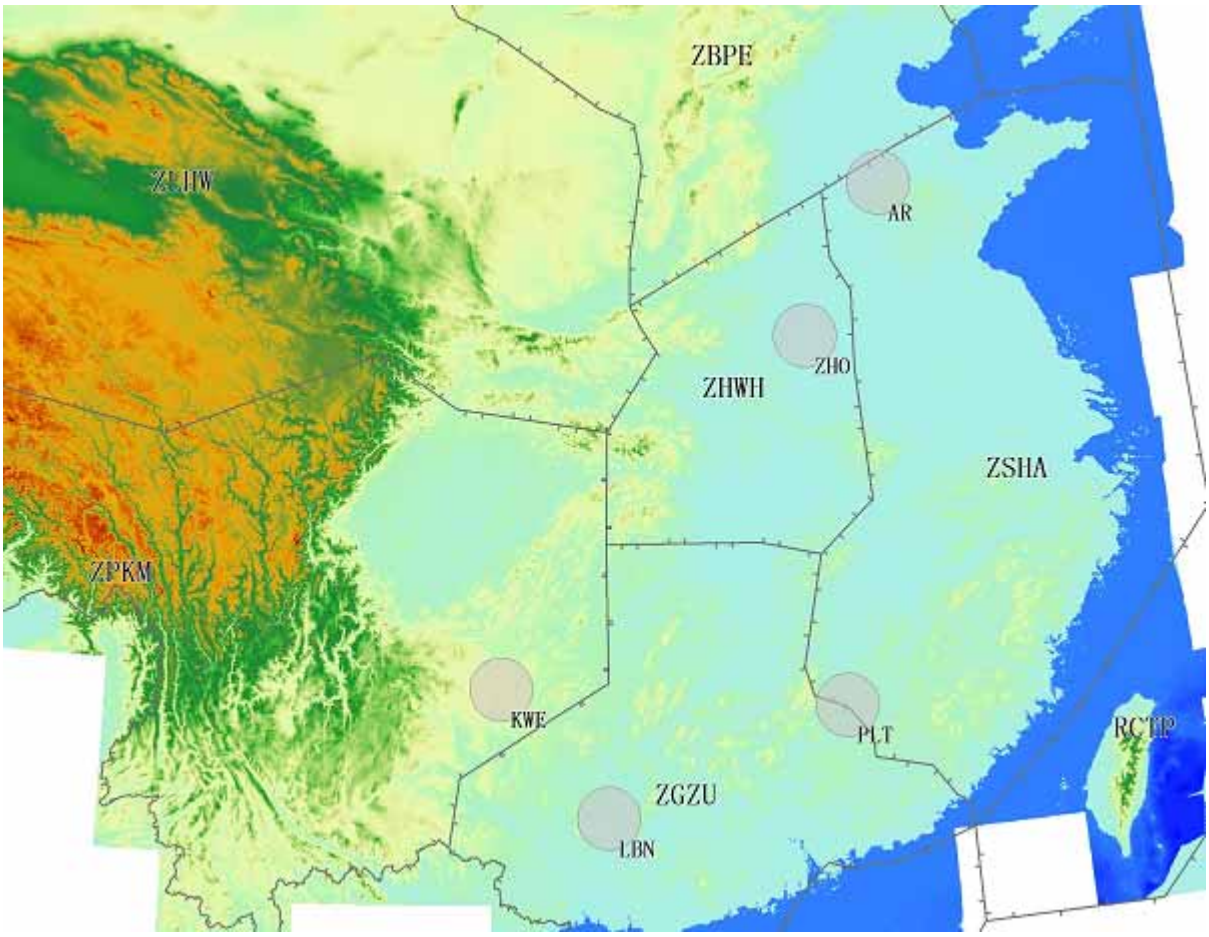

Figure 2.4: The Locations for Five Stations.

2.5 The Suggested Sequence for the Ground Station Establishment

2.5.1 In section 2.4 the preliminary proposal of the site selection of ground-based monitoring system in China is suggested. In fact, it is impossible to establish all the five stations at one time. So it is necessary to make a sequence for the station establishment, and this sequence is expected to achieve the best coverage effect for getting the high monitoring proportion as soon as possible. Based on the analysis in section 2.3.2 and section 2.3.3, the "ZHO" should be the first station to establish. So our task is to determine the sequence of establishment for the second to the fifth station. **Table 2.6** presented the result for the suggested sequence.

Table 2.6: Result for the Sequence of the Station Establishment

2-station combination	3-station combination	4-station combination	5-station combination
ZHO(1st)	ZHO(1st)	ZHO(1st)	ZHO(1st)
PLT(2nd)	PLT(2nd)	PLT(2nd)	PLT(2nd)
	KWE(3rd)	KWE(3rd)	KWE(3rd)
		LBN(4th)	LBN(4th)
			AR(5th)

2.5.2 In this process we repeated the test of all the combination using the uniformization method. The difference is, each time we reduced the number of *j* in Equation (2.1) from three to one. The process is as presented in the following figure:

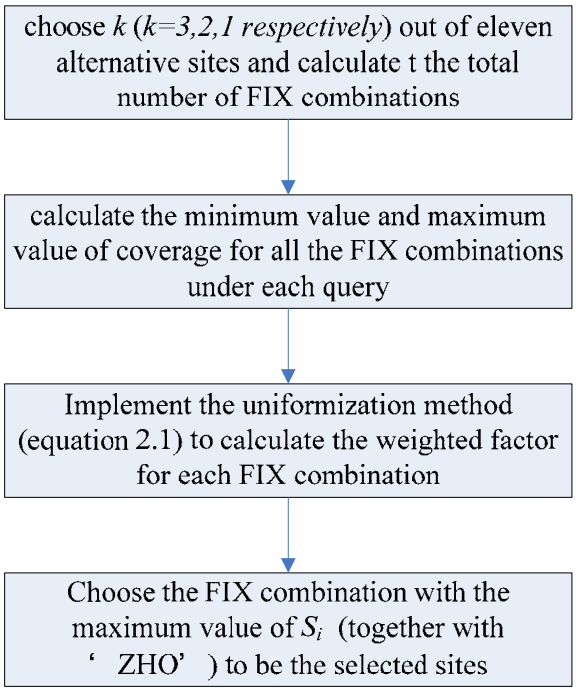

Figure 2.5: The process to determine the sequence of station establishment

2.5.3 For instance: when k=2, a two-FIX combination was determined. Together with the fix 'ZHO', the first three recommended sites for ground-based monitoring system are produced. **Table 2.7** presented the detail result for the test of site sequence selection. It can be found from **Table 2.6** and **Table 2.7**, firstly we consider the four stations situation and the FIX combination is "ZHO", "PLT", "KWE" and "LBN"; Secondly the situation of three stations was considered and the "LBN" is out of the result. Finally under the two stations situation, only "ZHO" and "PLT" remained. The uniformization method analysis for each different station number is independent. According to these analyses result just right[3] get a wonderful result for the establishment sequence. Under the result the sequence of the station establishment for all of the five stations is: ZHO(1st)→PLT(2nd)→KWE(3rd)→LBN(4th)→AR(5th).

Table 2.7: The Detail Result for the Analysis using Uniformization Method

Consideration Condition	Total Number	5-Fix Combination	x_{ij}	s_{ij}	**Proportion**	4-Fix Combination	x_{ij}	s_{ij}	**Proportion**
Flight	69242	ZHO PLT KWE LBN AR	18787	0.965664712	**0.271324**	ZHO PLT KWE LBN	15950	0.959776696	**0.230352**
Global Aircraft	3571		2210	0.870607029	**0.618874**		2114	0.924268503	**0.591991**
Domestic Aircraft	1540		1330	0.935064935	**0.863636**		1258	0.832635983	**0.816883**

[3] Use the word "just right" is want to say that the wonderful result is now always get by the same process based on different TSD data. For example, in the condition of the choose three from eleven the result is "PLT", "KWE", and "LBN", and the in the condition of the choose two from eleven the result is "PLT", "KWE", there are same FIXes "PLT" and "KWE" in the result. But if we don't get the same FIXes other method is needed for the sequence selection.

Global Operator-Type	779		404	0.902985075	**0.518614**		383	0.919354839	**0.491656**
Domestic Operator-Type	201		151	0.88	**0.751244**		143	0.772727273	**0.711443**
		Max(S_i)		0.910864		*Max*(S_i)		0.881753	
Consideration Condition	Total Number	3-Fix Combination	x_{ij}	s_{ij}	**Proportion**	2-Fix Combination	x_{ij}	s_{ij}	**Proportion**
Flight	69242	ZHO PLT KWE	13235	1	**0.191141**	ZHO PLT	9550	1	**0.137922**
Global Aircraft	3571		1878	0.888607595	**0.525903**		1561	0.920930233	**0.437132**
Domestic Aircraft	1540		1219	0.962790698	**0.791558**		1054	0.844827586	**0.684416**
Global Operator-Type	779		318	0.542553191	**0.408216**		266	0.245283019	**0.341463**
Domestic Operator-Type	201		138	0.857142857	**0.686567**		125	0.8	**0.621891**
		Max(S_i)		0.850219		*Max*(S_i)		0.762208	

From table 2.7, even if the China RMA only implement two ground-based stations at “ZHO” and “PLT”, more than 60% of the domestic aircraft or the domestic operator-type will be covered. It is an encouraging result for the long term monitoring program in China.

2.6 Conclusion

2.6.1 From section 2.1 to section 2.6 we presented the whole process of the ground-based monitoring system site selection, including consideration condition, selection process. The preliminary proposal of sites and establishment sequence analysis shown in this paper will assist China to form a solution for the establishment of ground-based monitoring system.

2.6.2 Further consideration and analysis will focus on:

2.6.2.1 Defining a rational target for the monitoring objectives. This paper provide a research on the methodology of selecting sites for the ground-based monitoring stations in China, and the preliminary result of coverage under two to five stations looks encouraging. The key objective is to capture as more airframes operating in the domestic Chinese airspace as possible, but the siting of additional stations would not increase the percentage affected to any large extent, and to cover all of the fleet a very large number of stations would be needed, which is economically unrealistic. The final determination of the target to this objective will be in accordance with the requirement of Civil Aviation Administration of China (CAAC).

2.6.2.2 Implementing more traffic flow information to re-estimate the site selection proposal. Due to the air route structure adjustment on 16 Dec, 2009, only half-month TSD data were used in this analysis. The China RMA decided to use more data to re-estimate the site before making the final determination.

2.6.2.3 Making necessary adjustment to the weighted factor according to the requirement. In this paper, $S_i = \frac{1}{5}\sum_{j=1}^{5} s_{ij}$ in which each S_{ij} has the same contribution to the S*i*. Further analysis will study if the proportion may be adjusted according to the actual requirement and how to adjust this proportion. For instance, the query result of domestic individual aircraft may be given a bigger weighted factor than the global aircraft.

2.6.2.4 Study the constraints and considerations for final site selections on a micro level to achieve the optimum architecture and geographical layout.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

3.1.1 note and review the contents of this working paper.

— END —

References

1. “Report of The Twelfth Meeting of The Regional Airspace Safety Monitoring Advisory Group (RASMAG/12)”, Bangkok, Thailand, 14 – 17 December 2009.

2. “Asia/Pacific Regional Impact Statement – RVSM Global Long Term Height Monitoring Requirements effective from November 2010”, Version 1.0 – September 2009, the ICAO Asia/Pacific Regional Office, Bangkok

3. “Ground-Based Monitoring FAA Training Material: Ground-Based Monitoring-Macro View of Site Selection”, FAA Technical Center, January 2009

4. “Installation and Flight Inspection of Height Monitoring Stations (HMU) in Europe”, M. Yves Garrigues, http://avnwww.jccbi.gov/

Attachment A

The Route Structure (Based on Chinese Digital Elevation Model (DEM) data) for the Preliminary Site Selection of Ground-Based Monitoring System in China

1. Zhou Kou (ZHO, He Nan province in Central China)

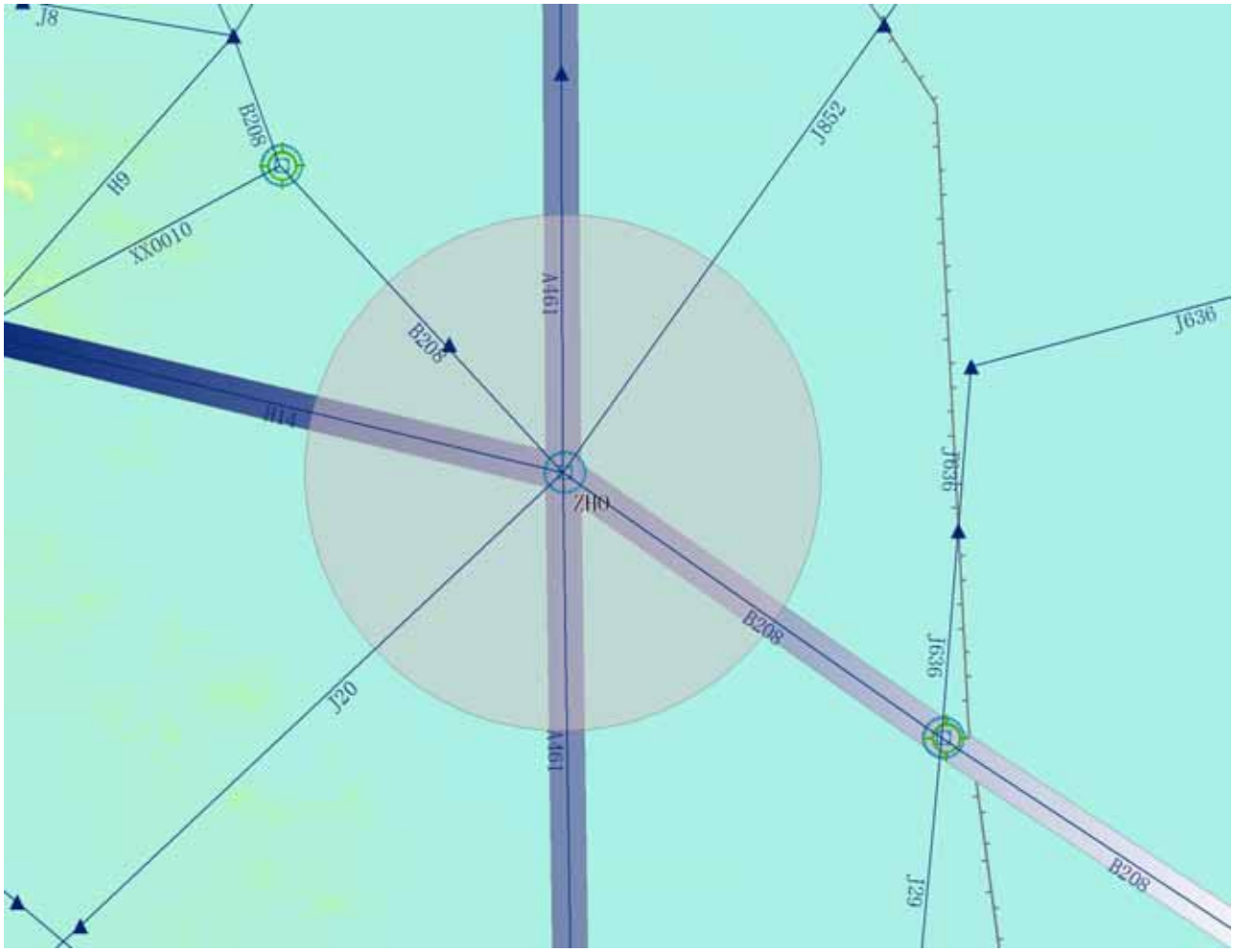

Figure A.1: Zhou Kou (ZHO)

2. Pan Long (PLT, Gui Zhou province in South China)

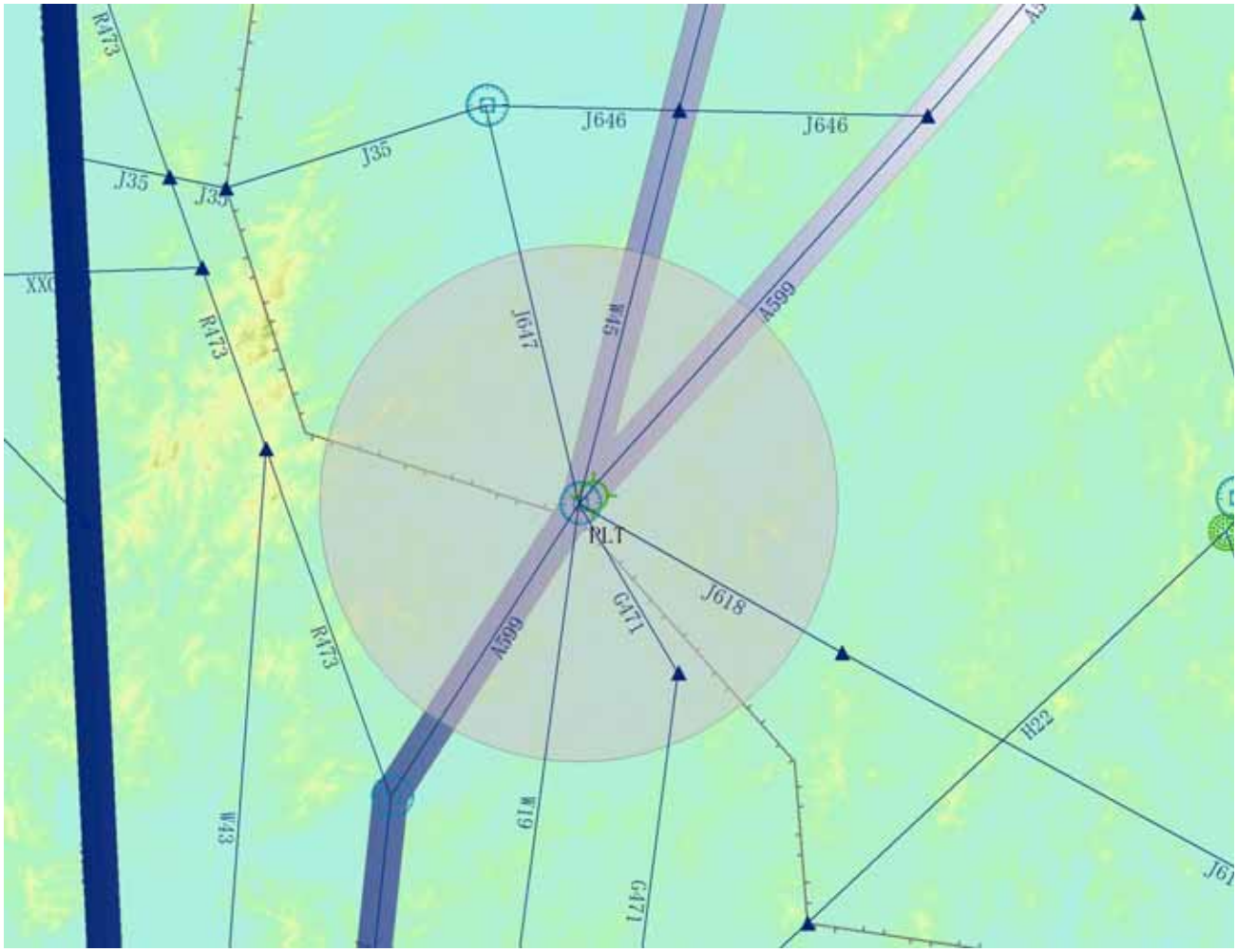

Figure A.2: Pan Long (PLT)

3. Gui Yang (KWE, Gui Zhou province in South China)

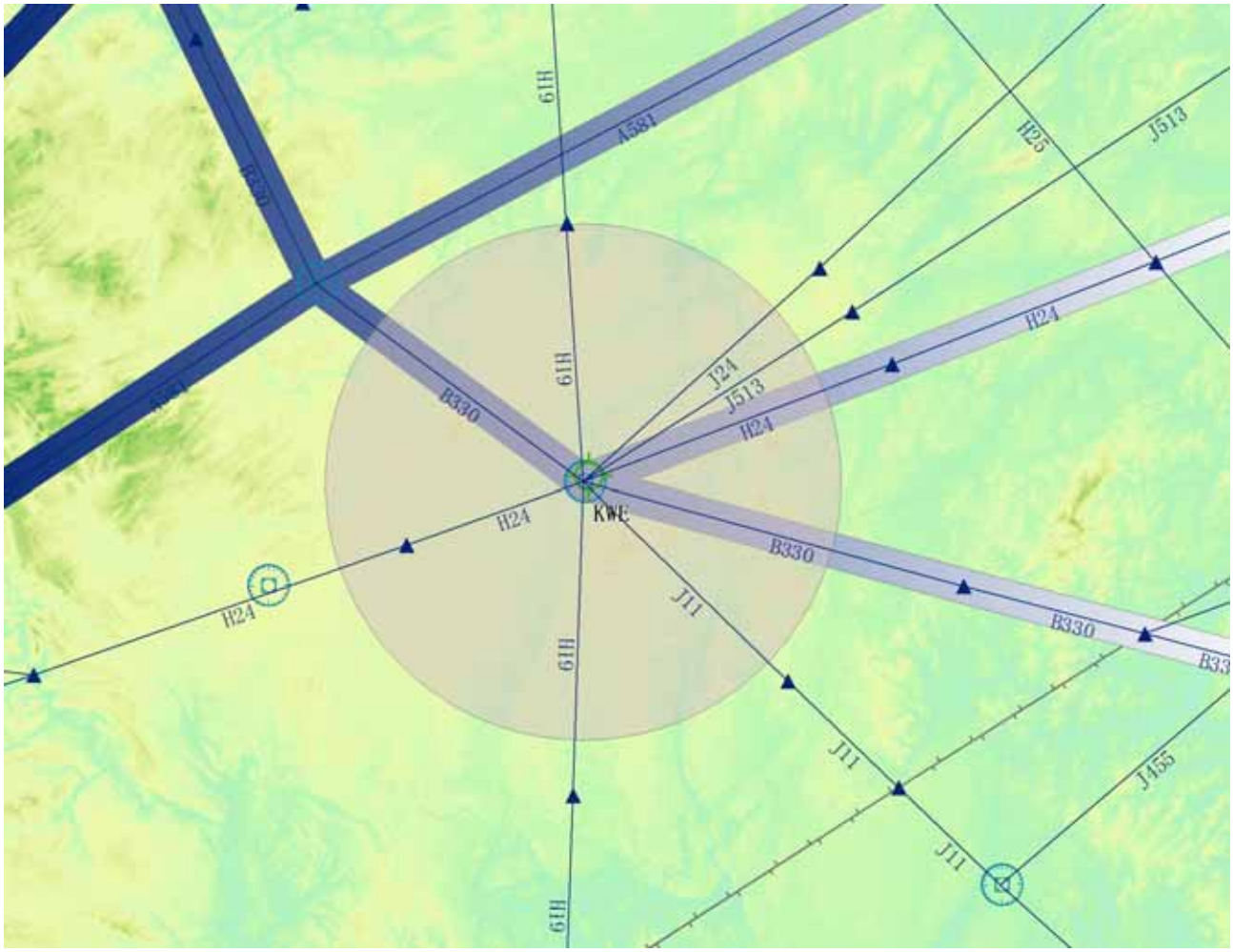

Figure A.3: Gui Yang (KWE)

4. Lai Bin (LBN, Guang Dong province in South China)

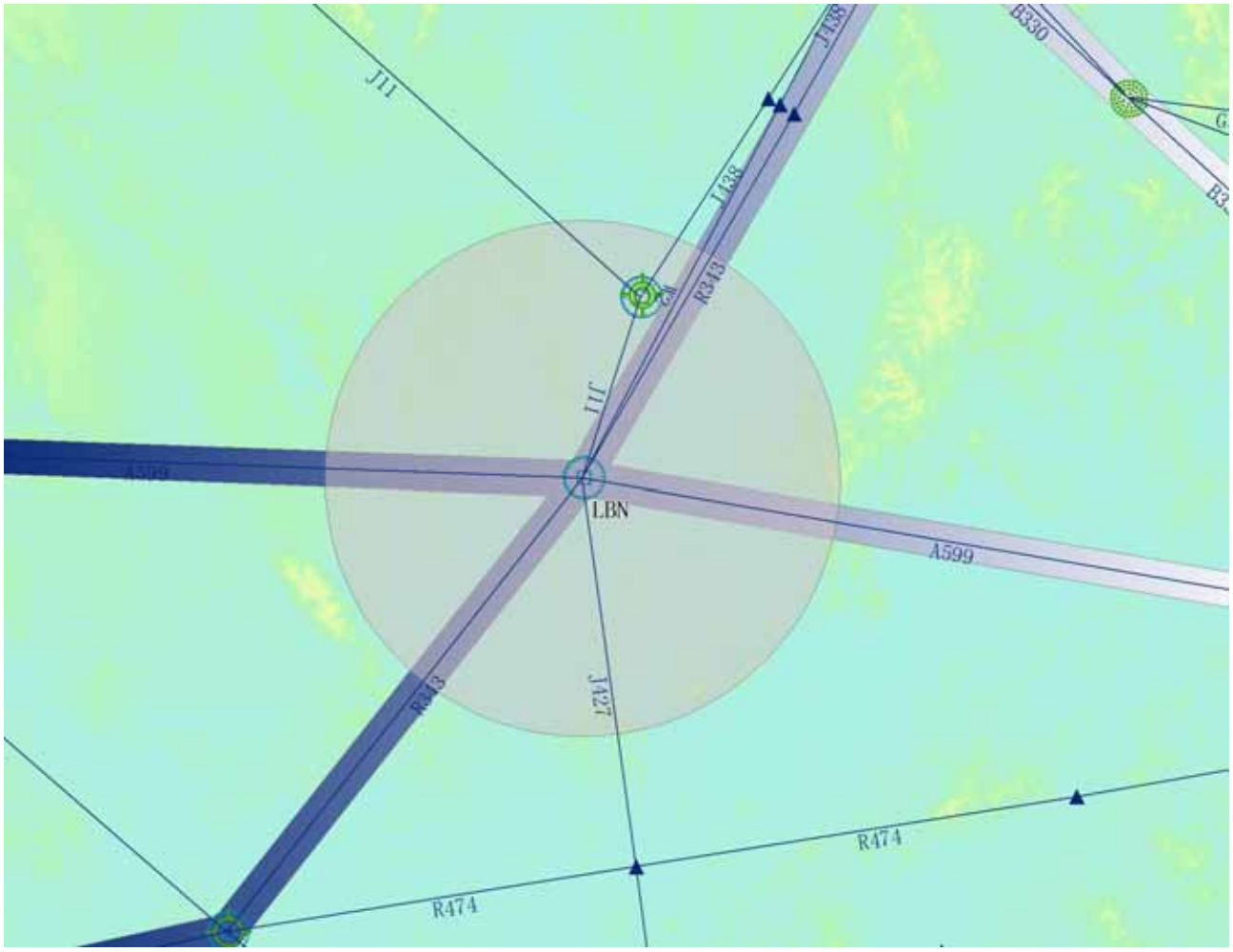

Figure A.4: Lai Bin (LBN)

5. Zhang Zhuang (AR, Shan Dong province in East China)

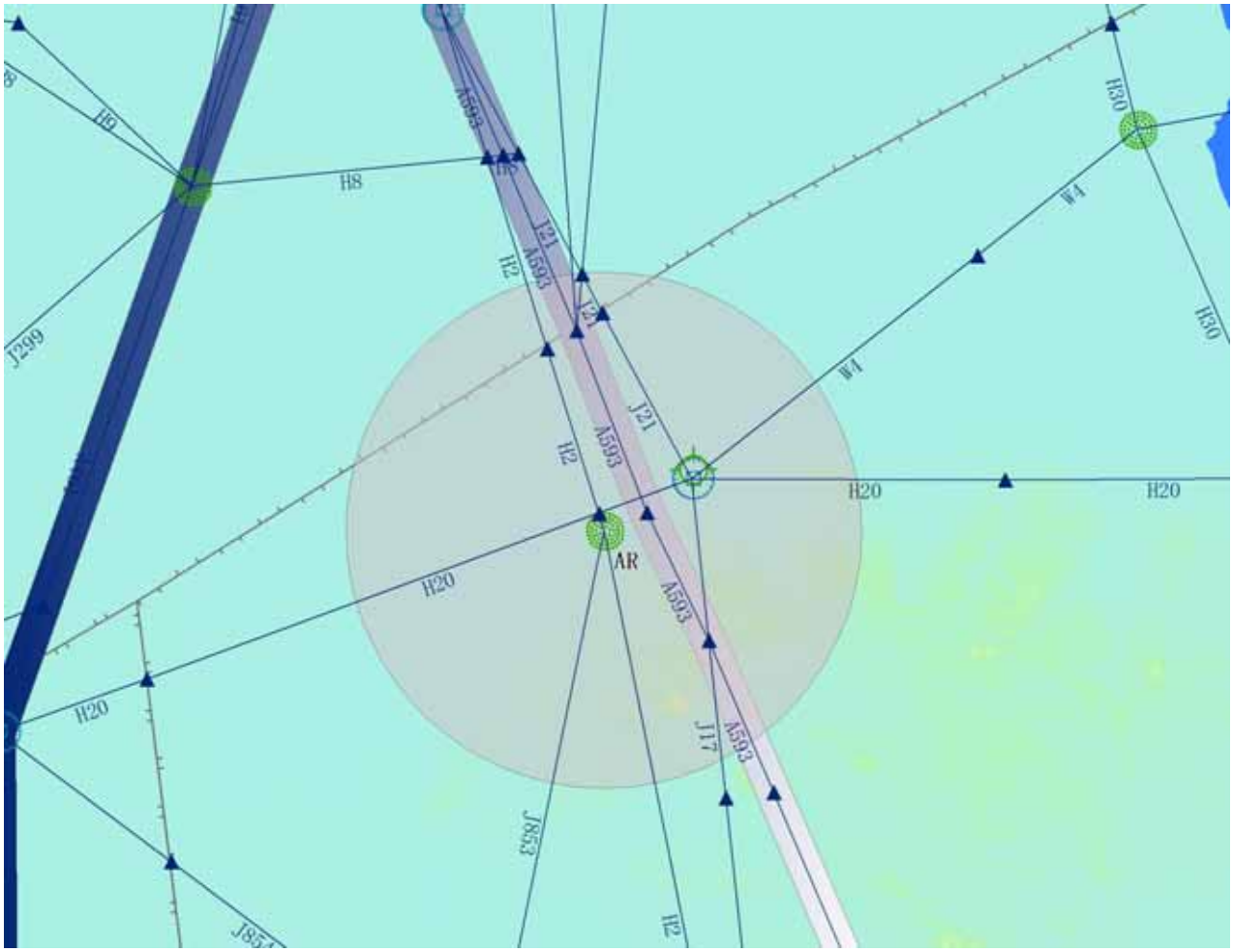

Figure A.5: Zhang Zhuang (AR)