ADS-B Implementation Workshop from 14 – 16 August 2024, Bangkok Thailand
Case Study for ADS-B Implementation in Lao PDR

Contents:

1. Introductory overview of Lao Airspace.
2. Current Status of ADS-B System.
3. ATM Automation System
4. Challenging and Need.
5. Discussion and next steps.

1. Introductory overview of Lao Airspace

The airspace structure of Laos is characterized by a long and narrow span from north to south, and a short span from east to west. Due to the unique geographical location of Laos, the airspace is essentially a fortress for entering and exiting Southeast Asia countries. The fix point of "SAGAG" is an obligatory waypoint for Southeast Asia countries to enter and exit China. The fix point of "BUTRA", SAV, VTN", "ANBOK", "YAKUA", "PONUK" "TOMIP and AKSAG" are obligatory waypoints for Asia countries to enter and exit Thailand, India and some countries in Central Asia. The fix LADON, LAPON, LAVOS, NALAO, VILAO, PRAPA and BOMPA are obligatory waypoint for Southeast Asia countries to enter and exit Hongkong China. Above FL 195 only IFR flight and the minimum horizontal radar separations are:

a. 5 NM (9,3 km) within Vientiane TMA;
b. 10NM (18km) outsides of Vientiane TMA and en-routes along airways within Vientiane FIR.

Radar Coverage

The 4 Mode S secondary radars of LANS are located in Vientiane Airport, Xiengkhouang, Savannakhet Airport and Paksong. The Vientiane and Xiengkhouang radars provide radar surveillance information for Sector North. Meanwhile, Savannakhet and Paksong radars provide radar surveillance information for Sector South. Vientiane and Paksong radars are operating in Mode S. Xiengkhouang and Savannakhet radars are in Mode A/C. Theoretical coverage of radar at 3,000 m, 6,000 m and 9,000 m ASL in Laos can be seen in Figure 1, Figure 2 and Figure 3. At 3,000m ASL, about 90% airspace volume of Laos can be covered by radars, the rest 10% blind airspace are in northern Laos, and most airspace in southern Laos have redundant coverage. At 6,000m ASL, almost 100% airspace volume of Laos can be covered. About 10% airspace in northern Laos only have single coverage, the others have redundant coverage. At 9,000m ASL, more than 95% airspace volume of Laos can be covered redundantly, and the radar coverage extends to neighboring countries, which can better meet the needs of ATC handover. Generally speaking, the whole controlled airspace of Laos can be covered by radars above 6,000m ASL. The redundant coverage is better in the south. And the low-altitude support capability of surveillance needs to be improved, especially in the north. In view of the situation, any radar out of service will affect the ATC activities. It is necessary to release the NOTAM when any radar off-line, so it is necessary for LANS to improve the surveillance redundancy support capability.

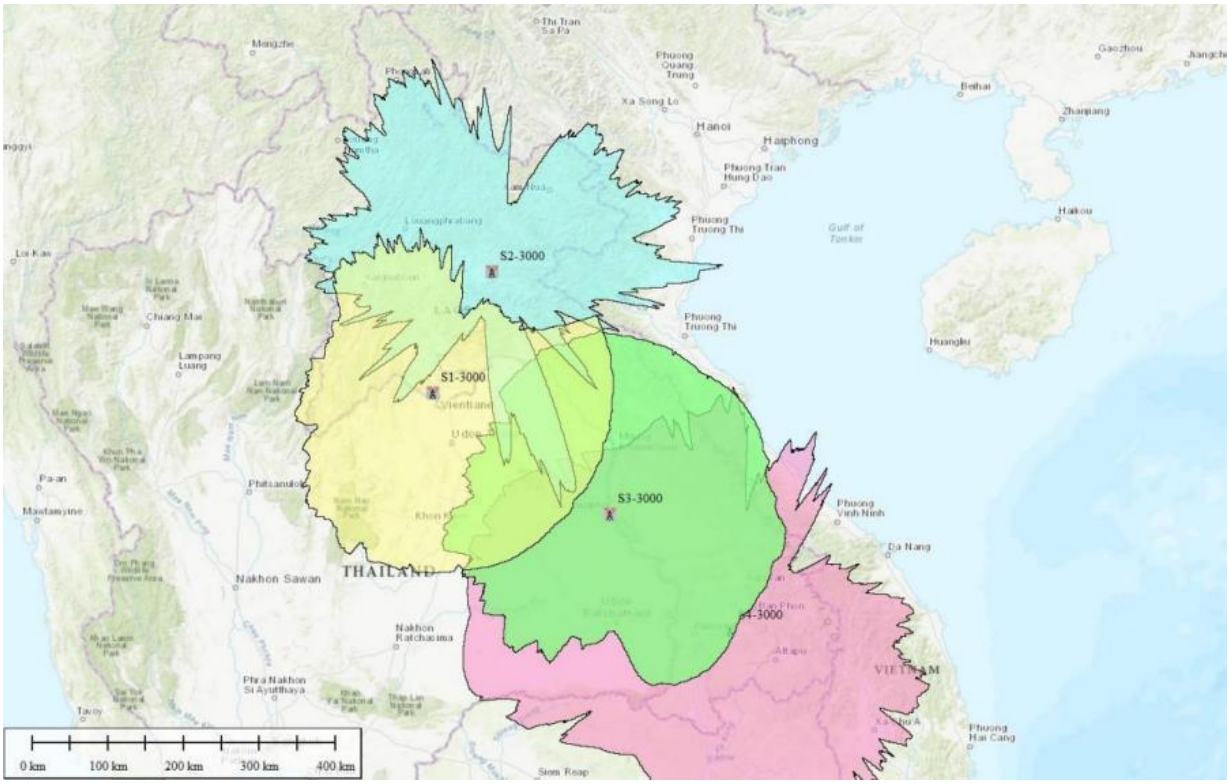

Figure 1 Theoretical Coverage of Radars at 3,000m ASL

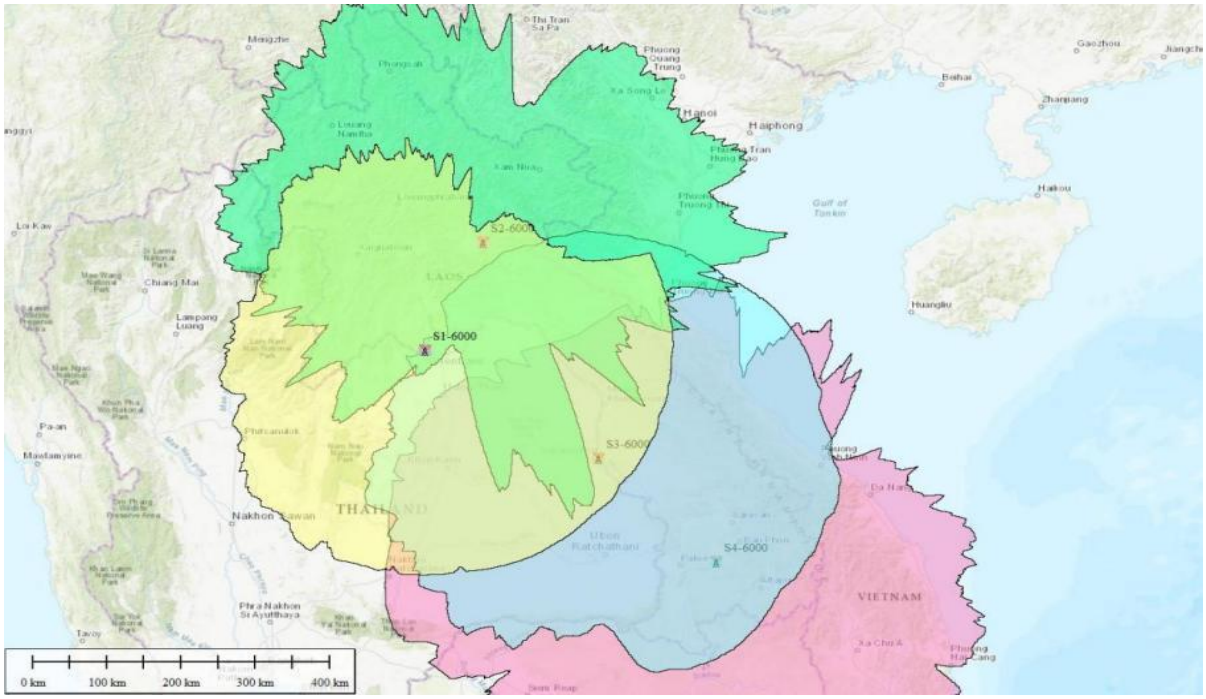

Figure 2 Theoretical Coverage of Radars at 6,000m ASL

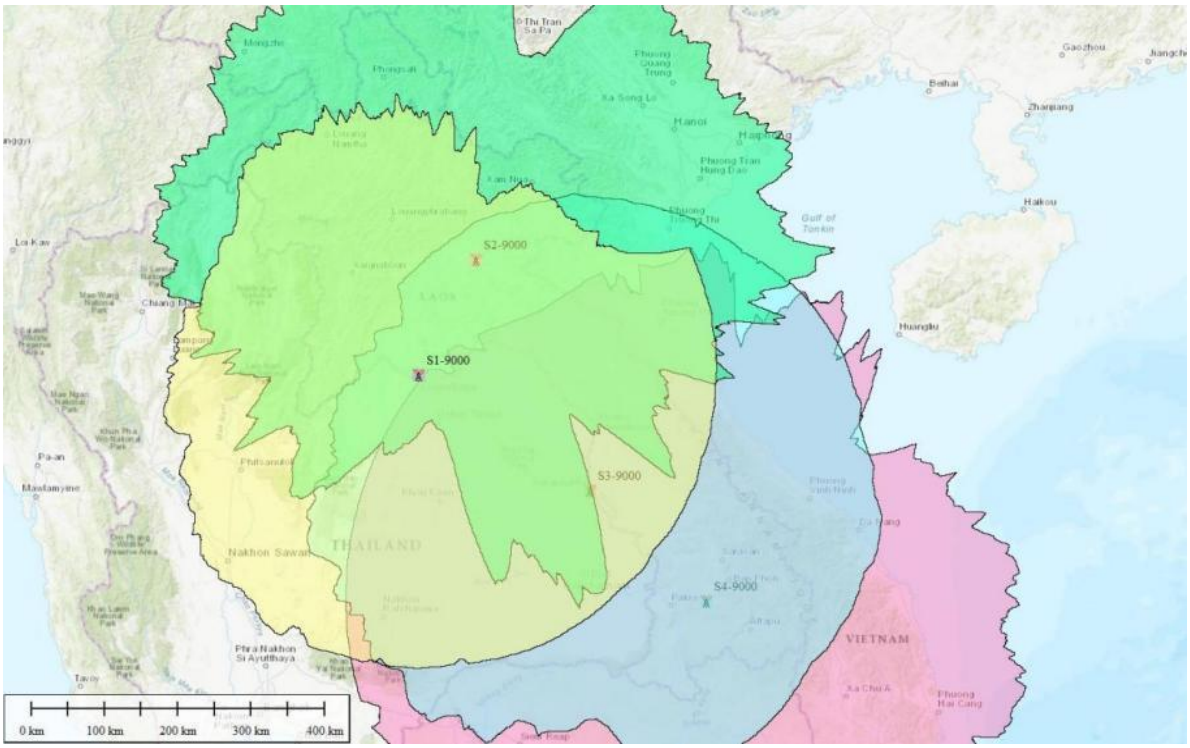

Figure 3 Theoretical Coverage of Radars at 9,000m ASL

Table 1 Radar Technical Information

RADAR						
NO	**Items**	**Vientiane**	**Xiengkhouang**	**Savannakhet**	**Paksong**	**Note**
1	The type of the secondary Radar	MSSR RSM970S	MSSR RSM970S	MSSR RSM970S	MSSR RSM970S	Basic Information
2	The time of the first startup of the secondary Radar	2018	2005	2016	2013	
3	How to use? (24-hours or service periodically)	Service 24-hours	Service 24-hours	Service 24-hours	Service 24-hours	
4	Provide the SAC/SIC/II/ SI Code information of the Secondary Radar	SAC= 38, SIC =1, II code: 11	SAC= 38, SIC =3, II code: 13	SAC= 38, SIC =2, II code: 12	SAC= 38, SIC =4, II code: 14	
5	Operational mode of the Secondary Radar（ Mode A/C or Mode S)	Mode S	Intermode	Mode S	Mode S	
6	PRF/Range/Strategy of the Secondary Radar	PRF=? /Range: 250 NM	PRF=? /Range: 250 NM	PRF=? /Range: 250 NM	PRF=? /Range: 250 NM	
7	Provide the Position information of Radar (Latitude, longitude, altitude of the antenna)	17D59'34"N102D33`14"/Alt: 167m ASL	19D25'01"N103D18`01"E/Alt: 1845 m ASL	16D33'12"N104D45`35"E/Alt: 153 m ASL	15D00'00"N106D15`51"E/Alt: 1415 m ASL	
8	Rotation speed of the Antenna	15 rpm	15 rpm	15 rpm	15 rpm	
9	The peak number of aircraft in the coverage.	No record	No record	No record	No record	Airspace Situation
10	The approximate proportion of aircraft equipped with Mode S transponders in the airspace.	90%	90%	90%	90%	
11	Is ELS or EHS operation required?	EHS	ELS	EHS	EHS	

Table 2 ADS-B Ground Station Information in Laos

ADS-B Ground Station Information in Laos						
No	**Items**	**Vientiane**	**Xiengkhouang**	**Savannakhet**	**Louangphabang Airport**	**Pakse Airport**
1	**ADS-B type**	THALES AS680	THALES AX680	THALES AX680	THALES AX680	THALES AS680
2	**ADS-B installation time**	2014	2017	2017	2017	2015
3	**ADS-B operating system**	THALIX	THALIX 11	THALIX 11	THALIX 11	THALIX
4	**ADS-B position (latitude, longitude, altitude of the antenna)**	E102° 33'56.76" N17° 58'42.30" Alt: 178.2 m ASL	E103° 18'01" N19° 25'01" Alt: 1840 m ASL	E104° 45'36.21" N16° 33'12.72" Alt: 148 m ASL	E102° 10'10.84" N19° 54'9.91" Alt: 333.7 m ASL	E105° 46'52.86" N15° 08'7.53" Alt: 139.5 m ASL
5	**ADS-B data**	Asterix CAT021	Asterix CAT021	Asterix CAT021	Asterix CAT021	Asterix CAT021
6	**ADS-B version**	ver.1	ver.2	ver.	ver.2	ver.
7	**ADS-B SAC/SIC**	38/2	38/3&4	38/1	38/5&6	38/10
8	**ADS-B receiver**	1 RX & Omni-Ant	2Rx & Directional-Ant	2Rx & Directional-Ant	2Rx & Directional-Ant	1 RX & Omni-Ant
9	**ADS-B test and assessment tool**	no	no	no	no	no
10	**ADS-B LCMS & RCMS**	Only RCMS	Only RCMS	LCMS-RCMS	LCMS-RCMS	Only RCMS
11	**ADS-B working status**	faile	OK	O	OK	faile
12	**Operation mode**	Only for monitoring	Only for monitoring	Only for monitoring	Only for monitoring	Only for monitoring

Table 3 ADS-B Technical Information

NO	Items	Vientiane	Xiengkhouang	Savannakhet	Louangphabang Airport	Pakse Airport
1	ADS-B Type	THALES AS680	THALES AX680	THALES AX680	THALES AX680	THALES AS680
2	ADS-B Year installation	2014	2017	2017	2017	2015
3	ADS-B operating system	THALIX	THALIX 11	THALIX 11	THALIX 11	THALIX
4	ADS-B data	Asterix	Asterix	Asterix	Asterix	Asterix
5	ADS-B version	ver.1 (DO 260A)	ver.2 (DO 260B)	ver.2 (DO 260B)	ver.2 (DO 260B)	ver.1 (DO 260A)
6	ADS-B SAC/SIC	38/252	38/3&4	38/1&2	38/5&6	38/102
7	ADS-B receiver	1 RX & Omni-Ant	2Rx & Directional- Ant	2Rx & Directional-Ant	2Rx & Directional-Ant	1 RX & Omni-Ant
8	ADS-B test and assessment tool	no	no	no	no	no
9	ADS-B LCMS & RCMS	only RCMS	LCMS-RCMS	LCMS-RCMS	LCMS-RCMS	only RCMS
10	Asterix version of configuration setting	V0.23	V0.23	V0.23	V0.23	V0.23

2. Current Status ADS-B System

Since the ADS-B ground stations has been deployed for many years but not yet put into operation by LANS, and LANS only uses them for auxiliary monitoring, it is not necessary to do the operation evaluation for ADS-B ground stations.

ADS-B Coverage

There are 5 ADS-B ground stations in Laos, which located in Vientiane, Xiengkhouang, Louangphabang, Savannakhet and Pakse. Vientiane and Pakse ADS-B ground stations are failed due to GPS module failure (This version of ADS-B the GPS receiver is old type which need to reconfigure the time manually).

The coverage of the ADS-B ground stations in Laos at 3,000m, 6,000m and 9,000m ASL are shown in Figure 4, Figure 5 and Figure 6. At 3,000m ASL, about 80% airspace volume of Laos can be covered by ADS-B, the rest 20% blind airspace is in the north, central and south of Laos. At 6,000m ASL, about 95% airspace volume of Laos can be covered, the rest 5% blind airspace is in southern Laos. At 9,000m ASL, 100% airspace volume of Laos can be covered, most airspace in northern and central Laos have redundant coverage, and the ADS-B coverage extends to neighboring countries, which can better meet the needs of ATC handover. Generally speaking, the 3 ADS-B ground stations which is working normally now can basically meet the requirements of monitoring above 6,000m in Laos.

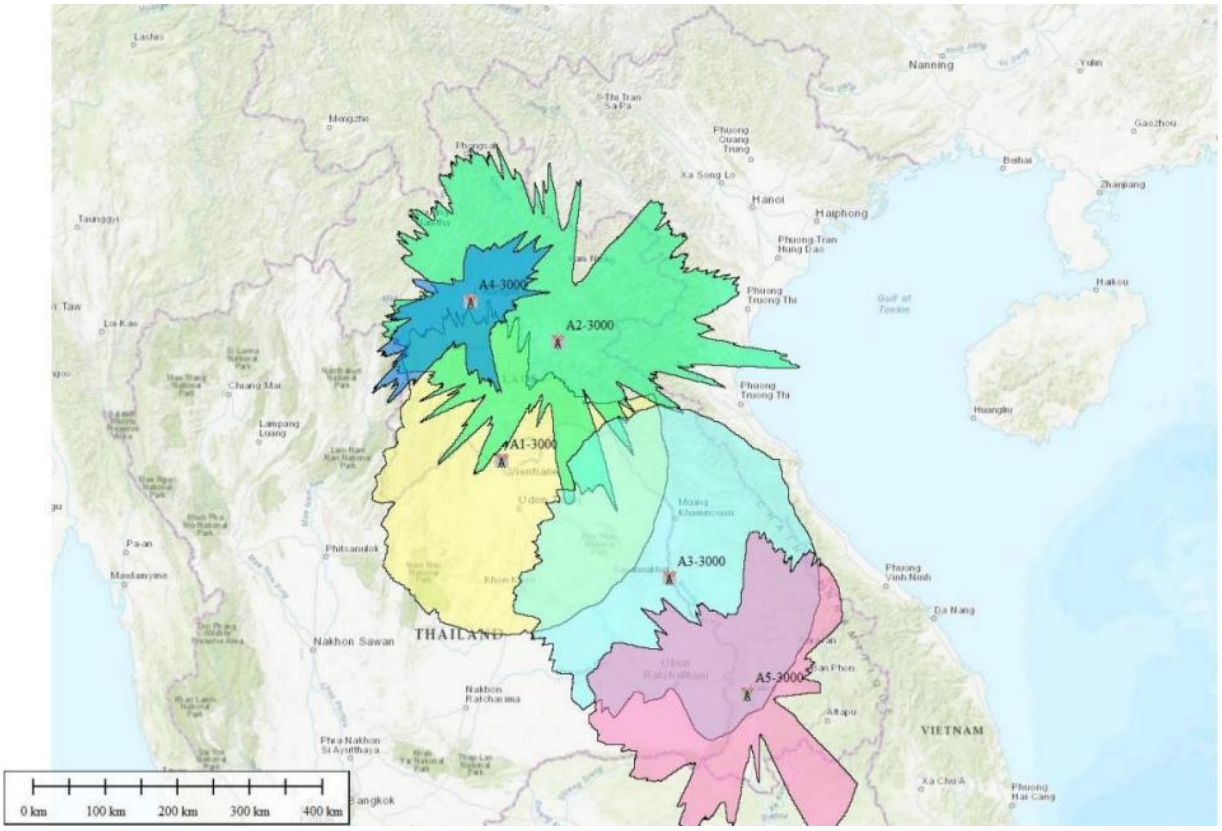

Figure 4 Theoretical Coverage of All ADS-B at 3,000m ASL

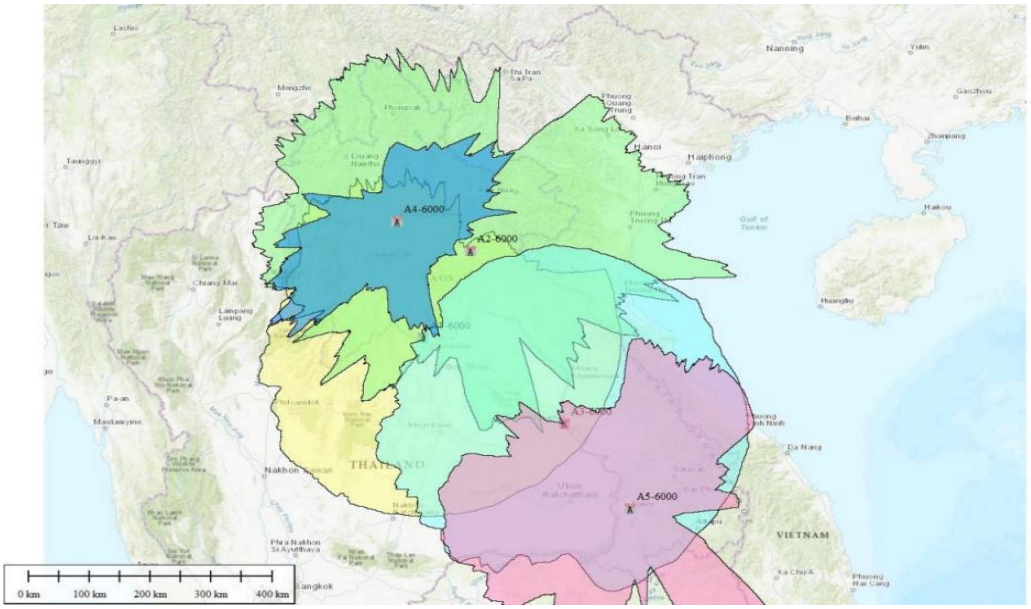

Figure 5 Theoretical Coverage of All ADS-B at 6,000m ASL

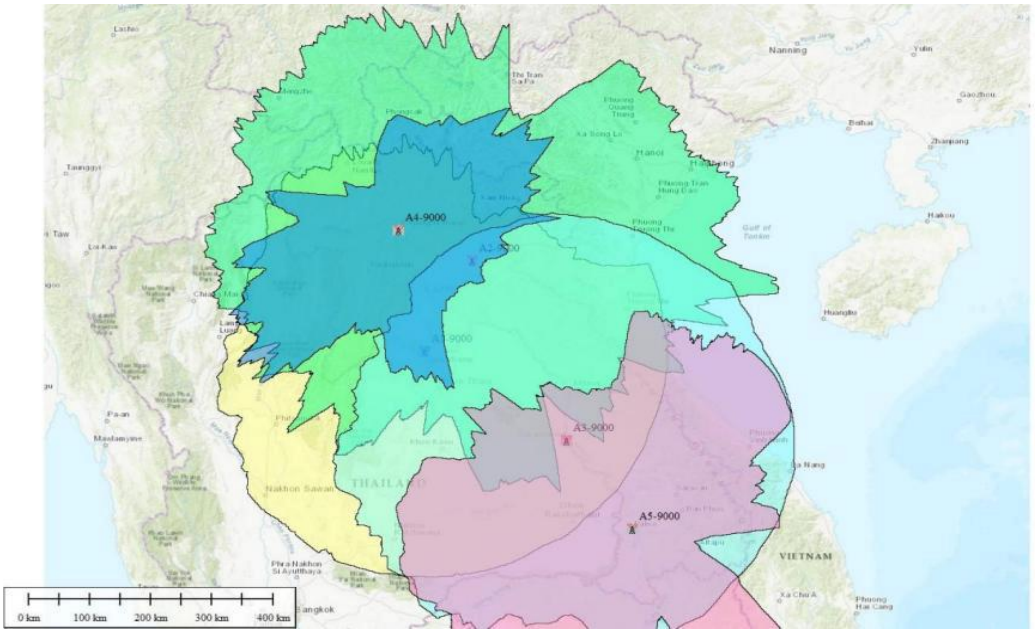

Figure 6 Theoretical Coverage of All ADS-B at 9,000m ASL

At 3,000m ASL, about 90% airspace volume of Laos can be covered by ADS-B except some blind airspace in the north and south of Laos.

At 6,000m ASL, almost 90% airspace volume in Laos can be covered by ADS-B redundantly.

At 9,000m ASL, almost 100% airspace volume in Laos can be covered by ADS-B redundantly, and the ADS-B coverage can be extended to neighboring countries, which can better meet the needs of ATC handover.

Generally speaking, if all the 5 ADS-B ground stations work normally, it can basically achieve redundant ADS-B coverage in Laos above 6,000m ASL. There are blind areas of ADS- B coverage at low altitude in the southern and northern Laos. The coverage effect of ADS-B in the southern is worse than radar because the elevation of Pakse ADS-B ground station is lower than Paksong radar station over 1,000m.

Therefore, the 2 failed ADS-B ground stations need to be solved urgently and put ADS-B into operation, it will greatly improve the redundancy of surveillance coverage and reduce the impact of radar shutdown on operation

The actual coverage of the 4 radars and 5 ADS-B is basically consistent with the theoretical coverage, which can basically achieve full coverage in Laos, and have triple radar and ADS-B signal coverage in the central area of Laos. According to the data record, there are few domestic flights in Laos, most flights are over flights.

3. ATM Automation System

THALES TOPSKY is used and there are 2 systems and Both TOPSKY systems of LANS have basic functions of ATM-AS: surveillance data processing, flight plan processing and warning and alerts. See the table below for more detailed information.

There are also 4 radars, 5 ADS-B ground stations, 1 GPS and AFTNs connected to the TOPSKY1/2. See the table below for more detailed information.

Table 4 Detail Information of the Server Racks of TOPSKY

Categor		Detail	Remark
Surveillance DATA	RADAR	Vientiane	Serial Port by P line
		Xiengkhouang	Network Connection
		Savannakhet	Network Connection
		Paksong	Network Connection
	ADS-B	Vientiane	Network Connection
		Xiengkhouang	
		Savannakhet	
		Louangphabang Airport	
		Paksong Airport	
	P line	Serial data to IP data	Pline×2
GPS	Receiver	GPS Receiver, 230 VAC	Network Connection
ATS message	AFTN	Current Way	Network Connection
	AMHS	NA	Network Connection
Servers	RFP	Main and Standby two servers Surveillance DATA Processing	HP-Z400
	FDP	Main and Standby two servers Flight DATA Processing	HP-Z400
	REC	Two servers for RECORDING	HP-Z400
Switch	RLANS	Front interface for flight plan and surveillance data	Cisco2960×2
	Work Lan	System redundant two LANS	Cisco2960×4

The Controller Work Stations of TOPSKY:

There is also total 25 controller work stations of TOPSKY1/2 system. The most significant difference between TOPSKY1 and TOPSK2 is that there aren’t SIM and PIL work stations for TOPSKY2.

Table 5 System Functions of TOPSKY

Element	Explanation
Number of ATS positions	25 nodes.
Surveillance Data Processing Function (SDP)	Surveillance data can be processed by the system, including PSR, Mode A/C, Mode S, ADS-B, WAM, or others.
Flight Data Communication Network	Type of Flight Data Communication Network used by the system (AFTN).
Flight Data Processing Function (FDP)	The system can support flight data processing, including Flight Message Processing, Life Cycle Management, 4D Profile Trajectory Calculation, SSR Code Management, Sector Management and Posting Computation.
Flight Strip	The system can support print Paper Flight Progress Strip, display Electronic Flight Strip, or both.
Correlation of surveillance and flight data	The system can perform an automatic correlation between the flight plan and the system track based on the SSR code, aircraft 24- bit address, or Aircraft Identification (ACID).
Emergency code warning (7500,7600,7700)	Once the emergency codes were received, the system is suggested to process it and display the Emergency on the concerned positions.
Short Term Conflict Alert (STCA)	The system will provide a separation alert for a potential or actual infringement of separation minima between aircraft as basic STCA, using aircraft intent parameters (Selected Flight Level), considering ATC practices (level-off prediction test and turn prediction test).
Minimum Safe Altitude Warning (MSAW)	The system will assist controllers with alerts of the potential risk of an aircraft infringing a defined minimum safe altitude over a concerned region.
Area Proximity Warning (APW)	The system will alert controllers of any potential or actual unauthorized penetration of aircraft into Special Use Airspaces (SUA).
Approach Path Monitoring (APM) Warning	The system will monitor the aircraft's vertical and lateral deviation from the final approach profile in ATMAS, and generate visual and/or aural alerts when an aircraft exceeds or is predicted to exceed the defined tolerance of deviation.
Route Adherence Monitoring (RAM)	The system will monitor if an aircraft (i.e., surveillance track) is following the planned route, as stated in the associate flight plan.
Cleared Level Adherence Monitoring (CLAM)	The system will monitor the conformance of the Actual Flight Level (AFL) of an aircraft to the Cleared Flight Level (CFL) issued by the air traffic controller and provide warnings if the deviation between the two levels (i.e., Level Bust) was found after the aircraft has been level-off.
Meteorological Information Processing	The system is capable of receiving, processing, and displaying meteorological information, including GRIB, QNH, and weather data derived from mono-radar, or other
System Parameter Management Function	The system is capable of managing the variable system parameters through a user/ops orientated adaptation interface used by trained adaptors.
ATS Inter-facility Data Communication Function (AIDC)	The system can support ATS-related information exchanges within the ATMAS of adjacent Control Units and Flight Information Regions adopted in the Asia-Pacific region, including Handover and Coordination.
Human Machine Interface Function (HMI)	Operational users can monitor air traffic situations and modify flight plans and other relevant information through physical peripherals and/or onscreen control interfaces.
Recording and Playback Function	The system has the basic, enhancement, none, or both recording and playback function.

System Monitoring and Control Function	The system can provide the monitoring and controlling function, and the failure of the monitoring and controlling function should not affect the operation of other modules.
GNSS Time	The system can synchronize with the external GNSS signals or not.
Synchronization	
System Log Management	The system is able to collect and manage operational logs and error messages.

Radar and ADS-B Parameters Optimized Analysis

Figure 7 Actual Target Tracking Radar and ADS-B Coverage in LAOS

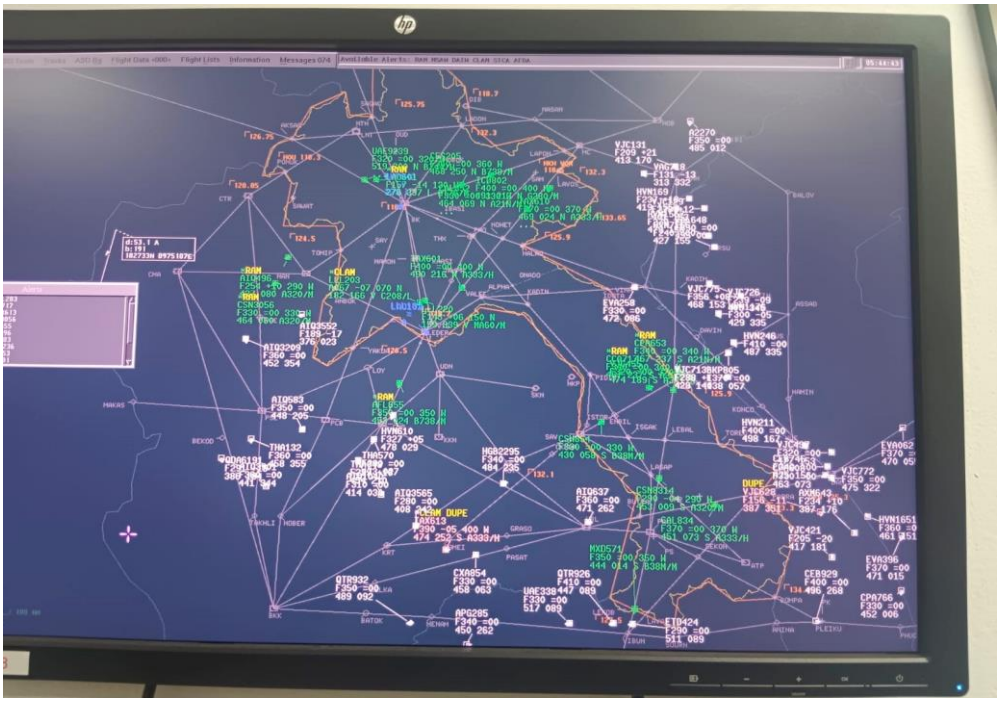

Figure 8 Actual TOPSKY display

TOPSKY ATC Display shown: SSR + ADS-B Track combination and update rate setting is 4s When observe the flight statistic for Overfly almost aircraft can be seen by ADS-B when bypass the SSR.

4. Challenging and Needs

According to the aspects below that still be some challenges and needs faced by Laos to implement ADS-B:

System Operation

1. Even though the 5 ADS-B systems are still operating, from same venders but two systems already outdate (Capability version 1). We need to further improve the surveillance coverage, and the capability of technician knowledge.
2. Talent is the first factor and driving force for development, we should attach importance to technicians training, improve the level of personnel qualification and ability, expand the technician team, which will promote the high-quality of systems operation. Especially how to assess and ensure that ADS-B data receiving is accurate and consistency because as of now the current status of ADS-B still not yet solved or evaluated which need to contact the system venders or other that have experience on similar or same type that we have.

Standards:

- Lao DCA adopted and create the guidance document based on the AIGD Ver. 15 but not yet create for Separation Minima requirement/Accuracy.

5. Discussion and next steps.

Gathering the lesson learnt, explicit experiences from other state in ADS-B implementation that already notified as Aeronautical Information Circular and published in their AIP especially in our neighbor FIRs. In this case we can assured that the overflying aircraft in certain level will already have ADS-B out.

For further steps we still need something to be clarify:

- **Should we require for Flight Inspection of ADS-B ground systems?**
- **Should we mandate Equipage requirement?**
  ADS-B Out with GNSS complied with
  - RTCA DO 260, DO 260A, DO 260B and newly DO 260C
  - EUROCAE ED102, ED102A, newly ED102B
- **ATC Operation/provision procedures?**
  - Flight Level, Airspace class?
  - Classify separation minima
    ADS-B with ADS-B aircraft
    ADS-B with non-ADS-B aircraft
  - In ADS-B separation can be use AIDC?
- **ADS-B** Asterix version of configuration setting can be set in mixed (2ADS-B are setting V1.0 and other 3 ADS-B are setting V2.1) or we should set to the same as V1.0?
- **ADS-B V1.0 the accuracy for separation minima how many NM?**
- **Set up team for planning ADS-B Implementation**
- **Promote the benefit**
- **Implementation of ADS-B in some specific flight level and publish in AIP**
- **Human resources (Training for ATC)**
- **Additional ADS-B System**