
NETRA RAIM Prediction Service





Introduction

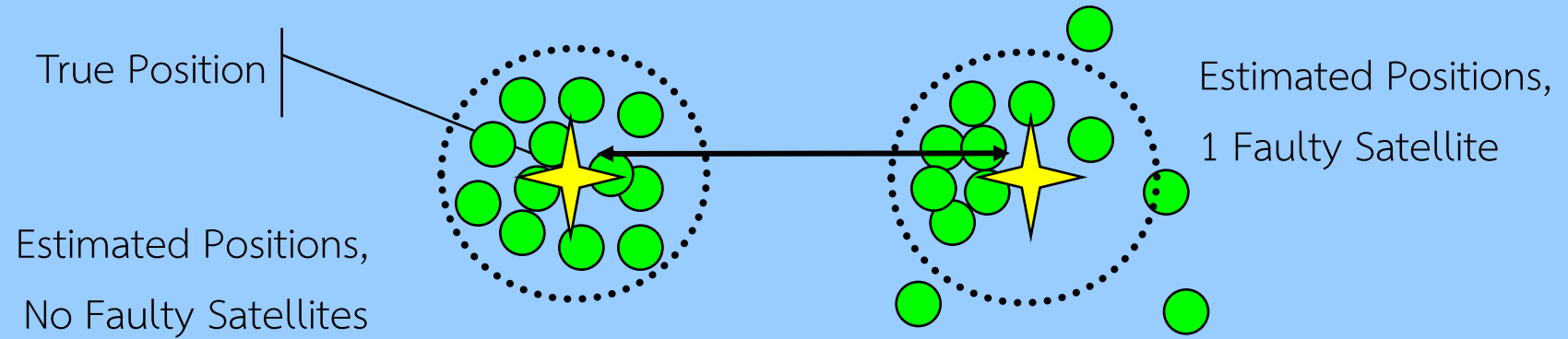
- GNSS is considered a main navigation infrastructure.
- GNSS is now becoming a critical component of surveillance system, such as ADS-B
- Unpredicted outages of GNSS services can cause undesired interruptions on aircraft operations



What is RAIM?

- Receiver Autonomous Integrity Monitoring (RAIM) provides integrity monitoring of GNSS satellites for aviation applications.
- RAIM utilizes redundancy of satellite signal measurements combined with aircraft barometric altitude equipment to detect any faulty satellite signal based on satellite geometry and probability analysis.

What is RAIM?



Checks the integrity of the position fix:

- Includes local errors, such as interference
- Based on the consistency of measurements

- redundant satellite measurements

A “rule of thumb”:

- 5+ satellites to detect a problem
- 6+ satellites to detect & isolate problem

Requires:

- no data from outside the satellite receiver

Most analyses assume only 1 faulty satellite

Multiple failures may be more difficult to detect



Operational Requirements

- ICAO Annex 10 and ICAO Doc 9613 PBN Manual require States and Air Navigation Service Providers (ANSPs) to provide timely warnings of GNSS RAIM outages.

4.3.4.1.3 Operators using GNSS equipment should confirm the availability of RAIM by using RAIM availability prediction software taking account of the latest GNSS NOTAMs. Operators using SBAS augmentation should also check the relevant SBAS NOTAMs to determine the availability of SBAS. Notwithstanding preflight analysis results, because of unplanned failure of some GNSS or DME elements (or local interference), pilots must realize that integrity availability (or GNSS/DME navigation altogether) may be lost while airborne which may require reversion to an alternate means of navigation. Therefore, pilots should assess their capability to navigate in case of failure of the primary sensor or the RNP system.



Operational Requirements

ICAO APANPIRG 22 – September 2011

Conclusion 22/24 – Endorsement of minimum Technical and Operational Requirements for a Regional RAIM Prediction System

That, the States in the Asia/Pacific Region be encouraged to participate in the Regional RAIM Prediction System and the Minimum Technical and Operational Requirements for ASIA/PAC Regional RAIM Prediction System provided be adopted.



Operational Requirements

- RAIM prediction results are needed daily by pilots, flight dispatchers, air traffic controllers and airspace planners.
- The use of appropriate RAIM prediction services is considered a necessary part of GNSS approvals.
- RAIM prediction is required for en-route, terminal area, and approach operations.

AEROTHAI's Progress

- Since September 2013, AEROTHAI has finished the procurement and testing of the RAIM prediction system.
- AEROTHAI's RAIM Prediction System utilizes the same engine as EUROCONTROL's AUGUR RAIM Prediction Service.
- The service can be accessed at www.netra.aero
- Full operations of NETRA Website for Bangkok FIR since Oct 2014.



NETRA Architecture

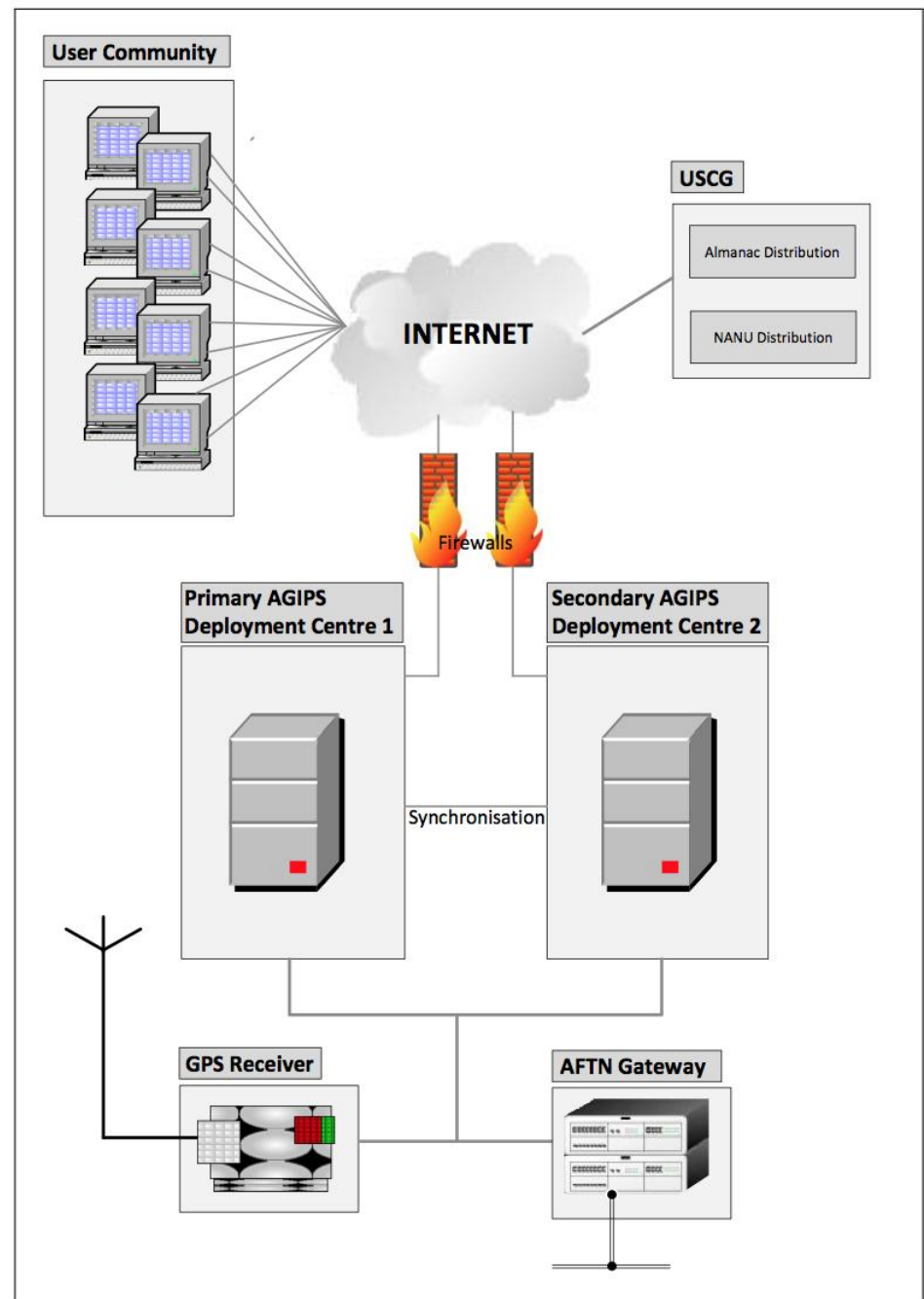
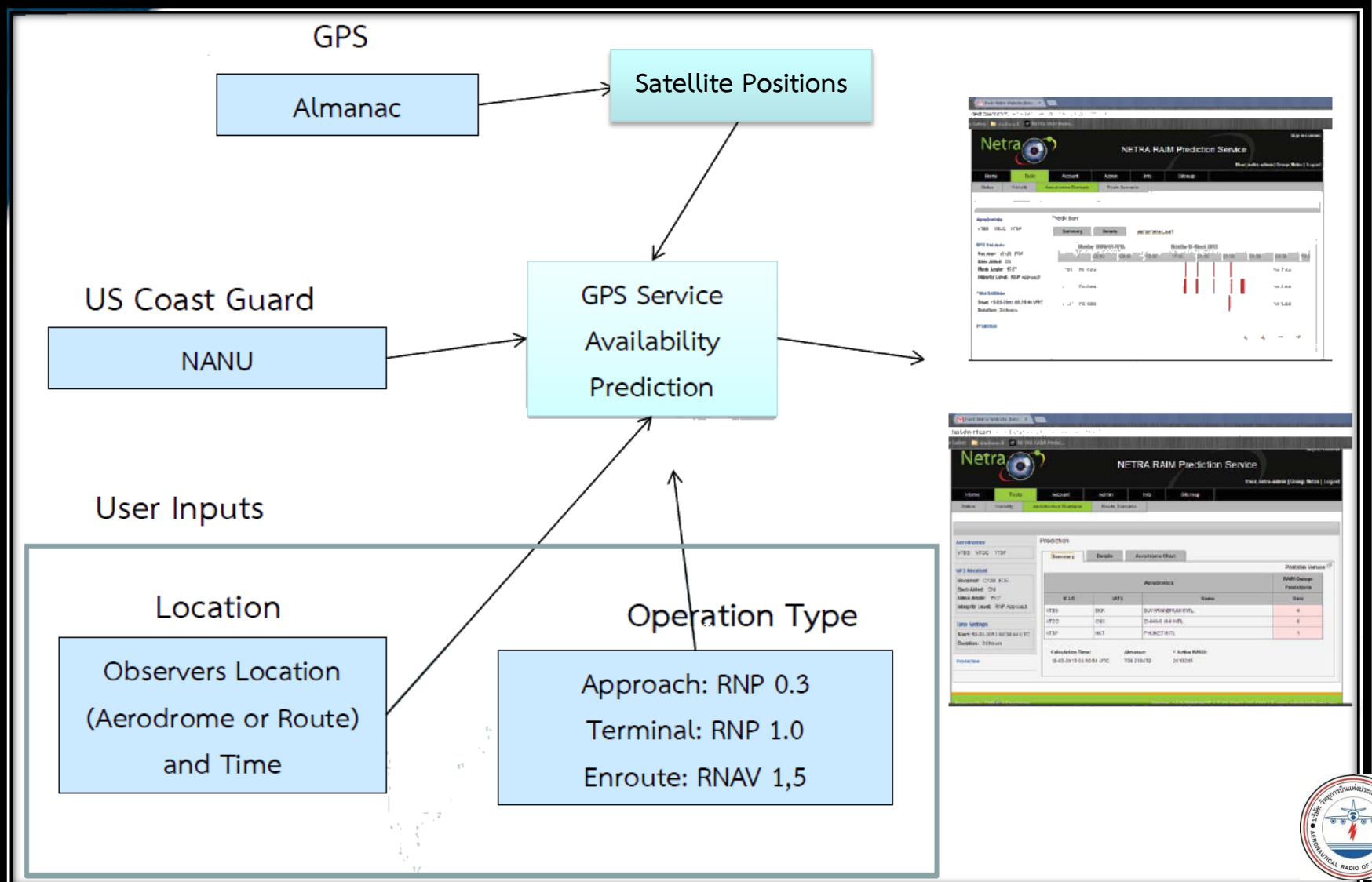


Figure 3 - NETRA Architecture



RAIM Prediction Process Diagram

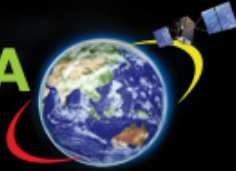


Phase	RAIM Design	RAIM Prediction
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NETRA RAIM Prediction Service

The NETRA RAIM Prediction Service has been developed to meet the RAIM prediction requirements as outlined in ICAO's Performance-Based Navigation (PBN) Manual (Doc 9613) including RNP 10, RNAV 5, RNAV 2, RNAV 1, RNP 4, RNP 1 (Basic RNP-1) and RNP Approach for the Asia Pacific region.

In addition NETRA's core service meets the requirements for RAIM prediction as outlined in International standards and advisory circulars including:

- Europe: EASA AMC 20-4, EASA AMC20-12, JAA TGL 10 (EASA AMC20-16), EASA AMC20-27, EASA AMC20-28.
- USA: FAA AC90-100(), FAA Order 8400.33 and FAA Order 8400.12()

For more information on the standards [click here](#).

NETRA has been designed for predictions relating to NAVSTAR GPS system.


NETRA provides access to four tools:

[Route Prediction](#) | [Aerodrome Prediction](#) | [Satellite Visibility](#) | [Constellation Status](#)

Registration

Login to perform RAIM predictions for Aerodromes and Routes.


To register send an email to netra_helpdesk@netra.aero and a representative from AeroThal will contact you as soon as possible with pricing information and contract options.



Who we are

Aeronautical Radio of Thailand Limited (AeroThal) is a state enterprise under the Ministry of Transport and Communications. This service is intended for use by member states of the ICAO APAC PBN Task Force.

Please visit the [AeroThal website](#) for further information about our products and services.






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Version: 1.0.2-SNAPSHOT | T: +66 2 237 8693 | E: netra_helpdesk@netra.aero

GPS Status: Current NANUs

Fwd: Netra Website (beta) x

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Scenario Time

Start: 18-03-2013 08:43:22 UTC
End: 21-03-2013 08:43:22 UTC
Duration: 72 hours

Overview

A minimum of 31 satellites are available during the query period.

Almanac

GPS Week: 708
GPS TOA: 233472
Total Satellites: 31
Unhealthy Satellites by PRN: none

[Report](#)

NANUs

Number	PRN	Start	Stop	Type
2013015	30	05-02-2013 21:28:00 UTC	06-02-2013 00:13:00 UTC	UNUSABLE

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Version: 1.0.0-SNAPSHOT | T: XX (X)XXX XXX XXXX | E: netra.helpdesk@netra.aero



Visibility Tool

(skyplot)




Visibility: Inputs

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Visibility Scenario

Location Name: SUVARNABHUMI INTL ICAO: VTBS IATA: BKK Latitude: 13.686° Longitude: 100.749° Elevation: 5 feet	Location Name: <input type="text" value="SUVARNABHUMI INTL"/> ICAO: <input type="text" value="VTBS"/> IATA: <input type="text" value="BKK"/> Latitude: <input type="text" value="13.686"/> degrees Longitude: <input type="text" value="100.749"/> degrees Elevation: <input type="text" value="5"/> feet <input type="button" value="OK"/> <input type="button" value="Lookup"/>
--	---

Configuration
Start: 18-03-2013 08:43:38 UTC
Duration: 1 hour
Samples: 5
Mask Angle: 5°

Prediction

Visibility: Satellite Sky Plot

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Visibility Scenario

Location

Name: SUVARNABHUMI INTL
 ICAO: VTBS
 IATA: BKK
 Latitude: 13.686°
 Longitude: 100.749°
 Elevation: 5 feet

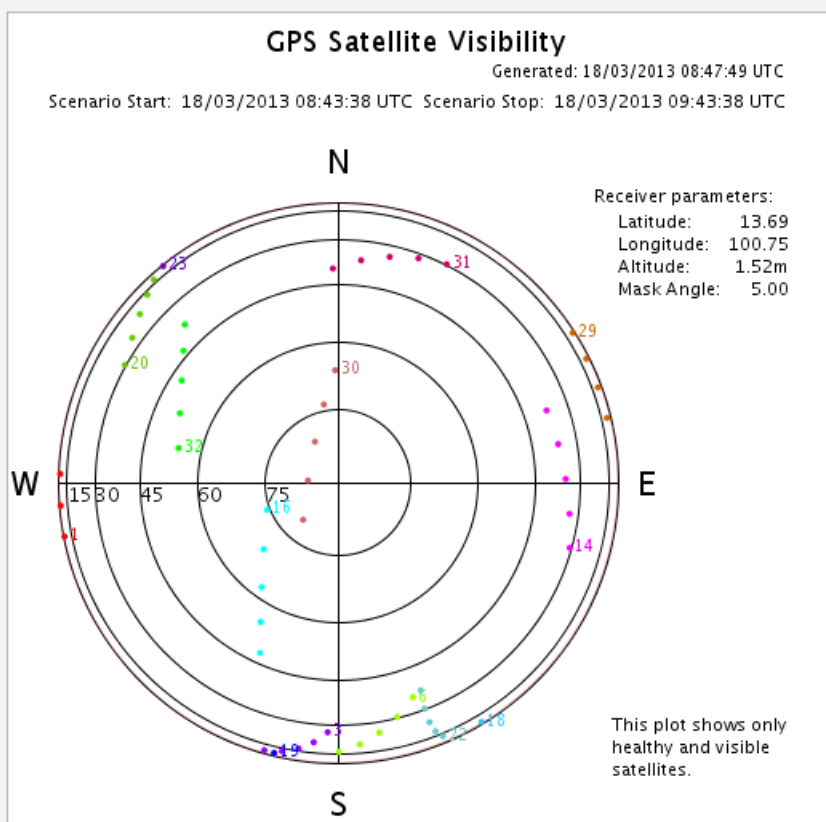
Configuration

Start: 18-03-2013 08:43:38 UTC
 Duration: 1 hour
 Samples: 5
 Mask Angle: 5°

Prediction

Prediction

Chart | **Table**



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Visibility: GPS Visibility Table

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Visibility Scenario

Location

Name: SUVARNABHUMI INTL
ICAO: VTBS
IATA: BKK
Latitude: 13.686°
Longitude: 100.749°
Elevation: 5 feet

Configuration

Start: 18-03-2013 08:43:38 UTC
Duration: 1 hour
Samples: 5
Mask Angle: 5°

Prediction

Prediction

Chart | **Table**

[Printable Version](#)

Time Instant: 18-03-2013 08:43:38 UTC			
PRN	Azimuth (Degrees)	Elevation (Degrees)	Visible
1	271.79096619102415	7.437665302866431	Visible
2	30.040564891536214	-40.94730505317565	Not Visible
3	195.38432561962233	7.817621631384403	Visible
4	353.0974773555276	-34.31134821653974	Not Visible
5	104.28622837434762	-75.46224818635913	Not Visible
6	179.77912246883906	16.116967665424028	Visible
7	234.33394302462364	-24.614241881298337	Not Visible
8	214.77400640734945	-40.19432823933812	Not Visible
9	138.7887207078528	-58.829126477767424	Not Visible
10	343.40017699980893	-63.268485023085546	Not Visible
11	249.94842932654734	1.907954620149086	Not Visible
12	32.4986994609971	-24.609777140275853	Not Visible
13	291.3091498779766	-24.75358513663917	Not Visible
14	70.96914179384062	37.99354726891827	Visible
15	137.52184019864166	-34.45162661730649	Not Visible
16	204.531882665882	48.051495814856516	Visible




Aerodrome Tool

RAIM Predictions: by Aerodrome

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Aerodromes ! **Aerodromes**
One or more aerodromes are required.

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ICAO	IATA	Name	Elevation	Latitude	Longitude
<input type="button" value="Add Custom"/> <input type="button" value="Show Lookup"/>					

GPS Receiver

Receiver: C129 FDE
Baro Aided: ON
Mask Angle: 15.0°
Integrity Level: RNP Approach

Time Settings

Start: 18-03-2013 08:39:44 UTC
Duration: 24 hours


Prediction !

RAIM Predictions: by Aerodrome

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Aerodromes

VTBS VTCC VTSP

GPS Receiver

Receiver: C129 FD
Baro Aided: OFF
Mask Angle: 5.0°
Integrity Level: RNP Approach

Time Settings

Start: 18-03-2013 08:39:44 UTC
Duration: 24 hours

Prediction

Aerodromes

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ICAO	IATA	Name	Elevation	Latitude	Longitude	
VTBS	BKK	SUVARNABHUMI INTL	5.0 ft	13.6858333°	100.7488889°	✘
VTCC	CNX	CHIANG MAI INTL	1036.0 ft	18.7713889°	98.9627778°	✘
VTSP	HKT	PHUKET INTL	82.0 ft	8.1125°	98.3091667°	✘

RAIM Aerodrome Prediction: Summary

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Aerodromes

VTBS VTCC VTSP

GPS Receiver

Receiver: C129 FDE
Baro Aided: ON
Mask Angle: 15.0°
Integrity Level: RNP Approach

Time Settings

Start: 18-03-2013 08:39:44 UTC
Duration: 24 hours

Prediction

Prediction

Summary
Details
Aerodrome Chart

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Aerodromes			RAIM Outage Predictions
ICAO	IATA	Name	Baro
VTBS	BKK	SUARNABHUMI INTL	4
VTCC	CNX	CHIANG MAI INTL	6
VTSP	HKT	PHUKET INTL	1

Calculation Time: 18-03-2013 08:50:56 UTC Almanac: 708 233472 1 Active NANU: 2013015



RAIM Aerodrome Prediction: Details

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Aerodromes

VTBS VTCC VTSP

GPS Receiver

Receiver: C-129 FDE
Baro Aided: ON
Mask Angle: 15.0°
Integrity Level: RNP Approach

Time Settings

Start: 18-03-2013 08:39:44 UTC
Duration: 24 hours

Prediction

Prediction

Summary | Details | Aerodrome Chart

Printable Version

VTBS | VTCC | VTSP

Name: SUVARNABHUMI **Start Time:** 18-03-2013 08:39:44 UTC
Latitude: INTL **Duration:** 24 Hours
Longitude: 13.6858333 degrees **End Time:** 19-03-2013 08:39:44 UTC
Elevation: 100.7488889 degrees **Mask Angle:** 15.0 degrees
5.0 feet **Integrity Level:** RNP Approach

Baro Aided Outages			
Start	End	Duration	Min. Visible Satellites
18-03-2013 19:14:14 UTC	18-03-2013 19:24:14 UTC	10m	7
18-03-2013 21:07:14 UTC	18-03-2013 21:17:14 UTC	10m	7
18-03-2013 23:33:14 UTC	18-03-2013 23:45:14 UTC	12m	8
19-03-2013 02:13:14 UTC	19-03-2013 02:27:14 UTC	14m	7


Calculation Time: 18-03-2013 08:50:56 UTC **Almanac:** 708 233472 **1 Active NANU:** 2013015

RAIM Aerodrome Prediction: Outage Chart

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Aerodromes Scenario
Route Scenario

Aerodromes

VTBS VTCC VTSP

GPS Receiver

Receiver: C129 FDE
Baro Aided: ON
Mask Angle: 15.0°
Integrity Level: RNP Approach

Time Settings

Start: 18-03-2013 08:39:44 UTC
Duration: 24 hours

Prediction

Prediction

Summary
Details
Aerodrome Chart

	Monday 18 March 2013				Monday 18 March 2013				
	05:00	09:00	13:00	17:00	21:00	01:00	05:00	09:00	13:00
VTBS	No data								No Data
VTCC	No data								No Data
VTSP	No data								No Data

←
→



Route Tool




RAIM Route Prediction

Fwd: Netra Website (beta) x

/test.dwint.com/netra-beta/route-scenario.html?13

e Gallery | NETRA RAIM Predic...


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NETRA RAIM Prediction Service

User: netra-admin | Group: Netra | Logout

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Route Sections

Section 1 - (0)

Aerodromes

GPS Receiver

Receiver: C129 FD OFF
Baro Aided: OFF

Time Settings

Start: 18-03-2013 08:52:36 UTC

Prediction

Route Sections

Section 1 contains too few route points, route sections need to contain at least two points.

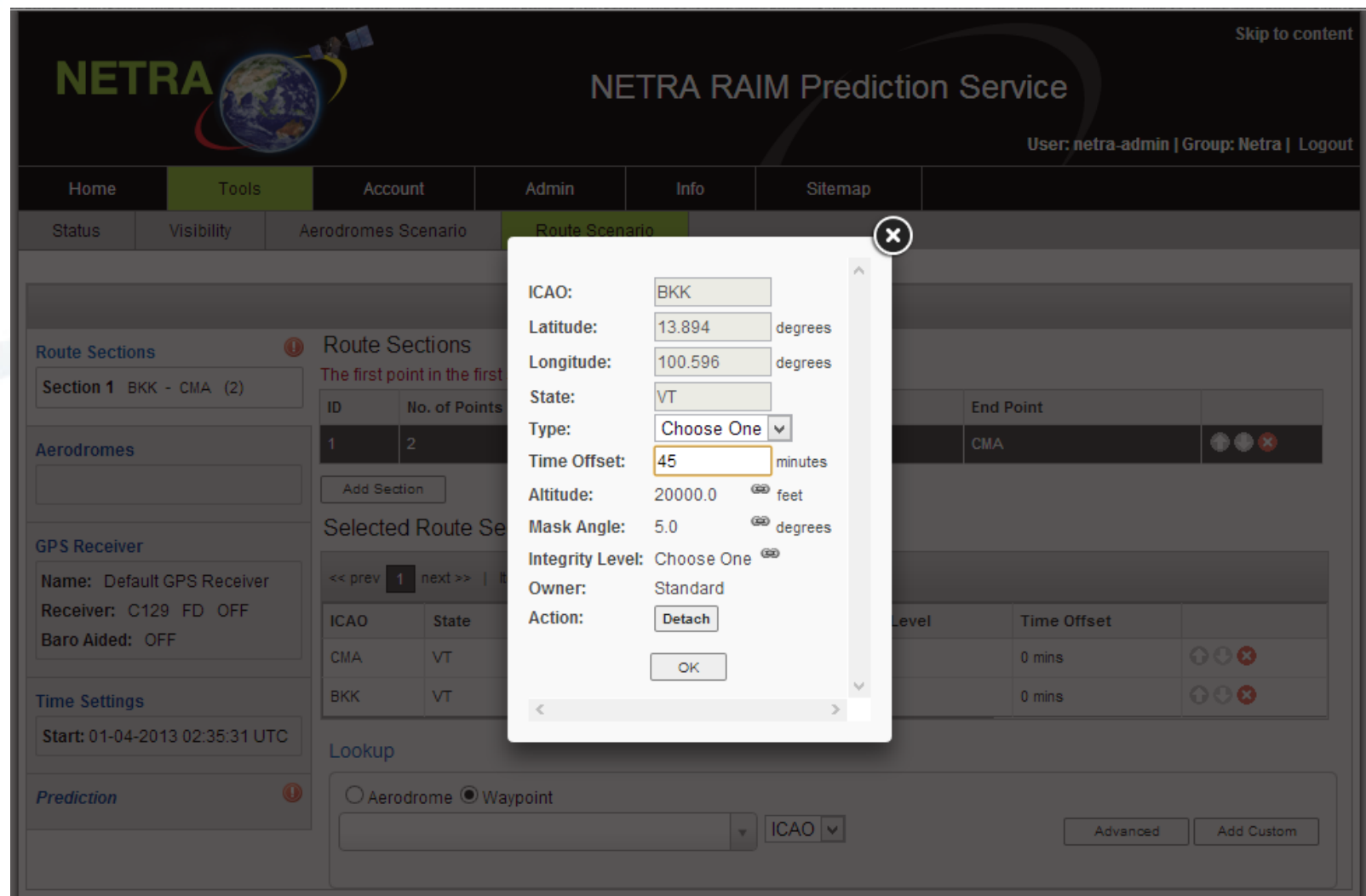
ID	No. of Points	Start Point	End Point	
1	0			⊕ ⊖ ✕

Selected Route Section Points

<< prev next >> | Items per page: 5

ICAO	State	Altitude	Mask Angle	Integrity Level	Time Offset

RAIM Route Prediction: Waypoint Selection



The screenshot displays the NETRA RAIM Prediction Service interface. A modal dialog box is open for editing a waypoint. The dialog contains the following fields:



- ICAO: BKK
- Latitude: 13.894 degrees
- Longitude: 100.596 degrees
- State: VT
- Type: Choose One (dropdown)
- Time Offset: 45 minutes
- Altitude: 20000.0 feet
- Mask Angle: 5.0 degrees
- Integrity Level: Choose One (dropdown)
- Owner: Standard
- Action: Detach

Buttons for 'OK' and 'Detach' are visible at the bottom of the dialog. The background interface shows a navigation menu with 'Tools' selected, and a 'Route Scenario' tab active. The main content area displays 'Route Sections' with a table for 'Section 1 BKK - CMA (2)'. The table has columns for 'ID' and 'No. of Points', with row 1 containing '1' and '2'. Below the table is an 'Add Section' button. A 'Selected Route Section' table shows the following data:

ICAO	State
CMA	VT
BKK	VT

At the bottom of the dialog, there is a 'Lookup' section with radio buttons for 'Aerodrome' and 'Waypoint' (selected), a search input field, and a dropdown for 'ICAO'. There are also 'Advanced' and 'Add Custom' buttons.

RAIM Route Prediction: Route Creation



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Route Sections

Section 1 BKK - CMA (2)

Aerodromes

GPS Receiver

Name: Default GPS Receiver
Receiver: C129 FD OFF
Baro Aided: OFF

Time Settings

Start: 01-04-2013 02:35:31 UTC

Prediction

Route Sections

The first point in the first section must have an integrity level.

ID	No. of Points	Start Point	End Point
1	2	BKK	CMA

Add Section

Selected Route Section Points

<< prev 1 next >> | Items per page: 5

ICAO	State	Altitude	Mask Angle	Integrity Level	Time Offset
CMA	VT	20000.0 ft	5.0°		0 mins
BKK	VT	20000.0 ft	5.0°		0 mins

Lookup

Aerodrome Waypoint

Advanced Add Custom

RAIM Route Prediction: Summary

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Route Sections

Section 1 CMA - BKK (2)

Aerodromes

VTCC VTBD

GPS Receiver

Name: Default GPS Receiver
 Receiver: C145 C146 FDE
 OFF
 Baro Aided: OFF

Time Settings

Start: 01-04-2013 04:35:00 UTC

Prediction

Prediction

Summary
Details
Route Chart
Aerodrome Chart

[Printable Version](#)

Route - RAIM Outage Predictions							
Section	Time Offsets (minutes relative to OTD)						
	-15	-10	-5	0	+5	+10	+15
Section 1:	0	0	0	0	0	0	0

Calculation Time:
01-04-2013 02:58:54 UTC

Almanac:
710 233472

2 Active NANUs:
2013022, 2013023

Aerodromes			RAIM Outage Predictions
ICAO	IATA	Name	Non-Baro
VTCC	CNX	CHIANG MAI INTL	2
VTBD	DMK	DON MUEANG INTL	1

Calculation Time:
01-04-2013 02:58:54 UTC

Almanac:
710 233472

2 Active NANUs:
2013022, 2013023

RAIM Route Prediction: Details by Legs

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NETRA RAIM Prediction Service

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Route Sections

Section 1 CMA - BKK (2)

Aerodromes

GPS Receiver

Name: Default GPS Receiver
Receiver: C145 C148 FDE
OFF
Baro Aided: OFF

Time Settings

Start: 01-04-2013 02:35:31 UTC

Prediction

Prediction

Summary **Details** Route Chart Aerodrome Chart

Printable Version

Section 1 By Leg By Outage

Leg	Time Offsets (minutes)						
	-15	-10	-5	0	+5	+10	+15
CMA - BKK	0	0	0	0	0	0	0

Time Offset (minutes)	Outages	Legs Affected
-15	0	-
-10	0	-
-5	0	-
0	0	-
+5	0	-
+10	0	-
+15	0	-

Calculation Time:
01-04-2013 02:48:02 UTC

Almanac:
710 233472

2 Active NANUs:
2013022, 2013023

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RAIM Route Prediction: Details by Outage

Route Sections

Section 1 CMA - BKK (2)

Aerodromes

GPS Receiver

Name: Default GPS Receiver
Receiver: C145 C146 FDE
OFF
Baro Aided: OFF

Time Settings

Start: 01-04-2013 02:35:31 UTC

Prediction

Prediction

Printable Version

By Leg By Outage

Section 1

-15 minute offset				
Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

-10 minute offset

Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

-5 minute offset

Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

0 minute offset

Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

+5 minute offset

Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

+10 minute offset


Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

+15 minute offset

Start	End	Duration	Legs	Min. Visible Satellites
No Outages				

Calculation Time: 01-04-2013 02:48:02 UTC Almanac: 710 233472 2 Active NANUs: 2013022, 2013023

RAIM Route Prediction: Outage Chart

skip to content

NETRA RAIM Prediction Service
User: netra-admin | Group: Netra | Logout

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Route sections

Section 1 CMA - BKK (2)

Aerodromes

GPS Receiver

Name: Default GPS Receiver
Receiver: C145 C146 FDE
OFF
Baro Aided: OFF

Time Settings


Start: 01-04-2013 02:35:31 UTC

Prediction

Prediction

Summary
Details
Route Chart
Aerodrome Chart

Monday 1 April 2013		0	01:45	02:00	02:15	02:30	02:45	03:00	03:15	03:30	03:45	04:00	04:
1: -15													
2: -10													
3: -5													
4: 0													
5: 5													
6: 10													
7: 15													
-													



Key

No Calculation Data

Outage Present

Controls

Show Waypoints:

Show Waypoint Labels:

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RAIM Aerodrome Prediction: Outage Chart

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Route Sections

Section 1 CMA - BKK (2)

Aerodromes

VTCC VTBD

GPS Receiver

Name: Default GPS Receiver
Receiver: C145 C146 FDE
OFF
Baro Aided: OFF

Time Settings

Start: 01-04-2013 04:35:00 UTC

Prediction

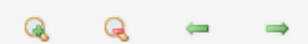
Prediction

Summary
Details
Route Chart
Aerodrome Chart

Outage Type

Non Baro

	Sunday 31 March 2013				Monday 1 April 2013	
	01:00	05:00	09:00	13:00	17:00	21:00
VTBD		█				
VTCC		█				
-						



Key

No Calculation Data

Outage Present



Region Tool

NETRA



NETRA RAIM Prediction Service

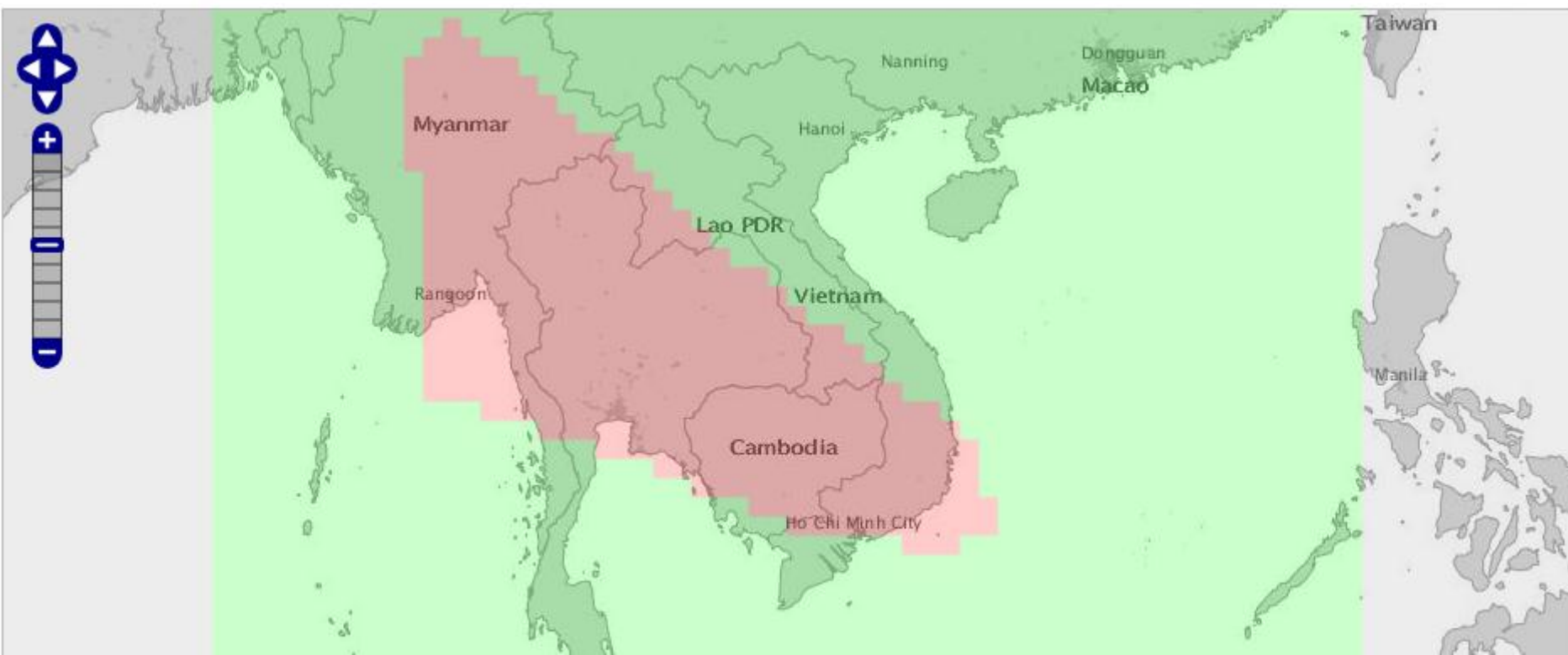
User: pabhakara | Group: Netra | Logout

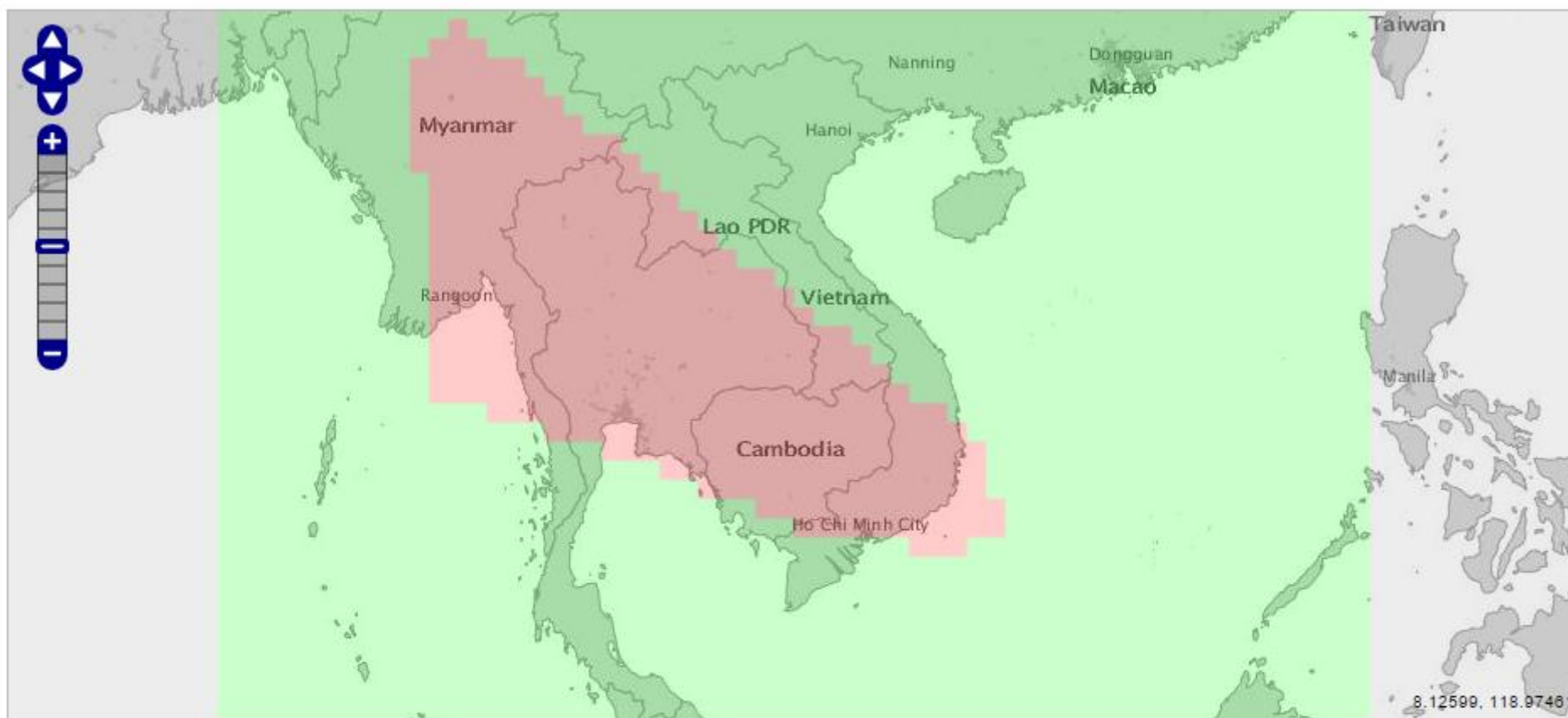
Home	Tools	Account	Admin	Info	Sitemap
Status	Visibility	Region	Aerodromes Scenario	Route Scenario	

Name: NETRA
Description: NETRA

Config: C_145_6 FDE Non-Baro
Elevation: 3048m
Mask Angle: 5°

Integrity Level: RNP Approach
Arguments:





Selected period: From 06-05-2015 18:00 to 06-05-2015 19:00.

Showing overview.

05-05-2015				06-05-2015																			
20 - 0				0 - 20																			
20 - 0				0 - 12								12 - 20											
20 - 0				0 - 6				6 - 12				12 - 18				18 - 20							
20	21	22	23	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19



RAIM NOTAM

Proposals



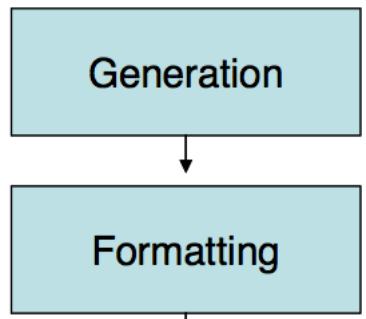
Thailand's Progress

- Since April 2015, AEROTHAI has upgraded NETRA to include the GPS RAIM NOTAM system.
- RAIM Outage Predictions will be sent out everyday at 2200 UTC for each of the aerodromes in Thailand that have GNSS procedures. (Currently, a total of 15 aerodromes)
- Full operations of RAIM NOTAM service for Bangkok FIR expected in June 2015.

RAIM NOTAM Process:

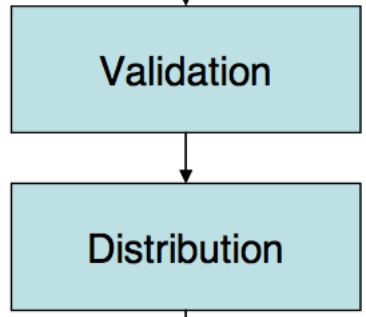
DWI

Under the NOTAM Generator responsibility



via AFTN and email

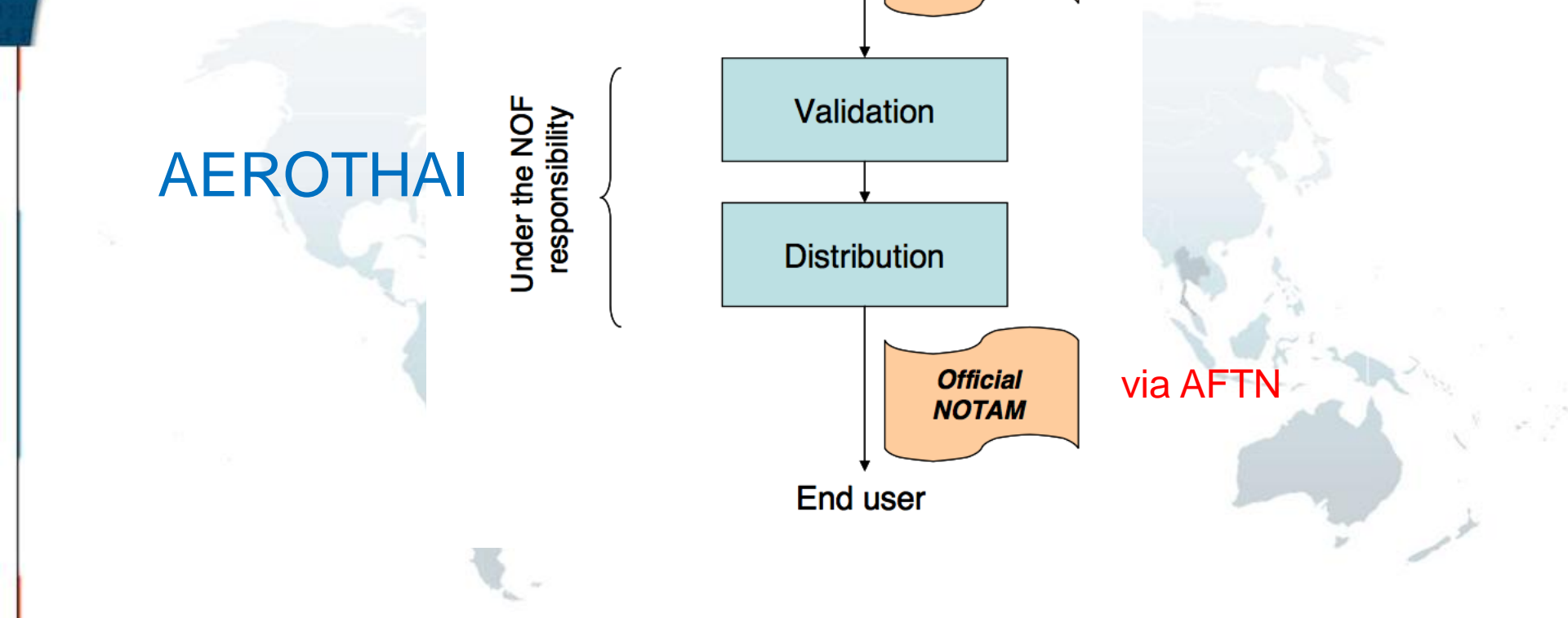
Under the NOF responsibility



via AFTN

End user

AEROTHAI





RAIM Prediction

(for NOTAM): AEROTHAI

Axxxx/YY NOTAMR

Q)VTBB/QGAXX/I/NBO/A/000/999/1341N10044E025

A)VTBS B)150506 0000 C)150507 2359

E)GPS RAIM PREDICTION FOR:

TSO-C129 FAULT DETECTION

NO GPS RAIM OUTAGES

TSO-C146A FAULT DETECTION ONLY

NO GPS RAIM OUTAGES

TSO-C146A FAULT DETECTION WITH EXCLUSION

20150506 1816 til 20150506 1828

20150507 1812 til 20150507 1825

GPS RAIM UNAVAILABLE FOR RNP APPROACH



RAIM Prediction

(for NOTAM): AEROTHAI

Axxxx/YY NOTAMR

Q) VTBB/QGAXX/I/NBO/A/000/999/0806N09818E025

A) VTSP B) 150506 0000 C) 150507 2359

E) GPS RAIM PREDICTION FOR:

TSO-C129 FAULT DETECTION

NO GPS RAIM OUTAGES

TSO-C146A FAULT DETECTION ONLY

NO GPS RAIM OUTAGES

TSO-C146A FAULT DETECTION WITH EXCLUSION

NO GPS RAIM OUTAGES



Thank you for your attention!

For more information, please contact

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Airspace Design Manager

Aeronautical Radio of Thailand Ltd.

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