Automotive Product Group
Automotive Infotainment Division

Navigation & Multimedia System & Architecture
SBAS Automatic Search Algorithm Description

1 Introduction

SBAS is a system of geostationary satellites located over three world regions that provides for every visible GPS satellite correction to have a more accurate user position. This correction is compound by three contributions that permit to correct the error due to three different effects related to the ionosphere, the troposphere and the satellite, respectively.

This document contains an overview of the algorithm implemented for the Automatic Search of the SBAS satellite.

In the following this algorithm will be referred as SBAS AutoSearch.

In section [4] the main flow of the algorithm is described and in section [5] the way to start and stop the AutoSearch algorithm at application level is reported.

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3 Document Management

3.1 Revision History

Rev	Date	Author	Notes
1.0	13/12/2012	Antonio Cascella	First revision.
1.1	17/12/2014	Antonio Furno	General review.

Table 1: Revision history

3.2 Acronyms

Keyword	Definition
DGPS	Differential GPS (it is the RTCM SC-104)
GLONASS	GLObal NAvigation Satellite System (the GNSS operated by the Russian Aerospace Defence Forces)
GNSS	Global Navigation Satellite System – It can include any combination of different satellite constellations like GPS, GLONASS, SBAS etc.
GPS	Global Positioning System (The GNSS created and realized by the U.S. Department of Defense)
NVM	Non Volatile Memory (In the contest of this document it is referred to the GNSS backup memory)
PGPS	Server based assisted GPS
PPS	Pulse Per Second
RTC	Real Time Clock
SBAS	Satellite Based Augmentation System
STAGPS	Self Trained Assisted GPS.
QZSS	Quasi-Zenith Satellite System
DTE	Data Terminal Equipment

Table 2. Acronyms

3.3 Reference Documents

Version	Document name
3.14	GNSS NMEA Interfaces

Table 3. Reference Documents

4 SBAS Automatic Search Algorithm Overview

In order to get as soon as possible the differential correction, the SBAS AutoSearch uses two hardware channels:

- Decoding Channel
- Searching Channel

4.1 Decoding Channel

In the Figure1 the flow diagram reports the main actions performed by the SBAS AutoSearch using the decoding channel.

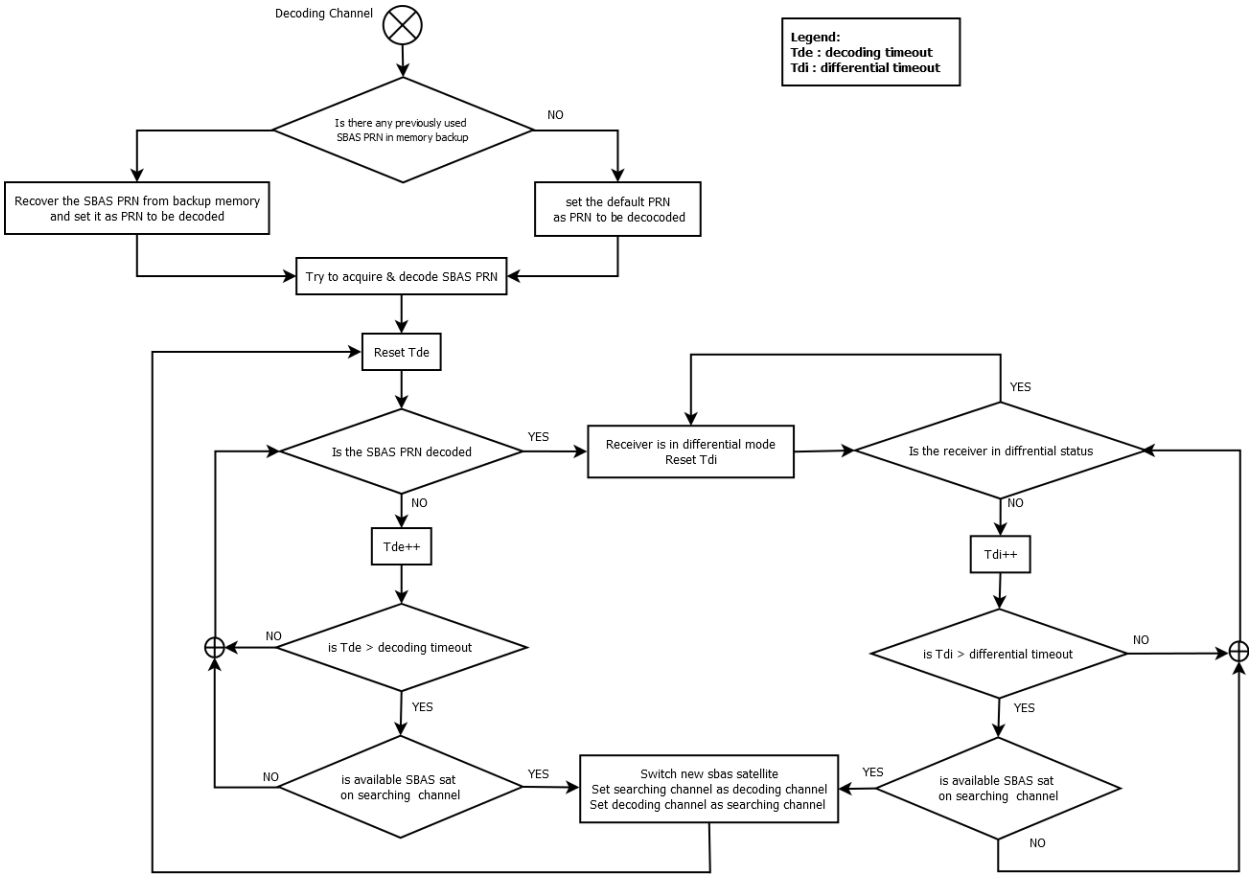

Figure1: Flow chart describing the Decoding Phase of SBAS AutoSearch Algorithm

Once the SBAS AutoSearch is launched, the presence inside the backup memory (NVM) of an already stored decoded SBAS satellite ID is checked. This operation is performed to determine which SBAS satellite ID (or PRN) shall be elected as PRN to be decoded; if there is no stored SBAS satellite inside the NVM, the default SBAS[1] satellite is set.

The overall SBAS differential correction mechanism can be conceived as built in 2 phases:

- "Acquire & Tracking" phase
- "Decoding" phase.

The "Acquire & Track" phase relates to the capacity of the acquisition engine to reliably track the configured SBAS satellite; during decoding phase the SBAS message can be decoded to fetch the differential corrections.

At startup this two phases are timed out[2] using *Tde* counter to permit to swap from current SBAS PRN on decoding channel to next candidate SBAS PRN on searching channel, if it is available.

The SBAS AutoSearch checks also if for a long time interval the receiver is no more in differential status. The NO differential condition is timed out[3] by *Tdi* counter to allow swapping to next SBAS PRN on searching channel, if it is present.

[1] Usually the default SBAS PRN is 124 (EGNOS). It can be configured

[2] The default value is 120 seconds. It can be configured

[3] The default value is 120 seconds. It can be configured

4.2 Searching Channel

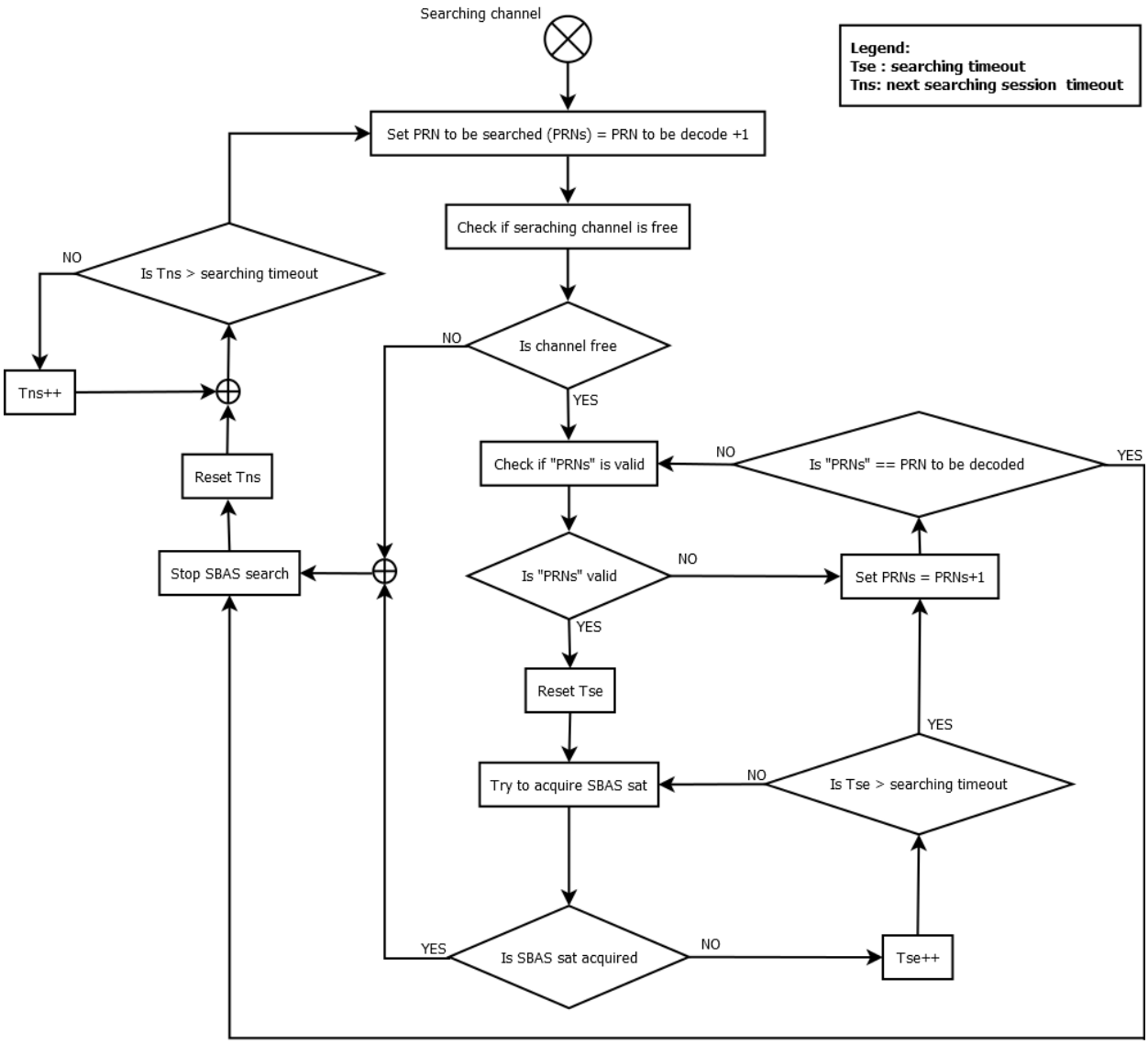

Figure2: Flow chart describing the Searching Phase of SBAS AutoSearch Algorithm

When the SBAS AutoSearch is enabled, the searching channel tries to acquire and track a second SBAS satellite in view.

After determining the first PRN to be searched (PRN on decoding channel +1), the SBAS auto search checks if the searching channel is free.

Before setting the new PRN on searching channel, the SBAS AutoSearch checks if it is a valid id, verifying if the SBAS id is in the [120,138] list and if the PRN has to be excluded as the user position is not in correct area.

The current longitude limits for each service are:

- WAAS -180 to -25 degrees

- EGNOS -25 degrees to +50 degrees
- GAGAN +50 degrees to +100 degrees
- MSAS +100 degrees to +180 degrees

The “Acquire & Track” is timed out[4] by *Tse* counter to permit to set the next satellite in SBAS list.

The searching phase stops if a new SBAS satellite is acquired and tracked or the SBAS list scrolling is completed.

The stop phase is timed out (Tns) in order to allow restarting the new research.

5 Application Management of the SBAS Automatic Search Algorithm

5.1 NMEA Commands

This section describes the NMEA commands to start and stop the SBAS Automatic Search Algorithm and the actions implemented when they are called; refer to [1] for a formal description of the proprietary commands here reported.

To start the SBAS Automatic Search algorithm the following NMEA command shall be sent over the NMEA port:

$PSTMSBASAUTOSEARCH,1<cr><lf>

Once the AutoSearch algorithm has been started, it shall be turned off using the following command:

$PSTMSBASAUTOSEARCH,0<cr><lf>

5.2 Configuration Block

It is possible to change some SBAS AutoSearch parameter using the firmware configuration facility.

Here after are reported the IDs of different parameter. Refer to [2] for more details.

- CDB-ID 200: allow to enable/disable the SBAS AutoSearch setting/resetting bit 28
- CDB-ID 216: allow to configure decode timeout (Tde) and differential timeout (Tdi). The first 16 LSBs refer to Tde; the bit 17:32 refer to Tdi
- CDB-ID 217: allow to configure next sat timeout (Tse) and next session timeout(Tns) (Tdi). The first 16 LSBs refer to Tse; the bit 17:32 refer to Tns

[4] The default value is 90 seconds. It can be configured

5.3 API for application management

5.3.1 waas_enable_autosearch

Allows turning ON the SBAS automatic search algorithm.

Synopsis:

```
#include "waas.h"

void waas_enable_autosearch( void);
```

Arguments:

None

Results:

None.

Errors:

None.

Description:

The SBAS automatic search algorithm is tuned ON.

5.3.2 waas_disable_autosearch

Allows turning OFF the SBAS automatic search algorithm.

Synopsis:

```
#include "waas.h"

void waas_disable_autosearch( void);
```

Arguments:

None

Results:

None.

Errors:

None.

Description:

The SBAS automatic search algorithm is tuned OFF.

5.3.3 gnss_set_tracking_threshold

Allow setting the timeout values

Synopsis:

```
#include "gnss_api.h"

void waas_autosearch_set_timeout( int Tse, int Tns, int Tde, int
Tdi);
```

Arguments:

`Int Tse`:	New next sat search timeout value in seconds
`Int Tns`:	New next session timeout value in seconds
`Int Tde`:	New decoding timeout value in seconds
`Int Tdi`:	New differential timeout value in seconds

Results:

None

Errors:

None

Description:

Change the timeout values. Tse and Tns refer to searching channel; Tde and Tdi refer to decoding channel.

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