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EfficienSea
Efficient, Safe and Sustainable Traffic at Sea

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Implementation AtoN and synthetic AIS AtoN service availability and reliability algorithms

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ANNOTATION

This document describes working principles and use of the automated AtoN service availability monitoring functionality implemented in the TeViNSA system (previously known as GPRS Monitoring Centre E752). Continuous availability monitoring results used for aids to navigation system performance counter of quality management system of Estonian Maritime Administration.

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1 Introduction

1.1 Scope and purpose

This document describes the software solution for continuous monitoring of several availability parameters for AtoN and synthetic AIS AtoN in particular implemented in the TeViNSA (*Telematics for Visual Navigation Situational Awareness*) system. The solution was developed by Cybernetica AS in cooperation with the Estonian Maritime Administration within the framework of the *Efficient, Safe and Sustainable Traffic at Sea (EfficienSea)* project that was part of the *Baltic Sea Region Programme 2007-2013.*

Availability in general is a measure of the ratio of available service time to the required service time. Marine aids to navigation (AtoN) availability refers to availabilities of the light signalling system, location, and synthetic AtoN AIS information broadcasting over the shore side AIS radio network. Availability can be calculated for various time periods, from a day to several years, and it is the main measure characterizing a single AtoN or a system as a whole – design, realization, and quality of service. This measure displays the weak points, thus allowing to improve the system.

On the other hand, collection and monitoring of availability data of AtoN is not an easy task since it depends on availability and reliability of sophisticated communication systems and the monitoring centre implementation itself. Both should be at exceptionally high availability level to provide availability calculations that can be trusted.

1.2 Abbreviations used

Abbreviation	Explanation
AIS	Universal *Automatic Identification System* used for marine navigation safety related ship-to-ship, ship-to-shore and shore-to-ship digital communications based on the standard ITU-R M.1371
AtoN	*Aid to Navigation*; refers either to a marine visual aid to navigation site in general, or to a set of electro-optical systems of an AtoN outstation for provision of visual light signalling.
GPRS	*General Packet Radio Service;* a GSM cellular network service for TCP/IP based data communications
GSM	*Global System for Mobile Communication*; a digital radio communication network standard (900/1800 MHz in Europe)
GMC	GPRS Monitoring Centre E752, set of software components developed by Cybernetica AS
GDB	Database component of the GMC, based on PostgreSQL
GBE	GPRS back-end component of the GMC, component to link logically AtoN outstations and GDB

Abbreviation	Explanation
NMEA	National Marine Electronics Association, best known by NMEA 0183 data format, data specification for communication between marine electronic devices such as echo sounder, sonar, anemometer, gyrocompass, autopilot, GPS receivers etc.
SNME	Synthetic AIS NMEA-like Messages are NMEA like ASCII coded sentences containing all necessary and information to form AIS M21, and also M12 and / or M14 if AtoN is not functioning as required (wrong location or light error)
TelFiCon	*Telematics Field Controller*; a GSM/GPRS/GPS based AtoN telematics hardware module developed and manufactured by Cybernetica AS
TeViNSA	*Telematics for Visual Navigation Situational Awareness*; a set of software and hardware components developed by Cybernetica AS for remote control and monitoring of remote AtoN site systems, measurement and broadcasting over AIS of relevant e-Navigation data

1.3 References

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2. GPRS-keskuse andmebaasi kirjeldus, Cybernetica AS, N-B67250-14
3. Pakettside (GPRS) Serveri (PaSS) ja EVA AIS serveri vaheline protokoll, versioon 1.9, N-B76250-2
4. AIS Router – a module for routing AtoN-specific AIS messages M8, M12, M14 and M21. Cybernetica AS, Y-399-28
5. Telematics Controller Telficon E9261. Instructions for Use. Cybernetica AS, 9261.004
6. IALA Recommendation O-130 On Categorization and Availability Objectives for Short Range Aids to Navigation, Edition 2, June 2011
7. IALA Recommendation A-126 On The use of the Automatic Identification System (AIS) in Marine Aids to Navigation Services, Edition 1.5, June 2011.
8. IALA Guideline No. 1035 To Availability and Reliability of Aids to Navigation, Theory and Examples, Edition 2, December 2004
9. AIS Router – a module for routing AtoN-specific AIS messages M8, M12, M14 and M21. Cybernetica AS, Y-399-28

2 Purpose

Provide availability information for:

- Fixed AtoN-s:
    - Light availability.
    - Light uncertainty
    - GPRS communication availability
- Floating AtoN-s. Additionally to fixed AtoN-s:
    - Location availability
    - Location uncertainty
    - Heel availability
    - Heel uncertainty
- Synthetic AIS AtoN-s. Additionally:
    - AIS transponder availability.
- Common for all AtoN-s:
    - GBE availability (no monitoring, also no synthetic AIS if GBE is not working)
- Availability should be calculated also for leading lights as single system using availability figures calculated for its components – AtoNs. This causes new type of pseudo-AtoN to be introduced and handled with its management forms and availability statistics.

Provide possibility to enter corrections for collected availability input data that can't be certain enough. Only person with sufficient rights can correct data. Each correction should be auto-commented by person user-name, data and correction value, and also commented by this person itself.

Availability should be calculated for following fixed time-periods:

- Day
- Month starting from 1-st date
- 3 month period available from beginning of any month with 3 consecutive months having month data available
- Year, starting from 1. January
- 3-years period available from beginning of any year with 3 consecutive years having month data available

For single AtoN many records with user chosen fixed period data should be displayed on GMC web-form. Also mean values for all records should be displayed.

There should be also combined availabilities and uncertainties for displayed records to be available for following combinations:

1. Light and heel

2. Light, heel and location
3. Light and location
4. Heel and location

Collect additional AtoN based information about synthetic AIS functioning to find out weakest component, research usability of AIS M12 and M14 messages and assess synthetic AIS as whole (GMC web forms for displaying this data will be created if future):

1. Number of composed by GBE synthetic AIS NMEA like messages (SANM).
2. Number of SANM-s successfully sent to AIS Router
3. Number of SANM-s positively acknowledged by AIS Router (according AIS M21 is formed and sent to AIS radio network)
4. Number of SANM-s negatively acknowledged by AIS Router (AIS M21 cannot be formed or sent out)
5. AIS location total delay (from reading coordinates of GPS till getting positive acknowledge from AIS Router) is too big (>59.5s, cannot be placed in AIS M21 time-stamp field)
6. Sum of all AIS location total delays (only positively acknowledged by AIS Router SANM-s)
7. Sum of squares all AIS location total delays (only positively acknowledged by AIS Router SANM-s, for characterizing spread of AIS location total delay)
8. Number of SANM-s formed with safety messages in it (in case of wrong location or light failure)
9. Number of addressed AIS M12-s formed and sent by AIS shore system (AIS Router sends to GBE message about this event, one safety message can cause zero or more M12-s)
10. Number of multicast AIS M14-s formed and sent by AIS shore system (AIS Router sends to GBE message about this event, one safety message can cause zero or more M14-s)

Possibility to track commented events of temporary discontinue and re-establish AtoN, possibility to have report of temporary discontinue periods of AtoN-s.

Following paragraphs will explain GMC approach to handle those goals.

2.1 Light signal availability

Availability of an AtoN light signal *lta* is calculated as follows:

lta = (ldst – ldt) / ldst

where:

ldst *light declared service time*. For night time AtoN lights it should be a time period beginning at the end of the day, before dusk when the ambient light intensity falls below light sensor activation level, and ending at dawn (after the sunrise) according to local geographical time. Duration of the night time period is calculated by the AtoN monitoring centre software (GMC) using AtoN coordinates and date information. The AtoN light should be on when the sun is 4 degrees or more below horizon. Precise algorithms are used because at 59° latitude the simplified algorithms do not work when duration of the day is shortest or longest (around June 22 and December 22).

ldt *light down time* – a period of time during which the AtoN light should be on but is not.

It is important to configure AtoNs with reporting intervals longer than 5 minutes are to initiate dedicated communication sessions when the light state is changed by the flasher.

It is possible to correct the light down time in GMC software. This is appropriate when a later investigation shows a different down time than the one reported automatically. Corrections can be positive (decreasing the downtime) as well as negative (increasing the downtime). The user performing the corrections must have sufficient GMC user rights. Each correction is auto-commented but must be commented by the user as well.

The issues still to be resolved are:

- Absolute availability of the communication system is not calculated.
- Sophisticated AtoN light configurations (various redundant lights, sector lights; a light system is not a binary InOrder / Broken device any more)

The GMC can handle redundant and multi-sector / multi-flasher AtoN lights and distinguish between operational warning states and failure states of an AtoN light system. A warning state is usually considered to be an operational state.

2.2 Operational uncertainty of an AtoN light

Operational uncertainty of an AtoN light *ltu* is calculated as follows:

$$ltu = lsnk / ldst$$

where:

lsnk *light status is not known at the time light should be on*. This state may be caused due to loss of communication with AtoN or some problems at an AtoN outstation.

An AtoN light is considered to be down when it was in a “light down” state before the loss of communication.

It is important to configure AtoNs with reporting intervals longer than 5 minutes are to initiate dedicated communication sessions when the light state is changed by the flasher.

It is possible to correct the "light status not known" state duration in the GMC. . This is appropriate when a later investigation shows a different duration of the unknown status than the one reported automatically.

The main problem is that availability of a general purpose GPRS communication channel creates a lot of uncertainty compared to availability objectives defined by IALA.

Fortunately, the flashers used have their own non-volatile (power independent) memory for changes of flashing state, faults etc. and investigation usually allows to correct and decrease uncertainty to actual level. Additional information collected about missing flasher states is also helpful.

2.3 Heel angle reduced availability

Heel angle induced effects decrease the actual availability of a floating AtoN light signal even when the light signal system itself is operating without any technical failures. Excessive heeling of a buoy decreases the nominal range of the AtoN light significantly and may also distort (modulate) the flashing character of the light signal, particularly for the observers at the longer end of the nominal range. Different buoy hull designs may behave in different ways due to varying stability parameters.

To enable researching this problem at different buoy deployment sites to determine which vertical divergence of the light signal is sufficient for a particular combination of location/buoy hull/mooring, Cybernetica AS has developed an AtoN telematics module TelFiCon that enables registration of buoy movements using a 3-axial accelerometer sensor. While a more detailed analysis is possible at the shore side, the TelFiCon firmware provides the capability of calculating the heel angle of the hosting buoy, monitoring the average in pre-configured way and initiating alerts in case when one of the two thresholds are exceeded. For triggering the availability alarm message, the TelFiCon can be configured in accordance with the vertical divergence of the AtoN light installed on a particular buoy. A single alert bit in the TelFiCon status message is used to report excess heel during the monitoring interval.

Heel angle reduced availability *ha* is calculated as follows:

$$ha = (ldst - hat) / ldst$$

where:

hat *heel alert state during the time when the AtoN light should be on*.

There is no good method to correct excessive heel duration because all measuring data will be lost if the communications are disrupted for whatever reason. Best assumptions can be made by weather conditions.

2.4 Heel uncertainty

Heel uncertainty is only caused due to loss of communication at time light is declared to be available. It is calculated similarly to the operational uncertainty of an AtoN light.

Also there is no reasons to correct values automatically got by monitoring.

2.5 Location availability

Location *loca* availability for floating AtoNs is calculated as follows:

$$loca = (dd - wlst) / dd$$

where:

wlst — *wrong location state time*. State begins when the location of a buoy is declared wrong after several consecutive measurements outside a guard ring (performed in TelFiCon firmware). The state ends when the location is declared correct after a position measurement inside the guard ring.

If communications are disrupted when buoy location was wrong then it is assumed that the wrong location state continues.

Duration of the wrong location state can be corrected by a GMC user with sufficient rights. The correction is auto-commented but must be commented in detail by the user as well.

dd — *day duration* – 86400s

2.6 Location uncertainty

Because communication availability for whole day is available as a figure on its own, the location uncertainty figure is based only on a number of known GPS measurements resulted in "no coordinates received". Therefore, in fact it shows availability of GPS signal (reception).

This is no problem at summertime but may present a challenge at late winter when buoys are covered with ice, heeling heavily or even under the ice. Heel angle and temperature measurements in TelFiCon status report can be used to help at diagnosing associated problems.

Location uncertainty *locu* is calculated as follows:

$$locu = ncm / tcs$$

where:

ncm — *number of "no coordinates received" measurements.*

There is no reason to correct this figure.

tcs Number of total communication sessions. Since a TelFiCon is also a communication device (data link) for the remote AtoN system, its own status is always shown in any session.

2.7 GPRS communication availability

GPRS communication availability *gca* is calculated as follows:

$$gca = (dd - ncsd) / dd$$

where:

ncsd "*no communication*" state duration. The state begins when a communication session with shore side server could not be initiated during predefined criteria (1.5...3.5 times the length of a reporting interval, less in case of longer reporting intervals).

There are no reasons to correct a "no communication" state duration afterwards.

dd *day duration* – 86400s

2.8 AIS transmission availability

AIS transmission availability *ata* is calculated as follows:

$$ata = ackm / fnm$$

where:

fnm *number of synthetic AIS NMEA-like messages formatted by the GBE*.

ackm *Number of NMEA-like messages positively acknowledged by the AIS Router.* Acknowledgement occurs only when a synthetic AIS message M21 received by the AIS Router is successfully broadcasted over the AIS radio network.

There are no reasons to correct whatever figure here afterwards.

There is also lot of additional data available to diagnose AIS message chain, see p. 22, Table 3, Additional data in day_sum for solving availability problems.

The synthetic AtoN AIS broadcasting system consists of several software/hardware components, see AIS path on figure 1 „Architecture of the system“, p. 14.

2.9 GPRS back-end availability

GPRS back-end is the most important component of the GMC:

- It receives data from AtoN outstations; each device on the remote AtoN system is handled by its individual way depending on version, serving also different device configurations (redundant and multi-flasher lights)
- It sends additional instructions to the AtoN outstations if necessary; every device version on AtoN is handled by its individual way; it can receive additional information when initiated by arbitrary commands (for example, reading setups and updating the firmware)
- It forms many different records in the day summary records of the GDB, including initial data for availability calculations
- It forms NMEA-like synthetic AtoN AIS sentences (SNME) for broadcasting using the AIS subsystem (through the AIS Router)
- It receives feedback to messages sent out and forms AIS availability data
- It receives information about AIS messages M12 and M14 sent to AIS radio network.
- It responds to Nagios monitoring requests (keeping an eye on GMC)

Therefore, it is important to obtain availability figures of the GBE. The GBE does this itself: it counts and updates its uptime inside GDB. GBE availability *gbea* is calculated as:

$$gbea = gut / dd$$

where:

gut	*GPRS back-end uptime*
dd	*day duration* – 86400s

There are no reasons to correct any of these figures afterwards.

2.10 Calculating leading line availability

To calculate availabilities for leading lines as a whole, availabilities of the AtoN-s forming a leading line need to be multiplied.

To calculate uncertainties for leading line as a whole:

- calculate certainties (as opposite of uncertainies) of subject AtoN-s as *1 – uncertainty*
- multiply equivalent certainties of AtoN-s forming a leading line, result is *mult_cert*
- find resulting uncertainty as *1 - mult_cert*

Leading lines are fixed (shore side) systems, therefore there is no need to calculate location and heel angle reduced availabilities and uncertainties.

2.11 Calculating availability data for periods

To calculate availability for predefined periods, all initial fields with the same meaning will be added and availability is calculated in the same way as for a single day.

Exceptions are GPRS availability and AIS availability: for both, non-operational (empty) day availabilities are summed and divided by operational day record count (mean values).

2.12 Calculating combined availability figures

Combined availabilities are calculated the same way as leading light availabilities – by multiplying the components. This is correct as different availabilities are based on independent stochastic error events.

Combined uncertainties are calculated used the same algorithm as by calculating uncertainties of leading lines. This is not always very correct because of light and heel for example consist both communication availability component and can be used if communication availability is close to 1 or for coarse estimation only.

2.13 Statistics for temporary discontinuing and re-establish of AtoN

Temporary discontinuing of an AtoN and appropriate announcement of mariner is used for cases when strong storm or ice moves a floating AtoN away from its assigned location but the weather makes it not possible to move it back or replace in a short time.

Because those events are in close relation with AtoN service availability, there is a need to have detailed reports about such cases.

The GMC approach is to have a special alarm at the moment when an AtoN will be temporarily discontinued, and a possibility to deactivate it only after an AtoN is re-deployed. Before deactivation, a comment from a GMC user with sufficient rights is required.

The discontinuation report is not designed yet, it will designed in a later stage of development of the GMC. Until then, such report can be created using database administration tools.

2.14 Collecting additional information

Additional, mainly AIS related information is collected by the GMC GBE software component and stored inside the database for future use. There is no possibility to display this information to GMC users at this time.

3 TeViNSA System Architecture

To achieve several purposes associated with AtoN operation and e-Navigation, many of the current TeViNSA (Telematics for Visual Navigation Situational Awareness) system components were enhanced with additional functionality and partially redesigned.

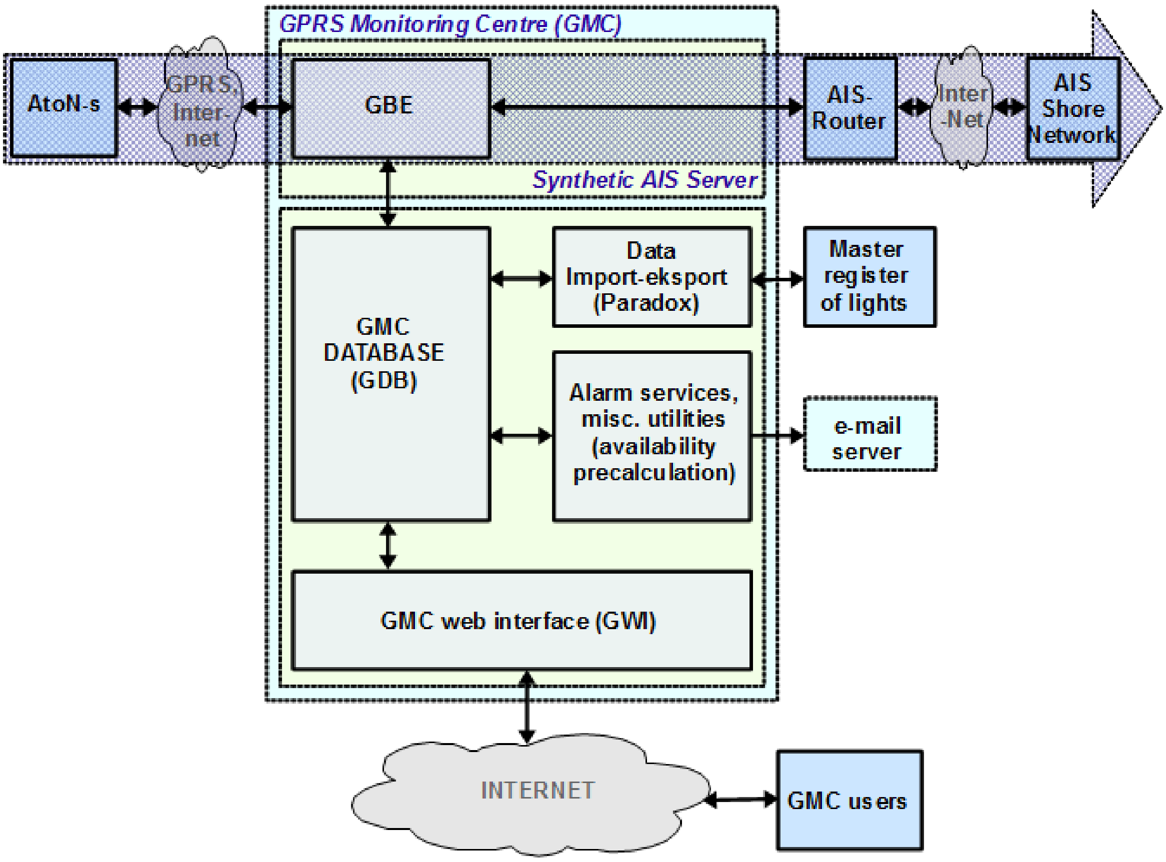

Figure 1, Architecture of the TeViNSA system

3.1 GPRS back-end software component

The GPRS back-end software component is enhanced in following:

- redesigned class that sends out NMEA-like AIS messages to the AIS Router,
- added class for processing feedback data from AIS Router, find match among sent NMEA-like messages, if available, handles sent NMEA-messages without or with timed-out acknowledges, form AtoN based data for availability statistics
- classes processing states of different software versions of TelFiCons are redesigned to extract heel angle state from status reports
- redesigned AtoN light status handling session-time and testing for “no communication state” algorithms, light state not known duration doesn't increase if light shouldn't be on but state remains, remember last known light state to decide the light state in case of “no communication” when light has to switch on etc.
- added AtoN heel angle state processing and updating in GDB (excessive heel angle is important only at time (night time) when the AtoN light signal should be operational)

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- some redesign in all device classes because some device level data has become AtoN level data now
- lots of logging added with new functionality (GBE has its own continuous logging system and date based log-files)
- additions into session text-format protocol, that is also saved in GDB when a communication session has to be saved
- enhanced thread for all kind of periodic tasks and checks (check for "no communication", activation of special communication scenarios, checking for cached in GBE AtoN and device data is changed in GDB, periodically writing down into DB AtoN day summary and GBE day summary data, start twilight time calculations and switching to new day summary record-sets if date is changed etc.)
- lots of smaller changes and enhancements.

3.2 Interface GBE to AIS Router

The previous unidirectional interface (out from GBE only) was redesigned to permit GBE to get feedback to NMEA-like synthetic AtoN AIS messages forwarded and for additional information about synthetic AIS messages M12 and AIS M14 broadcasted by the shore side AIS network.

Dispatched messages are now equipped with a unique identifier field allowing to collect AtoN based availability input data.

The interface itself is described in [3].

3.3 GPRS monitoring centre database

Lots of changes and additions with new functionality. Added new fields (heel, corrections, AIS-related) and triggers, added a new pseudo device GDB to have alarms for events for temporarily discontinued and re-established AtoNs.

3.4 Data import-export

An alarm is created in the GDB for AtoN if import script detects new temporary discontinued AtoN. Temporary discontinue alarm is found, commented and its deactivation is de-blocked, when the script detects that the AtoN became re-established.

3.5 Services and utilities

The main addition to services and utilities part is the availability pre-calculation module. This module works at night, calculating availability data for all non-calculated pre-defined fixed periods for all AtoNs having day summary data for according period. Thus, availability data for the current date is not available.

The availability pre-calculation module is mandatory because availability figures for long time periods in combination of many AtoNs and many data consumers causes very long delays to compute and display availability data and thus makes availability data in fact useless.

On the other hand, availability data is not changed immediately after changing of corrections and adding data.

At first, the availability pre-calculation module functions as follows for each AtoN having a day summary record in the GDB:

- Calculates the required operational time (for the signalling light to be on) for AtoN
- calculates signalling light availability based on required operational time and corrected light down times,
- calculates signalling light uncertainty based on required operational time and corrected "light state not known" times, for old records with light known durations covering all the day, automatic corrections tried to be applied,
- calculates heel angle reduced availability based on required operational time and excessive buoy heel angle times,
- calculates heel uncertainty based on required operational time and heel angle data missing (no communication at this period) times; correction is used but this is probably not necessary,
- calculates AtoN location availability based on corrected wrong location and date durations,
- calculates AtoN location uncertainty based on single GPD measuring states at session time and number of sessions with correct device states, no correction here, this is purely GPS quality measure,
- calculates AIS infrastructure availability based on sent by GBE out NMEA-like message and received from AIS Router positive acknowledge counts, no corrections here.

Next, the module calculates GPRS back-end day availability based on its uptime and date duration. No corrections are possible here.

Then, day availability figures for leading light pseudo-AtoNs with associated AtoN availability records available are calculated for this date.

- availabilities are calculated multiplying corresponding availabilities of component AtoNs,
- uncertainties are calculated multiplying the certainties ant taking uncertainty of the result

  $1 - ((1 - u1) * (1 - u2))$ commonly,
- durations for light failures and "not known" states are computed using already calculated availability and uncertainty as well; the maximum darkness-time (light should be on time) among component AtoNs is recorded in GDB as darkness-time for a leading line.

Then monthly availabilities are calculated. This is done by summing up the corresponding corrected day based durations and then using the same formulas as for single day (including for GBE availability), except for GPRS and AIS availabilities, mean values are calculated for those. Monthly availability figures for leading lines are calculated in the same way because of single day durations are available.

Then, availability figures for 3-month periods are calculated if the availability figures exist in GDB for this AtoN for 3 continuous months. Monthly records are used for these

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calculations. Calculations are performed in the same way as monthly availability calculations.

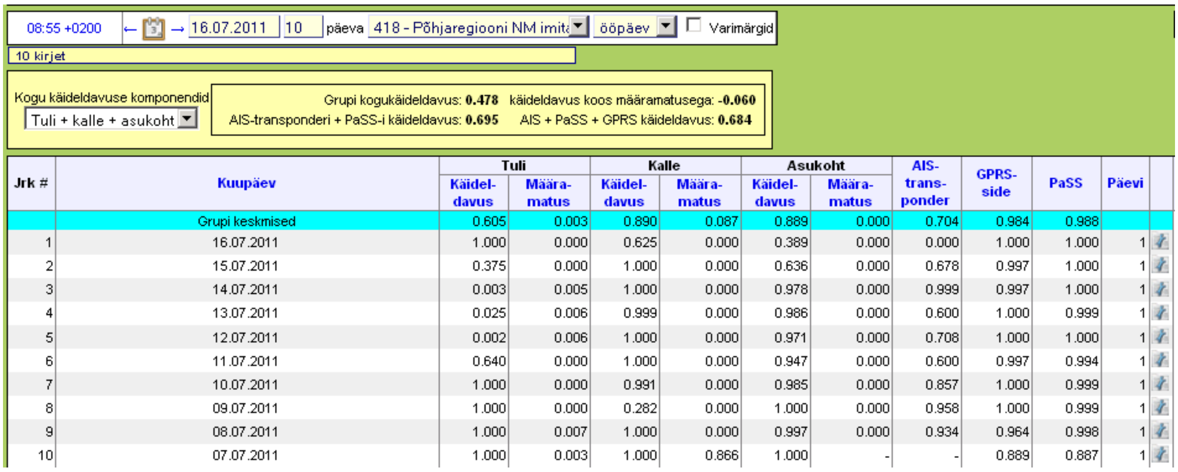
Yearly availability calculations are performed similarly to monthly calculations, and 3-year period calculations similarly to 3-month ones.

For every change in records after calculations, all records influenced by this changed record are marked as “recomputing needed” and will be recalculated next night. Some corrections cause significant recalculation.

3.6 GMC web interface

Forms for managing leading light pseudo-AtoN-s, displaying availability data, entering corrections for availability input data are created.

4 Sample screen-shots



Jrk #	Kuupäev	Tuli		Kalle		Asukoht		AIS-trans-ponder	GPRS-side	PaSS	Päevi
		Käidel-davus	Määra-matus	Käidel-davus	Määra-matus	Käidel-davus	Määra-matus				
	Grupi keskmised	0.605	0.003	0.890	0.087	0.889	0.000	0.704	0.984	0.988	
1	16.07.2011	1.000	0.000	0.625	0.000	0.389	0.000	0.000	1.000	1.000	1
2	15.07.2011	0.375	0.000	1.000	0.000	0.636	0.000	0.678	0.997	1.000	1
3	14.07.2011	0.003	0.005	1.000	0.000	0.978	0.000	0.999	0.997	1.000	1
4	13.07.2011	0.025	0.006	0.999	0.000	0.986	0.000	0.600	1.000	0.999	1
5	12.07.2011	0.002	0.006	1.000	0.000	0.971	0.000	0.708	1.000	1.000	1
6	11.07.2011	0.640	0.000	1.000	0.000	0.947	0.000	0.600	0.997	0.994	1
7	10.07.2011	1.000	0.000	0.991	0.000	0.985	0.000	0.857	1.000	0.999	1
8	09.07.2011	1.000	0.000	0.282	0.000	1.000	0.000	0.958	1.000	0.999	1
9	08.07.2011	1.000	0.007	1.000	0.000	0.997	0.000	0.934	0.964	0.998	1
10	07.07.2011	1.000	0.003	1.000	0.866	1.000	-	-	0.889	0.887	1

Figure 2, 10 day availability history of AtoN (simulated data)

Columns from left - Ord #, date, light (availability, uncertainty), heel (availability, uncertainty), location (availability, uncertainty), AIS availability, GPRS communication, GBE, days

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07:52 +0200 ← → 17.07.2011 1 päeva Kõik Varimärgid

103 kirjet

Jrk #		Navigatsioonimärk	Aeg	Hälve	Alarm-raadius	Asimuut	Nihe lat (m)	Nihe lon (m)	Laiuskraad	Pikkuskraad
1	159	Nygrundi põhjapoi	07:47	14.7	38	46.0°	10.2	10.6	59° 39.4154′ N	24° 52.2811′ E
2	650	Glotovi madala põhjapoi	07:43	40.0	80	61.0°	19.1	35.1	59° 12.5203′ N	22° 16.8768′ E
3	585	Soolarahu vasaku külje poi	07:39	12.4	80	321.0°	9.6	-7.8	58° 57.5321′ N	23° 7.137′ E
4	697.1	Soela väina laevatee parema külje poi	07:39	11.5	40	358.0°	11.5	-0.4	58° 41.4239′ N	22° 30.8519′ E
5	185	Karbimadala idapoi	07:39	3.5	80	282.0°	0.7	-3.4	59° 32.8103′ N	24° 58.6164′ E
6	697.2	Soela väina laevatee parema külje poi	07:39	10.2	40	355.0°	10.2	-0.9	58° 41.4017′ N	22° 30.9922′ E
7	907	Triigi sadama parema külje poi	07:39	4.4	40	174.0°	-4.4	0.5	58° 35.8126′ N	22° 43.3854′ E
8	254	Russalka madala põhjapoi	07:39	10.3	45	108.0°	-3.1	9.8	59° 26.9582′ N	24° 47.0102′ E
9	697.3	Soela väina laevatee vasaku külje poi	07:39	6.6	40	234.0°	-3.9	-5.3	58° 41.4556′ N	22° 30.9636′ E
10	415	Neugrundi põhjapoi	07:38	5.9	50	73.0°	1.7	5.6	59° 20.8249′ N	23° 31.3379′ E
11	151	Ihasalu põhjapoi	07:38	4.5	57	13.0°	4.4	1.0	59° 33.2224′ N	25° 5.5911′ E
12	006	Narva- Jõesuu B teljepoi	07:35	6.6	25	103.0°	-1.5	6.4	59° 28.5706′ N	28° 1.8053′ E
13	861	Sorgu idapoi	07:34	6.1	81	80.0°	1.1	6.0	58° 7.2955′ N	24° 11.9461′ E

Figure 3, Day availability for group of AtoN -s (simulated data)

12:52 +0200 ← → 17.07.2011 10 päeva Kõik Lõpetatud Varimärgid

4 kirjet

Navigatsioonimärk		Seade	Viga	Aeg		Kommént.
				Tekkis	Side	
005	Narva-Jõesuu teljepoi	98863034	Reset	08.07.2011 13:02	08.07.2011 13:03	14.07.2011
777	Lääne regiooni NM imitatsioon	PaSSv101	NM tule rike	12.07.2011 00:02	12.07.2011 00:02	14.07.2011
777	Lääne regiooni NM imitatsioon	PaSSv101	NM tule rike	11.07.2011 23:42	11.07.2011 23:42	14.07.2011
828	Saaremaa regiooni NM imitatsioon	GAB	AJUTISELT TÜHISTATUD	14.07.2011 20:10	14.07.2011 20:10	14.07.2011

Figure 4, Deactivated „TEMPORARY DSCONTINUED“ alarm

Vea kommentaarid

Navigatsioonimärk:	828 Saaremaa regiooni NM imitatsioon
Seade:	GAB
Versioon:	GAB
Viga:	AJUTISELT TÜHISTATUD
Tekkis:	14.07.2011 20:10
Side:	14.07.2011 20:10
Kõrvaldatud:	14.07.2011

alar, *14.07.2011 20:31*
Kviteeritud

alar, *14.07.2011 20:36*
jama lugu

alar, *14.07.2011 20:39*
läks mööda

Figure 5, Entering comment for „TEMPORARY DSCONTINUED" alarm

Part-financed by the European Union

Figure 6, Entering corrections form (see current and old comments)

07:52 +0200 ← → 17.07.2011 1 päeva Kõik ☐ Varimärgid

103 kirjet

Jrk #		Navigatsioonimärk	Aeg	Hälve	Alarm-raadius	Asimuut	Nihe lat (m)	Nihe lon (m)	Laiuskraad	Pikkuskraad
1	159	Nygrundi põhjapoi	07:47	14.7	38	46.0°	10.2	10.6	59° 39.4154′ N	24° 52.2811′ E
2	650	Glotovi madala põhjapoi	07:43	40.0	80	61.0°	19.1	35.1	59° 12.5203′ N	22° 16.8768′ E
3	585	Soolarahu vasaku külje poi	07:39	12.4	80	321.0°	9.6	-7.8	58° 57.5321′ N	23° 7.137′ E
4	697.1	Soela väina laevatee parema külje poi	07:39	11.5	40	358.0°	11.5	-0.4	58° 41.4239′ N	22° 30.8519′ E
5	185	Karbimadala idapoi	07:39	3.5	80	282.0°	0.7	-3.4	59° 32.8103′ N	24° 58.6164′ E
6	697.2	Soela väina laevatee parema külje poi	07:39	10.2	40	355.0°	10.2	-0.9	58° 41.4017′ N	22° 30.9922′ E
7	907	Triigi sadama parema külje poi	07:39	4.4	40	174.0°	-4.4	0.5	58° 35.8126′ N	22° 43.3854′ E
8	254	Russalka madala põhjapoi	07:39	10.3	45	108.0°	-3.1	9.8	59° 26.9582′ N	24° 47.0102′ E
9	697.3	Soela väina laevatee vasaku külje poi	07:39	6.6	40	234.0°	-3.9	-5.3	58° 41.4556′ N	22° 30.9636′ E
10	415	Neugrundi põhjapoi	07:38	5.9	50	73.0°	1.7	5.6	59° 20.8249′ N	23° 31.3379′ E
11	151	Ihasalu põhjapoi	07:38	4.5	57	13.0°	4.4	1.0	59° 33.2224′ N	25° 5.5911′ E
12	006	Narva- Jõesuu B teljepoi	07:35	6.6	25	103.0°	-1.5	6.4	59° 28.5706′ N	28° 1.8053′ E
13	861	Sorgu idapoi	07:34	6.1	81	80.0°	1.1	6.0	58° 7.2955′ N	24° 11.9461′ E

Figure 7, There are lots of availability related initial data on earlier design too, this one shows distance from assigned location for group of AtoN-s

Part-financed by the European Union

07:47 +0200 | ← → 17.07.2011 | 10 | päeva 211 - Tallinna teljepoi Nr.1 | Varimärgid

10 kirjet

Jrk #	Kuupäev	"Asukoht vale/puudub" viga				Üksikmõõtmised				
		Asukoht vale		Asukoht puudu		Arv	Asukoht vale		Asukoht puudu	
		min	%	min	%		Arv	%	Arv	%
1	08.07.2011	0.0	0	0.0	0	578	0	0	0	0
2	09.07.2011	0.0	0	0.0	0	584	0	0	0	0
3	10.07.2011	0.0	0	55.0	4	545	0	0	0	0
4	11.07.2011	0.0	0	0.0	0	565	0	0	0	0
5	12.07.2011	0.0	0	0.0	0	555	0	0	0	0
6	13.07.2011	0.0	0	0.0	0	482	0	0	0	0
7	14.07.2011	0.0	0	0.0	0	479	0	0	0	0
8	15.07.2011	0.0	0	12.0	1	479	1	0	0	0
9	16.07.2011	0.0	0	0.0	0	482	0	0	0	0
10	17.07.2011	0.0	0	0.0	0	157	0	0	0	0

Figure 8, There are lots of availability related initial data on earlier designed forms too, this one shows location measuring history for selected AtoN

07:33 +0200 | ← → 17.07.2011 | 10 | päeva 211 - Tallinna teljepoi Nr.1 | Varimärgid

10 kirjet

Jrk #	Kuupäev	GPRS side			AIS-teated %	AIS-teate viide			
		Arv	%	Puudu min.		Keskv. s.	99,8% max s	Liiga suur	
								Arv	%
1	08.07.2011	579	120.6		100	10.67	46.14	37	6
2	09.07.2011	585	121.9		100	10.25	44.27	42	7
3	10.07.2011	545	113.5	56	100	9.35	37.85	26	4
4	11.07.2011	565	117.7		100	9.02	35.39	20	3
5	12.07.2011	555	115.6		100	11.01	56.41	65	11
6	13.07.2011	482	100.4		100	4.61	12.20	1	0
7	14.07.2011	479	99.8		100	5.09	22.03	7	1
8	15.07.2011	480	100.0	12	100	4.82	22.45	1	0
9	16.07.2011	483	100.6		100	4.39	11.29	1	0
10	17.07.2011	152	100.5		100	4.53	17.15	1	0

Figure 9, There is lot of availability related initial data on earlier designed forms too, this one shows GPRS communication quality data and AIS location delay from AtoN outstation to GBE history for selected AtoN

5 Availability related data in GDB

Table 1, Data collected by GFE for availability calculations

#	Field name	Field type	Description, purpose
1	aton_id	integer	Identifies AtoN the following data belongs to, link to record in table describing AtoN-s
2	date	time-stamp	The following availability-related data is collected during this date.
3	light_active	integer	Describes required light on time (night only, all the day, none at all)
4	darkend	time	Until this time light shall be functioning at morning (requirement)
5	darkstart	time	Beginning this time light shall be functioning at evening (requirement)
6	stateoknum	integer	Number of communication sessions where transmitted automatically states of the devices on AtoN were received correctly. Each such session should contain flasher state (states of flashers) and state of TelFiCon
7	nocomdur	integer	Time duration of missing communication state with AtoN
8	lighterrdur	integer	Time duration where light shall be on and in sufficent order but it is not.
9	lighterrcorr	integer	Correction for lighterrdur (will be subtracted)
10	lightnkdur	integer	Light state not known while shall be on
11	lightnkcorr	integer	Correction for lightnkdur (will be subtracted)
12	outareadur	integer	Time duration when AtoN according to its state is off-position (outside guard ring). This state is expected to be continuous if communication with AtoN is lost.

13	outareacorr	integer	Correction for outareadur (will be subtracted)
14	nolocnum	integer	Number of communication sessions with „last GPS fix not successful" in TelFiCon state
15	noaisdur	integer	Time duration when GMC was not able to send out synthetic AIS messages or received no acknowledges to sent AIS messages or received acknowledges with error flag

Table 2, Data for availability collected by GPRS Backend about himself

#	Field name	Field type	Description, purpose
1	date	date	Date of record
2	passupt	integer	GFE uptime for date
3	uptcorrect	integer	Correction for passupt (will be subtracted)

There is also additional availability-related date oriented data in GDB recorded in table day_sum. There are currently no long time statistics forms in GMC

Table 3, Additional data in day_sum for solving availability problems

#	Field name	Field type	Description, purpose
1	totalsess	integer	Total started number of communication sessions from remote AtoN outstation. In conjunction with planned communication interval
2	lighton	timestamp	Last time light gone on
3	lightoff	timestamp	First time light gone off
4	oomult	boolean	TRUE, if multiple off-on or on-off cycles (check daylight switch or it's settings)
5	missingflst	integer	Number of flasher states missing in communication sessions

6	locnkdur	integer	Time duration when actual location of floating AtoN is not known due to GPS or no communication with AtoN
7	aisoknum	integer	Number of synthetic AIS messages sent out to AIS Router
8	aiserrnum	integer	Unsuccessful tries to send synthetic AtoN AIS messages to the AIS Router (router probably down)
9	aisacknum	integer	Positively acknowledged by AIS Router sent out synthetic AIS messages (number of AIS M21-s composed and successfully sent to AIS radio network)
10	aisnacknum	integer	Negatively acknowledged by AIS Router sent out synthetic AtoN AIS messages (AIS M21 not formed or not sent into AIS radio network)
11	aisdlytoobig	integer	Delay from getting coordinates (in TelFiCon state) till getting positive acknowledge from AIS Router is more than 59.5s
12	aisdelaysum	integer	Sum of delays from getting coordinates (in TelFiCon state) till getting positive acknowledge from AIS Router
13	aisdrmssum	integer	Sum of squares of delays as in aisdelaysum to assess stability of delays
14	safmessnum	integer	Number of synthetic AIS messages composed with safety message
15	aism12num	integer	Number of AIS M12-s for this AtoN formed and sent in AIS radio network by AIS Router
16	aism14num	integer	Number of AIS M14-s for this AtoN formed and sent in AIS radio network by AIS Router