PNT Integrity Documentation

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Contents

Chapter 1

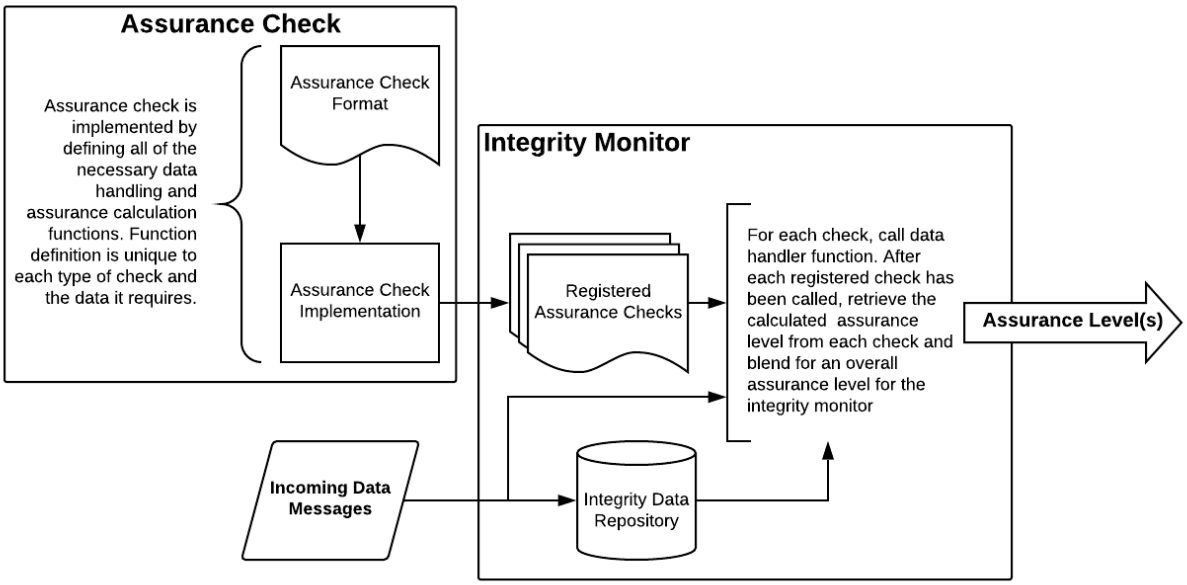
The PNT-Integrity Library

The PNT Integrity Library provides a scalable framework for GNSS-based PNT manipulation detection that offers varying levels of protection based on the available data. The software is to be provided to GNSS receiver and GNSS-based timing server OEMs for use in future development or integration into existing products and platforms.

The modular nature of the application allows additional checks to be added as new threats arise. It also allows for the future addition of network-based data to further improve integrity.

Framework Overview

The PNT Integrity Library can be used out-of-the-box with existing, built-in integrity checks. The framework also allows additional, user-defined integrity check algorithms to be incorporated into the application. The figure below gives a high-level description of the framework and how user-defined modules can be included.



The initial release of this Library has the following built-in assurance / integrity checks:

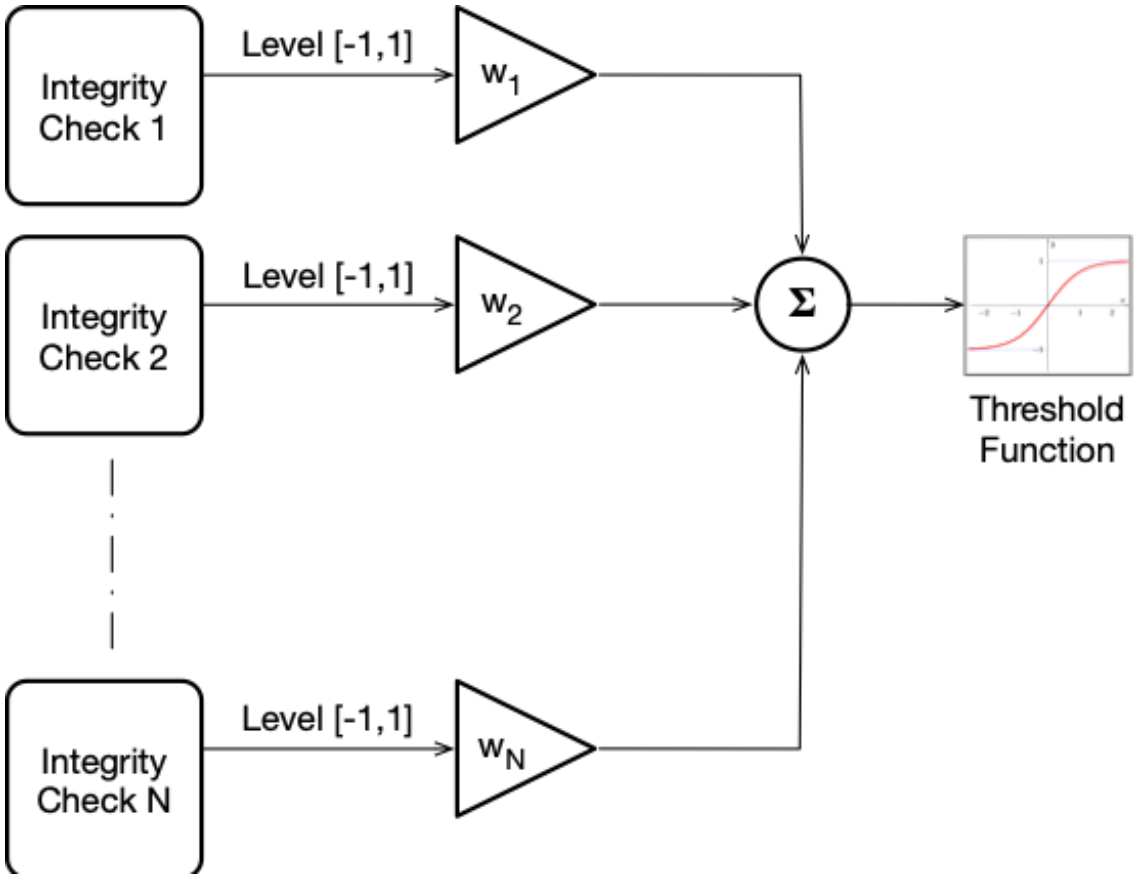
- Multi-Antenna / Receiver Detection Methods
  - Angle of Arrival (AOA)
  - Range / Position Verification (for networked receivers)
- Signal-Power and Vestigial-Peak Detection Methods
  - Spoofer signature detection in code / doppler 2D search
  - Automatic Gain Control (AGC) monitoring
- Model-based Consistency Checks
  - PNT discontinuities (time / position jumps)
  - Carrier-to-noise (CNo) consistency checks
  - Code - Carrier divergence checks
  - Navigation data monitoring

System Components

Each of the following sections describe each component of the framework in more detail.

Blending Functions

The PNT-Integrity Library provides functionality for monitoring the integrity of single or multiple receiver outputs. It provides a confidence level on the receiver PVT solution(s) using a modular set of integrity checks based on receiver outputs and observables. The output of each individual integrity check is weighted based on the effectiveness of that check. The weighted outputs of all checks are then summed, and a threshold applied to determine a confidence level in the PVT solution as shown below.



Each individual integrity check returns an assurance level with a n associated numeric value for blending with other checks for a total level. This value, l_i, will be either -1, 0, or 1. The table below defines the levels and their values. Note that the first assurance level, 'Unavailable', does not provide a value and therefore will not be used when calculating a total assurance level.

Level	Description	Enumeration	Value
Unavailable	Assurance level is unavailable (insufficient data or has not yet been run)	0	N/A
Unassured	Indicates a high likelihood that the measurement / source cannot be trusted	1	-1
Inconsistent	Cannot reliably determine the validity of the measurement / source	2	0
Assured	Indicates a high likelihood that measurement / source can be trusted	3	1

A weight, w_i, is assigned to each check to indicate the relative accuracy in determining the integrity level. The weighted sum (L') of these N individual levels l_i is then calculated:

$$L' = \frac{\sum_{i=1}^{N} w_i l_i}{\sum_{i=1}^{N} w_i}$$

Note: Weights must be positive and cannot all be 0.

Weights are normalized for faster implementation:

$$w_i' = \frac{w_i}{\sum_{j=1}^{N} w_j}$$

$$L' = \sum_{i=1}^{N} w_i' l_i$$

The resulting level, L', is then thresholded to determine the overall integrity output L, which is then mapped to an overall assurance level using the values given in the table above.

$$L = \begin{cases} -1, & L' < threshold_{low} \\ 0, & threshold_{low} \leq L' < threshold_{hi} \\ 1, & L' \geq threshold_{hi} \end{cases}$$

For a simple rounding scheme, use the following thresholds:

$$threshold_{low} = -0.5$$
$$threshold_{hi} = 0.5$$

Positive Weighting Exception

In some situations it may be desirable to only weight certain assurance checks in the negative direction (i.e. when the check is attempting to lower the overall assurance level). For example, if a certain check should only be used to lower the overall assurance level and not keep it raised. Each assurance check has an internal flag used to indicate whether or not it allows positive weighting. Currently, this flag is hard-coded for each check Future versions of the software will allow this to be an input parameter. The table below shows which checks allow positive weighting and which do not.

Assurance Check

The "AssuranceCheck" module is a virtual object within the framework, meaning that it cannot be directly used, but rather a specific implementation must inherent its interface in order to be incorporated into the integrity monitor. As previously mentioned, several existing assurance check definitions are included out-of-the-box with the framework. An integrated application must either define a new/custom assurance check(s) or use existing, pre-defined check(s). Refer to the included software documentation for details on how to implement a user-defined check. The included example application can be referenced on how to incorporate, initialize, and use the built-in checks.

The Assurance Check base class contains all data and functions that are common to every assurance check child derivative class. As an example, the parent class contains a setting known as the assurance level period. This setting defines how long each check must hold a lowered assurance level before it can be raised again. If a child check detects that the level should be lowered to indicate an attack, this level change is allowed immediately. However, if the child check decides that the attack condition is no longer present, the check must hold previously lowered value for this pre-determined amount of time. This single-sided hysteresis is intended to prevent level "flickering."

Integrity Monitor

The "IntegrityMonitor" module is the primary component that the user application will interface with. All assurance checks, both user-defined and built-in, must be registered with the integrity montior, which will keep a vector of all registered checks. The enclosing application will then pass all received data messages to the integrity monitor for processing as they are received. The monitor will cycle through all registered checks, calling the appropriate data processing function in each check. After all checks have been called, the monitor will then extract the calculated assurance level from each check and blend them for an overall result.

Integrity Data Repository

A time history of received integrity data is available for use by the built-in and user-defined assurance checks. The repository has a time-history length that can be controlled with a setting. Repository use is not required for user-defined checks, but it is accessible if desired. See the attached documentation on how to utilize the repository.

Data Structures

Refer to the software documentation in later chapters for details on the data structures used in the framework.

Included Assurance Checks

The table below lists the out-of-the-box assurance checks that are packaged with the library. The table shows which checks allow positive weighting, the class of check, and the resilience level associated with each check. A definition of the resilience levels and how they apply to a PNT system can be found [here](link).

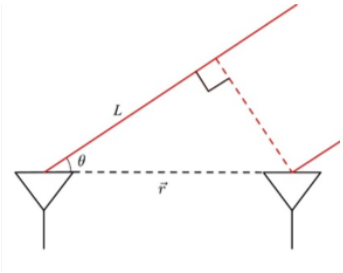
Check Name	Allows Positive Weighting	Assurance Check Class	Resilience Level
Angle-of-Arrival (AOA) Check	Yes	Multi-Antenna / Node	2
Range-Position Check	Yes	Multi-Antenna / Node	1
Automatic Gain Control (A↩ GC) Check	Yes	Signal Power and Peak Detection (CAF)	2
Acquisition Check	Yes	Signal Power and Peak Detection (CAF)	3
Static-Position Check	Yes	Model-Based Consistency	1
Position-Jump Check	Yes	Model-Based Consistency	1
Position-Velocity Consistency Check	Yes	Model-Based Consistency	1
Clock-Jump Check	Yes	Model-Based Consistency	2
Carrier-to-Noise (CNo) Check	No	Model-Based Consistency	2

Multi-Antenna Detection Algorithms

Multiple receivers / antennas connected a system can be leveraged to form power assurance checks. Two such checks included with the PNT Integrity Library are described in the following sub-sections.

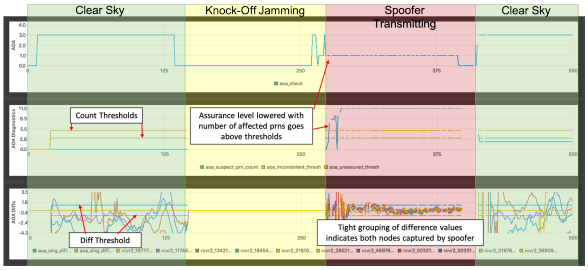
The Angle of Arrival Check

The most effective method for detecting GPS spoofing is using angle of arrival (AOA) with multiple receiver antennas. This method can be implemented using a single receiver with multiple antennas or multiple independent receivers with an available network connection for sharing data. Relative pseudorange or carrier phase from each antenna in an array is a function of the angle of the arriving signal, as shown in the figure below.



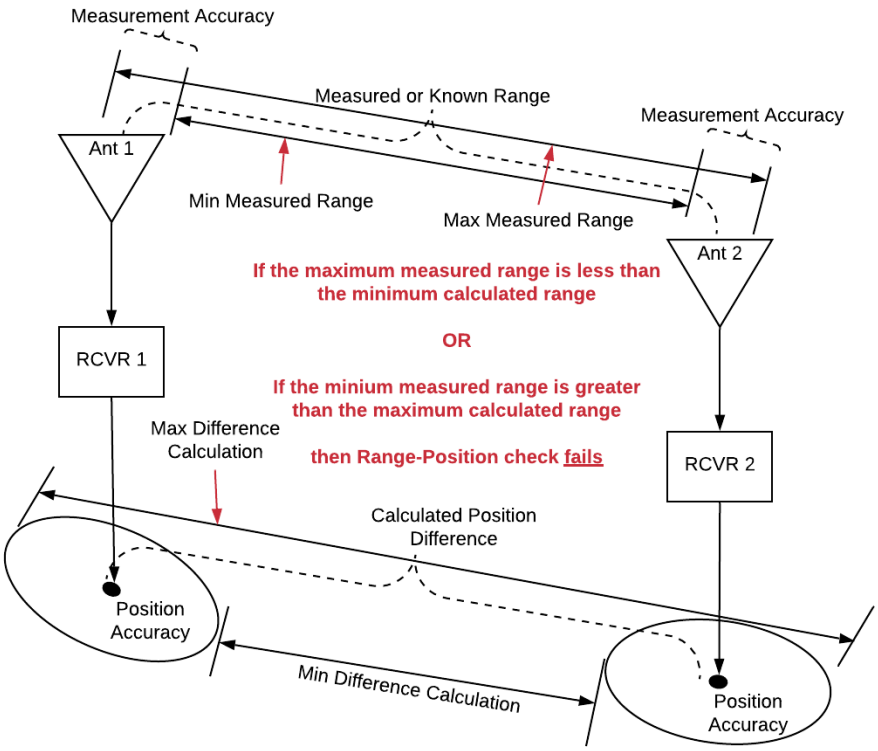
To determine the AOA, pseudorange or carrier phase measurements from two antennas are subtracted to produce a single differenced observable. The AOA is dependent on the satellite position in the sky (and platform attitude). As a result, the phase differences will vary from channel to channel. However, during a spoofing attack, the AOA of every captured channel will converge to the same value as all signals will be propagating from the same source.

The figure below demonstrates the calculations and logic used inside the AOA check. Single differences are computed between common prn psuedoranges (or carrier-phases) between two communicating nodes (node = receiver + antenna). Under clear-sky conditions, the difference values are separated (providing that the receiving antennas are separated sufficiently). When both nodes become captured by the spoofer, the difference values collapse to a tight grouping. The algorithm counts the number of prns that are within the difference thresholds and sets the level according to a separate set of thresholds (count thresholds).



The Range-Position Check

If the distance between two antennas is known (or measured), a simple but effective assurance check can be achieved by comparing the measured range to the differenced position of the two antennas. A differenced position is computed by taking the absolute value of the position of receiver A minus the position of receiver B. This computed range is then compared to the measured range between the two antennas. Taking position and range measurement variances into account, the two are compared to see if the difference is within reasonable tolerances. If either receiver (or both) is captured by the spoofer, then this check can be a reliable indicator of a position-based spoofing attack. Obviously, this check will not be reliable when both antennas are close together, as the range measurement will not be large enough to invalidate a position difference, regardless of spoofer effectiveness.



Signal Power and Vestigial Peak Detection Algorithms

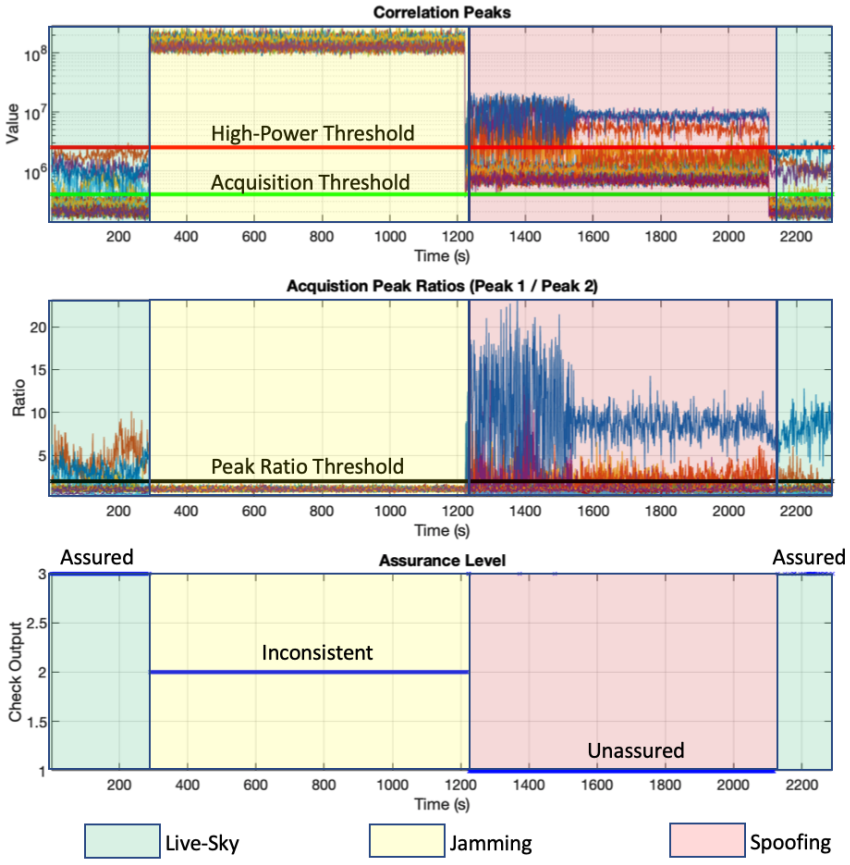
Acquisition Check

Often a jammer will be used in conjunction with a spoofer in order to raise the noise floor and hide the authentic signal. Other times the spoofer will transmit at much higher power levels than the live-sky signal in order to cover a large area or due to miscalibration (a very difficult process). One straightforward way of detecting spoofers is by closely monitoring the power levels of the signals in the acquisition process. Despite the fact that the GPS signal transmission was designed to provide roughly constant power from horizon to horizon, there are still power level differences of three to six decibels from horizon to zenith. By knowing the possible power change across the satellites path, the amount of amplification coming from the antenna, amplification from low noise amplifiers, and using previously known correlation values, a range of possible correlation values can be determined and set as a threshold. Should any correlation value be higher than the threshold, it is likely from an attack and can be quickly detected.

The acquisition check currently implemented in this library takes IF data snippets from a receiver front end, runs a signal acquisition process, and then monitors the correlator outputs for suspect power levels . Each tracking channel (up to 32 for GPS L1) is assessed independently and then aggregated to form a composite assurance level for the check. For each channel, the highest two peaks in the signal correlation plane are selected. If the highest peak is above a threshold, then this channel is considered to be suspect. If PRN is considered to be acquired in this high-power state (i.e. when the ratio of peak1 to peak 2 is above the threshold), then it is flagged as "unassured" to indicate a possible attack. If it is not acquired in this high-power state, then it is flagged as "inconsistent" to indicate possible jamming. If the peak 1 value is below the high-power threshold, but still aove the acquisition threshold, then that PRN is considered to be acquired in safe state and is acquired as "assured". Otherwise, the PRN is flagged as "unavailable" (i.e. the satellite is not in view). The number of PRNs in each state are summed and passed through the following logic to determine the assurance level for any given time.

```
if (unassuredCount >= assuranceUnassuredThresh_)
{
    level = UNASSURED
}
else if (inconsistentCount >= assuranceInconsistentThresh_)
{
    level = INCONSISTENT
}
else if (assuredCount >= assuredThresh)
{
    level = ASSURED
}
else
{
    level = UNAVAILABLE
}
```

The figure below shows output data from the Acquisition Check during a "knock-off-then-spoof" attack. The check is tuned to produce an overall level of "Inconsistent" in a pure-jamming environment and "Unassured" when it is being spoofed.



Automatic-Gain Control (AGC) Check

A relatively simple check for a jamming / spoofing attack can be achieved by monitoring the output of the receiver's automatic gain control (AGC). An AGC is a common component in any radio device, and attempts to regulate the incoming signal to a desired level to optimizes the downstream signal processing. If the incoming power level is high,

the AGC will lower its gain so that the incoming signal will not saturate. Conversely, if the incoming power level is low, the AGC will increase its gain to boost the signal for better signal processing and data demodulation. By simply monitoring the current AGC setting of the receiver (provided that it is available), a user (or detection software) can gain a good sense of what might be happening in the signal environment.

In this library, the AGC check implementation simply monitors the AGC setting (in all available bands), normalizes its current value, and compares it to a threshold to indicate attack. To operate this check, the minimum and maximum setting values for the AGC must be known. In addition, this check is currently tuned so that the assurance level of the check is only raised to "Inconsistent." On its own, the AGC check cannot discern the difference between a jamming or spoofing attack. In future versions of this library, the AGC check and acquisition checks will be integrated together to form a complete picture of what is happening in the signal environment.

Model-based Consistency Checks

Another effective approach in developing assurance checks is to analyze output data from the receiver (solution(s), measurements, and raw observables) and compare to known behavior. This grouping of checks is labeled "model-based" checks, as they aim to perform sanity reference checks of available data to known models.

Static-Position Check

For PNT applications where system receiver remains static (cell towers, power stations, financial centers, etc), a static position check be employed for a simple check against attacks. The check can be provided with a surveyed position of the receiver's antenna to compare with the solution that is being published by the receiver. If the difference is greater than a configurable threshold, then the check will attempt to lower the assurance level. The check also has the capability to perform an initial survey at startup, with the assumption that things are started in a "safe" environment.

Position-Jump Check

The position jump check is an advanced extension of the static-position check. The receiver's position solution is monitored and compared to a secondary source of the platform position and covariance. If the receiver's position travels outside of the bounds of the secondary source, then the assurance level is lowered. Additionally, for systems that do not have a separate position measurement available, a maximum platform velocity can be used to propagate the error bounds by using a "last known good position" and a maximum distance traveled since that time.

Position-Velocity Consistency Check

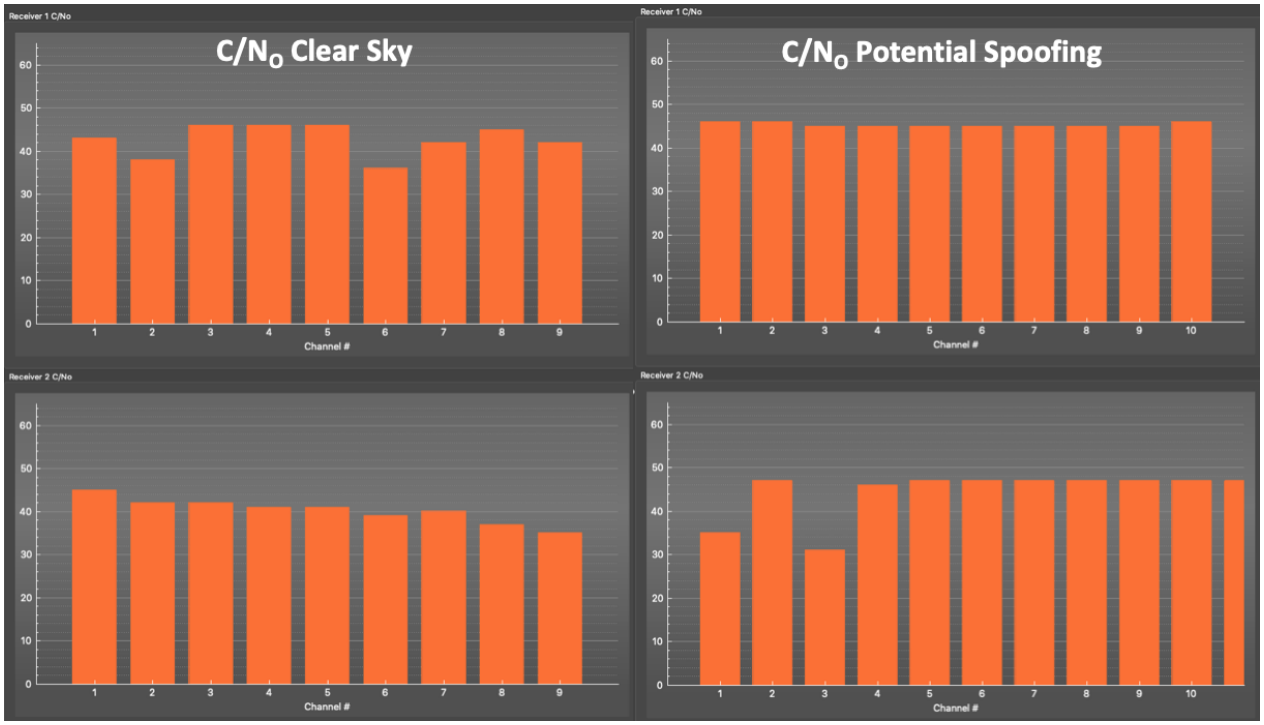
Another model-based check is available by comparing the consistency between the position and velocity measurements out of a receiver. A pseudo-velocity measurement can be created by differencing the position measurements over time. If these measurements are not in agreement with the velocity measurement (within a threshold / bound), then the assurance level is lowered.

Clock-Jump Check

Another model-based check examines the clock bias and drift for normal behavior. The Clock Bias Check calculates the expectation and variance of the clock drift for the most recent set of clock samples, minus the most recent sample. The expectation is used to propagate the clock forward to themost recent single sample's arrival time and check if it is within reasonable bounds. The variance is used to check for zero-bias disruption.

Carrier-to-noise (CNo) Consistency Check

This check is often effective in detecting a code-generating spoofing attack. In live sky signals, observed C/No values have significant variation due to differences in SV elevation, signal obstructions, multipath, etc. During simulator-based spoofing attack, all spoofed signals may be transmitted at the same C/No level. This check detects this artifact by monitoring the distribution of observed signal C/No's.



Chapter 2

License

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Chapter 3

Namespace Index

3.1 Namespace List

Here is a list of all documented namespaces with brief descriptions:

Chapter 4

Hierarchical Index

4.1 Class Hierarchy

This inheritance list is sorted roughly, but not completely, alphabetically:

Chapter 5

Class Index

5.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions:

Chapter 6

File Index

6.1 File List

Here is a list of all documented files with brief descriptions:

Chapter 7

Namespace Documentation

7.1 geodetic_converter Namespace Reference

Third-party. Downloaded from: https://github.com/ethz-asl/geodetic_utils //.

Classes

- class GeodeticConverter

  Class to implement gedetic conversions for the pnt_integrity library.

Variables

- const double kSemimajorAxis = 6378137

  Equatorial radius (a), in meters.
- const double kSemiminorAxis = 6356752.3142

  Semi-minor radius (b), in meters.
- const double kFirstEccentricitySquared = 6.69437999014 * 0.001

  *First eccentricity squared (e2), dimensionless e2 = (a^2 - b^2) / a^2 = f * (2 - f)*
- const double kSecondEccentricitySquared = 6.73949674228 * 0.001

  Second eccentricity squared (e'2), dimensionless e'2 = (a^2 - b^2) / b^2 = e^2 / (1 - e^2) = e2 / (1 - e2)
- const double kFlattening = 1 / 298.257223563

  flattening, dimensionless
- const double PI = 3.14159265358979323846

  Pi (pi), dimensionless.

7.1.1 Detailed Description

Third-party. Downloaded from: https://github.com/ethz-asl/geodetic_utils //.

7.2 pnt_integrity Namespace Reference

Namespace for all pnt_integrity applications.

Namespaces

- data

  Namespace for all integrity data definitions.

Classes

- struct AcqCheckDiagnostics

  Structure for publishing Acquisition Check diagnostics.
- class AcquisitionCheck

  Class implementation for the acquisition check.
- class AgcCheck

  Class implementation for the AGC check.
- struct AgcCheckDiagnostics

  Diagnostic data for AGC check.
- class AngleOfArrivalCheck

  Class implementation for the angle of arrival check.
- struct AoaCheckDiagnostics

  Structure used to publish diagnostic data.
- class AssuranceCheck

  Parent class for all integrity checks.
- class ClockBiasCheck

  Class implementation for the position velocity check.
- struct ClockBiasCheckDiagnostics

  Structure used to publish diagnostic data.
- class CnoCheck

  Class implementation of the carrier-to-noise (CnO) assurance check. The check analyzes the CnO values for abnormalities.
- struct CnoCheckDiagnostics

  Diagnostic data for the check.
- class IntegrityDataRepository

  Class definition for the history of data at a single PNT node.
- class IntegrityMonitor

  Class implementation of integrity monitoring using AssuranceChecks and IntegrityData.
- class PositionJumpCheck

  Class implementation for the position-jump check.
- class PositionVelocityConsistencyCheck

  Class implementation for the position velocity check.
- struct PosJumpCheckDiagnostics

  Structure for check diagnostics.
- struct PosVelConsCheckDiagnostics

Structure used to publish diagnostic data.

- class RangePositionCheck

  Class implementation for the range / position check.

- class RepositoryEntry

  Class definition for an entry into the repository.

- struct RngPosCheckNodeDiagnostic

  Structure for check diagnostics.

- struct StaticPosCheckDiagnostics

  Structure used to publish diagnostic data.

- class StaticPositionCheck

  Class implementation for the static-position check.

- struct TimeEntry

  Structure for a time entry into the repository.

Typedefs

- using CodeMap = std::map< int, std::vector< float > >

  A map for holding PRN codes, indexed on prn.

- using CodeMapEntry = std::pair< int, std::vector< float > >

  A pair for holding a PRN and it's code.

- using CodeFreqMap = std::map< int, Eigen::ArrayXcf >

  A map for holding frequency bin values.

- using CodeFreqMapEntry = std::pair< int, Eigen::ArrayXcf >

  A pair for holding a frequency bin number its values.

- using CorrelationResultsMap = std::map< int, Eigen::ArrayXXf >

  A map that stores the correlation results for a prn.

- using PeakResultsMap = std::map< int, std::pair< double, double > >

- using PrnList = std::vector< int >

  A vector type for a list of prns.

- using SingleDiffMap = std::map< int, double >

  Defines a type that maps PRN to a calculated difference.

- using PrnAssuranceEachNode = std::map< int, std::vector< data::AssuranceLevel > >

  Defines a map that holds an assurance level for each prn for each node.

- using MultiPrnAssuranceMap = std::map< int, data::AssuranceLevel >

  A map for pairing an assurance level to each PRN.

- using RemoteRepoEntries = std::map< std::string, RepositoryEntry >

  A type to map remote entries to their node name / device id.

- using TimeEntryHistory = std::map< double, TimeEntry >

- using AssuranceChecks = std::map< std::string, AssuranceCheck * >

  A vector type for a collection of AssuranceChecks.

- using RngPosCheckDiagnostics = std::map< std::string, RngPosCheckNodeDiagnostic >

  Defined type for check diagnostics.

Enumerations

- enum AoaCheckData { **UsePseudorange** = 0, **UseCarrierPhase**, **UseBoth** }

  Enumeration to indicate what data field to use for the AOA check.
- enum DataLocaleType { **Local** = 0, **Remote** = 1 }

  Defines the possible observable types.

Variables

- const std::string INTEGRITY_ACQ_PEAK_VALS = "INTEGRITY_ACQ_PEAK_VALS"

  String ID for the ACQ check peak vals.
- const std::string INTEGRITY_ACQ_PEAK1_KEY = "INT_ACQ_PEAK1_"

  String ID for the ACQ check peak 1 key.
- const std::string INTEGRITY_ACQ_PEAK2_KEY = "INT_ACQ_PEAK2_"

  String ID for the ACQ check peak 2 key.
- const std::string INTEGRITY_ACQ_DIAGNOSTICS = "INTEGRITY_ACQ_DIAGNOSTICS"

  String ID for the ACQ check diagnostic data.
- const std::string INT_ACQ_DIAG_HI_PWR_THRESH = "INT_ACQ_DIAG_HI_PWR_THRESH"

  String ID for the ACQ check high power threshold.
- const std::string INT_ACQ_DIAG_PEAK_RATIO_THRESH

  String ID for the ACQ check peak ratio threshold.
- const std::string INT_ACQ_DIAG_ACQ_THRESH = "INT_ACQ_DIAG_ACQ_THRESH"

  String ID for the ACQ check acquisition threshold.
- const std::string INT_ACQ_DIAG_ITHRESH = "INT_ACQ_DIAG_ITHRESH"

  String ID for the ACQ check survey inconsistent thresh.
- const std::string INT_ACQ_DIAG_UTHRESH = "INT_ACQ_DIAG_UTHRESH"

  String ID for the ACQ check survey unassured thresh.
- const std::string INT_ACQ_DIAG_ICOUNT = "INT_ACQ_DIAG_ICOUNT"

  String ID for the ACQ check survey inconsistent count.
- const std::string INT_ACQ_DIAG_UCOUNT = "INT_ACQ_DIAG_UCOUNT"

  String ID for the ACQ check survey unassured count.
- const std::string INT_ACQ_DIAG_PEAK_RATIO_KEY = "INT_ACQ_DIAG_PEAK_RATIO_KEY_"

  String ID for the ACQ check survey peak ratio key.
- const std::string INTEGRITY_AGC_DIAGNOSTICS = "INTEGRITY_AGC_DIAGNOSTICS"

  String ID for the AGC check diagnostic data.
- const std::string INTEGRITY_AGC_DIAG_ITHRESH = "INTEGRITY_AGC_DIAG_ITHRESH"

  String ID for the AGC check survey inconsistent thresh.
- const std::string INTEGRITY_AOA_DIFF_DIAGNOSTICS

  String ID for the AOA check difference diagnostic data.
- const std::string INTEGRITY_AOA_DIFF_NODE_ID = "INTEGRITY_AOA_DIFF_NODE_ID"

  String ID for the AOA check diagnostic node id.
- const std::string INTEGRITY_AOA_DIAGNOSTICS = "INTEGRITY_AOA_DIAGNOSTICS"

  String ID for the AOA check diagnostic data.
- const std::string INTEGRITY_AOA_DIAG_DIFF_THRESH

  String ID for the AOA check diagnostic difference threshold.
- const std::string INTEGRITY_AOA_DIAG_SUSPECT_PRN_COUNT

  String ID for the AOA check diagnostic suspect prn count.

- const std::string INTEGRITY_AOA_DIAG_ITHRESH = "INTEGRITY_AOA_DIAG_ITHRESH"

  String ID for the AOA check survey inconsistent thresh.
- const std::string INTEGRITY_AOA_DIAG_UTHRESH = "INTEGRITY_AOA_DIAG_UTHRESH"

  String ID for the AOA check survey unassured thresh.
- const std::string INTEGRITY_CLOCK_BIAS_DIAGNOSTICS

  String ID for the clock-bias check diagnostic data.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT

  String ID for the clock-bias check expected drift.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT_VAR

  String ID for the clock-bias check drift variance.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_PROP_OFFSET

  String ID for the clock-bias check propagation offset.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_ACTUAL_OFFSET

  String ID for the clock-bias check actual offset.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_OFFSET_ERROR

  String ID for the clock-bias check offset error.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_BOUND

  String ID for the clock-bias check drift rate bound.
- const std::string INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_VAR_BOUND

  String ID for the clock-bias check drift rate var bound.
- const std::string INTEGRITY_CN0_DIAGNOSTICS = "INTEGRITY_CN0_DIAGNOSTICS"

  String ID for the CNO check diagnostic data.
- const std::string INTEGRITY_CN0_DIAG_AVG_COUNT = "INTEGRITY_CN0_DIAG_AVG_COUNT"

  String ID for the CNO check average count.
- const std::string INTEGRITY_CN0_DIAG_ITHRESH = "INTEGRITY_CN0_DIAG_ITHRESH"

  String ID for the CNO check survey inconsistent thresh.
- const std::string INTEGRITY_CN0_DIAG_UTHRESH = "INTEGRITY_CN0_DIAG_UTHRESH"

  String ID for the CNO check survey unassured thresh.
- const std::string INTEGRITY_POS_JUMP_DIAGNOSTICS

  String ID for the position-jump check diagnostic data.
- const std::string INTEGRITY_POS_JUMP_DIAG_BOUND

  String ID for the position-jump check bound.
- const std::string INTEGRITY_POS_JUMP_DIAG_DIST = "INTEGRITY_POS_JUMP_DIAG_DIST"

  String ID for the position-jump check distance.
- const std::string INTEGRITY_PVC_DIAGNOSTICS = "INTEGRITY_PVC_DIAGNOSTICS"

  String ID for the position-velocity consistent check diagnostics data.
- const std::string INTEGRITY_PVC_DIAG_PB = "INTEGRITY_PVC_DIAG_PB"

  String ID for PVC diagnostic key for the "percent bad" variable.
- const std::string INTEGRITY_PVC_DIAG_ITHRESH = "INTEGRITY_PVC_DIAG_ITHRESH"

  String ID for the PVC diagnostic key for the inconsistent threshold.
- const std::string INTEGRITY_PVC_DIAG_UTHRESH = "INTEGRITY_PVC_DIAG_UTHRESH"

  String ID for the PVC diagnostic key for the unassured threshold.
- const std::string INTEGRITY_PVC_DIAG_ERR_VAL = "INTEGRITY_PVC_DIAG_ERR_VAL"

  String ID for the PVC diagnostic key for error values.
- const std::string INTEGRITY_PVC_DIAG_ERR_THRESH

  String ID for the PVC diagnostic key for error thresh values.
- const std::string INTEGRITY_RNG_POS_DIAGNOSTICS

String ID for the range-position check diagnostic data.

- const std::string INTEGRITY_RNG_POS_DIAG_MAX_CALC

  String ID for the range-position check max calculated range.
- const std::string INTEGRITY_RNG_POS_DIAG_MIN_CALC

  String ID for the range-position check min calculated range.
- const std::string INTEGRITY_RNG_POS_DIAG_MAX_MEAS

  String ID for the range-position check max measured range.
- const std::string INTEGRITY_RNG_POS_DIAG_MIN_MEAS

  String ID for the range-position check min measured range.
- const double pi = 3.1415926535898

  Definition of 'pi' to use in this check.
- const double deg2rad = pi / 180.0

  Convenience constant for 1/2 pi.
- const double rad2deg = 1.0 / deg2rad

  Convenience converter for radians to degrees.
- const std::string INTEGRITY_STATIC_POS_DIAGNOSTICS

  String ID for the static position check diagnostic data.
- const std::string INTEGRITY_STAIC_POS_DIAG_POS_LAT

  String ID for the static position check survey latitude.
- const std::string INTEGRITY_STAIC_POS_DIAG_POS_LON

  String ID for the static position check survey longitdue.
- const std::string INTEGRITY_STAIC_POS_DIAG_POS_ALT

  String ID for the static position check survey altitude.
- const std::string INTEGRITY_STAIC_POS_DIAG_POS_CHNG_THRESH

  String ID for the static position check change threshold.
- const std::string INTEGRITY_STAIC_POS_DIAG_PERCENT_OVER

  String ID for the static position check percentage threshold.
- const std::string INTEGRITY_STAIC_POS_DIAG_ITHRESH

  String ID for the static position check survey inconsistent thresh.
- const std::string INTEGRITY_STAIC_POS_DIAG_UTHRESH

  String ID for the static position check survey unassured thresh.

7.2.1 Detailed Description

Namespace for all pnt_integrity applications.

7.2.2 Typedef Documentation

7.2.2.1 PeakResultsMap

```
using pnt_integrity::PeakResultsMap = typedef std::map<int, std::pair<double, double> >
```

A map that holds the first and second peak values in each acquisition plan

Definition at line 92 of file AcquisitionCheck.hpp.

7.2.2.2 TimeEntryHistory

```
using pnt_integrity::TimeEntryHistory = typedef std::map<double, TimeEntry>
```

Defining a type for a history of time entries, which is realized by an ordered map keyed on time.

Definition at line 85 of file IntegrityDataRepository.hpp.

7.2.3 Variable Documentation

7.2.3.1 INT_ACQ_DIAG_PEAK_RATIO_THRESH

```
const std::string pnt_integrity::INT_ACQ_DIAG_PEAK_RATIO_THRESH
```

Initial value:

```
=
  "INT_ACQ_DIAG_PEAK_RATIO_THRESH"
```

String ID for the ACQ check peak ratio threshold.

Definition at line 65 of file AcquisitionCheck.hpp.

7.2.3.2 INTEGRITY_AOA_DIAG_DIFF_THRESH

```
const std::string pnt_integrity::INTEGRITY_AOA_DIAG_DIFF_THRESH
```

Initial value:

```
=
  "INTEGRITY_AOA_DIAG_DIFF_THRESH"
```

String ID for the AOA check diagnostic difference threshold.

Definition at line 57 of file AngleOfArrivalCheck.hpp.

7.2.3.3 INTEGRITY_AOA_DIAG_SUSPECT_PRN_COUNT

```
const std::string pnt_integrity::INTEGRITY_AOA_DIAG_SUSPECT_PRN_COUNT
```

Initial value:

```
=
  "INTEGRITY_AOA_DIAG_SUSPECT_PRN_COUNT"
```

String ID for the AOA check diagnostic suspect prn count.

Definition at line 60 of file AngleOfArrivalCheck.hpp.

7.2.3.4 INTEGRITY_AOA_DIFF_DIAGNOSTICS

```
const std::string pnt_integrity::INTEGRITY_AOA_DIFF_DIAGNOSTICS
```

Initial value:

```
=
  "INTEGRITY_AOA_DIFF_DIAGNOSTICS"
```

String ID for the AOA check difference diagnostic data.

Definition at line 50 of file AngleOfArrivalCheck.hpp.

7.2.3.5 INTEGRITY_CLOCK_BIAS_DIAG_ACTUAL_OFFSET

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_ACTUAL_OFFSET
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_ACTUAL_OFFSET"
```

String ID for the clock-bias check actual offset.

Definition at line 60 of file ClockBiasCheck.hpp.

7.2.3.6 INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_BOUND

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_BOUND
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_BOUND"
```

String ID for the clock-bias check drift rate bound.

Definition at line 66 of file ClockBiasCheck.hpp.

7.2.3.7 INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_VAR_BOUND

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_VAR_BOUND
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_VAR_BOUND"
```

String ID for the clock-bias check drift rate var bound.

Definition at line 69 of file ClockBiasCheck.hpp.

7.2.3.8 INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT"
```

String ID for the clock-bias check expected drift.

Definition at line 51 of file ClockBiasCheck.hpp.

7.2.3.9 INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT_VAR

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT_VAR
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT_VAR"
```

String ID for the clock-bias check drift variance.

Definition at line 54 of file ClockBiasCheck.hpp.

7.2.3.10 INTEGRITY_CLOCK_BIAS_DIAG_OFFSET_ERROR

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_OFFSET_ERROR
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_OFFSET_ERROR"
```

String ID for the clock-bias check offset error.

Definition at line 63 of file ClockBiasCheck.hpp.

7.2.3.11 INTEGRITY_CLOCK_BIAS_DIAG_PROP_OFFSET

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_PROP_OFFSET
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAG_PROP_OFFSET"
```

String ID for the clock-bias check propagation offset.

Definition at line 57 of file ClockBiasCheck.hpp.

7.2.3.12 INTEGRITY_CLOCK_BIAS_DIAGNOSTICS

```
const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAGNOSTICS
```

Initial value:

```
=
  "INTEGRITY_CLOCK_BIAS_DIAGNOSTICS"
```

String ID for the clock-bias check diagnostic data.

Definition at line 48 of file ClockBiasCheck.hpp.

7.2.3.13 INTEGRITY_POS_JUMP_DIAG_BOUND

```
const std::string pnt_integrity::INTEGRITY_POS_JUMP_DIAG_BOUND
```

Initial value:

```
=
  "INTEGRITY_POS_JUMP_DIAG_BOUND"
```

String ID for the position-jump check bound.

Definition at line 52 of file PositionJumpCheck.hpp.

7.2.3.14 INTEGRITY_POS_JUMP_DIAGNOSTICS

```
const std::string pnt_integrity::INTEGRITY_POS_JUMP_DIAGNOSTICS
```

Initial value:

```
=
  "INTEGRITY_POS_JUMP_DIAGNOSTICS"
```

String ID for the position-jump check diagnostic data.

Definition at line 49 of file PositionJumpCheck.hpp.

7.2.3.15 INTEGRITY_PVC_DIAG_ERR_THRESH

```
const std::string pnt_integrity::INTEGRITY_PVC_DIAG_ERR_THRESH
```

Initial value:

```
=
  "INTEGRITY_PVC_DIAG_ERR_THRESH"
```

String ID for the PVC diagnostic key for error thresh values.

Definition at line 61 of file PositionVelocityConsistencyCheck.hpp.

7.2.3.16 INTEGRITY_RNG_POS_DIAG_MAX_CALC

```
const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MAX_CALC
```

Initial value:

```
=
  "INTEGRITY_RNG_POS_DIAG_MAX_CALC"
```

String ID for the range-position check max calculated range.

Definition at line 50 of file RangePositionCheck.hpp.

7.2.3.17 INTEGRITY_RNG_POS_DIAG_MAX_MEAS

```
const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MAX_MEAS
```

Initial value:

```
=
  "INTEGRITY_RNG_POS_DIAG_MAX_MEAS"
```

String ID for the range-position check max measured range.

Definition at line 56 of file RangePositionCheck.hpp.

7.2.3.18 INTEGRITY_RNG_POS_DIAG_MIN_CALC

```
const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MIN_CALC
```

Initial value:

```
=
  "INTEGRITY_RNG_POS_DIAG_MIN_CALC"
```

String ID for the range-position check min calculated range.

Definition at line 53 of file RangePositionCheck.hpp.

7.2.3.19 INTEGRITY_RNG_POS_DIAG_MIN_MEAS

```
const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MIN_MEAS
```

Initial value:

```
=
  "INTEGRITY_RNG_POS_DIAG_MIN_MEAS"
```

String ID for the range-position check min measured range.

Definition at line 59 of file RangePositionCheck.hpp.

7.2.3.20 INTEGRITY_RNG_POS_DIAGNOSTICS

```
const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAGNOSTICS
```

Initial value:

```
=
  "INTEGRITY_RNG_POS_DIAGNOSTICS"
```

String ID for the range-position check diagnostic data.

Definition at line 47 of file RangePositionCheck.hpp.

7.2.3.21 INTEGRITY_STAIC_POS_DIAG_ITHRESH

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_ITHRESH
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_ITHRESH"
```

String ID for the static position check survey inconsistent thresh.

Definition at line 68 of file StaticPositionCheck.hpp.

7.2.3.22 INTEGRITY_STAIC_POS_DIAG_PERCENT_OVER

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_PERCENT_OVER
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_PERCENT_OVER"
```

String ID for the static position check percentage threshold.

Definition at line 65 of file StaticPositionCheck.hpp.

7.2.3.23 INTEGRITY_STAIC_POS_DIAG_POS_ALT

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_ALT
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_POS_ALT"
```

String ID for the static position check survey altitude.

Definition at line 59 of file StaticPositionCheck.hpp.

7.2.3.24 INTEGRITY_STAIC_POS_DIAG_POS_CHNG_THRESH

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_CHNG_THRESH
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_POS_CHNG_THRESH"
```

String ID for the static position check change threshold.

Definition at line 62 of file StaticPositionCheck.hpp.

7.2.3.25 INTEGRITY_STAIC_POS_DIAG_POS_LAT

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_LAT
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_POS_LAT"
```

String ID for the static position check survey latitude.

Definition at line 53 of file StaticPositionCheck.hpp.

7.2.3.26 INTEGRITY_STAIC_POS_DIAG_POS_LON

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_LON
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_POS_LON"
```

String ID for the static position check survey longitdue.

Definition at line 56 of file StaticPositionCheck.hpp.

7.2.3.27 INTEGRITY_STAIC_POS_DIAG_UTHRESH

```
const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_UTHRESH
```

Initial value:

```
=
  "INTEGRITY_STAIC_POS_DIAG_UTHRESH"
```

String ID for the static position check survey unassured thresh.

Definition at line 71 of file StaticPositionCheck.hpp.

7.2.3.28 INTEGRITY_STATIC_POS_DIAGNOSTICS

```
const std::string pnt_integrity::INTEGRITY_STATIC_POS_DIAGNOSTICS
```

Initial value:

```
=
  "INTEGRITY_STATIC_POS_DIAGNOSTICS"
```

String ID for the static position check diagnostic data.

Definition at line 50 of file StaticPositionCheck.hpp.

7.3 pnt_integrity::data Namespace Reference

Namespace for all integrity data definitions.

Classes

- struct AccumulatedDistranceTraveled

  A structure that represents a distance traveled over a time period.
- struct AgcValue

  A structure to represent an AGC measurement.
- struct AssuranceReport

  A structure to hold a single assurance report.
- struct AssuranceReports

  A structure to hold assurance data for all registered checks.
- class AssuranceState

  A structure to hold an AssuranceLevel and value.
- struct ClockOffset

  A structure for measuring the offset between two clocks.
- struct CommandResponse

  A structure for command / response messages.
- struct Diagnostics

  A structure for general diagnostic messages.
- struct EventLog

  Structure for event log messages.
- struct GeodeticPosition3d

  A structure to represent 3D geodetic position.
- struct GNSSObservable

  A structure for pseudorange observables.
- struct GNSSObservables

  The GNSSObservables message.
- struct GNSSTime

  A GNSS time.
- struct Header

  The header used for all associated data types.
- struct IMU

  A structure that represents IMU measurement data.
- struct KeyValue

  A structure for key value pairs.
- struct MeasuredRange

  A structure that represents a distance measurement to a known point.
- struct PositionVelocity

  A structure to represent a Position / Velocity message.
- struct Timestamp

  A timestamp used in all headers.

Typedefs

- using GNSSObservableMap = std::map< uint64_t, GNSSObservable >

  A map to relate a GNSSObservable to a PRN.

Enumerations

- enum TimeSystem { **GLO** = 0, **GPS**, **GAL**, **BDT** }

  Enumeration for all available satellite-based time system sources.
- enum SatelliteSystem : uint8_t {
  GPS = 0, **Glonass**, **Galileo**, **QZSS**,
  BeiDou, **IRNSS**, **SBAS**, **Mixed**,
  Other }

  Enumeration for satellite system identification.
- enum FrequencyBand : uint8_t {
  Band1 = 0, **Band2**, **Band5**, **Band6**,
  Band7, **Band8**, **Band9**, **Band0**,
  Band10 }

  Defines all possible frequency types.
- enum CodeType : uint8_t {
  SigP = 0, **SigC**, **SigD**, **SigY**,
  SigM, **SigN**, **SigA**, **SigB**,
  SigI, **SigQ**, **SigS**, **SigL**,
  SigX, **SigW**, **SigZ**, **SigBLANK** }

  Defines all possible code types.
- enum AssuranceLevel : int8_t { **Unavailable** = 0, **Unassured**, **Inconsistent**, **Assured** }

  Defines all available assurance level values.
- enum LevelEnum { **DIAG_OK** = 0, **DIAG_WARN**, **DIAG_ERROR**, **DIAG_STALE** }

  An enumeration for diagnostic level.
- enum EventLogType {
  NotSet = 0, **Debug**, **Info**, **Warning**,
  Error, **Critical** }

  An enumeration for event log type.
- enum CommandResponseType { **COMMAND** = 0, **RESPONSE** }

  The command / response type enumeration.

7.3.1 Detailed Description

Namespace for all integrity data definitions.

Chapter 8

Class Documentation

8.1 pnt_integrity::data::AccumulatedDistranceTraveled Struct Reference

A structure that represents a distance traveled over a time period.

`#include <IntegrityData.hpp>`

Public Attributes

- Header header
  The message header.
- double dt
  Time span of accumulated distance (s)
- double distance
  Accumulated distance traveled over time period (m)
- double variance
  Accumulated distance traveled variance (m^ 2)

8.1.1 Detailed Description

A structure that represents a distance traveled over a time period.

Definition at line 739 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.2 pnt_integrity::AcqCheckDiagnostics Struct Reference

Structure for publishing Acquisition Check diagnostics.

`#include <AcquisitionCheck.hpp>`

Public Attributes

- double highPowerThresh
  The threshold to indicate high-power in a prn acquisition.
- double peakRatioThresh
  The threshold on peak 1 to peak 2 ratio to determine a suspect prn.
- double acquisitionThresh
  The threshold on the acuqisition plane to indicate a good prn.
- double inconsistentThresh
  The threshold used for determining an overall inconsistent assurance level.
- double unassuredThresh
  The threshold used for determining an overall unassured assurance level.
- double unassuredCount
  The number of prns flagged as unassured.
- double inconsistentCount
  The number of prns flagged as inconsistent.
- std::map< int, double > ratioMap
  A map that pairs PRN id to the peak ratio.

8.2.1 Detailed Description

Structure for publishing Acquisition Check diagnostics.

Definition at line 97 of file AcquisitionCheck.hpp.

The documentation for this struct was generated from the following file:

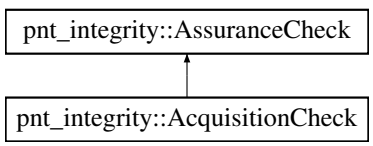
- include/pnt_integrity/AcquisitionCheck.hpp

8.3 pnt_integrity::AcquisitionCheck Class Reference

Class implementation for the acquisition check.

`#include <AcquisitionCheck.hpp>`

Inheritance diagram for pnt_integrity::AcquisitionCheck:



Public Member Functions

- AcquisitionCheck (const std::string &name="Acquisition check", const double &highPowerThreshold=2.5e7, const double &peakRatioThreshold=7.0, const double &acqusitionThreshold=3e6, const double &expectedSampling↩ Freq=5e6, const double &intermediateFreq=0.0, const double &searchBand=10e3, const double &search↩ StepSize=0.5e3, const double &integrationPeriod=1e-3, const double &codeFrequencyBasis=1.023e6, const int &codeLength=1023, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor for the check class.
- bool handleIFSampleData (const double &checkTime, const if_data_utils::IFSampleData< if_data_utils::IF↩ SampleSC8 > &ifData)

  Handler function for IF sample data (SC8)
- bool handleIFSampleData (const double &checkTime, const if_data_utils::IFSampleData< if_data_utils::IF↩ SampleSC16 > &ifData)

  Handler function for IF sample data (SC16)
- template<typename samp_type >
  bool processIFSampleData (const if_data_utils::IFSampleData< samp_type > &sampleData)

  Functon to processing incoming samples.
- void calculateAssuranceLevel (const double &time)

  Function to explicitly set the assurance level of the check.
- void setPublishAquisition (std::function< void(const CorrelationResultsMap &)> handler)

  Connects the internal publishing function to external interface.
- void setPublishPeakData (std::function< void(const double &, const PeakResultsMap &)> handler)

  Connects the internal publishing function to external interface.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const AcqCheckDiagnostics &check↩ Data)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.3.1 Detailed Description

Class implementation for the acquisition check.

Class implementation of the acquisition check. The class is a child class of AssuranceCheck

Definition at line 120 of file AcquisitionCheck.hpp.

8.3.2 Constructor & Destructor Documentation

8.3.2.1 AcquisitionCheck()

```
pnt_integrity::AcquisitionCheck::AcquisitionCheck (
            const std::string & name = "Acquisition check",
            const double & highPowerThreshold = 2.5e7,
            const double & peakRatioThreshold = 7.0,
            const double & acqusitionThreshold = 3e6,
            const double & expectedSamplingFreq = 5e6,
            const double & intermediateFreq = 0.0,
            const double & searchBand = 10e3,
            const double & searchStepSize = 0.5e3,
            const double & integrationPeriod = 1e-3,
            const double & codeFrequencyBasis = 1.023e6,
            const int & codeLength = 1023,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor for the check class.

Constructor for the acuqisiton check, the default constructor configures the check for L1-CA at 5 MSps. Acquisition parameters will be recalculated if a different sampling frequency is detected

Parameters

name	A string name for the check instance
highPowerThreshold	A threshold that indicates abnormally high power levels
peakRatioThreshold	A threshold for the ratio of the first and second peaks in the acquisition plane, indicating a possible unauthentic signal
acqusitionThreshold	A threshold for classifiing a signal as acquired or unacquired
expectedSamplingFreq	The expected sampling frequency
intermediateFreq	The intermediate frequency of incoming sample stream
searchBand	The acquisition search band
searchStepSize	The acquisition search step size (defines bins)
integrationPeriod	Integration period to use for acquisition
codeFrequencyBasis	Freqeuncy basis for the code of interest
codeLength	Length of the code (in chips)
log	The provided log handler function

Definition at line 146 of file AcquisitionCheck.hpp.

8.3.3 Member Function Documentation

8.3.3.1 calculateAssuranceLevel()

```
void pnt_integrity::AcquisitionCheck::calculateAssuranceLevel (
            const double & time )  [virtual]
```

Function to explicitly set the assurance level of the check.

For this check, this function cycles through all of the individual PRN assurance values, analyzes them, and then sets the master assurance level associted with the check.

Implements pnt_integrity::AssuranceCheck.

8.3.3.2 handleIFSampleData() [1/2]

```
bool pnt_integrity::AcquisitionCheck::handleIFSampleData (
            const double & checkTime,
            const if_data_utils::IFSampleData< if_data_utils::IFSampleSC8 > & ifData )  [inline],
[virtual]
```

Handler function for IF sample data (SC8)

Function to handle provided IF data. (Overriding inherited function from parent class). Calls the common templated function processIfSampleData for convenience

Parameters

checkTime	The timestamp associated with the data
ifData	The provided IF data sample set

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

Definition at line 201 of file AcquisitionCheck.hpp.

8.3.3.3 handleIFSampleData() [2/2]

```
bool pnt_integrity::AcquisitionCheck::handleIFSampleData (
            const double & checkTime,
            const if_data_utils::IFSampleData< if_data_utils::IFSampleSC16 > & ifData )  [inline],
[virtual]
```

Handler function for IF sample data (SC16)

Function to handle provided IF data (Overriding inherited function from parent class). Calls the common templated function processIfSampleData for convenience

Parameters

checkTime	The timestamp associated with the data
ifData	The provided IF data sample set

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

Definition at line 228 of file AcquisitionCheck.hpp.

8.3.3.4 processIFSampleData()

```
template<typename samp_type >
bool pnt_integrity::AcquisitionCheck::processIFSampleData (
            const if_data_utils::IFSampleData< samp_type > & sampleData )
```

Functon to processing incoming samples.

Template function for processing incoming samples

Parameters

sampleData	Incoming sample data

Definition at line 415 of file AcquisitionCheck.hpp.

8.3.3.5 setPublishAquisition()

```
void pnt_integrity::AcquisitionCheck::setPublishAquisition (
            std::function< void(const CorrelationResultsMap &)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishAcquisitionData" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 268 of file AcquisitionCheck.hpp.

8.3.3.6 setPublishDiagnostics()

```
void pnt_integrity::AcquisitionCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const AcqCheckDiagnostics &checkData)>
handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 294 of file AcquisitionCheck.hpp.

8.3.3.7 setPublishPeakData()

```
void pnt_integrity::AcquisitionCheck::setPublishPeakData (
            std::function< void(const double &, const PeakResultsMap &)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishPeakData" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 281 of file AcquisitionCheck.hpp.

The documentation for this class was generated from the following file:

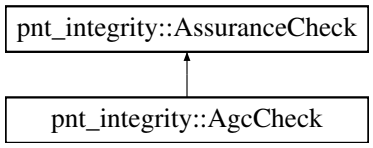
- include/pnt_integrity/AcquisitionCheck.hpp

8.4 pnt_integrity::AgcCheck Class Reference

Class implementation for the AGC check.

`#include <AgcCheck.hpp>`

Inheritance diagram for pnt_integrity::AgcCheck:



Public Member Functions

- AgcCheck (const std::string &name="agc_check", const double &minValue=0.0, const double &maxValue=10000, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor for the AgcCheck class.
- bool handleAGC (const data::AgcValue &agcValue)

  Handler function for AGC value.
- void calculateAssuranceLevel (const double &)

  Function to explicitly set the assurance level of the check.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const AgcCheckDiagnostics &checkData)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.4.1 Detailed Description

Class implementation for the AGC check.

Definition at line 61 of file AgcCheck.hpp.

8.4.2 Constructor & Destructor Documentation

8.4.2.1 AgcCheck()

```
pnt_integrity::AgcCheck::AgcCheck (
            const std::string & name = "agc_check",
            const double & minValue = 0.0,
            const double & maxValue = 10000,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor for the AgcCheck class.

Parameters

name	The name of the check
minValue	The minimum possible reported value for the AGC
maxValue	The maximum possible reported value for the AGC
log	Log handler function

Definition at line 70 of file AgcCheck.hpp.

8.4.3 Member Function Documentation

8.4.3.1 handleAGC()

```
bool pnt_integrity::AgcCheck::handleAGC (
            const data::AgcValue & agcValue )  [inline], [virtual]
```

Handler function for AGC value.

Function to handle provided AGC values (virtual)

Parameters

agcValue	The provided AGC message / structure

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

Definition at line 95 of file AgcCheck.hpp.

8.4.3.2 setPublishDiagnostics()

```
void pnt_integrity::AgcCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const AgcCheckDiagnostics &checkData)>
handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 111 of file AgcCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/AgcCheck.hpp

8.5 pnt_integrity::AgcCheckDiagnostics Struct Reference

Diagnostic data for AGC check.

```
#include <AgcCheck.hpp>
```

Public Attributes

- data::AgcValue values
  The AGC values.
- double inconsistentThresh
  The inconsistent threshold.

8.5.1 Detailed Description

Diagnostic data for AGC check.

Definition at line 52 of file AgcCheck.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/AgcCheck.hpp

8.6 pnt_integrity::data::AgcValue Struct Reference

A structure to represent an AGC measurement.

```
#include <IntegrityData.hpp>
```

Public Attributes

- Header header

  The message header.
- std::map< FrequencyBand, double > agcValues

  A vector for AGC values (multiple bands possible)

8.6.1 Detailed Description

A structure to represent an AGC measurement.

Definition at line 799 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

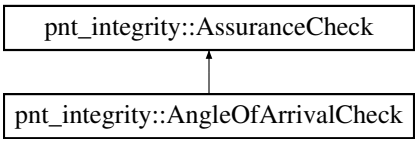
- include/pnt_integrity/IntegrityData.hpp

8.7 pnt_integrity::AngleOfArrivalCheck Class Reference

Class implementation for the angle of arrival check.

`#include <AngleOfArrivalCheck.hpp>`

Inheritance diagram for pnt_integrity::AngleOfArrivalCheck:



Public Member Functions

- AngleOfArrivalCheck (const std::string &name="AOA check", const AoaCheckData &aoaCheckData=Aoa↩ CheckData::UsePseudorange, const double &singleDiffCompareThresh=5.0, const int &prnCountThresh=5, const double &rangeThreshold=5.0, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor.
- bool handleGnssObservables (const data::GNSSObservables &gnssObs)

  Handler function for GNSS Observables.
- bool runCheck ()

  Triggers a manual check calculation.
- void calculateAssuranceLevel (const double &time)

  Function to explicitly set the assurance level of the check.
- void setDifferenceComparisonThreshold (const double &thresh)

  Sets the difference comparison threshold.

- void setPrnCountThreshold (const int &thresh)

  Sets the prn count threshold.
- void setRangeThreshold (const double &thresh)

  Sets the range threshold.
- void setPublishDiffData (std::function< void(const double &time, const std::string &remoteNodeId, const SingleDiffMap &)> handler)

  Connects the internal publishing function to external interface.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const AoaCheckDiagnostics &checkData)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.7.1 Detailed Description

Class implementation for the angle of arrival check.

Class implementation of the angle of arrival check. The class is a child class of AssuranceCheck

Definition at line 98 of file AngleOfArrivalCheck.hpp.

8.7.2 Constructor & Destructor Documentation

8.7.2.1 AngleOfArrivalCheck()

```
pnt_integrity::AngleOfArrivalCheck::AngleOfArrivalCheck (
            const std::string & name = "AOA check",
            const AoaCheckData & aoaCheckData = AoaCheckData::UsePseudorange,
            const double & singleDiffCompareThresh = 5.0,
            const int & prnCountThresh = 5,
            const double & rangeThreshold = 5.0,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor.

Constructor for the angle of arrival check class. The constructor defaults the multi-prn support to true for this check, so enableMultiPrnSupport need not be called.

Parameters

name	The name associated with the check
aoaCheckData	Sets which type of data will be used
singleDiffCompareThresh	Sets the threshold for comparing single difference values
prnCountThresh	A threshold used in the AOA check to determine if a PRN has a common AOA with other PRNs.
rangeThreshold	A distance threshold that is used when to determine if a remote node is to close to the local node to perform the AOA check
log	A provided log callback function to use

Definition at line 117 of file AngleOfArrivalCheck.hpp.

8.7.3 Member Function Documentation

8.7.3.1 calculateAssuranceLevel()

```
void pnt_integrity::AngleOfArrivalCheck::calculateAssuranceLevel (
            const double & time )  [virtual]
```

Function to explicitly set the assurance level of the check.

For this check, this function cycles through all of the individual PRN assurance values, analyzes them, and then sets the master assurance level associted with the check.

Implements pnt_integrity::AssuranceCheck.

8.7.3.2 handleGnssObservables()

```
bool pnt_integrity::AngleOfArrivalCheck::handleGnssObservables (
            const data::GNSSObservables & gnssObs )  [virtual]
```

Handler function for GNSS Observables.

Function to handle provided GNSS Observables. This function simply calls runCheck(), as the provided data has already been added to the repository

Parameters

gnssObs	The provided GNSS observable data

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.7.3.3 runCheck()

```
bool pnt_integrity::AngleOfArrivalCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.7.3.4 setDifferenceComparisonThreshold()

```
void pnt_integrity::AngleOfArrivalCheck::setDifferenceComparisonThreshold (
            const double & thresh )  [inline]
```

Sets the difference comparison threshold.

This threshold is used to determine when 2 separate single differences (between a local and remote node) should be flagged has having a common angle of arrival. The units on this threshold depend on the type of data that is being used for the check (AoaCheckData). For example if, AoaCheckData::UsePseudorange is being used, then the units are in meters.

Parameters

thresh	The threshold value to use

Definition at line 177 of file AngleOfArrivalCheck.hpp.

8.7.3.5 setPrnCountThreshold()

```
void pnt_integrity::AngleOfArrivalCheck::setPrnCountThreshold (
            const int & thresh )  [inline]
```

Sets the prn count threshold.

This threshold is used to determine when to raise the assurance level of a particular prn. If a PRN is found to have a common AOA with at least [threshold] other PRNS, then the AssuranceLevel is raised

Parameters

thresh	The threshold value to use

Definition at line 190 of file AngleOfArrivalCheck.hpp.

8.7.3.6 setPublishDiagnostics()

```
void pnt_integrity::AngleOfArrivalCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const AoaCheckDiagnostics &checkData)>
handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 230 of file AngleOfArrivalCheck.hpp.

8.7.3.7 setPublishDiffData()

```
void pnt_integrity::AngleOfArrivalCheck::setPublishDiffData (
            std::function< void(const double &time, const std::string &remoteNodeId, const Single↩
DiffMap &)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishSingleDiffData" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 216 of file AngleOfArrivalCheck.hpp.

8.7.3.8 setRangeThreshold()

```
void pnt_integrity::AngleOfArrivalCheck::setRangeThreshold (
            const double & thresh )  [inline]
```

Sets the range threshold.

When calculating differences between local and remote observables, if a measured range is available between the two, it is compared to this threshold. If the measured range is less than the threshold, then the difference is not calculated

Parameters

thresh	The threshold to use

Definition at line 204 of file AngleOfArrivalCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/AngleOfArrivalCheck.hpp

8.8 pnt_integrity::AoaCheckDiagnostics Struct Reference

Structure used to publish diagnostic data.

```
#include <AngleOfArrivalCheck.hpp>
```

Public Attributes

- double singleDiffThresh

  The threshold that is used when comparing single differences.
- int suspectPrnCount

  The number of PRNS that appear suspect (UNASSURED or INCONSISTENT)
- double inconsistentThresh

  The threshold used to check against the number of suspect PRNS.
- double unassuredThresh

  The threshold used to check against the number of suspect PRNS.

8.8.1 Detailed Description

Structure used to publish diagnostic data.

Definition at line 68 of file AngleOfArrivalCheck.hpp.

The documentation for this struct was generated from the following file:

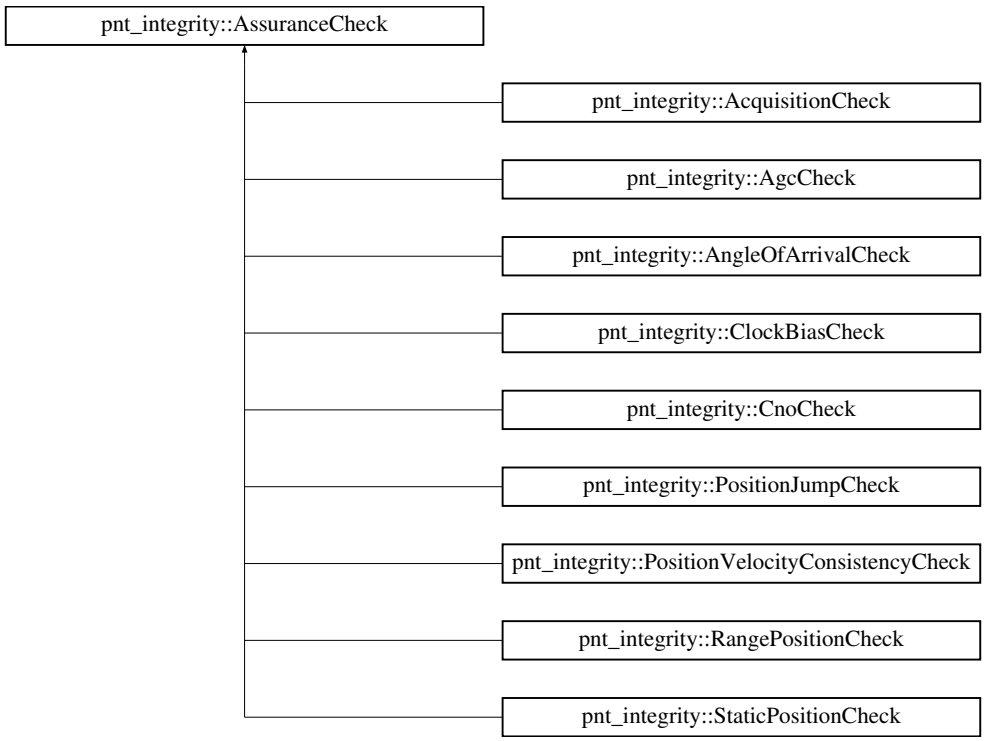
- include/pnt_integrity/AngleOfArrivalCheck.hpp

8.9 pnt_integrity::AssuranceCheck Class Reference

Parent class for all integrity checks.

`#include <AssuranceCheck.hpp>`

Inheritance diagram for pnt_integrity::AssuranceCheck:



Public Member Functions

- AssuranceCheck (const bool &multiPrnSupport=false, const std::string &checkName="AssuranceCheck", const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor.
- virtual bool handleGnssObservables (const data::GNSSObservables &)

  Handler function for GNSS Observables.
- MultiPrnAssuranceMap getMultiPrnAssuranceData ()

  Return function for the multi-prn assurance data.
- virtual bool handlePositionVelocity (const data::PositionVelocity &, const bool &)

  Handler function for Position / Velocity message.
- virtual bool handleEstimatedPositionVelocity (const data::PositionVelocity &)

  Handler function for an estimated Position / Velocity message.
- virtual bool handleDistanceTraveled (const data::AccumulatedDistranceTraveled &)

  Handler function for AccumulatedDistranceTraveled messages.
- virtual bool handleMeasuredRange (const data::MeasuredRange &)

  Handler function for measured range.

- virtual bool handleIFSampleData (const double &, const if_data_utils::IFSampleData< if_data_utils::IFSample↩ SC8 > &)

  Handler function for IF sample data (SC8)
- virtual bool handleIFSampleData (const double &, const if_data_utils::IFSampleData< if_data_utils::IFSample↩ SC16 > &)

  Handler function for IF sample data (SC16)
- virtual bool handleClockOffset (const data::ClockOffset &)

  Handler function for Clock Offset sample data.
- virtual bool handleAGC (const data::AgcValue &)

  Handler function for AGC value.
- data::AssuranceLevel getAssuranceLevel ()

  Returns the AssuranceLevel enumeration value associated with the check's AssuranceState.
- double getAssuranceValue ()

  Returns the interger value associated with the check's AssuranceState.
- data::AssuranceState getAssuranceState ()

  Returns the AssuranceState of the check.
- virtual void calculateAssuranceLevel (const double &time)=0

  Function to calculate the assurance level of the check.
- void setAssuranceThresholds (const double &unknownThresh, const double &unusableThresh)

  Sets the assurance level transition thresholds.
- virtual bool runCheck ()=0

  Triggers a manual check calculation.
- void setLogMessageHandler (const logutils::LogCallback &logMsgHandler)

  Sets the log message handler to provided callback.
- void enableMultiPrnSupport ()

  Enables support for multiple prn checks.
- std::string getName ()

  Returns the name of the check.
- void changeAssuranceLevel (const double &updateTime, const data::AssuranceLevel &newLevel)

  Changes the check's assurance level to the provided value.
- void setAssuranceLevelPeriod (const double &levelPeriod)

  Sets the assurance level period.
- virtual void setLastGoodPosition (const double &updateTime, const data::GeodeticPosition3d &position)

  Sets the last known good position.
- virtual void setPositionAssurance (const double &, const data::GeodeticPosition3d &, const data::AssuranceLevel &)

  Provides the check with an updated position and assuarance level.
- void setWeight (const double &weightVal)

  Sets the weight of the check.
- double getWeight ()

  Returns the weight for the check.
- void setAllowPositiveWeighting (const bool &allowVal)

  Sets the positive check weighting allowed boolean.
- bool isCheckUsed ()

  Returns whether or not the check's level should be weighted.

Static Protected Member Functions

- static double calculateDistance (const data::GeodeticPosition3d &pos1, const data::GeodeticPosition3d &pos2)

  Computes the distance between two geodetic coordinates.
- static bool checkDistance (const data::GeodeticPosition3d &pos1, const data::GeodeticPosition3d &pos2, const double &distanceThresh, double &distance)

  Checks if the distance between two points is greater than the provided threshold.
- static bool checkDistance (const double &dist, const double &thresh)

  Compares the provided distance value with the threshold.

Protected Attributes

- std::recursive_mutex **assuranceCheckMutex_**
- logutils::LogCallback **logMsg_**
- MultiPrnAssuranceMap prnAssuranceLevels_
- double assuranceInconsistentThresh_
- double assuranceUnassuredThresh_
- std::string checkName_

  The name of the check.
- double assuranceLevelPeriod_

  The hold time for an elevated assurance level.
- double lastAssuranceUpdate_

  The last time the assurance level was updated.
- data::GeodeticPosition3d lastKnownGoodPosition_

  The last known good position set by external application.
- double lastKnownGoodPositionTime_

  The time associated with the last known good position.
- double lastKnownGoodSet_

  Flag to indicate that last known good has been set.
- bool allowPositiveWeighting_

8.9.1 Detailed Description

Parent class for all integrity checks.

Pure virtual parent class that holds common functionality accross all assurance checks. Any child class that inherits from this must lock assuranceCheckMutex_ before access any protected data in this class. Any child class that inherits from this class can also use assuranceCheckMutex_ to protect private data in the child class.

Definition at line 59 of file AssuranceCheck.hpp.

8.9.2 Constructor & Destructor Documentation

8.9.2.1 AssuranceCheck()

```
pnt_integrity::AssuranceCheck::AssuranceCheck (
            const bool & multiPrnSupport = false,
            const std::string & checkName = "AssuranceCheck",
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor.

Constructor for the parent class. Multiple PRN support is disabled by default

Parameters

multiPrnSupport	Constructor argument to enable / disable multiple PRN support
checkName	A string name identifier for the check
log	The provided log callback function

Definition at line 71 of file AssuranceCheck.hpp.

8.9.3 Member Function Documentation

8.9.3.1 calculateAssuranceLevel()

```
virtual void pnt_integrity::AssuranceCheck::calculateAssuranceLevel (
            const double & time )  [pure virtual]
```

Function to calculate the assurance level of the check.

Child classes should define this function to calculate the assurance level of the check by using whatever data / calculation necessary

Implemented in pnt_integrity::AcquisitionCheck, pnt_integrity::PositionJumpCheck, pnt_integrity::ClockBiasCheck, pnt_integrity::AngleOfArrivalCheck, pnt_integrity::StaticPositionCheck, pnt_integrity::RangePositionCheck, pnt_integrity::PositionVelocityConsistencyCheck, pnt_integrity::CnoCheck, and pnt_integrity::AgcCheck.

8.9.3.2 calculateDistance()

```
static double pnt_integrity::AssuranceCheck::calculateDistance (
            const data::GeodeticPosition3d & pos1,
            const data::GeodeticPosition3d & pos2 )  [static], [protected]
```

Computes the distance between two geodetic coordinates.

Parameters

pos1	The first position
pos2	The second position

Returns

The calculated distance

8.9.3.3 changeAssuranceLevel()

```
void pnt_integrity::AssuranceCheck::changeAssuranceLevel (
            const double & updateTime,
            const data::AssuranceLevel & newLevel )
```

Changes the check's assurance level to the provided value.

This function will change the assurance level of the check. Usually called by internal functions after a calculation based on provided assurance data. The function will raise the assurance level immediately if the provided level is higher than the current level. If the level is lower, the function will not change the level unless a certain period of time has passed since the last assurnace level upgrade (assuranceLevelPeriod_)

Parameters

updateTime	The timestampe associated with the requested level change
newLevel	The newly provided / requested assurance level

8.9.3.4 checkDistance() [1/2]

```
static bool pnt_integrity::AssuranceCheck::checkDistance (
            const data::GeodeticPosition3d & pos1,
            const data::GeodeticPosition3d & pos2,
            const double & distanceThresh,
            double & distance )  [inline], [static], [protected]
```

Checks if the distance between two points is greater than the provided threshold.

Parameters

pos1	The first position
pos2	The second position
distanceThresh	The provided threshold do compare against
distance	The calculated distance

Returns

True if distance is greater than provided threshold

Definition at line 462 of file AssuranceCheck.hpp.

8.9.3.5 checkDistance() [2/2]

```
static bool pnt_integrity::AssuranceCheck::checkDistance (
            const double & dist,
            const double & thresh )  [inline], [static], [protected]
```

Compares the provided distance value with the threshold.

Parameters

dist	The provided distance
thresh	The threshold to compare against

Returns

True if distance is greater than provided threshold

Definition at line 475 of file AssuranceCheck.hpp.

8.9.3.6 getMultiPrnAssuranceData()

```
MultiPrnAssuranceMap pnt_integrity::AssuranceCheck::getMultiPrnAssuranceData ( )  [inline]
```

Return function for the multi-prn assurance data.

Returns the multiple-prn assurance levels for the check. An assertion is implemented to gaurantee that the function only returns the map when multi-prn support is enabled for the check.

Returns

The prn-to-assurance level map

Definition at line 110 of file AssuranceCheck.hpp.

8.9.3.7 getWeight()

```
double pnt_integrity::AssuranceCheck::getWeight ( )  [inline]
```

Returns the weight for the check.

Returns

The weight for the check

Definition at line 360 of file AssuranceCheck.hpp.

8.9.3.8 handleAGC()

```
virtual bool pnt_integrity::AssuranceCheck::handleAGC (
            const data::AgcValue &  )  [inline], [virtual]
```

Handler function for AGC value.

Function to handle provided AGC values (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::AgcCheck.

Definition at line 195 of file AssuranceCheck.hpp.

8.9.3.9 handleClockOffset()

```
virtual bool pnt_integrity::AssuranceCheck::handleClockOffset (
            const data::ClockOffset &  )  [inline], [virtual]
```

Handler function for Clock Offset sample data.

Function to handle provided Clock Offset data (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::ClockBiasCheck.

Definition at line 185 of file AssuranceCheck.hpp.

8.9.3.10 handleDistanceTraveled()

```
virtual bool pnt_integrity::AssuranceCheck::handleDistanceTraveled (
            const data::AccumulatedDistranceTraveled &  )  [inline], [virtual]
```

Handler function for AccumulatedDistranceTraveled messages.

Returns

True if successful

Reimplemented in pnt_integrity::PositionJumpCheck.

Definition at line 140 of file AssuranceCheck.hpp.

8.9.3.11 handleEstimatedPositionVelocity()

```
virtual bool pnt_integrity::AssuranceCheck::handleEstimatedPositionVelocity (
            const data::PositionVelocity &  )  [inline], [virtual]
```

Handler function for an estimated Position / Velocity message.

Function to handle provided posivion / velocity messages (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::PositionJumpCheck.

Definition at line 132 of file AssuranceCheck.hpp.

8.9.3.12 handleGnssObservables()

```
virtual bool pnt_integrity::AssuranceCheck::handleGnssObservables (
            const data::GNSSObservables &  )  [inline], [virtual]
```

Handler function for GNSS Observables.

Function to handle provided GNSS Observables. (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::AngleOfArrivalCheck, and pnt_integrity::CnoCheck.

Definition at line 98 of file AssuranceCheck.hpp.

8.9.3.13 handleIFSampleData() [1/2]

```
virtual bool pnt_integrity::AssuranceCheck::handleIFSampleData (
            const double & ,
            const if_data_utils::IFSampleData< if_data_utils::IFSampleSC8 > &  )  [inline],
[virtual]
```

Handler function for IF sample data (SC8)

Function to handle provided IF data (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::AcquisitionCheck.

Definition at line 161 of file AssuranceCheck.hpp.

8.9.3.14 handleIFSampleData() [2/2]

```
virtual bool pnt_integrity::AssuranceCheck::handleIFSampleData (
            const double & ,
            const if_data_utils::IFSampleData< if_data_utils::IFSampleSC16 > &  )  [inline],
[virtual]
```

Handler function for IF sample data (SC16)

Function to handle provided IF data (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::AcquisitionCheck.

Definition at line 173 of file AssuranceCheck.hpp.

8.9.3.15 handleMeasuredRange()

```
virtual bool pnt_integrity::AssuranceCheck::handleMeasuredRange (
            const data::MeasuredRange &  )  [inline], [virtual]
```

Handler function for measured range.

Function to handle provided range measurements (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::RangePositionCheck.

Definition at line 151 of file AssuranceCheck.hpp.

8.9.3.16 handlePositionVelocity()

```
virtual bool pnt_integrity::AssuranceCheck::handlePositionVelocity (
            const data::PositionVelocity & ,
            const bool &  )  [inline], [virtual]
```

Handler function for Position / Velocity message.

Function to handle provided posivion / velocity messages (virtual)

Returns

True if successful

Reimplemented in pnt_integrity::StaticPositionCheck, pnt_integrity::PositionJumpCheck, pnt_integrity::RangePosition↩Check, and pnt_integrity::PositionVelocityConsistencyCheck.

Definition at line 121 of file AssuranceCheck.hpp.

8.9.3.17 isCheckUsed()

```
bool pnt_integrity::AssuranceCheck::isCheckUsed ( )  [inline]
```

Returns whether or not the check's level should be weighted.

If the assurance level is Assured and postive weighting is not allowed, then this function will return false. It will also return false if the level is Unavailable

Returns

The flag to indicate if weighting should be used

Definition at line 384 of file AssuranceCheck.hpp.

8.9.3.18 runCheck()

```
virtual bool pnt_integrity::AssuranceCheck::runCheck ( )  [pure virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implemented in pnt_integrity::PositionJumpCheck, pnt_integrity::ClockBiasCheck, pnt_integrity::AngleOfArrivalCheck, pnt_integrity::StaticPositionCheck, pnt_integrity::PositionVelocityConsistencyCheck, pnt_integrity::CnoCheck, and pnt_integrity::RangePositionCheck.

8.9.3.19 setAllowPositiveWeighting()

```
void pnt_integrity::AssuranceCheck::setAllowPositiveWeighting (
            const bool & allowVal )  [inline]
```

Sets the positive check weighting allowed boolean.

Positive weighting allows a check to increase the overall assurance level

Parameters

allowVal	The flag indicating whether to allow positive weights

Definition at line 371 of file AssuranceCheck.hpp.

8.9.3.20 setAssuranceLevelPeriod()

```
void pnt_integrity::AssuranceCheck::setAssuranceLevelPeriod (
            const double & levelPeriod )  [inline]
```

Sets the assurance level period.

The assurance level period is the amount of time required to hold an elevated assurance level.

Parameters

levelPeriod	The period (in seconds) the the check is required to hold an elevated assurance level before lowering

Definition at line 305 of file AssuranceCheck.hpp.

8.9.3.21 setAssuranceThresholds()

```
void pnt_integrity::AssuranceCheck::setAssuranceThresholds (
            const double & unknownThresh,
            const double & unusableThresh )  [inline]
```

Sets the assurance level transition thresholds.

Sets arbitrary thresholds that can be used in child classes to indicate or trigger a transition into different assurance levels associated with the check

Parameters

unknownThresh	Use this threshold to trigger or indicate a transition into AssuranceLevel::Inconsistent
unusableThresh	Use this value to trigger or indicate a transition into AssuranceLevel::Unassured

Definition at line 237 of file AssuranceCheck.hpp.

8.9.3.22 setLastGoodPosition()

```
virtual void pnt_integrity::AssuranceCheck::setLastGoodPosition (
            const double & updateTime,
            const data::GeodeticPosition3d & position )  [inline], [virtual]
```

Sets the last known good position.

Provides if the assurance check with knowledge of a last known good position for use in calculations (if needed by the specific implementation)

Parameters

updateTime	The timestamp associated with the provided position
position	The last known good position

Reimplemented in pnt_integrity::PositionJumpCheck.

Definition at line 324 of file AssuranceCheck.hpp.

8.9.3.23 setLogMessageHandler()

```
void pnt_integrity::AssuranceCheck::setLogMessageHandler (
            const logutils::LogCallback & logMsgHandler )  [inline]
```

Sets the log message handler to provided callback.

Parameters

logMsgHandler	The provided call back function

Definition at line 263 of file AssuranceCheck.hpp.

8.9.3.24 setPositionAssurance()

```
virtual void pnt_integrity::AssuranceCheck::setPositionAssurance (
            const double & ,
            const data::GeodeticPosition3d & ,
            const data::AssuranceLevel &  )  [inline], [virtual]
```

Provides the check with an updated position and assuarance level.

This method provides the check function with an updted position and associated assurance level for use in the check's calculation. The default behavior is null, but can be overridden in child classes.

Definition at line 340 of file AssuranceCheck.hpp.

8.9.3.25 setWeight()

```
void pnt_integrity::AssuranceCheck::setWeight (
            const double & weightVal )  [inline]
```

Sets the weight of the check.

The weight of the check is used when combining the assurance level of this check with other checks for a cumulative assurance level

Parameters

weightVal	The weight for this check

Definition at line 351 of file AssuranceCheck.hpp.

8.9.4 Member Data Documentation

8.9.4.1 allowPositiveWeighting_

```
bool pnt_integrity::AssuranceCheck::allowPositiveWeighting_  [protected]
```

flag to indicate if the check can be used in a positive weighting (i.e. do you weight the check when its level is assured)

Definition at line 445 of file AssuranceCheck.hpp.

8.9.4.2 assuranceInconsistentThresh_

```
double pnt_integrity::AssuranceCheck::assuranceInconsistentThresh_  [protected]
```

The arbitrary threshold for elevating the check's overall assurance level to AssuranceLevel::Inconsistent. It is up to the AssuranceCheck implementation on how this threshold is used internally.

Definition at line 418 of file AssuranceCheck.hpp.

8.9.4.3 assuranceUnassuredThresh_

```
double pnt_integrity::AssuranceCheck::assuranceUnassuredThresh_  [protected]
```

The arbitrary threshold for elevating the check's overall assurance level to AssuranceLevel::Unassured. It is up to the AssuranceCheck implementation on how this threshold is used internally.

Definition at line 423 of file AssuranceCheck.hpp.

8.9.4.4 prnAssuranceLevels_

```
MultiPrnAssuranceMap pnt_integrity::AssuranceCheck::prnAssuranceLevels_  [protected]
```

The assurance level for each PRN (if applicable to the defined check). Should only be populated if enableMultiPrn↩ Support() has been called

Definition at line 413 of file AssuranceCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/AssuranceCheck.hpp

8.10 pnt_integrity::data::AssuranceReport Struct Reference

A structure to hold a single assurance report.

`#include <IntegrityData.hpp>`

Public Attributes

- Header header
  The header for the structure message.
- AssuranceState state
  The assurance state.

8.10.1 Detailed Description

A structure to hold a single assurance report.

Definition at line 381 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.11 pnt_integrity::data::AssuranceReports Struct Reference

A structure to hold assurance data for all registered checks.

`#include <IntegrityData.hpp>`

Public Member Functions

- AssuranceReports ()
  Default constructor for the struct. Initializes numStates to 0.
- void addReport (const AssuranceState &state)
  Adds a reported state to the vector, increments count.

Public Attributes

- Header header
  The header for the structure message.
- long numStates
  Number of assurance states reported.
- std::vector< AssuranceState > states
  A vector of AssuranceState, length numStates.

8.11.1 Detailed Description

A structure to hold assurance data for all registered checks.

Definition at line 391 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.12 pnt_integrity::data::AssuranceState Class Reference

A structure to hold an AssuranceLevel and value.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- bool setWithValue (const double &valueIn)
  Sets the state with a provided value.
- bool setWithLevel (const AssuranceLevel &levelIn)
  Sets the state with a provided enumeration.
- double getAssuranceValue ()
  Retrieves the internal assurance value.
- data::AssuranceLevel getAssuranceLevel ()
  Retrieves the internal assurance level.
- int getIntegerAssuranceValue () const
  Retrieves the internal assurance value as an integer.
- void setWeight (const double &weight)
  Sets the weight associated with the state.
- double getWeight ()
  Retrieves the weight associated with the state.
- void setName (const std::string &name)
  Sets the string name of the state.
- std::string getName ()
  Retrieves the name of the check.

8.12.1 Detailed Description

A structure to hold an AssuranceLevel and value.

A structure for holding the idea of assurance both as an enumeration and separate numeric value.

Definition at line 266 of file IntegrityData.hpp.

8.12.2 Member Function Documentation

8.12.2.1 getAssuranceLevel()

```
data::AssuranceLevel pnt_integrity::data::AssuranceState::getAssuranceLevel ( )  [inline]
```

Retrieves the internal assurance level.

Returns

The assurance level

Definition at line 344 of file IntegrityData.hpp.

8.12.2.2 getAssuranceValue()

```
double pnt_integrity::data::AssuranceState::getAssuranceValue ( )  [inline]
```

Retrieves the internal assurance value.

Returns

The assurance value

Definition at line 340 of file IntegrityData.hpp.

8.12.2.3 getIntegerAssuranceValue()

```
int pnt_integrity::data::AssuranceState::getIntegerAssuranceValue ( ) const  [inline]
```

Retrieves the internal assurance value as an integer.

Returns

An integer representation of the assurance value

Definition at line 348 of file IntegrityData.hpp.

8.12.2.4 getName()

```
std::string pnt_integrity::data::AssuranceState::getName ( )  [inline]
```

Retrieves the name of the check.

Returns

The string name of the check

Definition at line 362 of file IntegrityData.hpp.

8.12.2.5 getWeight()

```
double pnt_integrity::data::AssuranceState::getWeight ( )  [inline]
```

Retrieves the weight associated with the state.

Returns

The weight value

Definition at line 355 of file IntegrityData.hpp.

8.12.2.6 setWithLevel()

```
bool pnt_integrity::data::AssuranceState::setWithLevel (
            const AssuranceLevel & levelIn )  [inline]
```

Sets the state with a provided enumeration.

This function will set the AssuranceState's level enumeration to the provided level and the value is set accordingly. The function returns false if the level is "Unavailable" to indicate that it should not be used in any cumulative calculations.

levelIn The provided level enumeration

Definition at line 318 of file IntegrityData.hpp.

8.12.2.7 setWithValue()

```
bool pnt_integrity::data::AssuranceState::setWithValue (
            const double & valueIn )  [inline]
```

Sets the state with a provided value.

This method allows the state to be set by an arbritrary value which is usually produced by a weighting function. The provided assurance value will be rounded to an integer and then thresholded to the appropriate value and the level enumeration is set appropriately.

Parameters

value↩ *In*	The provided value.

Definition at line 283 of file IntegrityData.hpp.

The documentation for this class was generated from the following file:

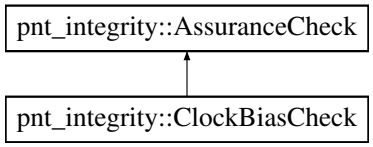
- include/pnt_integrity/IntegrityData.hpp

8.13 pnt_integrity::ClockBiasCheck Class Reference

Class implementation for the position velocity check.

`#include <ClockBiasCheck.hpp>`

Inheritance diagram for pnt_integrity::ClockBiasCheck:



Public Member Functions

- ClockBiasCheck (const std::string &name="Clock Bias Check", const unsigned int &minNumSamples=10, const unsigned int &maxNumSamples=30, const double &minSampleTimeSec=10.0, const double &driftRate↩ Bound=5e-7, const double &driftRateVarBound=1e-6, const logutils::LogCallback &log=logutils::printLogToStd↩ Out)

  Default constructor for the check class.
- bool handleClockOffset (const data::ClockOffset &clockOffset)

  Handler function for clock offset (bias and drift)
- void calculateAssuranceLevel (const double &)

  Function to explicitly set the assurance level of the check.
- bool runCheck ()

  Triggers a manual check calculation.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const ClockBiasCheckDiagnostics &checkData)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.13.1 Detailed Description

Class implementation for the position velocity check.

The Clock Bias Check calculates the expectation and variance of the clock drift for the most recent set of clock samples, minus the most recent sample. The expectation is used to propagate the clock forward to the most recent single sample's arrival time and check if it is within reasonable bounds. The variance is used to check for zero-bias disruption. The expectation and variance are calculated like normal, using the drift value in each sample. The propagated sample's clock offset is calculated by multiplying the drift expectation by the sample time difference between the second to most recent sample and the most recent sample (called dt), and then adding the second to most recent sample's clock offset. (i.e. velocity∗dt + last position). The propagated sample's clock offset is subtracted from the most recent sample's clock offset (and then run through the absolute value function) to obtain the offset error. If the offset error is greater than the drift rate bound multiplied by dt, then the clock bias check returns Unassured. Else if the clock drift variance is greater than the predetermined drift variance bound, then it returns Inconsistent.

Definition at line 117 of file ClockBiasCheck.hpp.

8.13.2 Constructor & Destructor Documentation

8.13.2.1 ClockBiasCheck()

```
pnt_integrity::ClockBiasCheck::ClockBiasCheck (
            const std::string & name = "Clock Bias Check",
            const unsigned int & minNumSamples = 10,
            const unsigned int & maxNumSamples = 30,
            const double & minSampleTimeSec = 10.0,
            const double & driftRateBound = 5e-7,
            const double & driftRateVarBound = 1e-6,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Default constructor for the check class.

Constructor explicitly disables multi-prn support.

Parameters

name	The name of the check object
minNumSamples	The minimum number of samples required for the check
maxNumSamples	The maximum number of samples required for the check
minSampleTimeSec	The duration of time (in seconds) over which to
driftRateBound	Maximum allowable drift rate
driftRateVarBound	Maximum allowable drift rate variance get clock data for checking integrity
log	A provided log callback function to use

Definition at line 132 of file ClockBiasCheck.hpp.

8.13.3 Member Function Documentation

8.13.3.1 calculateAssuranceLevel()

```
void pnt_integrity::ClockBiasCheck::calculateAssuranceLevel (
            const double &  )  [inline], [virtual]
```

Function to explicitly set the assurance level of the check.

Uses whatever data is available to calculate the assurance level

Implements pnt_integrity::AssuranceCheck.

Definition at line 170 of file ClockBiasCheck.hpp.

8.13.3.2 handleClockOffset()

```
bool pnt_integrity::ClockBiasCheck::handleClockOffset (
            const data::ClockOffset & clockOffset )  [virtual]
```

Handler function for clock offset (bias and drift)

Function to handle provided clock offset.

Parameters

clockOffset	The provided clock offset message

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.13.3.3 runCheck()

```
bool pnt_integrity::ClockBiasCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.13.3.4 setPublishDiagnostics()

```
void pnt_integrity::ClockBiasCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const ClockBiasCheckDiagnostics &check↩
Data)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 186 of file ClockBiasCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/ClockBiasCheck.hpp

8.14 pnt_integrity::ClockBiasCheckDiagnostics Struct Reference

Structure used to publish diagnostic data.

`#include <ClockBiasCheck.hpp>`

Public Attributes

- double expectedDrift
  The excpected drift based on the recent history.
- double expectedDriftVar
  The expected variance of the drift based on recent history.
- double propagatedOffset
  The clock bias propagated to the current time step.
- double actualOffset
  The actual clock bias at the current time stamp.
- double offsetError
  The error threshold for comparing the actual and propagated.
- double driftRateBound
  The error bound on the drift rate.
- double driftRateVarBound
  The error baound on the drift rate variance.

8.14.1 Detailed Description

Structure used to publish diagnostic data.

Definition at line 73 of file ClockBiasCheck.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/ClockBiasCheck.hpp

8.15 pnt_integrity::data::ClockOffset Struct Reference

A structure for measuring the offset between two clocks.

`#include <IntegrityData.hpp>`

Public Member Functions

- ClockOffset (const Header &headerIn=Header())
  Constructor for the ClockOffset structure.

Public Attributes

- Header header
  A header for the message.
- int8_t timecode1
- int8_t timecode2
- double offset
  Time offset between the two clocks (sec)
- double drift
  The drift between the two clocks (sec / sec)
- double covariance [2][2]
  The measurement covariance of the offset parameters (2x2 matrix)

8.15.1 Detailed Description

A structure for measuring the offset between two clocks.

Definition at line 145 of file IntegrityData.hpp.

8.15.2 Constructor & Destructor Documentation

8.15.2.1 ClockOffset()

```
pnt_integrity::data::ClockOffset::ClockOffset (
            const Header & headerIn = Header() )  [inline]
```

Constructor for the ClockOffset structure.

The default constructor for the clock offset message can be optionally provided with a pre-built header. The offset, drift, and time error covariance is initialized to NaN and must be set to desired values after object construction. Timecodes are initialized to -1 and must also be set after construction to desired values

Parameters

header↩ In	A provided header object

Definition at line 176 of file IntegrityData.hpp.

8.15.3 Member Data Documentation

8.15.3.1 timecode1

```
int8_t pnt_integrity::data::ClockOffset::timecode1
```

Indicator for clock 1 timebase, 0 if synced to TAI, non-zero if device using a specific timebase

Definition at line 152 of file IntegrityData.hpp.

8.15.3.2 timecode2

```
int8_t pnt_integrity::data::ClockOffset::timecode2
```

Indicator for clock 2 timebase, 0 if synced to TAI, non-zero if device using a specific timebase

Definition at line 156 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

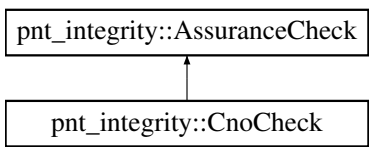
- include/pnt_integrity/IntegrityData.hpp

8.16 pnt_integrity::CnoCheck Class Reference

Class implementation of the carrier-to-noise (CnO) assurance check. The check analyzes the CnO values for abnormalities.

```
#include <CnoCheck.hpp>
```

Inheritance diagram for pnt_integrity::CnoCheck:



Public Member Functions

- CnoCheck (const std::string &name="Cno Check", const size_t &cnoFilterWindow=10, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor for the CnoCheck object.
- bool handleGnssObservables (const data::GNSSObservables &gnssObs)

  Handler function for GNSS Observables.
- void calculateAssuranceLevel (const double &)

  Function to explicitly set the assurance level of the check.
- virtual bool runCheck ()

  Triggers a manual check calculation.
- void setFilterWindow (const size_t &windowSize)

  Sets the time filter window for CnO analysis.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const CnoCheckDiagnostics &check↩ Data)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.16.1 Detailed Description

Class implementation of the carrier-to-noise (CnO) assurance check. The check analyzes the CnO values for abnormalities.

Definition at line 68 of file CnoCheck.hpp.

8.16.2 Constructor & Destructor Documentation

8.16.2.1 CnoCheck()

```
pnt_integrity::CnoCheck::CnoCheck (
            const std::string & name = "Cno Check",
            const size_t & cnoFilterWindow = 10,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor for the CnoCheck object.

Parameters

name	The name identifier of the check
cnoFilterWindow	The time window across which CnO values are analyzed
log	A provided log callback function to use

Definition at line 77 of file CnoCheck.hpp.

8.16.3 Member Function Documentation

8.16.3.1 calculateAssuranceLevel()

```
void pnt_integrity::CnoCheck::calculateAssuranceLevel (
            const double &  )  [inline], [virtual]
```

Function to explicitly set the assurance level of the check.

For this check, this function cycles through all of the individual PRN assurance values, analyzes them, and then sets the master assurance level associted with the check.

Implements pnt_integrity::AssuranceCheck.

Definition at line 107 of file CnoCheck.hpp.

8.16.3.2 handleGnssObservables()

```
bool pnt_integrity::CnoCheck::handleGnssObservables (
            const data::GNSSObservables & gnssObs )  [virtual]
```

Handler function for GNSS Observables.

Function to handle provided GNSS Observables. This function simply calls runCheck(), as the provided data has already been added to the repository

Parameters

gnssObs	The provided GNSS observable data

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.16.3.3 runCheck()

```
virtual bool pnt_integrity::CnoCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.16.3.4 setFilterWindow()

```
void pnt_integrity::CnoCheck::setFilterWindow (
            const size_t & windowSize )  [inline]
```

Sets the time filter window for CnO analysis.

Parameters

windowSize	The time of the analysis window to use

Definition at line 120 of file CnoCheck.hpp.

8.16.3.5 setPublishDiagnostics()

```
void pnt_integrity::CnoCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const CnoCheckDiagnostics &checkData)>
handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 132 of file CnoCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/CnoCheck.hpp

8.17 pnt_integrity::CnoCheckDiagnostics Struct Reference

Diagnostic data for the check.

`#include <CnoCheck.hpp>`

Public Attributes

- int averageCount
  the number of PRNs within 1 unit of the mode
- double inconsistentThresh
  The threshold for the inconsistent assurance level.
- double unassuredThresh
  The threshold for the unassured assurance level.

8.17.1 Detailed Description

Diagnostic data for the check.

Definition at line 56 of file CnoCheck.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/CnoCheck.hpp

8.18 pnt_integrity::data::CommandResponse Struct Reference

A structure for command / response messages.

`#include <IntegrityData.hpp>`

Public Attributes

- data::Header header
  The header associated with the command / response structure.
- long deviceId
  The device id of the command target (only used for responses)
- long commandId
  The identifier for the command.
- data::CommandResponseType type
  Tye type of message.
- std::string message
  The command or response message.

8.18.1 Detailed Description

A structure for command / response messages.

Definition at line 889 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.19 pnt_integrity::data::Diagnostics Struct Reference

A structure for general diagnostic messages.

`#include <IntegrityData.hpp>`

Public Attributes

- data::Header header
  The message header.
- data::LevelEnum level
- std::string name
  The name of the diagnostic.
- std::string message
  Detailed description of message.
- std::string hardwareId
- long numValues
  The number of key/value pairs in the diagnostic message.
- std::vector< data::KeyValue > values
  A vector of id / value pairs.

8.19.1 Detailed Description

A structure for general diagnostic messages.

Definition at line 831 of file IntegrityData.hpp.

8.19.2 Member Data Documentation

8.19.2.1 hardwareId

```
std::string pnt_integrity::data::Diagnostics::hardwareId
```

An identifier for the source of the diagnostic (i.e. hardware serial number or name of the generating application)

Definition at line 848 of file IntegrityData.hpp.

8.19.2.2 level

```
data::LevelEnum pnt_integrity::data::Diagnostics::level
```

Enumeration field to indicate operating level of source application or component

Definition at line 838 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.20 pnt_integrity::data::EventLog Struct Reference

Structure for event log messages.

```
#include <IntegrityData.hpp>
```

Public Attributes

- data::Header header
  The message header.
- data::EventLogType eventLogType
  The type of event log.
- std::string eventLog
  The log message.

8.20.1 Detailed Description

Structure for event log messages.

Definition at line 869 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.21 geodetic_converter::GeodeticConverter Class Reference

Class to implement gedetic conversions for the pnt_integrity library.

`#include <GeodeticConverter.hpp>`

Public Member Functions

- GeodeticConverter ()

  Constructor for converter object.
- ~GeodeticConverter ()

  Destructor for the converter object.
- bool isInitialised ()

  Returns the reference flag.
- void getReference (double *latitude, double *longitude, double *altitude)

  Returns the reference position.
- void initialiseReference (const double latitude, const double longitude, const double altitude)

  Sets the reference position.
- void geodetic2Ecef (const double latitude, const double longitude, const double altitude, double *x, double *y, double *z)

  Converts the provided LLA to ECEF.
- void ecef2Geodetic (const double x, const double y, const double z, double *latitude, double *longitude, double *altitude)

  Converts the provided ECEF to LLA.
- void ecef2Ned (const double x, const double y, const double z, double *north, double *east, double *down)

  Converts the provided ECEF to NED.
- void ned2Ecef (const double north, const double east, const double down, double *x, double *y, double *z)

  Converts the provided NED to ECEF.
- void geodetic2Ned (const double latitude, const double longitude, const double altitude, double *north, double *east, double *down)

  Converts the provided LLA to NED.
- void ned2Geodetic (const double north, const double east, const double down, double *latitude, double *longitude, double *altitude)

  Converts the provided NED to LLA.
- void geodetic2Enu (const double latitude, const double longitude, const double altitude, double *east, double *north, double *up)

  Converts the provided LLA to ENU.
- void enu2Geodetic (const double east, const double north, const double up, double *latitude, double *longitude, double *altitude)

  Converts the provided ENU to LLA.

8.21.1 Detailed Description

Class to implement gedetic conversions for the pnt_integrity library.

Definition at line 60 of file GeodeticConverter.hpp.

8.21.2 Constructor & Destructor Documentation

8.21.2.1 GeodeticConverter()

```
geodetic_converter::GeodeticConverter::GeodeticConverter ( )  [inline]
```

Constructor for converter object.

Constructor initializes the reference flag to false.

Definition at line 66 of file GeodeticConverter.hpp.

8.21.3 Member Function Documentation

8.21.3.1 ecef2Geodetic()

```
void geodetic_converter::GeodeticConverter::ecef2Geodetic (
            const double x,
            const double y,
            const double z,
            double * latitude,
            double * longitude,
            double * altitude )  [inline]
```

Converts the provided ECEF to LLA.

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters
x	The ECEF X psoition in meters
y	The ECEF Y position in meters
z	The ECEF Z position in meters

Definition at line 164 of file GeodeticConverter.hpp.

8.21.3.2 ecef2Ned()

```
void geodetic_converter::GeodeticConverter::ecef2Ned (
            const double x,
            const double y,
            const double z,
            double * north,
            double * east,
            double * down )  [inline]
```

Converts the provided ECEF to NED.

Parameters

east	NED east in meters
north	NED north in meters
down	NED down in meters
x	The ECEF X psoition in meters
y	The ECEF Y position in meters
z	The ECEF Z position in meters

Definition at line 212 of file GeodeticConverter.hpp.

8.21.3.3 enu2Geodetic()

```
void geodetic_converter::GeodeticConverter::enu2Geodetic (
            const double east,
            const double north,
            const double up,
            double * latitude,
            double * longitude,
            double * altitude )  [inline]
```

Converts the provided ENU to LLA.

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters
east	ENU east in meters
north	ENU north in meters
up	ENU up in meters

Definition at line 335 of file GeodeticConverter.hpp.

8.21.3.4 geodetic2Ecef()

```
void geodetic_converter::GeodeticConverter::geodetic2Ecef (
             const double latitude,
             const double longitude,
             const double altitude,
             double * x,
             double * y,
             double * z )  [inline]
```

Converts the provided LLA to ECEF.

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters
x	The ECEF X psoition in meters
y	The ECEF Y position in meters
z	The ECEF Z position in meters

Definition at line 137 of file GeodeticConverter.hpp.

8.21.3.5 geodetic2Enu()

```
void geodetic_converter::GeodeticConverter::geodetic2Enu (
             const double latitude,
             const double longitude,
             const double altitude,
             double * east,
             double * north,
             double * up )  [inline]
```

Converts the provided LLA to ENU.

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters
east	ENU east in meters
north	ENU north in meters
up	ENU up in meters

Definition at line 308 of file GeodeticConverter.hpp.

8.21.3.6 geodetic2Ned()

```
void geodetic_converter::GeodeticConverter::geodetic2Ned (
            const double latitude,
            const double longitude,
            const double altitude,
            double * north,
            double * east,
            double * down )  [inline]
```

Converts the provided LLA to NED.

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters
east	NED east in meters
north	NED north in meters
down	NED down in meters

Definition at line 266 of file GeodeticConverter.hpp.

8.21.3.7 getReference()

```
void geodetic_converter::GeodeticConverter::getReference (
            double * latitude,
            double * longitude,
            double * altitude )  [inline]
```

Returns the reference position.

Returns the reference position with the latitude / longitude in radians and altitude in meters

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters

Definition at line 87 of file GeodeticConverter.hpp.

8.21.3.8 initialiseReference()

```
void geodetic_converter::GeodeticConverter::initialiseReference (
            const double latitude,
            const double longitude,
            const double altitude )  [inline]
```

Sets the reference position.

Sets the reference to the provided position (LLA)

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters

Definition at line 101 of file GeodeticConverter.hpp.

8.21.3.9 isInitialised()

```
bool geodetic_converter::GeodeticConverter::isInitialised ( )  [inline]
```

Returns the reference flag.

Returns a flag to indicate if the converter's reference position has been set.

Definition at line 77 of file GeodeticConverter.hpp.

8.21.3.10 ned2Ecef()

```
void geodetic_converter::GeodeticConverter::ned2Ecef (
            const double north,
            const double east,
            const double down,
            double * x,
            double * y,
            double * z )  [inline]
```

Converts the provided NED to ECEF.

Parameters

east	NED east in meters
north	NED north in meters
down	NED down in meters
x	The ECEF X psoition in meters
y	The ECEF Y position in meters
z	The ECEF Z position in meters

Definition at line 240 of file GeodeticConverter.hpp.

8.21.3.11 ned2Geodetic()

```
void geodetic_converter::GeodeticConverter::ned2Geodetic (
            const double north,
            const double east,
            const double down,
            double * latitude,
            double * longitude,
            double * altitude )  [inline]
```

Converts the provided NED to LLA.

Parameters

latitude	Latitude in radians
longitude	Longitude in radians
altitude	Altitude in meters
east	NED east in meters
north	NED north in meters
down	NED down in meters

Definition at line 287 of file GeodeticConverter.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/GeodeticConverter.hpp

8.22 pnt_integrity::data::GeodeticPosition3d Struct Reference

A structure to represent 3D geodetic position.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- GeodeticPosition3d (const double &latIn=std::numeric_limits< double >::quiet_NaN(), const double &lonIn=std::numeric_limits< double >::quiet_NaN(), const double &altIn=std::numeric_limits< double >::quiet_NaN())

  Constructor for the 3D geodetic position.
- bool getECEF (double *ecef) const

  Returns the coordinates from lla to ecef using WGS84.

Public Attributes

- double latitude

  The latitude in radians.
- double longitude

  The longitude in radians.
- double altitude

  The altitude in meters above the WGS-84 ellipsoid.

8.22.1 Detailed Description

A structure to represent 3D geodetic position.

This structure represents that latitude, longitude, and altitude of a geodetic position

Definition at line 577 of file IntegrityData.hpp.

8.22.2 Constructor & Destructor Documentation

8.22.2.1 GeodeticPosition3d()

```
pnt_integrity::data::GeodeticPosition3d::GeodeticPosition3d (
            const double & latIn = std::numeric_limits<double>::quiet_NaN(),
            const double & lonIn = std::numeric_limits<double>::quiet_NaN(),
            const double & altIn = std::numeric_limits<double>::quiet_NaN() )  [inline]
```

Constructor for the 3D geodetic position.

Parameters

latIn	The latitude of the 3d position (radians)
lonIn	The longitude of the 3d position (radians)
altIn	The altitude of the 3d position (meters above WGS-84)

Definition at line 591 of file IntegrityData.hpp.

8.22.3 Member Function Documentation

8.22.3.1 getECEF()

```
bool pnt_integrity::data::GeodeticPosition3d::getECEF (
            double * ecef ) const  [inline]
```

Returns the coordinates from lla to ecef using WGS84.

Parameters

ecef	The output location for the generated coordinates, must be at least 3∗sizeof(double) large

Returns

false if any values are NaN, true otherwise

Definition at line 603 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.23 pnt_integrity::data::GNSSObservable Struct Reference

A structure for pseudorange observables.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- GNSSObservable (const uint16_t &prnIn=0, const SatelliteSystem &satTypeIn=SatelliteSystem::Other, const CodeType &codeTypeIn=CodeType::SigBLANK, const FrequencyBand &freqTypeIn=FrequencyBand::Band0, const AssuranceLevel &assuranceLevelIn=AssuranceLevel::Unavailable, const double &cnoIn=std::numeric_limits< double >::quiet_NaN(), const bool &psrValIn=false, const double &psrIn=std::numeric_limits< double >::quiet_NaN(), const double &psrVarIn=std::numeric_limits< double >::quiet_NaN(), const bool &doppValIn=false, const double &doppIn=std::numeric_limits< double >::quiet_NaN(), const double &doppVarIn=std::numeric_limits< double >::quiet_NaN(), const bool &cpValIn=false, const double &cpIn=std::numeric_limits< double >::quiet_NaN(), const double &cpVarIn=std::numeric_limits< double >::quiet_NaN(), const bool &lossOfLockIn=false)

  Default constructor to initialize values.
- uint64_t getUniqueID ()

  Returns a unique identifier for the observable.

Public Attributes

- uint16_t prn

  Satellite ID or PRN.
- SatelliteSystem satelliteType

  The satellite system that the observable originates.
- CodeType codeType

  The code type of the received signal.
- FrequencyBand frequencyType

  The frequency carrier of the received signal.
- AssuranceLevel assurance

  Assurance level for this observable.
- double carrierToNoise

  The carrier to noise ratio (C_no) of the received signal.
- bool pseudorangeValid

  Flag to indiate the validity of the observable pseudorange.
- double pseudorange

  The pseudorange measurement.
- double pseudorangeVariance

  The pseudorange measurement's variance.
- bool dopplerValid

  Flag to indicate the validity of the observable doppler.
- double doppler

  The doppler measurement.
- double dopplerVariance

  The variance of the doppler measurement.
- bool carrierPhaseValid

  Flag to indicate the validity of the observable carrier phase.
- double carrierPhase

  The carrier-phase measurement.
- double carrierPhaseVariance

  The variance of the carrier-phase measurement.
- bool lossOfLock

  Flag to indicate loss of carrier lock.

8.23.1 Detailed Description

A structure for pseudorange observables.

Definition at line 415 of file IntegrityData.hpp.

8.23.2 Constructor & Destructor Documentation

8.23.2.1 GNSSObservable()

```
pnt_integrity::data::GNSSObservable::GNSSObservable (
            const uint16_t & prnIn = 0,
            const SatelliteSystem & satTypeIn = SatelliteSystem::Other,
            const CodeType & codeTypeIn = CodeType::SigBLANK,
            const FrequencyBand & freqTypeIn = FrequencyBand::Band0,
            const AssuranceLevel & assuranceLevelIn = AssuranceLevel::Unavailable,
            const double & cnoIn = std::numeric_limits<double>::quiet_NaN(),
            const bool & psrValIn = false,
            const double & psrIn = std::numeric_limits<double>::quiet_NaN(),
            const double & psrVarIn = std::numeric_limits<double>::quiet_NaN(),
            const bool & doppValIn = false,
            const double & doppIn = std::numeric_limits<double>::quiet_NaN(),
            const double & doppVarIn = std::numeric_limits<double>::quiet_NaN(),
            const bool & cpValIn = false,
            const double & cpIn = std::numeric_limits<double>::quiet_NaN(),
            const double & cpVarIn = std::numeric_limits<double>::quiet_NaN(),
            const bool & lossOfLockIn = false ) [inline]
```

Default constructor to initialize values.

The constructor initializes all member variables to null states (i.e. NAN for double values, false for booleans, and unknown types for signal parameters

Parameters

prnIn	Satellite ID or PRN
satTypeIn	The satellite system that the observable originates
codeTypeIn	The code type of the observable
freqTypeIn	The frequency carrier of the received signal
assurance↩ LevelIn	The assurance level for this observable
cnoIn	The carrier to noise ratio (C_no) of the received signal
psrValIn	Flag to indiate the validity of the pseudorange
psrIn	The pseudorange measurement
psrVarIn	The pseudorange measurement's variance
doppValIn	Flag to indicate the validity of the doppler
doppIn	The doppler measurement
doppVarIn	The variance of the doppler measurement
cpValIn	Flag to indicate the validity of the carrier phase
cpIn	The carrier-phase measurement
cpVarIn	The variance of the carrier-phase measurement
lossOfLockIn	Flag to indicate loss of carrier lock

Definition at line 487 of file IntegrityData.hpp.

8.23.3 Member Function Documentation

8.23.3.1 getUniqueID()

```
uint64_t pnt_integrity::data::GNSSObservable::getUniqueID ( )  [inline]
```

Returns a unique identifier for the observable.

Returns a unique identifier by multiplying the prn, satellite type, code type, and frequency type enumeration values (adjusted for zero-based entries). This function assumes that there are no enumeration values that have a value of -1.

Returns

A long integer representing the unique identifier

Definition at line 529 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.24 pnt_integrity::data::GNSSObservables Struct Reference

The GNSSObservables message.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- GNSSObservables ()
  Default constructor for the structure.
- GNSSObservables (const Header &header, const GNSSTime &gnssTime, const GNSSObservableMap obsMap)
  Constructor with provided data.

Public Attributes

- Header header
  The message header.
- GNSSTime gnssTime
  The GNSSTime associated with the observable data.
- GNSSObservableMap observables
  A map of observables, keyed off of satellite id (or prn)

8.24.1 Detailed Description

The GNSSObservables message.

This data structure represents the message format for a GNSS observable

Definition at line 546 of file IntegrityData.hpp.

8.24.2 Constructor & Destructor Documentation

8.24.2.1 GNSSObservables()

```
pnt_integrity::data::GNSSObservables::GNSSObservables (
            const Header & header,
            const GNSSTime & gnssTime,
            const GNSSObservableMap obsMap )  [inline]
```

Constructor with provided data.

Parameters

header	The provided header structure
gnssTime	A provided GNSSTime object
obsMap	The map of observables, keyed off of prn

Definition at line 566 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.25 pnt_integrity::data::GNSSTime Struct Reference

A GNSS time.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- GNSSTime (const int &week=0, const double &seconds=0.0, const TimeSystem &system=TimeSystem::GPS)
  Default constructor for GNSSTime.

Public Attributes

- int weekNumber

  The number of elapsed week since a pre-defined epoch (non-rollover)
- double secondsOfWeek

  Seconds into the week.
- TimeSystem timeSystem

  The reference time system.

8.25.1 Detailed Description

A GNSS time.

Definition at line 93 of file IntegrityData.hpp.

8.25.2 Constructor & Destructor Documentation

8.25.2.1 GNSSTime()

```
pnt_integrity::data::GNSSTime::GNSSTime (
            const int & week = 0,
            const double & seconds = 0.0,
            const TimeSystem & system = TimeSystem::GPS )  [inline]
```

Default constructor for GNSSTime.

Parameters

week	The number of elapsed week since a pre-defined epoch (non-rollover)
seconds	Seconds into the week
system	The base timesystem used for the GNSS time

Definition at line 107 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.26 pnt_integrity::data::Header Struct Reference

The header used for all associated data types.

`#include <IntegrityData.hpp>`

Public Member Functions

- Header (const long &seq=0, const Timestamp &ts_arrival=Timestamp(), const Timestamp &ts_valid=Timestamp(), const std::string &dev_id="")

  Default constructor for a header.

Public Attributes

- long seq_num

  The sequence number of the header.
- Timestamp timestampArrival

  The arrival time of the header at the data transport layer.
- Timestamp timestampValid

  The valid time of the header / measurement data.
- std::string deviceId

  Unique identifier for the measurement system / sensor / source.

8.26.1 Detailed Description

The header used for all associated data types.

Definition at line 115 of file IntegrityData.hpp.

8.26.2 Constructor & Destructor Documentation

8.26.2.1 Header()

```
pnt_integrity::data::Header::Header (
            const long & seq = 0,
            const Timestamp & ts_arrival = Timestamp(),
            const Timestamp & ts_valid = Timestamp(),
            const std::string & dev_id = "" )  [inline]
```

Default constructor for a header.

Parameters

seq	The sequence number of the header
ts_arrival	The arrival time of the header at the data transport layer
ts_valid	The valid time of the header / data
dev_id	Unique identifier for the measurement source

Definition at line 133 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.27 pnt_integrity::data::IMU Struct Reference

A structure that represents IMU measurement data.

`#include <IntegrityData.hpp>`

Public Attributes

- Header header
  The message header.
- double delta_v [3]
- double delta_theta [3]

8.27.1 Detailed Description

A structure that represents IMU measurement data.

Definition at line 756 of file IntegrityData.hpp.

8.27.2 Member Data Documentation

8.27.2.1 delta_theta

`double pnt_integrity::data::IMU::delta_theta[3]`

Angular rate integrated over period delta_t, providing an "average change in angle" measurement. units: rad

Definition at line 767 of file IntegrityData.hpp.

8.27.2.2 delta_v

```
double pnt_integrity::data::IMU::delta_v[3]
```

Acceleration integrated over period delta_t, providing an "average change in velocity" measurement. units: m/s

Definition at line 763 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.28 pnt_integrity::IntegrityDataRepository Class Reference

Class definition for the history of data at a single PNT node.

```
#include <IntegrityDataRepository.hpp>
```

Public Member Functions

- IntegrityDataRepository (IntegrityDataRepository const &)=delete
  Delete the copy constructor.
- void operator= (IntegrityDataRepository constIntegrityDataRepository)=delete
  Delete the assignment operator.
- template<class T >
  void addEntry (const double &timeOfWeek, const T &data)
  Adds a local data entry to the repo.
- template<class T >
  void addEntry (const double &timeOfWeek, const std::string &nodeId, const T &data)
  Adds a remote data entry to the repo.
- template<class T >
  bool getData (const double &timeOfWeek, T &data)
  Returns the local data entry at the specified time.
- template<class T >
  bool getData (const double &timeOfWeek, const std::string &nodeId, T &data)
  Returns the remote data entry at the specified time.
- void addEntry (const double &timeOfWeek, const uint32_t &satelliteID, const data::GNSSObservable &gnssObs)
  Adds a local GNSSObservable value entry.
- bool getData (const double &timeOfWeek, const uint32_t &satelliteID, data::GNSSObservable &gnssObs)
  Retrieves a local GNSS observable from the time history.
- void addEntry (const double &timeOfWeek, const std::string &nodeID, const uint32_t &satelliteID, const data::↩ GNSSObservable &gnssObs)
  Adds a remote GNSSObservable entry.
- bool getData (const double &timeOfWeek, const std::string &nodeID, const uint32_t &satelliteID, data::GNSS↩ Observable &gnssObs)
  Retrieves a local GNSS observable from the time history.

- void setHistoryPeriod (const double &period)

  Sets the history period.
- void setLogMessageHandler (const logutils::LogCallback &logMsgHandler)

  Sets the log message handler to provided callback.
- void manageHistory ()

  Trims the stored data in the repository.
- size_t getRepoSize ()

  Returns the size of the repo (number of time entries)
- bool getNewestEntry (TimeEntry &timeEntry)

  Returns the newest time entry.
- bool getNewestEntries (std::vector< TimeEntry > &timeEntryVec, double startTime)

  Returns the newest time entries that start appear after a given time.

Static Public Member Functions

- static IntegrityDataRepository & getInstance ()

  Function to gain a singlton instance of the history.
- static bool sortTimeEntry (TimeEntry &t0, TimeEntry &t1)

  Comparator function for sorting TimeEntry objects by their time of week.

8.28.1 Detailed Description

Class definition for the history of data at a single PNT node.

The IntegrityDataRepository object is a singleton, so therefore only 1 observable history lives in the application

Definition at line 94 of file IntegrityDataRepository.hpp.

8.28.2 Constructor & Destructor Documentation

8.28.2.1 IntegrityDataRepository()

```
pnt_integrity::IntegrityDataRepository::IntegrityDataRepository (
            IntegrityDataRepository const &  )  [delete]
```

Delete the copy constructor.

Deleting the copy constructor to help ensure singleton

8.28.3 Member Function Documentation

8.28.3.1 addEntry() [1/4]

```
template<class T >
void pnt_integrity::IntegrityDataRepository::addEntry (
            const double & timeOfWeek,
            const T & data )
```

Adds a local data entry to the repo.

Adds a local measurement to the entry

Parameters

timeOfWeek	The time associated with the observable
data	The local data structure

Definition at line 322 of file IntegrityDataRepository.hpp.

8.28.3.2 addEntry() [2/4]

```
template<class T >
void pnt_integrity::IntegrityDataRepository::addEntry (
            const double & timeOfWeek,
            const std::string & nodeId,
            const T & data )
```

Adds a remote data entry to the repo.

Adds a local remote to the entry

Parameters

timeOfWeek	The time associated with the observable
nodeId	The name or node ID of the remote
data	The remote data structure

Definition at line 338 of file IntegrityDataRepository.hpp.

8.28.3.3 addEntry() [3/4]

```
void pnt_integrity::IntegrityDataRepository::addEntry (
            const double & timeOfWeek,
```

```
            const uint32_t & satelliteID,
            const data::GNSSObservable & gnssObs )
```

Adds a local GNSSObservable value entry.

Parameters

timeOfWeek	The time associated with the observable
satelliteID	The ID number for the GNSS observable's origin
gnssObs	The GNSS observable to add to the repository

8.28.3.4 addEntry() [4/4]

```
void pnt_integrity::IntegrityDataRepository::addEntry (
            const double & timeOfWeek,
            const std::string & nodeID,
            const uint32_t & satelliteID,
            const data::GNSSObservable & gnssObs )
```

Adds a remote GNSSObservable entry.

Parameters

timeOfWeek	The time associated with the observable
nodeID	The identifier of the remote node
satelliteID	The ID number for the GNSS observable's origin
gnssObs	The GNSS observable.

8.28.3.5 getData() [1/4]

```
template<class T >
bool pnt_integrity::IntegrityDataRepository::getData (
            const double & timeOfWeek,
            T & data )
```

Returns the local data entry at the specified time.

Parameters

timeOfWeek	The time of the desired data
data	The requested local data entry

Definition at line 374 of file IntegrityDataRepository.hpp.

8.28.3.6 getData() [2/4]

```
template<class T >
bool pnt_integrity::IntegrityDataRepository::getData (
            const double & timeOfWeek,
            const std::string & nodeId,
            T & data )
```

Returns the remote data entry at the specified time.

Parameters

timeOfWeek	The time of the desired data
nodeId	The identifier string for the desired node
data	The requested remote data entry

Definition at line 398 of file IntegrityDataRepository.hpp.

8.28.3.7 getData() [3/4]

```
bool pnt_integrity::IntegrityDataRepository::getData (
            const double & timeOfWeek,
            const uint32_t & satelliteID,
            data::GNSSObservable & gnssObs )
```

Retrieves a local GNSS observable from the time history.

Parameters

timeOfWeek	The time associated with the observable
satelliteID	The ID number for the GNSS observable's origin
gnssObs	The GNSS observable.

Returns

True if the observable exists

8.28.3.8 getData() [4/4]

```
bool pnt_integrity::IntegrityDataRepository::getData (
            const double & timeOfWeek,
```

```
            const std::string & nodeID,
            const uint32_t & satelliteID,
            data::GNSSObservable & gnssObs )
```

Retrieves a local GNSS observable from the time history.

Parameters

timeOfWeek	The time associated with the observable
nodeID	The identifier of the remote node
satelliteID	The ID number for the GNSS observable's origin
gnssObs	The GNSS observable.

Returns

True if the remote node and observable exist

8.28.3.9 getInstance()

```
static IntegrityDataRepository& pnt_integrity::IntegrityDataRepository::getInstance ( )  [inline],
[static]
```

Function to gain a singlton instance of the history.

Returns

The unique instance of the history object

Definition at line 104 of file IntegrityDataRepository.hpp.

8.28.3.10 getNewestEntries()

```
bool pnt_integrity::IntegrityDataRepository::getNewestEntries (
            std::vector< TimeEntry > & timeEntryVec,
            double startTime )
```

Returns the newest time entries that start appear after a given time.

This function will return the time entries that are within the time range of now and the given start time. It will return as many as it can before running out of entries.

Parameters

timeEntryVec	The vector of the newest time entries
startTime	The earliest time entry to return

Returns

True if the repository is not empty

8.28.3.11 getNewestEntry()

```
bool pnt_integrity::IntegrityDataRepository::getNewestEntry (
            TimeEntry & timeEntry )
```

Returns the newest time entry.

This function will return the newest time entry in the repo

Parameters

timeEntry	The newest time entry returned by reference

Returns

True if the repository is not empty

8.28.3.12 getRepoSize()

```
size_t pnt_integrity::IntegrityDataRepository::getRepoSize ( )  [inline]
```

Returns the size of the repo (number of time entries)

Returns the number of time entries into the repsoitory

Returns

The number of time entries

Definition at line 248 of file IntegrityDataRepository.hpp.

8.28.3.13 manageHistory()

```
void pnt_integrity::IntegrityDataRepository::manageHistory ( )
```

Trims the stored data in the repository.

This function will trim the repository to the length determined by setHistoryPeriod. The default history is 10 if not set

8.28.3.14 operator=()

```
void pnt_integrity::IntegrityDataRepository::operator= (
            IntegrityDataRepository constIntegrityDataRepository )  [delete]
```

Delete the assignment operator.

Deleting the assignment operator to help insure singleton

8.28.3.15 setHistoryPeriod()

```
void pnt_integrity::IntegrityDataRepository::setHistoryPeriod (
            const double & period )  [inline]
```

Sets the history period.

Defines the time history length that resides in the data history. Defaults to 10 if this function is not called

Parameters

period	The time (in seconds) that will be kept in the history

Definition at line 219 of file IntegrityDataRepository.hpp.

8.28.3.16 setLogMessageHandler()

```
void pnt_integrity::IntegrityDataRepository::setLogMessageHandler (
            const logutils::LogCallback & logMsgHandler )  [inline]
```

Sets the log message handler to provided callback.

Parameters

logMsgHandler	The provided call back function

Definition at line 228 of file IntegrityDataRepository.hpp.

8.28.3.17 sortTimeEntry()

```
static bool pnt_integrity::IntegrityDataRepository::sortTimeEntry (
            TimeEntry & t0,
            TimeEntry & t1 )  [inline], [static]
```

Comparator function for sorting TimeEntry objects by their time of week.

Can be used with std::sort on vectors of TimeEntry objects.

Parameters

t0	The first TimeEntry to compare
t1	The second TimeEntry to compare

Returns

true if t0.timeOfWeek_ < t1.timeOfWeek_, false otherwise

Definition at line 282 of file IntegrityDataRepository.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/IntegrityDataRepository.hpp

8.29 pnt_integrity::IntegrityMonitor Class Reference

Class implementation of integrity monitoring using AssuranceChecks and IntegrityData.

```
#include <IntegrityMonitor.hpp>
```

Public Member Functions

- IntegrityMonitor (const logutils::LogCallback &log=logutils::printLogToStdOut)
  Default constructor.
- IntegrityDataRepository & getRepo ()
  Returns an instance to the repository.
- bool registerCheck (const std::string &checkName, AssuranceCheck *checkPtr)
  Function to register user-defined check.
- MultiPrnAssuranceMap getMultiPrnAssuranceData ()

Return function for the multi-prn assurance data.

- data::AssuranceLevel getAssuranceLevel ()

  Returns overall assurance level.
- double getAssuranceValue ()

  Returns overall assurance value.
- data::AssuranceReports getAssuranceReports ()

  Returns assurance reports from all registered checks.
- void determineAssuranceLevels ()

  Calculates overall assurance levels accross all registered checks.
- void handleGnssObservables (const data::GNSSObservables &gnssObs, const bool &localFlag=true)

  Handler function for GNSSObservables.
- void handlePositionVelocity (const data::PositionVelocity &posVel, const bool &localFlag=true)

  Handler function for PositionVelocity messages.
- void handleEstimatedPositionVelocity (const data::PositionVelocity &posVel, const bool &localFlag=true)

  Handler function for Estimated PositionVelocity messages.
- void handleDistanceTraveled (const data::AccumulatedDistranceTraveled &dist)

  Handler function for AccumulatedDistranceTraveled messages.
- void handleMeasuredRange (const data::MeasuredRange &range, const bool &localFlag=true)

  Handler function for MeasuredRange messages.
- template<typename samp_type >
  void handleIfSampleData (const double &time, const if_data_utils::IFSampleData< samp_type > &ifData)

  Handler function for IFSampleData messages.
- void handleClockOffset (const data::ClockOffset &clockOffset, const bool &localFlag)

  Handler function for ClockOffset messages.
- void handleAGC (const data::AgcValue &agcValue)

  Handler function AGC setting.
- template<class T >
  void addDataToRepo (const double &time, const T &data, const bool &local=true, const std::string &deviceId=std::string())

  Template function that adds received data to the repository.
- void setLogMessageHandler (const logutils::LogCallback &logMsgHandler)

  Sets the log message handler to provided callback.
- size_t getNumUsedChecks ()

  Returns the number of assurance checks currently used in the monitor.
- bool isCheckUsed (const std::string &checkName)

  Returns a flag to indicate if check was used in current level calculation.

8.29.1 Detailed Description

Class implementation of integrity monitoring using AssuranceChecks and IntegrityData.

Definition at line 60 of file IntegrityMonitor.hpp.

8.29.2 Constructor & Destructor Documentation

8.29.2.1 IntegrityMonitor()

```
pnt_integrity::IntegrityMonitor::IntegrityMonitor (
            const logutils::LogCallback & log = logutils::printLogToStdOut )
```

Default constructor.

The constructor set's the repository's log handling to use the logging function provided by the integrity monitor

Parameters

log	A log callback function for log messages

8.29.3 Member Function Documentation

8.29.3.1 addDataToRepo()

```
template<class T >
void pnt_integrity::IntegrityMonitor::addDataToRepo (
            const double & time,
            const T & data,
            const bool & local = true,
            const std::string & deviceId = std::string() )
```

Template function that adds received data to the repository.

Parameters

time	The timestamp used for time entries into the repo
data	The received data message /structure to be entered
local	A flag to indicate if the data is local or remote data
deviceId	A string to identify remote data entries

Definition at line 271 of file IntegrityMonitor.hpp.

8.29.3.2 getNumUsedChecks()

```
size_t pnt_integrity::IntegrityMonitor::getNumUsedChecks ( )  [inline]
```

Returns the number of assurance checks currently used in the monitor.

Returns

The number of assurance checks

Definition at line 220 of file IntegrityMonitor.hpp.

8.29.3.3 getRepo()

```
IntegrityDataRepository& pnt_integrity::IntegrityMonitor::getRepo ( )  [inline]
```

Returns an instance to the repository.

Returns

A singleton instance of the repository

Definition at line 75 of file IntegrityMonitor.hpp.

8.29.3.4 handleAGC()

```
void pnt_integrity::IntegrityMonitor::handleAGC (
            const data::AgcValue & agcValue )
```

Handler function AGC setting.

Call this function on receipt of an AGC setting

Parameters

agcValue	The current AGC setting from a a receiver

8.29.3.5 handleClockOffset()

```
void pnt_integrity::IntegrityMonitor::handleClockOffset (
            const data::ClockOffset & clockOffset,
            const bool & localFlag )
```

Handler function for ClockOffset messages.

Call this function on receipt of a ClockOffset message. The function will call the handleClockOffset on all registered checks

Parameters

clockOffset	The clock bias and drift with Header for timestamp
localFlag	Flag to indicate local or remote data

8.29.3.6 handleDistanceTraveled()

```
void pnt_integrity::IntegrityMonitor::handleDistanceTraveled (
            const data::AccumulatedDistranceTraveled & dist )
```

Handler function for AccumulatedDistranceTraveled messages.

Parameters

dist	The provided distance traveled message

8.29.3.7 handleEstimatedPositionVelocity()

```
void pnt_integrity::IntegrityMonitor::handleEstimatedPositionVelocity (
            const data::PositionVelocity & posVel,
            const bool & localFlag = true )
```

Handler function for Estimated PositionVelocity messages.

Call this function on receipt of a PositionVelocity message that contains an external estimate of the current position and velocity. The function will call the handleEstimatedPositionVelocity in all registered checks

Parameters

localFlag	A flag to indicate if the source of the data is from a local or remote source (defaults to "True")
posVel	The provided data message

8.29.3.8 handleGnssObservables()

```
void pnt_integrity::IntegrityMonitor::handleGnssObservables (
            const data::GNSSObservables & gnssObs,
            const bool & localFlag = true )
```

Handler function for GNSSObservables.

Call this function on receipt of a GNSSObservables message. The function will call the handleGnssObservables in all registered checks

Parameters

localFlag	A flag to indicate if the source of the observable data is from a local or remote source (defaults to "True")
gnssObs	The provided data message

8.29.3.9 handleIfSampleData()

```
template<typename samp_type >
void pnt_integrity::IntegrityMonitor::handleIfSampleData (
            const double & time,
            const if_data_utils::IFSampleData< samp_type > & ifData )
```

Handler function for IFSampleData messages.

Call this function on receipt of an IFSampleData message. The function will call the handleIfSampleData on all registered checks

Parameters

time	The timestamp of the IF Data
ifData	The incoming IF sample data

Definition at line 300 of file IntegrityMonitor.hpp.

8.29.3.10 handleMeasuredRange()

```
void pnt_integrity::IntegrityMonitor::handleMeasuredRange (
            const data::MeasuredRange & range,
            const bool & localFlag = true )
```

Handler function for MeasuredRange messages.

Call this function on receipt of a MeasuredRange message. The function will call the handleMeasuredRange in all registered checks

Parameters

localFlag	A flag to indicate if the source of the data is from a local or remote source (defaults to "True")
range	The provided measured range message

8.29.3.11 handlePositionVelocity()

```
void pnt_integrity::IntegrityMonitor::handlePositionVelocity (
            const data::PositionVelocity & posVel,
            const bool & localFlag = true )
```

Handler function for PositionVelocity messages.

Call this function on receipt of a PositionVelocity message. The function will call the handlePositionVelocity in all registered checks

Parameters

localFlag	A flag to indicate if the source of the data is from a local or remote source (defaults to "True")
posVel	The provided data message

8.29.3.12 registerCheck()

```
bool pnt_integrity::IntegrityMonitor::registerCheck (
            const std::string & checkName,
            AssuranceCheck * checkPtr )
```

Function to register user-defined check.

Register's an assurance check with the monitor. The process simply adds a provided pointer to the check to an internally held vector of check pointers

Parameters

checkName	The name of the check object
checkPtr	A pointer to an AssuranceCheck

Returns

True if successful

8.29.3.13 setLogMessageHandler()

```
void pnt_integrity::IntegrityMonitor::setLogMessageHandler (
            const logutils::LogCallback & logMsgHandler )  [inline]
```

Sets the log message handler to provided callback.

Parameters

logMsgHandler	The provided call back function

Definition at line 208 of file IntegrityMonitor.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/IntegrityMonitor.hpp

8.30 pnt_integrity::data::KeyValue Struct Reference

A structure for key value pairs.

```
#include <IntegrityData.hpp>
```

Public Attributes

- std::string key
  Label for the value.
- std::string value
  Value.

8.30.1 Detailed Description

A structure for key value pairs.

Definition at line 819 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

8.31 pnt_integrity::data::MeasuredRange Struct Reference

A structure that represents a distance measurement to a known point.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- MeasuredRange (const bool &valid=false)

  Default constructor.

Public Attributes

- Header header

  The message header.
- bool rangeValid

  Flag to indicate validity of range measurement.
- double range

  The range measurement to the feature.
- double variance

  The variance associated with the range measurement.
- GeodeticPosition3d featurePosition

  The feature location.
- double feature_position_covariance_ [3][3]

  The covariance of the geodetic position.

8.31.1 Detailed Description

A structure that represents a distance measurement to a known point.

This structure holds all relative data that represents a measured distance to a feature with a known location

Definition at line 775 of file IntegrityData.hpp.

8.31.2 Constructor & Destructor Documentation

8.31.2.1 MeasuredRange()

```
pnt_integrity::data::MeasuredRange::MeasuredRange (
            const bool & valid = false )  [inline]
```

Default constructor.

Parameters

valid	Flag to indicate measurement validity

Definition at line 794 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

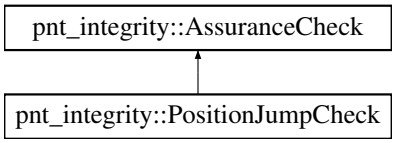
- include/pnt_integrity/IntegrityData.hpp

8.32 pnt_integrity::PositionJumpCheck Class Reference

Class implementation for the position-jump check.

`#include <PositionJumpCheck.hpp>`

Inheritance diagram for pnt_integrity::PositionJumpCheck:



Public Member Functions

- PositionJumpCheck (const std::string &name="position_jump_check", const double &minimumBound=15.0, const bool &useEstimatedPv=false, const bool &useDistTraveled=false, const double &maximumVelocity=5.0, const double &posStdDevMultiplier=6.0, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor for the check class.
- virtual bool handlePositionVelocity (const data::PositionVelocity &posVel, const bool &localFlag)

  Handler function for Position / Velocity message.
- virtual bool handleEstimatedPositionVelocity (const data::PositionVelocity &pv)

  Handler function for an estimated Position / Velocity message.
- virtual bool handleDistanceTraveled (const data::AccumulatedDistranceTraveled &dist)

  Handler function for AccumulatedDistranceTraveled messages.
- void setLastGoodPosition (const double &updateTime, const data::GeodeticPosition3d &position)

  Sets the last known good position.
- virtual bool runCheck ()

  Triggers a manual check calculation.
- virtual void calculateAssuranceLevel (const double &)

  Function to explicitly set the assurance level of the check.
- double getCalculatedDistance ()

  Returns the calculated distance between the current position to the last good position.
- double getDistanceTraveled ()

  Returns the currently estimated distance traveled since the last known good position.
- double getBound ()

  Returns the current bound that is used by the check.
- void setPublishDiagnostics (std::function< void(const double &, const PosJumpCheckDiagnostics &)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.32.1 Detailed Description

Class implementation for the position-jump check.

Definition at line 68 of file PositionJumpCheck.hpp.

8.32.2 Constructor & Destructor Documentation

8.32.2.1 PositionJumpCheck()

```
pnt_integrity::PositionJumpCheck::PositionJumpCheck (
            const std::string & name = "position_jump_check",
            const double & minimumBound = 15.0,
            const bool & useEstimatedPv = false,
            const bool & useDistTraveled = false,
            const double & maximumVelocity = 5.0,
            const double & posStdDevMultiplier = 6.0,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor for the check class.

Parameters

name	The string name of the check
minimumBound	The minimum amount of position jump that will trigger the check (meters).
useEstimatedPv	Flag to tell check to use the incoming estimated position rather than distance traveled or max velocity propagation
useDistTraveled	Flag to indicate whether or not the check should use a provided distance traveled to compute the jump bound
maximumVelocity	The maximum velocity of the platform that will be used to calculate the bound if a distance traveled is not used (m/s)
posStdDevMultiplier	Scale factor on input position standard deviation
log	A provided log callback function to use for log mesages

Definition at line 91 of file PositionJumpCheck.hpp.

8.32.3 Member Function Documentation

8.32.3.1 calculateAssuranceLevel()

```
virtual void pnt_integrity::PositionJumpCheck::calculateAssuranceLevel (
            const double &  )  [inline], [virtual]
```

Function to explicitly set the assurance level of the check.

Uses whatever data is available to calculate the current assurance level

Implements pnt_integrity::AssuranceCheck.

Definition at line 187 of file PositionJumpCheck.hpp.

8.32.3.2 getBound()

```
double pnt_integrity::PositionJumpCheck::getBound ( )  [inline]
```

Returns the current bound that is used by the check.

Returns

The current jump bound

Definition at line 209 of file PositionJumpCheck.hpp.

8.32.3.3 getCalculatedDistance()

```
double pnt_integrity::PositionJumpCheck::getCalculatedDistance ( )  [inline]
```

Returns the calculated distance between the current position to the last good position.

Returns

The calculated distance

Definition at line 192 of file PositionJumpCheck.hpp.

8.32.3.4 getDistanceTraveled()

```
double pnt_integrity::PositionJumpCheck::getDistanceTraveled ( )  [inline]
```

Returns the currently estimated distance traveled since the last known good position.

Returns

The estimated distance traveled

Definition at line 201 of file PositionJumpCheck.hpp.

8.32.3.5 handleDistanceTraveled()

```
virtual bool pnt_integrity::PositionJumpCheck::handleDistanceTraveled (
            const data::AccumulatedDistranceTraveled & dist )  [inline], [virtual]
```

Handler function for AccumulatedDistranceTraveled messages.

Parameters

dist	The provided distance traveled message

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

Definition at line 153 of file PositionJumpCheck.hpp.

8.32.3.6 handleEstimatedPositionVelocity()

```
virtual bool pnt_integrity::PositionJumpCheck::handleEstimatedPositionVelocity (
            const data::PositionVelocity & pv )  [virtual]
```

Handler function for an estimated Position / Velocity message.

Function to handle provided posivion / velocity messages (virtual)

Parameters

pv	The provided estimated position velocity message / structure

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.32.3.7 handlePositionVelocity()

```
virtual bool pnt_integrity::PositionJumpCheck::handlePositionVelocity (
            const data::PositionVelocity & posVel,
            const bool & localFlag )  [virtual]
```

Handler function for Position / Velocity message.

Function to handle provided posivion / velocity messages

Parameters

posVel	The provided position velocity message / structure
localFlag	Indicates if this is a local or remote message

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.32.3.8 runCheck()

```
virtual bool pnt_integrity::PositionJumpCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.32.3.9 setLastGoodPosition()

```
void pnt_integrity::PositionJumpCheck::setLastGoodPosition (
            const double & updateTime,
            const data::GeodeticPosition3d & position )  [virtual]
```

Sets the last known good position.

Provides if the assurance check with knowledge of a last known good position for use in calculations (if needed by the specific implementation)

Parameters

updateTime	The time associated with the last good position
position	The last known good position

Reimplemented from pnt_integrity::AssuranceCheck.

8.32.3.10 setPublishDiagnostics()

```
void pnt_integrity::PositionJumpCheck::setPublishDiagnostics (
            std::function< void(const double &, const PosJumpCheckDiagnostics &)> handler )
[inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 221 of file PositionJumpCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/PositionJumpCheck.hpp

8.33 pnt_integrity::data::PositionVelocity Struct Reference

A structure to represent a Position / Velocity message.

```
#include <IntegrityData.hpp>
```

Public Member Functions

- PositionVelocity (const Header &headerIn=Header(), const GeodeticPosition3d &positionIn=GeodeticPosition3d())
  Constructor for the PositionVelocity structure.
- bool isPositionValid ()
  Checks the validity of the position.
- bool isPositionCovarianceValid ()
  Checks the validity of the covariance.
- bool isVelocityValid ()
  Checks the validity of the veocity.
- bool isVelocityCovarianceValid ()
  Checks the validity of the covariance.
- bool checkValidity ()
  Checks the structure to make sure all data fields are valid.

Public Attributes

- Header header
  The message header.
- GeodeticPosition3d position
  The 3D geodetic position.
- double velocity [3]
  The velocity in north-east-down (NED)
- double covariance [6][6]
  The cross-covariance for position / velocity in NED (6x6)

8.33.1 Detailed Description

A structure to represent a Position / Velocity message.

This structure represents a data message that contains a geodetic 3d position, an NED velocity, and a 6x6 cross-covariance of position / velocity

Definition at line 635 of file IntegrityData.hpp.

8.33.2 Constructor & Destructor Documentation

8.33.2.1 PositionVelocity()

```
pnt_integrity::data::PositionVelocity::PositionVelocity (
            const Header & headerIn = Header(),
            const GeodeticPosition3d & positionIn = GeodeticPosition3d() )  [inline]
```

Constructor for the PositionVelocity structure.

The default constructor for the position / velocity message can be optionally provided with a pre-built header and position structure. The velocity and covariance arrays are initialized to NaN and must be set to desired values after object construction

Parameters

headerIn	A provided header object
positionIn	A provided 3D position (geodetic)

Definition at line 655 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

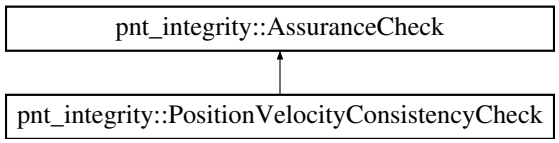
- include/pnt_integrity/IntegrityData.hpp

8.34 pnt_integrity::PositionVelocityConsistencyCheck Class Reference

Class implementation for the position velocity check.

`#include <PositionVelocityConsistencyCheck.hpp>`

Inheritance diagram for pnt_integrity::PositionVelocityConsistencyCheck:



Public Member Functions

- PositionVelocityConsistencyCheck (const std::string &name="Position Velocity Check", const double &sample↩ Window=5.0, const double &errorThreshSF=2.0, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Default constructor for the check class.
- bool handlePositionVelocity (const data::PositionVelocity &posVel, const bool &localFlag)

  Handler function for Position / Velocity message.
- void calculateAssuranceLevel (const double &)

  Function to explicitly set the assurance level of the check.
- bool runCheck ()

  Triggers a manual check calculation.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const PosVelConsCheckDiagnostics &checkData)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.34.1 Detailed Description

Class implementation for the position velocity check.

Definition at line 80 of file PositionVelocityConsistencyCheck.hpp.

8.34.2 Constructor & Destructor Documentation

8.34.2.1 PositionVelocityConsistencyCheck()

```
pnt_integrity::PositionVelocityConsistencyCheck::PositionVelocityConsistencyCheck (
            const std::string & name = "Position Velocity Check",
            const double & sampleWindow = 5.0,
            const double & errorThreshSF = 2.0,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Default constructor for the check class.

Constructor explicitly disables multi-prn support.

Parameters

name	The name of the check object
sampleWindow	The duration of time (in seconds) over which to get position and velocity data for checking integrity
errorThreshSF	The scale factor to apply to the velocity variance that is used as an error threshold
log	A provided log callback function to use

Definition at line 93 of file PositionVelocityConsistencyCheck.hpp.

8.34.3 Member Function Documentation

8.34.3.1 calculateAssuranceLevel()

```
void pnt_integrity::PositionVelocityConsistencyCheck::calculateAssuranceLevel (
            const double &  )  [inline], [virtual]
```

Function to explicitly set the assurance level of the check.

Uses whatever data is available to calculate the assurance level

Implements pnt_integrity::AssuranceCheck.

Definition at line 123 of file PositionVelocityConsistencyCheck.hpp.

8.34.3.2 handlePositionVelocity()

```
bool pnt_integrity::PositionVelocityConsistencyCheck::handlePositionVelocity (
            const data::PositionVelocity & posVel,
            const bool & localFlag )  [virtual]
```

Handler function for Position / Velocity message.

Function to handle provided posivion / velocity messages

Parameters

posVel	The provided position velocity message / structure
localFlag	Indicates if this is a local or remote message

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.34.3.3 runCheck()

```
bool pnt_integrity::PositionVelocityConsistencyCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.34.3.4 setPublishDiagnostics()

```
void pnt_integrity::PositionVelocityConsistencyCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const PosVelConsCheckDiagnostics &check↩
Data)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 139 of file PositionVelocityConsistencyCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/PositionVelocityConsistencyCheck.hpp

8.35 pnt_integrity::PosJumpCheckDiagnostics Struct Reference

Structure for check diagnostics.

`#include <PositionJumpCheck.hpp>`

Public Attributes

- double distance
- double bound

8.35.1 Detailed Description

Structure for check diagnostics.

Definition at line 58 of file PositionJumpCheck.hpp.

8.35.2 Member Data Documentation

8.35.2.1 bound

`double pnt_integrity::PosJumpCheckDiagnostics::bound`

The bound on the distance, determined by maximum velocity, distance traveled, or the covariance on the estimated position

Definition at line 65 of file PositionJumpCheck.hpp.

8.35.2.2 distance

`double pnt_integrity::PosJumpCheckDiagnostics::distance`

Depending on the mode, this is either the distance to the last known good position, or the distance to the current estimated position

Definition at line 62 of file PositionJumpCheck.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/PositionJumpCheck.hpp

8.36 pnt_integrity::PosVelConsCheckDiagnostics Struct Reference

Structure used to publish diagnostic data.

`#include <PositionVelocityConsistencyCheck.hpp>`

Public Attributes

- std::vector< double > errorVals

  The error values over all examined pairs.
- std::vector< double > errorThresh

  The threshold for each error based on velocity variance.
- double percentBad

  Percentage of pairs that are above the threshold.
- double inconsistentThresh

  The inconsistent threshold used.
- double unassuredThresh

  The unassured threshold used.

8.36.1 Detailed Description

Structure used to publish diagnostic data.

Definition at line 65 of file PositionVelocityConsistencyCheck.hpp.

The documentation for this struct was generated from the following file:

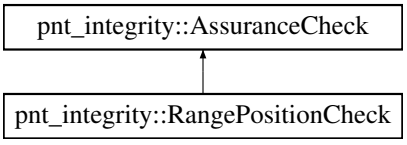
- include/pnt_integrity/PositionVelocityConsistencyCheck.hpp

8.37 pnt_integrity::RangePositionCheck Class Reference

Class implementation for the range / position check.

`#include <RangePositionCheck.hpp>`

Inheritance diagram for pnt_integrity::RangePositionCheck:



Public Member Functions

- RangePositionCheck (const std::string &name="Range-Position check", const logutils::LogCallback &log=logutils↩ ::printLogToStdOut)

  Default constructor for the check class.
- bool runCheck ()

  Triggers a manual check calculation.
- virtual bool handlePositionVelocity (const data::PositionVelocity &posVel, const bool &local)

  Handler function for Position / Velocity message.
- virtual bool handleMeasuredRange (const data::MeasuredRange &range)

  Handler function for measrured range.
- void calculateAssuranceLevel (const double &time)

  Function to explicitly set the assurance level of the check.
- void setPublishDiagnostics (std::function< void(const double &, const RngPosCheckDiagnostics &)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.37.1 Detailed Description

Class implementation for the range / position check.

Definition at line 85 of file RangePositionCheck.hpp.

8.37.2 Constructor & Destructor Documentation

8.37.2.1 RangePositionCheck()

```
pnt_integrity::RangePositionCheck::RangePositionCheck (
            const std::string & name = "Range-Position check",
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Default constructor for the check class.

Constructor explicitly disables multi-prn support.

Parameters

name	The name of the check object
log	A provided log callback function to use

Definition at line 94 of file RangePositionCheck.hpp.

8.37.3 Member Function Documentation

8.37.3.1 calculateAssuranceLevel()

```
void pnt_integrity::RangePositionCheck::calculateAssuranceLevel (
            const double & time )  [virtual]
```

Function to explicitly set the assurance level of the check.

For this check, this function cycles through all of the individual PRN assurance values, analyzes them, and then sets the master assurance level associted with the check.

Implements pnt_integrity::AssuranceCheck.

8.37.3.2 handleMeasuredRange()

```
virtual bool pnt_integrity::RangePositionCheck::handleMeasuredRange (
            const data::MeasuredRange & range )  [virtual]
```

Handler function for measrured range.

Function to handle provided range measurements (pure virtual)

Parameters

range	The provided range measurement message / structure

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.37.3.3 handlePositionVelocity()

```
virtual bool pnt_integrity::RangePositionCheck::handlePositionVelocity (
            const data::PositionVelocity & posVel,
            const bool & local )  [virtual]
```

Handler function for Position / Velocity message.

Function to handle provided posivion / velocity messages

Parameters

posVel	The provided position velocity message / structure
local	Indicates if this is a local or remote message

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.37.3.4 runCheck()

```
bool pnt_integrity::RangePositionCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.37.3.5 setPublishDiagnostics()

```
void pnt_integrity::RangePositionCheck::setPublishDiagnostics (
            std::function< void(const double &, const RngPosCheckDiagnostics &)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 146 of file RangePositionCheck.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/RangePositionCheck.hpp

8.38 pnt_integrity::RepositoryEntry Class Reference

Class definition for an entry into the repository.

`#include <RepositoryEntry.hpp>`

Public Member Functions

- RepositoryEntry (const DataLocaleType &type=DataLocaleType::Local, const std::string &nodeID="local", const logutils::LogCallback &log=logutils::printLogToStdOut)

  Constructor for an entry into the repository.
- void addEntry (const uint32_t &satelliteID, const data::GNSSObservable &gnssObs)

  Adds a provided GNSS observable into the data entry.
- bool getData (const uint32_t &satelliteID, data::GNSSObservable &gnssObs) const

  Returns a GNSS Observable.
- void addEntry (const data::GNSSObservableMap &gnssObsMap)

  Adds a provided GNSS observable map into the data entry.
- void getData (data::GNSSObservableMap &gnssObsMap) const

  Returns a GNSS Observable.
- void addEntry (const data::MeasuredRange &range)

  Adds an a measured (RF) range to another location or node.
- void getData (data::MeasuredRange &range) const

  Returns the RF range observable.
- void addEntry (const data::PositionVelocity &posVel)

  Adds position velocity measurement data to the entry.
- void getData (data::PositionVelocity &posVel) const

  Returns the position velocity data from the repo entry.
- void addEntry (const data::ClockOffset &clockOffset)

  Adds clock offset data to the entry.
- void getData (data::ClockOffset &clockOffset) const

  Returns the clock offset data from the repo entry.
- void setLogMessageHandler (const logutils::LogCallback &logMsgHandler)

  Sets the log message handler to provided callback.

8.38.1 Detailed Description

Class definition for an entry into the repository.

A RepositoryEntry represents a collection of integrity data measurements from a single node at a unique time. Currently the object containes an RfRange and a GNSSObservableMap. More data structures will be added as new integrity checks are added to the framework.

Definition at line 72 of file RepositoryEntry.hpp.

8.38.2 Constructor & Destructor Documentation

8.38.2.1 RepositoryEntry()

```
pnt_integrity::RepositoryEntry::RepositoryEntry (
            const DataLocaleType & type = DataLocaleType::Local,
            const std::string & nodeID = "local",
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Constructor for an entry into the repository.

The constructor takes in a string that indicates what node the data / measurement / observable belongs to. Defaults to "local" to indicate that the observable was taken at this node's location.

Definition at line 80 of file RepositoryEntry.hpp.

8.38.3 Member Function Documentation

8.38.3.1 addEntry() [1/5]

```
void pnt_integrity::RepositoryEntry::addEntry (
            const uint32_t & satelliteID,
            const data::GNSSObservable & gnssObs )  [inline]
```

Adds a provided GNSS observable into the data entry.

This function will place the provided GNSS observable structure in the map with the corresponding satellite ID key.

Note

If data for the provided satelite ID already exists, it will be overwritten.

Parameters

satelliteID	The satellite id number (or PRN)
gnssObs	The GNSS observable data structure

Definition at line 99 of file RepositoryEntry.hpp.

8.38.3.2 addEntry() [2/5]

```
void pnt_integrity::RepositoryEntry::addEntry (
            const data::GNSSObservableMap & gnssObsMap )  [inline]
```

Adds a provided GNSS observable map into the data entry.

This function will place the provided GNSS observable map into the entry. It overwrites the existing map entry with the provided one. Use the addEntry function for a single GNSSObservable to add to the existing map

Parameters

gnssObsMap	The provided GNSS observableMap

Definition at line 124 of file RepositoryEntry.hpp.

8.38.3.3 addEntry() [3/5]

```
void pnt_integrity::RepositoryEntry::addEntry (
            const data::MeasuredRange & range )
```

Adds an a measured (RF) range to another location or node.

Note

Any existing value will be overwritten

Parameters

range	The measured range

8.38.3.4 addEntry() [4/5]

```
void pnt_integrity::RepositoryEntry::addEntry (
            const data::PositionVelocity & posVel )  [inline]
```

Adds position velocity measurement data to the entry.

Parameters

posVel	The provided position / velocity structure

Definition at line 160 of file RepositoryEntry.hpp.

8.38.3.5 addEntry() [5/5]

```
void pnt_integrity::RepositoryEntry::addEntry (
            const data::ClockOffset & clockOffset )  [inline]
```

Adds clock offset data to the entry.

Parameters

clockOffset	The provided clock offset structure

Definition at line 179 of file RepositoryEntry.hpp.

8.38.3.6 getData() [1/3]

```
bool pnt_integrity::RepositoryEntry::getData (
            const uint32_t & satelliteID,
            data::GNSSObservable & gnssObs ) const
```

Returns a GNSS Observable.

Parameters

satelliteID	The satellite id number (or PRN)
gnssObs	The returned GNSS observable data structure

Returns

True if the observable exists

8.38.3.7 getData() [2/3]

```
void pnt_integrity::RepositoryEntry::getData (
            data::GNSSObservableMap & gnssObsMap ) const  [inline]
```

Returns a GNSS Observable.

Parameters

gnssObsMap	The returned GNSS observable map

Returns

True if the observable map exists

Definition at line 133 of file RepositoryEntry.hpp.

8.38.3.8 getData() [3/3]

```
void pnt_integrity::RepositoryEntry::getData (
            data::MeasuredRange & range ) const  [inline]
```

Returns the RF range observable.

Parameters

range	The returned value

Definition at line 152 of file RepositoryEntry.hpp.

8.38.3.9 setLogMessageHandler()

```
void pnt_integrity::RepositoryEntry::setLogMessageHandler (
            const logutils::LogCallback & logMsgHandler )  [inline]
```

Sets the log message handler to provided callback.

Parameters

logMsgHandler	The provided call back function

Definition at line 198 of file RepositoryEntry.hpp.

The documentation for this class was generated from the following file:

- include/pnt_integrity/RepositoryEntry.hpp

8.39 pnt_integrity::RngPosCheckNodeDiagnostic Struct Reference

Structure for check diagnostics.

`#include <RangePositionCheck.hpp>`

Public Attributes

- double minCalculatedRange
  The minimum calculated distance based on both positions and variances.
- double maxCalculatedRange
  The maximum calculated distance based on both positions and variances.
- double minMeasRange
  The minimum possible distance based on measured range and variance.
- double maxMeasRange
  The maximum possible distance based on measured range and variance.

8.39.1 Detailed Description

Structure for check diagnostics.

Definition at line 70 of file RangePositionCheck.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/RangePositionCheck.hpp

8.40 pnt_integrity::StaticPosCheckDiagnostics Struct Reference

Structure used to publish diagnostic data.

`#include <StaticPositionCheck.hpp>`

Public Attributes

- data::GeodeticPosition3d staticPosition
  The static position used in the check (surveyed or provided)
- double posChangeThresh
  Threshold to check current position against static position.
- double percentOverThresh
  The percent of positions in the window that are over the threshold.
- double inconsistentThresh
  The threshold used for the INCONSISTENT assurance level.
- double unassuredThresh
  The threshold used for the UNASSURED assurance level.

8.40.1 Detailed Description

Structure used to publish diagnostic data.

Definition at line 75 of file StaticPositionCheck.hpp.

The documentation for this struct was generated from the following file:

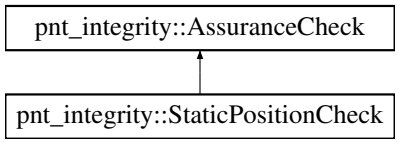
- include/pnt_integrity/StaticPositionCheck.hpp

8.41 pnt_integrity::StaticPositionCheck Class Reference

Class implementation for the static-position check.

`#include <StaticPositionCheck.hpp>`

Inheritance diagram for pnt_integrity::StaticPositionCheck:



Public Member Functions

- StaticPositionCheck (const std::string &name="static_position_check", const size_t &numPositionsForInit=60, const unsigned int &checkWindowSize=10, const double &posChangeThresh=5.0, const logutils::LogCallback &log=logutils::printLogToStdOut)

  Default constructor for the check class.
- bool handlePositionVelocity (const data::PositionVelocity &posVel, const bool &local)

  Handler function for Position / Velocity message.
- virtual bool runCheck ()

  Triggers a manual check calculation.
- virtual void calculateAssuranceLevel (const double &)

  Function to explicitly set the assurance level of the check.
- void setStaticPosition (const data::GeodeticPosition3d &staticPos)

  Sets the expected static position that will be used for the check.
- void setPublishDiagnostics (std::function< void(const double &timestamp, const StaticPosCheckDiagnostics &checkData)> handler)

  Connects the internal publishing function to external interface.

Additional Inherited Members

8.41.1 Detailed Description

Class implementation for the static-position check.

Definition at line 90 of file StaticPositionCheck.hpp.

8.41.2 Constructor & Destructor Documentation

8.41.2.1 StaticPositionCheck()

```
pnt_integrity::StaticPositionCheck::StaticPositionCheck (
            const std::string & name = "static_position_check",
            const size_t & numPositionsForInit = 60,
            const unsigned int & checkWindowSize = 10,
            const double & posChangeThresh = 5.0,
            const logutils::LogCallback & log = logutils::printLogToStdOut )  [inline]
```

Default constructor for the check class.

Constructor explicitly disables multi-prn support.

Parameters

name	The name of the check object
numPositionsForInit	The number of static positiosn required for the initialization survey
checkWindowSize	The minimum number of samples (after throwing out invalid positions) necessary to make an informed statement about integrity, includes start positions if in averaging mode
posChangeThresh	The threshold radius (in meters) for noisy position changes
log	A provided log callback function to use

Definition at line 111 of file StaticPositionCheck.hpp.

8.41.3 Member Function Documentation

8.41.3.1 calculateAssuranceLevel()

```
virtual void pnt_integrity::StaticPositionCheck::calculateAssuranceLevel (
            const double &  )  [inline], [virtual]
```

Function to explicitly set the assurance level of the check.

Uses whatever data is available to calculate the current assurance level

Implements pnt_integrity::AssuranceCheck.

Definition at line 154 of file StaticPositionCheck.hpp.

8.41.3.2 handlePositionVelocity()

```
bool pnt_integrity::StaticPositionCheck::handlePositionVelocity (
            const data::PositionVelocity & posVel,
            const bool & local )  [virtual]
```

Handler function for Position / Velocity message.

Function to handle provided posivion / velocity messages

Parameters

posVel	The provided position velocity message / structure
local	Indicates if this is a local or remote message

Returns

True if successful

Reimplemented from pnt_integrity::AssuranceCheck.

8.41.3.3 runCheck()

```
virtual bool pnt_integrity::StaticPositionCheck::runCheck ( )  [virtual]
```

Triggers a manual check calculation.

Use this function to run a manual check calculation that is not triggered off the receipt of a message (pure virtual)

Returns

True if successful

Implements pnt_integrity::AssuranceCheck.

8.41.3.4 setPublishDiagnostics()

```
void pnt_integrity::StaticPositionCheck::setPublishDiagnostics (
            std::function< void(const double &timestamp, const StaticPosCheckDiagnostics &check↩
Data)> handler )  [inline]
```

Connects the internal publishing function to external interface.

This function connects the internal "publishDiagnostics" function to an external, custom function of choice

Parameters

handler	Provided handler function

Definition at line 167 of file StaticPositionCheck.hpp.

8.41.3.5 setStaticPosition()

```
void pnt_integrity::StaticPositionCheck::setStaticPosition (
            const data::GeodeticPosition3d & staticPos )
```

Sets the expected static position that will be used for the check.

Parameters

staticPos	The provided position value

The documentation for this class was generated from the following file:

- include/pnt_integrity/StaticPositionCheck.hpp

8.42 pnt_integrity::TimeEntry Struct Reference

Structure for a time entry into the repository.

```
#include <IntegrityDataRepository.hpp>
```

Public Member Functions

- TimeEntry ()
  Default constructor.
- TimeEntry (const double &timeOfWeek)
  Constructor for creation of entry with time field already known.

Public Attributes

- double timeOfWeek_

  The time of week the data were measured or correspond to.
- RepositoryEntry localData_

  The local observables.
- RemoteRepoEntries remoteData_

  A map of remote observables.

8.42.1 Detailed Description

Structure for a time entry into the repository.

The structure contains the time corresponding to the observables, the local observables, and a set of remote observables contained in a map that is keyed off of remote node id

Definition at line 61 of file IntegrityDataRepository.hpp.

8.42.2 Constructor & Destructor Documentation

8.42.2.1 TimeEntry() [1/2]

```
pnt_integrity::TimeEntry::TimeEntry ( )  [inline]
```

Default constructor.

Declaring the default constructor implicitly allows for copy construction which is used when a new time entry is created

Definition at line 74 of file IntegrityDataRepository.hpp.

8.42.2.2 TimeEntry() [2/2]

```
pnt_integrity::TimeEntry::TimeEntry (
            const double & timeOfWeek )  [inline]
```

Constructor for creation of entry with time field already known.

Parameters

timeOfWeek	The time of week that all observables in the entry correspond to

Definition at line 80 of file IntegrityDataRepository.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityDataRepository.hpp

8.43 pnt_integrity::data::Timestamp Struct Reference

A timestamp used in all headers.

`#include <IntegrityData.hpp>`

Public Member Functions

- Timestamp (const int64_t &secIn=0, const int32_t &nsIn=0, const int8_t &timecodeIn=0)
  Default constructor for timestamp.

Public Attributes

- int64_t sec
  The whole seconds portion of the timestamp.
- int32_t nanoseconds
- int8_t timecode

8.43.1 Detailed Description

A timestamp used in all headers.

Definition at line 57 of file IntegrityData.hpp.

8.43.2 Constructor & Destructor Documentation

8.43.2.1 Timestamp()

```
pnt_integrity::data::Timestamp::Timestamp (
            const int64_t & secIn = 0,
            const int32_t & nsIn = 0,
            const int8_t & timecodeIn = 0 )  [inline]
```

Default constructor for timestamp.

Parameters

secIn	The whole seconds portion of the timestamp
nsIn	Fractional portion of the timestamp represented in ns
timecodeIn	Indicator for timebase, 0 for TAI, non-zero for other

Definition at line 75 of file IntegrityData.hpp.

8.43.3 Member Data Documentation

8.43.3.1 nanoseconds

```
int32_t pnt_integrity::data::Timestamp::nanoseconds
```

Fractional portion of the timestamp represented in ns, giving the timestamp 1 ns resolution

Definition at line 64 of file IntegrityData.hpp.

8.43.3.2 timecode

```
int8_t pnt_integrity::data::Timestamp::timecode
```

Indicator for timebase, 0 if synced to TAI, non-zero if device using a specific timebase

Definition at line 68 of file IntegrityData.hpp.

The documentation for this struct was generated from the following file:

- include/pnt_integrity/IntegrityData.hpp

Chapter 9

File Documentation

9.1 include/pnt_integrity/AcquisitionCheck.hpp File Reference

Class defined for the acquisition level checks.

```
#include "if_data_utils/IFSampleData.hpp"
#include "pnt_integrity/AssuranceCheck.hpp"
#include <Eigen/Dense>
#include <Eigen/StdVector>
#include <list>
#include <map>
#include <unsupported/Eigen/FFT>
#include <vector>
```

Classes

- struct pnt_integrity::AcqCheckDiagnostics

  Structure for publishing Acquisition Check diagnostics.
- class pnt_integrity::AcquisitionCheck

  Class implementation for the acquisition check.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Typedefs

- using pnt_integrity::CodeMap = std::map< int, std::vector< float > >

  A map for holding PRN codes, indexed on prn.
- using pnt_integrity::CodeMapEntry = std::pair< int, std::vector< float > >

  A pair for holding a PRN and it's code.
- using pnt_integrity::CodeFreqMap = std::map< int, Eigen::ArrayXcf >

  A map for holding frequency bin values.
- using pnt_integrity::CodeFreqMapEntry = std::pair< int, Eigen::ArrayXcf >

  A pair for holding a frequency bin number its values.
- using pnt_integrity::CorrelationResultsMap = std::map< int, Eigen::ArrayXXf >

  A map that stores the correlation results for a prn.
- using pnt_integrity::PeakResultsMap = std::map< int, std::pair< double, double > >
- using pnt_integrity::PrnList = std::vector< int >

  A vector type for a list of prns.

Variables

- const std::string pnt_integrity::INTEGRITY_ACQ_PEAK_VALS = "INTEGRITY_ACQ_PEAK_VALS"

  String ID for the ACQ check peak vals.
- const std::string pnt_integrity::INTEGRITY_ACQ_PEAK1_KEY = "INT_ACQ_PEAK1_"

  String ID for the ACQ check peak 1 key.
- const std::string pnt_integrity::INTEGRITY_ACQ_PEAK2_KEY = "INT_ACQ_PEAK2_"

  String ID for the ACQ check peak 2 key.
- const std::string pnt_integrity::INTEGRITY_ACQ_DIAGNOSTICS = "INTEGRITY_ACQ_DIAGNOSTICS"

  String ID for the ACQ check diagnostic data.
- const std::string pnt_integrity::INT_ACQ_DIAG_HI_PWR_THRESH = "INT_ACQ_DIAG_HI_PWR_THRESH"

  String ID for the ACQ check high power threshold.
- const std::string pnt_integrity::INT_ACQ_DIAG_PEAK_RATIO_THRESH

  String ID for the ACQ check peak ratio threshold.
- const std::string pnt_integrity::INT_ACQ_DIAG_ACQ_THRESH = "INT_ACQ_DIAG_ACQ_THRESH"

  String ID for the ACQ check acquisition threshold.
- const std::string pnt_integrity::INT_ACQ_DIAG_ITHRESH = "INT_ACQ_DIAG_ITHRESH"

  String ID for the ACQ check survey inconsistent thresh.
- const std::string pnt_integrity::INT_ACQ_DIAG_UTHRESH = "INT_ACQ_DIAG_UTHRESH"

  String ID for the ACQ check survey unassured thresh.
- const std::string pnt_integrity::INT_ACQ_DIAG_ICOUNT = "INT_ACQ_DIAG_ICOUNT"

  String ID for the ACQ check survey inconsistent count.
- const std::string pnt_integrity::INT_ACQ_DIAG_UCOUNT = "INT_ACQ_DIAG_UCOUNT"

  String ID for the ACQ check survey unassured count.
- const std::string pnt_integrity::INT_ACQ_DIAG_PEAK_RATIO_KEY = "INT_ACQ_DIAG_PEAK_RATIO_KEY↩_"

  String ID for the ACQ check survey peak ratio key.

9.1.1 Detailed Description

Class defined for the acquisition level checks.

Author

Josh Clanton josh.clanton@is4s.com

Date

September 30, 2019

9.2 include/pnt_integrity/AgcCheck.hpp File Reference

Class defined for the AGC check.

```
#include "pnt_integrity/AssuranceCheck.hpp"
```

Classes

- struct pnt_integrity::AgcCheckDiagnostics

  Diagnostic data for AGC check.
- class pnt_integrity::AgcCheck

  Class implementation for the AGC check.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Variables

- const std::string pnt_integrity::INTEGRITY_AGC_DIAGNOSTICS = "INTEGRITY_AGC_DIAGNOSTICS"

  String ID for the AGC check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_AGC_DIAG_ITHRESH = "INTEGRITY_AGC_DIAG_ITHRESH"

  String ID for the AGC check survey inconsistent thresh.

9.2.1 Detailed Description

Class defined for the AGC check.

Author

Josh Clanton josh.clanton@is4s.com

Date

February 18, 2020

9.3 include/pnt_integrity/AngleOfArrivalCheck.hpp File Reference

AssurancCheck class defined for the angle of arrival check.

```
#include <chrono>
#include "pnt_integrity/AssuranceCheck.hpp"
#include "pnt_integrity/IntegrityData.hpp"
```

Classes

- struct pnt_integrity::AoaCheckDiagnostics
  Structure used to publish diagnostic data.
- class pnt_integrity::AngleOfArrivalCheck
  Class implementation for the angle of arrival check.

Namespaces

- pnt_integrity
  Namespace for all pnt_integrity applications.

Typedefs

- using pnt_integrity::SingleDiffMap = std::map< int, double >
  Defines a type that maps PRN to a calculated difference.
- using pnt_integrity::PrnAssuranceEachNode = std::map< int, std::vector< data::AssuranceLevel > >
  Defines a map that holds an assurance level for each prn for each node.

Enumerations

- enum pnt_integrity::AoaCheckData { **UsePseudorange** = 0, **UseCarrierPhase**, **UseBoth** }
  Enumeration to indicate what data field to use for the AOA check.

Variables

- const std::string pnt_integrity::INTEGRITY_AOA_DIFF_DIAGNOSTICS
  String ID for the AOA check difference diagnostic data.
- const std::string pnt_integrity::INTEGRITY_AOA_DIFF_NODE_ID = "INTEGRITY_AOA_DIFF_NODE_ID"
  String ID for the AOA check diagnostic node id.
- const std::string pnt_integrity::INTEGRITY_AOA_DIAGNOSTICS = "INTEGRITY_AOA_DIAGNOSTICS"
  String ID for the AOA check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_AOA_DIAG_DIFF_THRESH
  String ID for the AOA check diagnostic difference threshold.
- const std::string pnt_integrity::INTEGRITY_AOA_DIAG_SUSPECT_PRN_COUNT
  String ID for the AOA check diagnostic suspect prn count.
- const std::string pnt_integrity::INTEGRITY_AOA_DIAG_ITHRESH = "INTEGRITY_AOA_DIAG_ITHRESH"
  String ID for the AOA check survey inconsistent thresh.
- const std::string pnt_integrity::INTEGRITY_AOA_DIAG_UTHRESH = "INTEGRITY_AOA_DIAG_UTHRESH"
  String ID for the AOA check survey unassured thresh.

9.3.1 Detailed Description

AssurancCheck class defined for the angle of arrival check.

Author

Josh Clanton josh.clanton@is4s.com

Date

June 3, 2019

9.4 include/pnt_integrity/AssuranceCheck.hpp File Reference

Base / parent class for a PNT assurance check.

```
#include "if_data_utils/IFSampleData.hpp"
#include "logutils/logutils.hpp"
#include "pnt_integrity/IntegrityData.hpp"
#include "pnt_integrity/IntegrityDataRepository.hpp"
```

Classes

- class pnt_integrity::AssuranceCheck
  Parent class for all integrity checks.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Typedefs

- using pnt_integrity::MultiPrnAssuranceMap = std::map< int, data::AssuranceLevel >

  A map for pairing an assurance level to each PRN.

9.4.1 Detailed Description

Base / parent class for a PNT assurance check.

Author

Josh Clanton josh.clanton@is4s.com

Date

May 28, 2019

9.5 include/pnt_integrity/ClockBiasCheck.hpp File Reference

AssurancCheck class defined for the clock bias check.

```
#include <cstring>
#include "pnt_integrity/AssuranceCheck.hpp"
```

Classes

- struct pnt_integrity::ClockBiasCheckDiagnostics

  Structure used to publish diagnostic data.
- class pnt_integrity::ClockBiasCheck

  Class implementation for the position velocity check.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Variables

- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAGNOSTICS

  String ID for the clock-bias check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT

  String ID for the clock-bias check expected drift.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_EXP_DRIFT_VAR

  String ID for the clock-bias check drift variance.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_PROP_OFFSET

  String ID for the clock-bias check propagation offset.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_ACTUAL_OFFSET

  String ID for the clock-bias check actual offset.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_OFFSET_ERROR

  String ID for the clock-bias check offset error.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_BOUND

  String ID for the clock-bias check drift rate bound.
- const std::string pnt_integrity::INTEGRITY_CLOCK_BIAS_DIAG_DRIFT_RATE_VAR_BOUND

  String ID for the clock-bias check drift rate var bound.

9.5.1 Detailed Description

AssurancCheck class defined for the clock bias check.

Author

Josh Clanton josh.clanton@is4s.com
John David Sprunger jss0027@tigermail.auburn.edu

Date

December 17, 2019

9.6 include/pnt_integrity/CnoCheck.hpp File Reference

Class defined for the carrier-to-noise ratio (Cno) checks.

```
#include "pnt_integrity/AssuranceCheck.hpp"
```

Classes

- struct pnt_integrity::CnoCheckDiagnostics

  Diagnostic data for the check.
- class pnt_integrity::CnoCheck

  Class implementation of the carrier-to-noise (CnO) assurance check. The check analyzes the CnO values for abnormalities.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Variables

- const std::string pnt_integrity::INTEGRITY_CN0_DIAGNOSTICS = "INTEGRITY_CN0_DIAGNOSTICS"

  String ID for the CNO check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_CN0_DIAG_AVG_COUNT = "INTEGRITY_CN0_DIAG_AVG_CO↩ UNT"

  String ID for the CNO check average count.
- const std::string pnt_integrity::INTEGRITY_CN0_DIAG_ITHRESH = "INTEGRITY_CN0_DIAG_ITHRESH"

  String ID for the CNO check survey inconsistent thresh.
- const std::string pnt_integrity::INTEGRITY_CN0_DIAG_UTHRESH = "INTEGRITY_CN0_DIAG_UTHRESH"

  String ID for the CNO check survey unassured thresh.

9.6.1 Detailed Description

Class defined for the carrier-to-noise ratio (Cno) checks.

Author

Josh Clanton josh.clanton@is4s.com

Date

October 23, 2019

9.7 include/pnt_integrity/IntegrityData.hpp File Reference

Defines all data types and structure definitions.

```
#include <cmath>
#include <cstdint>
#include <iostream>
#include <limits>
#include <map>
#include <string>
#include <vector>
```

Classes

- struct pnt_integrity::data::Timestamp

  A timestamp used in all headers.
- struct pnt_integrity::data::GNSSTime

  A GNSS time.
- struct pnt_integrity::data::Header

  The header used for all associated data types.
- struct pnt_integrity::data::ClockOffset

  A structure for measuring the offset between two clocks.
- class pnt_integrity::data::AssuranceState

  A structure to hold an AssuranceLevel and value.
- struct pnt_integrity::data::AssuranceReport

  A structure to hold a single assurance report.
- struct pnt_integrity::data::AssuranceReports

  A structure to hold assurance data for all registered checks.
- struct pnt_integrity::data::GNSSObservable

  A structure for pseudorange observables.
- struct pnt_integrity::data::GNSSObservables

  The GNSSObservables message.
- struct pnt_integrity::data::GeodeticPosition3d

  A structure to represent 3D geodetic position.
- struct pnt_integrity::data::PositionVelocity

  A structure to represent a Position / Velocity message.
- struct pnt_integrity::data::AccumulatedDistranceTraveled

  A structure that represents a distance traveled over a time period.
- struct pnt_integrity::data::IMU

  A structure that represents IMU measurement data.
- struct pnt_integrity::data::MeasuredRange

  A structure that represents a distance measurement to a known point.
- struct pnt_integrity::data::AgcValue

  A structure to represent an AGC measurement.
- struct pnt_integrity::data::KeyValue

  A structure for key value pairs.
- struct pnt_integrity::data::Diagnostics

  A structure for general diagnostic messages.
- struct pnt_integrity::data::EventLog

  Structure for event log messages.
- struct pnt_integrity::data::CommandResponse

  A structure for command / response messages.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.
- pnt_integrity::data

  Namespace for all integrity data definitions.

Typedefs

- using pnt_integrity::data::GNSSObservableMap = std::map< uint64_t, GNSSObservable >

  A map to relate a GNSSObservable to a PRN.

Enumerations

- enum pnt_integrity::data::TimeSystem { **GLO** = 0, **GPS**, **GAL**, **BDT** }

  Enumeration for all available satellite-based time system sources.
- enum pnt_integrity::data::SatelliteSystem : uint8_t {
  GPS = 0, **Glonass**, **Galileo**, **QZSS**,
  BeiDou, **IRNSS**, **SBAS**, **Mixed**,
  Other }

  Enumeration for satellite system identification.
- enum pnt_integrity::data::FrequencyBand : uint8_t {
  Band1 = 0, **Band2**, **Band5**, **Band6**,
  Band7, **Band8**, **Band9**, **Band0**,
  Band10 }

  Defines all possible frequency types.
- enum pnt_integrity::data::CodeType : uint8_t {
  SigP = 0, **SigC**, **SigD**, **SigY**,
  SigM, **SigN**, **SigA**, **SigB**,
  SigI, **SigQ**, **SigS**, **SigL**,
  SigX, **SigW**, **SigZ**, **SigBLANK** }

  Defines all possible code types.
- enum pnt_integrity::data::AssuranceLevel : int8_t { **Unavailable** = 0, **Unassured**, **Inconsistent**, **Assured** }

  Defines all available assurance level values.
- enum pnt_integrity::data::LevelEnum { **DIAG_OK** = 0, **DIAG_WARN**, **DIAG_ERROR**, **DIAG_STALE** }

  An enumeration for diagnostic level.
- enum pnt_integrity::data::EventLogType {
  NotSet = 0, **Debug**, **Info**, **Warning**,
  Error, **Critical** }

  An enumeration for event log type.
- enum pnt_integrity::data::CommandResponseType { **COMMAND** = 0, **RESPONSE** }

  The command / response type enumeration.

9.7.1 Detailed Description

Defines all data types and structure definitions.

Author

Josh Clanton josh.clanton@is4s.com

Date

May 28, 2019

9.8 include/pnt_integrity/IntegrityDataRepository.hpp File Reference

Defines the IntegrityDataRepository class in pnt_integrity.

```
#include <atomic>
#include <deque>
#include <iostream>
#include <sstream>
#include <vector>
#include <mutex>
#include "logutils/logutils.hpp"
#include "pnt_integrity/RepositoryEntry.hpp"
```

Classes

- struct pnt_integrity::TimeEntry

  Structure for a time entry into the repository.
- class pnt_integrity::IntegrityDataRepository

  Class definition for the history of data at a single PNT node.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Typedefs

- using pnt_integrity::RemoteRepoEntries = std::map< std::string, RepositoryEntry >

  A type to map remote entries to their node name / device id.
- using pnt_integrity::TimeEntryHistory = std::map< double, TimeEntry >

9.8.1 Detailed Description

Defines the IntegrityDataRepository class in pnt_integrity.

Author

Josh Clanton josh.clanton@is4s.com

Date

May 28, 2019

9.9 include/pnt_integrity/IntegrityMonitor.hpp File Reference

Defines the IntegrityMonitor class in pnt_integrity.

```
#include "logutils/logutils.hpp"
#include "pnt_integrity/AssuranceCheck.hpp"
#include <iomanip>
#include <memory>
#include <sstream>
#include <vector>
#include <mutex>
#include <shared_mutex>
```

Classes

- class pnt_integrity::IntegrityMonitor

  Class implementation of integrity monitoring using AssuranceChecks and IntegrityData.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Typedefs

- using pnt_integrity::AssuranceChecks = std::map< std::string, AssuranceCheck * >

  A vector type for a collection of AssuranceChecks.

9.9.1 Detailed Description

Defines the IntegrityMonitor class in pnt_integrity.

Author

Josh Clanton josh.clanton@is4s.com

Date

May 28, 2019

9.10 include/pnt_integrity/PositionJumpCheck.hpp File Reference

AssuranceCheck class defined for the position jump check.

```
#include "pnt_integrity/AssuranceCheck.hpp"
#include "pnt_integrity/GeodeticConverter.hpp"
```

Classes

- struct pnt_integrity::PosJumpCheckDiagnostics

  Structure for check diagnostics.
- class pnt_integrity::PositionJumpCheck

  Class implementation for the position-jump check.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Variables

- const std::string pnt_integrity::INTEGRITY_POS_JUMP_DIAGNOSTICS

  String ID for the position-jump check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_POS_JUMP_DIAG_BOUND

  String ID for the position-jump check bound.
- const std::string pnt_integrity::INTEGRITY_POS_JUMP_DIAG_DIST = "INTEGRITY_POS_JUMP_DIAG_DIST"

  String ID for the position-jump check distance.

9.10.1 Detailed Description

AssuranceCheck class defined for the position jump check.

Author

Will Travis will.travis@is4s.com
Josh Clanton josh.clanton@is4s.com

Date

November 27, 2019

9.11 include/pnt_integrity/PositionVelocityConsistencyCheck.hpp File Reference

AssurancCheck class defined for the position velocity consistency check.

```
#include <cstring>
#include "pnt_integrity/AssuranceCheck.hpp"
```

Classes

- struct pnt_integrity::PosVelConsCheckDiagnostics
  Structure used to publish diagnostic data.
- class pnt_integrity::PositionVelocityConsistencyCheck
  Class implementation for the position velocity check.

Namespaces

- pnt_integrity
  Namespace for all pnt_integrity applications.

Variables

- const std::string pnt_integrity::INTEGRITY_PVC_DIAGNOSTICS = "INTEGRITY_PVC_DIAGNOSTICS"
  String ID for the position-velocity consistent check diagnostics data.
- const std::string pnt_integrity::INTEGRITY_PVC_DIAG_PB = "INTEGRITY_PVC_DIAG_PB"
  String ID for PVC diagnostic key for the "percent bad" variable.
- const std::string pnt_integrity::INTEGRITY_PVC_DIAG_ITHRESH = "INTEGRITY_PVC_DIAG_ITHRESH"
  String ID for the PVC diagnostic key for the inconsistent threshold.
- const std::string pnt_integrity::INTEGRITY_PVC_DIAG_UTHRESH = "INTEGRITY_PVC_DIAG_UTHRESH"
  String ID for the PVC diagnostic key for the unassured threshold.
- const std::string pnt_integrity::INTEGRITY_PVC_DIAG_ERR_VAL = "INTEGRITY_PVC_DIAG_ERR_VAL"
  String ID for the PVC diagnostic key for error values.
- const std::string pnt_integrity::INTEGRITY_PVC_DIAG_ERR_THRESH
  String ID for the PVC diagnostic key for error thresh values.

9.11.1 Detailed Description

AssurancCheck class defined for the position velocity consistency check.

Author

Josh Clanton josh.clanton@is4s.com
John David Sprunger jss0027@tigermail.auburn.edu

Date

September 18, 2019

9.12 include/pnt_integrity/RangePositionCheck.hpp File Reference

AssurancCheck class defined for the range / position check.

```
#include "pnt_integrity/AssuranceCheck.hpp"
```

Classes

- struct pnt_integrity::RngPosCheckNodeDiagnostic
  Structure for check diagnostics.
- class pnt_integrity::RangePositionCheck
  Class implementation for the range / position check.

Namespaces

- pnt_integrity
  Namespace for all pnt_integrity applications.

Typedefs

- using pnt_integrity::RngPosCheckDiagnostics = std::map< std::string, RngPosCheckNodeDiagnostic >
  Defined type for check diagnostics.

Variables

- const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAGNOSTICS
  String ID for the range-position check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MAX_CALC
  String ID for the range-position check max calculated range.
- const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MIN_CALC
  String ID for the range-position check min calculated range.
- const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MAX_MEAS
  String ID for the range-position check max measured range.
- const std::string pnt_integrity::INTEGRITY_RNG_POS_DIAG_MIN_MEAS
  String ID for the range-position check min measured range.
- const double pnt_integrity::pi = 3.1415926535898
  Definition of 'pi' to use in this check.
- const double pnt_integrity::deg2rad = pi / 180.0
  Convenience constant for 1/2 pi.
- const double pnt_integrity::rad2deg = 1.0 / deg2rad
  Convenience converter for radians to degrees.

9.12.1 Detailed Description

AssurancCheck class defined for the range / position check.

Author

Josh Clanton josh.clanton@is4s.com

Date

June 11, 2019

9.13 include/pnt_integrity/RepositoryEntry.hpp File Reference

Defines the RepositoryEntry class in pnt_integrity.

```
#include <cmath>
#include <functional>
#include <map>
#include <string>
#include <vector>
#include "logutils/logutils.hpp"
#include "pnt_integrity/IntegrityData.hpp"
```

Classes

- class pnt_integrity::RepositoryEntry

  Class definition for an entry into the repository.

Namespaces

- pnt_integrity

  Namespace for all pnt_integrity applications.

Enumerations

- enum pnt_integrity::DataLocaleType { **Local** = 0, **Remote** = 1 }

  Defines the possible observable types.

9.13.1 Detailed Description

Defines the RepositoryEntry class in pnt_integrity.

Author

Josh Clanton josh.clanton@is4s.com

Date

May 28, 2019

9.14 include/pnt_integrity/StaticPositionCheck.hpp File Reference

AssurancCheck class defined for the static position check.

```
#include <cstring>
#include "pnt_integrity/AssuranceCheck.hpp"
```

Classes

- struct pnt_integrity::StaticPosCheckDiagnostics
  Structure used to publish diagnostic data.
- class pnt_integrity::StaticPositionCheck
  Class implementation for the static-position check.

Namespaces

- pnt_integrity
  Namespace for all pnt_integrity applications.

Variables

- const std::string pnt_integrity::INTEGRITY_STATIC_POS_DIAGNOSTICS
  String ID for the static position check diagnostic data.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_LAT
  String ID for the static position check survey latitude.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_LON
  String ID for the static position check survey longitdue.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_ALT
  String ID for the static position check survey altitude.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_POS_CHNG_THRESH
  String ID for the static position check change threshold.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_PERCENT_OVER
  String ID for the static position check percentage threshold.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_ITHRESH
  String ID for the static position check survey inconsistent thresh.
- const std::string pnt_integrity::INTEGRITY_STAIC_POS_DIAG_UTHRESH
  String ID for the static position check survey unassured thresh.

9.14.1 Detailed Description

AssurancCheck class defined for the static position check.

Author

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Date

September 3, 2019

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