Data Quality Handling in proDAS

This document provides an explanation of the data validity system in proDAS, and indicates how proDAS will determine if the quality associated to acquired data is GOOD, BAD or SUSPECT.

1. The quality flag in proDAS conveys one of the following three states:
    - GOOD
    - SUSPECT
    - BAD

    GOOD represents the best quality for the associated channel value, and BAD the worst quality. SUSPECT data quality provides a warning that the associated channel value can not be completely trusted.

2. In general, there is a user quality, a hardware quality and an overall quality in proDAS.

3. **proDAS User quality** is broken down into the current ceiling and the user ceiling. Both the user ceiling and the current ceiling are initialised from the channel configuration data, and are specified in the **QUALITY CEILING** field that is part of the generic channel definition columns in the channel editor. The current ceiling can be modified from the Limits and Actions subsystem, via specific actions. The user ceiling can be modified from the Management GUI using the Set Channel panel. The **proDAS User quality** is represented as the worst of these two ceilings.

4. **proDAS hardware quality** can only be changed by hardware subsystems, and reflects the quality of the data being received by these subsystems.

5. **proDAS overall quality** is represented as the worst of user quality and hardware quality.

6. Once the overall quality of a channel is flagged as BAD, the channel value is automatically set to BAD_VALUE, which represents a value of -99999.0.

7. The user can check the overall quality of a channel by viewing the channel in a DataViews page or in a spotlight sticky window. From either of these display windows, the user can also select to view additional channel information, which will always include the overall channel quality. The transition of a channel value to BAD_VALUE can also indicate that the channel has gone BAD.

8. If a user utilises the Set Channel panel on the Management GUI to redirect a user-entered value to the selected channel, the quality of the selected channel will be changed to SUSPECT to indicate the redirection (over-ride of value).

    If a user utilises the Set Channel panel on the Management GUI to redirect a different channel's value to the selected channel, the quality of the selected channel will be updated based on the

quality of the redirected channel. If the redirected channel has a quality of GOOD or SUSPECT, the selected channel's quality will be set to SUSPECT to indicate the redirection. If the redirected channel has a quality of BAD, the selected channel's quality will also be set to BAD.

9. In transient logs, the current overall channel quality is recorded along with the channel value. In steady-state fullsets, the fullset channel quality takes on the worst overall quality of the individual readings being averaged.

10. Calculated channels will be flagged as BAD if the overall quality of any of the reference channels being evaluated in the equation is BAD. Calculated channels will be flagged as SUSPECT if the overall quality of any of the reference channels being evaluated in the equation is SUSPECT, and no reference channels are BAD quality.

    This behaviour can be over-ridden using the *propagated_quality* configuration parameter in the Calculated subsystem section of the RTE .config file. If *propagated_quality* is set to SUSPECT, then calculated channels will be flagged as SUSPECT if the overall quality of any of the reference channels being evaluated in the equation is either SUSPECT or BAD.

    If the evaluation of any calculated expression results in an error (e.g. lookup table access outside the bounds of the break point table, or trying to get the square root of a negative number), the quality of the calculated channel is set to BAD.

    If the calculated expression evaluates correctly, and the overall quality of all the reference channels being evaluated in the expression is GOOD, then the quality of the calculated channel is set to GOOD.

11. Channels can be assigned generic sensor data – both calibration sensor data and fixed sensor data. If a channel has generic sensor data associated with it, the channel's hardware quality will be changed to BAD if it fails to get EU data from the generic sensor tables.

12. Hardware subsystems will flag channel data as GOOD quality if they are receiving valid readings from the hardware that they are interfacing with. BAD quality is used to indicate situations where the subsystem fails to configure properly (goes off-line), if the specific channel fails to configure, or if hardware errors prevent the subsystem from either receiving or sending data, for an individual channel, or for all channels belonging to the subsystem.

    Hardware subsystems that transmit data to other systems will normally set the quality of these output channels to the quality of the associated reference channel, whose value is used to send data to the other system.

    Following are some specific examples of data quality handling in hardware subsystems, with a

special emphasis on the subsystems that use SUSPECT data quality indications.

13. The HPVXI hardware includes six separate subsystems: VXI (analogue inputs from the VT1413, VT1415 and VT1419 cards), GASSAI (analogue inputs from the VT1413 card), GASSTC (totaliser analogue inputs from the VT1415 card), GASSDIO (discrete inputs and outputs from the E1458 card), GASSAO (analogue outputs on the E1418 card), and HSV (high speed analogue inputs from the VT1413 card).

    13.1. For the VXI, GASSAI, GASSTC and HSV subsystems, a channel is flagged with a BAD hardware data quality if:
    - It is not configured properly,
    - If there are any hardware errors with the card,
    - If the raw value retrieved from the card is outside very large limits, or
    - If the EU conversion of the raw value fails.

    In addition, for the VXI, GASSAI and HSV subsystems, if the EU conversion results in an extrapolation of a pre-defined percentage (this is configurable) beyond the existing break-point table, then the hardware data quality can be set to a configurable value (one of GOOD, SUSPECT or BAD). Otherwise, if the EU conversion is successful, the hardware data quality for the channel is set to GOOD.

    For the GASSTC subsystem, if the EU conversion results in an extrapolation of the existing break-point table, then the hardware data quality is set to BAD.

    For VXI and HSV subsystems that have a thermocouple channel configured using a reference RTD channel, the hardware quality of the thermocouple channel will be set to SUSPECT if the RTD channel has SUSPECT quality, and the hardware quality of the thermocouple channel will be set to BAD if the RTD channel has BAD quality.

    13.2. For the GASSDIO subsystem, a channel is flagged with a BAD hardware data quality if the channel is not configured properly. For discrete inputs, the channel is flagged with BAD hardware data quality if any errors occur in retrieving the data from the card. Otherwise the quality is set to GOOD. For discrete outputs, the channel's hardware data quality is set to the quality of the reference channel whose value is being used to send the data.

    13.3. For the GASSAO subsystem, the channel hardware data quality is based on the reference channel. If no reference channel is specified, the hardware data quality is set to GOOD. If the reference channel has BAD data quality, the channel's hardware data quality is set to BAD. If the reference channel value exceeds the limits of the analogue output card, the channel's hardware data quality is set to BAD. Otherwise, the channel takes on the quality of the reference channel.

13. For the Pressure Brick subsystem (PBS), DSA Pressure Scanning (DPS) subsystem, and DTCI subsystem, a channel is flagged with a BAD hardware data quality if the associated pressure scanner is not configured or not communicating. Otherwise, the channel will have a GOOD hardware data quality.

    The one exception to this is if the pressure channel has an associated reference ambient pressure channel. In this case, the value of the reference ambient pressure channel is added to the pressure channel value to obtain an absolute pressure reading, only if the quality of the ambient pressure channel is GOOD or SUSPECT. The pressure channel's hardware quality will be set to GOOD if the ambient channel's quality is GOOD, and set to SUSPECT if the ambient channel's quality is either SUSPECT or BAD.

14. For the ARINC subsystem, if BCD channel data is received with an SSM (Sign Status Matrix) indicating NCD (No Computed Data) or FT (Functional Test), the hardware quality of the channel is set to SUSPECT.

    If BNR or Discrete channel data is received with an SSM that does not match the expected SSM as defined in the channel configuration data, then the hardware quality of the channel is set to BAD. This behaviour can be over-ridden using the *ignore_SSM* configuration parameter in the ARINC subsystem section of the RTE .config file. If *ignore_SSM* is set to TRUE, then these BNR and Discrete channels will be flagged as SUSPECT if the SSM value being received is not the expected value.

15. For the HYSCAN subsystem, the processing for ABS (Absolute) type channels is similar to the processing in the PBS subsystem for the reference ambient pressure channel. The ABS type channels refer to a reference channel (the value originates with a 9032 scanner) used to convert the differential HYSCAN reading into an absolute reading.

    The value of the reference pressure channel is added to the pressure channel value to obtain an absolute pressure reading, only if the quality of the reference pressure channel is GOOD or SUSPECT. The pressure channel's hardware quality will be set to GOOD if the reference channel's quality is GOOD, and set to SUSPECT if the reference channel's quality is either SUSPECT or BAD.

16. For the PWM subsystem, if the received data contains any parity, framing, over-run, or block errors, but can still be processed, all channels belonging to the subsystem are set to a SUSPECT hardware quality.

17. For the THRUST and THRUST_ES subsystems, if communication is temporarily lost with a WEI unit, the hardware quality of the corresponding channel will be set to a pre-configured quality – either GOOD, SUSPECT or BAD.

18. For the THRUST 55 subsystem, if the retrieved health channel indicates an error state, then all the retrieved channels are set to a hardware quality of SUSPECT.

19. For the RTP subsystem, critical data is being exchanged between proDAS and the RTP system. There is no provision for transferring data quality in the RTP protocol. A convention has been established within proDAS that if the subsystem were to receive a channel with a BAD_VALUE, that the channel would be set to a hardware quality of BAD. Similarly, if proDAS were transmitting a channel value that was BAD quality, the subsystem would transmit a BAD_VALUE reading. This same convention can be used in the RTP system.

20. For the FTOTS subsystem, if communication is temporarily lost with the FTOTS device, the channel hardware quality will be set to SUSPECT; it will be set to BAD if it exceeds its tolerable duration.

21. For the M1553 subsystem, if the monitored M1553 message status indicates any error other than "NO_RESPONSE" or "DATA COUNT ERROR", the hardware quality of the corresponding channel will be set to SUSPECT; otherwise, it will be set to BAD. The hardware quality of the channel will also be set to SUSPECT if the data response time exceeds the user defined one.

22. For the UTR Halfbox subsystem, if either of the bridge input or bridge output voltage channels are BAD value, then the corresponding UTR channel will have its hardware quality set to BAD. If either of the bridge input or bridge output voltage channels have an overall quality of SUSPECT, then the corresponding UTR channel will have its hardware quality set to SUSPECT.

23. For the Mechanical Scanivalve subsystem (MSS), if the port home position zero pressure value has a SUSPECT quality, or if the zero pressure reading exceeds the tolerance value, then all associated pressure readings for that port will be flagged with a SUSPECT hardware quality. In addition, if an ambient channel is associated to the pressure channel and its quality is set to BAD or SUSPECT, the pressure channel will have its hardware quality set to SUSPECT.

24. For the Consort subsystem, if the channel type defined in the configuration (ie. FLOAT or DISCRETE) doesn't match with the one returned from the Consort system, the corresponding channel hardware quality will be set to SUSPECT.

25. For the TSM subsystem, if the UTR associated to the temperature channel is in an alarm state indicating it is not within tolerance of the other UTR readings on the scanner, the corresponding temperature channel hardware quality will be set to SUSPECT. If the TSM subsystem was unable to read the gain factor for a voltage channel, the corresponding voltage channel hardware quality will be set to SUSPECT. A temperature channel will be flagged with a BAD hardware quality if the channel receives out of range data, based on the sensor type of the channel.

26. For the Thrust Generic (THG) subsystem, if communication is temporarily lost with a master or working load cell signal conditioning unit, the hardware quality of the corresponding channel will be set to SUSPECT.

27. For the DTS3250 subsystem (DTS), a channel is flagged with a BAD hardware quality if the associated DTS3250 scanner is not configured or not communicating. A channel can also be flagged with a BAD hardware quality if the channel has failed the A/D diagnostic or if the channel T/C has been identified to be in an open circuit condition as part of the open circuit test for the scanner. A channel is flagged with a Suspect hardware quality if the channel is reported by the scanner to be in either an over limit violation or under limit violation, based on the limit values downloaded to the scanner.

28. For the OPC subsystem, a channel is flagged with a BAD hardware data quality if the associated OPC server is not configured or not communicating. Otherwise, the channel will have a GOOD hardware data quality.

29. For the VEXA subsystem, if the subsystem fails to get the channel reading from the scanner at its specified scan rate, the hardware quality of the corresponding channel will be set to SUSPECT. If the subsystem fails to get the channel reading for more than 5 seconds, the hardware quality will then be set to BAD.