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Data Stewardship Maturity Report for Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys

Table 1 Legend				
Level 1	Level 2	Level 3	Level 4	Level 5
Ad Hoc	Minimal	Intermediate	Advanced	Optimal
Little or no management	Limited Management	Defined Management, partially implemented	Well-defined Management, fully implemented	Full Management, audited, measured, controlled

Table 1. Scores for the Nine DSMM Key Components at a Glance		
Preservability - 5	Accessibility - 5	Usability - 3.5
Production Sustainability - 5	Data Quality Assurance - 4	Data Quality Control/Monitoring - 3.5
Data Quality Assessment - 3	Transparency/Traceability - 2.25	Data Integrity - 3

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Cover Image: Data Stewardship Rating Diagram for Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys

Shades of green are used to represent level 1 through level 5 ratings; denoting Ad Hoc, Minimal, Intermediate, Advanced, and Optimal stages for each of the nine key components, respectively. The dark green level indicates all the practices are completely satisfied. The lighter green levels indicate only some of the practices are satisfied. The lightest green level indicates none of the practices are satisfied.

The stewardship maturity of NCEI data product, Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys, is assessed based on a reference stewardship maturity framework. The current maturity ratings of Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys are at Level 1 or higher for all nine key components with zero Level 1, one Level 2, four Level 3, one Level 4, and three Level 5 key components.

NOAA Technical Memorandum Series
National Environmental Satellite, Data, and Information Service

The National Environmental Satellite, Data, and Information Service (NESDIS) manages the Nation's civil Earth-observing satellite systems, as well as global national data bases for meteorology, oceanography, geophysics, and solar-terrestrial sciences. From these sources, it develops and disseminates environmental data and information products critical to the protection of life and property, national defense, and the national economy, energy development and distribution, global food supplies, and the development of natural resources.

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Data Stewardship Maturity Report for Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys

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Preface

In response to the President's Open Government Initiative and related policies, NOAA has committed to providing improved public access to all of its environmental information, to enable research and commercial innovation through ease of data discovery and use [*Casey*, 2016].

OneStop supports NOAA's efforts by leveraging existing access technologies and infusing specific innovations to provide improved discover, access, and visualization services for NOAA's data. Also, OneStop is viewed by a NESDIS as a pathfinder effort with an initial focus on selected high-priority datasets from NESDIS and other program data meeting OneStop standards, but eventually scalable across NOAA's data. Lastly, OneStop is implementing the USGEO Common Framework for Earth Observation Data and leveraging/supporting the NOAA Big Data Project (BDP) and Big Earth Data Initiative (BEDI) [*Casey*, 2016].

As with any process of improvement planning, agencies need to find out where they are in terms of their compliance to the federal regulations and what they need to do if any areas of non-compliance are identified. To this end, a unified framework would be beneficial for assessing the current stage of stewardship practices applied to individual datasets and for providing a road map that will guide future investments towards enhanced stewardship of environmental datasets. The value and quality of a dataset depends in part on the stewardship practices applied after its development and production. Therefore, a unified framework providing a holistic view of the quality of stewardship practices applied to individual datasets is beneficial to data stewards and users [*Casey*, 2016].

The data stewardship maturity matrix (DSMM), jointly developed by domain (data management, technology, and science) subject matter experts from NOAA's National Centers for Environmental Information (NCEI) and Cooperative Institute for Climate and Satellites – North Carolina (CICS-NC), provides such a consistent framework [*Peng et al.,* 2016]. The DSMM, leveraging institutional knowledge and community practices and standards, defines a graduated maturity scale for each of nine key components of scientific data stewardship to enable a consistent assessment of the measureable stewardship practices applied to a given data set or product.

The NOAA data stewardship maturity technical series captures stewardship maturity assessment results for individual datasets, provides consistent representation and citable documents of those assessments, ensures transparency, and allows better data quality information integration and content-based search and discovery of NOAA data.

NOAA Technical Report NESDIS DSMR-00009

Data Stewardship Maturity Report for Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys

1. Introduction

1.1 Purpose

The purpose of this document is to describe the results of stewardship maturity assessment for NOAA Climate Data Record for Mean Layer Temperature (Upper Troposphere & Lower Stratosphere from UCAR, Version 2, utilizing the Scientific Data Stewardship Maturity Matrix or DSMM [Peng, et al, 2016]. DSMM defines levels of stewardship maturity stages for Preservability, Accessibility, Usability, Production Sustainability, Data Quality Assurance, Data Quality Control/Monitoring, Data Quality Assessment, Transparency/Traceability, and Data Integrity key components. Each of these components is ranked from 'Ad hoc' to 'Optimal' (see Appendix I). This report is based on evaluation performed by NOAA OneStop metadata specialists working with Subject Matter Experts and utilizing the DSMM template [Peng, 2016].

1.2 Scope

Assessing stewardship maturity - the current state of how datasets are documented, preserved, stewarded, and made accessible publicly, is a critical step towards meeting U.S. federal regulations, organizational requirements, and user needs [Peng et al., 2016]. The goal of this document is to provide consistent and transparent stewardship maturity information to data users and decision-makers.

1.3 Dataset Abstract

The National Data Buoy Center (NDBC) established the Coastal-Marine Automated Network (C-MAN) for the National Weather Service in the early 1980's. NDBC has installed approximately 50 C-MAN stations on lighthouses, at capes and beaches, on near shore islands, and on offshore platforms. NDBC has also deployed over 100 moored (a.k.a., weather) buoys in coastal and offshore waters from the western Atlantic to the Pacific Ocean around Hawaii, and from the Bering Sea to the South Pacific. C-MAN and moored buoy data typically include barometric pressure, wind direction, speed and gust, and air temperature; however, some C-MAN stations are equipped to also measure seawater temperature, water level, waves, and relative humidity. Moored buoys measure wave energy spectra from which NDBC derives significant wave height, dominant wave period, and average wave period. In addition, many moored buoys measure the direction of wave propagation. In collaboration, NDBC and the National Centers for Environmental Information (NCEI) -- formerly the National

Oceanographic Data Center (NODC) -- are archiving these data from C-MAN and moored buoys. This collection is part of the collaboration and it contains both NODC F291 and netCDF (version 4) files with data collected from February 1970 through the present day.

1.4 Document Maintenance

This document is generated and maintained by NOAA's National Centers for Environmental Information. More on policy is available at https://www.ncei.noaa.gov/.

2. Results

The data stewardship maturity assessment information is summarized in Table 1. Each component is displayed along with its corresponding score in a color-coded table.

Table 2. Dataset and Data Stewardship Maturity Assessment Metadata	
Dataset Title	Meteorological and Oceanographic Data Collected from the National Data Buoy Center Coastal-Marine Automated Network (C-MAN) and Moored (Weather) Buoys
Dataset Information URL	https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.nodc%3ANDBC-CMANWx/html#
Data Provider POC (name; email; Affiliation)	National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce301-713-3277NCEI.Info@noaa.gov
Dataset POC (name; email; affliation)	National Centers for Environmental Information, NESDIS, NOAA, U.S. Department of Commerce301-713-3277NCEI.Info@noaa.gov
SMM Version (Document ID and Version Number)	NCDC-CICS-SMM_0001_Rev.1 12/09/2014
SMM POC (Name; E-mail; Affiliation)	Ge Peng, ge.peng@uah.edu, University of Alabama-Huntsville
SMM Template Version (Document ID and Version Numbers)	NCDC-CICS-SMM_0001_Rev.1 v4.0 06/23/2015
SMM Template POC	Ge Peng, ge.peng@uah.edu, University of Alabama-Huntsville
SMM Assessment Version (v<nn>r<mm>, e.g., v01r00)	V01r03
SMM Assessment Date (MM/DD/YYYY)	04/10/2019
SMM Assessment POC (Name; E-mail; Affiliation)	Raisa Ionin; raisa.ionin@noaa.gov; NOAA’s National Centers of Environmental Information (NCEI); Ge Peng; ge.peng@uah.edu; University of Alabama-Huntsville
Stewardship Maturity Ratings (each key component) (kc1/kc2/kc3/kc4/kc5/kc6/kc7/kc8/kc9)	5 /5 /3.5 /5 /4 /3.5 /3 /2.25 /3
SMM Original Assessment Date (MM/DD/YYYY)	11/08/2016
SMM Original Assessment POC (Name; E-mail; Affiliation)	Raisa Ionin; raisa.ionin@noaa.gov; NOAA’s National Centers of Environmental Information (NCEI)
SMM Last Modified Date (MM/DD/YYYY)	09/01/2021
SMM Last Modification POC (Name; E-mail; Affiliation)	Katy Luquire, catherine.luquire@noaa.gov, CASE Consultants International
SMM Modified Date (MM/DD/YYYY)	04/10/2019
SMM Modification POC (Name; E-mail; Affiliation)	Raisa Ionin; raisa.ionin@noaa.gov; NOAA’s National Centers of Environmental Information (NCEI)

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Preservability	Level 5 ▪ Archived by NCEI, which is NOAA designated repository. NOAA is compliant to NARA standards ▪ Metadata following ISO 19115-2 standards. ▪ Compliant to OIAS RM ▪ Plans to update metadata to ISO 19115-1 at a later date ▪ Using NCEI Silver Spring Archive Management System, AMS. Comments:
Accessibility	Level 5 ▪ Collection level searchable online ▪ Granule level is searchable online ▪ Geoportal: https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/gov.noaa.nodc%3ANDBC-CMANWx/html ▪ Additional search options available from collection level site ▪ Direct file download available from THREDDS: https://www.ncei.noaa.gov/thredds-ocean/catalog/ndbc/cmanwx/catalog.html ▪ HTTP: https://www.ncei.noaa.gov/data/oceans/ndbc/cmanwx/ ▪ FTP: ftp://ftp-oceans.ncei.noaa.gov/pub/data.nodc/ndbc/cmanwx/ ▪ NOAA Marine Environmental Buoy Database: https://www.ncei.noaa.gov/access/marine-environmental-buoy-database/ ▪ Dissemination reports are available ▪ FTP: https://www.nodc.noaa.gov/webstats/cman/ftp/2017/02/cman-ftp.html ▪ THREDDS: ▪ https://www.nodc.noaa.gov/webstats/cman/thredds/2017/02/cman-thredds.html ▪ WWW: https://www.nodc.noaa.gov/webstats/cman/www/2017/02/cman-www.html ▪ Future technology changes are planned. Comments:

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Usability	Level 3.5 ▪ The format is interoperable: NetCDF, nc for granules. ▪ Algorithm is described in the Handbook of Automated Data Quality Control Checks and Procedures: [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ Algorithm is also mentioned in the following publications: ▪ [Gilhousen , 1989] is available online https://www.nodc.noaa.gov/archive/arc0056/0070493/1.1/data/0-data/2ndWaves.pdf ▪ [Gilhousen] available online http://www.ndbc.noaa.gov/realtime.pdf ▪ [Steele, 1985] is available online https://doi.org/10.1109/JOE.1985.1145116 ▪ Multiple data formats: File format description for meteorology, oceanography, and wave spectra data from buoys (National Oceanographic Data Center F291 format) https://www.nodc.noaa.gov/archive/arc0056/0070493/2.2/data/0-data/F291_format.html ▪ No error estimates online ▪ No climatology error estimates ▪ No community metrics of data ▪ No external ranking ▪ No enhanced data visualization. Comments:
Production Sustainability	Level 5 ▪ The data is currently supported. ▪ Long-term National commitment by NOAA Weather Service. ▪ Product improvement process is in place. ▪ Changes for technology planned Comments:
Data Quality Assurance	Level 4 ▪ Data Quality Assurance (DQA) is defined and documented in Handbook of Automated Data Quality Control Checks and Procedures [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ File level quality flags exist which can be considered limited data quality assurance metadata ▪ No External review Comments:

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Data Quality Control/ Monitoring	Level 3.5 ▪ Community Quality Control Metrics are defined, fully implemented and automatic. Documented in Handbook of Automated Data Quality Control Checks and Procedures [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ Anomaly detection for high frequency portion of wave displacement spectra only. ▪ Climatology is used for other oceanographic data anomalies. Anomaly detection for range and spike checks. Comments:

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Data Quality Assessment	Level 3 ▪ Algorithm is described in the Handbook of Automated Data Quality Control Checks and Procedures: [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ Algorithm is also described in the following publications: ▪ [Gilhousen , 1989] is available online https://www.nodc.noaa.gov/archive/arc0056/0070493/1.1/data/0-data/2ndWaves.pdf ▪ [Gilhousen, 1998] available online http://www.ndbc.noaa.gov/realtime.pdf ▪ [Steele, 1985] is available online https://doi.org/10.1109/JOE.1985.1145116 ▪ Research product is assessed. Multiple publications are available: ▪ [Anctil, 1993] is available online https://doi.org/10.1175/1520-0426(1993)010<0097:dwfeot>2.0.co;2] ▪ [Chelton, 1985] is available online https://doi.org/10.1029/jc090ic03p04707] ▪ [Gilhousen , 1989] is available online https://www.nodc.noaa.gov/archive/arc0056/0070493/1.1/data/0-data/2ndWaves.pdf ▪ [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ [Gillhousen, D, 1986] is available online ftp://ftp.nodc.noaa.gov/nodc/archive/arc0056/0070493/1.1/data/0-data/Gilhousen_1986_MDS.pdf ▪ [Gillhousen, D., 1987] is available online http://doi.org/10.1175/1520-0426(1987)004<0094:AFEONM>2.0.CO;2 ▪ [Steele, 1985] is available online https://doi.org/10.1109/JOE.1985.1145116 ▪ [Wilkerson , 1990] is available online https://doi.org/10.1029/jc095ic03p03373 ▪ [Anctil, 1993] is available online https://doi.org/10.1175/1520-0426(1993)010<0097:dwfeot>2.0.co;2 ▪ Operational Product assessed in the following publications: ▪ [Gilhousen , 1989] is available online https://www.nodc.noaa.gov/archive/arc0056/0070493/1.1/data/0-data/2ndWaves.pdf ▪ [Anctil, 1993] is available online https://doi.org/10.1175/1520-0426(1993)010<0097:dwfeot>2.0.co;2 ▪ [Gillhousen, D, 1986] is available online ftp://ftp.nodc.noaa.gov/nodc/archive/arc0056/0070493/1.1/data/0-data/Gilhousen_1986_MDS.pdf ▪ [Gillhousen, D., 1987] is available online http://doi.org/10.1175/1520-0426(1987)004<0094:AFEONM>2.0.CO;2 ▪ [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ [Steele, 1985] is available online https://doi.org/10.1109/JOE.1985.1145116 Comments: Additional publications:{{Chelton, 1985} Chelton, D. B., and P. J. Mccabe (1985), A review of satellite altimeter measurement of sea surface wind

Table 3. Stewardship Maturity Levels and Detailed Justifications for Each of Nine DSMM Key Components for the Dataset.	
DSMM Key Component	Stewardship Maturity Rating, Justification, and Comments
Transparency / Traceability	Level 2.25 ▪ Algorithm is available in the Handbook of Automated Data Quality Control Checks and Procedures: [NDBC, NOAA, 2009] is available online https://www.nodc.noaa.gov/archive/arc0056/0107300/1.1/data/0-data/NDBCHandbookofAutomatedDataQualityControl2009.pdf ▪ Algorithm and product information is also available in the following articles: ▪ [Gilhousen , 1989] is available online https://www.nodc.noaa.gov/archive/arc0056/0070493/1.1/data/0-data/2ndWaves.pdf ▪ [Gilhousen , 1998] available online http://www.ndbc.noaa.gov/realtime.pdf ▪ [Steele, 1985] is available online https://doi.org/10.1109/JOE.1985.1145116 ▪ No Dataset configuration management ▪ No DOI ▪ No UID Comments: Additional publications: {{Chelton, 1985} Chelton, D. B., and P. J. Mccabe (1985), A review of satellite altimeter measurement of sea surface wind speed: With a proposed new algorithm, _Journal of Geophysical Research_, 90(C3), 4707, doi:10.1029/jc090ic03p04707} is available online http://onlinelibrary.wiley.com/doi/10.1029/JC090iC03p04707/abstract }
Data Integrity	Level 3 ▪ Data archive integrity verifiable - Checksum technology is available, each C-MAN/Wx package is accompanied by a manifest in XML format containing hash digests generated using various algorithms, including MD5, SHA-1, SHA-384, etc. That includes checksums (.md5) for every file package. http://www.nodc.noaa.gov/archive/arc0098/0156604/0156604.1.1.xml ▪ Data authenticity is verifiable (since data can be downloaded via HTTPS and HTTPS uses certificates to prove site authenticity) ▪ NCEI-MD does not provide digital signatures for data dissemination Comments:

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Steele, K., J. Lau, and Y.-H. Hsu (1985), Theory and application of calibration techniques for an NDBC directional wave measurements buoy, _IEEE Journal of Oceanic Engineering_, 10(4), 382–396, doi:10.1109/joe.1985.1145116

Appendix I: The Scientific Data Stewardship Maturity Matrix (DSMM)

Table A1: This matrix (Version: NCDC-CICS-SMM-0001-Rev.1. 12/09/2014) describes the criterion used to evaluate data stewardship maturity for each of the nine DSMM key components [*Peng et al.*, 2015].

DSMM Component	**Level 1** ***Ad hoc*** Little or no management	**Level 2** ***Minimal*** Limited management	**Level 3** ***Intermediate*** Defined management, partially implemented	**Level 4** ***Advanced*** Well-defined management, fully implemented	**Level 5** ***Optimal*** Full management, audited, measured, controlled
Preservability *(The state of being preservable)*	Any storage location Data only	Non-designated repository Redundancy Limited archiving metadata	Designated archive Redundancy Community-standard archiving metadata Conforming to limited archiving standards	Level 3 + Conforming to community archiving standards	Level 4 + Archiving process performance controlled, measured, and audited Future archiving standard changes planned
Accessibility *(The state of being searchable and accessible publicly)*	Not publically available person-to-person	Publically available direct file download (e.g., via anonymous FTP server) Collection or dataset level searchable online	Level 2 + Non-standard data service Limited data server performance Granule/file level searchable Limited search metrics	Level 3 + Community-standard data service Enhanced data server performance Conforming to community search metrics Dissemination report metrics defined and implemented internally	Level 4 + Dissemination reports available online Future technology and standard changes planned

Usability *(The state of being easy to use)*	Extensive product-specific knowledge required No documentation online	Non-standard data format Limited documentation (e.g., user's guide online)	Community standard-based interoperable format & metadata Documentation (e.g. source code, product algorithm document, processing or/and data flow diagram) online	Level 3 + Basic capability (e.g., subsetting, aggregating) & data characterization overall/global, e.g., climatology, error estimates) available online	Level 4 + Enhanced online capability (e.g., visualization, multiple data formats) Community metrics of data characterization (regional/cell) online External ranking
Production Sustainability *(The state of data production being sustainable and extendable)*	Ad Hoc or Not applicable To obligation or deliverable requirement	Short-term Individual PI's commitment (grant obligations)	Medium-term Institutional commitment (contractual deliverables with specs and schedule defined)	Long-term Institutional commitment Product improvement process in place	Level 4 + National or international commitment Changes for echnology planned
Data Quality Assurance *(The state of data quality being assured)*	Data quality assurance (DQA) procedure unknown or none	Ad Hoc and random QA procedure not defined and documented	DQA procedure defined and documented and partially implemented	DQA procedure well documented, fully implemented and available online with master reference data Limited data quality assurance metadata	Level 4 + DQA procedure monitored and reported Conforming to community quality metadata & standards External review

Data Quality Control/ Monitoring *The state of data quality being controlled and monitored*	None or Sampling unknown or spotty Analysis unknown or random in time	Sampling and analysis are regular in time and space Limited product-specific metrics defined & implemented	Level 2 + Sampling and analysis are frequent and systematic but not automatic Community metrics defined and partially implemented Procedure documented and available online	Level 3 + Anomaly detection procedure well-documented and fully implemented using community metrics, automatic, tracked and reported Limited quality monitoring metadata	Level 4 + Cross-validation of temporal & spatial characteristics Physical consistency check Conforming to community quality metadata & standards
Data Quality Assessment *(The state of data quality being assessed)*	Algorithm/ method/model Theoretical basis assessed (methods and results online)	Level 1 + Research product assessed (methods and results online)	Level 2 + Operational product assessed (methods and results online)	Level 3 + Quality metadata assessed Limited quality assessment metadata	Level 4 + Assessment performed on a recurring basis Conforming to community quality metadata & standards External ranking
Transparency/ Traceability *(The state of being transparent, trackable, and traceable)*	Limited product information available Person-to-person	Product information available in literature	Algorithm Theoretical Basis Document (ATBD) & source code online Dataset configuration managed (CM) Unique Object Identifier (OID) assigned (dataset, documentation, source code) Data citation tracked (e.g., utilizing Digital Object Identifier	Level 3 + Operational Algorithm Description (OAD) online, OID assigned, and under CM	Level 4 + System information online Complete data provenance online

Data Integrity *(The state of data integrity being verifiable)*	Unknown or no data ingest integrity check	Data ingest integrity verifiable (e.g, checksum technology)	(DOI) system) Level 2 + Data archive integrity verifiable	Level 3 + Data access integrity verifiable Conforming to community data integrity technology standard	Level 4 + Data authenticity verifiable (e.g., data signature technology) Performance of data integrity check monitored and reported