

RECORD FOR SPACE DATA SYSTEM STANDARDS

|  |
| --- |
| Planning Information Formats  Prototype test Plan and Report |

Draft CCSDS Record

Draft Yellow Book

January 2018

FOREWORD

This document records the prototype test plan and results for the Planning Information Formats, CCSDS 902.2-W-0.7, White Book. As a record of prototype testing, it is expected that expansion, deletion, or modification of this document will **not** occur. This document is subject to CCSDS document management and change control procedures, which are defined in the *Organization and Processes for the Consultative Committee for Space Data Systems*. Current versions of CCSDS documents are maintained at the CCSDS Web site:

<http://www.ccsds.org/>

This Report is published and maintained by:

CCSDS Secretariat

National Aeronautics and Space Administration

Washington, DC 20546-0001, USA

E-mail: secretariat@mailman.ccsds.org

At time of publication, the active Member and Observer Agencies of the CCSDS were:

Member Agencies

– Agenzia Spaziale Italiana (ASI)/Italy.

– Canadian Space Agency (CSA)/Canada.

– Centre National d’Etudes Spatiales (CNES)/France.

– China National Space Administration (CNSA)/People’s Republic of China.

– Deutsches Zentrum für Luft und Raumfahrt (DLR)/Germany.

– European Space Agency (ESA)/Europe.

– Federal Space Agency (FSA)/Russian Federation.

– Instituto Nacional de Pesquisas Espaciais (INPE)/Brazil.

– Japan Aerospace Exploration Agency (JAXA)/Japan.

– National Aeronautics and Space Administration (NASA)/USA.

– UK Space Agency/United Kingdom.

Observer Agencies

– Austrian Space Agency (ASA)/Austria.

– Belgian Federal Science Policy Office (BFSPO)/Belgium.

– Central Research Institute of Machine Building (TsNIIMash)/Russian Federation.

– China Satellite Launch and Tracking Control General, Beijing Institute of Tracking

and Telecommunications Technology (CLTC/BITTT)/China.

– Chinese Academy of Sciences (CAS)/China.

– Chinese Academy of Space Technology (CAST)/China.

– Commonwealth Scientific and Industrial Research Organization (CSIRO)/Australia.

– Danish National Space Center (DNSC)/Denmark.

– Departamento de Ciência e Tecnologia Aeroespacial (DCTA)/Brazil.

– European Organization for the Exploitation of Meteorological Satellites

(EUMETSAT)/Europe.

– European Telecommunications Satellite Organization (EUTELSAT)/Europe.

– Geo-Informatics and Space Technology Development Agency (GISTDA)/Thailand.

– Hellenic National Space Committee (HNSC)/Greece.

– Indian Space Research Organization (ISRO)/India.

– Institute of Space Research (IKI)/Russian Federation.

– KFKI Research Institute for Particle & Nuclear Physics (KFKI)/Hungary.

– Korea Aerospace Research Institute (KARI)/Korea.

– Ministry of Communications (MOC)/Israel.

– National Institute of Information and Communications Technology (NICT)/Japan.

– National Oceanic and Atmospheric Administration (NOAA)/USA.

– National Space Agency of the Republic of Kazakhstan (NSARK)/Kazakhstan.

– National Space Organization (NSPO)/Chinese Taipei.

– Naval Center for Space Technology (NCST)/USA.

– Scientific and Technological Research Council of Turkey (TUBITAK)/Turkey.

– South African National Space Agency (SANSA)/Republic of South Africa.

– Space and Upper Atmosphere Research Commission (SUPARCO)/Pakistan.

– Swedish Space Corporation (SSC)/Sweden.

– Swiss Space Office (SSO)/Switzerland.

– United States Geological Survey (USGS)/USA.

DOCUMENT CONTROL

|  |  |  |  |
| --- | --- | --- | --- |
| **Document** | **Title and Issue** | **Date** | **Status** |
| CCSDS 902.2-Y-0.1 | Planning Data Format Prototype Test/Plan Report, CCSDS Record, Draft | Sept. 2015 | Initial Draft |
| CCSDS 902.2-Y-0.2 | Planning Data Format Prototype Test/Plan Report, CCSDS Record, Draft | Oct. 2015 | Verification Test Table and Prototype Test Data Sheet added to Test Plan Overview section; Corrected footer |
| CCSDS 902.2-Y-0.3 | Planning Data Format Prototype Test/Plan Report, CCSDS Record, Draft | Mar. 2016 | Updated with 902.2-W-0.07 revisions. |
| CCSDS 902.2-Y-0.4 | Planning Information Formats Prototype Test/Plan Report, CCSDS Record, Draft | Apr. 2016 | Changed name to PIF; made changes discussed in Cleveland meeting |
| CCSDS 902.2-Y-0.5 | Planning Information Formats Prototype Test/Plan Report, CCSDS Record, Draft | Oct. 2016 | Added use case for space-based aperture |
| CCSDS 902.2-Y-0.6 | Planning Information Formats Prototype Test/Plan Report, CCSDS Record, Draft | Jan. 2018 | Removed CESG and CMC process discussion and included new test cases |

Table of CONTENTS

1 INTRODUCTION 1-5

1.1 PURPOSE 1-5

1.2 SCOPE 1-5

1.3 RATIONALE 1-5

1.4 DOCUMENT STRUCTURE 1-5

1.5 References 1-6

2 Planning Information Formats (PIF) TEST Plan 2-1

2.1 TEST GOALS 2-1

2.2 TEST PLAN OVERVIEW 2-1

2.3 Test success criteria 2-1

2.4 TEST PLAN DETAILS 2-1

2.4.1 Phase 1: Manual Development TESTING 2-1

2.4.2 Phase 2: Semi-Automated Development Testing 2-2

3 Test Results Summary, CONCLUSIONs & RECOMMENDATION 3-1

3.1 Test summary and Conclusion 3-1

3.2 Recommendation 3-4

4 PIF Test report 4-5

4.1 Phase 1: MANUAL DEVELOPMENT TESTING 4-5

4.1.1 Phase 1 Goals 4-5

4.1.2 Steps Used for Phase 1 4-5

4.1.3 Test run 1 4-5

4.2 Phase 2: Automated DEVELOPMENT TESTING 4-5

4.2.1 Goals 4-5

4.2.2 Steps Used for Phase 2 4-5

4.2.3 Test run 2 4-5

5 ABBREVIATIONS AND ACRONYMS 5-6

6 Test Run Provider XML Formatted Files with User Translation 6-7

# INTRODUCTION

## PURPOSE

This test plan and report provides a record of the interoperability testing that will occur in support of the production of the Consultative Committee for Space Data Systems (CCSDS) recommendation Planning Information Formats (PIF) Blue Book.

## SCOPE

This record addresses the formal prototype testing that will occur between NASA and ESA against the White book version of the draft PIF [reference 1] and focuses on the exchange of Planning Information required in the context of the CCSDS Service Management, specifically for communication geometry events. Prototype testing shall incorporate modifications to the PIF document and ongoing working group activity as applicable.

## RATIONALE

The CCSDS Procedures Manual states that for a Recommendation to become a Blue Book, the draft standard must be tested in an operational manner. The following requirements for an

implementation exercise were excerpted from reference [2]:

“At least two independent and interoperable prototypes or implementations

must have been developed and demonstrated in an operationally relevant

environment, either real or simulated.”

This document outlines the Cross Support Services-Service Management Working Group’s (CSS-SM WG’s) approach to meeting this requirement for the PIF Blue Book.

## DOCUMENT STRUCTURE

A brief description is provided for each section and annex so the reader will have an idea of where information can be found within the document. This document is organized as follows:

1. Section 1 provides the purpose, scope, rationale and references of this test plan and report. This section also describes how this document is organized.
2. Section 2 provides the test plan description including the test goals, overview and details of each test case. It also presents the test report formats that were used including samples of the Test Report and Verification Spreadsheet.
3. Section 3 provides the summary of test result conclusions and a recommendation for the supported Blue Book.
4. Section 4 describes the test results and provides test reports for each use case and test run.
5. Annex A lists the abbreviations and acronyms used within this document
6. Annex B lists the XML formatted files, Interface Control Documents (ICDs) and Interpretation of each test run.

## References

The following documents are referenced in this document. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS documents.

[1] *Planning Information Formats,* CCSDS 902.2-W-0.16, Draft Recommended Standard.

[2] *Organization and Processes for the Consultative Committee for Space Data Systems*. CCSDS A02.1-Y-4. Yellow Book. Issue 4. Washington, D.C.: CCSDS, April 2014.

# Planning Information Formats (PIF) TEST Plan

## TEST GOALS

The prototype testing shall be performed to demonstrate that the proposed standard data format has been written with enough clarity to be used to exchange Planning Information between the groundstations and/or relay satellites of various Space Agencies and commercial or governmental spacecraft operators.

## TEST PLAN OVERVIEW

ESA and NASA, acting as either the Provider or User, shall perform several tests to support the PIF development. Each test run shall represent Planning Information exchanged between a Provider and a User. Throughout the rest of this document, the terms “Provider” and “User” refer to ESA and NASA acting in those roles.

To provide prototype testing that is as realistic as possible, data from existing missions should be used. The tests should verify that data from existing missions can be rendered using the proposed XML schema, and the user can successfully interpret the data.

The Planning Information Formats prototype testing will include two phases:

* Phase 1 shall be performed by creating the test files manually using Notepad, XMLSpy, or some other XML editor to develop a Planning Information Format with extended information and exchanged by email. It is expected that four test runs will be performed during this phase – two initiated by ESA and two initiated by NASA whereby the initiator will play the role of Provider providing planning information to a User. (Note: The actual User data is outside of the scope of this prototype testing.)
* Phase 2 shall be performed using automated conversion tools, as much as possible, to convert the “Provider” mission data into a Planning Information Format using the latest XML schema and then send the file to the “User” to be converted back using automated conversion tools. The file exchange shall be done using email or other mechanism agreed upon by both parties. During this phase, several test runs shall be conducted for different use cases. During each test run, the “Provider” shall check to see if the interpreted version matches the original data that was sent. Table 2.1 shows an example of an Excel Test Verification Table, which will be used to facilitate the comparison of the interpreted data with the original data. In the event that discrepancies are found, the recipient and originator shall discuss the discrepancies and document the variances along with all other observed issues and concerns. Tests shall be rerun to get a clean final run after the deficiencies are corrected. The roles will then be reversed.



Table 2‑1 PIF Prototype Test Verification Table Sample

The test reports for each test run shall be documented in a Prototype Test Data Sheet (see Table 2-2 for sample) in Section 4. Comparison of the XML formatted file and the interpretation (using either plain text or the Test Verification Tables) shall be shown in Annex B along with any ICD associated with the test run. The CSS-SM WG shall discuss the results to determine success.

|  |  |  |
| --- | --- | --- |
| 1 | Test Date: |  |
| 2 | Project Under Test: | Planning Information Formats |
| 3 | Agency Responsible for  Prototype: (“Provider) |  |
| 4 | Prototype Test Case # |  |
| 5 | Agency/Test Engineers: |  |
| 6 | Provider Complex: |  |
| 7 | Mission |  |
| 8 | Test Description |  |
| 9 | Variances from Expected  Results: |  |
| 10 | Results (Pass, Partial Pass,  Fail): |  |
| 11 | Results Reviewed /  Approved By: |  |
| 12 | Comments: |  |

Table 2‑2 PIF Prototype Test Data Sheet Sample

## 

## Test success criteria

Success criteria for the data/file format:

* The file formatting shall be easily created by the generating side, so that all the required information content shall be provided (no workarounds are needed)
* The file format created by the Provider, shall be re-read by the Provider and respectively all the information content is assessed as being complete (no information is lost)
* It is desirable that the file format allows some kind of sanity check mechanism (i.e. schema mechanism for XML files)
* The data/file format allows safe transport over whatever transport media (File Transfer Protocol (FTP), e-mail, web-services, etc…), so that no information content is lost or changed during transport
* The User shall read all information and assess the correctness and completeness of the provided file
* All the information shall be easily (uniquely) identifiable
* The User shall be able to read the file format and make use of the transported information content
* In the case of the use of automated software tools for processing the file format, the systems shall be able to process all different combinations of allowed content or file format options, as defined (i.e. with schema file) without a need for reprogramming.
* The file format shall allow for different amounts of information transported, thus not imposing any artificial limits on number of entries.
* File format containing large amount of data may be processed by both sides (Provider and User).

Note that all of the above requirements shall be covered in the context of realistic use cases.

## TEST PLAN DETAILS

### Phase 1: Manual Development TESTING

#### PHASE 1 PURPOSE

The Provider shall manually build an XML formatted file using the PIF schema to test the ability to generate and exchange the planning information that is understandable to the User.

The purpose is to perform a rough sanity check of the file format and familiarize both prototyping parties with contents of the Planning Information Formats. Note: it is seen as an advantage if a developer of any tools used in Phase 2 participates in Phase 1 for a better understanding of the content and usage of the proprietary agency’s systems as well as the Planning Information Formats.

#### PHASE 1 DESCRIPTION

For the first phase, ESA or NASA will assume the role of Provider and shall generate and send two XML files consistent with the PIF to the other party acting in the role of User for interpretation. The User shall then manually interpret the information rendered in plain text and passed it back to the Provider for verification that the information sent was understood correctly by comparing the interpreted information with the original data. The goal is to exercise basic format exchanges.

ESA and NASA shall exchange roles and then repeat the above tests.

Table 1-2 Phase 1, Test Run Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No | Test Run | Provider | User | Description |
| 1 | PIF-P1-1 | ESA | NASA | First test with XML formatting of Planning Information Formats. Content may be invented, needs to include all metadata and at least one event item, such as COMMS Start/End type events |
| 2 | PIF-P1-2 | ESA | NASA | Consecutive test. In case some excluding options are available (in comparison to PIF-P1-1), this shall be used now. At least 5 up to 20 event items shall be included. |
| 3 | PIF-P1-3 | NASA | ESA | First test with PIF generated by another prototyping party. See PIF-P1-1 |
| 4 | PIF-P1-4 | NASA | ESA | Second test by second prototype. See PIF-P1-2 |

#### PHASE 1 EXPECTED RESULTS

It is anticipated that Provider and User will be able to successfully exchange and read the planning data in the Planning Information Format.

### Phase 2: Semi-Automated Development Testing

#### PHASE 2 PURPOSE

The purpose of Phase 2 is to show that the PIF can be used in planning and operational scenarios where different types of planning data and services are requested. Consequently, the PIF shall be used to render planning information using automated tools to handle the data conversion. The data shall be rendered in a manner such that all original data can be recovered.

#### PHASE 2 DESCRIPTION

The Provider and User functions performed in Phase 1 shall be repeated, however, these test runs shall demonstrate an automatic planning data generation based on the PIF schema as well as to provide the ability to generate different types of planning information consistent with planning and operational scenarios. This in turn, shall allow for the development of more planning data use cases over longer time spans than when generating XML responses manually as in Phase 1. By developing more planning data use cases, there is a better chance of determining if there is some specific parameter that is used in an Agency’s planning tools that cannot be reflected with the XML schema. Use cases may include mission design, planning and operational scenarios and shall include:

* Small vs. large number of events;
* Specific time frame;
* Deep Space, LEO, GEO, and Space-based aperture events;
* Mandatory and optional parameters to demonstrate extensibility
* Key events based in relation to real world trajectories such as ElevationAscending/Descending; LightTime Information; Comms Start/End
* Event List only
* Generating “correct” intervals based on associations meta-data using as full as possible event list

Note: Test pass criteria #11 (see test pass criteria table 3-2) will be based on utilizing the above use cases.

Table 2-2 Phase 2, Test Run Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No | Test Run | Provider | User | Description |
| 1-2 | PIF-P2-1  PIF-P2-2 | ESA | NASA | Provision of the PIF-based information for some specific case of operational scenario (i.e.user needs to articulate his needs, like “give me events for mission preparation”). No other specific requirements. Best case: the information should be provided based on real data. Two runs with different data sets or different scenarios. |
| 3-4 | PIF-P2-3  PIF-P2-4 | NASA | ESA | Same as above |
| 5-6 | PIF-P2-5  PIF-P2-6 | ESA | NASA | Provision of small number of events (~10) and compare to large number (~1000), therefore two runs. |
| 7-8 | PIF-P2-7  PIF-P2-8 | NASA | ESA | Same as above |
| 9 | PIF-P2-9 | ESA | NASA | Provision of events of the specific time frame (the user will ask “provide events for Spacecraft X from DOY100, 20:00:00 until DOY103, 13:00:00”) |
| 10 | PIF-P2-10 | NASA | ESA | Same as above |
| 11 | PIF-P2-11 | ESA | NASA | Provision of events for Deep Space/GEO mission (focus on event types and additional/defined event parameter). |
| 12 | PIF-P2-12 | NASA | ESA | Provision of events for LEO mission (focus on event types and additional/defined event parameter). |
| 13 | PIF-P2-13 | ESA | NASA | Provision of events with only mandatory parameters/attributes. Purpose is to check if the mandatory set is enough to convey the information |
| 14 | PIF-P2-14 | NASA | ESA | Same as above |
| 15 | PIF-P2-15 | ESA | NASA | Provision of events with maximum possible set of optional parameters. Purpose is to check on ability of PIF to convey complex information/scenarios. (see note) |
| 16 | PIF-P2-16 | NASA | ESA | Same as above |
| 17 | PIF-P2-17 | ESA | NASA | Produce selected key events based in relation to real world trajectories like ElevationAscending/Descending; LightTime Information; Comms Start/End |
| 18 | PIF-P2-18 | NASA | ESA | Same as above |
| 19 | PIF-P2-19 | ESA | NASA | Generate “correct” intervals based on associations meta data with as full as possible event list |
| 20 | PIF-P2-20 | NASA | ESA | Same as above |

Note: The prototyping is being performed by the two specified agencies and it is possible that these agencies may not be able to test all possible parameters (having no use of these parameters on their own). It is explicitly desired that the prototypers involve another agency or organization, if needed, to provide respective data source to cover all cases and to fullfil the Test Plan requirements.

Phase 2 should correctly execute the following steps:

Provider:

1. Obtain an existing mission’s planning data in a conventional format
2. Use automated tools to render the planning data in an XML file using the PIF XML schema.
3. Send email to User with attached the XML file

User:

1. Receive the Provider furnished XML file via e-mail
2. Interpret the XML file consistent with the PIF XML schema
3. Render the output tabular form using automated tools and then manually verify it against the input by picking random response entries to spot check\*.
4. Send the random tabular output to the Provider for verification that the random entries were interpreted correctly.

\*Note: Random response entries will be pick for spot checking because of the large volume of data involved in the manual verification process.

The test coordinator shall verify that the random entry text matches the XML data sent. In the event that the text does not match, the User and Provider shall discuss the discrepancies and variances and document them along with all other observed issues or concerns and discuss with the CSS-SM WG.

#### PHASE 2 EXPECTED RESULTS

It is anticipated that both ESA and NASA will be able to successfully use automated tools to ingest their own planning data into an XML format using the PIF and to translate the XML format into an understandable format. Each recipient shall provide a summary of the results to the CSS-SM WG. The CSS-SM WG will discuss the results to determine success. Success will be indicated by the Provider agreeing that the XML files were correctly interpreted.

r

# Test Results Summary, CONCLUSIONs & RECOMMENDATION

## Test summary and Conclusion

[When the testing is complete, this section will be updated:] The Planning Information Formats provides the Unified Modeling Language (UML) model for the Provider’s planning data. XML schemas were developed to follow the UML model. The UML model and XML schema were developed to render (translate) data from the planning data to suit the applications envisioned for the PIF.

For the prototype testing, data generated by the Provider’s operational systems were converted into the standard XML document using the PIF XML schema. On the receiving side, the standard XML document was rendered into a view that represented the view required by the User’s Agency system. The end-to-end flow and demonstrating that the schema can accommodate the essential cross support information from a User’s native system is what establishes the viability of the model/schema and convinces potential users that it’s a workable standard.

Test cases performed are shown in Table 3-1. The table lists the test phase, description, content, transport mechanism, success and completeness percentage. In the event of discrepancies, troubleshooting was conducted by the participants in the test and discussed, if necessary, with the CSS-SM WG.

Table 3‑1 Summary Test Results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test  Phase | Description | Content | Transport | Fully Successful? | % Complete |
| 1 | Manual | Simple/Mandatory, Optional, and Extended data |  |  |  |
| 2 | Semi-Automatic  (automated generation/manual or automated verification) | Some or all content and translation automated; Single provider and single or multiple user use cases; Large schedules (week) with operational verification |  |  |  |

The Agencies performing the prototype testing were NASA and ESA. When one Agency performed the role of Provider the other Agency performed the role of User. During the first test case, the Provider extracted a small amount of data from native planning information manually and then generated an XML document from the schema using an XML editor. The resulting XML document was sent to the User in an email. The XML document was manually translated into usable User view. In later test runs, automated tools were created to perform the same functions that were performed manually in order to test larger files. Tests also covered all use cases. All tests were performed successfully and the usability has been proven.

According to the Test Pass Criteria defined in Chapter 2.3, the following result can be provided:

Table 3‑2 Test Pass Criteria Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Test Pass Criteria | Verified | Result | Comments |
| 1 | Easy file format generation. |  |  |  |
| 2 | File created by the creator may be also re-read by the same instance. |  |  |  |
| 3 | Sanity check mechanisms inherent to the file format itself. |  |  |  |
| 4 | Safe transport of information |  |  |  |
| 5 | Correctness and completeness of the provided file my be assessed |  |  |  |
| 6 | All the information shall be easily (uniquely) identifiable (i.e. with help of descriptive keywords or identifiers) |  |  |  |
| 7 | The User shall be able to read the file format and make use of the transported information content |  |  |  |
| 8 | In the case of the use of automated software tools for processing the file format, the systems shall be able to process all different combinations of allowed content or file format options, as defined (i.e. with schema file) without a need for reprogramming. |  |  |  |
| 9 | The file format shall allow for different amounts of information transported, thus not imposing any artificial limits on number of entries. |  |  |  |
| 10 | File format containing high amount of information (like a schedule for 1000 passes) may be processed by boths sides (generator and receiver). |  |  |  |
| 11 | All use cases have been tested |  |  |  |

Details of the Test Plan are presented in Chapter 2. The Test Report details can be found in Chapter 4.

## Recommendation

# PIF Test report

## Phase 1: MANUAL DEVELOPMENT TESTING

### Phase 1 Goals

Test case 1 focused on manually building an XML formatted file using the PIF schema to test the ability to generate and exchange the planning information in a format consistent with the PIF and is understandable to the User.

### Steps Used for Phase 1

### Test run 1

Test Run 1A XML formatted file [click here](#XML1A)

Test Run 1A User Interpretation [click here](#Tran1A)

#### Test Run 1 Test Description

#### Test Run 1 Results

## Phase 2: Automated DEVELOPMENT TESTING

### Goals

Phase 2 utilized automated tools to build XML formatted files using the PIF schema to test the ability to generate a planning data that is understandable to the User using the PIF. Mission design, mission planning and operational scenarios were represented.

### Steps Used for Phase 2

### Test run 2

Test Run 2 XML formatted file [click here](#XML2A)

Test Run 2 User Interpretation [click here](#Trans2A)

#### Test Run 2 Test Description

# ABBREVIATIONS AND ACRONYMS

CCSDS Consultative Committee for Space Data Systems

CESG CCSDS Engineering Steering Group

CMC CCSDS Management Council

CSS Cross Support Services

CSSS Cross Support Service System

CSS-SM WG Cross Support Services-Service Management Working Group

CWE CCSDS Working Environment

FTP File Transfer Protocol

ICD Interface Control Document

ID Identifier

i.e. That is; in other words; that is to say

MOC Mission Operations Center

NASA National Aeronautics and Space Administration

NEN Near Earth Network

NOAA National Oceanic and Atmospheric Administration

SN Space Network

SM Service Management

PIF Planning Information Formats

UML Unified Modeling Language

WG Working Group

XML Extensible Markup Language

# Test Run Provider XML Formatted Files with User Translation

# 