March 31, 2008

PDS4 Information Model
Use Cases

PDS4 Data Model Working Group

-Draft-

Open Issues:

- Should we include "Target" in the data model?
  << Ed Guinness: No >>
  << Chris Isbell: if you mean as presented below, I say "yes" >>

Reviews:

- Full Tech review Mar 27, 2008

Preface

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1. Scope

This document captures illustrative use cases for the fourth generation of the Planetary Data System (PDS) Information Model. The moniker for this effort is "PDS4". The intent of the PDS4 Information Model is to provide an enduring data model that can describe the relevant attributes of data and ancillary information collected as part of planetary science activities. This information is to be included in the Planetary Data System archive that is described in the PDS Roadmap [1] as:

> The PDS archives and makes available space-borne, ground-based, and laboratory experiment data from over 50 years of NASA-based exploration of comets, asteroids, moons, and planets.
>
> The archives include data products derived from a very wide range of measurements, e.g., imaging experiments, gravity and magnetic field and plasma measurements, altimetry data, and various spectroscopic observations.

2. Audience

This document is written for those who will evaluate the vision for the system components and for those who will design and implement the system. The expected audience includes the following member of PDS:

- Managers and administrators
- Engineering Staff
- Technical Staff

3. Introduction

To derive the requirements for the PDS4 Information Model we have collected a set of use cases which illustrate the common activities, tasks and goals related to archiving and using data within PDS archive.

4. Actors

An actor is a person, organization, or external system that plays a role in one or more interactions with the system. (Adapted from Harvey 2008)

Producer – Producer is the role played by those persons, or client systems, which provide the information to be preserved in a PDS science data archive.

> **Providers** supply the data to the archive. Provider typically also supplies the metadata necessary to archive the data.
>
> **Archivist** is an individual who supplies or reviews metadata that describes data archived in the system.

User – A User is the role played by those persons, or client systems, that interact with the services of a PDS science data archive to find and acquire data products of interest.

Researchers are the scientists and collaborators who are users of the system. For a science information system the Researchers are the main source for requirements and drivers.
Public are other users who visit the system seeking data or general information.

Manager – Manager is the role played by one who plans, organizes, leads, and controls a PDS science data archive.

5. Use Cases

The Use Cases describe scenarios to illustrate the type of information which is important to understanding, locate or manage an artifact. An artifact is any physical or abstract item which has attributes that are described within an information model. All artifact related scenarios end with a formal expression of the information. The "formal expression" will be implementation dependent. It can be in any appropriate format. Currently PDS uses ODL as the method of expressing metadata.

The Use Cases have been divided into 3 categories related to artifacts. They are:

Context: Artifacts which are relevant to the understanding other artifacts
Content: Information acquired as a result of an observation
Resources: Artifacts that have an assigned identity.

Use Cases describing how to locate and manage an artifact are divided into 2 categories. They are:

Locate: The most common criteria used to locate a resource within the system
Management: System scenarios that make some contribution to the attributes of artifacts.

Many of the Use Cases have a similar sequence of steps. While this may make reading the Use Cases seem repetitive or tedious it helps to highlight the common characteristics of some artifacts.

5.1. Context

Context artifacts are those artifacts which are relevant to the understanding other artifacts. A Context artifact is typically a physical item which plays a role in the acquisition of data.

5.1.1. Describe a Campaign

Description: A Provider describes a campaign which includes the expected duration of the mission, the targets observed, and the observatory/instruments that have participated. A campaign may be part of larger campaigns (i.e., missions)

Actors: Provider

Scenario:

1. The Provider determines the desired name or title for the mission or campaign.
2. The Provider determines the agency assigned name for the campaign.

3. The Provider determines the duration of the campaign.
4. The Provider determines the targets of the campaign.
5. The Provider determines the observatories and instruments which have participated in the campaign.
6. The Provider collects a short description for the campaign.
7. The Provider determines if this campaign if part of a larger campaign (i.e., mission).
8. The Provider describes each attribute of the campaign with a formal expression (metadata).

5.1.2. Describe an Observation Platform

Description: A Provider describes an observation platform. An observation platform can be a ground-based location, facility, spacecraft, or probe.

Actors: Provider

Scenario:

1. The Provider determines the class of observation platform. Example classes are ground-based location, facility, spacecraft, or probe.
2. The Provider determines the agency assigned name for the observatory.
3. The Provider determines the geographic location of the observatory (if applicable)
4. The Provider collects a short description for the observatory.
5. The Provider describes each attribute of the observation with a formal expression (metadata).

5.1.3. Describe an Instrument

Description: A Provider describes an instrument. An instrument is a device for measuring observations of a physical phenomenon.

Actors: Provider

Scenario:

1. The Provider determines the class of instrument. Example antenna, imager, magnetometer, etc.
2. The Provider determines the agency assigned name for the instrument.
3. The Provider collects a short description for the instrument.
4. The Provider describes each attribute of the instrument with a formal expression (metadata).

5.1.4. Describe an Organization

Description: A Provider describes an organization. An organization can be a research group, institute, agency or government entity.

Actors: Provider

Scenario:

1. The Provider determines the formal name for the organization.
2. The Provider determines the contact location of the organization (mailing address)
3. The Provider collects a short description for the organization.
4. The Provider describes each attribute of the organization with a formal expression (metadata).

5.1.5. Describe a Contact

Description: A Provider describes a contact. An contact is an individual or generic point of contact with-in an organization.

Actors: Provider

Scenario:

1. The Provider determines the formal name for the contact.
2. The Provider determines the location of the contact (mailing address)
3. The Provider determines the phone number of the contact.
4. The Provider determines the FAX number of the contact.
5. The Provider determines the e-mail address of the contact.
6. The Provider describes each attribute of the contact with a formal expression (metadata).

5.1.6. Describe a Target

Description: A Provider describes a target of an observation. A target can be a spatial region or physical body (natural or man-made, e.g. planet, calibration target, etc).

Actors: Provider

Scenario:

1. The Provider determines the type of the target which may be included in an observation. Targets can be a spatial region or physical body.
2. The Provider determines the standard or formal name for the target. The standard name may be defined in approved external lists or internal (PDS) maintained lists.
3. If a spatial region, the Provider determines the primary body that influences the spatial region.
4. The Provider describes each attribute of the target with a formal expression (metadata).

5.2. Content (Observations)

A Content artifact is the information acquired as a result of an observation. It can include artifacts which are derived from direct observations. A Content artifact is the substantive data or intellectual property typically associated with a Context artifact.

5.2.1. Describe a Single Instance Observation

Description: A Provider describes a single instance observation. This type of artifact in often referred to as a "Sample".

Actors: Provider

Scenarios:

1. The Provider determines the object or phenomenon observed.
2. The Provider determines the source of the observation which includes the facility and instrument.
3. The Provider determines the method of observation.
4. The Provider determines the time of the observation.
5. The Provider determines the observed quantities.
6. The Provider determines the data type, units and precision of the observed quantities.
7. The Provider determines producer requested acknowledgments.
8. The Provider constructs a brief description of the observation.
9. The Provider describes each attribute of the observation and the observed quantities with a formal expression (metadata).

5.2.2. Describe an Image Observation

Description: A Provider describes a 2 dimensional observation of a spatial region. This type of observation is commonly referred to as an image.

Actors: Provider

Scenarios:

1. The Provider determines the object or phenomenon observed. (i.e. spectral range)
2. The Provider determines the source of the observation which includes the facility and instrument.
3. The Provider determines the method of observation.
4. The Provider determines the time of the observation.
5. The Provider determines spatial region of the observation.
6. The Provider determines resolution of resulting image.
7. The Provider determines the data type, units and precision of the observed quantity.
8. The Provider determines orientation of resulting image with respect to a preferred or standard orientation.
9. The Provider determines the relevant geometry and ancillary information.
10. The Provider determines the relevant elevation models that apply to the image.
11. The Provider determines producer requested acknowledgments.
12. The Provider constructs a brief description of the observation.
13. The Provider determines the storage format for the data.
14. The Provider determines the storage location (file) for the data.
15. The Provider describes each attribute of the observation with a formal expression (metadata).

5.2.3. Describe a Time Sequence of Image Observations (Movie)

Description: A Provider describes a time-ordered set of 2 dimensional observations. This type of artifact is commonly referred to as a "movie". Some movies illustrate

complex concepts and serve as documentation. Other movies contain scientifically useful information which can be analyzed.

Actors: Provider

Scenarios:

1. The Provider determines the object or phenomenon observed. (i.e. spectral range)
2. The Provider determines the source of the observation which includes the facility and instrument.
3. The Provider determines the method of observation.
4. The Provider determines the time span of the observation.
5. The Provider determines the cadence (regular or irregular) of the observations.
6. The Provider determines the resolution of an individual image.
7. The Provider determines the relevant geometry and ancillary information.
8. The Provider determines the relevant elevation models that apply to the image.
9. The Provider determines producer requested acknowledgments.
10. The Provider constructs a brief description of the observation.
11. The Provider determines the storage format for the data.
12. The Provider determines the storage location (file) for the data.
13. The Provider describes each attribute of the observation with a formal expression (metadata).

5.2.4. Describe a Time Series Observation

Description: A Provider describes a sequence of observations which are stored as a time series. This type of artifact is sometimes referred to as a "Table"

Actors: Provider

Scenarios:

1. The Provider determines the object or phenomenon observed.
2. The Provider determines the source of the observation which includes the facility and instrument.
3. The Provider determines the method of observation.
4. The Provider determines the time range of the observation.
5. The Provider determines the cadence (regular or irregular) of the observations.
6. The Provider determines the parameters of the observation.
7. The Provider determines the observed quantities.
8. The Provider determines the data type, units and precision for each quanity.
9. The Provider determines producer requested acknowledgments.
10. The Provider constructs a brief description of the observation.
11. The Provider determines the storage format for the data.
12. The Provider determines the storage location (file) for the data.
13. The Provider describes each attribute of the time series of data with a formal expression (metadata).

5.2.5. Describe a Spectral Observation

Description: A Provider describes a set of concurrent sequences of observations which are stored as a series. This type of artifact is commonly called a "spectrum". Each sequence in the set shares the same time frame and cadence, but differs in the phenomenon observed.

Actors: Provider

Scenarios:

1. The Provider determines the object or phenomenon observed.
2. The Provider determines the source of the observation which includes the facility and instrument.
3. The Provider determines the method of observation.
4. The Provider determines the time range of the observation.
5. The Provider determines the parameters of the observation for each sequence.
6. The Provider determines the data type, units and precision for each parameter.
7. The Provider determines the relevant geometry and ancillary information.
8. The Provider determines the relevant elevation models that apply to the image.
9. The Provider determines producer requested acknowledgments.
10. The Provider constructs a brief description of the observation.
11. The Provider determines the storage format for the data.
12. The Provider determines the storage location (file) for the data.
13. The Provider describes each attribute of the time series of data with a formal expression (metadata).

5.2.6. Describe a Event List

Description: A Provider describes a time ordered list of observed or inferred phenomenon. This type of artifact is commonly referred to as an "Event List", but may also be referred to as a "Catalog". An Event List/Catalog can be both a Context and Content entity. It can be a Context entity when an Event List/Catalog is searched and accessed at a record level by some system services. It is a Content entity when used as the basis for making additional assertions.

Actors: Provider

Scenarios:

1. The Provider determines the phenomenon that are classified in the list. Some examples are: bowshock crossing, CME, or substorm.
2. The Provider determines the time range of the list.
3. The Provider determines the parameters included in the list.
4. The Provider determines the observation quantity including data type, units and precision for each parameter.
5. The Provider determines producer requested acknowledgments.
6. The Provider constructs a brief description of the observation.
7. The Provider determines the storage format for the data.

8. The Provider determines the storage location (file) for the data.
9. The Provider describes each attribute of the time series of data with a formal expression (metadata).

5.2.7. Describe Navigational Ancillary Information

Description: A Provider describes a set of parameters that characterize the orientation and position of contextual artifacts of an observation. This type of artifact is commonly represented as a "SPICE kernel".

Actors: Provider

Scenarios:

1. The Provider determines the type of artifact that is characterized. (for example, instrument, observatory, target, events)
2. The Provider determines the time range of the characterization.
3. The Provider determines external identifiers for the characterization.
4. The Provider determines producer requested acknowledgments.
5. The Provider constructs a brief description of the observation.
6. The Provider determines the storage format for the data.
7. The Provider determines the storage location (file) for the data.
8. The Provider describes each attribute of the characterization with a formal expression (metadata).

5.2.8. Describe Structured Data

Description: A Provider describes a data file that contains structured information. The data file may contain multiple well defined structures which may, but not necessarily, appear a well-defined pattern. A structure may have an attribute that identifies the type of structure that it is. For example, the first byte may contain a code which indicates the structure type. This type of "artifacts" is sometimes referred to as "telemetry" data.

Actors: Provider

Scenarios:

1. The Provider determines the object or phenomenon observed.
2. The Provider determines the source of the observation which includes the facility and instrument.
3. The Provider determines the method of observation.
4. The Provider determines the time range of the observation.
5. The Provider determines the structures which are present.
6. The Provider determines the order of the structures or the identifying attribute of each structure.
7. The Provider determines the parameters of the observation for each structure.
8. The Provider determines the observation quantity including data type, units and precision for each parameter.
9. The Provider determines producer requested acknowledgments.
10. The Provider constructs a brief description of the observation.

11. The Provider determines the storage format for the data.
12. The Provider determines the storage location (file) for the data.
13. The Provider describes each attribute of the structured data of data with a formal expression (metadata).

5.2.9. Describe a Document

Description: A Provider describes a narrative. A narrative may contain any combination of text, images, tables or movies. This type of artifact is commonly called a "document".

Actors: Provider

Scenarios:

1. The Provider determines the applicability or purpose of the document. For example, is it a detailed description of an instrument, calibration technique, goals, or analysis results?
2. The Provider determines copyright ownership.
3. The Provider determines producer requested acknowledgments.
4. The Provider constructs a brief description of the document.
5. The Provider determines the storage format (including version) for the data.
6. The Provider determines the storage location (file) for the data.
7. The Provider describes each attribute of the document with a formal expression (metadata).

5.2.10. Describe a Software Application

Description: A Provider describes a software application.

Actors: Provider

Scenarios:

1. The Provider determines the applicability or purpose of the software. For example, does it perform rendering, analysis, validation, interpretation, or transformation?
2. The Provider determines intended platforms for software execution.
3. The Provider determines if source code is available.
4. The Provider determines the release identifier (version number).
5. The Provider determines copyright ownership.
6. The Provider determines producer requested acknowledgments.
7. The Provider constructs a brief description of the software.
8. The Provider determines the storage format for the software.
9. The Provider determines the storage location (file) for the software.
10. The Provider describes each attribute of the document with a formal expression (metadata).

5.3. Resources

A Resource artifact is an artifact that is assigned an identity. An assigned identity can then be used to locate or reference the artifact.

5.3.1. Describe a Product

Description: A Provider describes one or more artifacts that form a set which exists as an entity within a system. This type of artifact is called a "product".

Actors: Provider

Scenarios:

1. The Provider determines the artifacts that comprise the product.
2. The Provider determines the identifier to associate with the product.
3. The Provider determines appropriate acknowledgments for the product.
4. The Provider constructs a brief description of the product.
5. The Provider describes by reference or inclusion each artifact that constitutes the product with a formal expression (metadata).

5.3.2. Describe a Collection of Products

Description: A Provider describes a collection of one or more products. A collection which consists of homogenous data products and the ancillary information needed to support and understand the data products is called a "dataset"

Actors: Provider

Scenarios:

1. The Provider determines the products that comprise the collection.
2. The Provider determines the identifier to associate with the collection.
3. The Provider determines appropriate acknowledgments for the collection.
4. The Provider constructs a brief description of the collection.
5. The Provider describes by reference or inclusion each product that constitutes the collection with a formal expression (metadata).

5.3.3. Describe a Storage Location (Repository)

Description: A Provider establishes an accessible location for storing the artifacts that comprise resources. This type of artifact is commonly called a "Repository". All type of artifacts and formal expressions (metadata) may be stored at a repository.

Actors: Provider

Scenarios:

1. The Provider determines the access point for the repository.
2. The Provider determines the identifier to associate with the repository.
3. The Provider determines appropriate acknowledgments for the repository.
4. The Provider constructs a brief description of the repository.
5. The Provider describes each attribute of the repository with a formal expression (metadata).

5.3.4. Describe an Inventory of Products and Collections (Registry)

Description: A Provider establishes an accessible location for a collection point of resource descriptions. This type of artifact is commonly called a "Registry". A registry stores all or part of the formal expression of a resource. A registry does not store the content artifacts.

Actors: Provider

Scenarios:

1. The Provider determines the access point for the registry.
2. The Provider determines the identifier to associate with the registry.
3. The Provider determines appropriate acknowledgments for the registry.
4. The Provider constructs a brief description of the registry.
5. The Provider describes each attribute of the registry with a formal expression (metadata).

5.3.5. Describe new information about a resource.

Description: A Provider acquires new information about an existing resource (product or collection) and associates that information with the resource.

Actors: Provider

Scenarios:

1. The Provider determines the identifier of the resource involved.
2. The Provider determines the new information to association with the resource.
3. The Provider determines appropriate acknowledgments for the new information.
4. The Provider describes each attribute of the new information (which includes the identifier of the resource) with a formal expression (metadata).

5.3.6. Describe updated information about a resource.

Description: A Provider acquires information about a resource which is an update to existing information about the resource (product or collection). This new information will override the corresponding information in a "frozen" resource. For example, new pointing or calibration information to be applied to an archived resource.

Actors: Provider

Scenarios:

1. The Provider determines the identifier of the resource involved.
2. The Provider determines which information about the resource is to be updated.
3. The Provider describes each attribute of the updated information (which includes the identifier of the resource) with a formal expression (metadata).

5.3.7. Describe "external" information about a resource.

Description: A Provider has "external" information about an existing resource (product or collection) and associates that information with the resource. The "external"

information can be project or mission specific information to associate with a resource. It can include other types of information to support specific services (plotting, transformation, etc.).

Actors: Provider

Scenarios:

1. The Provider determines the identifier of the resource involved.
2. The Provider determines the information to association with the resource.
3. The Provider selects the information (data) model to represent the information.
4. The Provider describes the identifier and the "external" information with a formal expression (metadata) of the selected information model.

5.4. Locate

The Locate Use Cases describe the most common criteria used to locate a resource within the system. The Use Cases in this section are not comprehensive. A more comprehensive list of Use Cases should be defined as part of the design of specific search interfaces.

5.4.1. Search Based On Measurement Type

Description: A User is seeking all resources that observed a particular type of phenomenon. The type of phenomenon observed is constrained by the measure type.

Actors: User, Registry

Scenarios:

1. The User locates the search interface for the desired resources.
2. The User describes the phenomenon of interest.
3. The Registry reports all matching resources.

5.4.2. Search Based On Time Range

Description: A User is seeking all resources which contain observation within a particular time range.

Actors: User, Registry

Scenarios:

1. The User locates the search interface for the desired resources.
2. The User describes the time range of interest. The constraints include
    a. Start time of interval
    b. End time of interval.
3. The Registry reports all matching resources.

5.4.3. Search Based On Geographic Location

Description: A User is seeking all resources that were observed with a particular geographic location.

Actors: User, Registry

Scenarios:

1. The User locates the search interface for the desired resources.
2. The User describes the geographic location of interest. The constraints include
    a. Latitude
    b. Longitude
    c. Radial distance

    or
    a. Lower Latitude
    b. Upper Latitude
    c. Leftmost Longitude
    d. Rightmost Longitude
3. The Registry reports all matching resources.

5.4.4. Search Based On Resource Identifier

Description: A User knows the identifier for a resource and is seeking all artifacts associated with the resource.

Actors: User, Registry

Scenarios:

1. The User locates the search interface for the desired resources.
2. The User provides the resource identifier.
3. The Registry inspects its holdings to determine which resources match the request.
4. The Registry reports all matching resources.

5.4.5. Search Based On Atmospheres (feature movie)

Description: A user wishes to locate data relevant to atmospheric observations of a target body which occurred within a particular time range or detected a particular atmospheric phenomenon.

Actors: User, Registry

Scenarios:

1. The User locates the search interface for the desired resources.
2. The User specifies the target body of interest.
3. The User optionally describes the time range of interest. The constraints include
    a. Start time of interval
    b. End time of interval.
4. The User optionally specifies the type of phenomenon of interest.
4. The Registry reports all matching resources.

5.4.6. Search Based On Rings (features and objects)

Description: A User wishes to obtain a subset of data that conforms to a large set of parameters including objects and/or features in the observation or observational field of view, physical parameters including the viewing and illumination geometry, timing, wavelength, mission, instrument, instrument type, and observation type.

Actors: User, Registry

Scenarios:

1. The User locates the search interface for the desired resources.
2. User provides one or more constraints to limit the search. The constraints include
    a. Observation field of view
    b. Observation type
    c. Time of observation
    d. Ring geometry
    e. Viewing geometry
    f. Illumination geometry
    g. Wavelength
    h. Mission
    i. Instrument
    j. Instrument type
3. The System lists and offers thumbnails of the artifacts to the User.
4. The user applies further constraints as necessary to obtain the desired subset of the data.
5. User identifies the artifacts desired.
6. The System delivers the artifacts to the User.

5.4.7. Search Based on Target Name

Description: A user wishes to locate data relevant to a particular target. The user knows at least part of an official designation for the target.

Actors: User, Registry

Scenario:

1. The user locates the search interface for the desired resource.
2. The user provides part of an official name for the target of interest.
3. The system returns a list of known target names that match or contain the name fragment input by the user.
4. The user selects for processing one or more of the target names returned by the system.
5. The system returns a list of pointers for each data set or resource that includes information on one or more of the selected targets.

5.5. Management

The Management Use Cases describe those system scenarios that make some contribution to the attributes of artifacts. Not all management Use Cases for the system are included in this section.

5.5.1. Preservation

Description: A User (Researcher, Provider, Manager, Producer) confirms that one or more artifacts is unaltered from its original form. Artifacts may be copied or replicated in which case "unaltered" is interpreted to mean "identical".

Actors: User, Registry

Scenarios:

1. The User acquires a resource.
2. The User locates a hash value (and hash function) for the resource.
3. The User calculates the hash value for the resource.
4. The User compares the calculated hash value to the known hash value for the resource.
5. The User determines whether the resource is unaltered.

5.5.2. Lifecycle Tracking

Description: A Manager checks on the status of a resource in the system. Each resource goes through a well-define lifecycle within the system. It begins with ingestion (bringing the resource under system control), then internal review, peer review, delivery to an archive.

Actors: Manager, Registry

Scenarios:

1. The Manager inquires about the status a resource.
2. The System replies with an indicator of where the resource is in the resource lifecycle.

6. Use Case Analysis

Several common themes emerge from the use cases.

1. Each use case results in a formal expression (description) of the artifact.
2. Each resource has a unique identifier
3. Each artifact can include a requested acknowledgment
4. That each Content artifact references one or more Context artifact.
5. That each artifact has an associated hash value.
6. Each resource has a status within the resource lifecycle.

There are three basic items within the information model. The relationship of these items is hierarchical. The items are:

Artifact: An artifact is any physical or abstract item which has attributes that are described within an information model.

Product: A Product is one or more artifacts that form an identifiable cohesive unit which exists within the system.

Collection: A Collection is one or more product that forms an identifiable cohesive unit which exists within the system.

The core set of Content Artifacts are:

Sample: A sample is a single observation. Dimension 1xM
Table: A Table is a homogenous set of observations that can be ordered by time. Time series, spectrum and event lists are all examples of a Table. Dimension NxM
Image: An Image is a two-dimensional observation where each element in a given image plane is a homogenous type of data. Dimension 1xNxM
Movie: A movie is a homogenous sequence of two-dimensional observations (or renditions thereof). LxNxM
Augment: An augment is a structured set of information often associated with a range of time. Structures may be simple like a record in a table or may be complex and have an "external" specification like a SPICE kernel.
Document: A document is an unstructured set of information consisting of any combination of text, images, movies.
Software: Software is set of machine instructions to perform a task which may be constructed for a particular platform or made available as source code.

The core set of Context Artifacts are:

Campaign: A planned set of observations.
Observatory: A location where observations occur.
Instrument: A device to detect the attributes of a phenomenon.
Organization: An entity which supports the activities of an observatory.
Contact: An entity with which other entities can communication with.
Target: A spatial region or physical body.

There exists a Semantic Artifact which is used to add additional meaning to existing artifacts.

7. References

[1] PDS Roadmap February 2006
[2] PDS Level 1,2,3 Requirements, August 2006
[3] PDS4 Architecture Preliminary Recommendations for 2008 and Beyond, Nov 28, 2007
[4] PDS4 Data Model White Paper
[5] PDS4 User Support White Paper, Dec 5, 2007