MSFC PROPULSION SYSTEMS DEPARTMENT

Knowledge Management Project

NASA KM International Conference

17 - 19 July 2007

Collaborate... Communicate... Innovate... Motivate
MSFC PROPULSION SYSTEMS DEPARTMENT
Knowledge Management Pilot Project

- PSD KM Project Overview / Approach / Purpose
- Strategic Planning of PSD KM Initiative
- Systems Requirements / Design Definition
- KM Technology Architecture Description
- PSD KM System UI / Custom Features
- Future Planning
- PSD KM Search Functionality Demo
MSFC PSD KM STRATEGIC PLAN

Overview/Approach

- KM Needed to Support Knowledge Capture/Preservation and an Information Sharing Culture
  
  - "If MSFC is to remain world-class in rocket propulsion systems design and development, substantial improvement in access to current and historical design, development and operational information must be made." *
  
  - "NASA has not demonstrated the characteristics of a learning organization after investigators observed mistakes being repeated..." **

- MSFC PSD KM initiative approach
  
  - Develop a KM Pilot project, within the context of a 3-5 year KM strategy
  
  - Introduce and evaluate the use of KM within PSD
    - IT Infrastructure, Turbomachinery Community of Practice (CoP)
    - Extend KM system functionality using results-based methodology

*MSFC Knowledge Management Evaluation Proposal, BASIS for PSD KM Initiative Funding  ** CAIB report
MSFC PSD KM Initiative

Project Purpose

• Develop a Knowledge Management Strategic Plan for MSFC PSD
• Define and Prioritize KM requirements, tailored to PSD's goals and objectives
• Provide KM IT infrastructure, processes and tools to enable and promote a learning / sharing culture
• Assure enterprise alignment and extensibility of PSD KM solution
• Apply leading edge Knowledge Management technologies and organizational practices to institutionalize NASA's experiences—promoting NASA engineer's competencies and growth.
MSFC PSD KM Initiative

KM Project Key Priorities

- Improve Safety, Reliability and Quality
- Reduce risk and impact of knowledge attrition associated with an aging workforce.
- Enable Learning Sharing Culture
  - Communities of Practice, collaboration, knowledge sharing/capture
  - Training
- Provide Efficient, Effective Access To Propulsion Systems And Component Knowledge Data
  - Apply cutting edge technologies and innovation to PSD knowledge assets
  - Infuse experiential knowledge, lessons learned, best practices into decision process
  - Reduce Test/Fail/Fix cycle resulting from failures and anomalies
- Demonstrate KM utility and functionality
- Increase stakeholders' awareness of KM technical innovations and benefits
- Extend PSD KM system functionality
  - ARES propulsion systems and component designs
  - Engineering Directorate
  - MSFC...
Data Gathering

- Formed PSD KM Team
- Conducted Two Day Group Work-Session for PSD KM Strategy Formulation
  - Developed PSD KM Purpose, Objectives, Priorities
- Conducted Structured Interviews
  - Examined Engineering Process Workflows
    - Collaborative, Resource and Analytical Tool Interfaces
- Surveyed Personnel
- Performed Independent Research
MSFC PSD KM STRATEGIC PLANNING
Cultural Change

Cultural Change Survey

➢ PSD Benchmarking

Working Together
Knowledge Sharing Incentives
Enterprise KM Strategy
Existing KM Infrastructure, capabilities
Senior Management Advocacy
Skills & Competencies
Change Management
Workforce Development
Organizational Alignment
Operational Processes
Performance Measurement
Evaluation & Feedback
Accountability & Empowerment

Challenges identified:
KM Infrastructure/Tools,
Knowledge Sharing Motivation & Incentives,
Leadership Advocacy

PSD is perceived by survey respondents as being ready to accept cultural change.
MSFC PSD KM STRATEGIC PLANNING

Solutions Map

PSD KM Strategic Objectives

1. Access-Links to External Databases, and Repositories
2. Intelligent Search Capabilities
3. Enterprise System Architecture and Design
4. Access-Links to Internal Databases, and Repositories
5. Collaborative Engineering Community of Practice
6. Leverage Data-Server Ownership
7. User-Derived Interface – Presentation Layer
8. PSD KM Process Definition

PSD KM Functional Solutions

Integrated Knowledge Management System (KM)

- Collaboration (CB)
- Expert Location & Profiling (EL&P)
- Tacit Knowledge Capture (TKC)
- Content Management (CM)
- CoP Management (CoP)
- Search & Indexing (S&I)
- Portal Management (PM)
- Problem Solving (PS)

Top 10 Day-to-Day Needs

1. Access to All External Servers, Databases, and Repositories (SSME Tech, NEXPRISE, etc.)
2. Single Sign-On (SSO) for All Resources
3. Ability to Search Adobe, Image Files, Hardcopy Old Reports
4. Capture of Tacit Knowledge from All Personnel During All Project Lifecycles
5. A Collaborative Engineering Community of Practice Organized by Discipline
6. Intelligent Search and Index Tool (Multi-Tiered Search, Advanced/Boolean)
7. A Customizable User Interface Tool for Desktop for Each User
8. Utilization of the NASA Taxonomy to Structure Project Documentation
9. Access to All Internal Servers, Databases, and Repositories (Stennis RAMS, etc.)
10. Pedigree Assurance for All Project Documentation

KM Solution Aligns With Team Defined Objectives and Needs
### System Requirements and Design Definition

#### Vendor Ranking

#### Functional Rating

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<th>AskME</th>
<th>Autonomy</th>
<th>EMC / Documentum</th>
<th>Entopia</th>
<th>Invention Machine (GoldFire Innovator)</th>
<th>Microsoft / Groove</th>
<th>Tealit</th>
<th>Vignette</th>
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#### Programmatic Rating

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<th>D&amp;B Fair</th>
<th>D&amp;B Limited</th>
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<th>Product Used</th>
<th>Funding Required</th>
<th>Funding Plan</th>
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<td>&gt;250</td>
<td>&gt;4 Years</td>
<td>3 or more</td>
<td>Used</td>
<td>&gt;$500,000</td>
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<td>2 to 4 Years</td>
<td>100 to 250</td>
<td>2 to 4 Years</td>
<td>1 or 2 Clients</td>
<td>Conforms but not used</td>
<td>Requires funding</td>
<td>Requires funding</td>
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<tr>
<td>Red</td>
<td>&lt;2 Years</td>
<td>&lt;100</td>
<td>&lt;2 Years</td>
<td>None</td>
<td>Alternates/ Proprietary</td>
<td>&lt;100,000</td>
<td>Not workable</td>
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</table>

*Note: D&B = Data & Background*
System Requirements and Design Summary

- Rigorous systems engineering approach employed at project outset; User defined, user centric, concept to solution
  - Formed initial MSFC team using Integrated Product Team constituency
  - Included Shuttle Project & Engineering, ER Component Design, ED Disciplines, S&MA participants
  - CIO, Enterprise Architect, CLV Projects, CLV KM, NASA Engineering Network (NEN) represented in requirements / design reviews

- PSD KM Project Milestones Achieved
  - Strategy developed, Strategic Plan delivered February 2006
  - System Requirements defined, System Requirements Specification delivered May 2006
  - Conceptual Design Review conducted June 2006
  - Critical Design Review conducted October 2006

- System designed to align with CLV, Constellation and Enterprise Architecture
- Compliant with NIST / FIPS standards, application security plan is approved
- Delta Design Review will address final system design implementation
  - Open Source Portal Platform

Solution traceable to user defined objectives, user needs and system requirements
Solution Mapping / Verification

Implementing over 250 KM System Requirements Has Led to Product Development Effort and Phased Deployment
What is PSD KM?

Engineering Data, Collaboration and Experiential Knowledge Available with a Point and Click

Test Data Analysis

Disciplines

Lessons learned

Engineering Communities (IPTs)

Web based User Interface

Broad Range of Data Resources/Types Across the Enterprise

Network Infrastructure

SOA Integrated Tool Suite

Program Structured File System

Project Planning, Scheduling/EVM

Requirements management

Risk Management

Legacy Data

MSFC Repository

Shuttle/Apollo technical

LASSe/CASSI/RSIC...

ICE

Technical/Design Standards

Voice/Audio

Video

Internet/ Web Pages

Community Discussion Forums

Expertise Locator/Knowledge Capture

Product Data Structure

Configuration / Document Management

Hardware CAD Environment

Evaluation/approval workflow/routing
MSFC KM Key Functionality

**Key KMS Features:**

- Single sign-on access and advanced data search of unstructured & structured technical data archives (Super "Google")
  - Global Search Returns from all Knowledge Sources
- Human expertise locator (Ask The Expert?)
- IPT and/or discipline focused on-line “Community of Practice” Collaboration Environment
- Knowledge capture/retrieval of discussion board/e-mail threads via on-line “Community of Practice”
- Process capture/viewer with point and click navigation to each process step instructions and all relevant data
- 3D Graphics/CAD Viewer with point and click navigation to all relevant “piece-part” data

![Diagram showing various components and functionalities of KM system]

- **Graphics/CAD Viewer drill down tool**
- **Process Capture/Viewer drill down tool**
- **Voice/Audio Search**
- **Video Search**
- **User approved E-mail postings to CoP**
- **Community of Practice (CoP) Collaboration & Discussion Forums**
- **Expertise Locator/Knowledge Capture**

**Internet/Web NASA Eng Network**

- **ICE**
  - Structured Program/Project File Archive
  - Project Planning, Scheduling/EVM
  - Requirements management
  - Risk Management

**Legacy and New Technical Data**

- Engineering File Shares
- MSFC Repository
- Shuttle/Apollo technical
- CASSI – Technical Journals
  - LASSE, RSIC, others....

**MSFC IEC / DDMS**

- Integrated Design Environment
  - Product Data Management
  - Configuration & Data Management
  - Work flow routing for approval
PSD KM Data Architecture Solution

- PSD KM Aligns with key CLV, Constellation and Enterprise data architecture needs
  - **Data integration and user requirements definition**
    - Engineering Community (IPT) defined requirements
    - Engineering process models (value steams)
    - Enabling data architecture, tools, collaborative, training and knowledge resources identified, mapped, integrated
  - **IT Solution User Interface Definition**
    - Develops / extends IT solution to establish a web base engineering community interface
    - Provides immediate access to mission enabling resources
  - **Leverages pilot system infrastructure and SOA KM technology investment to offer critical data architecture solutions**
"Question?"

Employee Has a Problem and Turns to the KM System for Assistance ...

Experienced Practitioner Provides Solution

Knowledgebase
Processes
Previous Solutions
Lessons Learned
Training

... and It Is Shared With Others Who Benefit

Global search of data resources

MSFC PSD KM PROJECT
Knowledge Capture

Experienced Practitioners

Employee Receives The Solution

Browse / Search / Discussion

Document Management Systems

File shares

Other
MSFC PSD KM PROJECT
Expertise Locator/Profile Builder

NASA Competency Management System
Resume
Technical Papers
Patents
Projects, Products, Insight, Hands-On Experience
PSD KM Profile Creation / Maintenance Pages
User Interface
MSFC PSD KM PROJECT
User Interface Navigation Flow

Single Sign-On Access

Turbine blade ECP

Categories
- Home
- Lessons Learned
- Best Practices
- Configuration
- Critical Design Review
- Drawings
- Engineering Change Proposals (ECP)
- Field Engineering Change (FEC)
- Hardware Readiness Review (HRR)
- High Pressure Oxidizer Turbopump (HPOTP)
- Material
- Critical Items List (CIL) / Hazards
- Failure Mode & Effects Analysis (FMEA)
- Design Environment
- History
- Non-Conformance
- Service Life
- Verification & Validation

Retrieval Results
1 - 6 of 501 entries

- COMMUNITIES
- PROCESS
- CAD VIEWER
- MY PAGE
- SEARCH

- RETRIEVAL
- COMMUNITY
- CATEGORIES
- CLUSTERING
- SAVE

Advanced B&
Turbine blade ECP

Query Parameters
- ENGINEERING CHANGE
- PROPOSALS: Approved with Changes
- Rocketdyne control applied Sheet 1 of 789
- Contract: CAGE 026022; Contract: 5
- FCN: 4; ECP No: 5; Rev: PM & Whitney Rocketdyne, Inc; NASC 01100; 176294
- [Source: CategoryTraining]
- [Size: 4236 KB]
- [spendingCategoryTraining_ECP_JPDF116519.pdf]

- ENGINEERING CHANGE PROPOSAL Sheet 1 of 466
- Pages Affected: Remarks NASA Disposition Authority Basic This ECP is to update the SSM Hazard report for the MNAS application.
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MSFC PSD KM PILOT PROJECT
Process Workflows Integral to KM Architecture

Failure / Anomaly Analysis Process

Design Engineering Analysis Process
MSFC PSD KM PROJECT
User Interface Navigation Flow

Overview Map
110%

Process Step Name: Develop / Update Fault Tree Matrix / Pro Con Chart

Process Description: The Fault Tree Matrix supports the Fault Tree Analysis Diagram by providing a worksheet of failure causes, fault tree cross references, pros (evidence supporting contribution to the observed condition), cons (evidence exonerating the cause as a contributor to the observed conditions) and status. This will be a working document and will be updated until the investigation is complete, and all credible causes dispositioned.

MSFC PSD KM PROJECT
User Interface Navigation Flow

Community of Practice Process Workflow Navigation

4.0

Develop & Maintain Event Timelines
Create Fault Tree Analysis / Failure Path Diagram
Develop Fault Tree Matrix / Pro/Con Chart

Typical process decomposition

Examine Existing Fault Trees & FMEA for Applicability
Identify All Possible Causes & Contributions
Tailor Existing or Create Failure Path Diagrams
Tailor Existing or Construct the Fault Tree

This step examines existing hazards analysis fault logic diagrams to assess relevance to observed conditions.
The purpose of this step is to identify and list all possible failure / anomaly causes and contributing elements. Subsequent steps will rule potential causes in or out based upon analysis, modeling, testing and / or inspections. In some cases, causes may be classified as Unknown or Inconclusive.
The purpose of this step is to create Failure Path Diagrams to support the Fault Tree Diagram. Tailoring existing component fault trees (EHAZARDS)
This step compiles failure scenarios and fault path diagrams into a specific failure logic model.
Process Description
This step compiles failure scenarios and fault path diagrams into a specific failure logic model.

Procedure(s)
NPR 8621.1A_Fault Trees

Affected Disciplines
Design Engineering, S&MA and support contractors

General Notes

Data Resources
EHAZARD, FMEA, DOCUMENTUM, Design Drawings, dedicated data server/computer

Input Artifacts
EHAZARD, FMEA, Design Drawings, observed HW conditions

Examine Existing Fault Trees & FMEA for Applicability
This step examines existing hazards analysis fault logic diagrams to assess relevance to observed conditions.

Identify All Possible Causes & Contributions
The purpose of this step is to identify and list all possible failure / anomaly causes and contributing elements, rule potential causes and identify those that are causes and contribute.

Example Cases
SSME 0523 902-772 Failure Invest. of AOIs (entire report) pg16 Event FT Graphic (specific element)

Tailor Existing or Create Failure Path Diagrams
The purpose of this step is to create Failure Path Diagrams to support the Fault Tree Diagram. (or reusing existing component fault tree)

Tailor Existing or Construct the Fault Tree
This step compiles failure scenarios and fault path diagrams into a specific failure logic model.
MSFC PSD KM PROJECT
User Interface Navigation Flow

Process Worksheet

Process Description
This step compiles failure scenarios and fault path diagrams into a specific failure logic model.

Procedure(s)
NPR 8621.1A_Fault Trees

Affected Disciplines
Design Engineering, S&MA and support contractors

General Notes

Data Resources
EHAZARD, FMEA, DOCUMENTUM, Design Drawings, dedicated data server/computer

Input Artifacts
EHAZARD, FMEA, Design Drawings, observed HW conditions

Output Artifacts
Event Fault Tree Graphic, Hernandez engineering, CAFTA modeling tool

Templates
Fault Tree Template

Checklists

Example Cases
SSME 0523 902-772 Failure Invest. Report (entire report)
pg16 Event FT Graphic (specific ex.)

Training
MSFC PSD KM PROJECT
User Interface Navigation Flow
MSFC PSD KM PROJECT
User Interface Navigation Flow
MSFC PSD KM PROJECT
User Interface Navigation Flow

Find Number: 0123456789  Material Properties
Quantity (per build): 123456  Readiness Review
Drawing Number: 7890-1234  902-772 Incident
Material: Super Alloy  Hydrogen Flow

Graphic “Drill - Down” Capability
Component Details View
MSFC PSD KM PROJECT
User Interface Navigation Flow

Atlantis STS-106
Space Shuttle Program
SSME Flight Readiness Review

Find Number: 0123456789  Material Properties
Quantity (per build): 123456  Readiness Review
Drawing Number: 7890-1234  902-772 Incident
Material: Super Alloy  Hydrogen Flow

Graphic “Drill - Down” Capability
Component Details View (Links)
### MSFC PSD KM PROJECT

**Communications & Roll-Out**

- **PSD KM System Briefings:**
  - JSC Knowledge Management Conference 02 March 06
  - ER Dept. Managers Brief 06 April 06
  - MSFC Technology Council 11 April 06
  - ED Management Brief 02 May 06
  - SSME Project Management Brief 09 May 06
  - SRS Review (Stakeholders) 31 May 06
  - Conceptual Design Review (Stakeholders) 29 June 06
  - PWR Meetings, Canoga Park 11 July 06
  - HQ Meetings, CIO, InsideNASA/NEN/ESMD 13 July 06
  - NACB-ISCB Brief 23 August 06
  - Preliminary Design / UI Review (Stakeholders) 29 August 06
  - Critical Design Review (Stakeholders) 03 October 06
  - WEB PCASS 07 February 07
  - Enterprise Architecture Advisory Committee 17 February 07
  - Engineering Management Council 20 February 07
  - RSIC 23 February 07
  - IEC/DDMS 27 February 07
  - Exploration Launch Office Brief 05 March 07
  - IHS/NASA Tech Standards 22 March 07
  - CIO/ED/CLV Data Architecture 26 March 07
  - Cx Data Architecture Working Group 23 April 07
  - CLV Chief Engineers Brief 20 April 2007
  - NASA HQ IDM Workshop 24 – 26 April 2007
  - CLV Element Managers 08 May 2007
  - Directives Access CIO 17 May 2007
  - Cx ARC Architecture Team 22 May 2007
  - PWR KM Program Manager Review 24 May 2007
  - Engineering Directorate Review 13 June 2007
  - Propulsion Department Review 14 June 2007
  - NASA KM International Conference 17 – 19 July 2007
MSFC PSD KM Initiative

MSFC PSD KM Information -

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Support
## DATA Resource Connection

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- **Pilot Indexed**: Phase II
- **MOU Negotiation Underway**: Long range
MSFC PSD KM PROJECT

Unique Functionality

• **Community of Practice** – Provides a forum for individuals with shared interest or expertise to exchange ideas and experiential knowledge
  - Collaboration / Sharing, Knowledge Capture, Expertise Locator, Training

• **Single Sign On** – MSFC domain log in provides authenticated user access to PSD KM and all authorized accounts

• **Automatic Profiling** – Monitors user data interaction preferences and automatically forms profiles of their interest and expertise

• **Categorization** – Automatically categorizes data without the need for manual intervention

• **Disparate Repository / Unstructured Data Interface** – Access data where it resides within or outside of product structure / data management system environment

• **Conceptual Retrieval** – Extracts meaning from key words and complex terminology embedded in query information; Returns search results based on concept matching
MSFC PSD KM PROJECT
Unique Functionality (Cont’d)

• **Hardware Graphics Viewer** – Point and click access from graphic image to broad range of related design information, subject matter expertise, lessons learned and training

• **Process Workflow Viewer** – Enables the user to locate relevant information within the context of a process step
  - Search and retrieval functionality from Failure/Anomaly and Design Engineering Analysis workflow navigation, "process-based" data associations

• **Expertise Locator** – Automatically identifies individuals with expertise in organizations and identifies subject matter knowledge in any required field

• **KM awareness, cultural change/motivational training** - Integral to CoP roll out
# PSD KM / PDMS Design Characteristics

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<th>PSD Knowledge Management</th>
<th>Product Data Management</th>
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<td>Individual &amp; Collective Knowledge</td>
<td>Managing Product/Project Data</td>
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<td>Contextual search outside of PDMS</td>
<td>Search limited to PDMS data structure</td>
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| Timeframe                      | Ongoing. Doesn't stop as long as the body of knowledge is relevant. | Project Life cycle. Has a finite start and end date. |

| Scope                           | Any repository or information source that contains useful knowledge | Only information contained in its internal repository. |
Componentized Resources System View

MSFC PSD KM PILOT PROJECT
Design / Architecture (Pilot)

Componentized Resources System View

PSD KM Vignette Application Portal
- Lessons Learned/Best Practice
- Personalized PSD KM Pages
- E-Mail Integration
- NIST/FIPS Security Compliance
- Tacit Knowledge Capture
- Collaboration Service Link
- Group Calendar
- NASA / PSD Taxonomy Linkage
- Expert Location & Profiling
- Publishing/Authoring (Future)
- Computer Based Training
- 508 Compliance
- CoP Content Management
- Report + Metrics Generation
- JSR-168 Portlets

Contractor & External Access
- E-Mail to CoP or Single Sign-On via NISE

NASA Taxonomy

NISE

NASA Taxonomy

Componentized Resources System View

PSD KM Vignette Collaboration Server (VCS)

Enterprise Search Engine Indexes
- InsideNASA
- NEN
- Other Agency Repositories

Video/Audio (Future)

Advanced Search Autonomy
- IDOL 7 Search & Index Engine

Invention Machine
- Goldfire Innovator
- Patent Search
- Fault Tree Gen (Future)

Workflow Process
- Process Decomposition
- Process Artifacts

CAD Viewer
- Component Level View
- Associated Data View

Hardware Viewer
- Componentized Resources System View

MAPTIS
PSD Server
SSME Technical
ICE

JETSON
MSFC Repository
MSFC PRACA
LASSE
CoP Process Creation / Maintenance

CoP User Inputs
Process / Change
- Use CoP Input Template and MS Office Suite to Propose Process Workflows
- Submit Using CoP Suggestion Box
- Post to Community Forum

CoP Moderator
Leads Review
- Recommended as Best Practice
- Review w / Initiator
- Collaborate w/ SMEs
- Approve / Reject

Enter & Validate
Process / Data
- Load Process Model / Data
- Validate in Process Viewer
- Publish in Community Knowledge Storehouse

Data Manager
- Data Manager to Allow Simple Maintenance of Process Data & Links

Community Can Create New, Change Existing and Maintain Processes ....
**MSFC PSD KM System**

**Pilot Portal Schematic**

- **MSFC Private Network**
  - SSME Technical
  - Jetson
  - PRACA
  - Inside Shuttle Shuttle Online
  - MSFC Desktop Computers
  - MSFC Domain Controller (Active Directory)
    - MSFC/PSDKM Group (MSFC users)

- **MSFC Public Network**
  - NDMSORA01 Oracle Database Server
  - NDC Domain Controller (Active Directory)
    - PSDKM Group: MSFC users

- **PSDKM Servers**
  - NDMSVIG01 Vignette Portal and Collaboration Server
  - NDMSIDL01 Autonomy IDOL Server
  - ATMSVIG01 Test Vignette & Autonomy VM
  - NDC Domain Controller (Active Directory)
    - PSDKM Group: MSFC/PSDKM

- **MSFC Repository**
- **WebPCASS**
- **Agency Public Network**

**DRAFT 01/11/07**

**NDMS**

**MSFC Repository**

**WebPCASS**

**Agency Public Network**

**MSFC Private Network**

**MSFC Public Network**

**MSFC Repository**

**WebPCASS**

**Agency Public Network**
MSFC PSD KM System

Pilot Portal Schematic, Documentum Query/Fetch

PSD KM Client

MSFC Private Network

NDC Public Network

PSDKM Servers

Vignette Portal and Collaboration Server

Autonomy DOL Server

NDMSVIDG01
xxx.xxx.xxx.xxx
Action Port: 9000
Index Port: 9001

Autonomy Documentum Fetch

MSFC Repository (Documentum)
xxx.xxx.xxx.xxx
TCP and UDP Port 1489
https://repository.msfc.nasa.gov/dam

Agency Public Network
KM Pilot System Data Security

Security Policy

- Designed for Compliance with Enterprise Architecture
- Enforcement of internal authentication models for repositories, proprietary applications, and software.
- Portal LDAP ensures automatic verification against user, group and role level entitlement
  - Will align with the NDC active directory, migrating to NISE
- KM Program will comply with NPR 2810.1, NIST 800-53
  - Moderate security classification based on FIPS 199, NIST 800-60
- Application Security Plan is in Work