USGS Data Preservation: A Path Forward

USGS Leadership 201 Team 1

1. Goal

To protect, preserve, and disseminate USGS data easily and effectively

2. Overview

As a result of US decisions driving USGS to better protect, preserve, and disseminate data easily and effectively to the Nation to save lives and dollars (Executive Branch OSTP [2013]; US Executive Order 13642 [2013]; OMB [2013]; and USGS-OSQI [2015b]), the USGS is now required to store the data associated with its publications on Trusted Data Repositories (TDRs). TDRs house and preserve USGS digital data assets for long term in a sustainable format with checksums. TDRs must meet specific metrics of digital asset preservation regarding storage and geographic location, data integrity, information security, metadata, file formats, and physical media outlined in USGS-OSQI (2015) to be certified as a TDR. Although the USGS has a 200-petabyte at EROS meets USGS-OSQI (2015) standards to be certified as a TDR, the rest (majority) of the USGS's data currently resides on approximately 5000 non-TDR certified servers across the country. Because OMB [2013] requires that all new USGS publications and associated data be made publically available upon release, these data and metadata will be required to be publically accessible from a USGS or USGS-approved TDR, the USGS must develop and maintain one or many TDRs to host and serve these data.

At first glance, the issue at hand can be seen as an IT procurement, configuration and implementation issue. However, the USGS is recognized as a trusted source of high-quality, unbiased data resulting from standardized procedures and policies. As such, we are framing the question in a data management context to be consistent with the recognition that data is the basis of all USGS science.

3. Benefits

The benefits of moving USGS digital data and associated products to TDRs so that they may be found and accessed by others are great, and would provide benefits all across the USGS and the world. Within the USGS, standardization and consolidation of data and associated metadata would reduce IT costs and needs, provide improved security, decreased fraud and abuse, increased data robustness, better foster scientific collaboration across the Mission Areas, galvanize data legacy, increases the stature of USGS, and increase cooperator access and thus OFA opportunities. USGS scientists with benefit from moving their data to TDRs because the increased access to USGS data all across the Bureau will generate new questions and lead to new discoveries, foster increased collaboration with outside partners as they become aware of and dependent on USGS data, and will generate increased citations of USGS data and products that will, in turn, result in greater scientific recognition and promotion potential. Furthermore, the movement of USGS data and metadata to TDRs will increase access to taxpayer-funded science and thus not only make our data more widely used, but increase the Nation's view of the USGS as a trusted and valuable data source. This will not only help the USGS better save lives and minimize economic losses, but also help stimulate commerce while better meshing with the actions by other Federal, state, and local agencies.

4. Impediments

As an unfunded mandate, there are significant issues that would affect the USGS at various organizational levels. Recognizing and mitigating these issues would greatly improve acceptance and adoption of the policy and use of the TDR. The following discussion is divided into several broad groups to illustrate the potential impact on that particular group.

USGS scientists
Although the 4 Instructional Memoranda from OSQI have been out for nearly a year, communications and training for scientists and support staff has been inconsistent across the organization. The overall policy goes into effect at the beginning of next fiscal year, which provides little time to provide training and resources to comply. There has been little guidance on how to handle the multitude of data types collected across the organization. Most scientists are unfamiliar with creating metadata standards, which could lead to delays in getting products published.

USGS science centers
Currently there is no provision to provide funding for centers to support this activity, and the timeline does not allow building costs into existing projects that will be creating publications in the near future. If a center decides to use an existing system as a TDR, there will be long-term hardware costs associated with the system in the center and the redundant systems outside of the center required to comply with the requirements for establishing a TDR. Many centers lack the expertise necessary to provide support for compliance with the policy. Further, its unclear on how to handle partner data that is used in a publication but is not archived in a TDR by the partner.

USGS
At the Bureau level, funding is not available to provide support for personnel to support and maintain enterprise-wide systems. Further, funding is not available for current and long-term procurement of equipment, and for costs associated with redundant systems outside of the center required to comply with the requirements for establishing a TDR. Currently there are too many programs with influence/opinions regarding this issue; these must be consolidated so there is clear guidance and oversight of the system. The procurement process could add significant time in setting up and maintaining an enterprise-wide system, as will complying with and certifying against agency IT standards.

DOI
For a cloud-based system, FISMA interpretation for the use of cloud services to meet the standards of level 3 or 4 TDR (i.e. approved services, bandwidth, security, preservation) could add significant time and expense for procuring and configuring the system. Differences in cloud services procurement differs between the USGS and DOI, along with differences in IT procurement between USGS and DOI.

5. Acceptable Options for Storing USGS Data

The team explored four possible options for USGS TDRs:

USGS physical data centers:

1) One - add on to existing EROS TDR
2) Few - build a few new, regional or mission area data centers that serve as TDRs
3) Many - certify the numerous existing servers to become TDRs

Non-USGS single system:

4) Cloud-based TDR.

6. Metrics for Evaluating Potential TDR Options

The four options listed above were evaluated via the following metrics: both up-front and long-term cost, IT personnel commitments, time to implement and maintain, ease of development and use, hardware, both physical and electronic security, standards, maintenance, hardware obsolescence, size, bandwidth, access/usage, and certification.

7. Results of Analysis

A table outlining the metrics for each potential TDR solution are listed below, demonstrating the relative weighting of each factor for the corresponding proposed solution.

Metric	Single	Few	Many	Cloud
Cost - up front	medium	high	high	low
Cost - long term	medium	medium	high	low
IT personnel	low	medium	high	low
Time	medium	medium	high	low
Ease	medium	medium	high	low
Hardware	medium	medium	high	low
Physical security	medium	medium	high	low
Electronic security	low	low	high	medium
Standards				
Maintenance	medium	medium	high	low
Obsolescence	medium	medium	high	low
Size	high	medium	low	low
Bandwidth				
Access/Usage				
Certification				

8. Recommendations

To meet 1 October 2016 deadline, it is proposed that the USGS start putting all new USGS publications and data associated with those publications into the EROS data center's TDR via IPDS and ScienceBase, respectively, where it can be found via the Pubs Warehouse and Science Data Catalog, respectively. Start process with DOI to find and evaluate Cloud options that meet DOI and USGS TDR guidelines. Once a TDR-quality Cloud option is found, contracts established, and the Pubs Warehouse and Science Data Catalog have been shown to work effectively both fiscally and operationally, show success and turn back to DOI and Congress to provide funding to support bringing all old USGS data into the Cloud.

Two general recommendation were devised. First, to use a phase IT approach to get USGS to TDR. Second is to communicated out about USGS TDR and Data Management.

<u>Recommendation 1</u>

The idea is to use a phased approach to get USGS to full OMB/OSTP TDR compliance without having to dedicate all of the resources required up front. A phased approach is also the most flexible way forward and allows the USGS to move in the direction of the mandate. Flexibility will allow USGS to change or update internal data management processes as situations or requirements arise.

Phase 1
Use the plan current plan to meet the 1 October 2016 requirement. Because the current plan is in process to establish a TDR containing Pubs Warehouse, Science Base, and the Science Data Catalog is well underway, the team suggests that it should not be interrupted.

Phase 1 Assumptions
1. ScienceBase will become an endorsed enterprise system.
2. The Science Data Catalog will become an endorsed enterprise system.

Phase 2
The second phase should make use of the TDR capability that exists at EROS. As the first phase is completed and supports metadata and publications, an expansion in dataset hosting will be required as project are completed post the October deadline is passed. This phase should be seen as a stepping stone to the final phase of the IT solution. However, a dataset classification system should be develop to determine its hosting location. EROS could potentially be used as a dark archive for infrequently accessed datasets.

Phase 2 Assumptions
1. EROS will allow for dataset hosting only.
2. This is a short-term data hosting only location until the cloud solution is ready.
3. EROS could be used as a dark archive for certain types of datasets.
4. Dataset classification system will be developed

Phase 3
Develop a cloud based solution for the archival and distribution of scientific data. This would be the final phase to get USGS to meet the Level 4 TDR specification. The nature of USGS datasets is that they will exist outside of ScienceBase and will need to be hosted as systems or application within the TDR environment to meet the mandate and distribute data as required by the mandate. The cloud gives us the best possible option for cost, flexibility and future mandates. Types of datasets may not be suitable for long term cloud hosting and should remain on government owned systems

Phase 3 Assumptions
1. The CHS cloud will continue to exist for the next 5 years
2. DOI will reconcile FISMA differences
3. More cloud services will become FISMA compliant
4. The cloud will not be used for as a dark archive

<u>Recommendation 2</u>
The team identified a need for an increase in communications about both USGS's plans for TDR and training on USGS Data Management Policy. This will help foster adoption, knowledge, and use of the mandated TDR systems. It will also help inform and educate USGS staff the status of the 3 phases outlined in the first solution.

Communications Strategies

A communications strategy should be developed for both topics, USGS Data Management Policy and Trusted Digital Repositories. Each should be composed of the follow 4 primary sections: Primary Audience, Key Messages, Communication Tools, and Delivery Tactics. A recurring, quarterly, training schedule should also be established to educate new USGS staff as well as serve as a refresher on the USGS Data Management Policy.

- Primary Audience - Identify all persons and groups at USGS that need to hear the key messages about TDR and USGS Data Management Policy.
- Key Messages - These are the messages that would be developed and communicated to the audience. See the Benefits section for examples.
- Comm Tools - USGS offers a variety of tools to help distribute key messages to audiences. Those include; Leader's Blog, internal websites, surveys, town halls, brown bags, project calendars, workshops, listening sessions, demos and examples.
- Delivery Tactics - A schedule or calendar should be developed to utilize the tools and deliver the key messages at the optimal times. The team also advises that the TDR & Data Management team go on a road show and visit each region, at a centralized location to hold listening sessions, training and face-to-face meetings.

<u>Issues Associated with the Recommendations</u>

DOI currently pushing back on USGS efforts to move products into the Cloud, despite the fact that the US Department of Defense and the National Atmospheric and Space Administration use the Cloud to store both standard and restricted-access data. It is also unclear as how to project Cloud costs far out into the future for USGS Procurement projections and how to deal with the potential closure of Cloud service providers. Another issue is the multitude of USGS groups/programs currently associated with directing and funding data management USGS group and TDRs in the USGS. We propose that a new, focused group or program be formed

9. References

Executive Branch OSTP, 2013, Increasing Access to the Results of Federally-funded Scientific Research US Executive Order 13642, 2013, Making Open and Machine Readable the New Default for Government Information
OMB 2013, Memorandum M-13-13 Open Data Policy-Managing Information as an Asset
US government Sundry Civil Bill, 1879, founding USGS requiring it to report its results to the public
USGS SM Chapter 500.24, 1993,
USGS SM Chapter 1000.3, 2003,
USGS SM Chapter 1000.4, 2004
USGS SM Chapter 502.4, 2011
USGS OSQI, 2015a, Fundamental Science Practices 2015-001
USGS OSQI, 2015b, Fundamental Science Practices 2015-002
USGS OSQI, 2015c, Fundamental Science Practices 2015-003
USGS OSQI, 2015d, Fundamental Science Practices 2015-004

Learning Tools

Tools	**Useful?**	**Comment**
Five Whys	No	Too often led completely off track; had to plan ahead in order to make it work
Visual explorer	Yes	See below
Hats	No	All hats led back to the white hat;
Soaking	Yes	We noticed a surge of new ideas at the beginning of the day
Brainstorming – verbal	Yes	Verbal and written brainstorming generated a very similar set of ideas
Brainstorming – written	Yes	Verbal and written brainstorming generated a very similar set of ideas
Dictionary	Yes	See below
Whack pack	Yes	
Storytelling	Yes	See below
PMI pillow	Yes	
Converging grids	Yes	See below
Polarity maps	No	Too many things are multi-dimensional
Diagramming	Yes	See below
Lists	Yes	
Free-form talking	Yes	
Iterative problem definition	Yes	Periodically re-visiting problem definition as individuals and as a group helped us converge on one definition
Bourbon drinking	Yes	Needs no explanation

Storytelling

Although we did not ultimately decide to use a story in our presentation, the process of creating a story was useful for refining our definition of the problem. We focused on character development and establishing a setting. As we discussed the squirrel (scientist who doesn't see the need for a TDR) and the beaver (scientist using a TDR), we realized that the biggest

difficulty with implementing TDRs is likely getting buy-in from individual scientists and Science Centers, not the technological challenges.

Here are the rudiments of the story we created: We created a story about a carefree squirrel and an OCD beaver to convey our recommendation for using a few TDRs versus many TDR's. This carefree squirrel has many acorns under various oak trees that he picks up and eats when he is hungry. His scattered organization works for him at the moment but at any given time a strong wind could blow away his entire storage facility. While along the riverbank, the OCD Beaver continually builds and renovates three distinct lodges as pantries for his wood/cellulose. The Beaver knows that if a natural disaster sweeps away one of his lodges he has two other lodges downstream that will remain functional, which will allow his food to survive.

Converging Grid

Our group found that the converging grid tool was useful for summarizing metrics for our four TDR scenarios. We spent most of the time wrestling with how to define the axes, persevering until we found two important factors that were continuous rather than categorical factors and that were independent from one another. We used the factors "COST of infrastructure and operations" and "TIME required for implementation", and estimated the relative cost and time for our four TDR scenarios. This tool also produced a visual summary that could be used to communicate our results to others.

Diagramming

Diagramming was not one of the official tools in the Leadership 201 toolbox. Our group included one person who was unfamiliar with USGS data management policies, and publications and data review procedures. After trying several other modalities, we discovered that drawing a diagram was the most efficient way to communicate the minimum information required. One person drew the original diagram and then three of us gathered around the flip-chart, modifying the diagram as the whole group discussed it. The diagram also prompted discussions to clarify the terminology we were using, and helped us identify from where we think the "push-back" from USGS scientists is most likely to come. The push-back issue is actually not related to TDRs, but we realized that some USGS scientists (and Science Centers) may conflate the Data Release policy with the TDR requirement.

Visual Explorer

Photos were used to describe metaphors and then expanded upon with each person's unique perspective. One photo depicted 100 various bicycles lined up outside a store with one person standing next to one. No two bicycles were exactly the same yet from a far their unique parts were unnoticed. One perspective saw the person as lost in a sea of bicycles similar to someone lost in a sea of data. How does the person know which one to choose? And different people could organize the bicycles in different ways. Just as data could be organized in different ways. The problem is deceptively simple. It's not just a technology issue; context also matters.

Dictionary

At random we chose nouns from the dictionary and used forced connections to capture as many ideas to connect to our learning activity. An example of this is the word, "well". A well could run dry without warning and so could funding. Another example is the word "plug". A plug can connect a lamp to electricity to create light. A TDR could connect data to a gateway for public access. A plug could also be used to block the flow of water in a bathtub. Or it could be used to plug the threat of losing data in a system.

USGS Trusted Digital Repositories

ELT Champion: **Randy Orndorff, Acting Associate Director, Office of Science Quality and Integrity (OSQI)**

Sponsor: **USGS Data Policy Team (represented by Keith Kirk, Hydrologist, OSQI)**

Issue/Challenges: The U.S. Geological Survey (USGS) has developed a plan and associated policies to increase public access to scientific publications and digital scientific data resulting from research funded by the USGS. The plan, entitled "Public Access to Results of Federally Funded Research at the U.S. Geological Survey: Scholarly Publications and Digital Data" which is effective October 1, 2016, describes how the USGS will meet requirements established by Office of Science Technology and Policy (OSTP) and Office of Management and Budget (OMB). One requirement states that supporting digital data (those data used to support the scholarly conclusions and final project data) and final project data for USGS funded research are to be made available at no cost to the public, accessible from a USGS or USGS-approved Trusted Digital Repository (TDR), and discoverable by submitting the complete metadata record to the USGS Science Data Catalog (http://data.usgs.gov).

Moving forward, there are challenges to implementation:

1. The OSTP and OMB directives provide no additional funding to accomplish these ends and hence we must maximize efficiency to minimize impact (both time and cost) on our science centers and programs;
2. In the current USGS highly distributed landscape there is only one USGS server that meets TDR requirements (EROS Data Center) but many of USGS's 5,000 servers providing data and publications do not and will need to meet TDR requirements, what should be done about this;
3. There are short-term (startup) and long-term (staffing, maintenance and operation) costs that must be considered for every server that is--or is designated to become--a TDR;
4. Datasets required to be publicly accessible may range in size from kilobytes to multi-terabytes *(Storage of many such large datasets, cumulatively reaching into petabytes and requiring significant bandwidth to achieve desired I/O rates, present significant infrastructure and data management resource challenges)*;
5. How do we deal with existing servers that do not meet TDR requirements?

Background Material/Resources:

- USGS Web Site "Public Access to Results of Federally Funded Research at the U.S. Geological Survey" which includes a link to the 25-page USGS public access plan where

sections 3 and 9 are most relevant and also offers a Flash-based module summarizing the plan.
- Standards for USGS TDRs (USGS intranet FSP web site)

Charge/Expectations: Develop a consensus document recommending the best approach to meeting OSTP and OMB requirements for making USGS data publicly accessible from TDR(s). These ideas may include:

- Carefully weighing the cost and benefits, strengths and weaknesses of science center specific, mission area specific, or an enterprise solution for developing and maintaining TDRs ();
- A communication strategy to explain your preferred solution;
- Buy in – what is the benefit to the USGS of your preferred approach and how do you demonstrate this?
- Accountability – what does it look like?
- How should this be funded?
- Role of current and future 'trusted' external (USGS-approved but not managed) data repositories in terms of rationale, reliability, desirability, costs, and potential pitfalls.

Please think broadly about the options to make this document the best it can be.

Leadership 201 Creativity Tools

Visual Explorer – Photos were used to describe metaphors and then expanded upon with each person's unique perspective. One photo depicted 100 various bicycles lined up outside a store with one person standing next to one. No two bicycles were exactly the same yet from a far their unique parts were unnoticed. One perspective saw the person as lost in a sea of bicycles similar to someone lost in a sea of data. How does the person know which one to choose? And different people could organize the bicycles in different ways. Just as data could be organized in different ways. The problem is deceptively simple. It's not just a technology issue; context also matters.

Dictionary – At random we chose nouns from the dictionary and used forced connections to capture as many ideas to connect to our learning activity. An example of this is the word, "well". A well could run dry without warning and so could funding. Another example is the word "plug". A plug can connect a lamp to electricity to create light. A TDR could connect data to a gateway for public access. A plug could also be used to block the flow of water in a bathtub. Or it could be used to plug the threat of losing data in a system.

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Converging Grids -

Diagramming –

USGS Data Preservation: The Path Forward
Creative Learning Tools

USGS Leadership 201 Team 1: Trusted Data Repositories
Miranda Fram, Sheryl Markham, Curt Storlazzi, John Walker, and Tim Woods

Tools	**Useful?**	**Comment**
Five Whys	No	Too often led completely off track; had to plan ahead in order to make it work
Visual Explorer	Yes	See below
Thinking Hats	No	All hats led back to the white hat
Soaking Time	Yes	We noticed a surge of new ideas at the beginning of the day
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Diagramming	Yes	See below
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Storytelling

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Converging Grid

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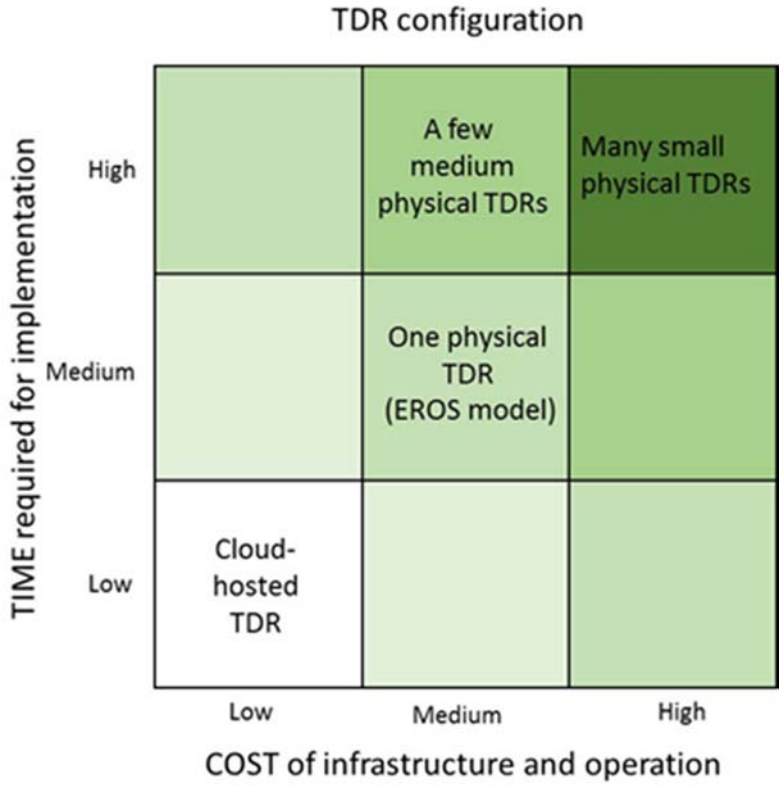

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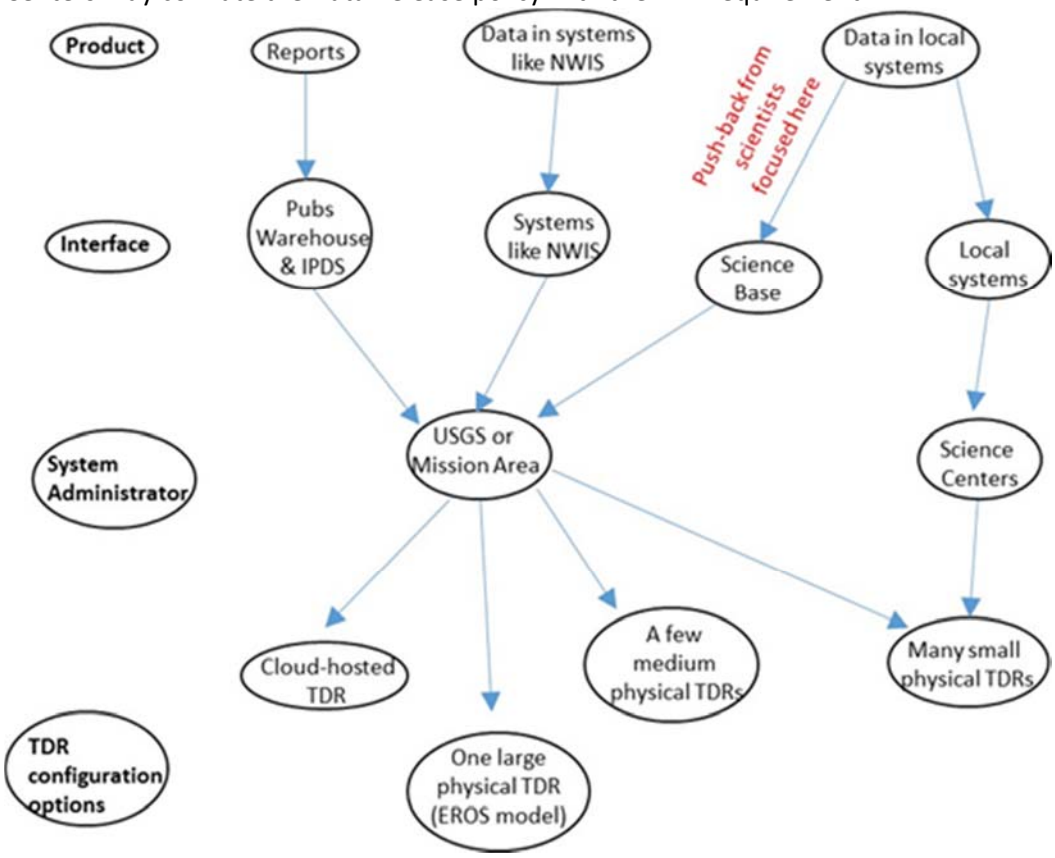

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Visual Explorer

Photos were used to describe metaphors and then expanded upon with each person's unique perspective. Even though one had picked the photo to highlight a few points, what was really interesting was how others saw numerous other means in the photo related to the topic that the one choosing the photo had not noticed. One photo depicted 100 various bicycles lined up outside a store with one person standing next to one. No two bicycles were exactly the same yet from a far their unique parts were unnoticed. One perspective saw the person as lost in a sea of bicycles similar to someone lost in a sea of data - how does the person know which one to choose? Furthermore, different people could organize the bicycles in different ways, just as data could be organized in different ways. The problem is deceptively simple: It's not just a technology issue - the context matters.

USGS
science for a changing world

USGS Data Preservation: A Path Forward

Miranda Fram
Sheryl Markham
Curt Storlazzi
John Walker
Tim Woods

Leadership 201 – August 2016

U.S. Department of the Interior
U.S. Geological Survey

Agenda

- Assessment of the Situation
- Overview
- Potential Options, Metrics & Analysis
- Recommendations
- Creative Learning Tools

USGS

Assessment of the Situation

- Action Learning Scenario Challenge
- Dilemma
- Reframing the question

USGS

Overview

- Goal
- Organizational Advantages
- Organizational Challenges

USGS

Filling in the Details

- Potential Options
- Metrics
- Analysis

USGS

Recommended Solutions

- Recommendation 1 A phased IT approach to TDR
  - Phase 1 Continue with current solution
    - ScienceBase Becomes enterprise system within TDR
    - Science Data Catalog Becomes enterprise system within TDR
    - Pubs Warehouse – Hosted in TDR
  - Phase 2 – Take advantage of TDR capabilities at EROS
    - EROS will allow dataset hosting only
    - Short until Phase 3
    - Potential Dark Archive
    - Dataset classification system developed
  - Phase 3 Cloud based TDR
    - CHS continues for next 5 years
    - DOI reconciles FISMA differences
    - More cloud services become FISMA compliant
    - Cloud is not used for Dark Archive

USGS

Recommended Solutions

- Recommendation 2 Communications & Training
  - Communications Strategy on TDR & Data Management Policy
    - Primary Audience
    - Key Message
    - Communication Tools
    - Delivery Tactics
    - Data Management Policy requires more staff training

USGS

Creative Learning Tools

USGS

Tools	Useful?	Comment
Five Whys	No	Too often led completely off track; had to plan ahead in order to make it work
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Lists	Yes	
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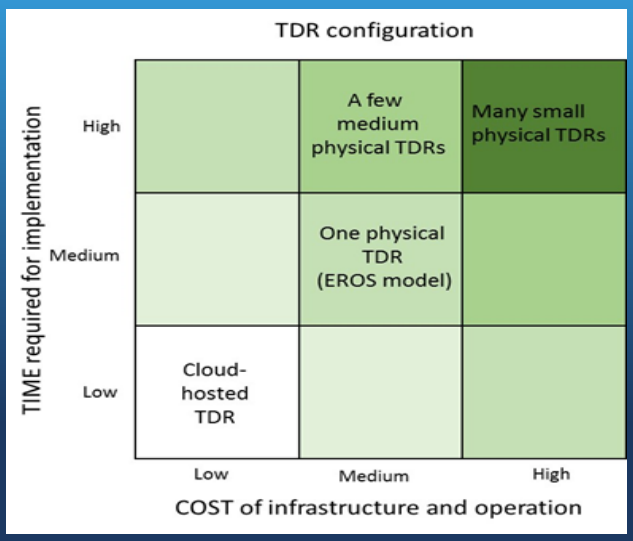
USGS

10

Visual Explorer
Story Telling
Dictionary

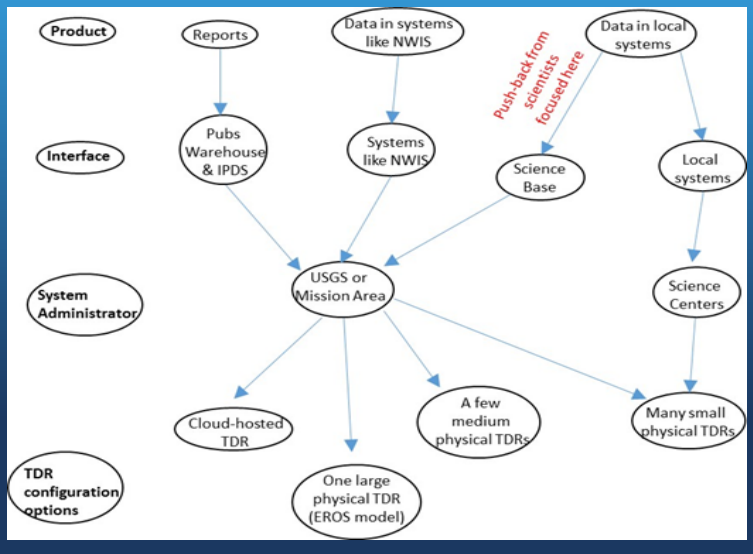
USGS

Converging Grids



USGS

Diagramming



USGS

13

Q & A

What else would you like to know?

USGS

USGS
data
requirements
TDR
Geological
Survey
accessible
plan
funded
Digital
USGS-approved
research
servers
scientific
specific
cost
Data
meet
OMB
challenges
Public
Office
Science
access
U.S
publicly
OSTP
public
Federally
current
project
may
Access
Results
Research
costs
approach
publications
server
final
many
Trusted
solution
significant
preferred
TDRs
must
Funded
science
digital
Repository
Repositories
Center
Material/Resources
Flash-based
document
Develop
Role
making
consensus
reliability
scholarly
Publications
describes
Web
module
centers
offers
benefit
staffing
buffing
Background
accomplish
supporting
large
efficiency
explain
support
area
time
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