



Data Grid Management System

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Why do we need Data Grids?



- Seamless access to widely distributed data
- Sharing of data across security/administrative realms
- Large Data Scales – Millions of Files and PetaBytes
- Large-scale data movement & Access to multiple data sets
- Mediate access control across administrations
- Data Placement Strategies - Replication, Segmentation, Staging, Distributed Cache Management
- Distributed Computation & data stored beyond computation

Virtual Organization of Data, Resources, Users and Methods



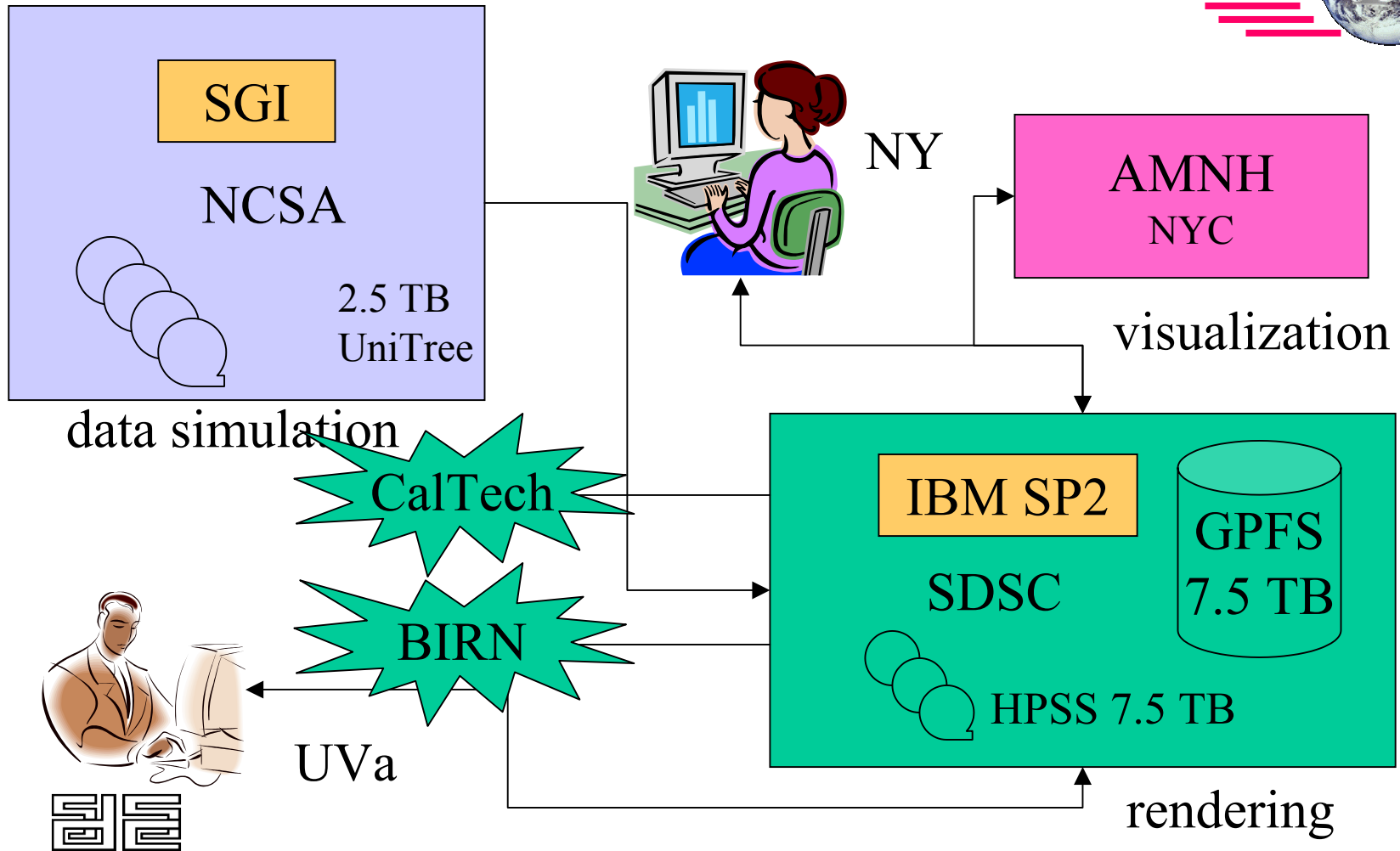
Data Grids – An Analogy



- Power Grid Analogy
 - Multiple power generators
 - Complex transmission networks with switching
 - Simple Usage Interface – plug and play
 - Guaranteed Supply - Meeting of demands (peak and lull)
 - Complex cost function
- Data Grid Architectures
 - More than one data provider
 - Movement of data across computer networks
 - Seamless Access to Data with good ‘Finding Aids’
 - Guarantee of Data Access
 - Access Control, Authentication, Quotas & Complex Usage Costing



Case Study: Hayden Planetarium



Data involved in Hayden



- ISM = Interstellar Medium Simulation
 - run by Mordecai Mac Low of AMNH at NCSA
 - 2.5 Terabytes sent from NCSA to SDSC.
 - Data stored in SRB (HPSS, GPFS).
- Ionization :
 - Simulation run at AMNH
 - 117 Gigabytes sent from AMNH to SDSC.
 - Data stored in SRB.
- Star motion:
 - Simulation run at AMNH by Ryan Wyatt
 - 38 Megabytes sent from AMNH to SDSC.
- Rendering Movies:
 - Intermediate Steps produced 7.5 Terabytes.
 - Data stored in SRB (SDSC, CalTech)



Data Grid Requirements



- Functional
- Logical
- Service-oriented
- Administrative
- Physical



Data Grid Requirements –1

(Functional)



- Seamless Access
- Scale in Size & Number
- Guaranteed Delivery
 - Fault tolerance, load sharing
 - Replication, Consistency Maintenance
- Handle Heterogeneity & Multiplicity - Resource Abstraction
 - Platforms & systems, vendors, types of storage, types of services, types of processes & users
- Controlled Data Movement - Grid Management
 - Demand-driven Data placement
 - Caching, archiving, version and locks
 - Third-party data movement
 - Parallel data transfer



- Server-driven or client-controlled

Data Grid Requirements –2

(Logical)



- Handle Autonomous Authentication - User Abstraction
 - Multiple Authentication Realms – single sign-on
 - Uniform user name space
- Single Point Authorization & Access Control - User Abstraction
 - Seamless authorization for distributed data
 - Roles, Tickets, Rules – inheritance & longevity
- Virtual Data Organization - Collection Abstraction
 - Data Location Independence
 - Uniform data name space, persistent identifiers
 - Collections Hierarchy
- Integrate with Metadata - Access Abstraction
 - ‘finding aids’ – complex querying & browsing
 - System, user-defined, domain-specific, application



Access Control for Metadata

Data Grid Requirements –3



- **Data Services** (Service-oriented)
 - **Third party services**
 - **Web- accessibility (HTTP GET, WSDL, SOAP)**
 - **Language API**
 - **Computational Grid Interaction - Globus**
 - **Examples**
 - Ingestion, Certification and Authenticity
 - Value-added integration
- **Server-side Operations**
 - **Close-to-data**
 - **Proxy-operation (security/access considerations)**
 - **Bulk Operations - batch**
 - **JIT operations – interactive or on-demand**
 - **Seamless Chaining and Composition**
 - **Examples**
 - Data Filtering – Eg. Data Cutter
 - Format Conversion – Eg. Thumbnail creation
 - Metadata Extraction



Data Grid Requirements -4

(Administrative)



- Virtual Administration - Administration Abstraction
 - Single-point administration
 - Autonomous local control
 - Multiple-levels of administrations –
 - Roles and Responsibilities
 - Policy Management
 - Distributed Caching, Archiving, Replication & Data Placement
 - Locking, Pinning, Back Up
 - Data Movement
 - Preferences, Priorities Administration
 - Auditing, Quotas, Pricing



Data Grid Requirements – 5

(Physical)

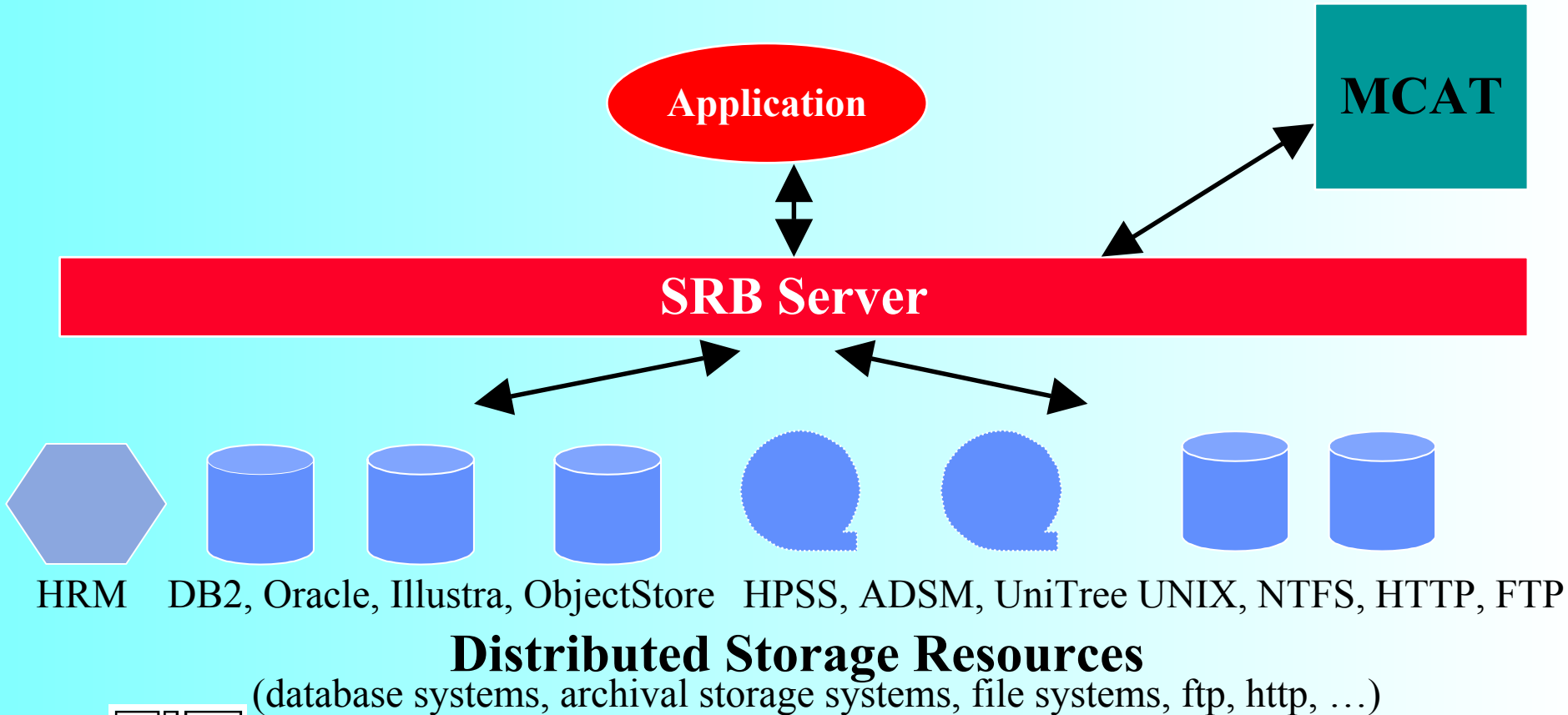


- Storage
 - Hierarchical Storage Systems, Tapes, Disks, SAN, NAS, NFS, Databases, FTP servers, HTTP servers, WSDL services, ...
 - Integration on Device Characteristics
 - Storage Bricks
 - Distributed Cluster Storage
- Network
 - Characteristics
 - NWS
 - Guaranteed Service



SRB – A Data Grid Solution

- The Storage Resource Broker is a Middleware
- It provides uniform access to data in heterogeneous resources
- It uses a MetaCatalog to facilitate the brokering



SRB Concepts



- **Abstraction of Data and Collections – Virtual Data Organization**
 - Virtual Collections: Persistent Identifier and Global Name Space
 - Organization independent of physical location
- **Virtual Data Management**
 - Replication & Segmentation
 - Data Aggregation: Containers
 - Seamless Cache Management and Data Placement
- **Metadata & Data Discovery – semantic linking**
 - System Metadata - metadata needed to run a data grid
 - User-defined Metadata – Structural & Descriptive
 - Application, Schema-based, Domain-centric
 - extensible and dynamic
 - Attribute-based Access (path names become irrelevant)



SRB Concepts



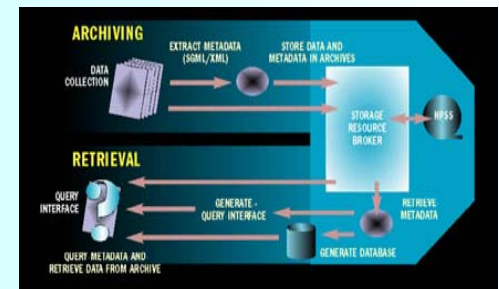
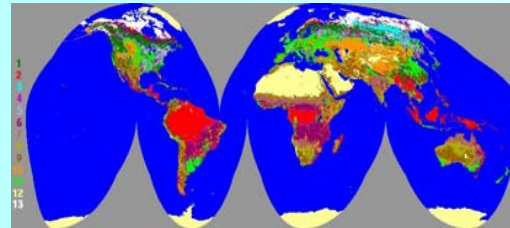
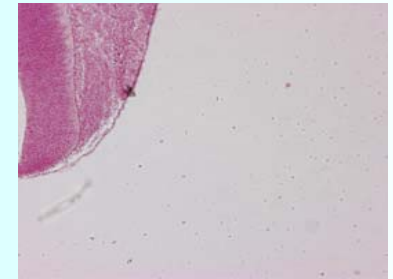
- **Abstraction of User Space – Global User Space**
 - Single sign-on & Seamless Authorization
 - Certificates, (secure) passwords, tickets, group permissions, roles
- **Abstraction of Methods**
 - APIs, Command Line, GUI Browsers, Web-Access (Portal, WSDL, CGI)
 - Parallel Access with both Client and Server-driven strategies
 - Fault-tolerant and Reliable data management and
 - Proxy and Remote Operations
- **Abstraction of Resources - Resource Virtualization**
 - Resource Location, Type & Access transparency
 - Logical Resource Definitions – bundling



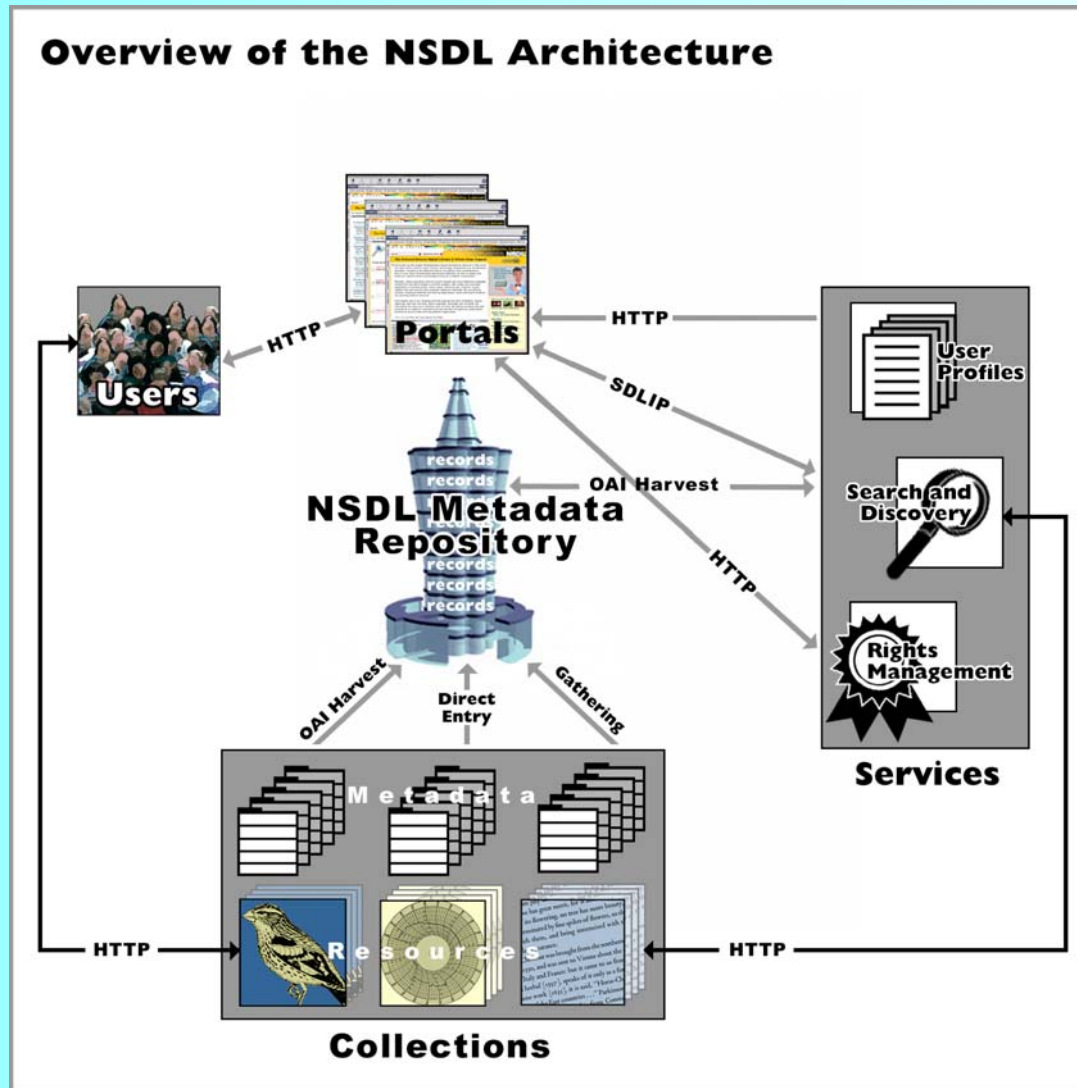
SRB Collections



- **Digital Libraries**
 - UCB, Umich, UCSB, Stanford, CDL
 - NSF NSDL - UCAR / DLESE
- **Medicine**
 - Digital Embryo (NLM)
- **Earth System Sciences**
 - ESIPS
- **Persistent Archives**
 - NARA
 - LOC



NSDL



SRB Collections



- **NASA Information Power Grid**
- **DOE ASCI Data Visualization Corridor**
- **Astronomy**
 - National Virtual Observatory
 - 2MASS Project (2 Micron All Sky Survey)
- **Particle Physics**
 - Particle Physics Data Grid (DOE)
 - GriPhyN
 - SLAC Synchrotron Data Repository
- **Earth Systems Sciences**
 - LTER
- **Neuro Science & Molecular Science**
 - TeleScience/NCMIR, Brain Images
 - SLAC, AfCS, ...

