

CineGrid Exchange

Building A Global Networked Testbed
for Distributed Media Management
and Preservation

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Originally presented by
Shaofeng Liu, UCSD/CSE
Jurgen Schulze, UCSD/Calit2
Laurin Herr, Pacific Interface

What is CineGrid?

- Formed 2004 – non-profit international membership organization
- Mission – to build an interdisciplinary community
Focus – the research, development & demonstration of networked collaborative tools
To enable – the production, use, preservation & exchange of very high-quality digital media over high-speed photonic networks
- Members – media arts schools, research universities, scientific labs, post-production facilities & hardware and software developers, network operators from around the world
- Connected via 1 G Ethernet & 10 G Ethernet networks
For – research & education

“Learning by Doing”

Early CineGrid Projects



CineGrid @ iGrid 2005



CineGrid @ AES 2006



CineGrid @ Holland Festival 2007



CineGrid @ GLIF 2007

CineGrid Exchange

Motivations

- TERABYTES PILING UP. Need to store & distribute own collection of digital media assets. Members access materials for experiments and demonstrations.
- THE DIGITAL DILEMMA. Report published by AMPAS – lessons learned by NDIPP and NARA + pioneering research at Stanford (LOCKSS) & UCSD (SRB and iRODS)
- Create global-scale testbed = high quality media assets + distributed storage + fast networks. Explore strategic issues in digital media storage, access, distribution and preservation



CineGrid Exchange 2009

Build on the Basic Concept

- Receive “seed” funding from AMPAS to start building multi-layer open source asset management & user access framework for distributed digital media repository
- Establish Working Group: AMPAS, PII, Ryerson, UCSD, UIC, Naval Postgraduate School, UW, UvA, Keio, NTT, CESNET
- Write CineGrid Exchange functional requirements document
- Expand CineGrid Exchange storage capacity

CineGrid Exchange 2009

Phase 1 Development Goals

- Define basic workflows for ingest, distribution, & deletion
- Define CineGrid Exchange metadata schema
- Implement basic workflows using iRODS rules-based microservices to automate the management of CineGrid Exchange assets
- Deploy iRODS to all CineGrid Exchange nodes
- Enable large amounts of data transfers between nodes
- Prepare for integration of CollectiveAccess cataloging application atop iRODS-managed distributed repository

CineGrid Exchange 2010

Distributed Storage Repository

CX Node Site	Storage Type	CX Allocation
Naval Postgraduate School, Monterey CA	RAID Array	50TB
UCSD/Calit2, San Diego, USA	Sun Thumper (x4540)	66 TB
UvA, Amsterdam, Netherlands	Sun Thumper (x4540)	30 TB
UIC/EVL, Chicago, USA	RAID Array	10 TB
Keio U./DMC, Tokyo, Japan	RAID Array	8 TB
CESNET, Prague, Czech Republic	Sun Thumper (x4540)	48 TB
Ryerson U, Toronto, Canada	Sun Thumper (x4540)	57 TB
AMPAS, Los Angeles, USA	Sun Thumper (x4540)	24 TB
Total CineGrid Exchange Capacity		293 TB

CineGrid Exchange 2008

Geographically Distributed Nodes + Fast Networks



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Geographically Distributed Nodes + Fast Networks



CineGrid Exchange Development

Multi-layer Open Software Stack

User Interface & Access

Open Source Application for
Collections Management & On-Line Access

Open Source Digital Repository Interface

Open Source Middleware for Rule-based
Management of Distributed Digital
Repository Resources & Asset

Testbed Infrastructure of
Distributed Storage and Network Links

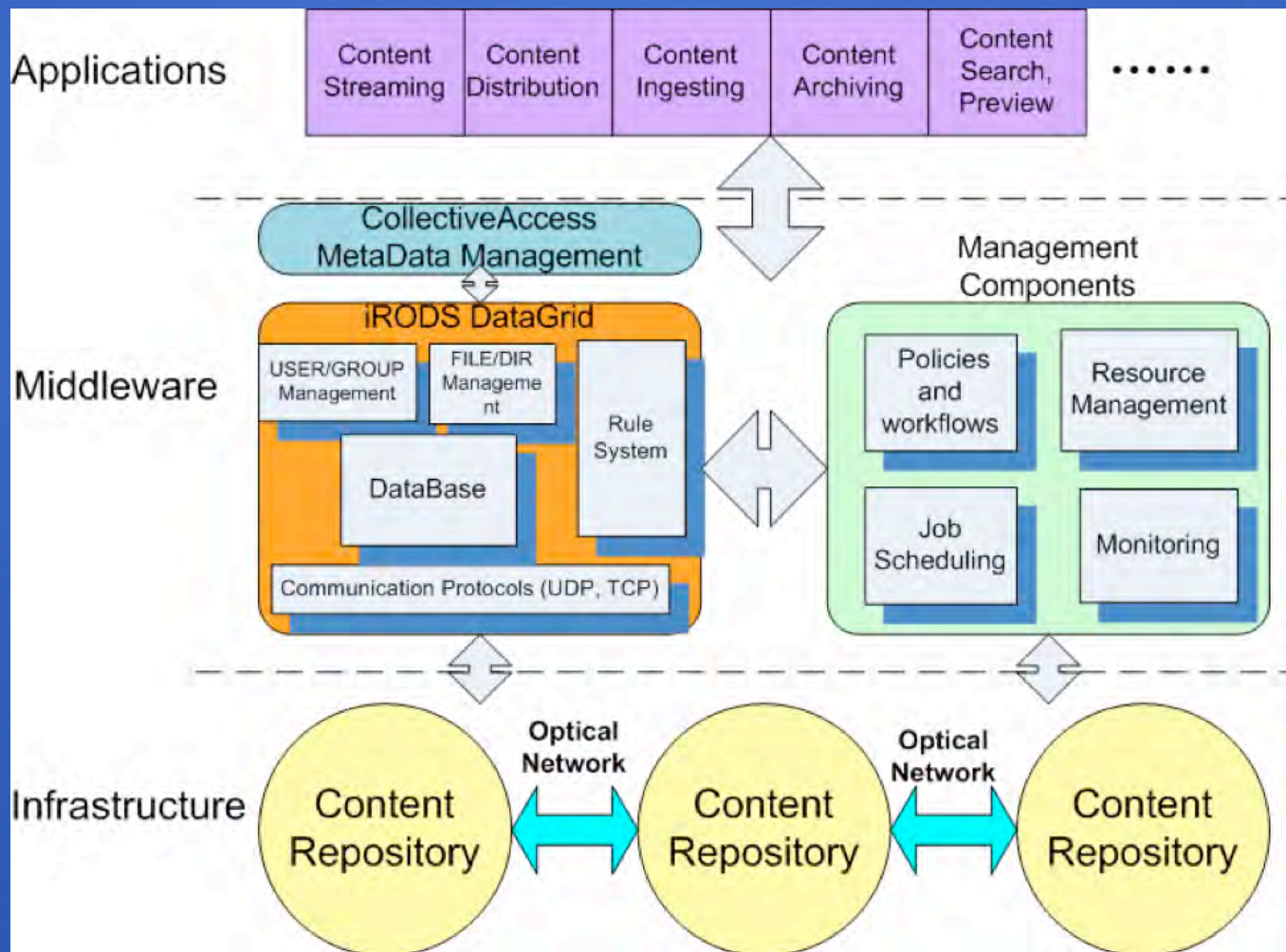
CineGrid Exchange Access Portal
For CineGrid by CineGrid

Collective Access
Extended by Whirl-I-Gig for AMPAS

iRODS by DICE
For CineGrid By Calit2

Resource Description Framework
For GLIF and CineGrid by UvA

CineGrid Exchange Architecture



CineGrid Exchange MiddleWare

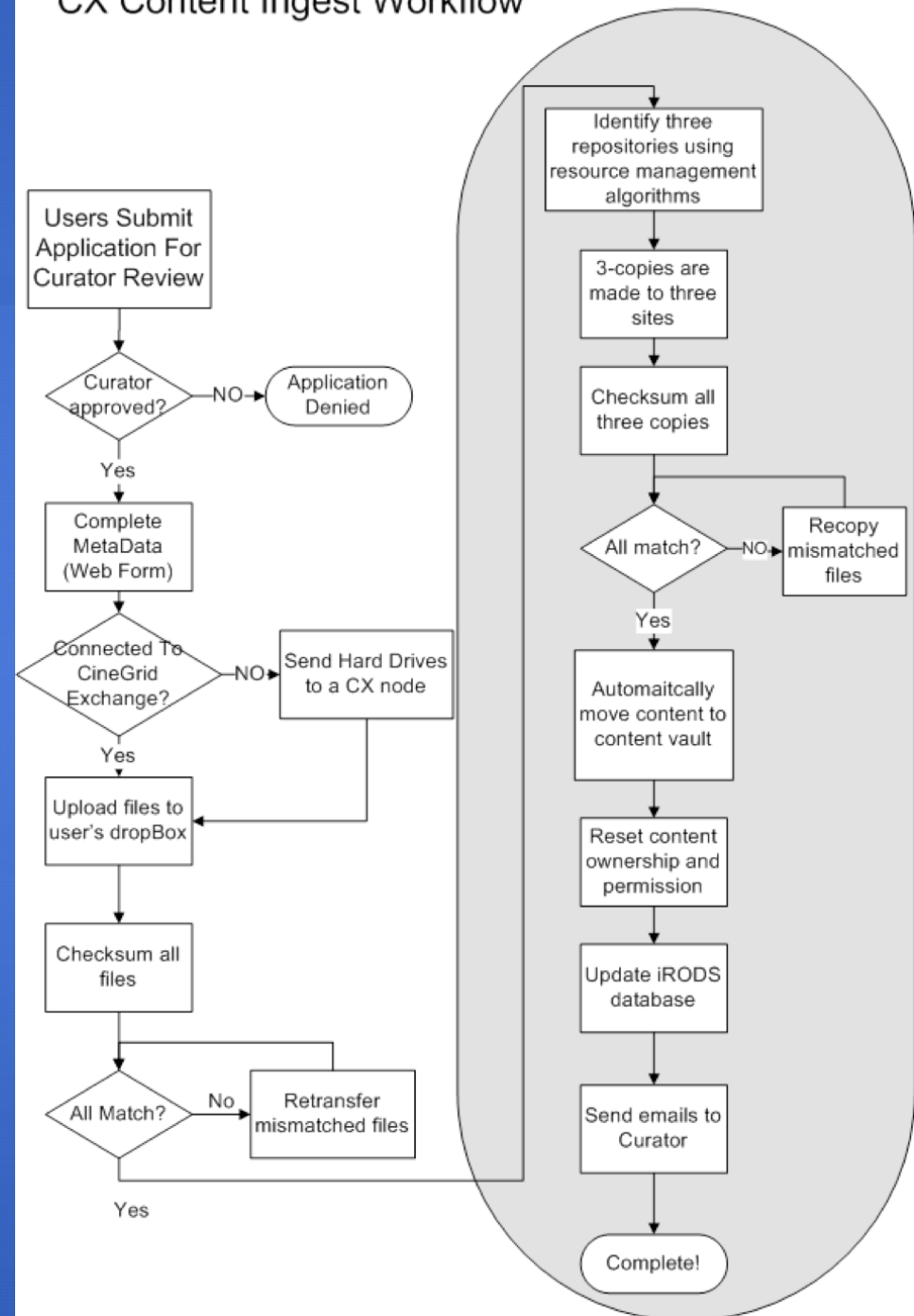
iRODS (Integrated Rules Oriented Data Services)

- Rule-based micro-services to implement management policies for automated operations across distributed storage repositories
- Transparent management of files in a distributed repository
- Independent of storage hardware or file system used at each node
- Centralized catalog (iCAT) deployed at each node
- File transfer using parallel TCP & UDP
- Multiple client API and programmable interface
- Suitable for experimenting with digital media preservation strategies

CineGrid Exchange *Ingest Workflow*

- First, complete manual steps in the workflow (currently permissions and initial metadata submissions)
- Upload files to CX drop box
- Checksum all files
- Identify three storage resources from all resources in the CX
- Replicate three copies, transfer to the three identified resources, and perform a checksum operation to confirm complete and accurate transfer
- Reset ownership = CX Curator
- Register files into iRODS database For all copies of each file, set the right access permissions
- Send notification email to the CX curator and content owner confirming successful ingest completed.

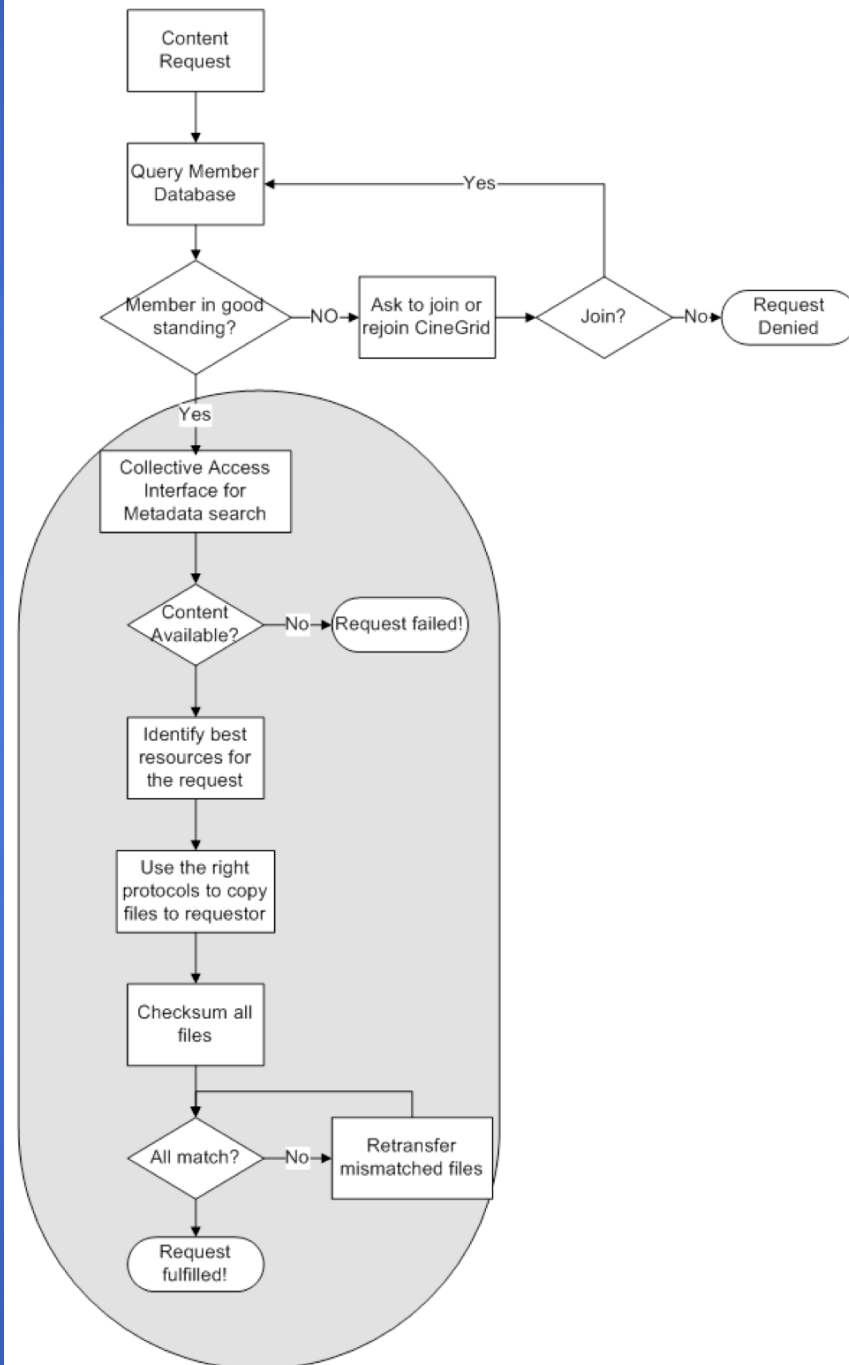
CX Content Ingest Workflow



CineGrid Exchange *Distribution Workflow*

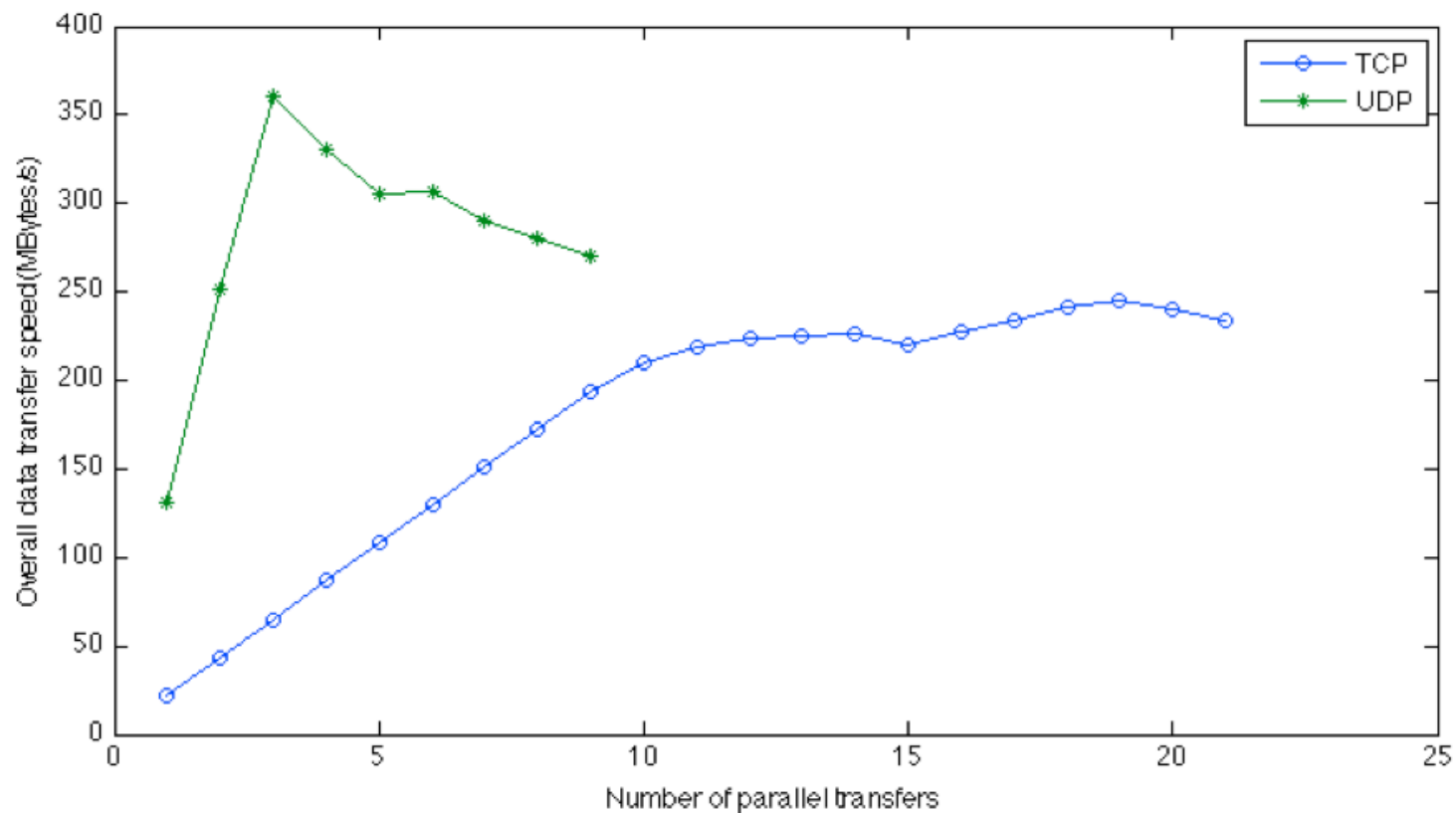
- Upon request for content, the CX metadata management interface (CollectiveAccess) will be searched to identify assets for distribution (pending integration)
- CollectiveAccess will query the iRODS resource management module to confirm availability of asset within CX distributed repository
- iRODS module will identify the best location from which to fetch the asset, set parameters and start the transfer using either TCP or UDP
- Integrity of all fetched files confirmed by checksum comparison
- Distribution permissions associated with asset checked
- Member access authorization confirmed
- Assets distributed via network or HDD

CX Distribution Workflow



CineGrid Exchange Testing

TCP & UDP Transfer Protocols



Between Keio University/DMC in Tokyo and UCSD/Calitz in San Diego

CineGrid Exchange Testing

Checksum vs. Transfer Time

Ingested Content	Sequential 50MB files		Sequential 1GB files	
	SD->LA	SD->Prague	SD->LA	SD->Prague
Transfer Cost	75%	74%	50%	42%
Checksum Cost	25%	26%	50%	58%

- Checksum calculations confirm that file transfers are complete and accurate
- CineGrid Exchange testing suggests checksums may be a potential bottleneck
- CineGrid Exchange Working Group is investigating alternatives to checksums for insuring data integrity

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Future Research Topics

- Metadata schema testing and refinement
- Robustness testing and refinement
- Scalable transfer protocols for more efficient content distribution
- Digital archiving strategies for long-term preservation
- Transcoding and format conversion
- Content version control
- Secure content distribution
- Media search and preview
- Media streaming at very high quality
- Job scheduling
- Alternatives for checking data integrity

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- Keio University/DMC
- University of Amsterdam
- Pacific Interface
- DICE Team at UNC & SDSC



www.cinegrid.org