Implementing Digital Geolibraries in Undergraduate Education

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ADEPT Goals

- Library as a “Digital Earth”
  - Geospatial access
  - Dynamic processes
  - Visualization
- Personal, customizable libraries
- Collaborative use of distributed resources
- Support instruction and learning
- Design for users and uses
- Specify interfaces; build services

ADEPT Approach

Convergence between top-down and bottom-up activities

- Top-down: Focus on education and learning

  repeat {
  - Needs assessment
  - Prototypes
  - Evaluations
  - Requirements

  }

- Bottom-up: Evolve ADL Testbed architecture and services
  - Interface specifications
  - Service prototypes
  - Interoperability
  - Collection growth and diversity

ADEPT in Undergraduate Education

- Services enabling customized collections for learning
  - Information discovery
  - Collection creation
  - Visualization and analysis
- Applications
  - Lectures
  - Laboratory sessions
  - Collaboration between students
- First step: prototype ADEPT modules
  - Mock-up ADEPT capabilities
  - Deploy and evaluate in real courses

Modules: Knowledge Organized by *Concepts*

- Concept Model (& examples)
  - Abstract representations
    - discharge
    - streamflow
  - Concrete representations
    - (time, flowrate) pairs
    - continuous graph
  - Transformations
    - average
    - maximum
    - Fourier transform
  - Integrative examples
    - Amazon
    - Mississippi
- Benefits
  - Appropriate granularity
    - Curriculum: too coarse
    - Concepts: pick and shuffle
  - Access
    - Libraries of knowledge, organized by concept
  - Pedagogy
    - Common practice in science and mathematics

Evaluation: Goals and Context

- Goals
  - Conduct evaluation of ADEPT as an integral component of the design process
  - Assess ADEPT usability in learning situations and provide feedback to the design process
- Implementation context
  - Undergraduate courses at UCSB and UCLA in geography and other disciplines that use geo-spatial data
  - User communities:
    - Faculty
    - Teaching assistants
    - Students

Evaluation: Selected Research Questions

- How can ADEPT modules support domain knowledge, work practices, and reasoning models of the multiple disciplines that use of geo-spatial resources?
- How can ADEPT accommodate users with different skills, knowledge, cognitive styles, and pedagogical styles?
- How can ADEPT help users to view original evidence in new ways to answer scientific or geographical questions?
- How can ADEPT support the range of heterogeneous resources and their metadata necessary for learning applications? (scalability, extensibility)

Evaluation: First Year Progress

- Course
  - Geography of the Physical Environment
    - 3 sections at UCLA
      - 1 ADEPT lecture
    - 1 section at UCSB
      - 4 ADEPT lectures
- Data collection
  - Developed instruments
  - Observed classrooms
  - Gathered baseline data on student demographics
  - Conducted interviews with faculty, students, and instructional development staff
- ADEPT deployment
  - Modules
    - fluvial processes
    - hydrology
  - Content
    - Static
      - slides
      - scanned images
      - Web
    - dynamic
      - sound
      - QuickTime movies
      - simulation packages
  - PowerPoint presentation
    - screen 1: lecture notes
    - screen 2: illustrations

Evaluation: Selected Initial Results

- Faculty approaches to teaching the same core course vary widely in
  - intellectual framing of course content
  - teaching styles
  - presentation of topics
- Faculty wish to integrate additional materials into ADEPT, which has implications for
  - system design
  - management of intellectual property
  - sharing of resources
- Even faculty who employ high end technology in their research tend to rely on
  - chalkboards
  - overheads
  - slide projectors

  for instruction.
- Display, layout, and other presentation features are important considerations. Visual context must be provided by
  - clear labeling
  - zooming
  - use of recognizable geographic features

  and other means

Testbed: Concepts

- a distributed catalog system
  - Library
    - set of collections
    - client (public) services
  - Collection
    - set of holdings
    - metadata reports
    - library (internal) services
  - Holding
    - unique identifier
- Holdings have footprints
  - Earth surface location(s)
    - point
    - bounding box
    - polygon(s)
  - Gazetteer converts names ↔ footprints
- Services accessible via HTTP
  - Methods = URLs
- Metadata encoded in XML
  - Queries
  - Reports

Testbed: Metadata

- "Search Buckets"
  (generic query metadata)
  - Geographic locations
  - Dates
  - Types
  - Formats
  - Originators
  - Subject-related text
    - Assigned terms
  - Identifiers

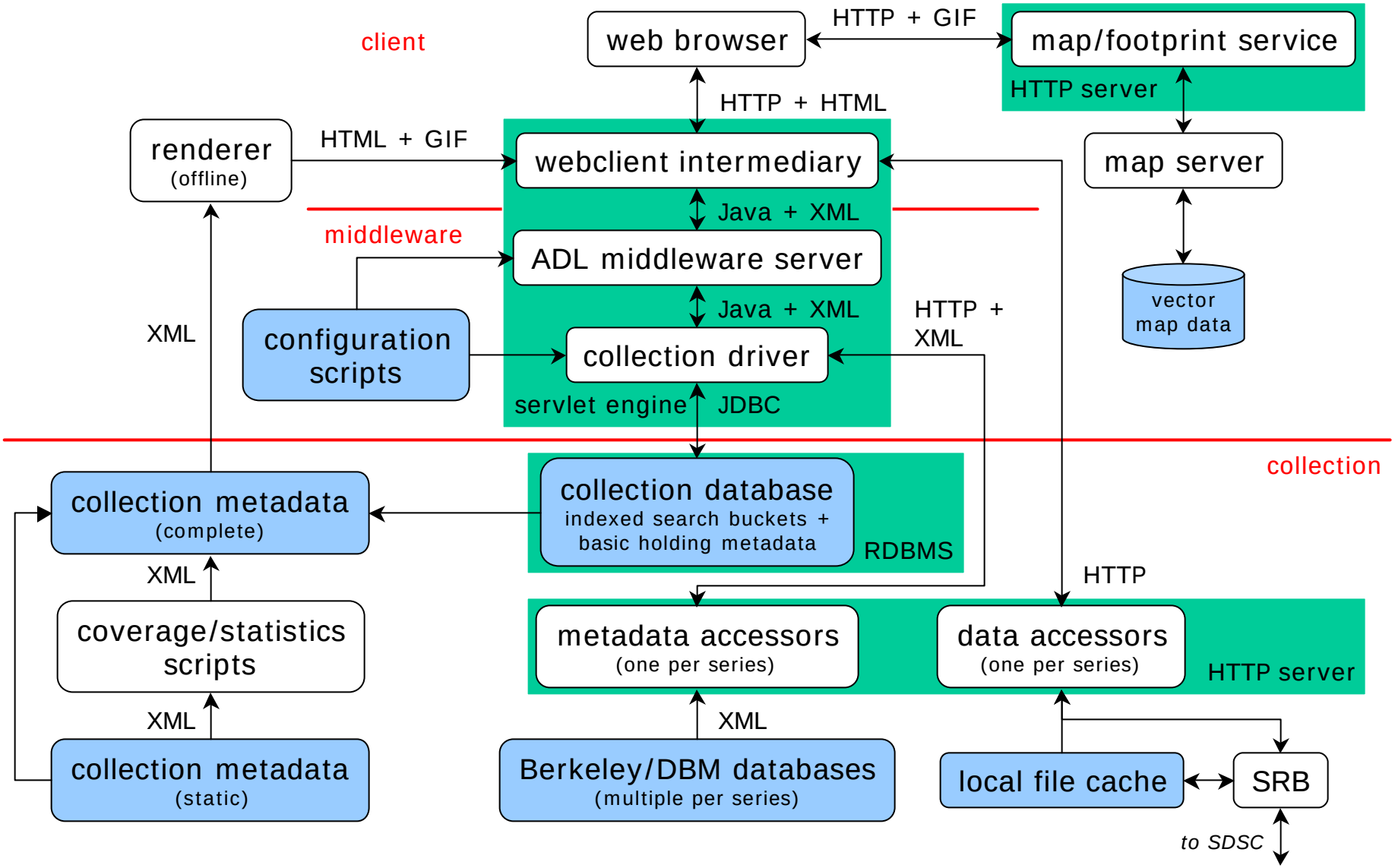
- Reports
  (descriptive metadata)
  - Collection
  - Scan
  - Full
  - Browse
  - Access

Testbed: Services

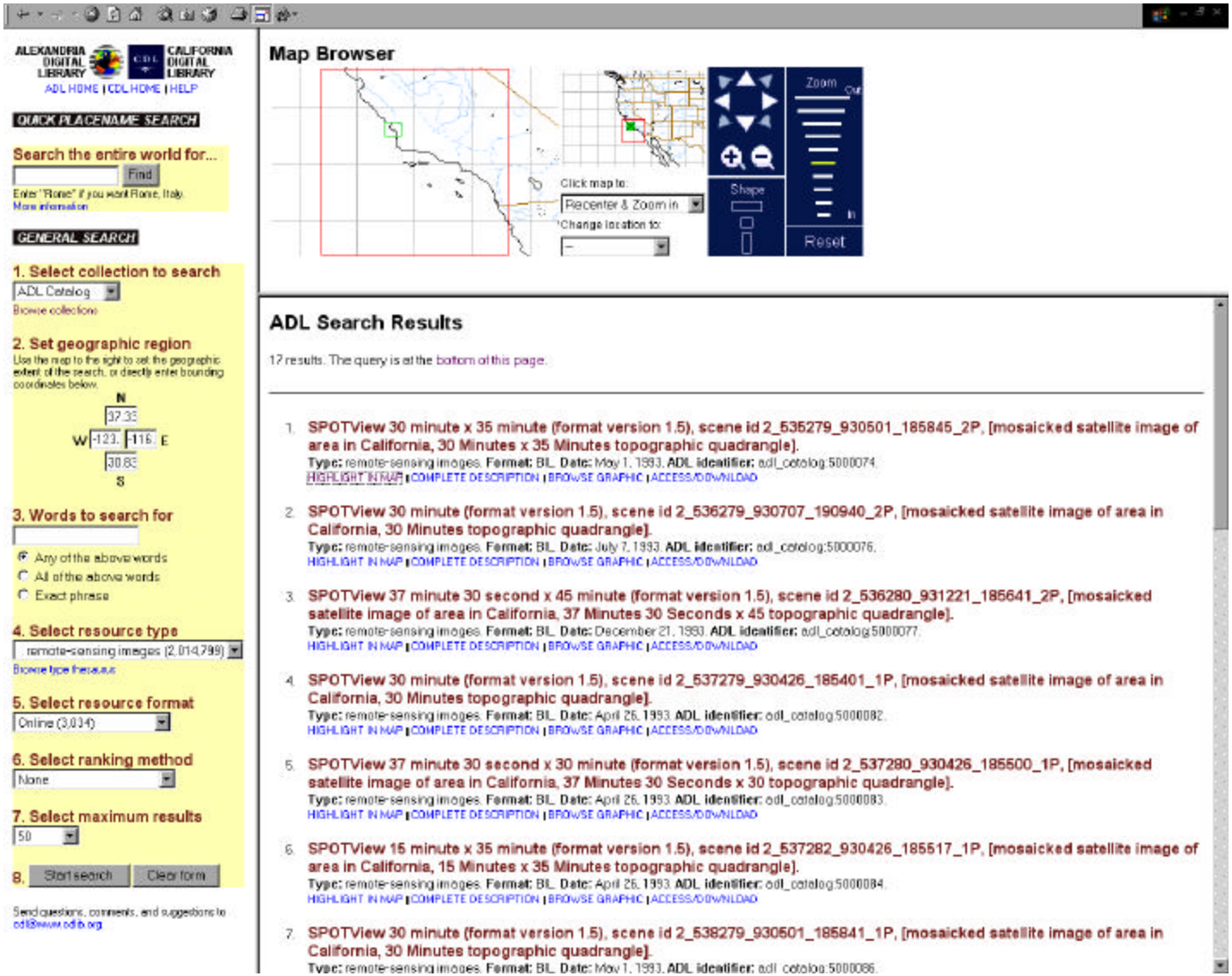
- **Configuration** → *{collection-id}*
- **Collection**(*collection-id*) ® *report*
- **Query**(*query*) ® *query-id*
- **Results**(*query-id*) ® *{holding-id}*
- **Metadata**(*collection-id*, *holding-id*, *view*) ® *report*

- **Collection** ® *report*
- **Query**(*query*, *accumulator*) ® *query-thread*
- **Metadata**(*holding-id*, *view*) ® *report*

Testbed: Implementation



Testbed: CDL Web Client



Testbed: Contents

Series	# Items	Size (GB)
Geodex map index	322,000	-
Landsat	1,514,000	-
DOQQ	10,000	600
DRG 1:24,000	3,000	66
DRG 1:100,000	250	6
NASA air photos	502,000	-
MIL air photos	15,000	450
SPOT	200	6
DEM	3,000	1
ADL Gazetteer	4,000,000	-
UCSB AVHRR	15,000	750
TOTAL	**6,385,450**	**1,879**

That’s All, Folks!

Research: Aggregation and Summarization

- *Browsing* and *interactive* exploration of digital libraries
- Efficient querying of high-dimensional data
  - Both sparse & dense
  - point data (no spatial extent)
    - Working on range data (spatial extent)
  - Fast feedback
    - approximate answers with absolute error bounds
    - progressively refined
  - Running against ADL metadata

Amr El-Abbadi; Divyakant Agrawal

Research: Collaboration Tools

- Distributed Collaborative Modeling Environment
  - 3D graphics modeling environment
- *Sticky*, *action*, and *active* notes
  - Shared annotation for multidimensional data
- Target domains
  - library help desk
  - classroom
  - group learning

Jianwen Su; Yuan-Fang Wang

Research: Scalable Web Services

- DCCP: Dynamic Content Caching Protocol
  - Exploit result equivalence and similarity
    - E.g.: Answer ADEPT map query with result from similar bounding box
  - Both server-side and proxy caching
  - HTTP 1.1 extension
- Cachuma: Server caching middleware for dynamic Web content
  - Dynamic page caching
  - Web server ↔ application interface
    - streams
    - CORBA
  - Efficient content-aware page invalidation and precomputing
    - result consistency
    - load smoothing
- Neptune: a software infrastructure for cluster-based network services
  - Deploy partitionable network services with minimal programming effort.
  - Data replication, storage consistency, load balancing, failover management
  - Enhance scalability, availability, and manageability

Tao Yang