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Towards a Design Approach for an Effective System Evolution of a Large Electronic Archive Information System

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Agenda

- Background
- Problem Statement
  - System Evolution
  - Evolving the System
- Service Decomposition
- Service Composition
- Conclusion

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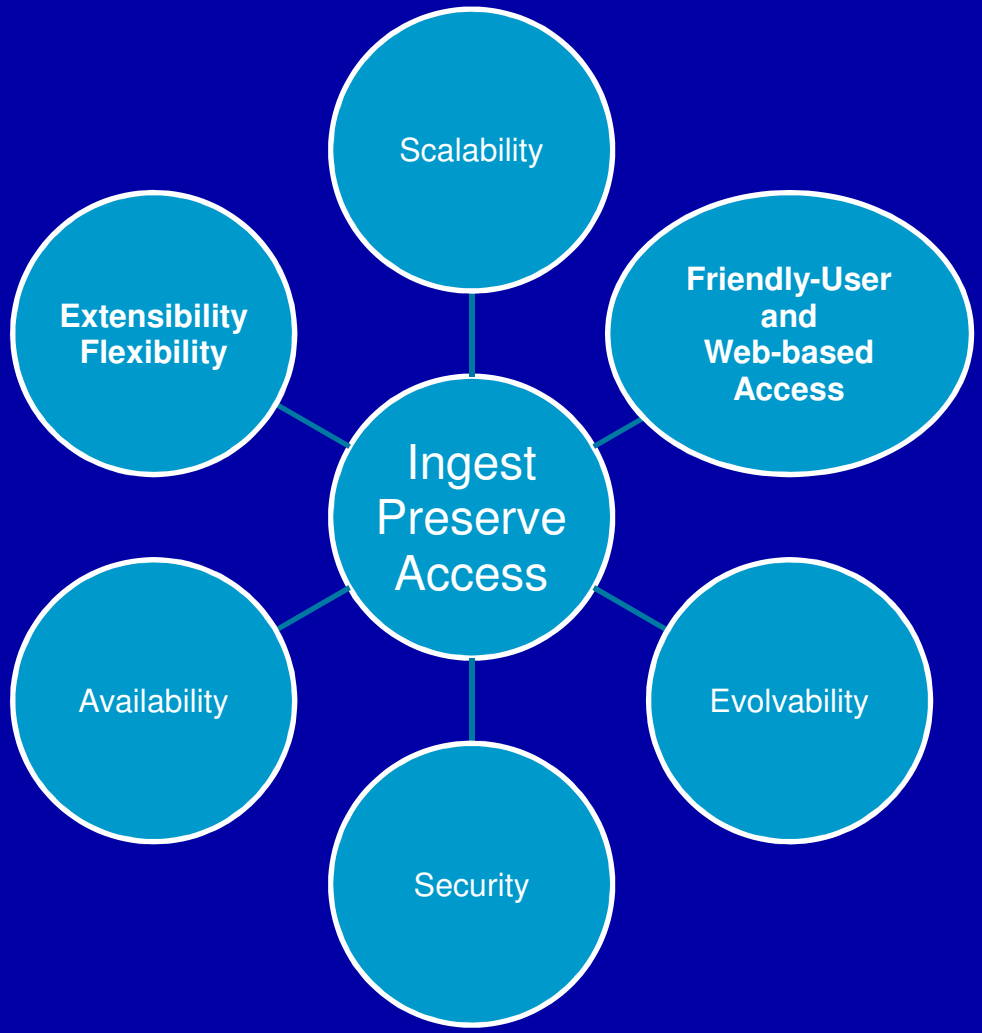
Electronic Records Archiving Challenges

- Variety
  - Records come from various application domains: health care, education, space exploration, census statistics, etc.
  - Different types of records: MS Office, database files, geospatial images, multimedia objects
- Obsolescence
  - To-be ingested records come from obsolete or old versions of applications and computing platforms
- Volume
  - Expected large amount of records: terabyte, petabyte, or exabyte
  - Volume growth is of exponential rate, in terms of total size and number of digital objects

ERA System Requirements

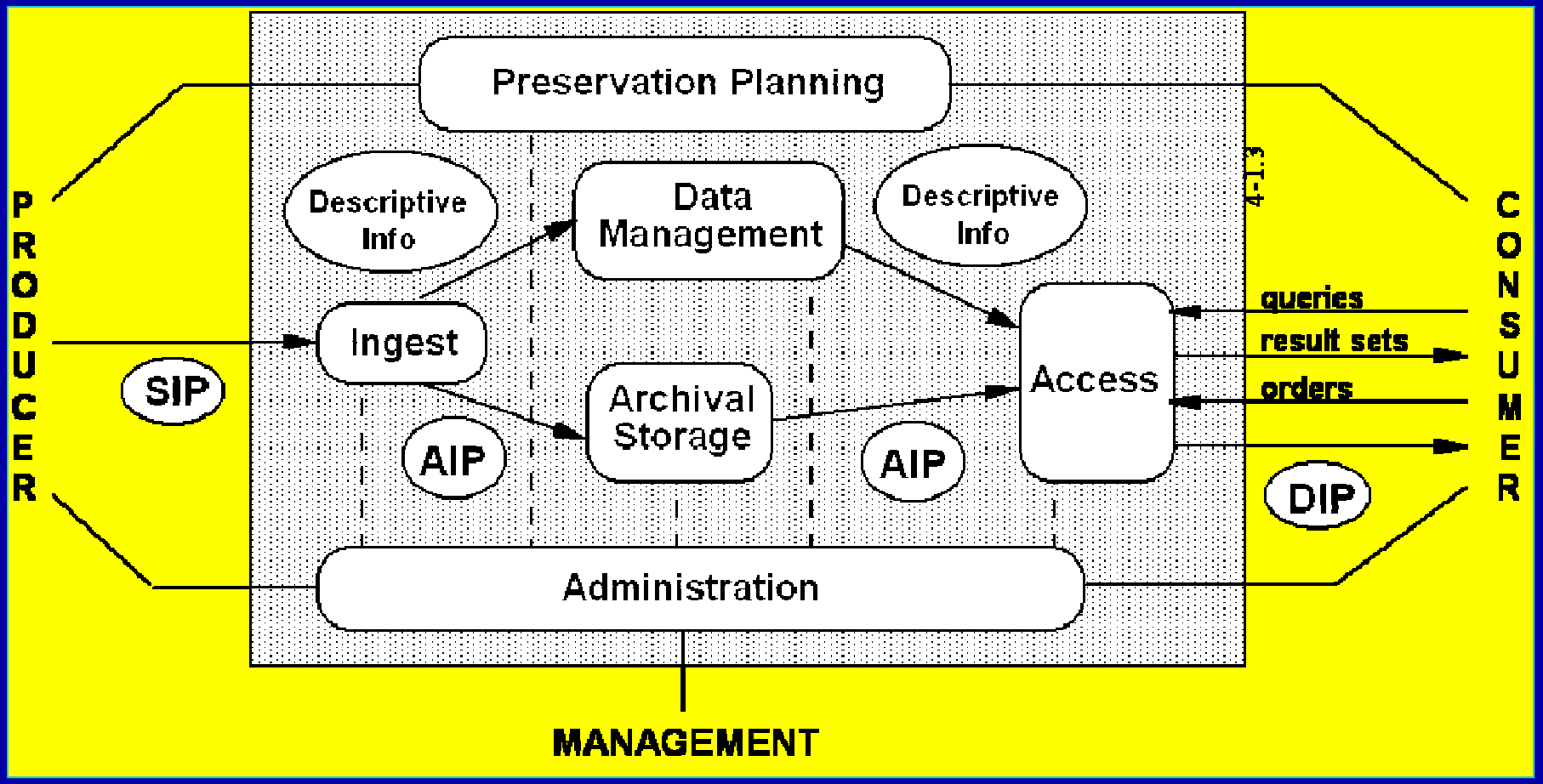
Electronic Records Archive



- ***Extensibility***: record types, data types, and services could be added without extensive redesign.
- ***Availability***: key functions must be available more than 99%; no single point of failure.
- ***Security***: protection of system and its assets.
- ***Evolvability***: new technologies could be inserted using standards APIs and interfaces.
- ***User Friendly***: browser interface, intuitive, 508 compliance.
- ***Scalability***: adapt to record volume and user community growth.

OAIS Functional Model

Open Archive Information System



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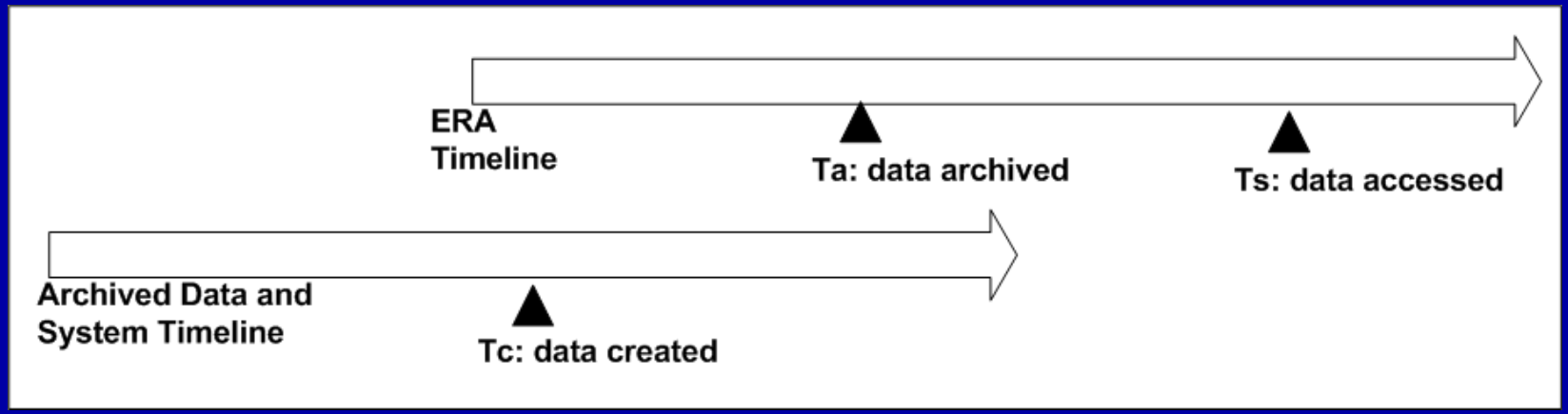
Local Evolution

- Domain
  - Higher scalability and throughput to accommodate the growth of digital record volume and user community.
  - Changing business rules
  - Archival science and concept of “essential characteristics” of digital record are still evolving
- Experience
  - Experienced users will demand enhanced search and discovery capabilities
  - Web 2.0: forum, tagging, interest groups, etc.
  - Soon, there will be a demand to access digital records not only on workstations but other devices such as mobile phones, or Wi-Fi enabled handheld devices.
- Process
  - New techniques and methodologies must be inserted to the system.

Evolution Relativity



- Upper timeline shows evolution of the system itself.
- Lower timeline shows evolution of external systems that created to-be archived data.
- Note the lags between the two timelines (**several years**).
- Challenge for WAIS: evolving itself to use current technologies of time Ta in order to provide long-term access to data born out of technologies at Tc time.

Data-Centric View of Evolution

- Ingested data
  - No longer active records
  - May need transformation before storing
- Stored data
  - Provide access to data using current technology
  - Data transformation and migration for preservation purposes
- Business data
  - Created by WAIS itself to govern the operations inside the system

Problem and Related Work

- What approach to take to face the challenges of evolution in terms of:
  - Maintaining the System
  - Evolving the System

- Christian Saul and Fanny Klett had an SOA-based framework to model a digital preservation system.
- Street and Gomaa provided guidance to maximize reusability of SOA systems via architectural constructs and patterns, service interface, service logic, service messaging, service discovery, and service differentiation.
- Papazoglou suggested leaning towards coarse-grained and high-level services so that they are more useful to business applications.

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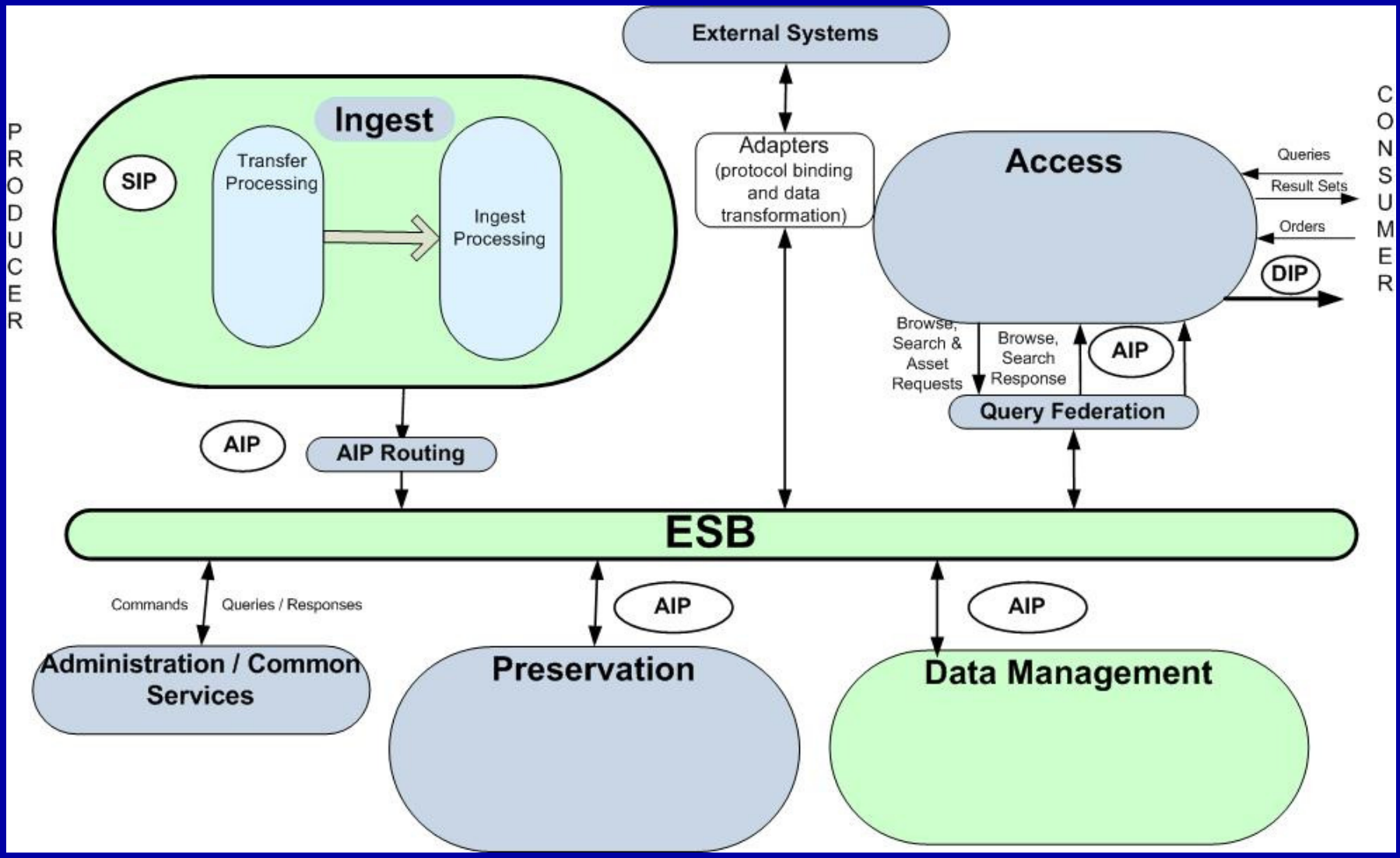
SOA Approach



Service Decomposition Scheme (SDS)

- Start with the set of high-level services S = {Ingest, Storage, Access, Data Management, Preservation Planning, Administration}.

```
Call decompose (S).
decompose(X):
For each service s in X, do:
   If s=<<tool>>, stop.
   Else
      Decompose s into a set of components R.
      Call decompose(R).
   Endif.
Endfor.
```

<<tool>>

- Stopping criterion is <<tool>>: corresponds to the lowest level of the service in the decomposition design process
- What constitutes the stereotype <<tool>>?
  - *A service is considered to be a "tool" if there is an implementation provided by a Commercial-off-the-shelf Software (COTS) or Free Open Source Software (FOSS)*
  - In digital archiving and preservation, such software packages exist
- For file format identification:
  - DROID (Digital Record Object Identification) from UK National Archives
  - JHOVE (JSTOR/Harvard Object Validation Environment)
  - APT (Archival Processing Tool) from Georgia Tech.
- For format transformation:
  - Xena Digital Preservation Software from Australia National Archives
  - Oracle Outside In

Example

decompose(Ingest):

Ingest is not a <<tool>>.

Decompose Ingest into a set of components R = {FormatIdentify, ExtractMetadata, BuildAIP, ValidateIngestData}.

Call *decompose* (FormatIdentify).

FormatIdentify is not a <<tool>.

Decompose FormatIdentify into a set of components R = {DROID, JHOVE, APT}.

DROID is a <<tool>>, stop.

JHOVE is a <<tool>>, stop.

APT is a <<tool>>, stop.

Call *decompose* (ExtractMetadata)….

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Service Composition

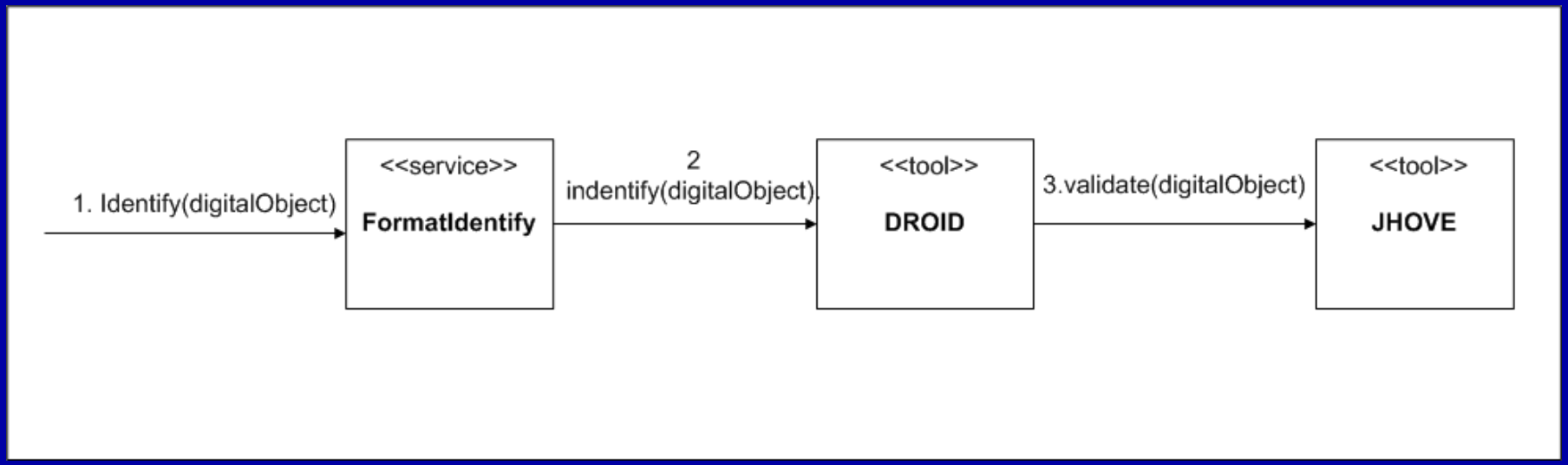
- Provide service interfaces to the applications
- Facilitate evolvability within a composition
- Use of BPEL
- Ability to modify logic in the BPEL script to
  - Swap in and out components as they evolve
  - Add new <<tool>> components to the process

Maintaining WAIS

Web-based Archive Information System

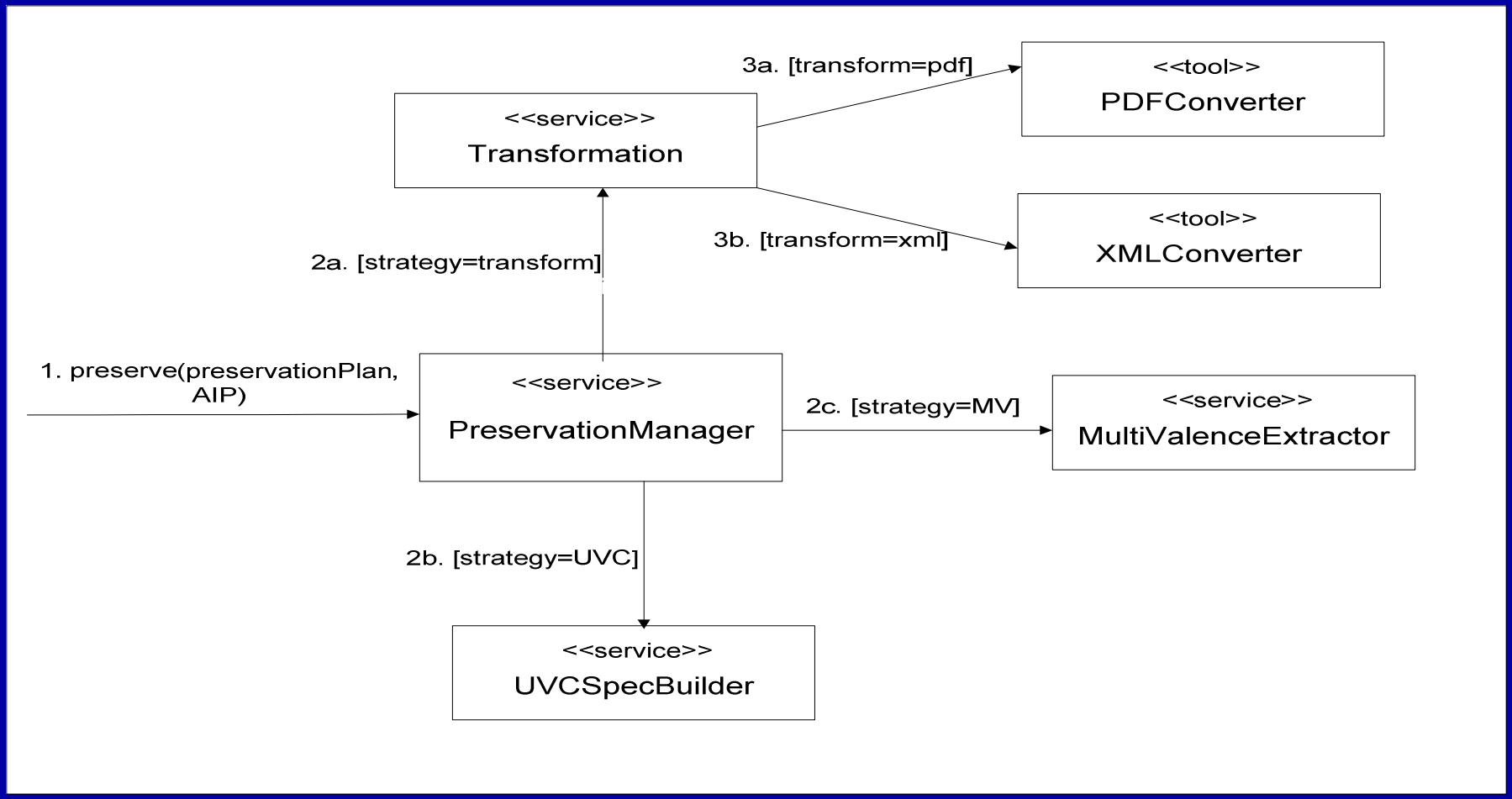
- Maintaining the system is tantamount to
  - Monitor evolution of existing <<tool>> components
  - Monitor evolution of current applications and their associated <<tool>> that are utilized during the archiving and preservation process
- What about <<tool>> that do not exist yet?
  - The service decomposition helps in defining interfaces for new <<tool>> components
  - These <<tool>> components will be researched and developed by the community

Ingest Service Composition Example
File Format Identification

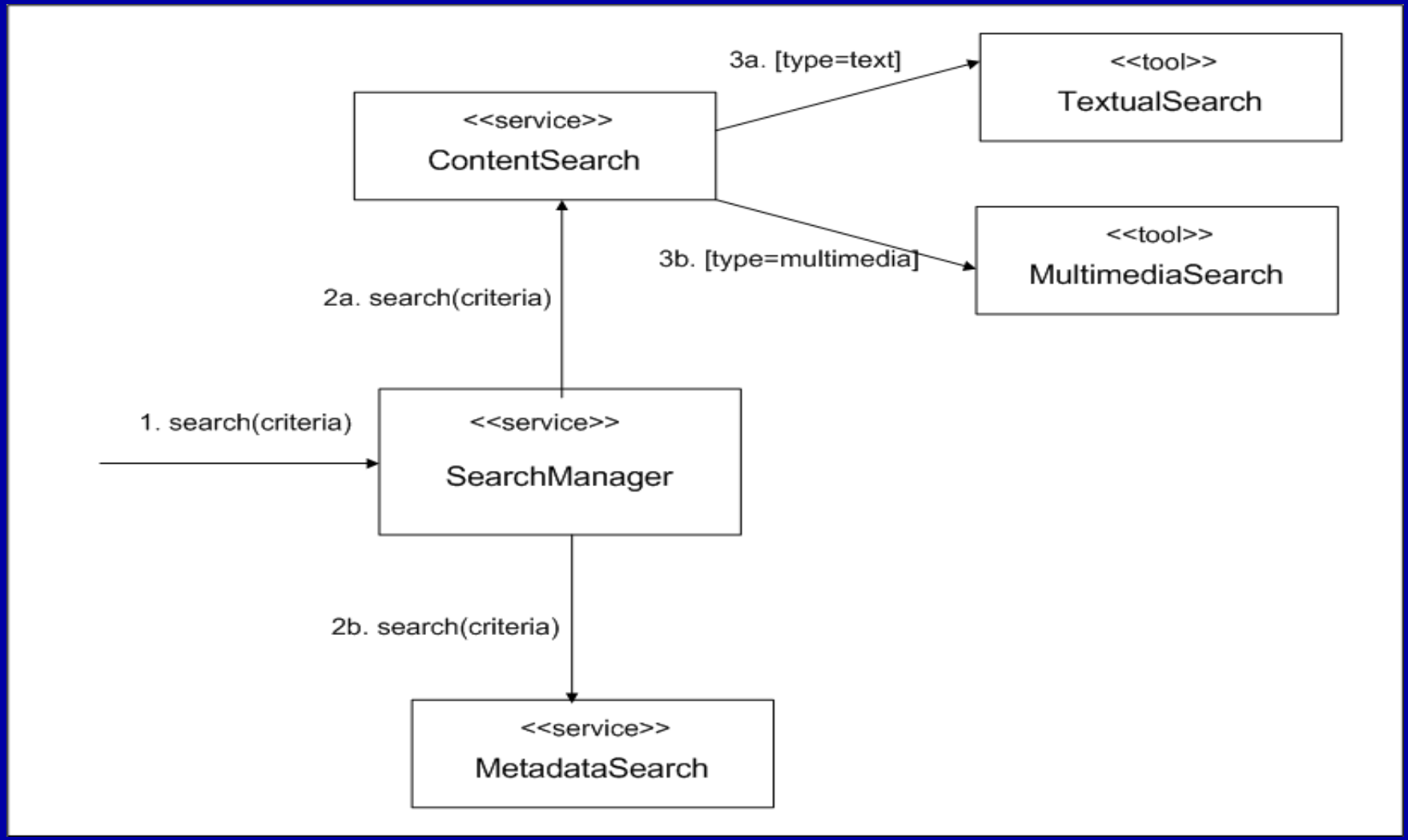


Preservation Service Composition Example

Preservation Manager



Access Service Composition Example
Search Manager



Current Issues

- Success depends on interests, research and development of <<tool>>
- Requires collaboration between digital libraries, national archives, and research institutions
- Could this concept of <<tool>> be applied to other SOA systems?
  - In some sense, a <<tool>> can be considered as a standardized part of a large machine that you can easily get from any “manufacturer”
  - Is this going back to the dream of software engineering to have ready-made components?

Summary

- Presented the evolution characteristics of a WAIS system
- Proposed an SOA-based approach for Evolvability:
  - Service Decomposition Scheme with <<tool>> concept
  - Service Composition using BPEL with application to WAIS
- Showed how the <<tool>> concept can help in the maintenance of this SOA system
- Presented some issues with the current solution

Thank You

References

1. The Consultative Committee for Space Data Systems. *Reference Model for an Open Archival Information System (OAIS)*, 2002. Available: http://public.ccsds.org/publications/archive/650x0b1.pdf . [Feb. 16, 2009].
2. D. E. Perry. **"Dimensions of software evolution".** Proceedings of ICSM 1994, pp. 296 – 303.
3. **J. Street and H. Gomaa. "Software Architectural Reuse Issues in Service-Oriented Architectures". Proceedings of the 41st Annual** Hawaii International Conference on System Sciences, Jan. 2008, pp. 316 – 316.
15. Christian Saul and Fanny Klett. "Conceptual Framework for the Use of the Service-oriented Architecture-Approach in the Digital Preservation". iPRES 2008, September 29-30, 2008, British Library Conference Centre. Available: http://www.bl.uk/ipres2008/presentations_day2/36_Saul.pdf.
16. DROID (Digital Record Object Identification) Available: http://droid.sourceforge.net/.
17. JHOVE - JSTOR/Harvard Object Validation Environment. Available: http://hul.harvard.edu/jhove/.
18. Xena Digital Preservation Software. Available: http://xena.sourceforge.net/.

References (2)

15. Oracle Outside In. Available: http://www.oracle.com/technologies/embedded/outside-in.html.
16. William E. Underwood, Marlit Hayslett-Keck and Sandra Laib. “The PERPOS Tools: User's Guide Version 3.0”. PERPOS Technical Report ITTL/CSITD 05-2 March, 2005. Available: http://perpos.gtri.gatech.edu/publications/PERPOS%20TR%202005-02.pdf.