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Open Hypermedia

COMP3227 Web Architecture & Hypertext Technologies

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What is Open Hypermedia?

Hypermedia is the approach to building **information systems** made up of nodes of various media connected together by a collection of associative links

An **open** system generally implies that:

- There is some interface by which third party programs may access the functionality of the system.
- The system may be accessed from applications on heterogeneous architectures.

Open hypermedia: hypertext features present within whole environment

- Links and anchors are kept separately from documents (i.e. first-class links)
- Linkbases and link services

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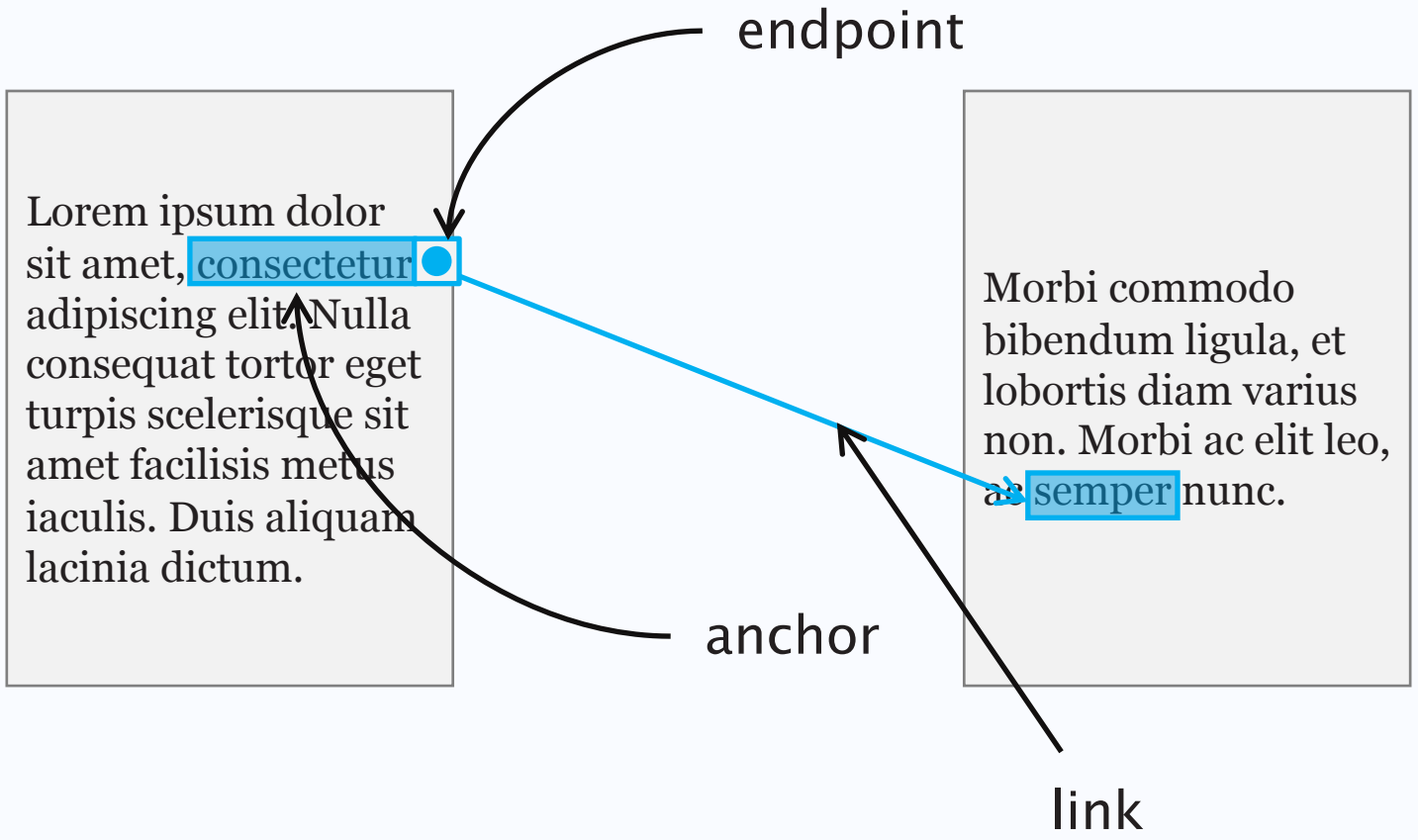
What is Open Hypermedia?

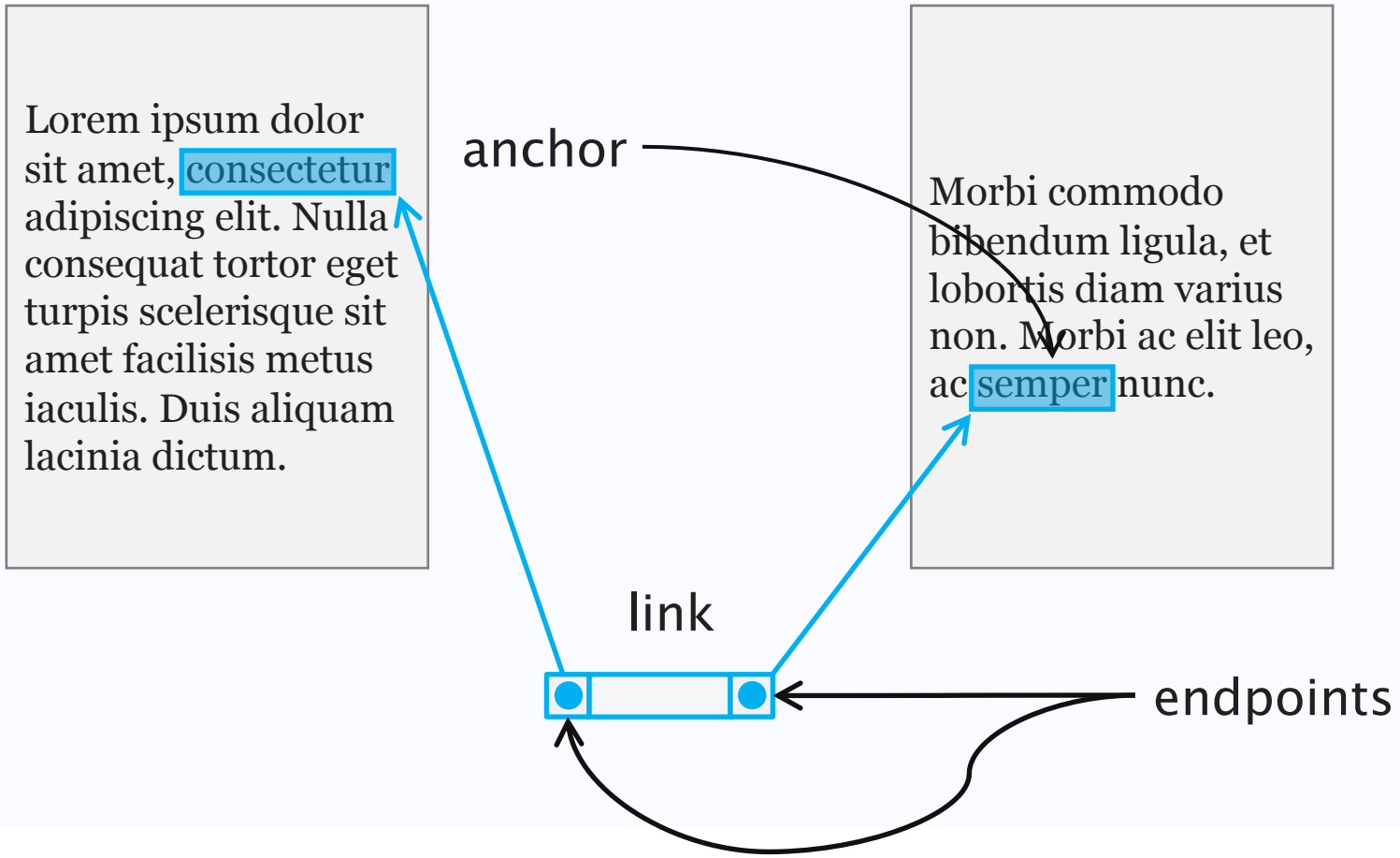
Open Hypermedia Systems are open with respect to:

- Applications
- Data formats (add links to any files)
- Functionality (configurable and extensible)
- Other OHS systems
- Platforms
- Users

Embedded links



First-class links



Dexter Hypertext Reference Model

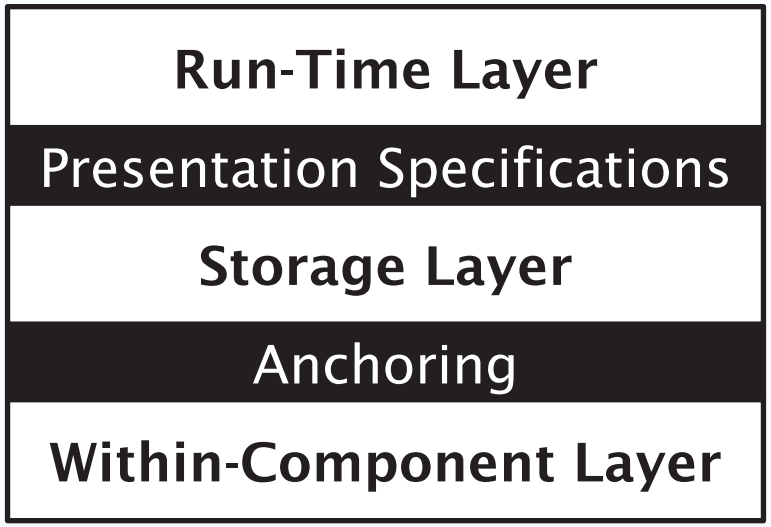
http://www.flickr.com/photos/hunkdujour/186391965/

Dexter Hypertext Reference Model (1988-1990)

Formal model of an open hypertext system, not an implementation

Used to compare functionalities of existing systems

Used to design new systems and develop standards for interoperability



presentation, dynamics, user interaction

database of nodes and links

node content, structure within nodes

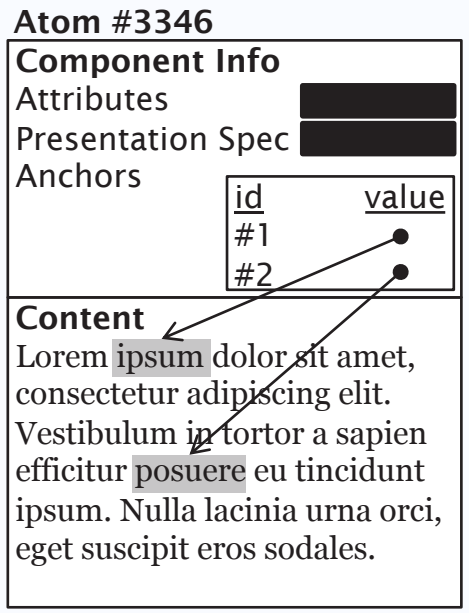
Halasz, F. and Schwartz, M. (1994) *The Dexter hypertext reference model*, Communications of the ACM, 37(2), pp. 30-39.

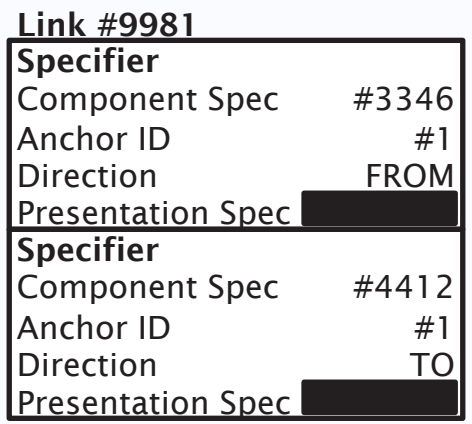
Dexter storage layer

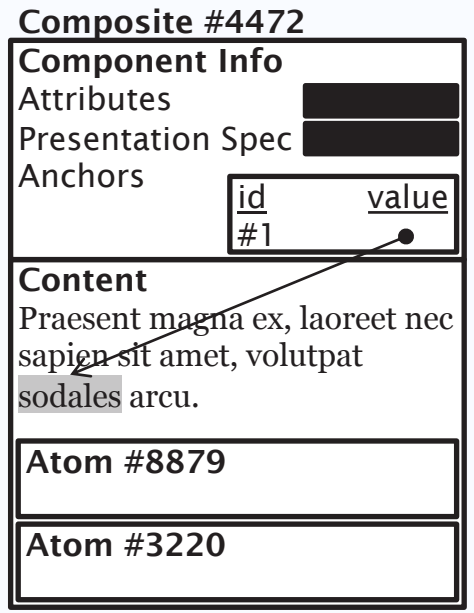
Three types of component: atoms, links and composites (sequences of components)

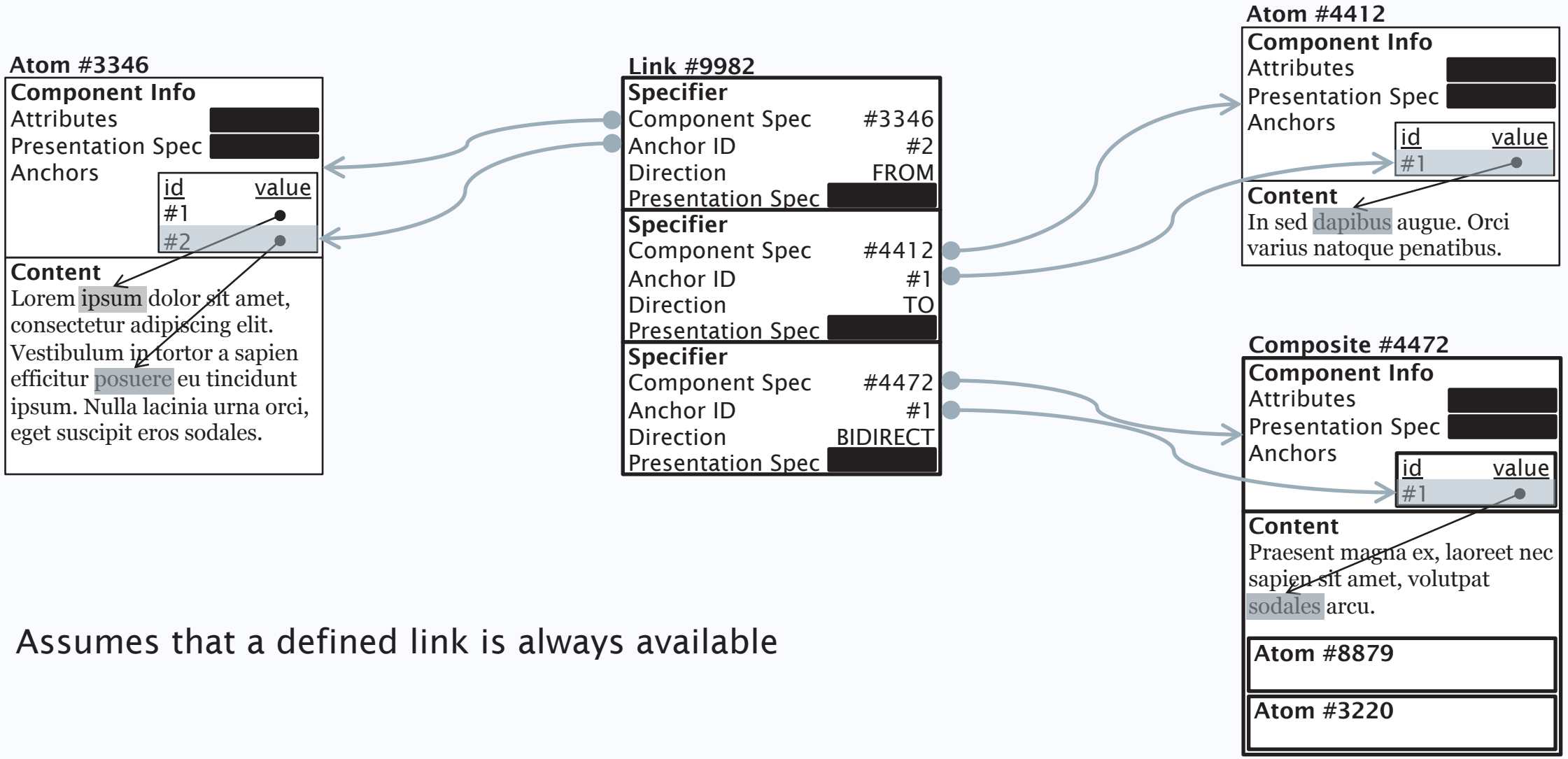
Key concept of a *specifier* – a robust description of a link endpoint

- Component specification, anchor, direction (to, from, bidirectional) and presentation spec
- Links as sequences of specifiers









Assumes that a defined link is always available

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Hyper-G

Hyper-G

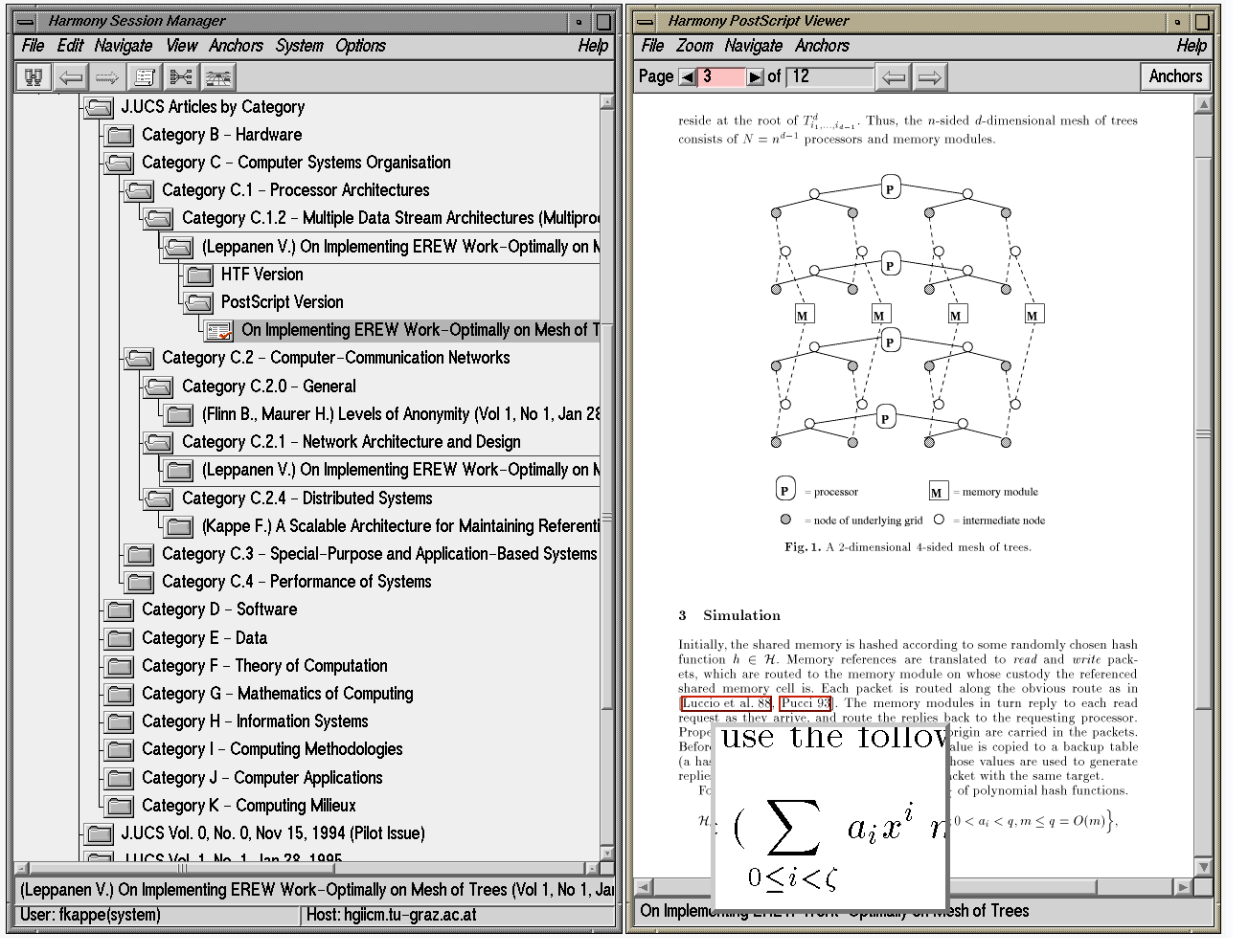
Developed at the Technical University of Graz, Austria around 1989-1990

Features:

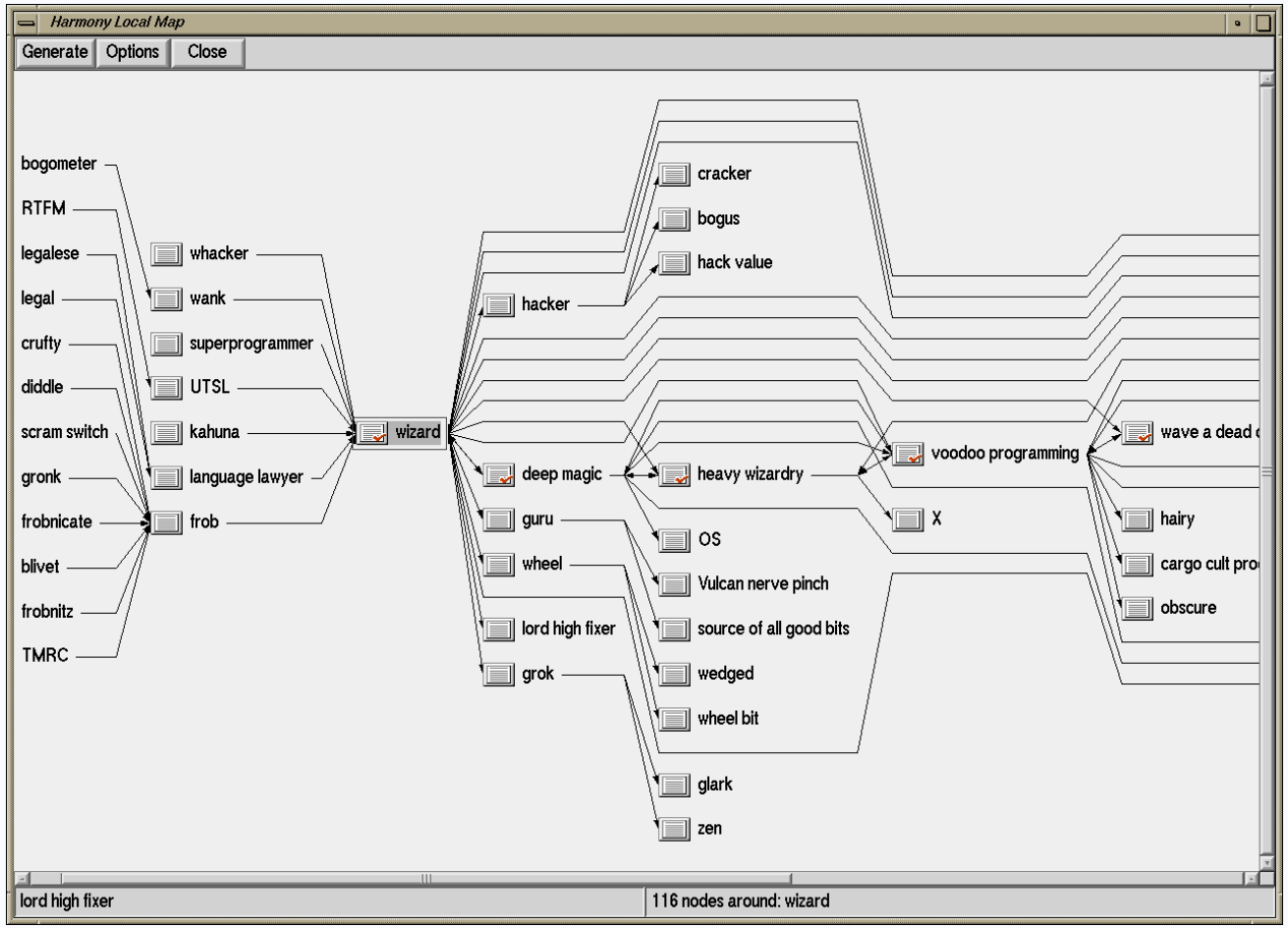
- Client-Server architecture (like the Web)
- Persistent session connections (unlike the Web?)
- First class nodes, links, anchors, composites and collections
- Bi-directional links
- Link integrity

Andrews, K., Kappe, F. and Maurer, H. (1995) *The Hyper-G Network Information System*, Journal of Universal Computer Science, 1(4).

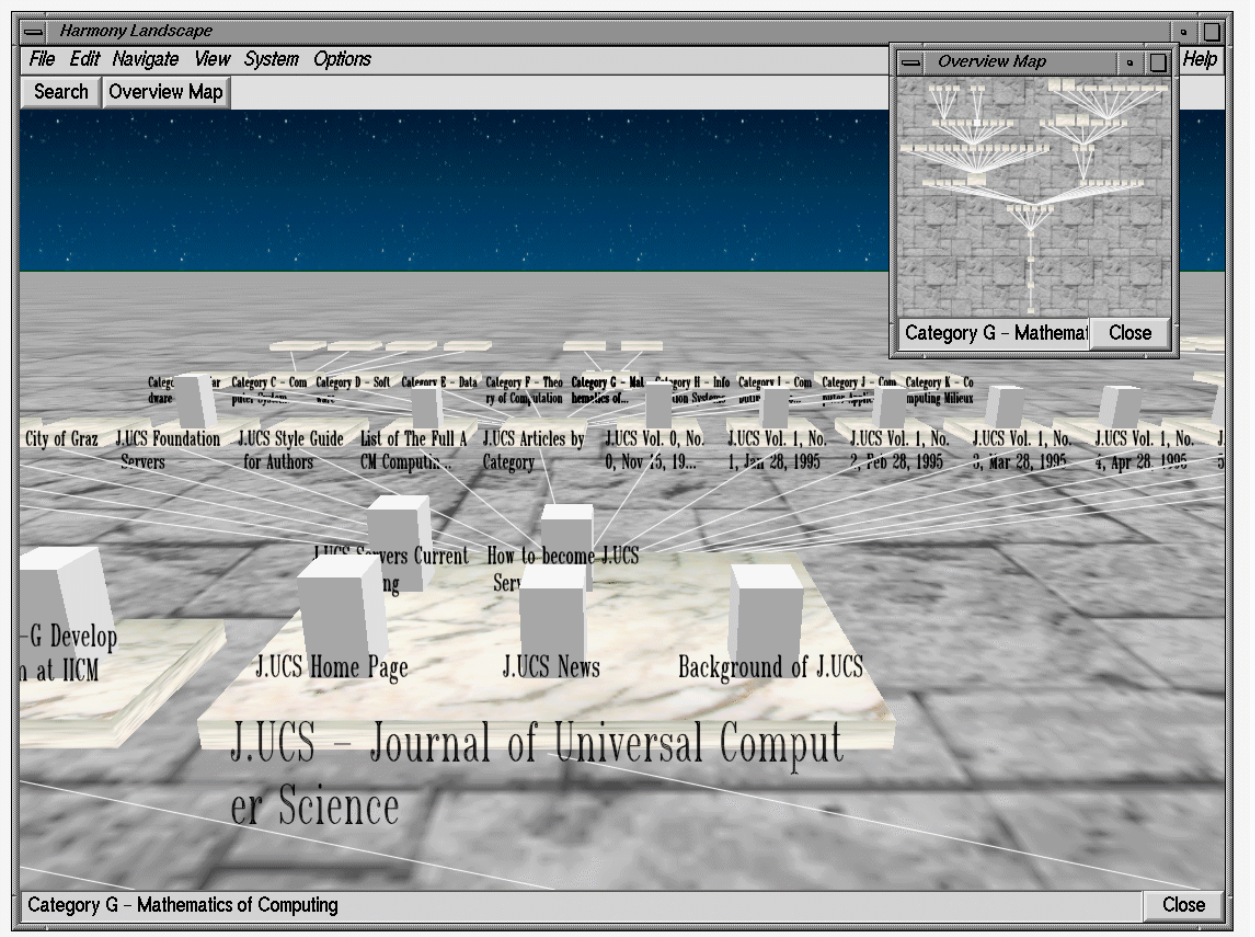
Harmony client



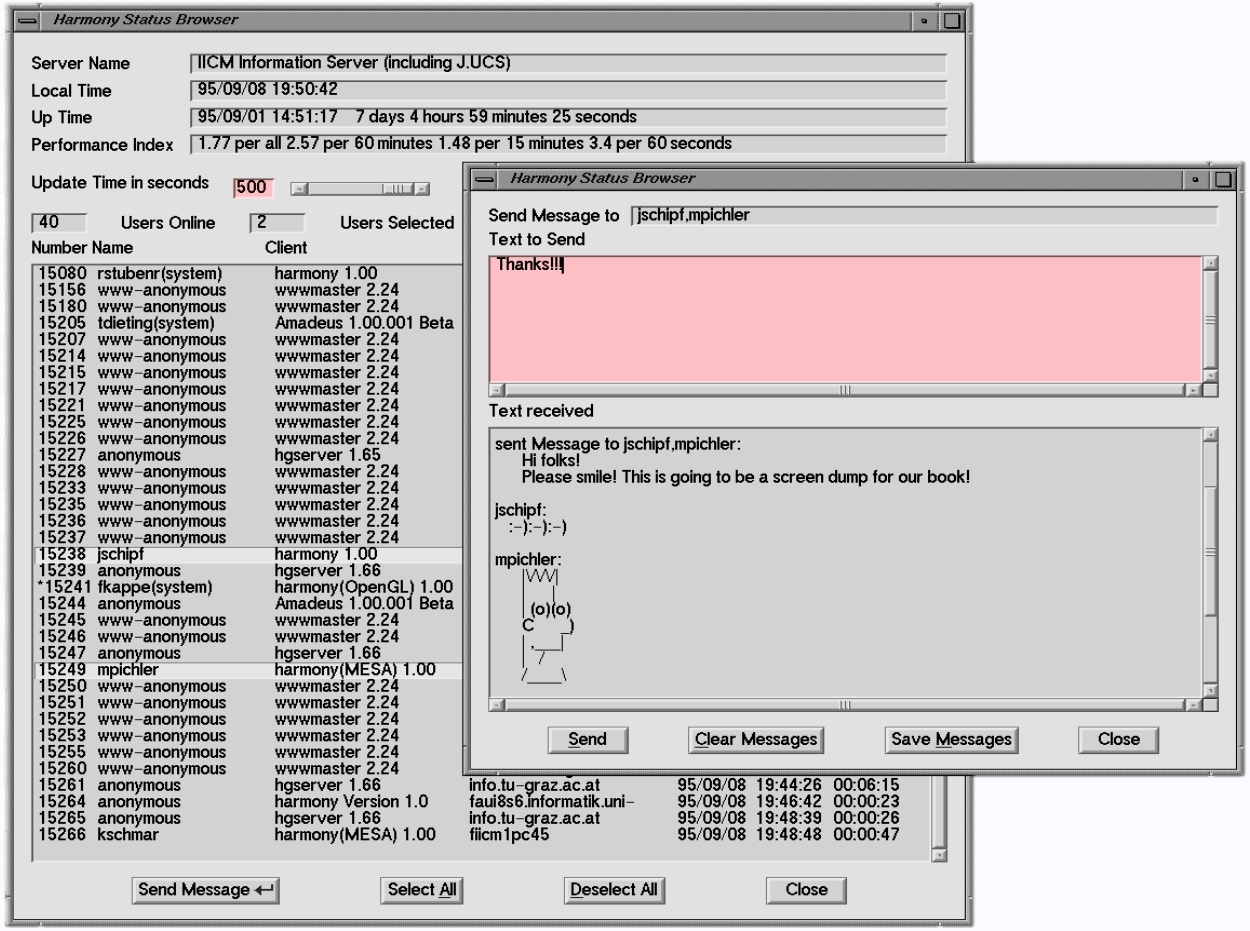
Harmony client: link structure view



Harmony client: landscape view



Harmony client: client-client communications



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Link integrity

Users should always be able to follow any link that is presented to them

- When documents are moved, edited or deleted, links must be updated
- Compare with the Web: if the destination of a link goes away, the user sees 404 Not Found

Hyper-G divides links into two categories:

- *Core links* relate documents stored on the same server
- *Surface links* relate documents stored on different servers

Changes that affect core links can be processed by a single server

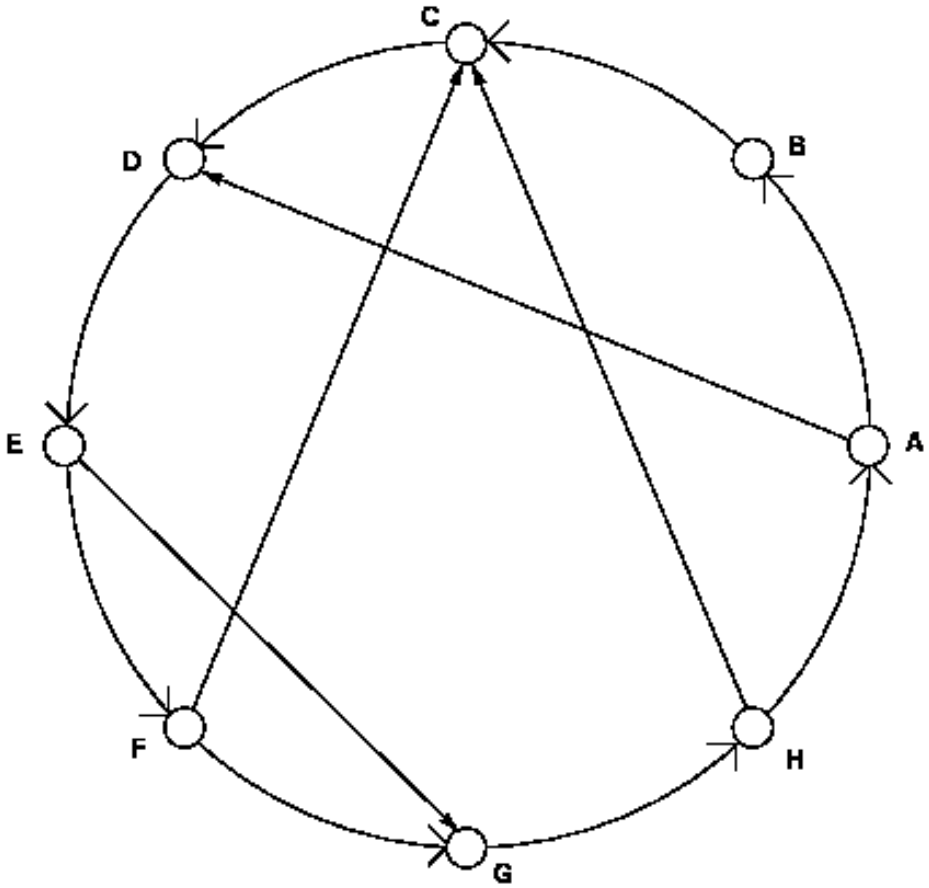
Changes that affect surface links involve multiple servers that need to be notified

P-flood Algorithm

Broadcasting surface link updates to all affected servers is expensive

Probabilistic flooding algorithm used to send surface link updates more efficiently

- Servers arranged in a ring
- Servers send link updates to their immediate successor and randomly to other servers
- Scalable and robust
- Parameterisable – number of additional servers can be altered



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Evaluation

Advantages

- Authoring support integrated into browser, and designed into protocols from outset
- Support for collaboration
- Early support for multimedia

Disadvantages

- Flooding algorithm would probably not scale to the Web
  (but some similarities with peer-to-peer approaches like distributed hash tables)

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Microcosm

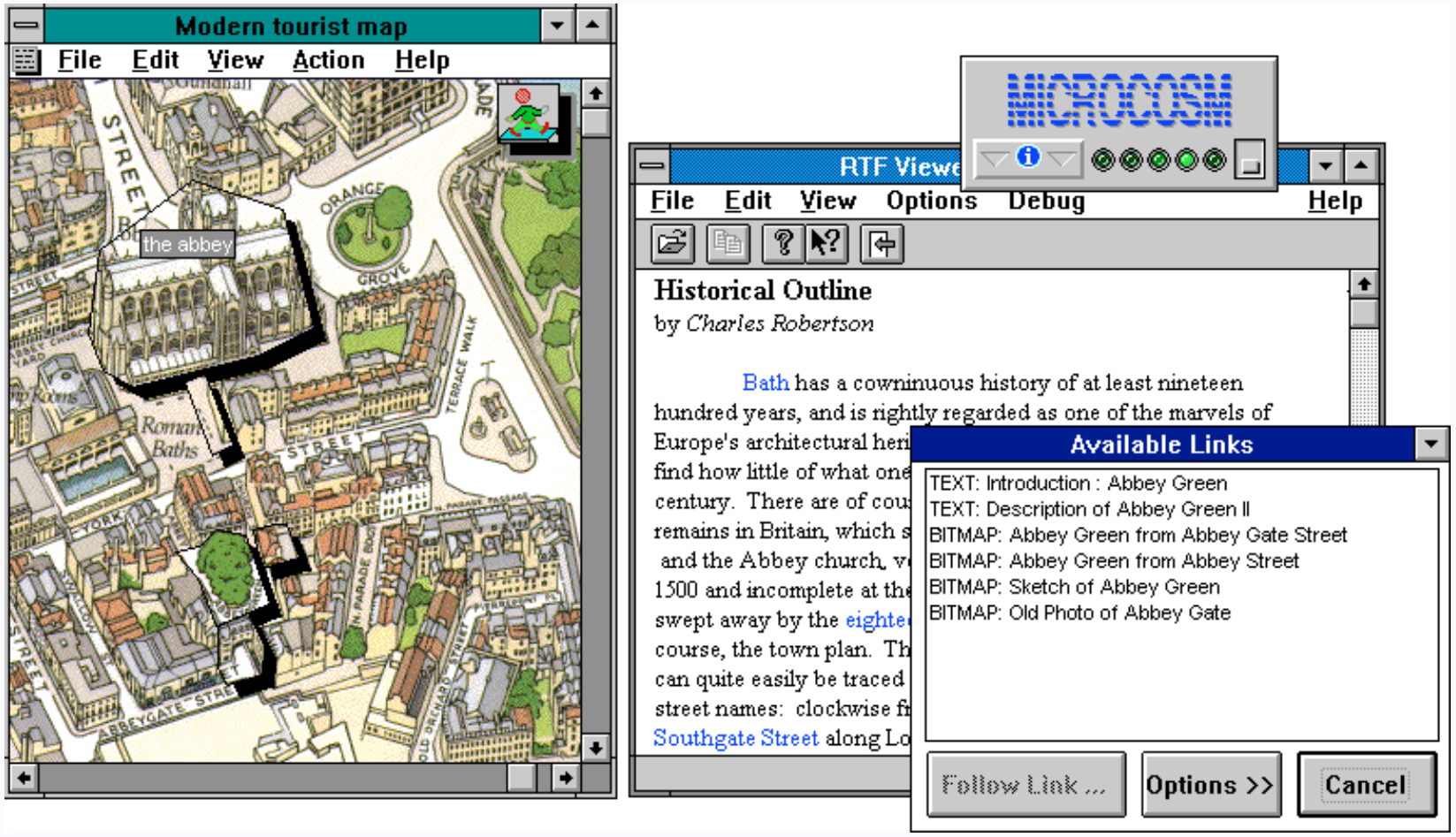
Overview

Developed at the University of Southampton around 1989

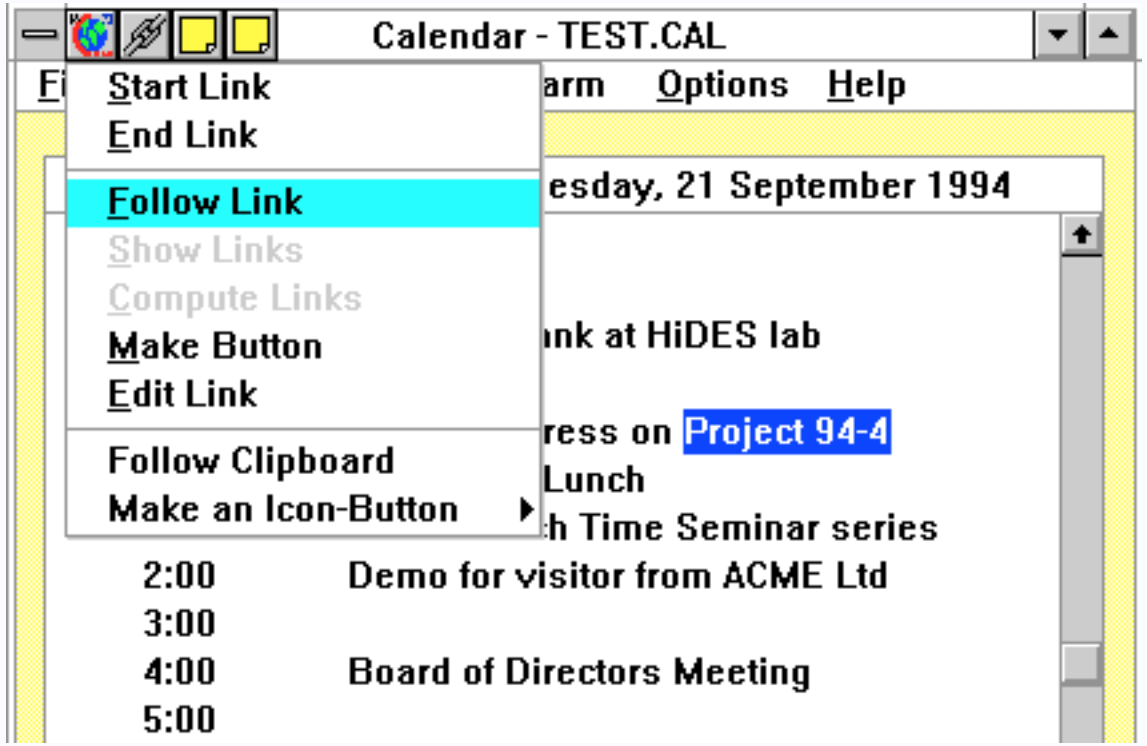
- Originally designed for use with read-only media (laser discs and later CD-ROMs)
- Originally designed as a desktop-based system, later expanded to a distributed system
- Mountbatten's personal papers were gifted to the University of Southampton Library
  - ≈250,000 papers
  - ≈50,000 photographs
- Informed much subsequent work within ECS: DLS, COHSE, etc

Fountain, A., Hall, W., Heath, I. and Davis, H. (1990). MICROCOSM: an open model for hypermedia with dynamic linking. Proceedings of ECHT90. pp. 298-311.

Microcosm client

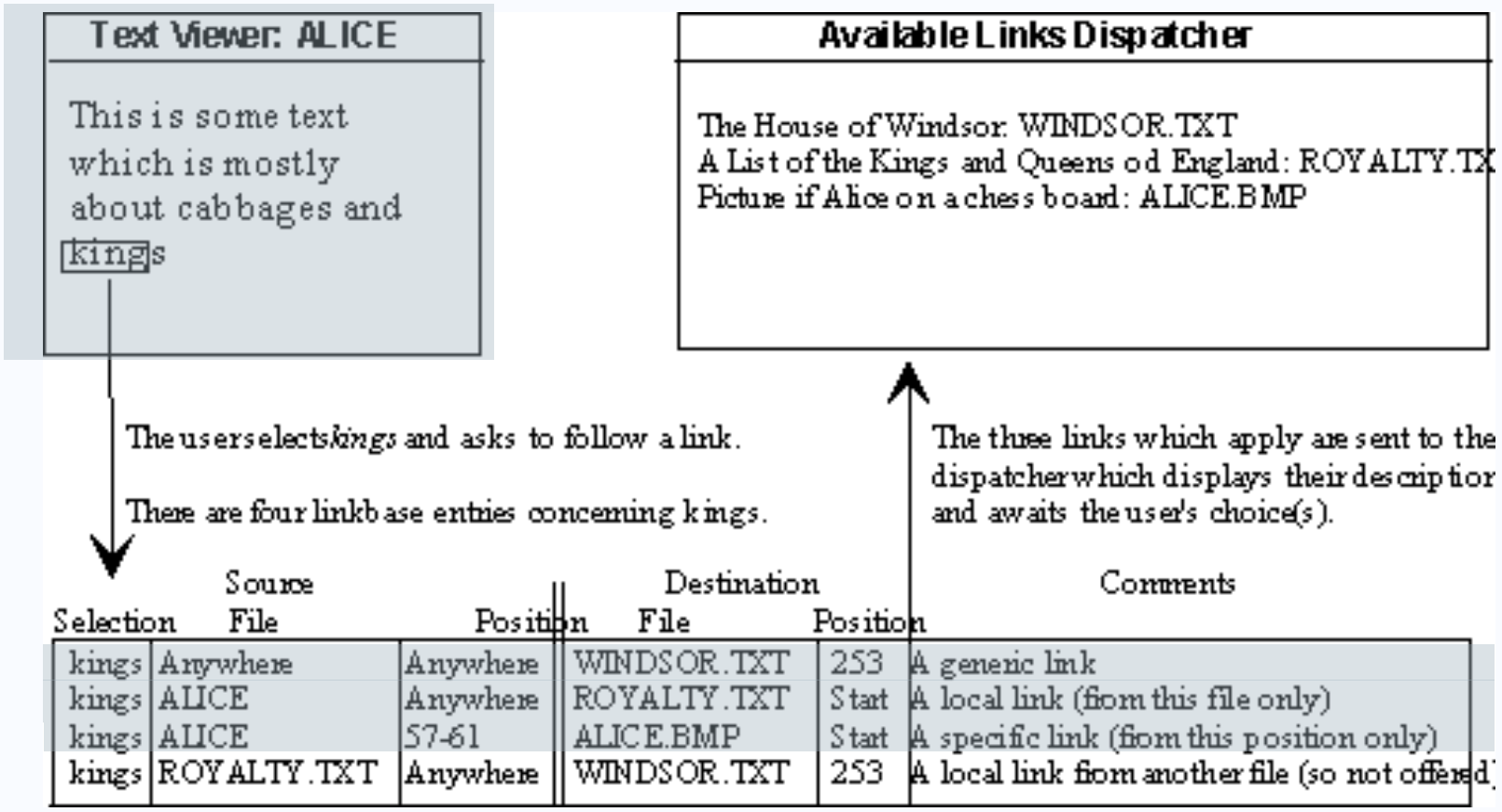


Microcosm universal viewer



Generic, Specific and Local links

Position of source anchor held in the linkbase



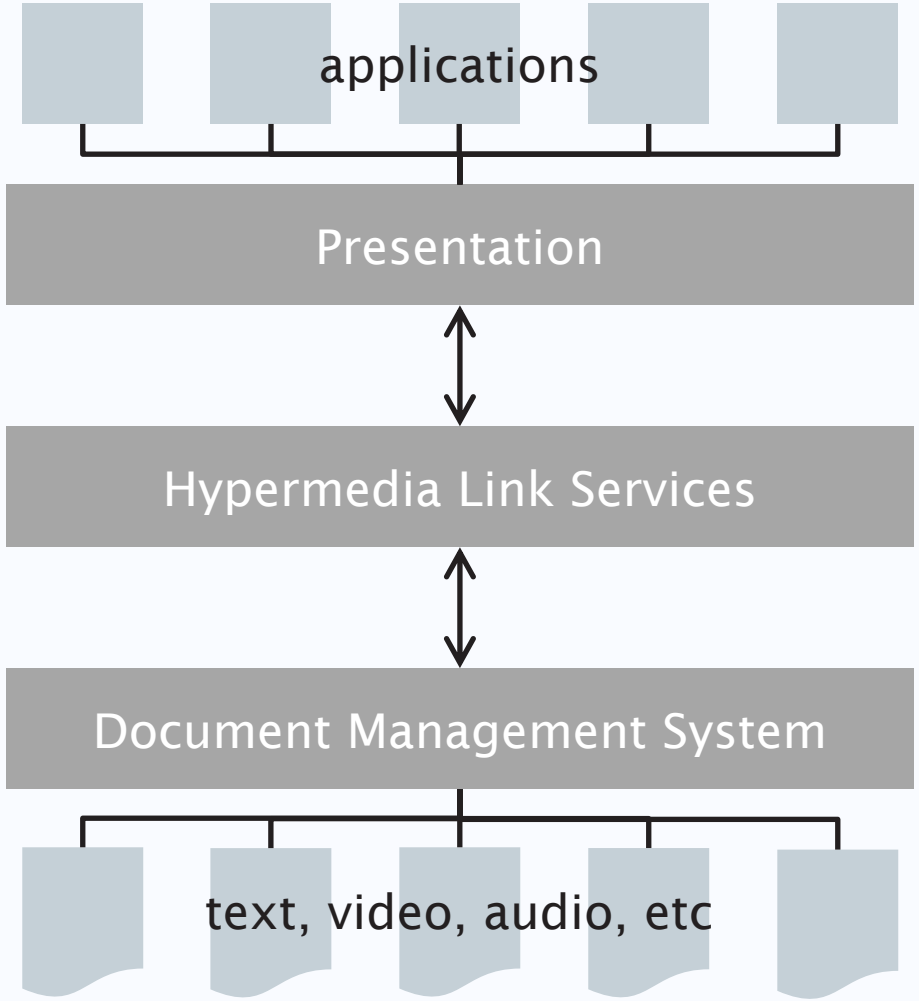
	Source		Destination		
Selection	File	Position	File	Position	Comments
kings	Anywhere	Anywhere	WINDSOR.TXT	253	A generic link
kings	ALICE	Anywhere	ROYALTY.TXT	Start	A local link (from this file only)
kings	ALICE	57-61	ALICE.BMP	Start	A specific link (from this position only)
kings	ROYALTY.TXT	Anywhere	WINDSOR.TXT	253	A local link from another file (so not offered)

Microcosm architecture

Separation of concerns:

- Document storage and management
- Link storage and management
- Applications and presentation

Link services mediate the other components

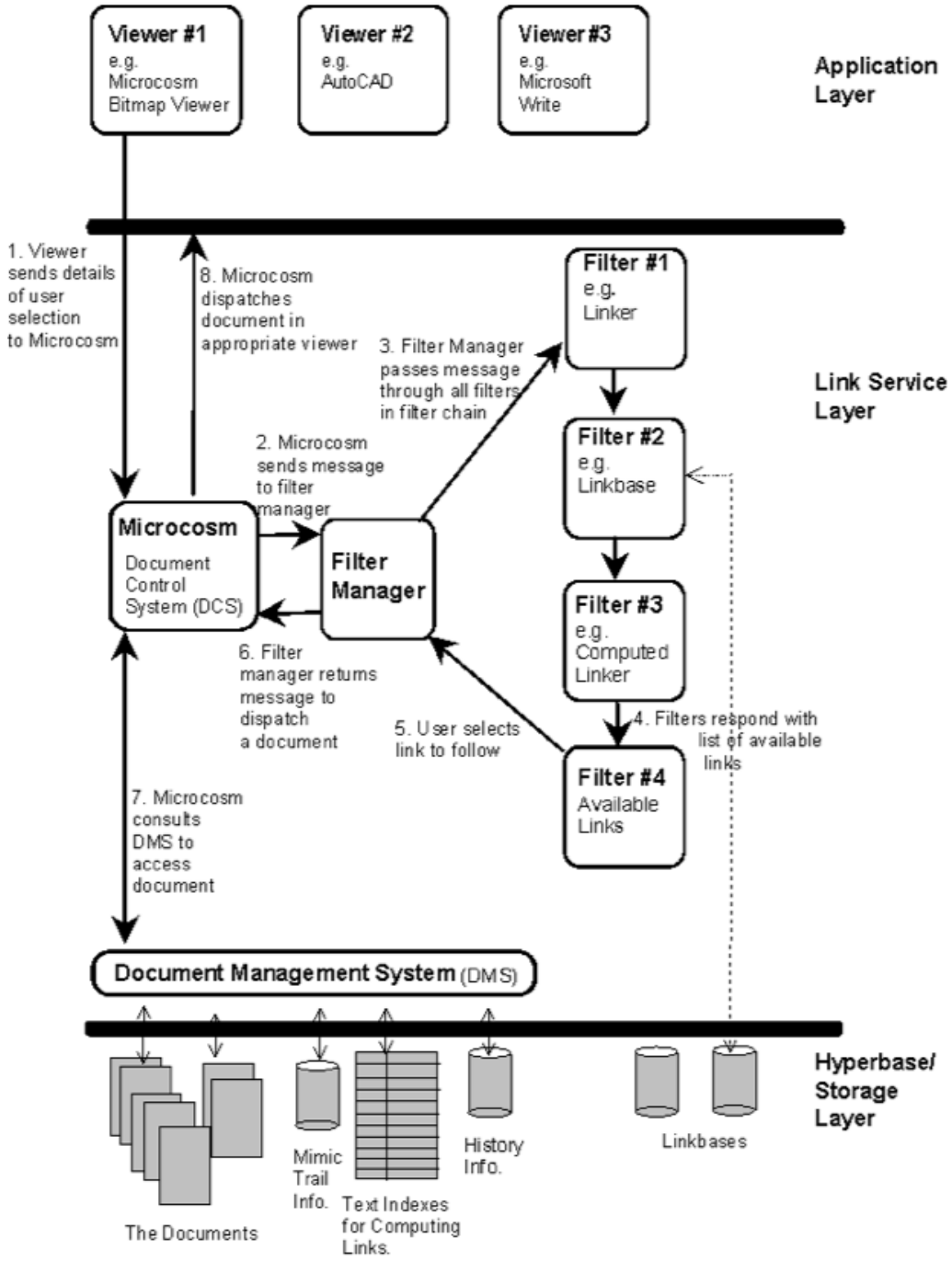


Microcosm architecture

Link service comprises a sequence of *filters*

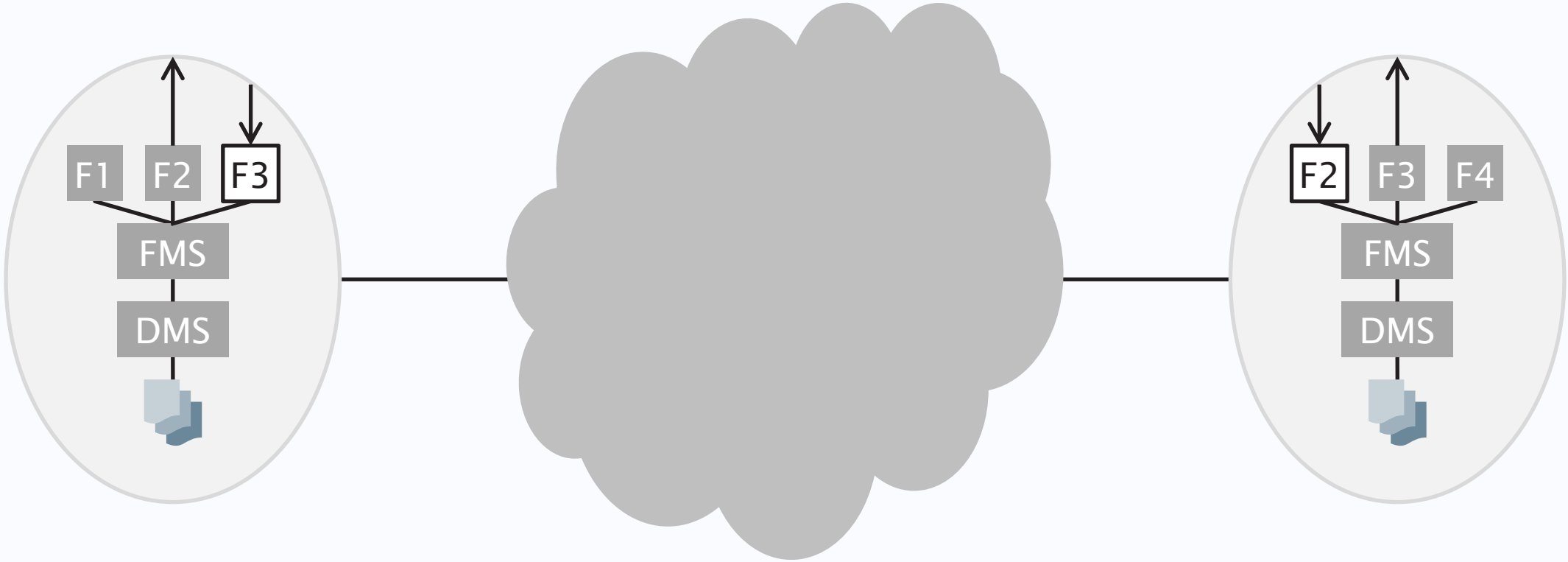
Filters are composable services that generate or manipulate links

Filter manager organises filters into chains



Distribution

Microcosm instances may publish filters to be used by other instances



Evaluation

Advantages

- Rich model of linking
  (generic links, n-ary links, etc)
- Flexible document processing
  (multiple linkbases)
- Integration with third-party applications

Disadvantages

- Poor scalability
  Intended for workgroups to enterprises
- Distribution not intended from the outset
- Arguably, no native document format
- No support for link integrity

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Open Hypermedia Protocol

Open Hypermedia Protocol

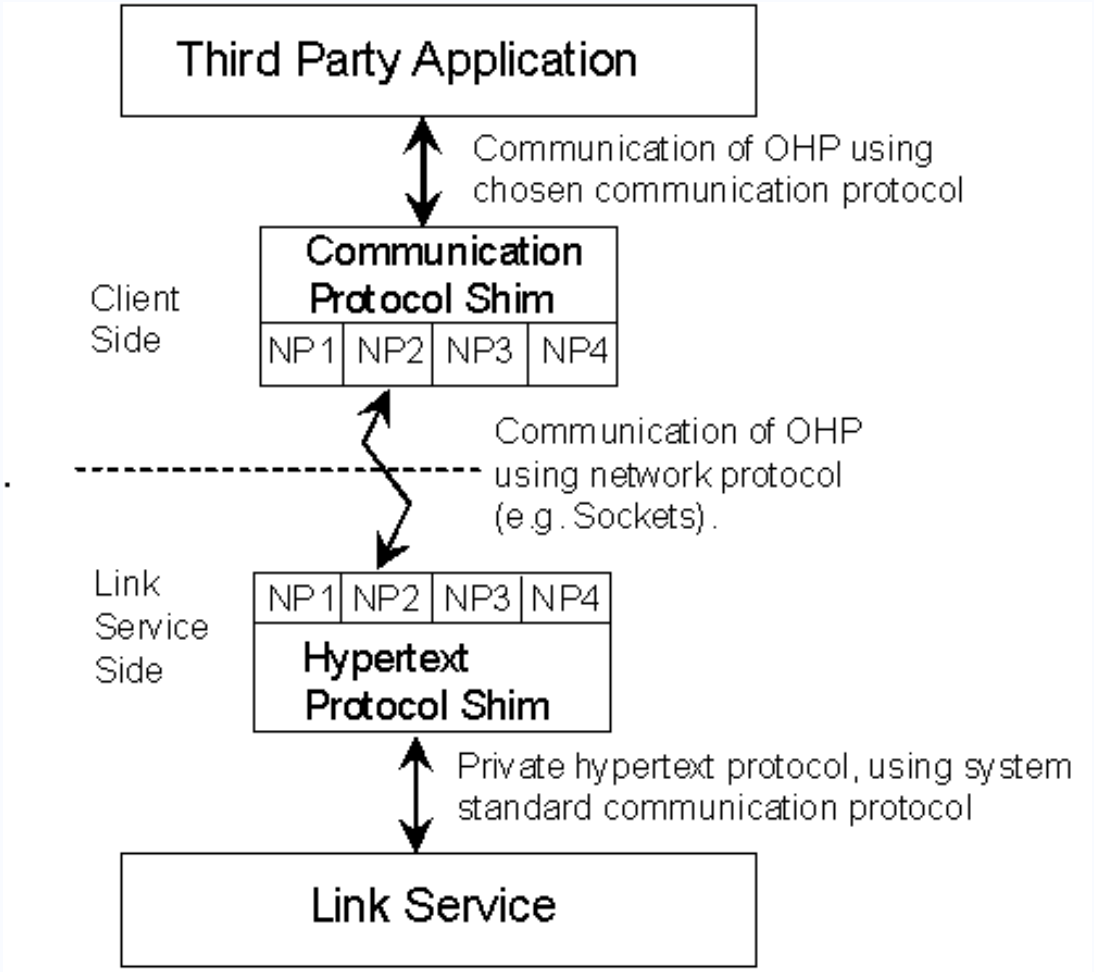
- Enables client side applications to communicate with server side programs
- Achieved by providing some ‘shim’ program that translates between OHP and the linkserver's native protocol
- Applications would be able to work with all linkservices.

Was not aimed at web scale

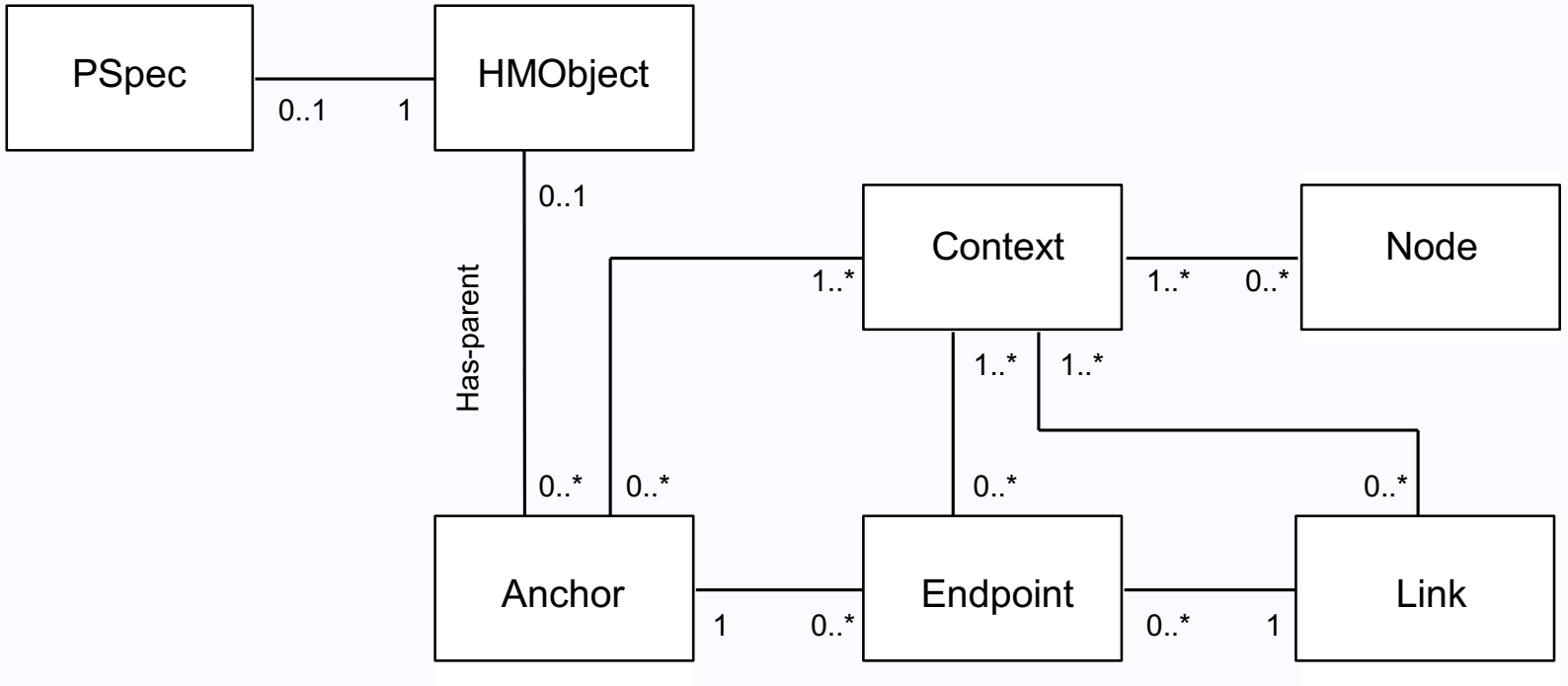
OHP formed the basis for later integration efforts (FOHM)

Reich, S., Will, U.K., Nürnberg, P., Davis, H.C., Grønbæk, K, Millard, D.E. and Haake, J.M. (1999) *Addressing interoperability in open hypermedia: the design of the Open Hypermedia Protocol*. New Review of Hypermedia and Multimedia 5(1), pp. 207-248.

OHP architecture



OHP data model



Location specifiers (LocSpec)

LocSpecs holds information about the position of an anchor

- Byte offset within file
- Occurrence of a given string (i.e. generic link)
- Named location within content (c.f. HTML `id` attribute)

Generalisation of Dexter's anchor values

But also:

- Can also exist within links
- Function to evaluate to identify anchor position

Grønbæk, K. and Trigg, R. (1996) *Toward a Dexter-based model for open hypermedia: unifying embedded references and link objects*. In HYPERTEXT '96: Proceedings of the the seventh ACM conference on Hypertext, pp.149-160.

Evaluation

Advantages

- Used in several demos and prototypes
- Commonly-accepted data model

Disadvantages

- Shim architecture was naïve (expensive to implement)
- High message overhead

Anderson, K.M. et al (1997) *A critique of the Open Hypermedia Protocol*. Journal of Inline Digital Information, 1(2). | Available at: https://journals.tdl.org/jodi/index.php/jodi/article/view/5

Link Integrity

http://www.flickr.com/photos/andreaswinterer/2460423132/

Link integrity

The endpoint of a link (source or destination) needs to define:

- a node
- (optionally) a position within a node (locspec)

If an endpoint fails to resolve to the place intended by the author, then it (and the link) is broken

Two types of link integrity failure:

- Dangling link
- Content reference

Davis, H.D. (1998) *Referential integrity of links in open hypermedia systems*. Proceedings of Hypertext 98. pp. 207-216.

The dangling link problem

Occurs when an endpoint refers to an invalid node

Commonly the result of a node being moved or deleted

Possible mitigations:

- Responsibility of link creators (current practice on the Web)
- Don't allow links to things that move
- Forward references (i.e. redirects to new location)
- Guaranteed names (PURL servers, DMS)
- The Hyper-G approach (i.e. propagate changes affecting links)
- Link integrity checking agent (Spider)

The content reference problem

Occurs when an endpoint refers to a valid node, but to an incorrect location within that node

Commonly the result of changes/updates to the content of a node that are not reflected in links to that node

Possible mitigations:

- The publishing model (i.e. published resources are read-only, editing creates new resources)
- Manual link editor
- Link service-aware editing tools
- Just-in-time link repairs
- Express specific link positions using queries
- Avoid specific links/anchors
- Versioning (c.f. publishing model)
- Use of diff files (c.f. JIT link repairs)

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Who is Responsible, link owner or system?

- Don’t bother: it’s a social issue.
- Avoid the problem: use declarative link definitions
- Loosely coupled: give the author tools to sort the problem if they want
- Automated link repairs: fix problems as they're encountered
- Tightly coupled: don’t let users have this freedom

Evaluating open hypermedia

Advantages

- Applications not responsible for maintaining "foreign" markup
- Tailor linkbases to user needs (contexts)
- Generic links, etc
- Necessary for linking read-only media (e.g. CD-ROM, no permission)

Disadvantages

- Keeping links separately introduces potential consistency issues
- Integration with existing applications can be difficult

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Next: Open Hypermedia on the Web