Meme Media and Knowledge Federation

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The Web as a repository of a huge variety of knowledge resources

- The Web is becoming a huge open repository of knowledge resources that cover almost all areas
  - knowledge resources
    - What can be dealt with by computers, including data, documents, tools, and services, for the sharing and reuse by users.
- What prevents our maximum utilization of Web resources?
  - the difficulty for a user to find what he or she is interested in
  - the difficulty for a user to make mutually related Web resources work together

R&D efforts

- the difficulty for a user to what he or she is interested in
  - Big projects in the US, Europe, and Japan, such as Digital Library Initiative (DLI) Projects in US, and Information Grand Voyage Project in Japan
- the difficulty for a user to make mutually related Web resources work together
  - no major projects except those on GRID computing,
    - which basically focuses on the interoperability of distributed resources to perform routine or frequently requested jobs.

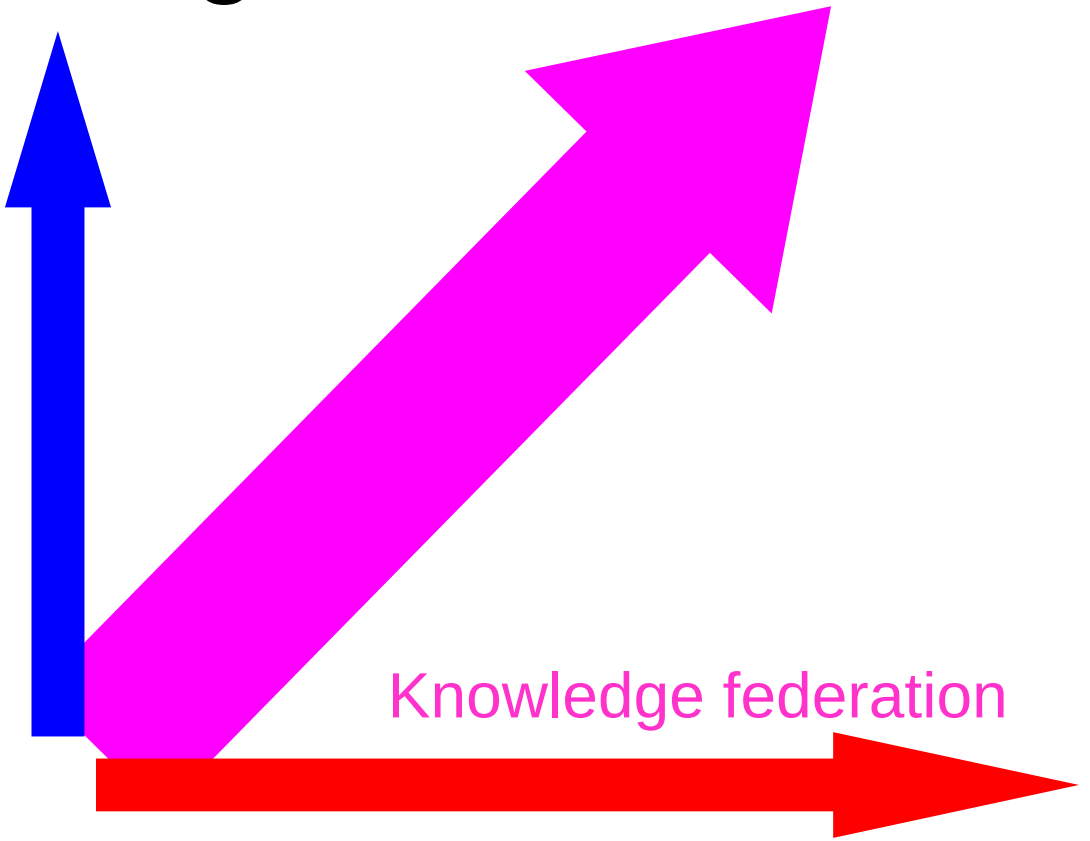
Knowledge federation as a key technology to develop

- "Federation" denotes ...
  - the process of combining multiple technology elements into a single virtual entity
- 2 origins in IT
  - a federated database architecture (Dennis Heimbigner,1985):
    - A collection of independent database systems are united into a loosely coupled federation in order to share and exchange information.
  - federation of services (Bill Joy, late 90s) :
    - A federation is a set of services that can work together to perform a task
- Knowledge federation (Yuzuru Tanaka, 2004)
  - flexible, *ad hoc*, and instantaneous selection, customization, and combination of knowledge resources by users
  - The 1st International Conference on Knowledge Federation, Oct. 20-22, 2008, Duvrovnik, Croatia

Extending the Web

Web 2.0

Collaborative and/or semantic reorganization of Web resources to structurally enrich relations among Web resources



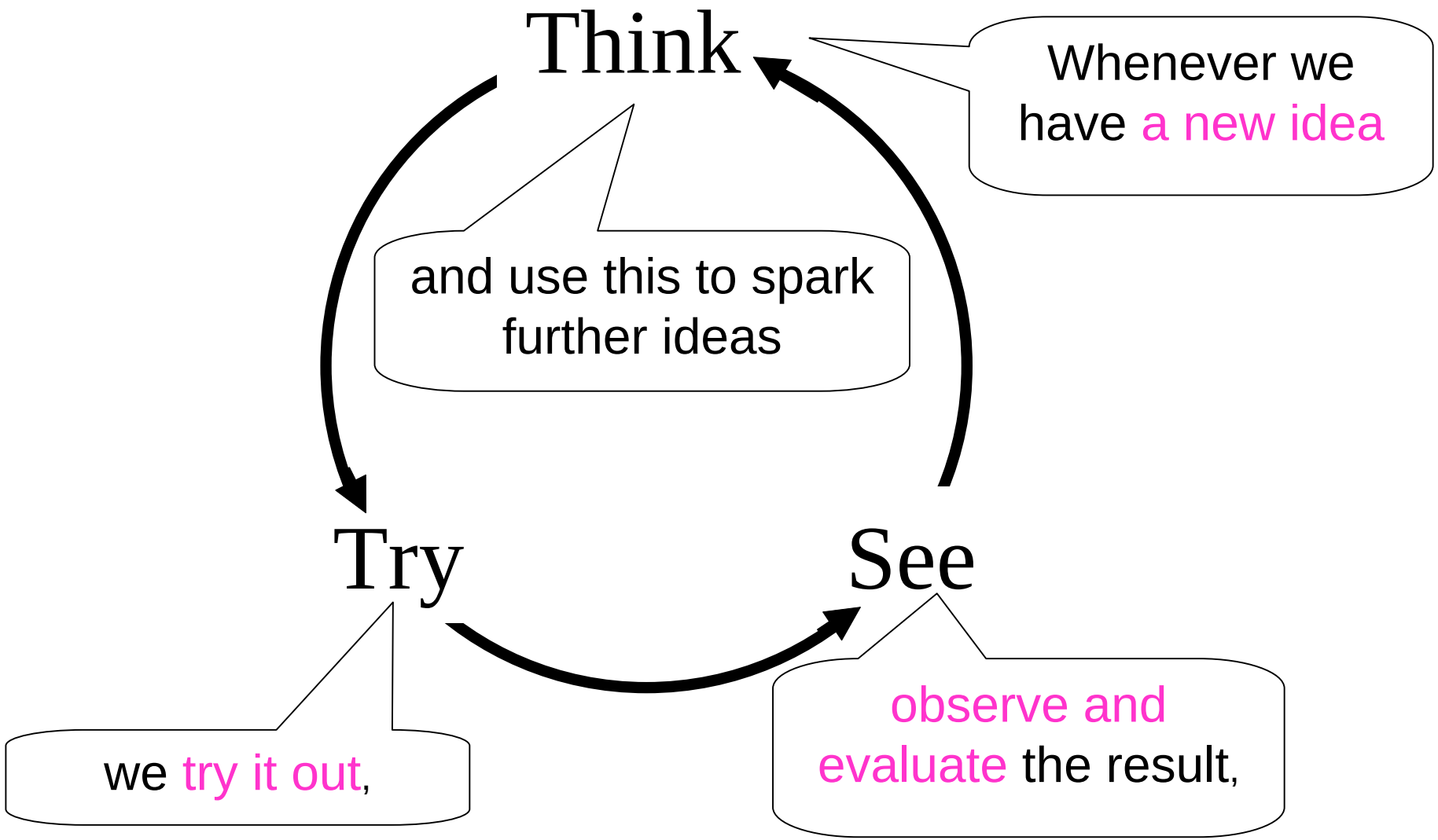
Knowledge federation

Collaborative reediting of Web resources for composing new ones to structurally and functionally enrich Web resources

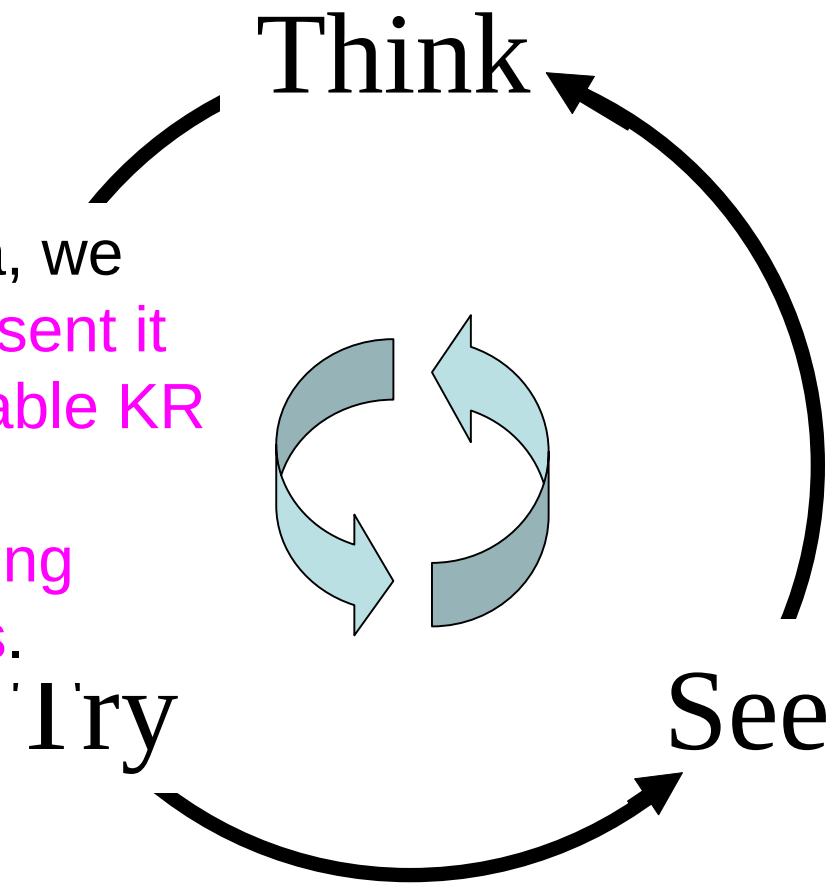
Federation is different from integration

- Federation
  - assumes an open networked environment of diverse, heterogeneous, autonomous, and distributed resources, and
  - deals with open scenarios of information processing.
- Integration
  - targets local and centralized management, and interoperation of resources in a closed environment, and
  - deals with closed scenarios of information processing.

Why ad hoc knowledge federation?



Acceleration of Creative Thinking



To try an idea, we need to represent it as an executable KR (knowledge resource), using available KRs.

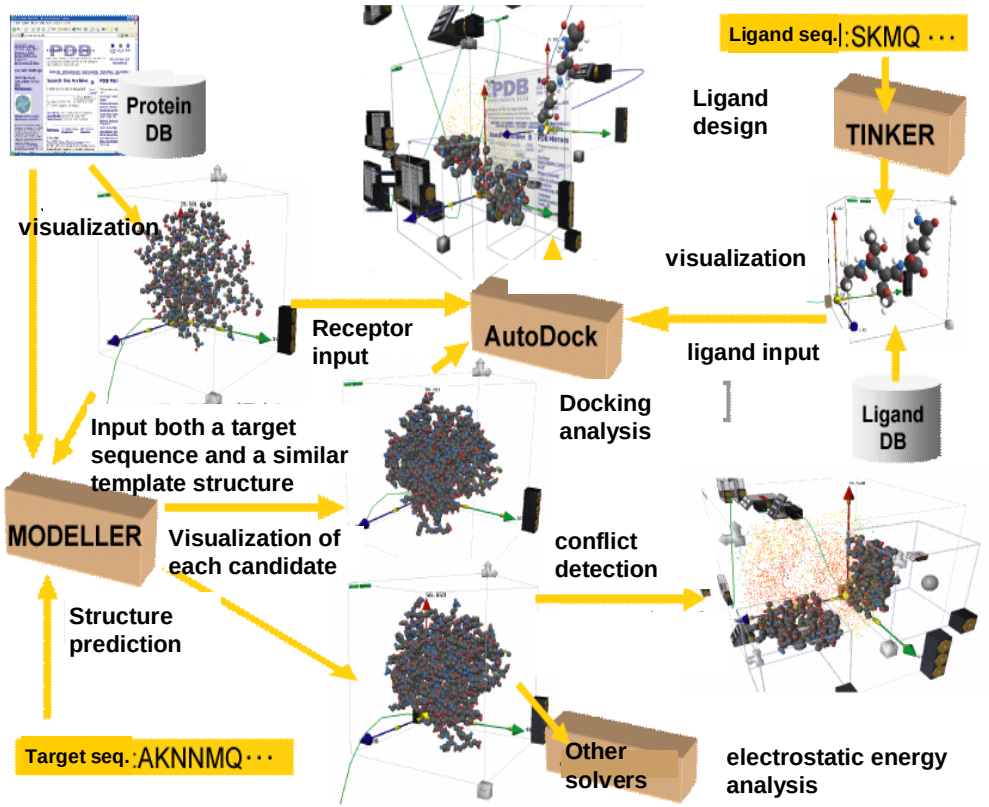
To evaluate the trial results, we need to apply various evaluation and analysis tools.

Ad hoc knowledge federation and the reuse of federation results

- Immediate trial of a new idea requires
  - rapid composition of a new tool from available resources,
  - its application to a data set extracted from available resources.
  - repetition of such processes.
- Further reuse by other people requires
  - republication of these composed tools and extracted data sets as web resources

A grand challenge of knowledge federation technologies

- Could one compose such a complex application as a drug design system just through ad hoc federation of available Web resources?



Components exist as Web resources.

Not possible now,

But yes in a near future.

Science Infrastructure

- new research methodology: ‘data-based science’, or ‘data-centric science’
  - systematic data acquisition first,
  - then data analysis for hypothesis validation
    - genomics, proteomics, brain science, clinical trials, nuclear physics, astrophysics, material science, meteorology, and seismology
- Leading to
  - a large number of huge, independent accumulations of data, and
  - a great variety of data analysis tools.
- Requiring knowledge federation operations
  - extraction of appropriate data sets from multiple seemingly unrelated sources,
  - their compilation or customization, and
  - the application of data analysis and/or data visualization tools to these data sets.
- Such operations are inherently performed in an *ad hoc* manner, and should be executable rapidly enough to follow up on fleeting ideas.

Science infrastructure vs. conventional e-science

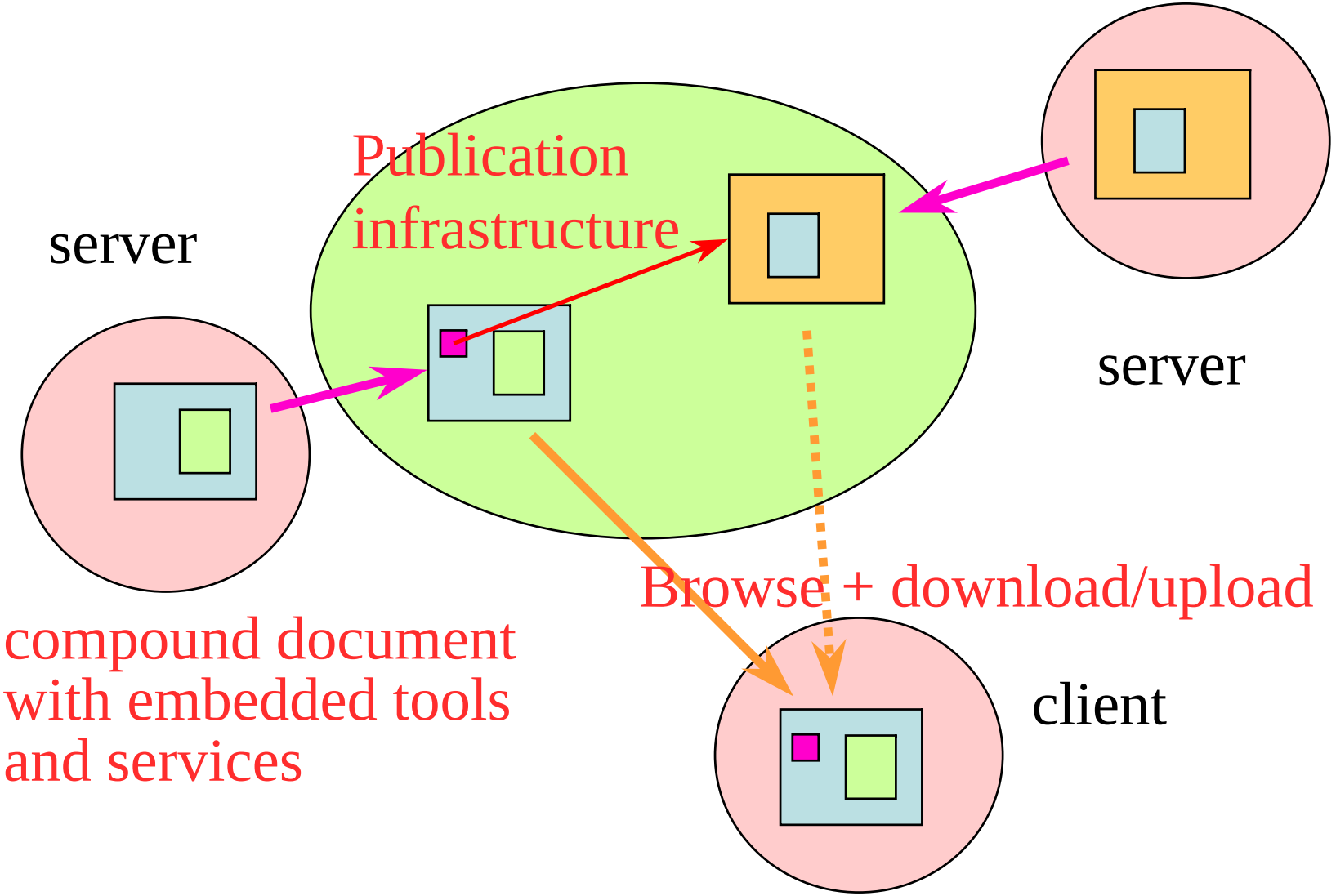
- Science infrastructure
  - requires a new generic technology for ‘knowledge federation’
    - as well as the development and extension of databases, simulators, and analysis tools in each area.
    - to meet the dynamically changing demands of creative activities.
- Conventional e-science
  - For routine or frequently requested jobs
    - work-flow and/or resource-orchestration technologies
    - based on GRID computing.

Taxonomy:
Knowledge Media, Meme Media, and Knowledge Federation

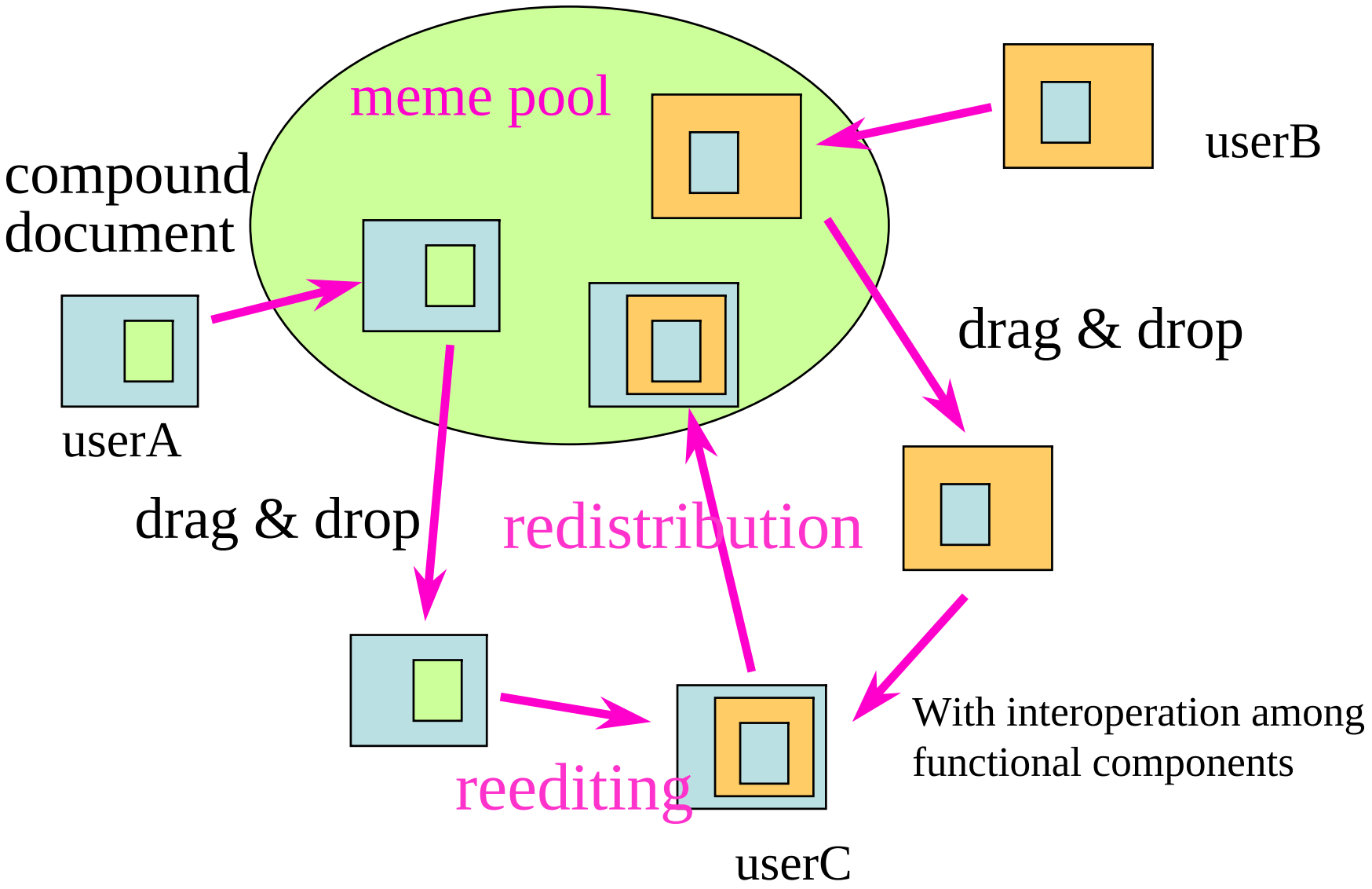
Knowledge resources, and knowledge media

- Knowledge resources
  - What can be dealt with by computers, including data, documents, tools, and services, for the sharing and reuse by users
- Knowledge media
  - externalize knowledge resources as compound documents, i.e., documents with
    - embedded nonfunctional multimedia contents and/or
    - functional contents such as application tools and services
  - The Web is an example of knowledge media.

The Web as knowledge media



Meme media


meme pool
compound
document
userA
userB
drag & drop
drag & drop
redistribution
reediting
userC
With interoperation among
functional components

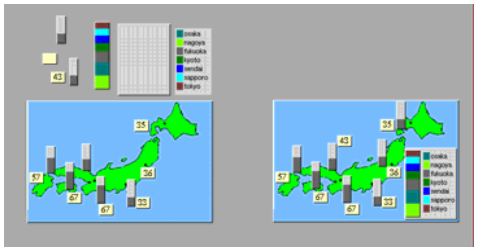
Knowledge federation to make the Web work as meme media

- Knowledge federation introduces memetic evolution to the Web
- Biological evolution is based on mechanisms
  - Replication / Recombination / Mutation / Natural selection
- Same is true with the evolution of knowledge resources (Web resources)
  - Replication / Reediting / Evaluation by a society or a community
  - Reediting
    - Easy for multimedia documents
    - Difficult for compound documents with functional components
  - Knowledge federation accelerates collaborative reediting of Web resources
- Web resource as a meme

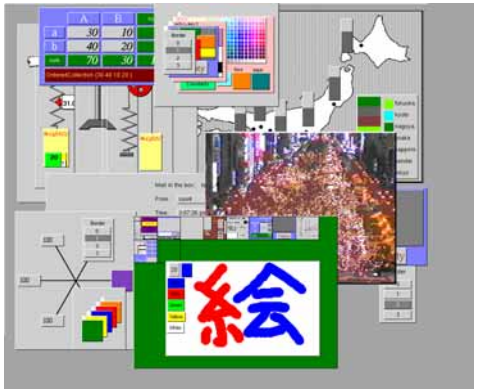
Meme Media as Basic Enabling Technologies

Meme Media Architectures: IntelligentPad and IntelligentBox

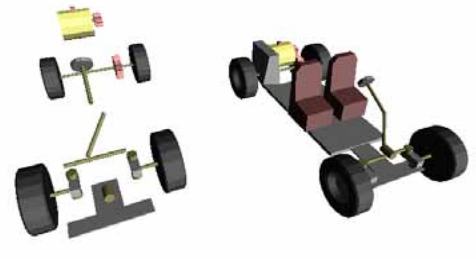
- 1987-1992:
  - Component-based media architecture IntelligentPad (1989)
    - pads as media components



- 1993-2001:
  - IntelligentPad as a Meme media architecture for users to reedit and to redistribute intellectual resources (1993)

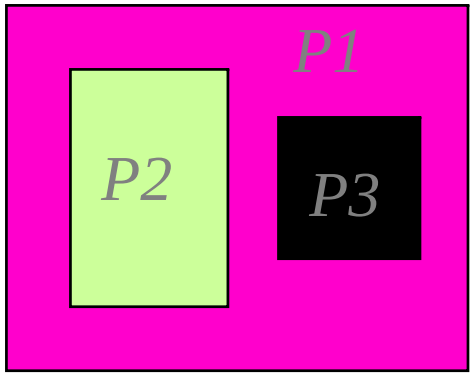


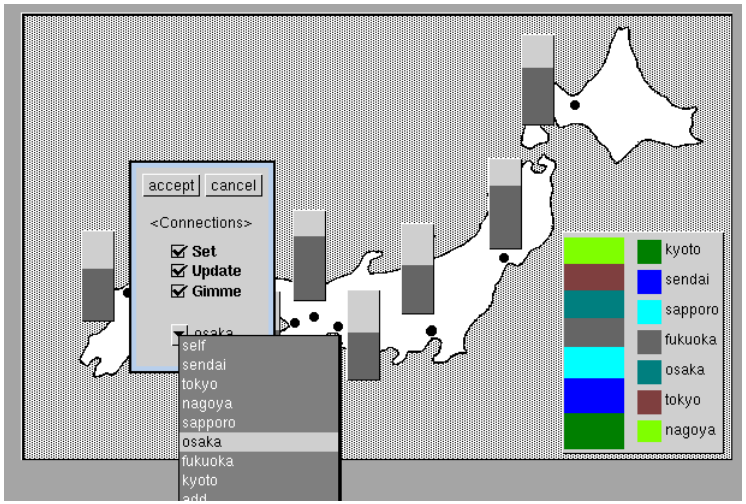
  - 3D meme media architecture IntelligentBox (1995-)
    - boxes as media components



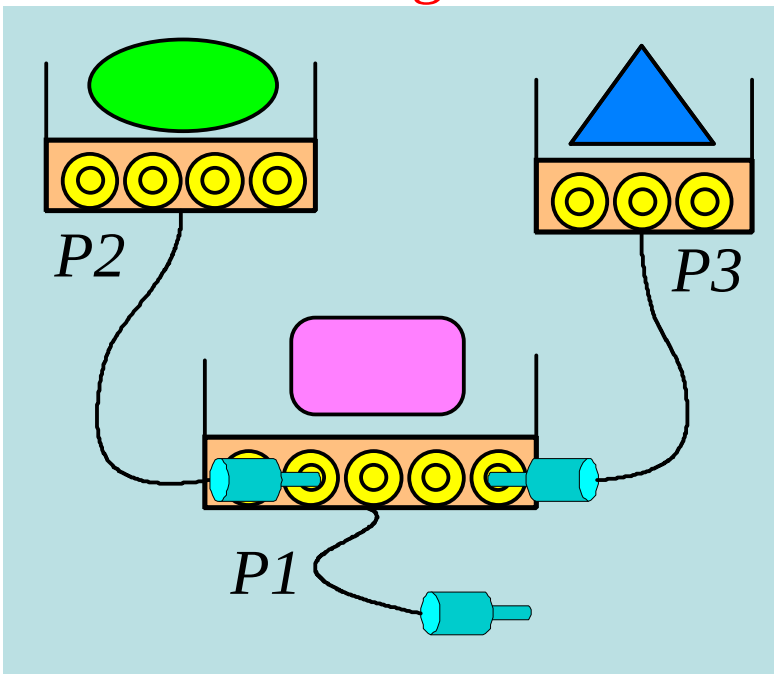
IntelligentPad as Meme Media

Pads are pasted together to define a Compound Document.





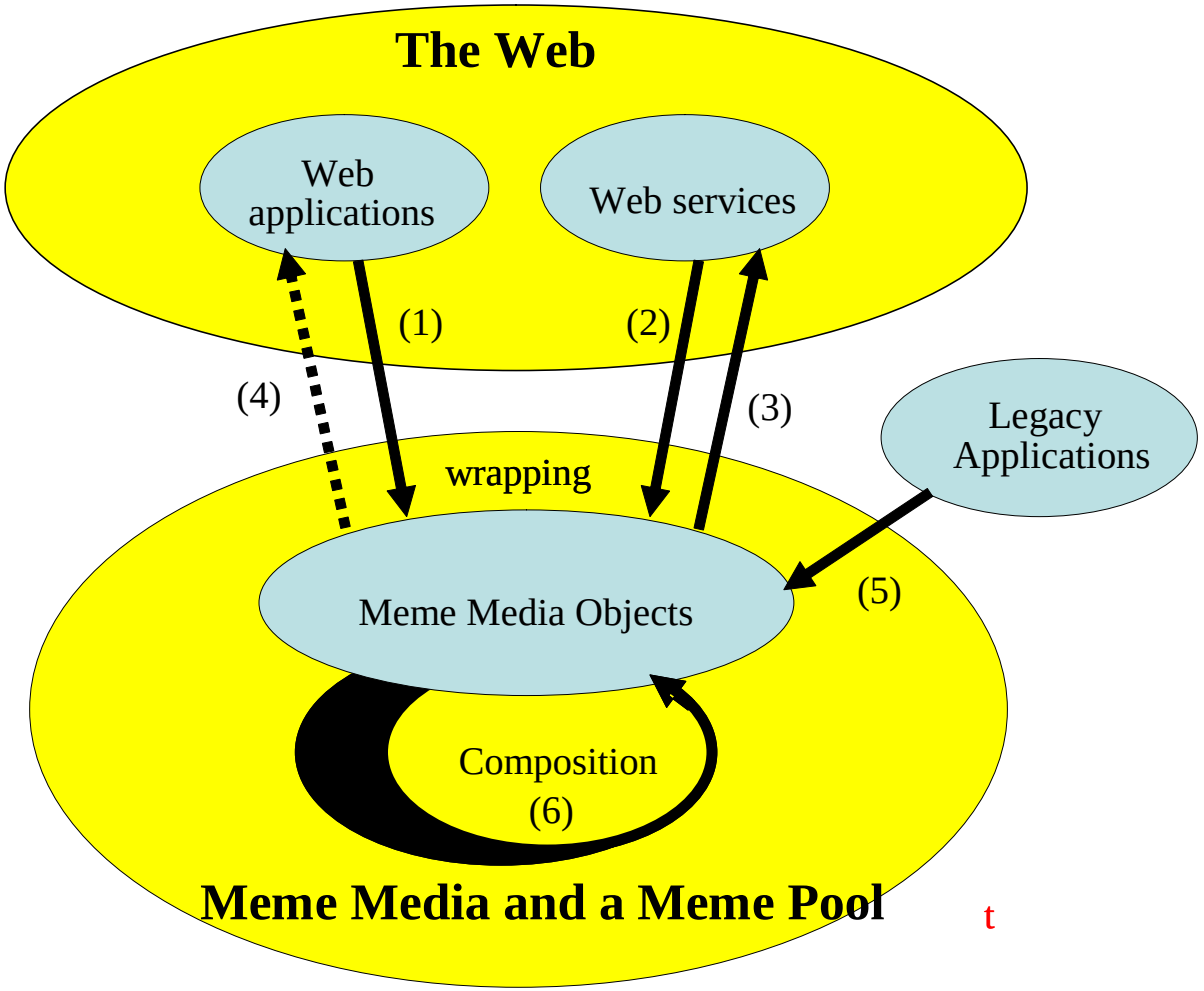
Each pad wraps an object with a standard display representation and a standard logical interface.



Each pad has a set of connection jacks called slots and a single pin plug to be inserted to one of its parent's slots

How to apply meme media to Web resources?

Wrapping web resources as meme media objects



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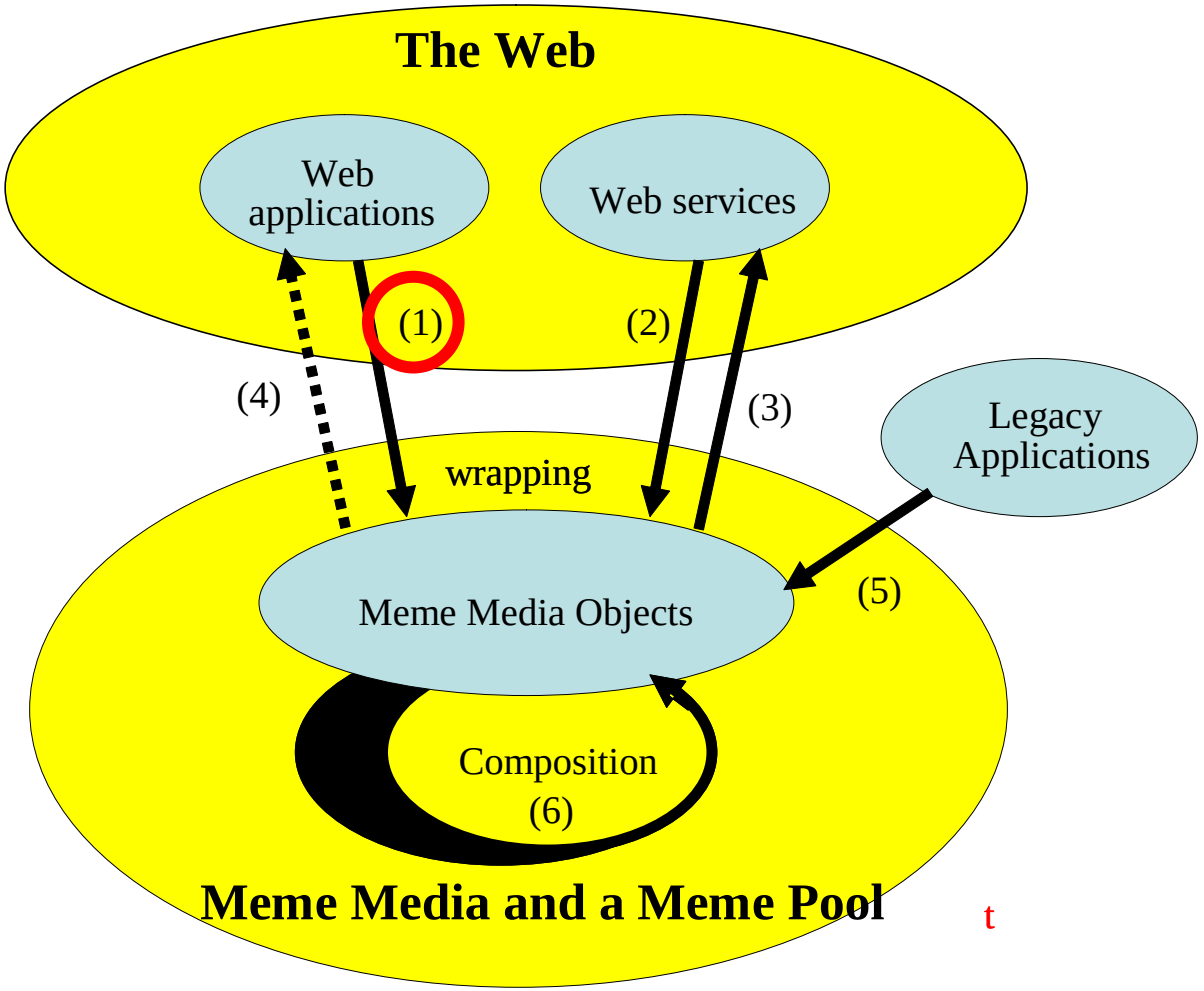
How to wrap different types of knowledge resources?



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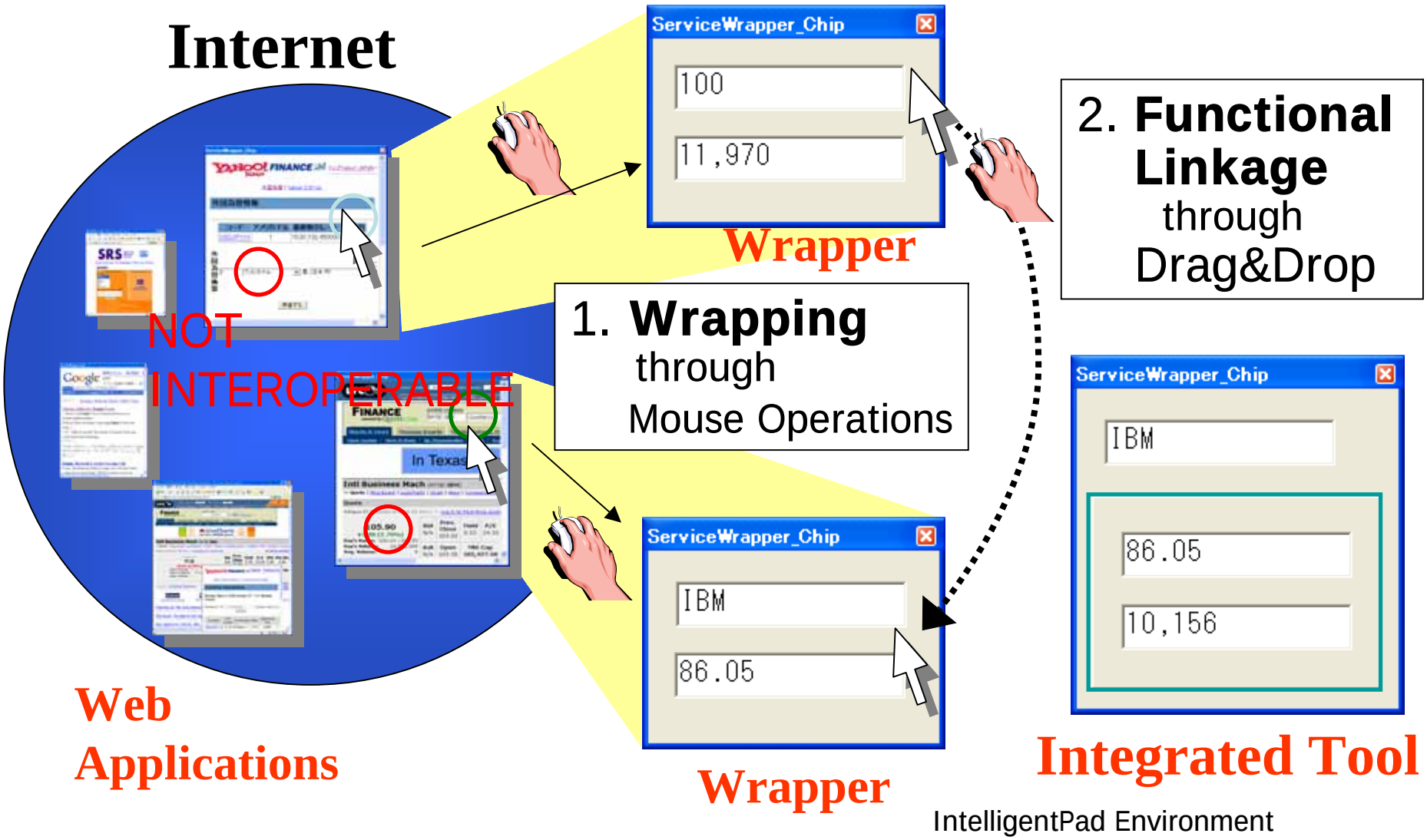
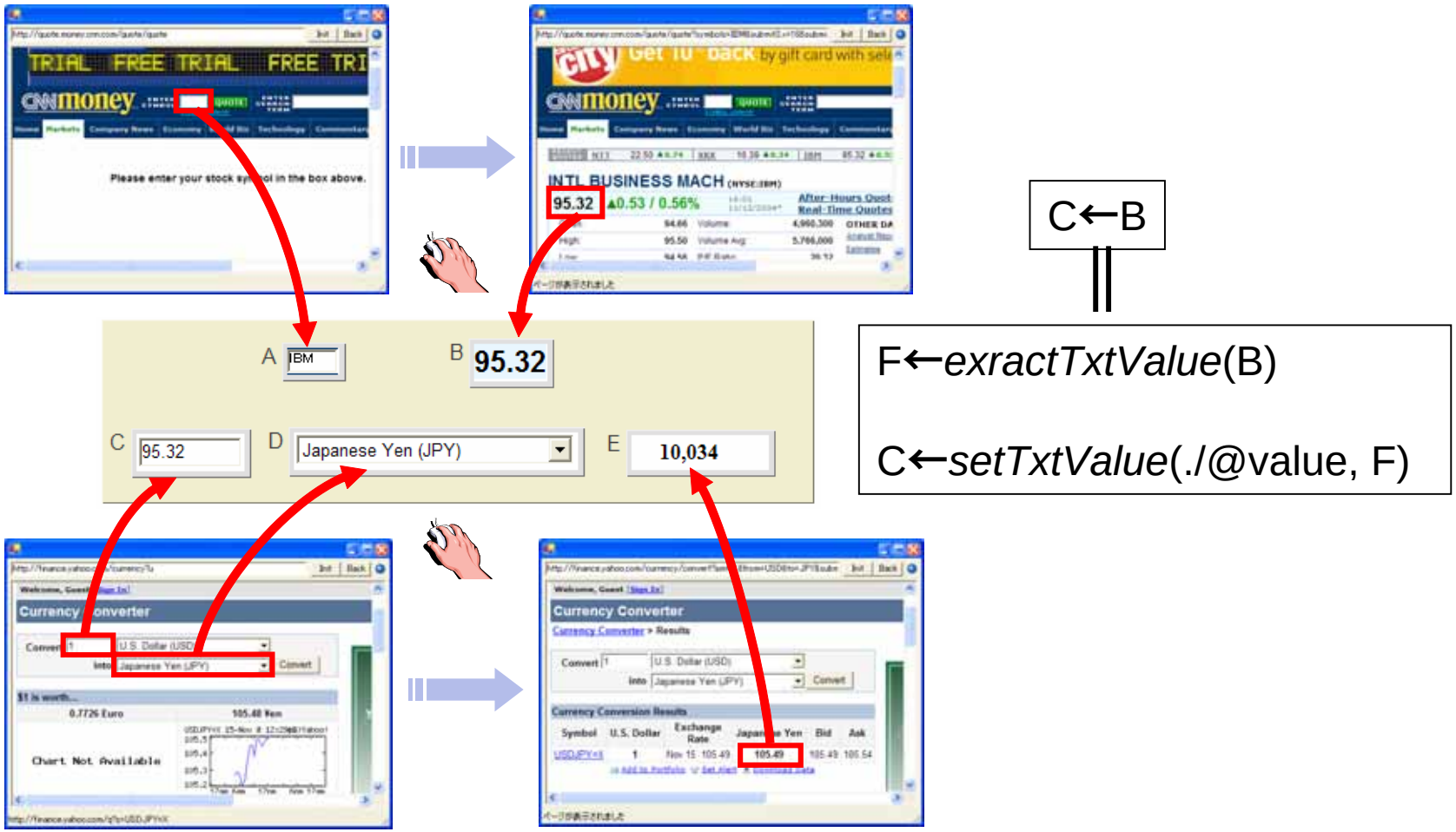
Wrapping and Linking of Web Applications

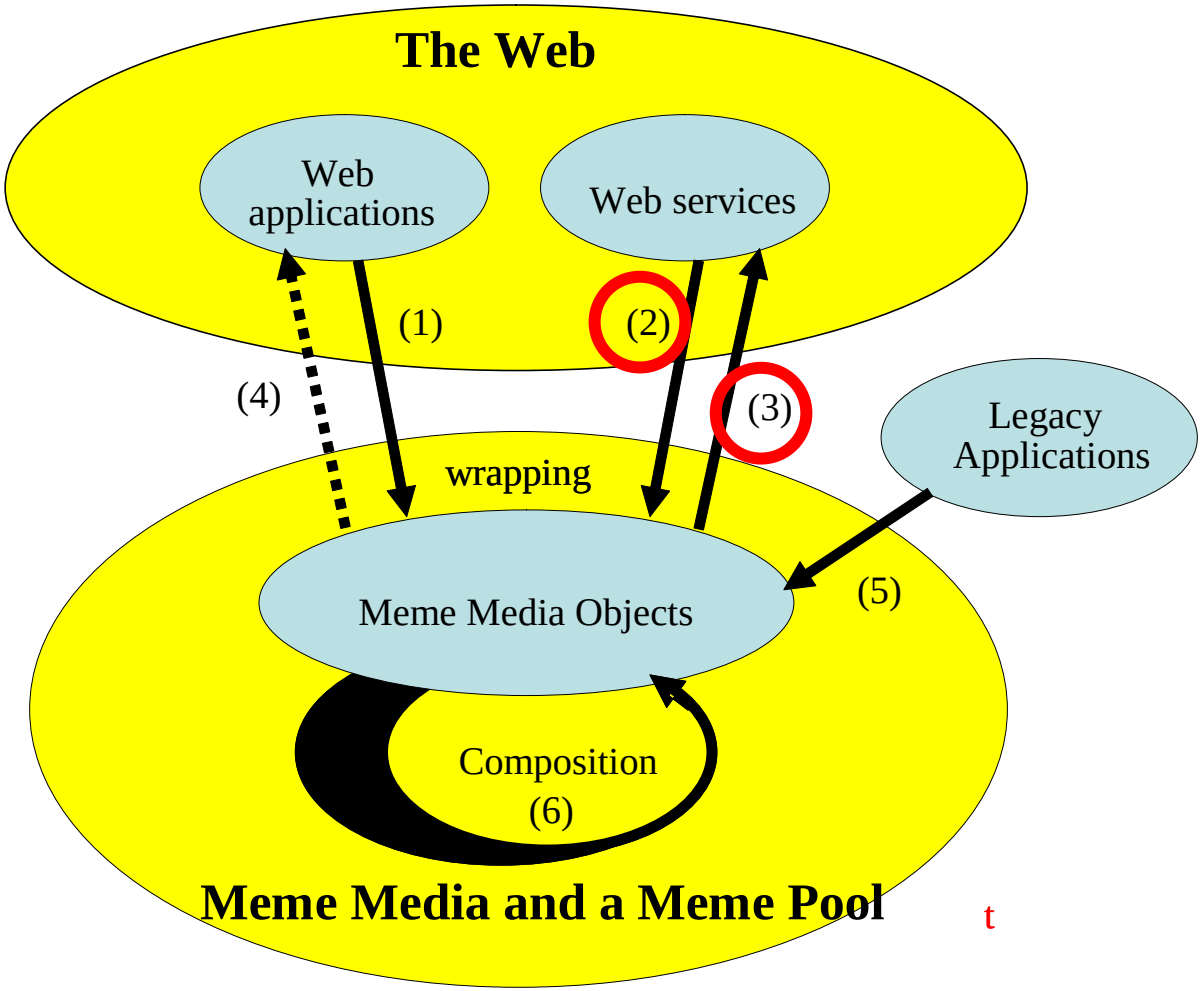
CHIP (2003) for Dynamic Linkage among Web Applications



Linkage between Web clips from different navigations (C3W, 2004)



How to wrap different types of knowledge resources?



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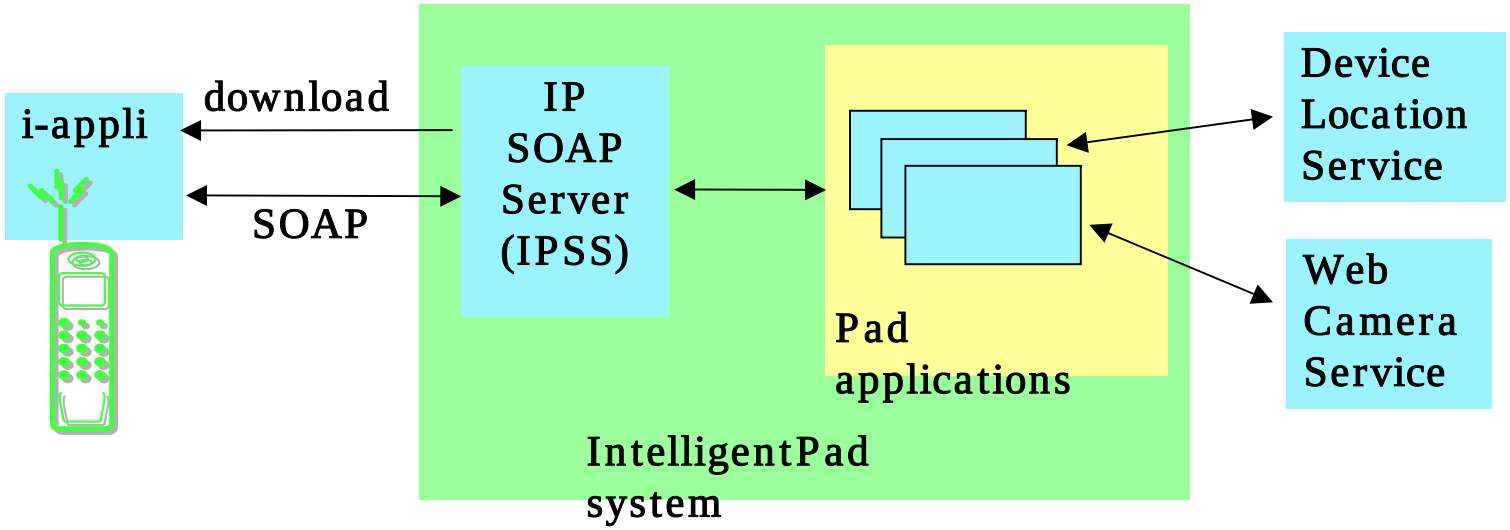
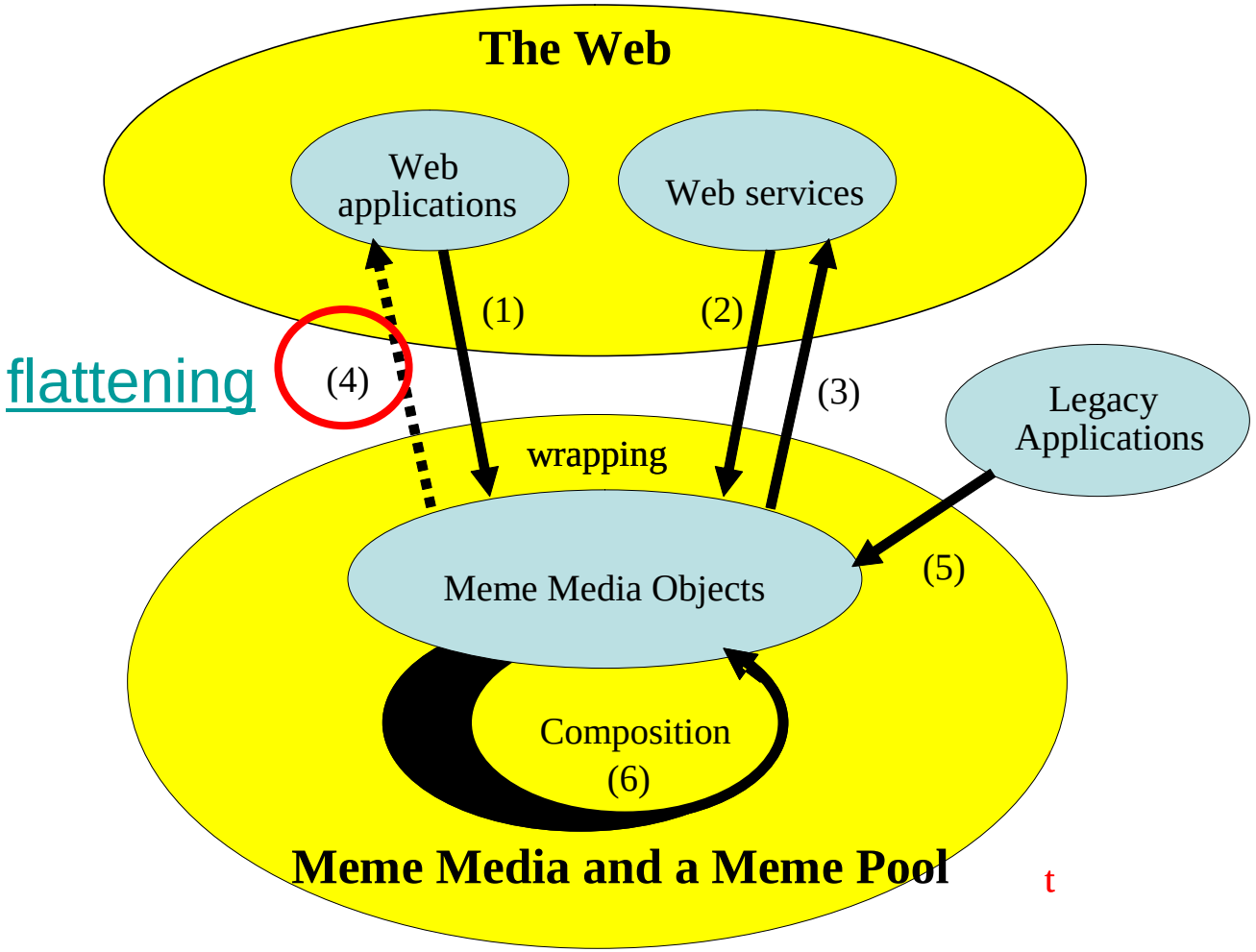
Proxy pads and server-side meme media

- Server-side Meme Media (2005) enabled users
  - to automatically generate proxy pads for accessing arbitrary Web services,
  - to paste them together for their composition, and
  - to convert the composite pad to a new Web service.



How to wrap different types of knowledge resources?



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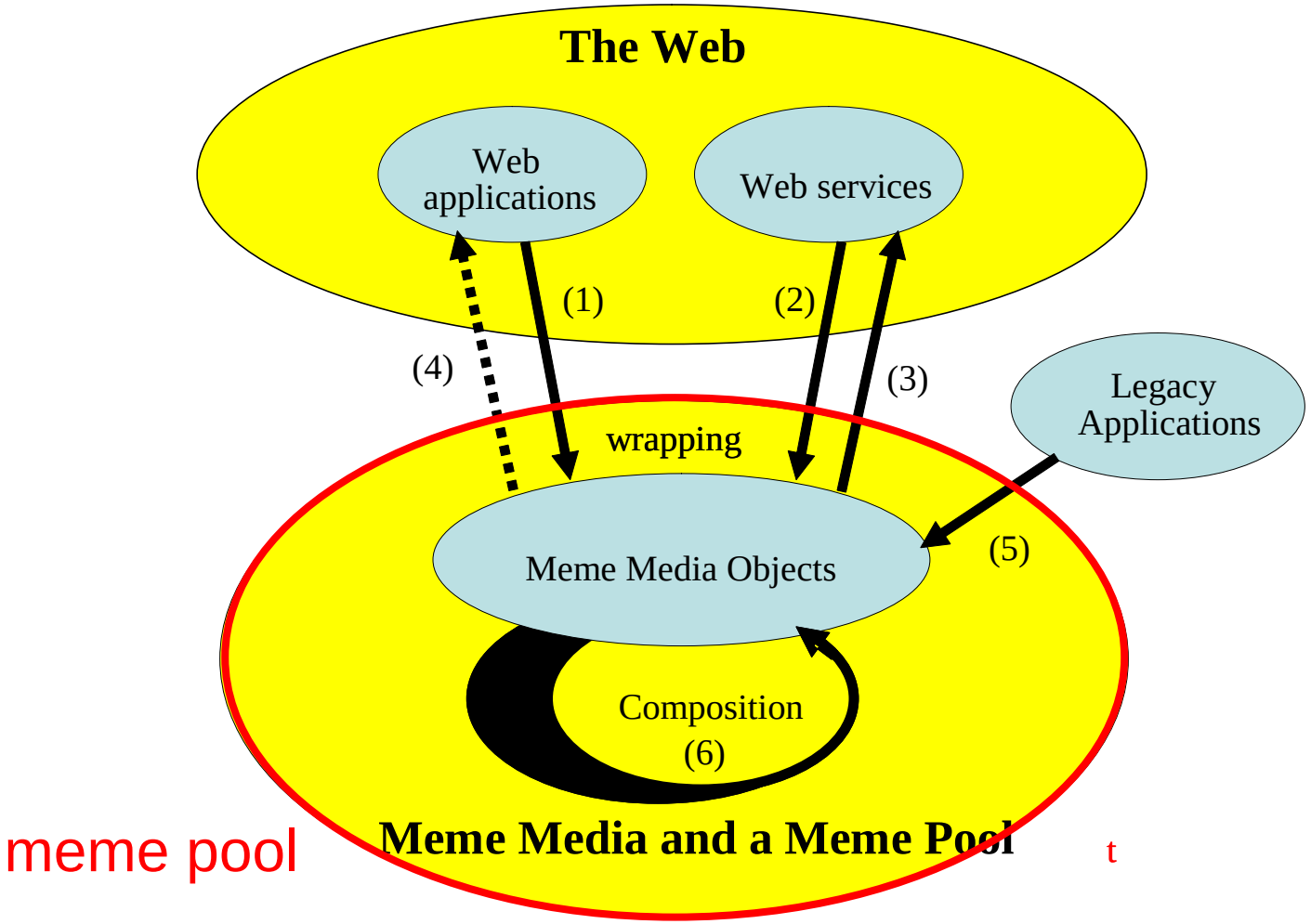
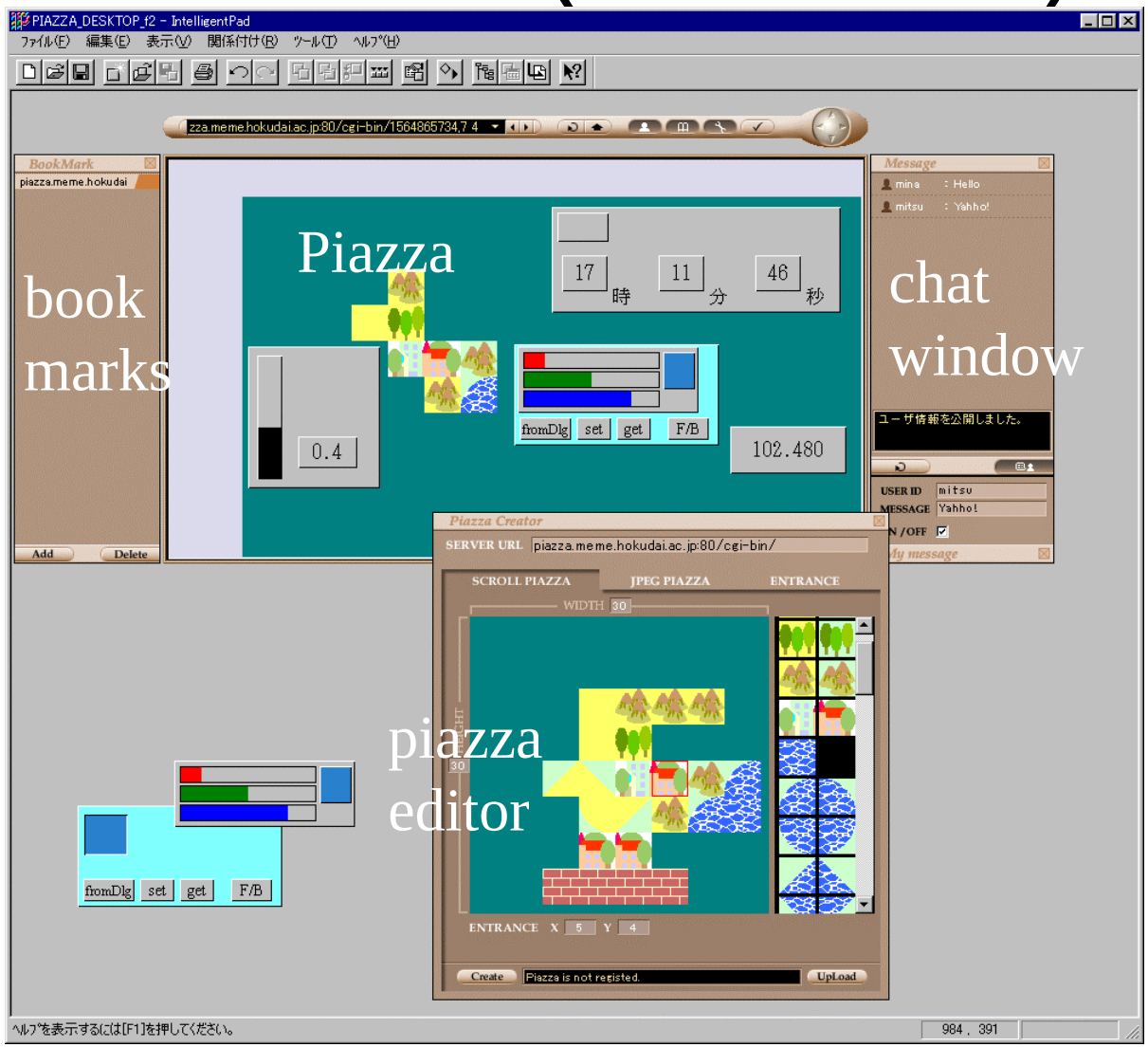
How to wrap different types of knowledge resources?



Piazza as a meme pool system (≠ the Web)



Upload and download of pads by drag-and-drop (1998)

Wiki Piazza (2004)

- Wiki piazza system works both
  - for resource providers to register new computing resources, and
  - for resource consumers or users to look up and to use available resources.

Repository service

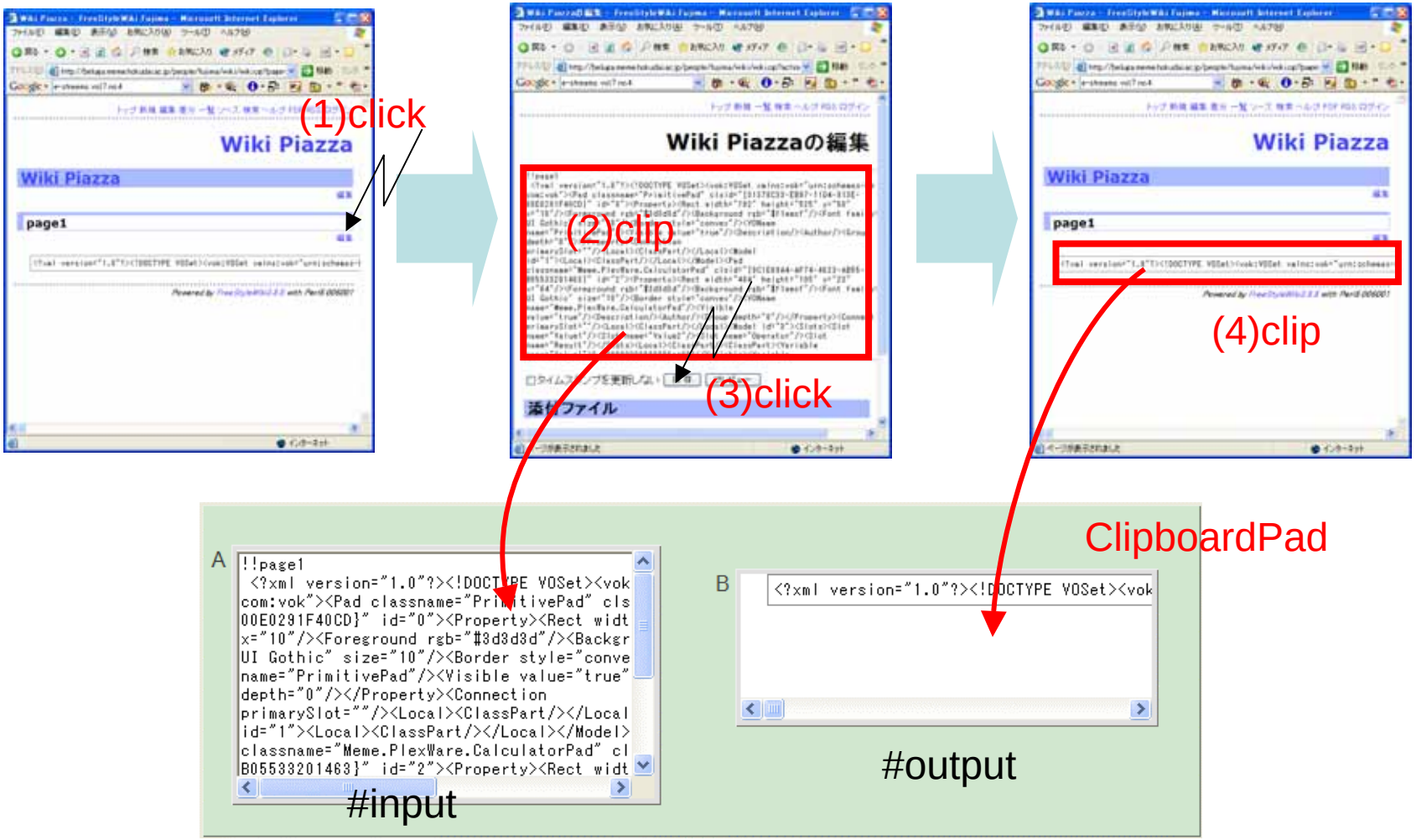
to register computing resources wrapped as pads

Lookup service

also composed by Wrapping of Wiki Search and Google Search: Similarity search

Piazza based on Wiki

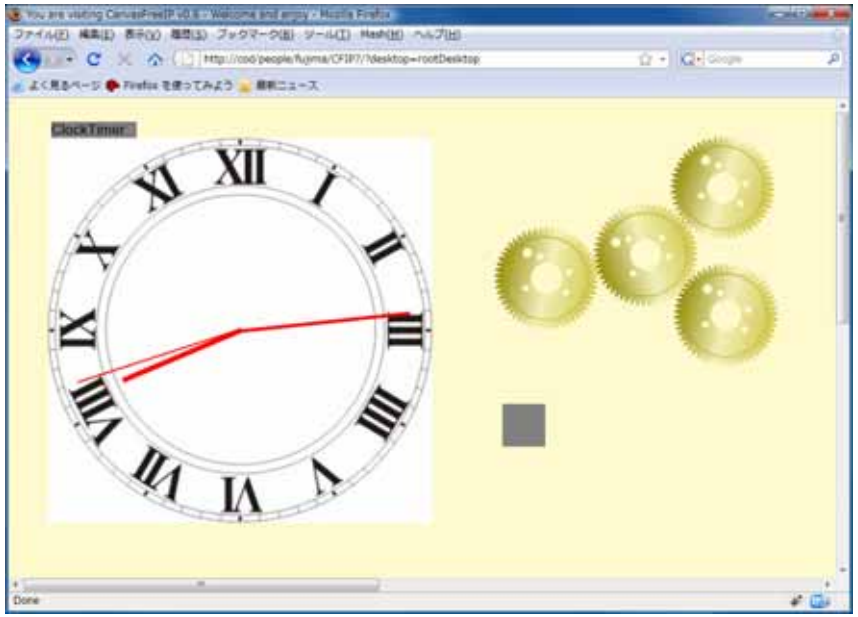
Wrapping Wiki to work as a Pad Repository



After defining slots to the ClipboardPad, we use only this pad.

How to make the Web work as a meme pool?

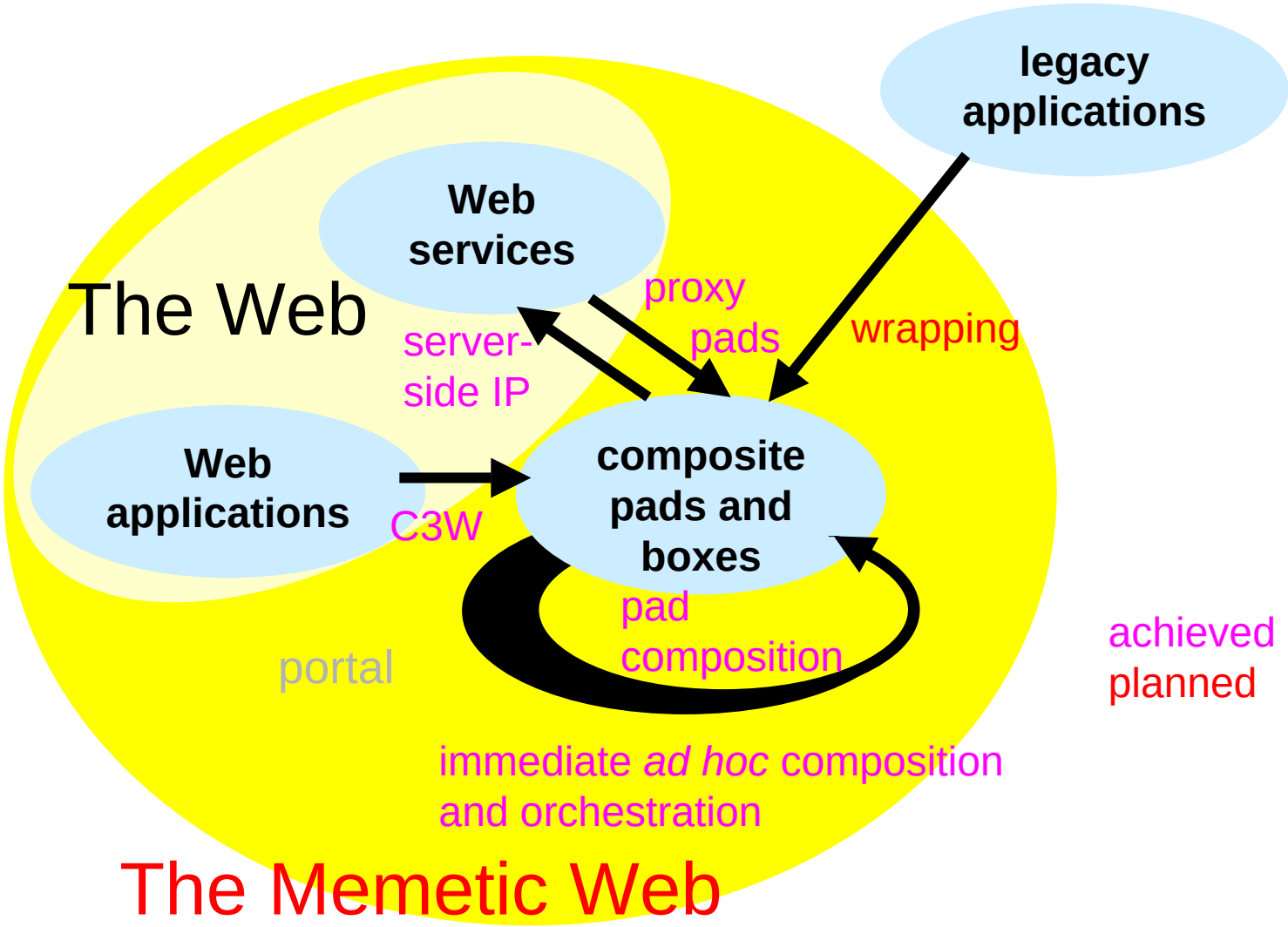
- The 2008 version of IntelligentPad: a web-top system
  - fully exploits Microsoft Silverlight technology, and runs on Internet Explorer 6 and 7, Mozilla Firefox, or Safari browser empowered by Silverlight plug-in.
  - no need to install any IntelligentPad kernel on clients



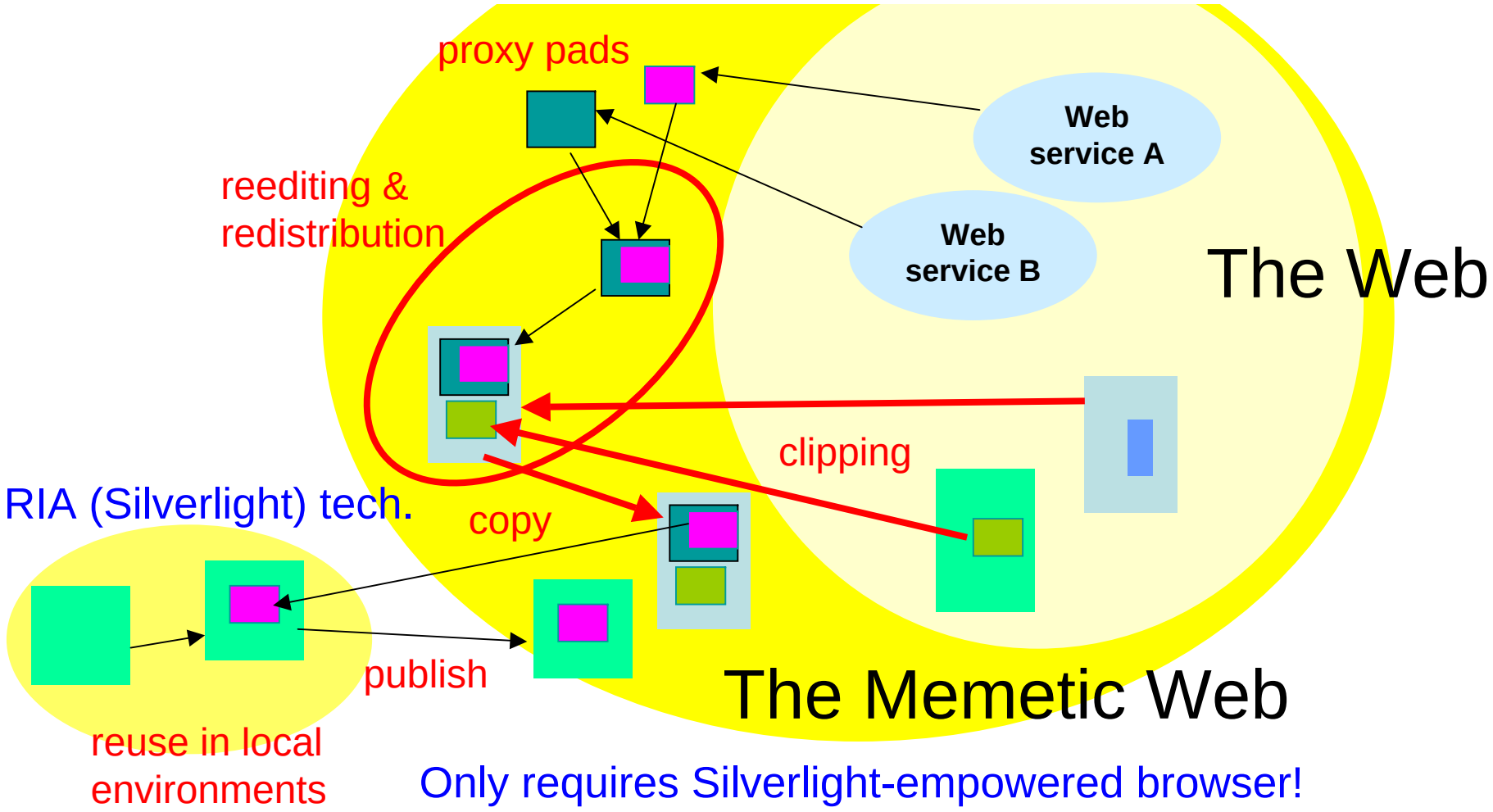
New features of the new version

- no IntelligentPad kernel running on clients
  - Users do not recognize any difference between web resources and composite pads.
  - Composite pads can be also registered in HTTP servers as extended web resources.
- canvas-free pads
  - Any graphical object including a line segment can be treated as a pad.
    - SVG (Scalable Vector Graphics) to describe graphical objects.
    - A child pad on a canvas-free pad is bound by the local coordinate system spanned by the latter pad,

The Memetic Web



The Memetic Web



Only requires Silverlight-empowered browser!

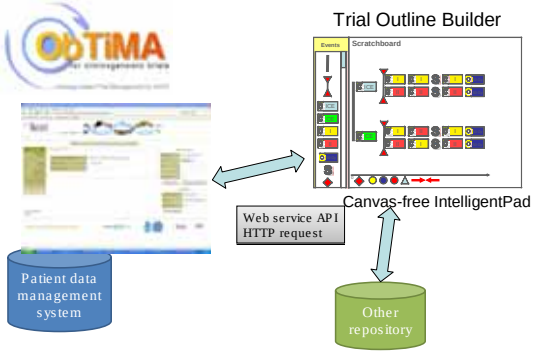
browsing, using, reediting and redistributing envt.

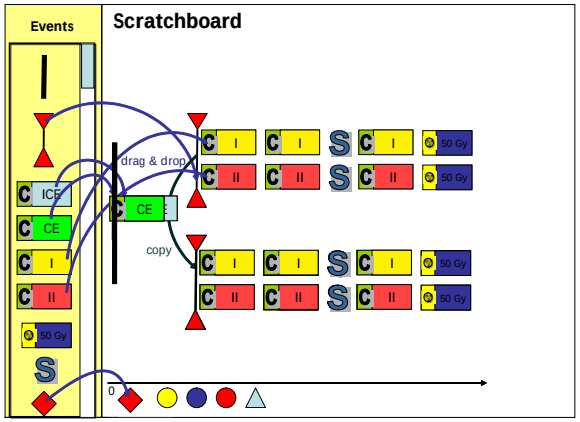
EU's FP6 Integrated Project ACGT (Advancing Clinico-Genomic Trials on Cancer)

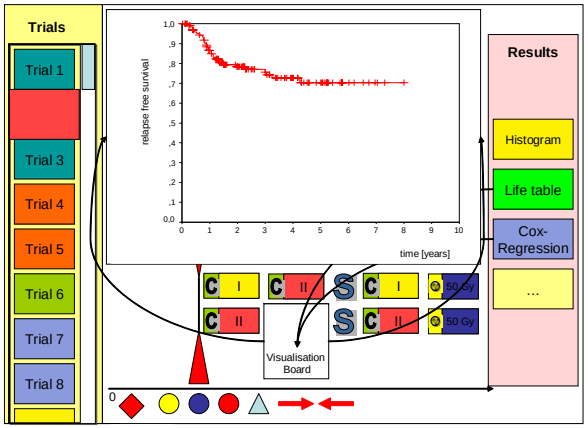
- Trial Outline Builder: a subsystem of ObTiMa
  - Joint development with the Department for Pediatric Hematology and Oncology at the University Hospital of the Saarland, and Fraunhofer IAIS

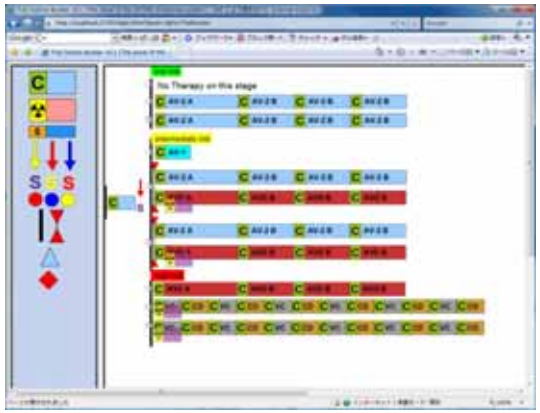
ACGT Trial Builder (2008-)

Architecture overview









Web-top Trial Outline Builder (2008)

Meme Media and Knowledge Federation
vs.
SOAs and Web Mashups

Related Technologies (1)
Service-Oriented Architecture (SOA)

- Two similar technology trends:
  - Science / Business Cloud-based SOA
    - Provides processing power, services, middleware, developers' toolkits through the Web
  - Science / Business GRID-based SOA
    - Provides HPC power, services, and service-composition workflow definition / execution / management systems.
- Both emphasize:
  - definition, execution, and management of routine or frequently requested jobs
  - **not** user-centric, immediate, unforeseen *ad hoc* composition
- Therefore both provide:
  - tools for editing internal representations of service compositions,
  - **not** tools for directly reediting compound documents to compose new knowledge resources

Related Technologies (2)
Mashup Technologies

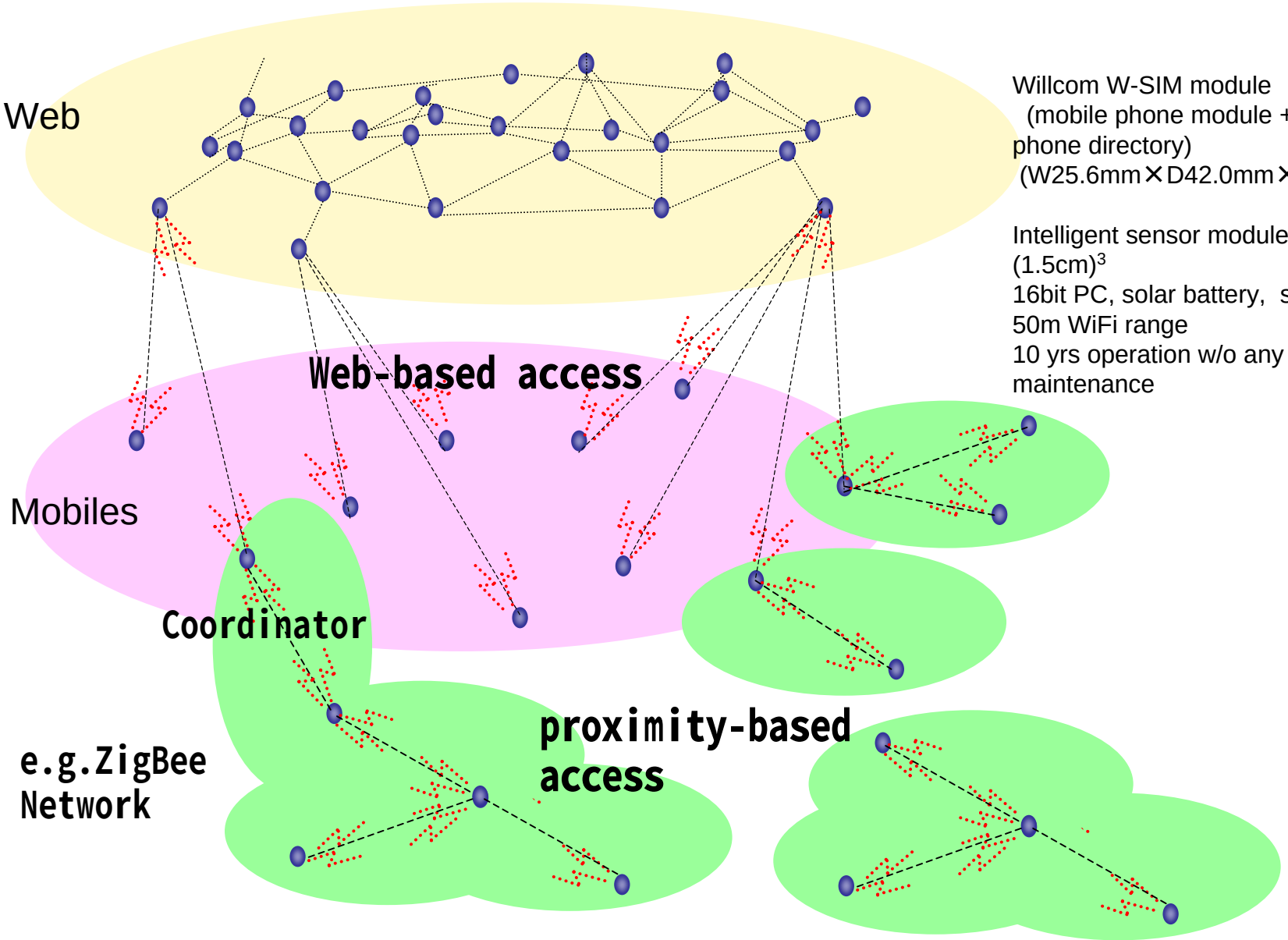
- Mashup: user-driven micro-integration of Web data
  - i.e., data merging / data feeding / data joining / data filtering / data annotating
  - Traditional mashup tools are based on workflow composition of Web services to construct a new Web application or service
- Strengths
  - They are starting to address RIA (Rich Internet Applications).
  - Some tools (e.g., Mash Maker and Lotus Mashup) allow users to clip widgets directly from Web applications.
- Weaknesses
  - Widget extraction and composition use different environments.
  - Widgets cannot be combined with local tools to compose new applications (other than limited support for *de facto* standard office tools).

Knowledge Federation beyond the Web

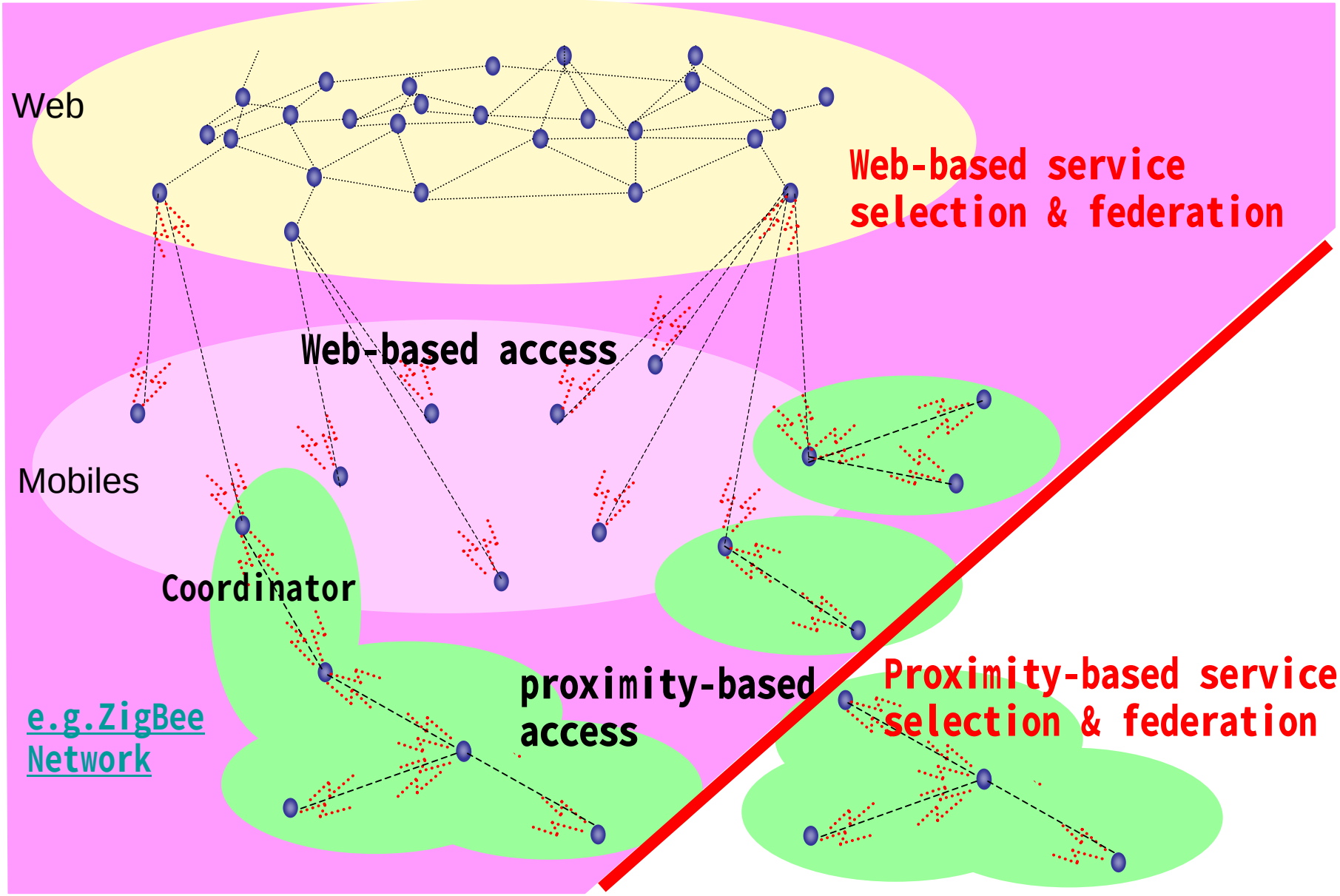
Service Selection and Federation

Willcom W-SIM module
(mobile phone module + antena + phone directory)
(W25.6mm×D42.0mm×H4.0mm)

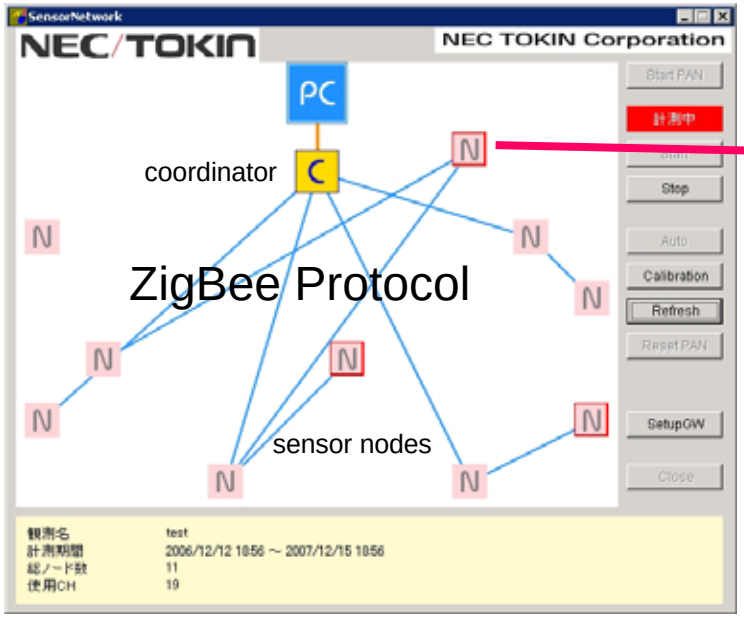
Intelligent sensor modules
$(1.5cm)^3$
16bit PC, solar battery, sensors
50m WiFi range
10 yrs operation w/o any maintenance



Web-based Federation

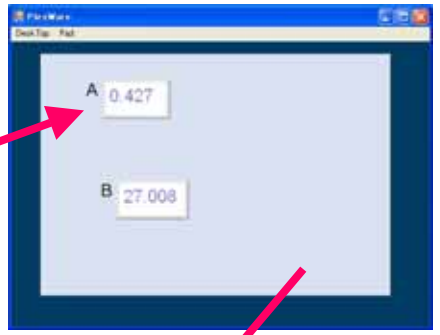


Knowledge Federation between a Sensor Network and a Robot

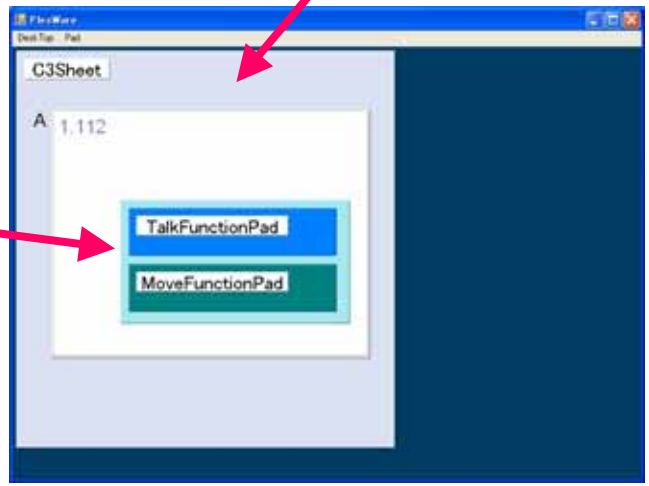


Web application showing sensor data of a specified node

clipping



composition



sensor node

8bit PC
sensors
(light, temperature,
3D acceleration)
100m WiFi range

Coordinator
(USB)

robot with
conversation
capability

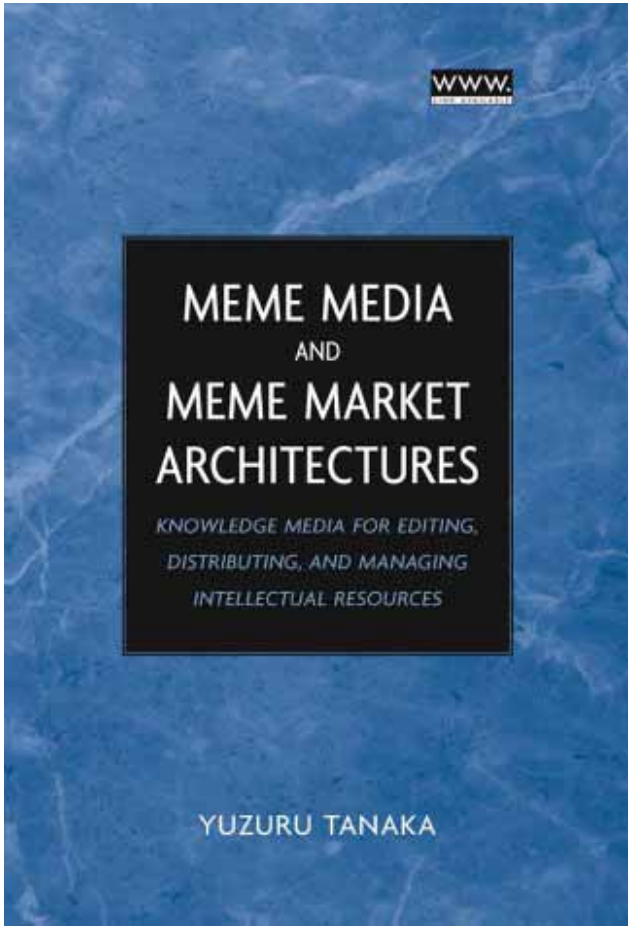
Concluding Remarks (1)

- The current Web
  - a huge repository of knowledge resources of almost all areas.
- The problem is how to make it easy
  - to select some set of resources including web resources and local ones,
  - to customize them, and
  - to make them work together.

Concluding Remarks (2)

- Knowledge federation as a key technology for people
  - to freely and immediately reedit some of the Web resources,
  - to compose a new knowledge resource for his or her own reuse, and
  - to publish it again as Web resources..
- The 2008 version of IntelligentPad extends the Web to the memetic Web.
  - Users can
    - freely publish both web resources and composite pads into the memetic Web,
    - extract resource fragments from some resources in the memetic Web,
    - make them work together to compose a composite pad, and
    - publish it into the memetic Web for its further reuse by others.

For further information on meme media architectures and applications



Tanaka, Y.

Meme Media and Meme Market Architectures: Knowledge Media for Editing, Distributing, and Managing Intellectual Resources.

IEEE Press & Wiley-Interscience, NJ (2003)