



VRIJE
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BRUSSEL

wise WEB & INFORMATION
SYSTEMS ENGINEERING

Cross-Media Information Spaces and Architectures

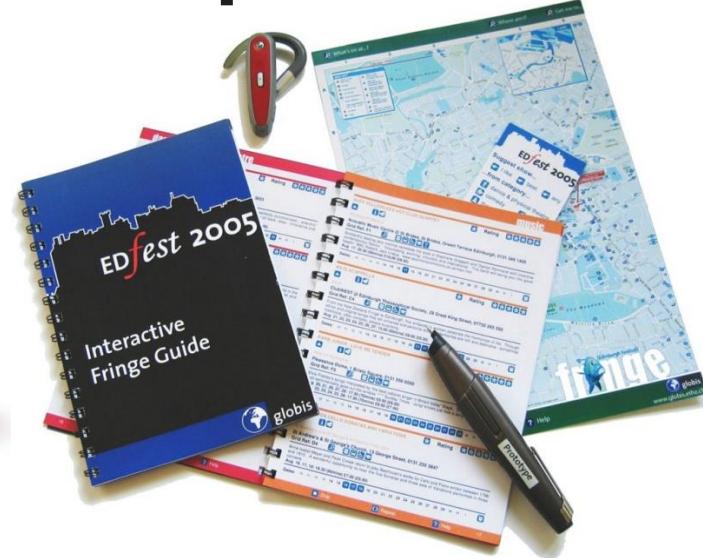
Prof. Dr. Beat Signer

beatsigner.com

Web & Information Systems Engineering Lab
Department of Computer Science
Vrije Universiteit Brussel

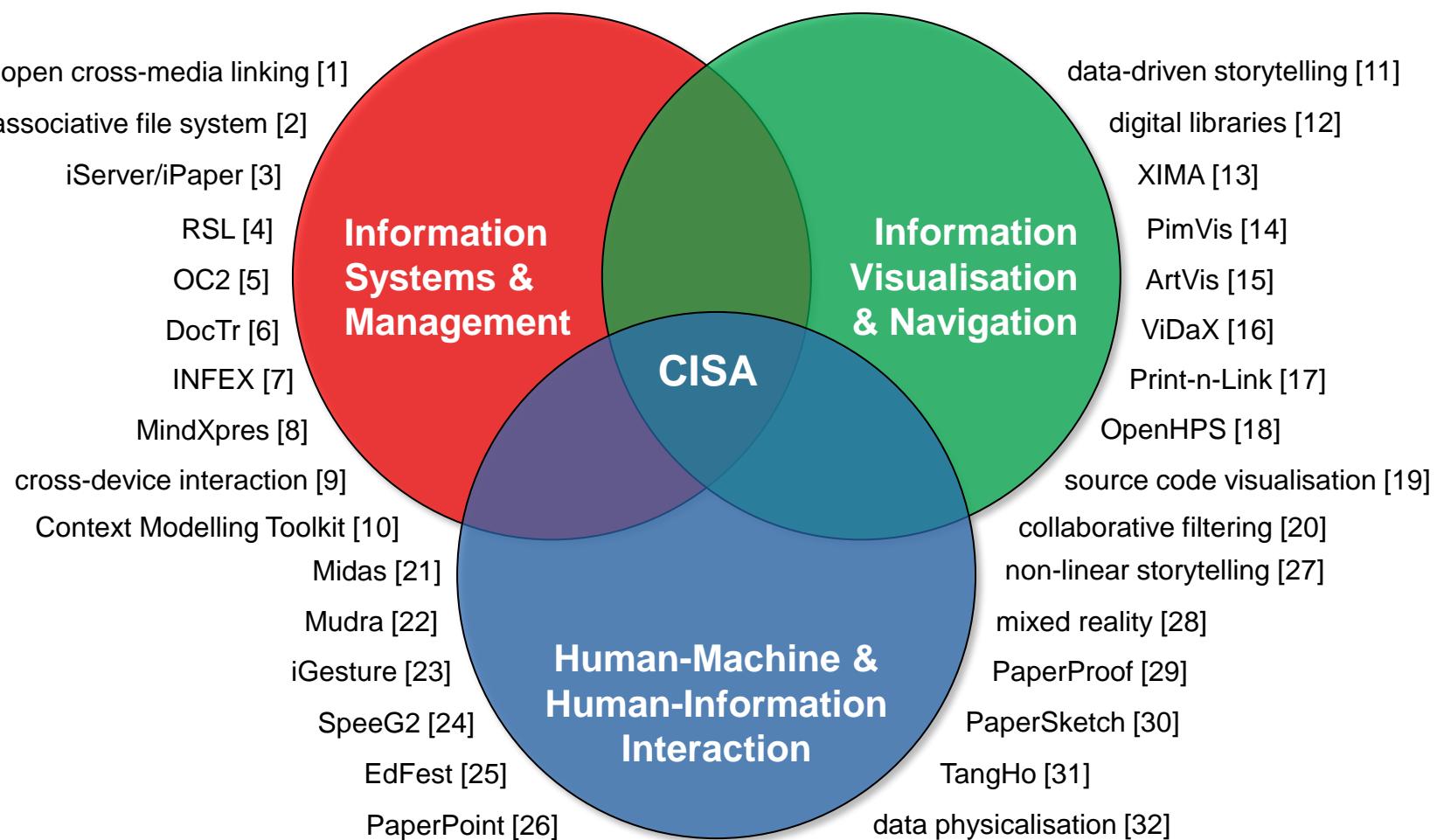


Fluid Cross-Media Information Spaces

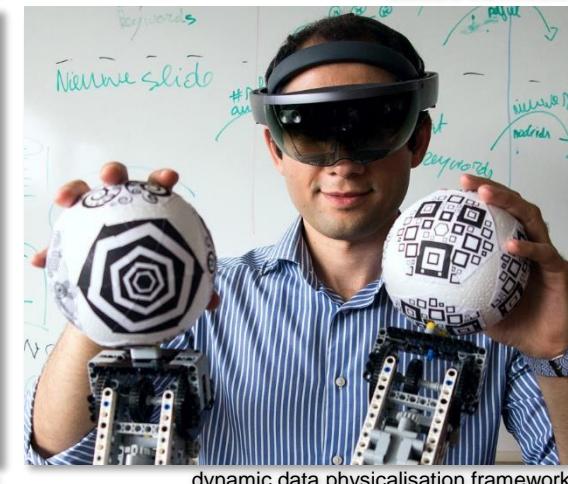
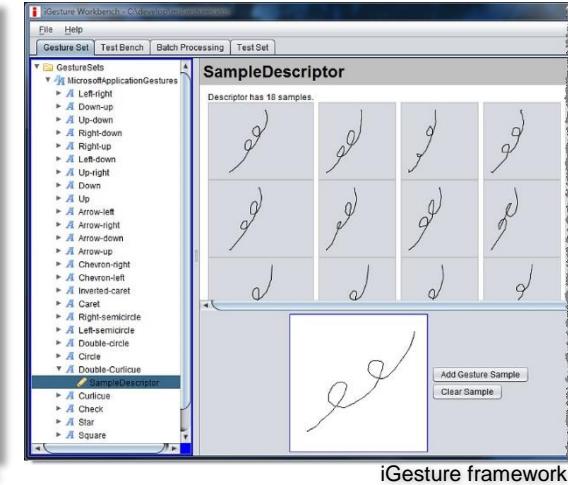
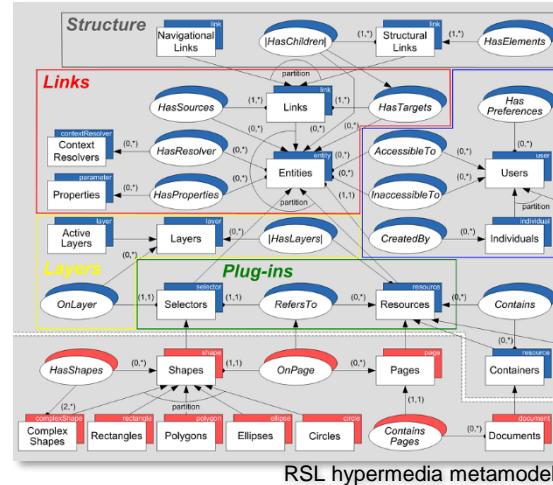




Cross-Media Information Spaces and Architectures



Models and Frameworks





Prof. Dr. Beat Signer
Cross-Media Technology, Interactive Paper, Data Physicalisation



Dr. Audrey Sanctorum
User-defined XDI and IoT Interaction, Human-AI Interaction



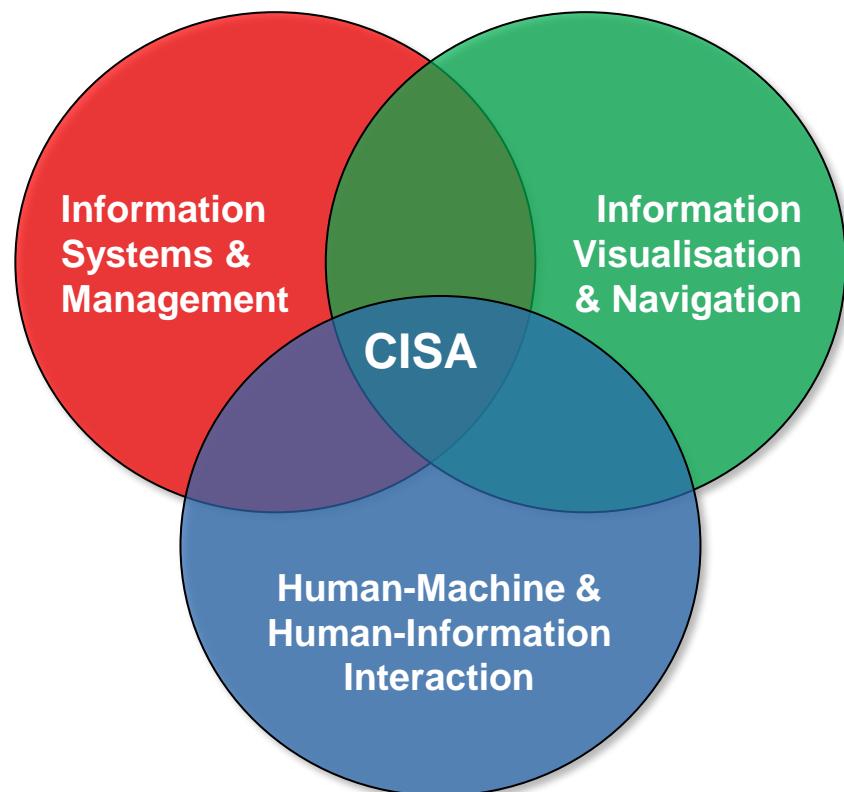
Maxim Van de Wynckel
Hybrid Positioning, Implicit Human-Computer Interaction



Payam Ebrahimi
Dynamic Data Physicalisation, Real-Time Point Cloud Analysis

WiSE WEB & INFORMATION SYSTEMS ENGINEERING

CROSS-MEDIA INFORMATION SPACES AND ARCHITECTURES (CISA)





Ekene Attoh
IoT Middleware, Context-aware Computing, Implicit HCI



Xuyao Zhang
Extensible Platform for Dynamic Data Physicalisation



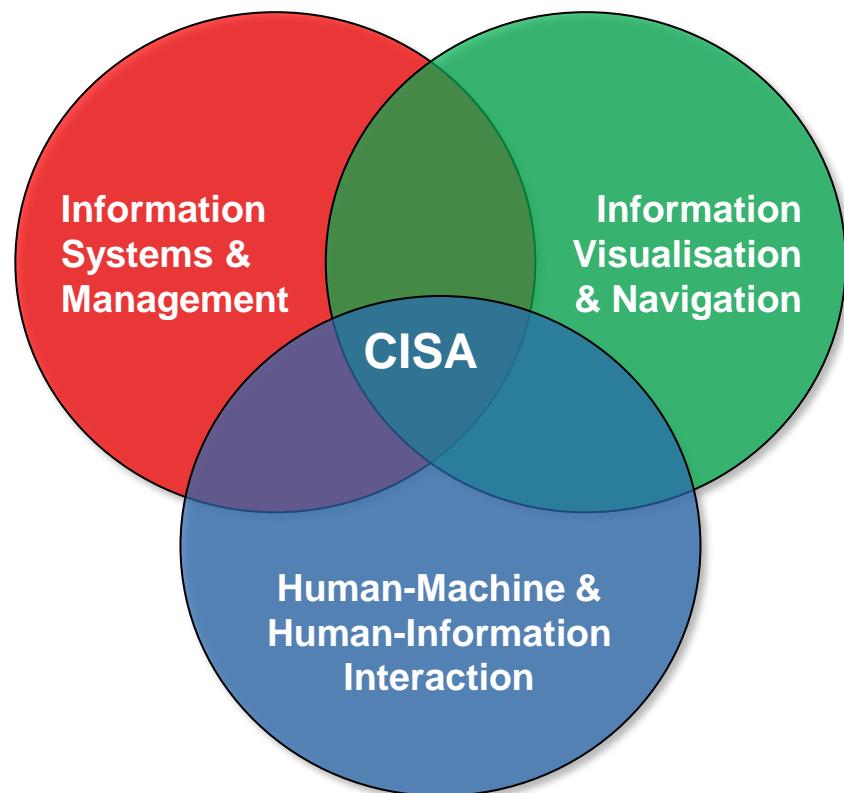
Isaac Valadez
Knowledge Physicalisation and Augmentation, Tangible UIs

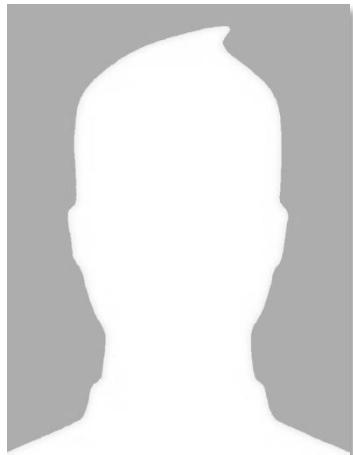


Jan Maushagen
Learning Analytics, Adaptive Persuasive ICT Tools

WiSE WEB & INFORMATION SYSTEMS ENGINEERING

CROSS-MEDIA INFORMATION SPACES AND ARCHITECTURES (CISA)





Piet Van Der Paelt
Julia-based Framework for
Simulation and Optimisation



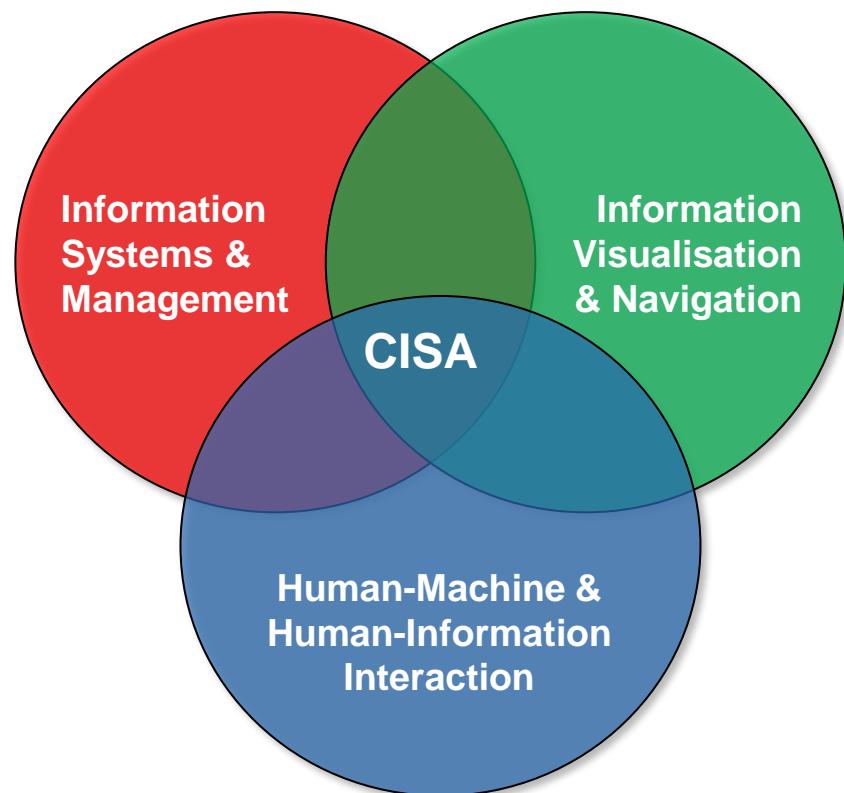
Dr. Reinout Roels
MindXpres: Extensible Content-
driven Presentation Tool



Dr. Ahmed A.O. Tayeh
Open Cross-Media Authoring,
Fluid Document Formats

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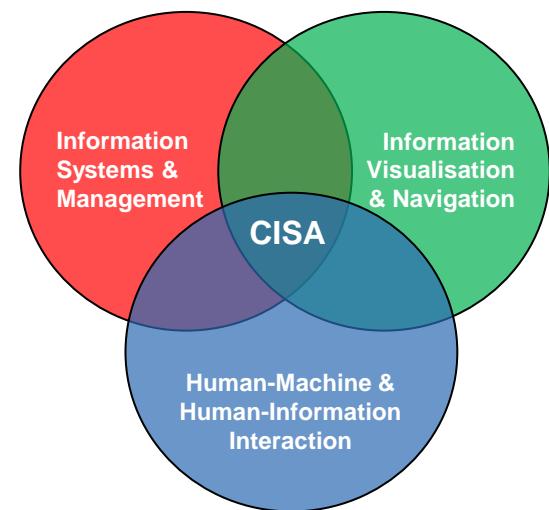
CROSS-MEDIA INFORMATION SPACES AND ARCHITECTURES (CISA)





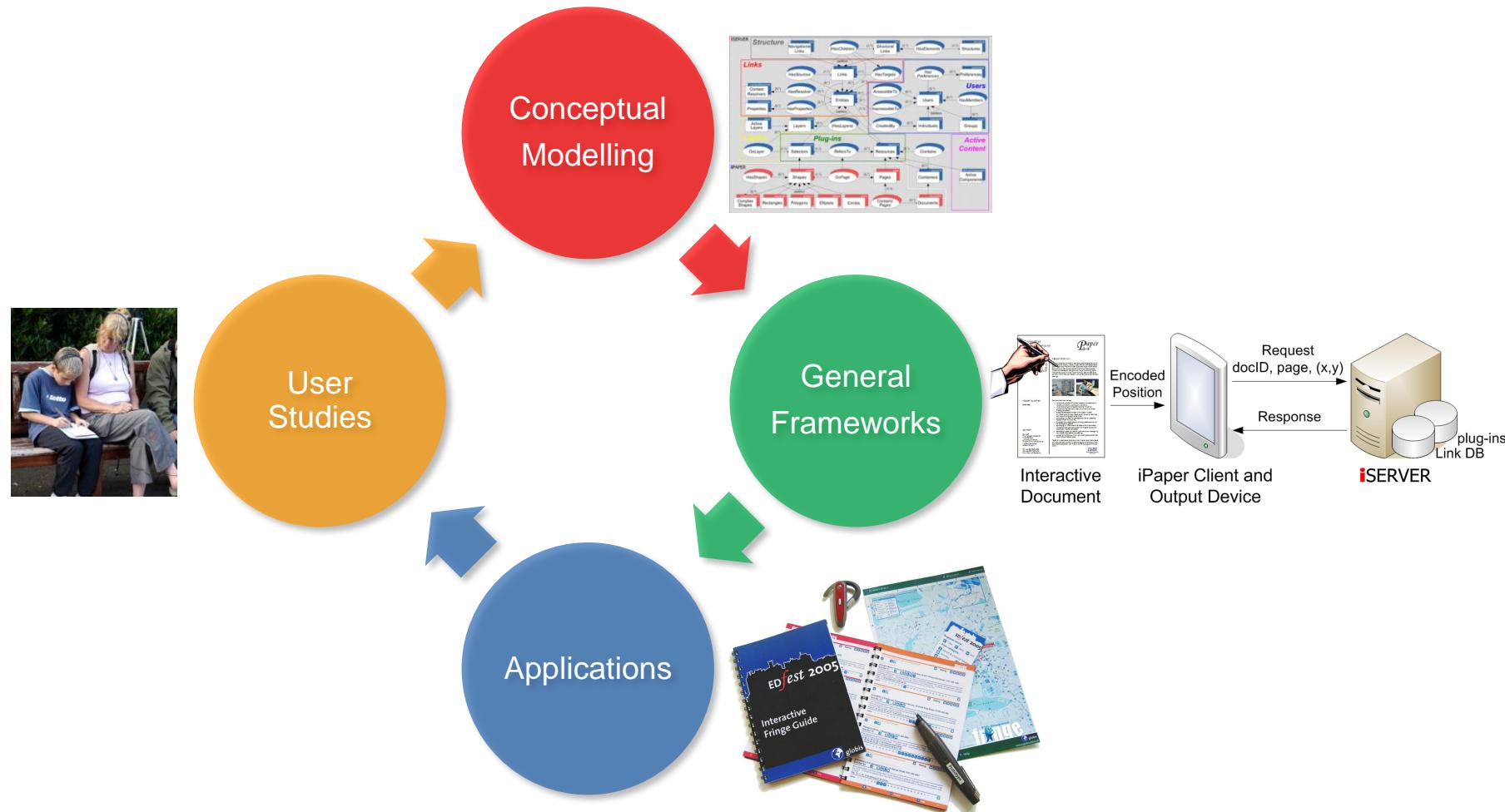
What is Wrong with Digital Documents?

- Existing document formats are based on the *simulation of paper affordances* on desktop computers
- How to manage mixed-media "documents" in *open and fluid cross-media information spaces*?
 - on the data level
 - context-sensitive adaptation
 - cross-media transclusion
 - on the visualisation and navigation level
 - zoomable user interfaces
 - on the cross-media interaction level
 - fluid multimodal cross-media interfaces
- *Remediation* of the "*paper simulation*" approach
 - WYSIWYG is only one out of many options!





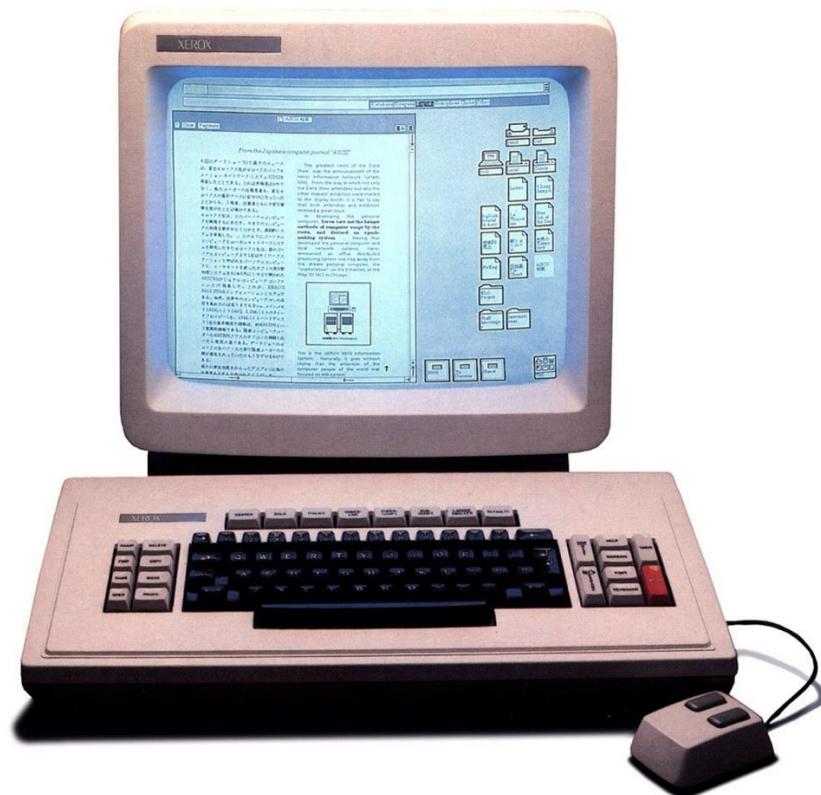
Research Methodology





PARC User Interface (Mid 70s)

- Desktop metaphor
 - WIMP interaction
 - "filing cabinets" with *hierarchical folders*
- Paper paradigm
 - "*What You See Is What You Get*" (WYSIWYG)
 - *what about richer document formats that existed at that time?*



Xerox Star 8010 [<http://www.digibarn.com/collections/systems/xerox-8010/>]



Digital Documents as a Paper Simulator?

Most people don't understand the logic of the concept: "[What You See Is What You Get](#)" is based on printing the document out ("get" means "[get WHEN YOU PRINT IT OUT](#)"). And that means a metaphysical shift: a document can [only consist of what can be printed!](#) [...] No overlays [...] – [PAPER UNDER GLASS](#).

Geeks Bearing Gifts: How the Computer World Got This Way, Mindful Press 2009

When data of any sort are placed in storage, they are filed alphabetically or numerically, and information is found (when it is) by [tracing it down from subclass to subclass](#). It can be in [only one place](#), unless duplicates are used [...] The human [mind](#) does not work that way. It [operates by association](#).

As We May Think, Atlantic Monthly, July 1945



Ted Nelson



Vannevar Bush



"Evolution" of Interfaces



original Macintosh



27-inch iMac

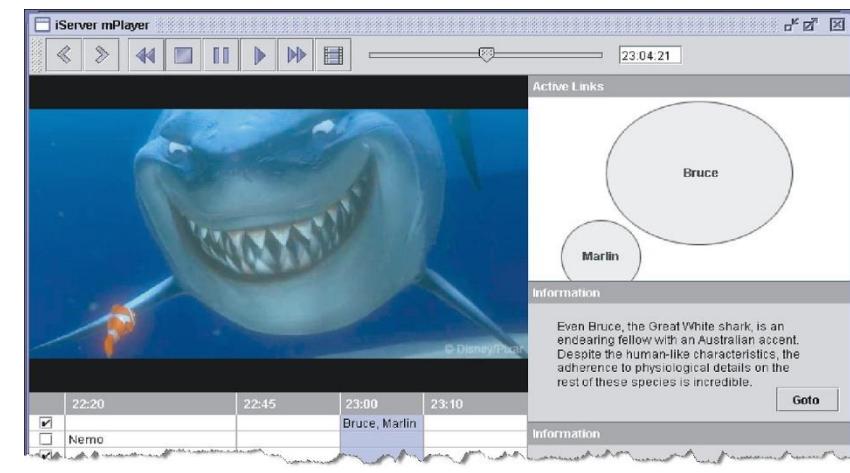
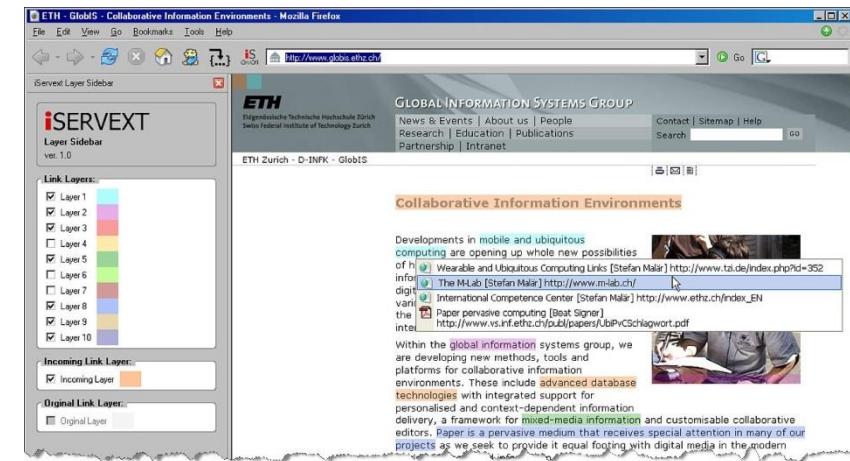
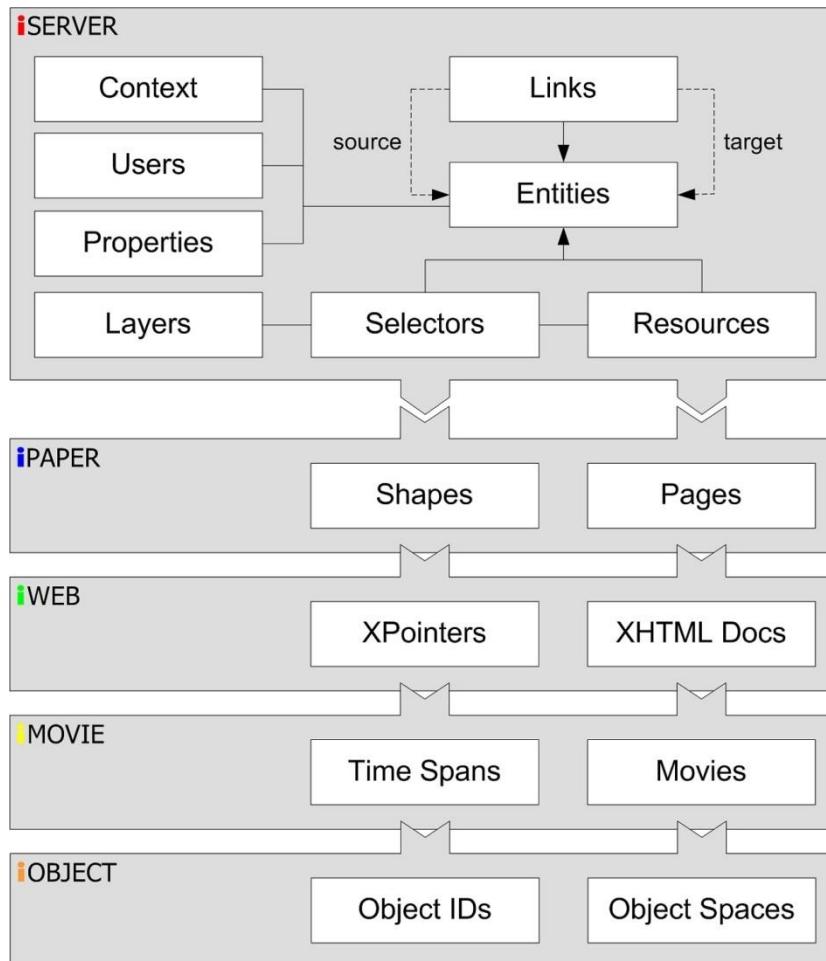
comparison

date	January 1984	May 2021	+ 37 years
price	\$2500	\$2299	x 0.92
CPU	68000 Motorola 8 MHz 0.7 MIPS	8-core Intel Core i7 3.8 GHz 238 310 MIPS	x 475 x 340442
memory	128 kB	8 GB	x 62500
storage	400 kB floppy drive	2 TB fusion drive	x 5 000 000
monitor	9" black and white 512 x 342 68 dpi	27" colour 5120 x 2880 218 dpi	x 3 x 84 x 3.2
devices	mouse keyboard	mouse keyboard	same same
GUI	desktop WIMP	desktop WIMP	same

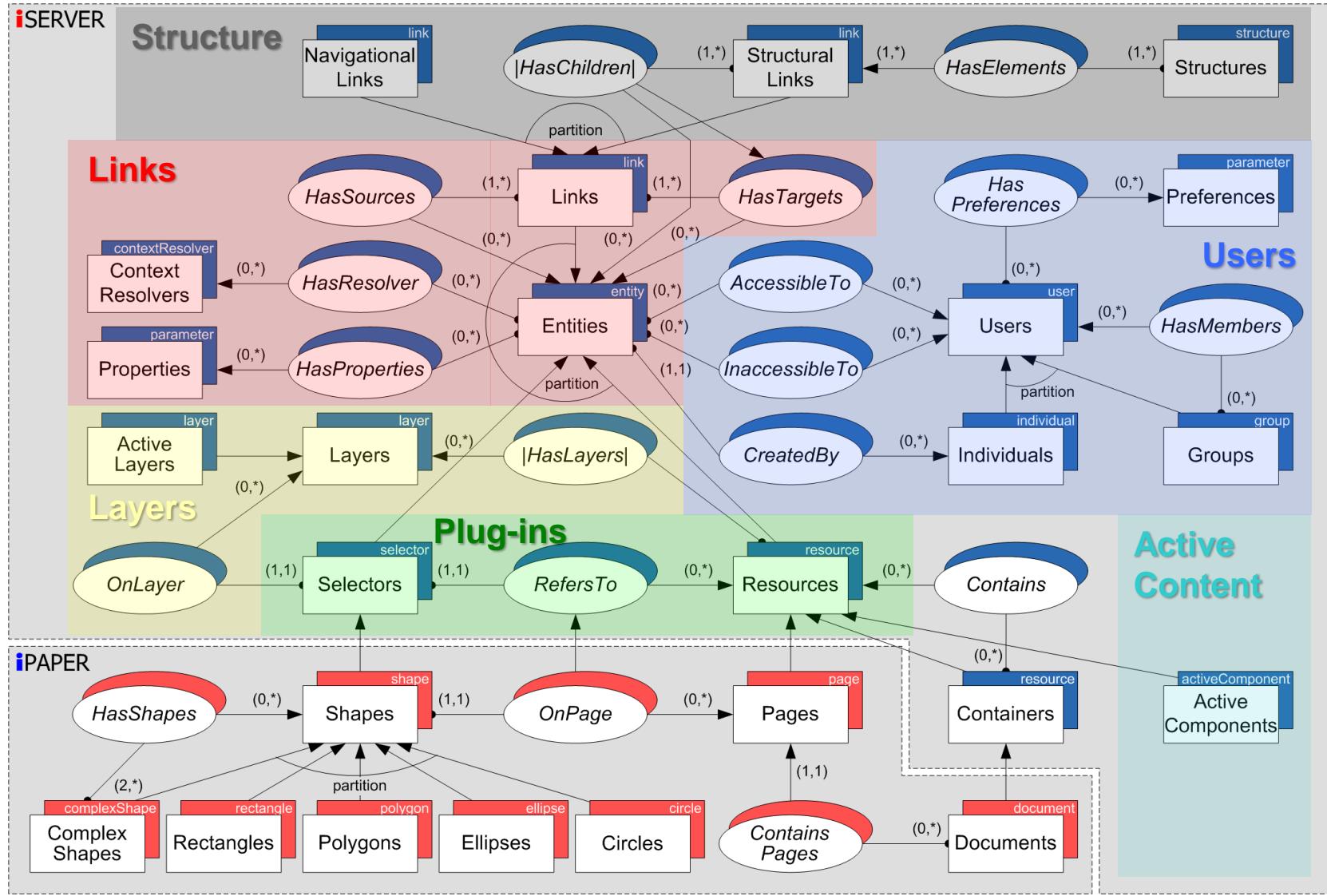
[partly based on Beaudouin-Lafon 2004]



RSL Hypermedia Metamodel

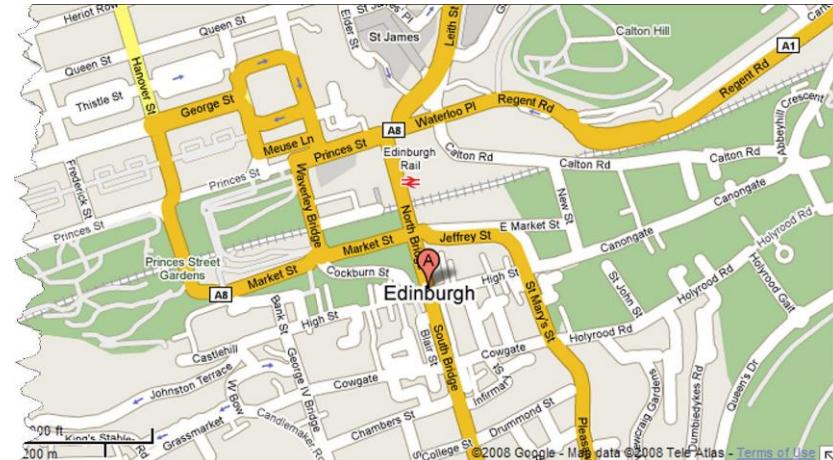
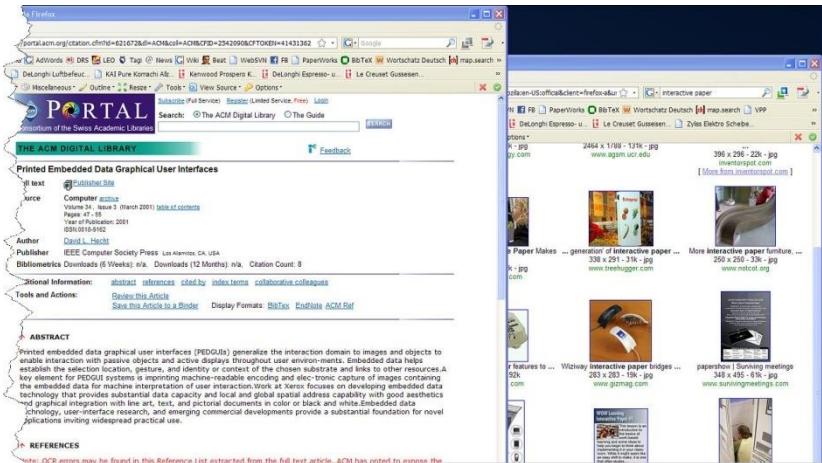


Global Information Systems Group, ETH Zurich





Bridging the Paper-Digital Divide





Paper-Digital Integration

Electronic Paper



Amazon Kindle

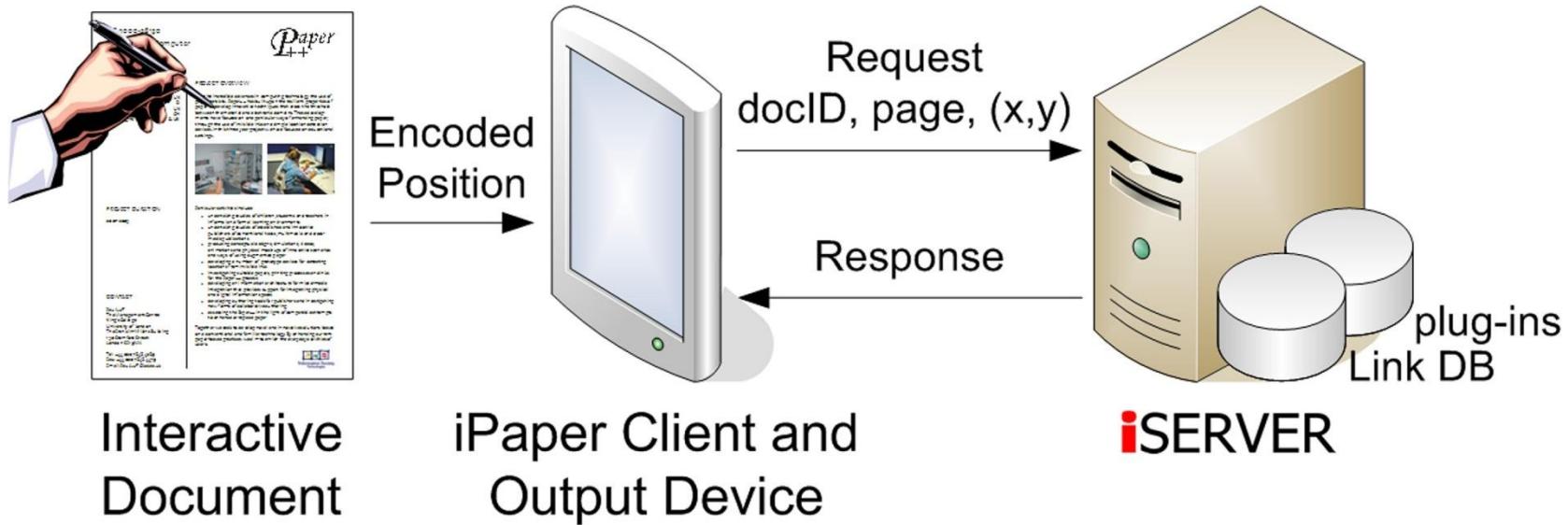
Augmented / Interactive Paper



Anoto Digital Pen and Paper Technology



Cross-Media Link Server (iServer)



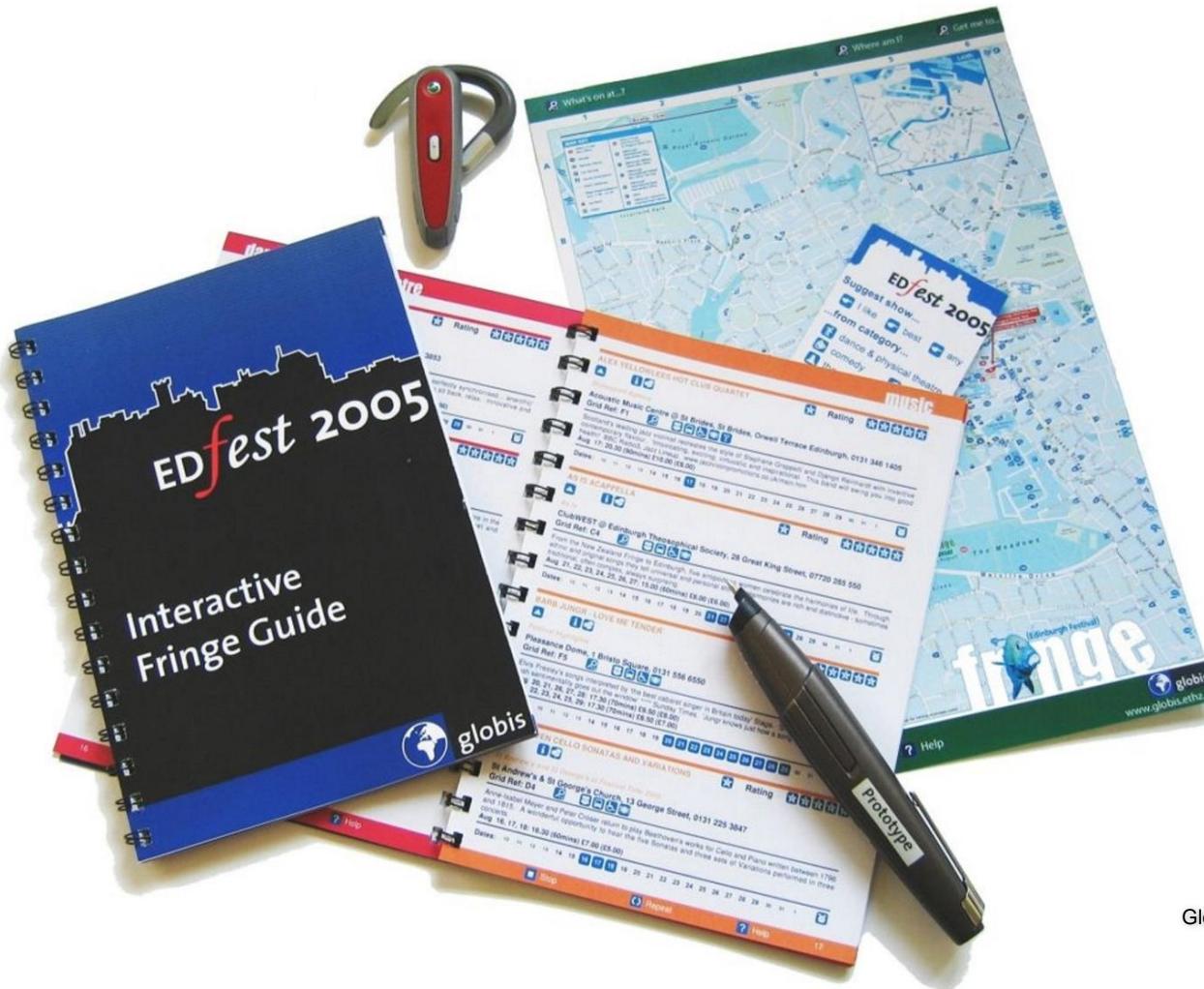


Interactive Paper Applications

- **Enhanced Reading**
 - paper-digital maps
 - interactive festival brochures
 - educational materials
 - auction brochures
 - scientific publications
 - ...
- **Paper-based Interfaces**
 - PowerPoint
 - document proof-editing
 - digital libraries
 - video analysis tool
 - educational games
- **Enhanced Writing**
 - photo album
 - researcher's notebook
 - mammography annotation
 - query by sketching
 - ...
- **Art Installations**
 - Lost Cosmonaut
 - Generosa Enterprise
- **Interactive Tabletops**
 - photo browser
 - collaborative sketch tool



Interactive Festival Guide (EdFest)



Global Information Systems Group
ETH Zurich



Visual and Interaction Design

- *Visualisation* of interactive areas and functionality
 - design patterns
- Interaction design
 - online versus offline input processing
 - lack of modal dialogues
 - *multimodal interaction*
- Findings might be applicable to traditional GUIs
 - e.g. cross-application widget interaction

Friday, 20.8.

10:00 - 14:00	Dazzle - 50 Contemporary Jewellers <i>Dazzle Exhibitions</i> Traverse Theatre 3,000 exhibits. Selling exhibition - designers from all over the world. Follows huge success at London's RNT. In spectacular Atrium space by leading restaurant. www.zone-d.com...	Exhibition
10:00 - 11:00	Craig McMaster: Scotland and the Environment <i>Craig McMaster</i>	Bookcase Event

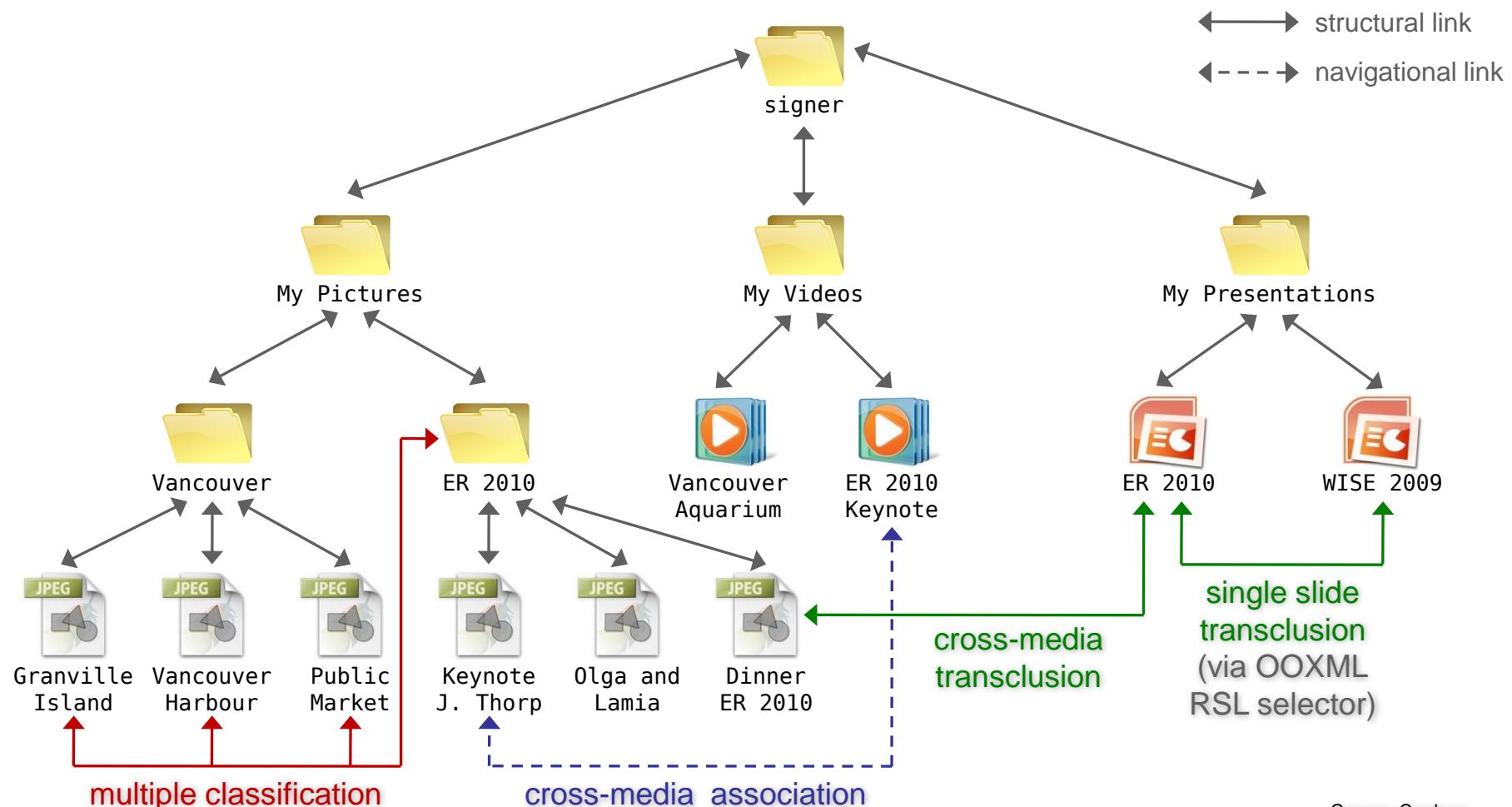
GO GO BURLESCO

				Rating	
<i>Assembly Theatre and Marshall Cordell</i>					
Assembly @ George Street, Assembly Rooms, 54 George Street, 0131 226 2428					
Grid Ref: D4					
See it before we get arrested! Rude, comic, sexy. Brilliant late-night fun with a glamorous giggle of hot burlesque divas. These women send comedy bumping and grinding off the Richter scale! Contains quite a lot of nudity!					
Aug 15, 16, 17, 18, 22, 23, 24: 23.45 (60mins) £12.00 (£11.00)					
Aug 19, 20, 21, 25, 26, 27, 28: 23.45 (60mins) £13.00 (£12.00)					
Dates: 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1					

Global Information Systems Group, ETH Zurich



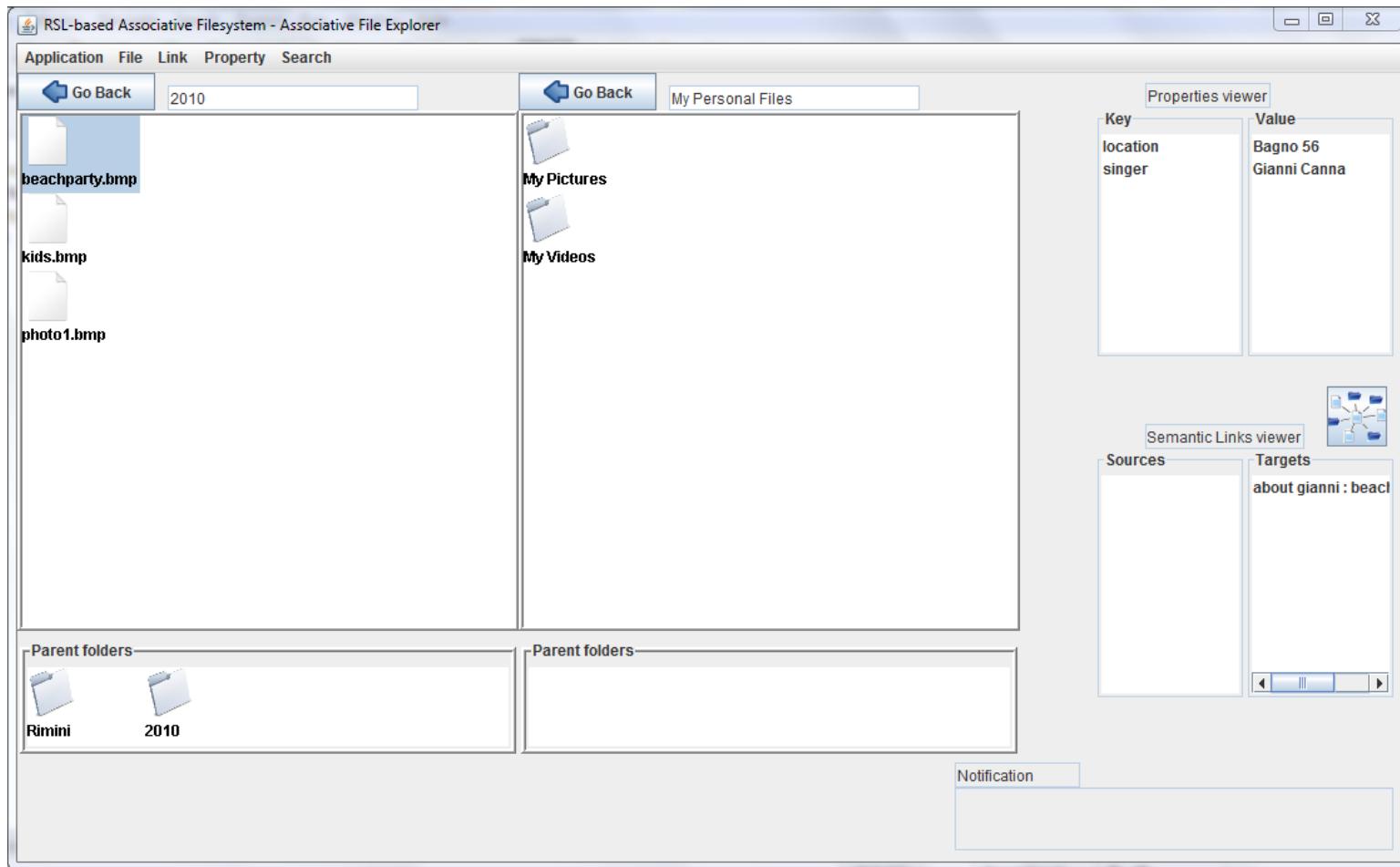
RSL-based Associative File System



Gregory Cardone



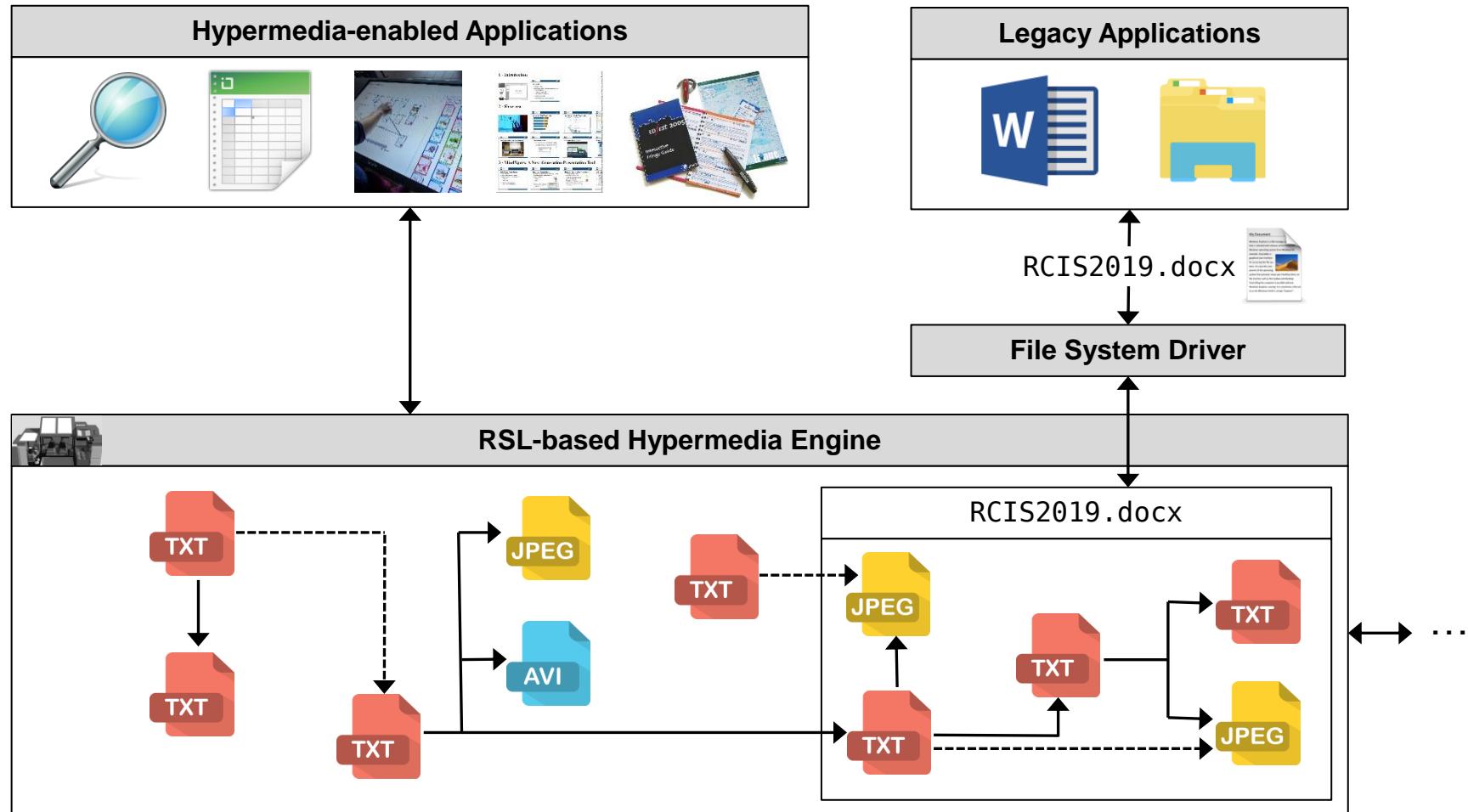
RSL-based Associative File System ...



Gregory Cardone



File Management System of the Future





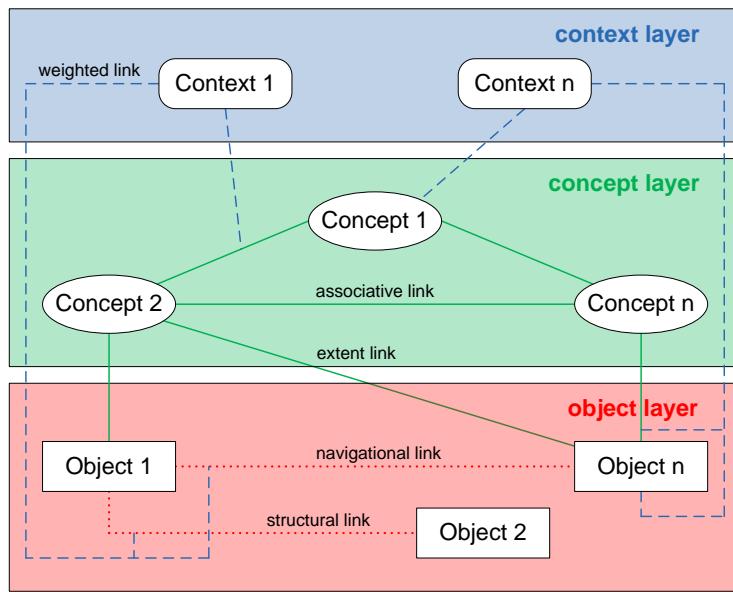
Personal Information Management (PIM)

- *Keeping, organising and re-finding* information
 - digital and physical
- Study of human-information interaction
 - files, piles, mixtures, ...
- OC2 PIM model
 - based on RSL hypermedia metamodel
- Cross-Media PIM system
 - *explicit* as well as *implicit* associations between entities

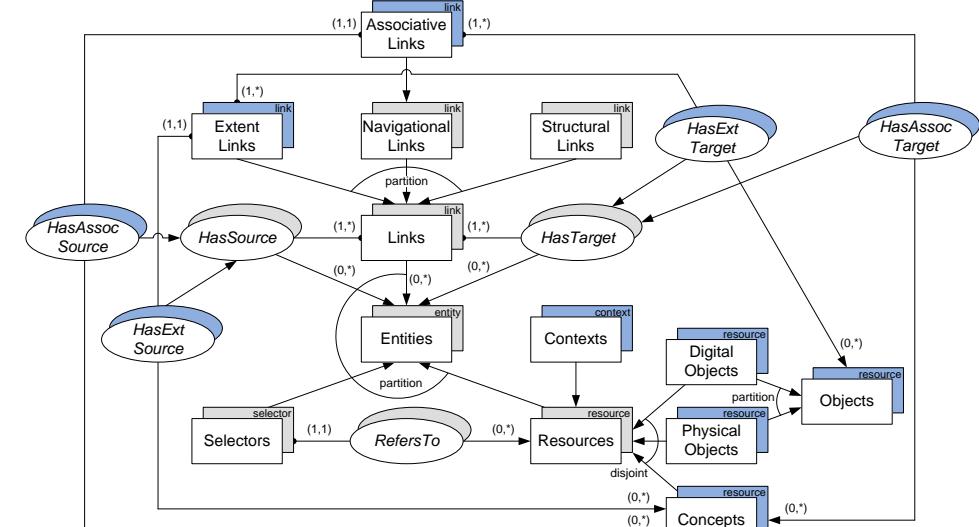




Object-Concept-Context (OC2) Framework



OC2 conceptual model



translation



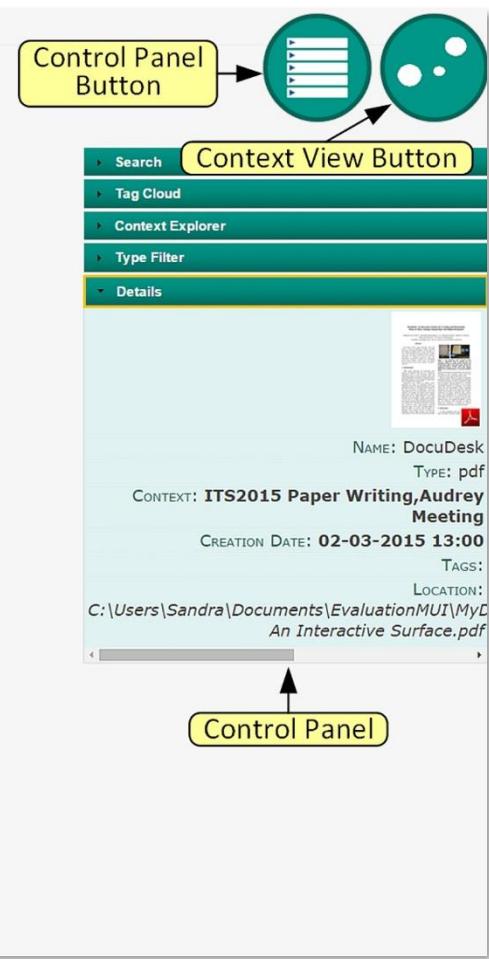
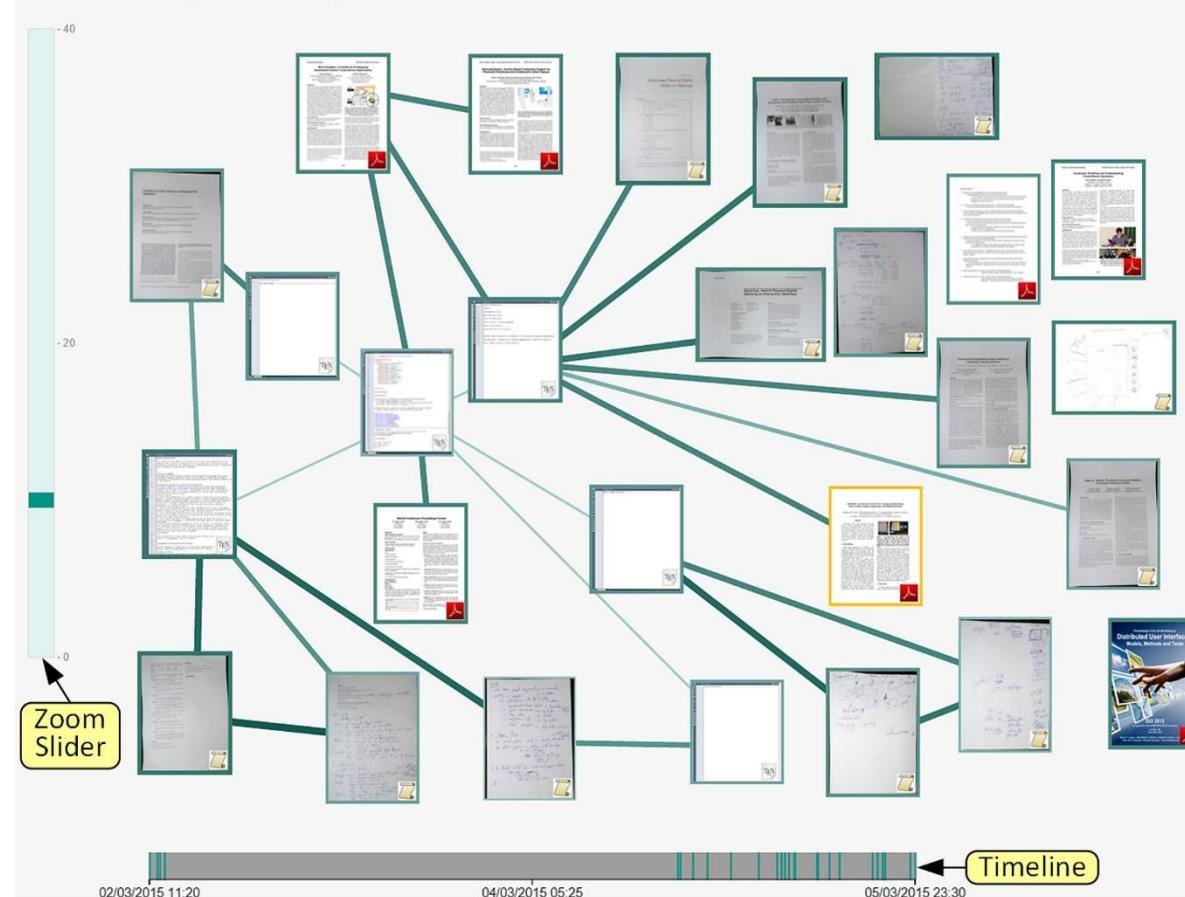
PimVis Setup





PimVis Document View

AVI2016 Paper Writing



Audrey Sanctorum



PimVis Focus View

Lee2013



Search

Tag Cloud

Context Explorer

Type Filter

Details

NAME: Dey2006

TYPE: pdf

CONTEXT: Augmented User Interfaces

CREATION DATE: 26-04-2015 00:07

TAGS:

LOCATION: C:\Users\Sandra\Documents\EvaluationMUI\MyDc

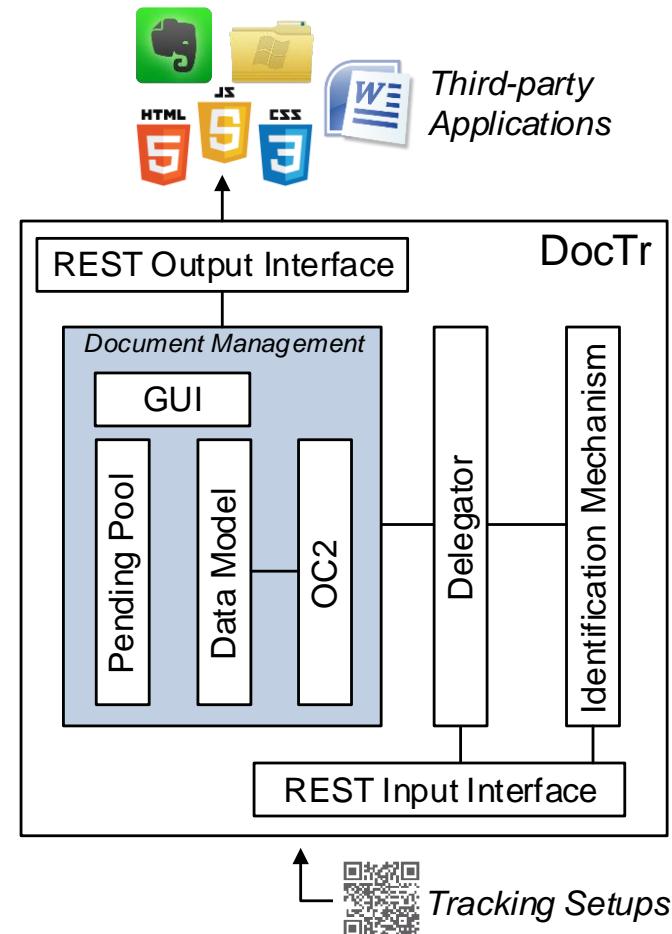


Audrey Sanctorum



Document Tracking (DocTr) Framework

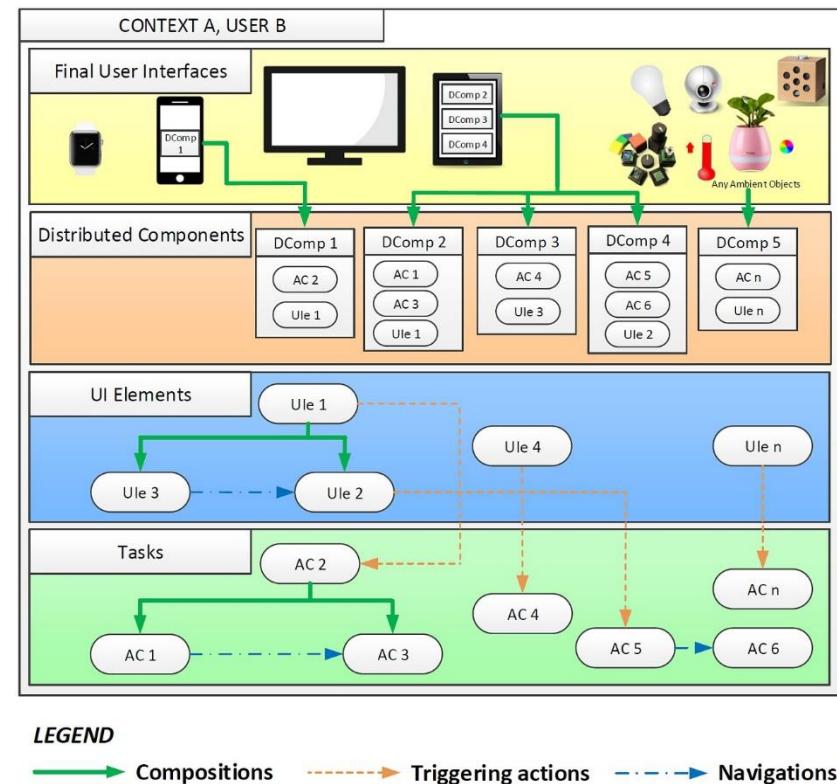
- *Unified* document (object) tracking solution
 - plug-ins for QR codes, RFID tags, SIFT algorithm, ...
 - *tracking* of documents *across organisational structures*
 - *avoid fragmentation* when using multiple tracking setups





EUD of Cross-Device and IoT Applications

- Rapid prototyping platform for cross-device and IoT applications (eSPACE)
- End-user authoring
 - customised distribution of user interface components
 - mashup tool for digital and physical (IoT) components





ArtVis: TUI-based Information Exploration

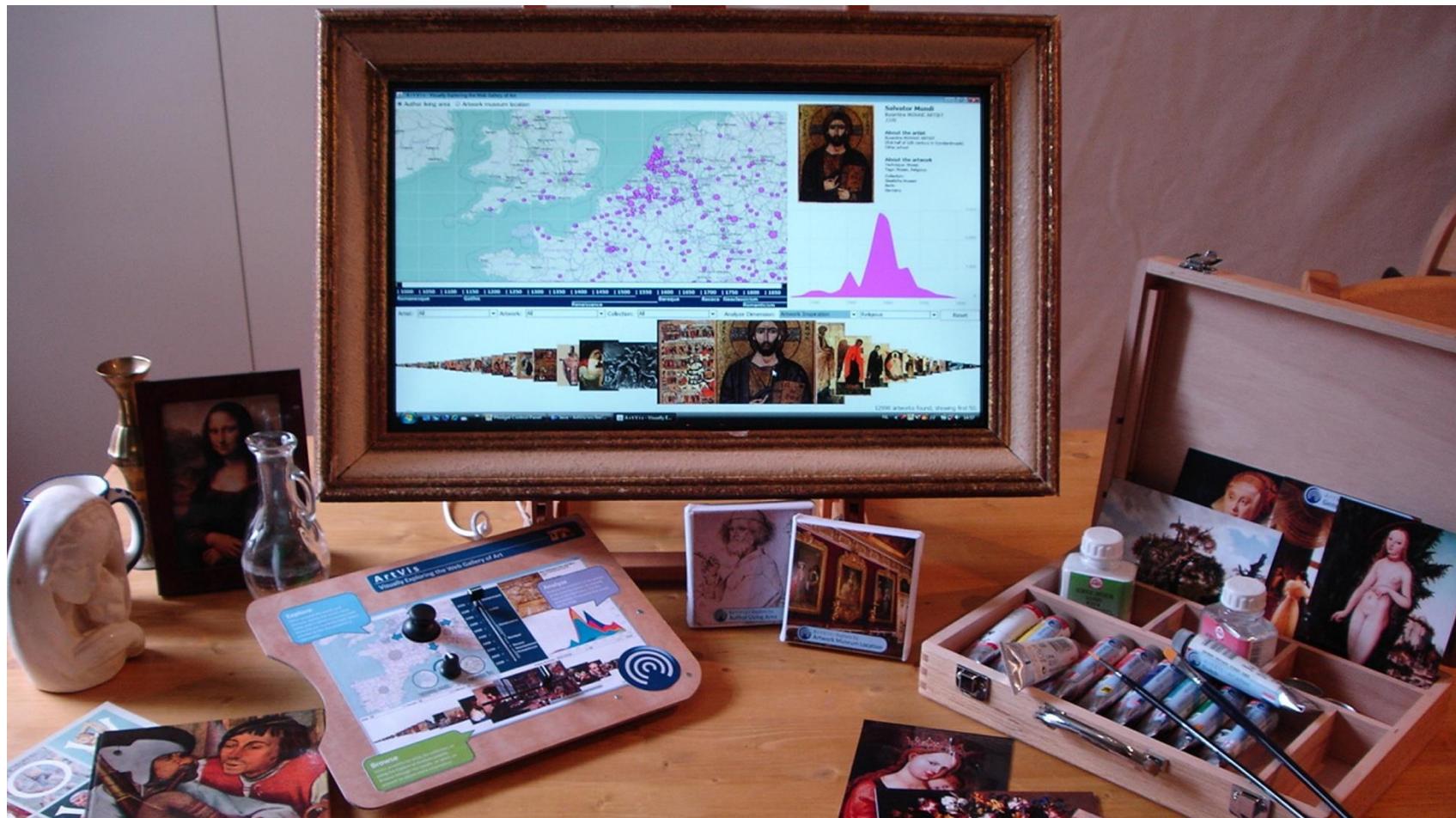
- Advanced visualisation techniques in combination with a TUI
 - explore Web Gallery of Art
 - faceted browsing
 - phidgets-based TUI
 - RFID-tagged physical objects
- Three main components to *explore*, *analyse* and *browse* the information



Bram Moerman



ArtVis Setup



Bram Moerman



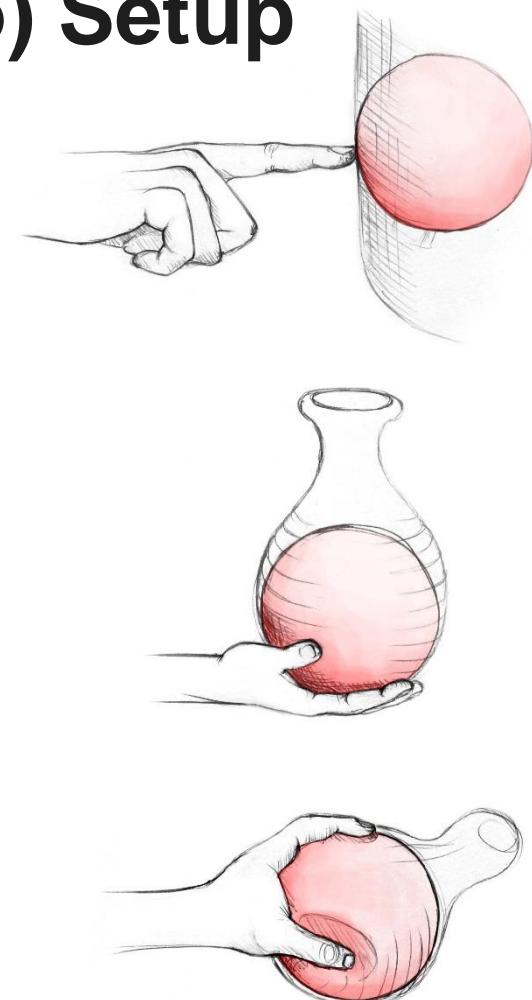
Video: ArtVis



Bram Moerman



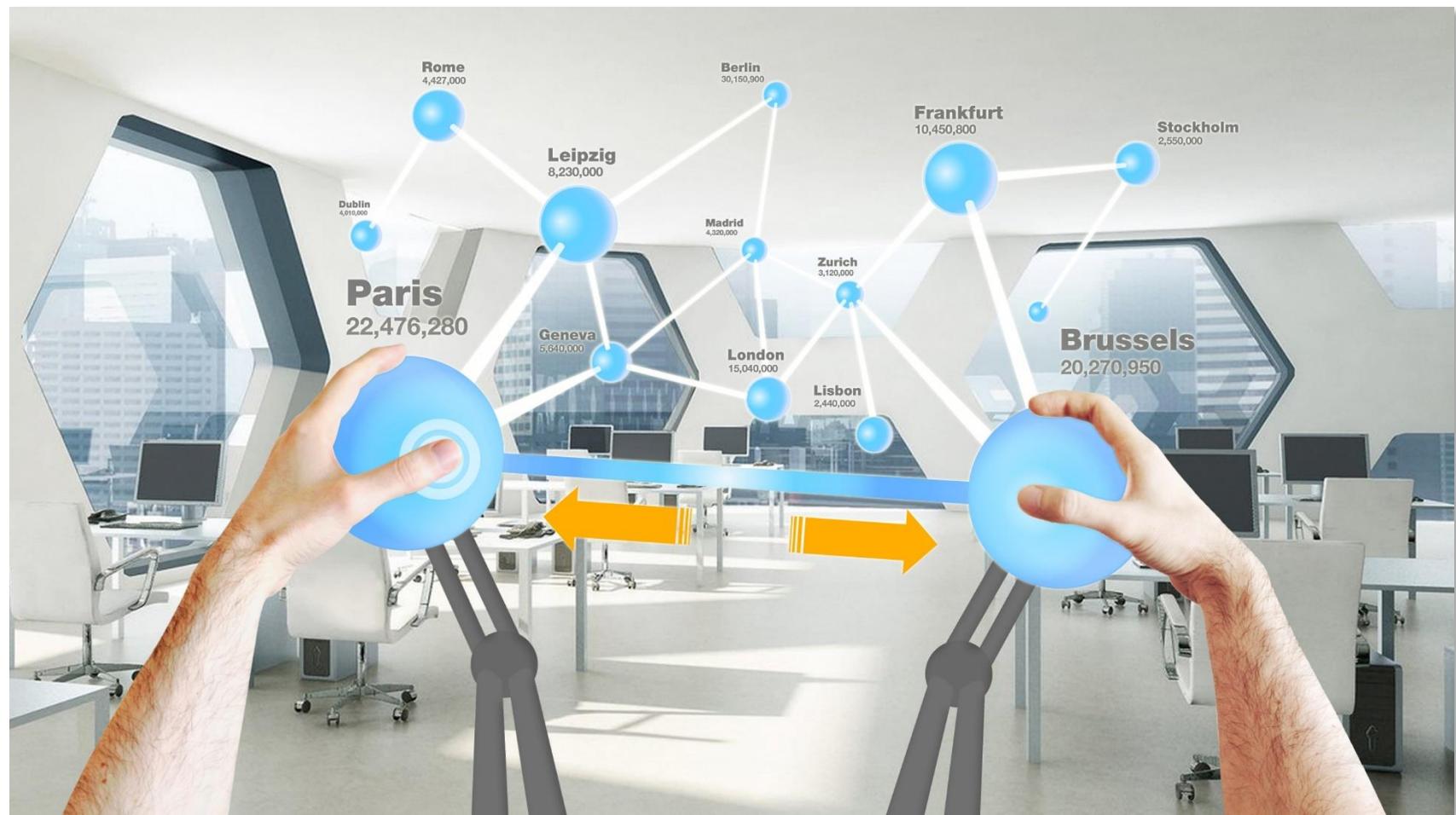
Tangible Hologram (TangHo) Setup



Timothy J. Curtin

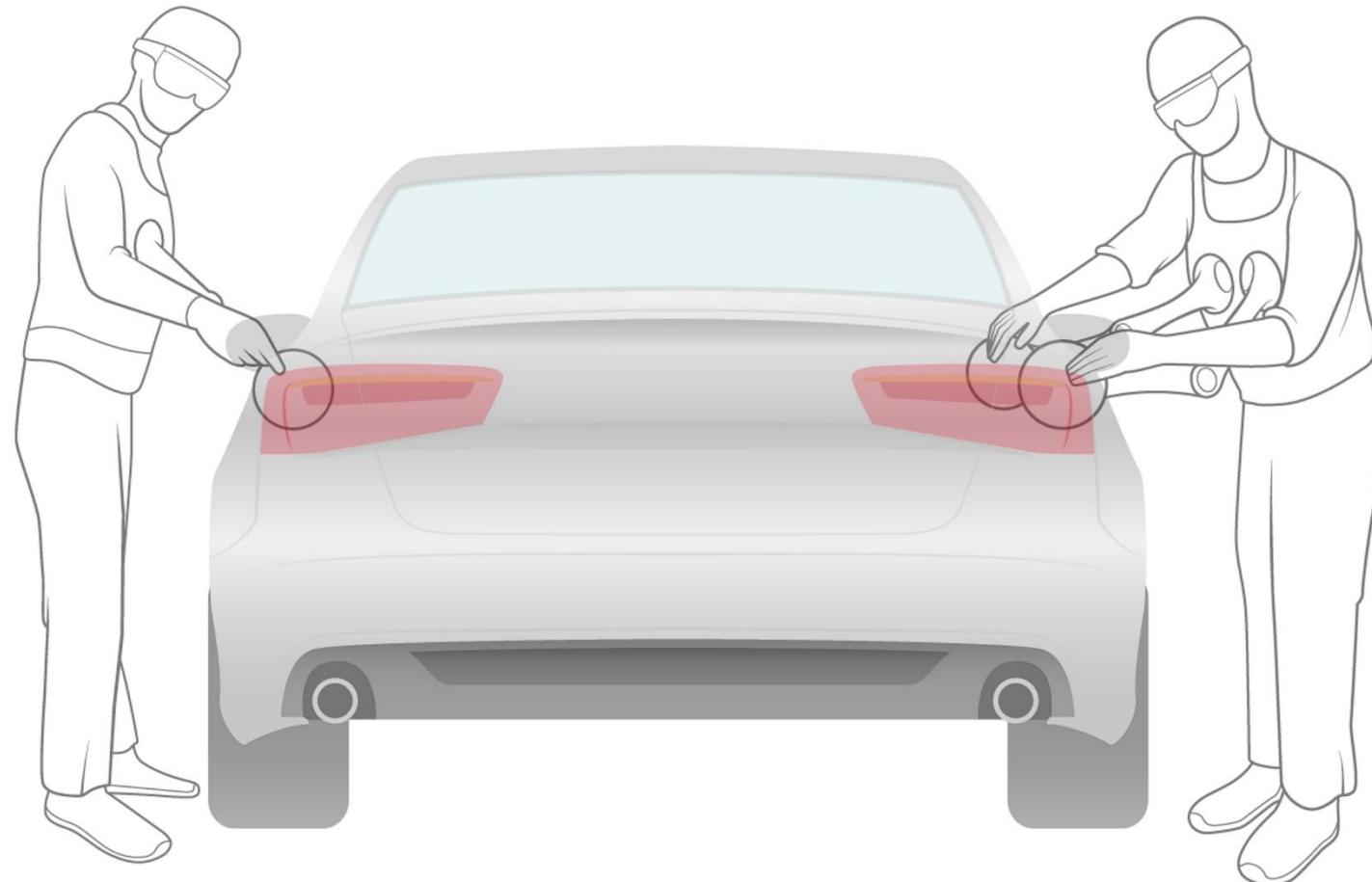


Tangible Graph Hologram





Collaborative TangHo Interaction



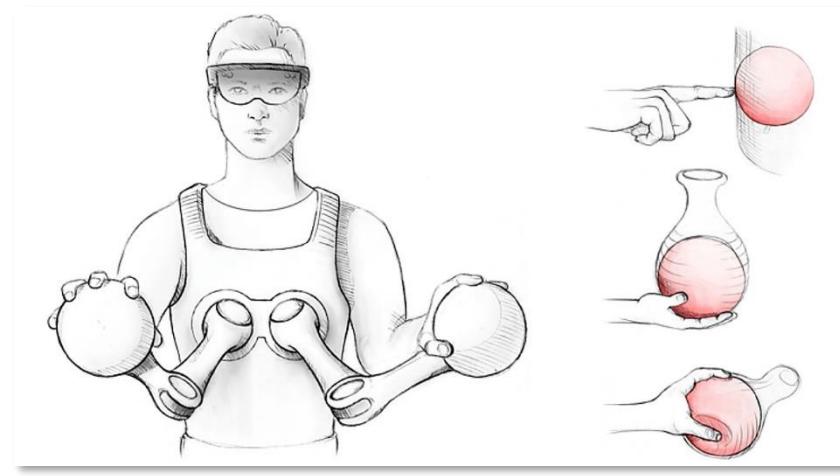


Real-Time Cross-Media Data Exploration



Dynamic Data Physicalisation

- Physical objects used for input as well as output
- How can we achieve *dynamic data physicalisation* with *dynamic affordances*
 - use *physical variables* such as temperature or texture
 - *exploration of big data sets*
 - experimental *tangible holograms* (TangHo) platform





TangHo Prototype

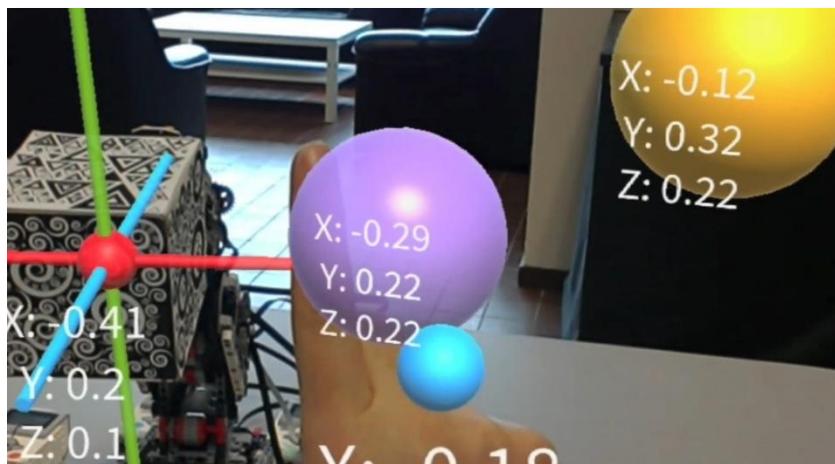
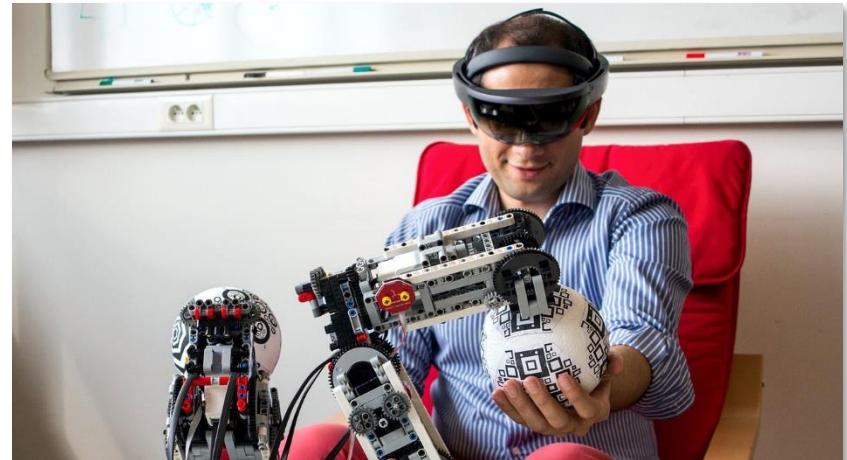
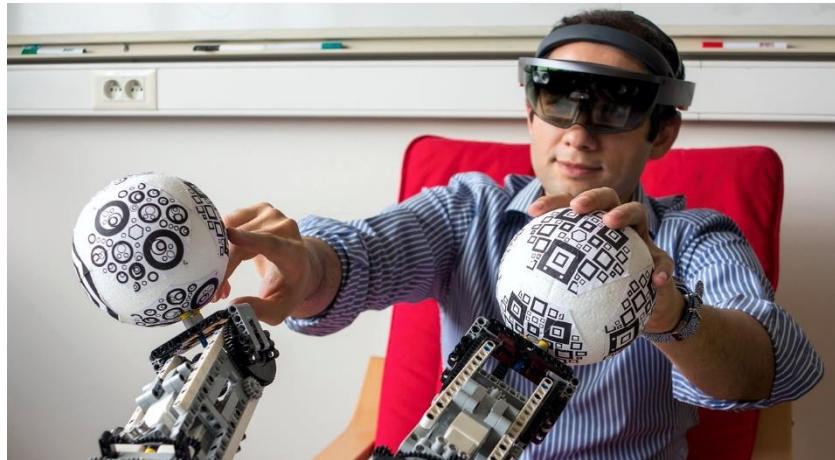
- Lego Mindstorms-based 6DOF arm prototype
 - motors can be locked or set to float mode
 - useful for bidirectional I/O
 - Replaceable end effector for different types of non-visual feedback
- Challenges
 - inverse kinematics (final system is body mounted)
 - use robotics toolbox (MATLAB)
 - limited HoloLens hand tracking
 - 3D printing of final arm



Timothy J. Curtin



TangHo Interactions



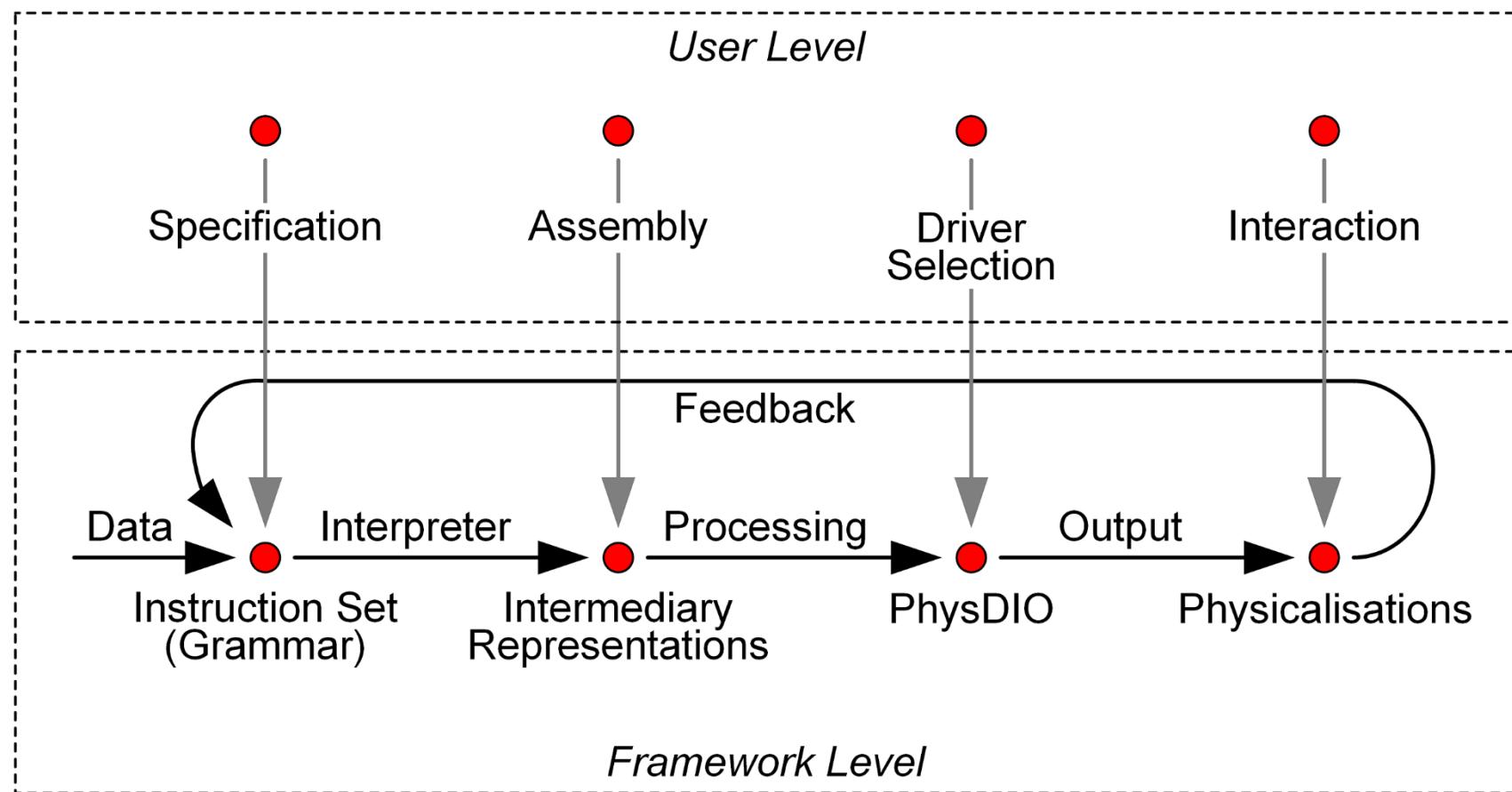


Data Physicalisation Framework

- Understanding the design space
 - how do users map data to physicalisations
- Understanding the perceptual effectiveness
 - e.g. what are the just-noticeable differences that a physical variable can convey?
- Framework for dynamic data physicalisation
 - data processing with device-independent output
 - TextDIO: text for static or dynamic reports
 - PhysDIO: data points, data variables and physical variables
 - text and visualisation drivers for representation on specific devices (e.g. TangHo)
 - new data physicalisation design guidelines (as in InfoVis)



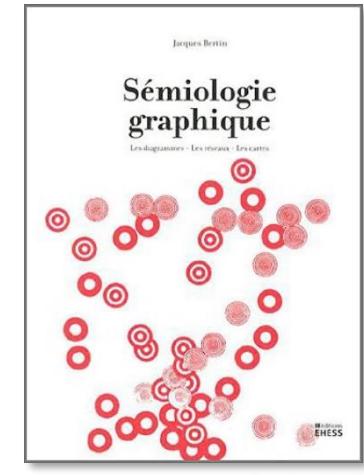
Data Physicalisation Framework ...





Dynamic Data Physicalisation

- Understanding the design space
 - how do users map data to physicalisations
- Data physicalisation *design guidelines*
 - what are the just-perceptual differences that a physical variable can convey?
- *Dynamic data physicalisation framework*
 - data physicalisation *grammar*
 - data processing with device-independent output
 - software drivers for different physicalisations (e.g. TangHo)
- New application domains



Jacques Bertin, 1967



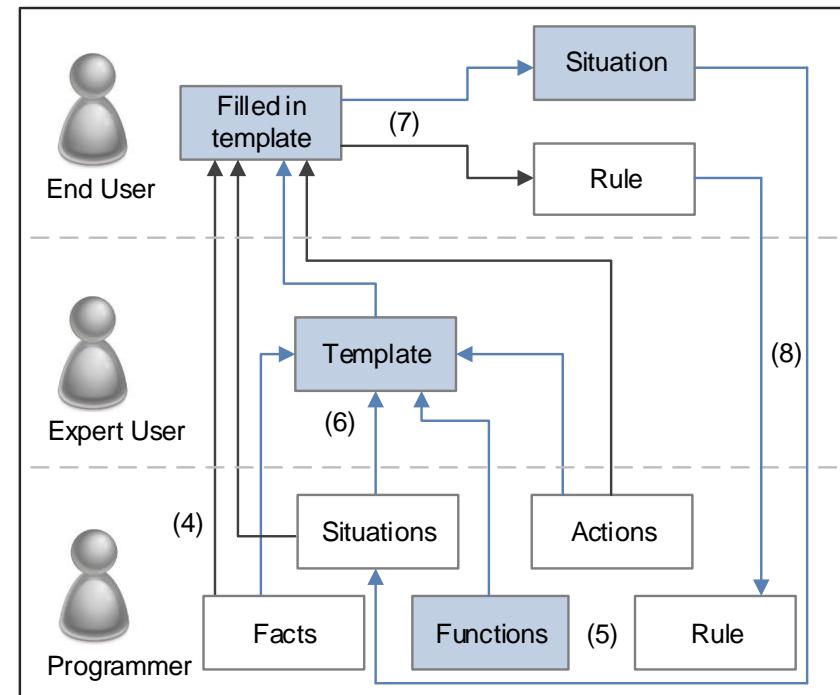
HCI and HCII in Smart Environments





Context Modelling Toolkit (CMT)

- Multi-layered context modelling approach
 - programmer, expert user and end user
- Beyond simple "*if this then that*" rules
- Client-server architecture
 - server: context reasoning based on Drools
 - client: sensor input as well as applications
- *Increase trust* via intelligibility



Context Modelling Toolkit (CMT) ...

The screenshot shows the CMT interface with several panels:

- Context Data:** A red box highlights this panel, which contains tables for Time, Persons, My Activities, Locations, Activities, and Objects.
- Desktop Space:** A red box highlights this panel, which displays an AND Template. It includes IF and THEN sections, and AND clauses. A placeholder box says "Drag an activity or time instance".
- Templates:** A list of templates: For Activities, For Rules, AND Template, (7).
- Actions:** A list of actions: NightLight, TV, Notify, OpenFolder, (8).
- My Rules:** An empty list, (9).

Annotations with numbers (1) through (9) point to specific elements:

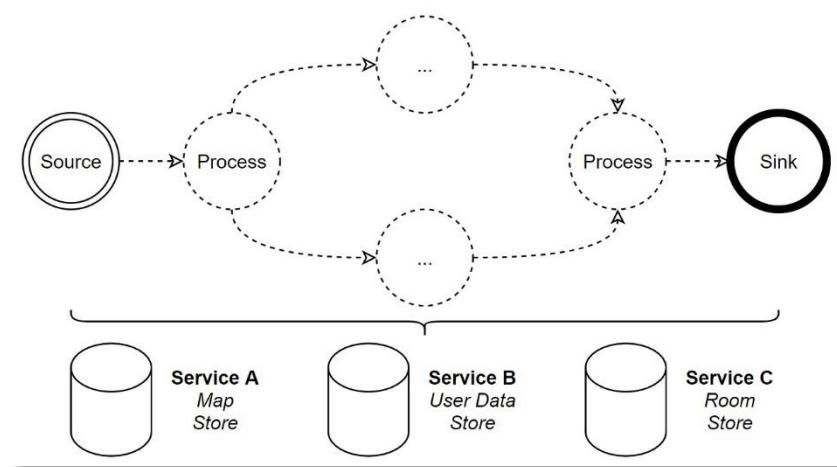
- (1) Day, Hour under Time
- (2) Sandra, Vince under Persons
- (3) StudentMeeting, GroupMeeting, BloodPressureLow, BloodPressureHigh under My Activities
- (4) SmartFridge, Toys, Radio under Objects
- (5) (5) under BloodPressureHigh
- (6) (6) under BloodPressure
- (7) (7) under Templates
- (8) (8) under Actions
- (9) (9) under My Rules



Hybrid Positioning System



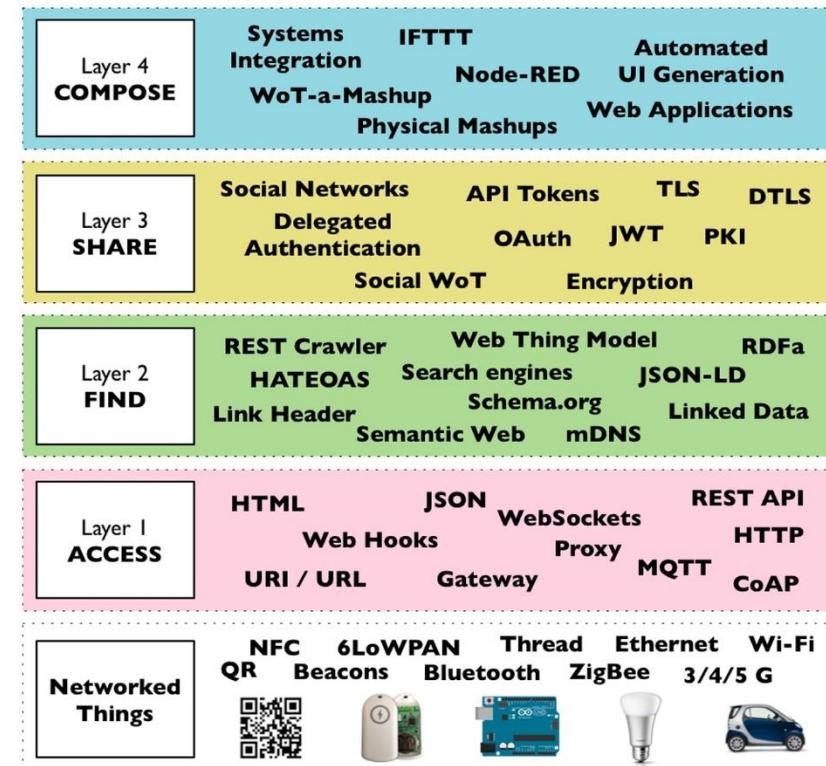
- OpenHPS hybrid positioning system
 - *reactive stream-based processing* of sensor data
 - support for motion-based and visual positioning
 - *decentralised* sensor fusion
- Combine existing and new positioning techniques
 - light-based positioning
 - noise-based positioning
 - SLAM using doppler radars
 - ...





Cross-Domain Internet of Things (IoT)

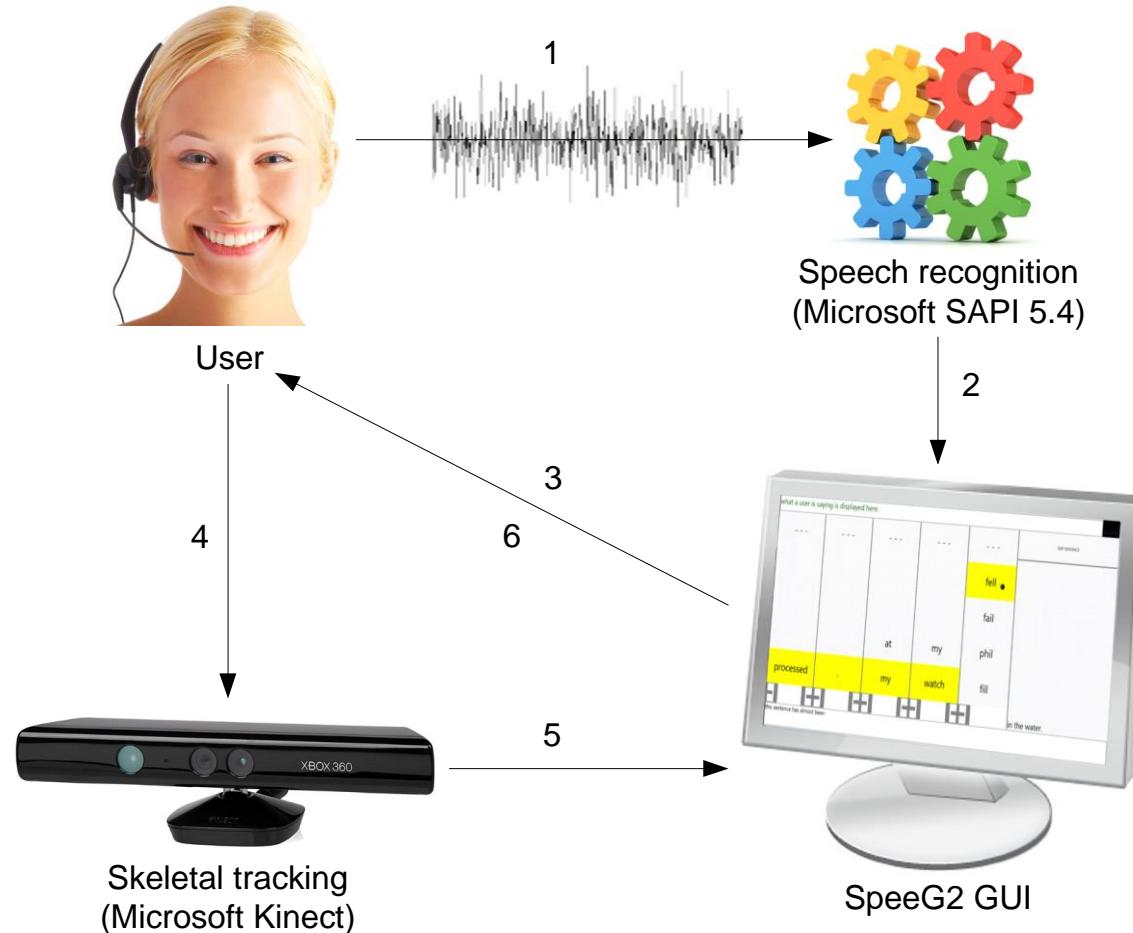
- Middleware for interoperability of *smart behaviour* across IoT platforms
 - implicit context-aware human-computer interaction
 - user management
 - rule management
 - cross-domain *conflict resolution*
- End-user authoring and *intelligibility*



Source: Building the Web of Things: book.webofthings.io
Creative Commons Attribution 4.0



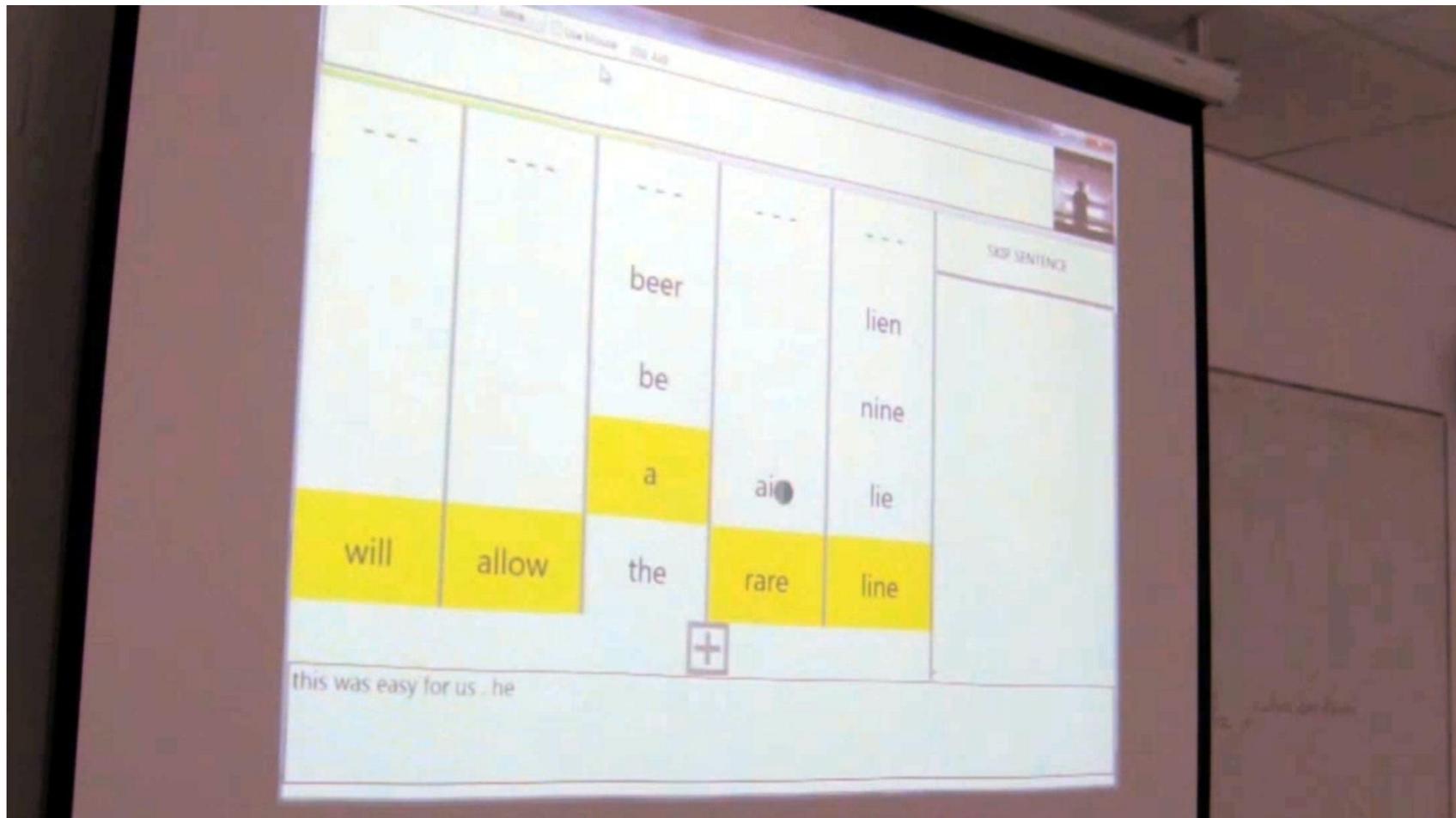
SpeeG2: Multimodal Text Input



Sven De Kock



Video: SpeeG2 Performance (21 WPM)



Sven De Kock



INFEX: Cross-Device Information Exchange

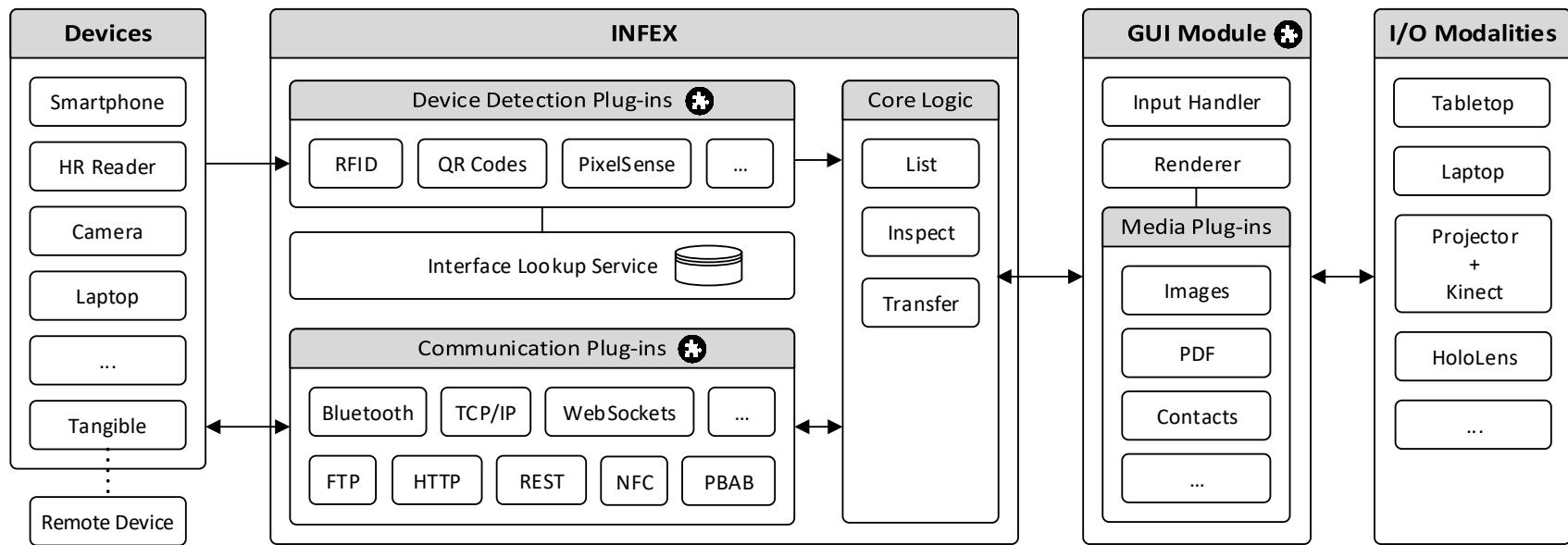
The image shows a large screen displaying various mobile device interfaces for cross-device information exchange:

- Top Left:** A smartphone interface showing a "Contacts" list with entries for Randy R. Walker, Kimberly G. Saucedo, Constance C. Faust, Bradley K. Cain, and Catherine H. Bramblett.
- Top Center:** A PDF viewer showing the "SIGCHI.pdf [482KB]" document. The document title is "SIGCHI Conference Proceedings Format". It includes fields for 1st Author Name, 2nd Author Name, 3rd Author Name, Address, City/Country, and e-mail address. The abstract section discusses the conference proceedings format.
- Top Right:** A smartphone interface showing a "Files" list with files like apalike.bst, apalike.sty, article.cls, abstract.tex, bibliography.bib, and clean.command. To the right is a small image of a GoPro camera.
- Middle Left:** A smartphone interface showing a "PDF" list with files template.pdf (1.6MB) and SIGCHI.pdf (482KB).
- Middle Center:** A photo viewer showing a large image titled "GOPR0003.jpg [4.8MB]" of a beach scene.
- Middle Right:** A smartphone interface showing a "Pictures" list with images GOPR0001.jpg, GOPR0002.jpg, GOPR0003.jpg, and GOPR0004.jpg. To the right is a small image of a GoPro camera.

At the bottom center of the screen, the text "TablerTV" is visible.



INFEX Architecture





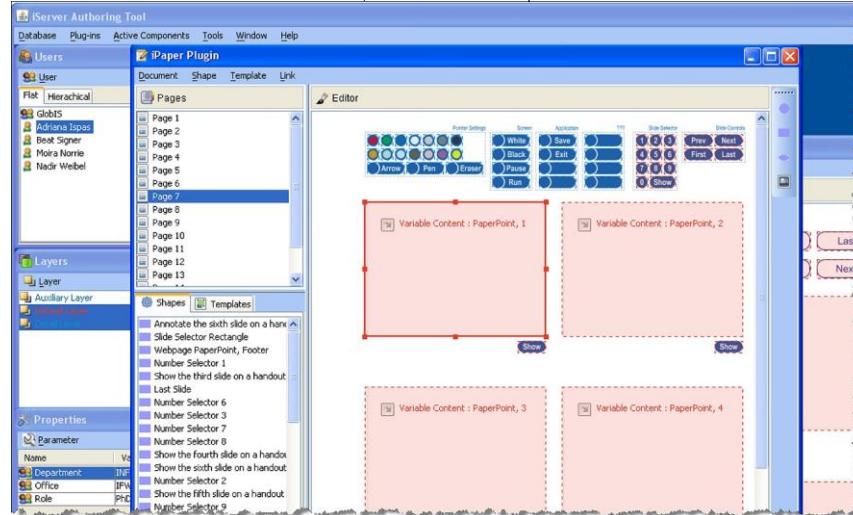
Open Cross-Media Linking

- Integration of a new resource type includes
 - development of a *data plug-in*
 - implementation of a *visual plug-in*
 - registration with the *resource plug-in repository*
- Link browser loads plug-ins on demand
 - *internal or external* (third party application) *visualisation*
- Third-party applications use the link browser for visualisation
 - similar to the integration of third-party applications with web browsers
- Non-monolithic annotation model and authoring tool
 - resource-specific plug-ins

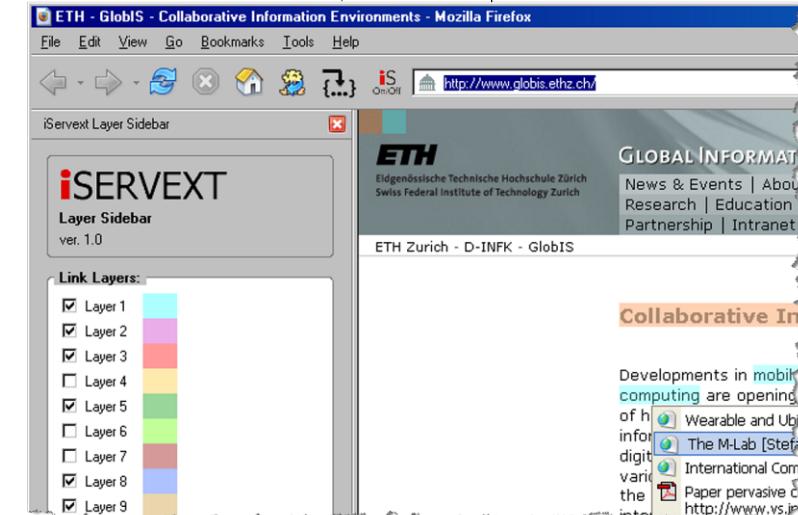
Visual Plug-ins

showEntity()

showEntity(), getSelectedEntity()



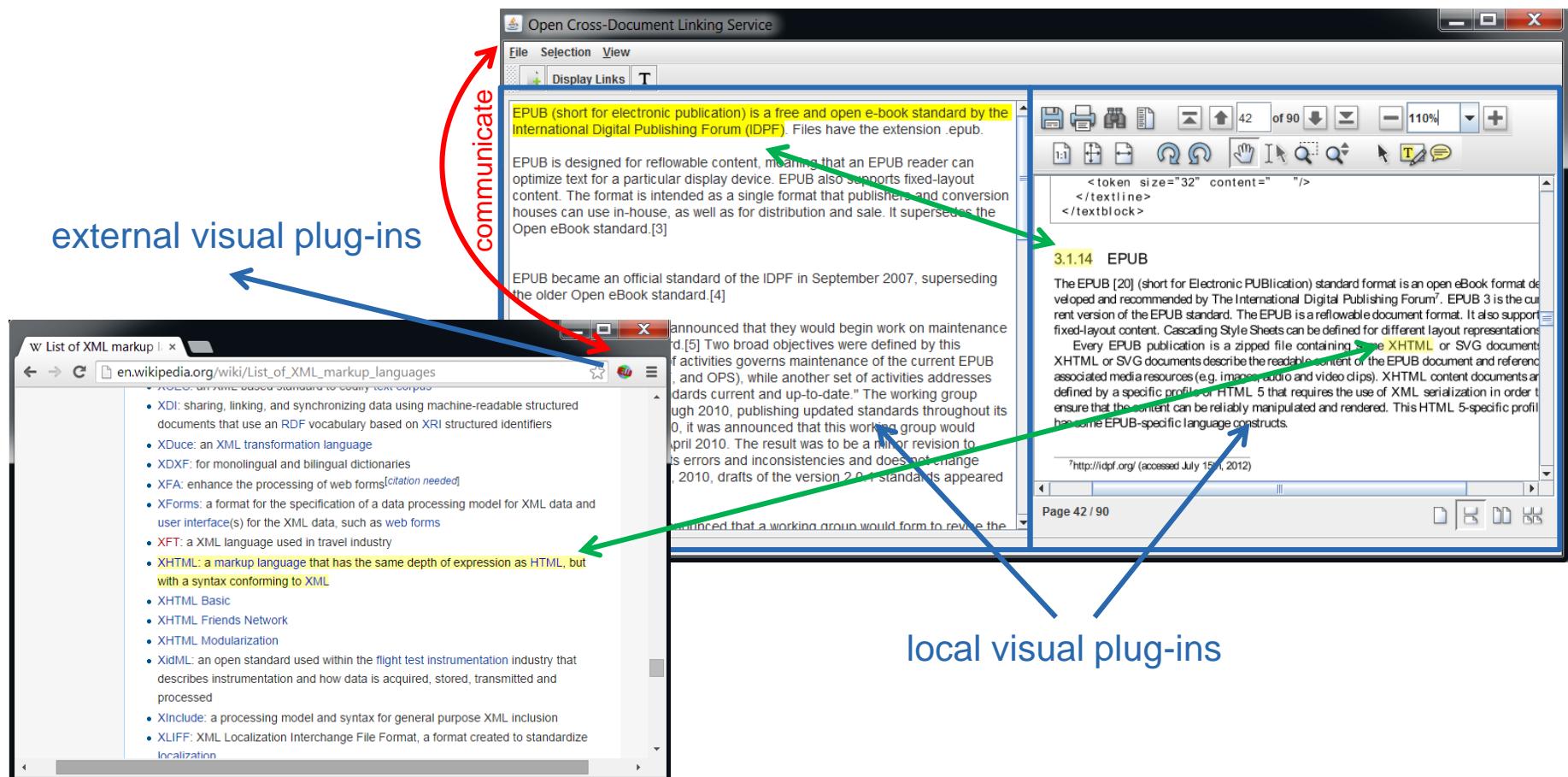
Annotation/Link Browser & Editor



Client Application

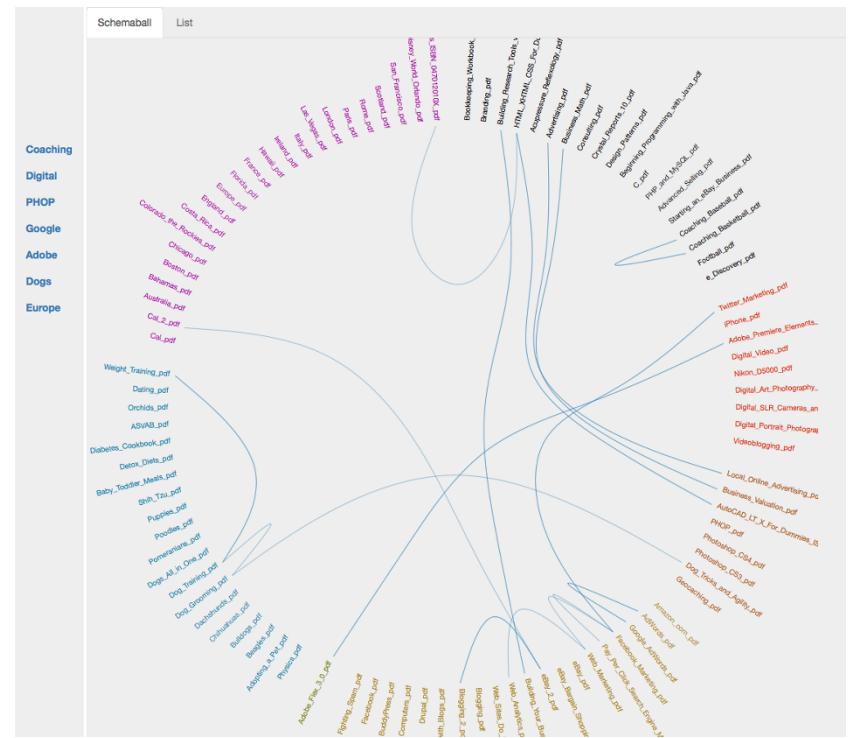
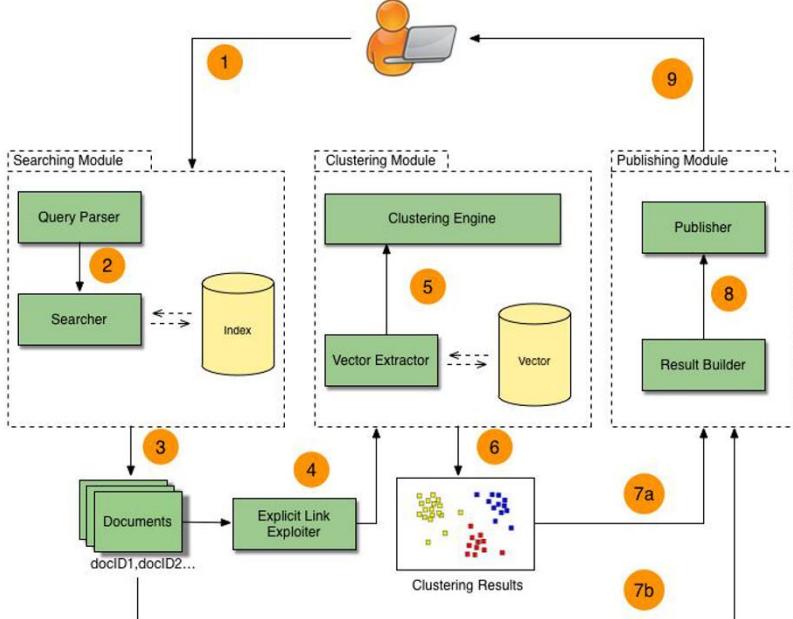
Cross-Document Linking

Link Browser



Document Retrieval and Discovery

- Use *explicit* as well as *implicit* document relationships





What is Wrong with Slideware?



- *Simulation of physical slides*
 - *limited space* due to the slide concept
 - *linear navigation* from slide to slide
 - *difficult to reuse content* and embed *rich media types*
- MindXpres addresses these issues
 - unlimited canvas with zoomable user interface
 - non-linear navigation and associative linking
 - *content-based approach* with automatic visualisation

Presentation Solutions

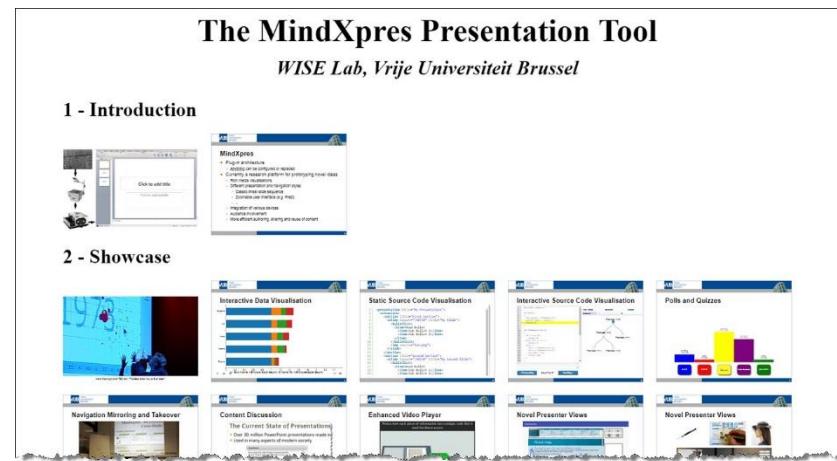
■ PaperPoint

- *interactive* PowerPoint *paper handouts*
- *non-linear navigation* and *annotations*
- in use since 2005



■ MindXpres

- *extensible* presentation platform
- *non-linear navigation* via *zoomable user interface*
- *rich media plug-ins*
- developed since 2011





PaperPoint Features

- Enhanced *mobility* during presentations
- Improved *presentation overview* for the presenter
 - see content of current and nearby slides (orientation)
- *Annotation* of static slide content
 - highlighting of content
 - dynamic creation of new content at presentation time
- Improved control of embedded media (e.g. video)
- Digital whiteboard
- Multi-pen support
 - collaborative presentations
 - brainstorming

MindXpres Presentation Platform

- *Flexible representation* of presentations
 - use of *structural RSL links*
 - separation of content and structure
- Extensible platform
 - *content-based approach*
 - cross-media *content reuse*
 - *non-linear navigation* and zoomable user interface
 - associative linking
 - *rich media types*

1 - Introduction

MindXpres

- Plug-in architecture
- Ability to be configured or replaced
- Content management platform for prototyping novel ideas
- Rich media visualizations
- Different presentation and navigation styles
- Cross-device support
- Zoomable user interface (e.g. Presi)
- Integration of various devices
- Audience involvement
- More efficient authoring, sharing and reuse of content

2 - Showcase

Interactive Data Visualisation

Static Source Code Visualisation

Navigation Mirroring and Takeover

Content Discussion

Enhanced Video Player

Novel Features

3 - MindXpres: A Next Generation Presentation Tool

Data-driven Presentations

- Focus on content
- Layout and styling mostly automatic
- Interactive plug-ins for hard to present data
- sound clips
- raw data
- real-time data
- Declarative authoring language
- Like LaTeX for dynamic presentations

Connected Presentations

- MindXpres presentations can connect and form a network
- Plug-ins for audience-oriented functionality
- Involve the audience
- Clicker
- Mobile devices
- Clickers
- Digital pens
- ...
- Integrate presenter hardware
- Mobile presenter interface
- Digital pen

Based on Modern Web Technologies

- Portable presentation bundles
- HTML5 and related technologies
- Websockets for connectivity
- Run on any device with a web browser!
- Also works without internet
- Easy plug-in development
- No need to learn new languages
- Existing JavaScript libraries can be reused
- Designers can directly apply their knowledge to create beautiful designs

A Repository

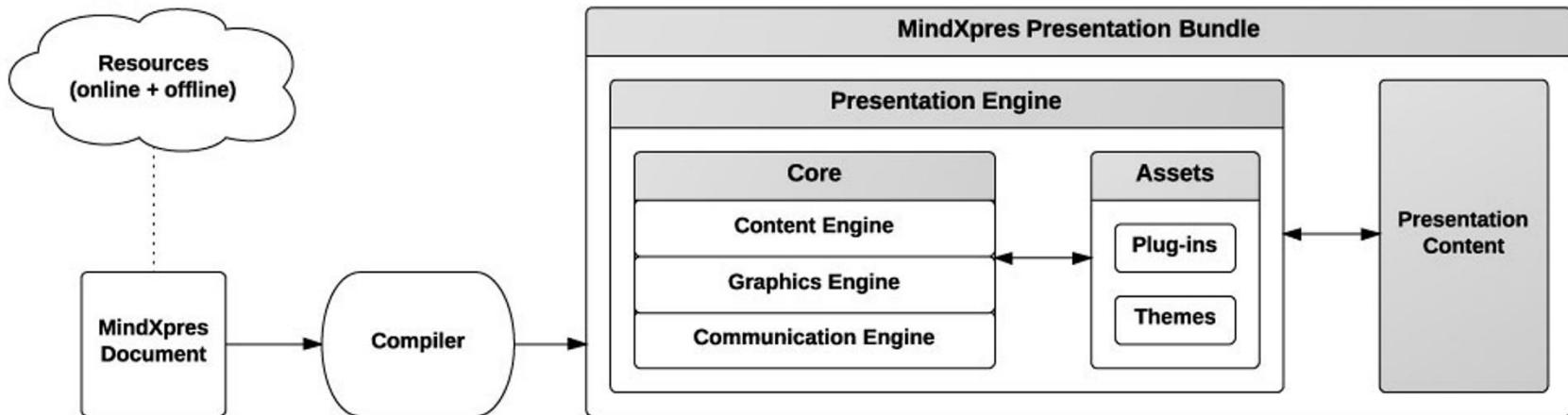
- ProvidePres
- Raise in difficult cases
- We store
- Raise
- Register
- Include
- Semantic
- Based on

Reinout Roels



MindXpres Platform

- MindXpres presentations are currently represented in the XML-based *MindXpres document format*
- Compiler (node.js application) translates XML to HTML
- Presentation engine based on HTML5 and related APIs
 - e.g. WebSockets for connectivity



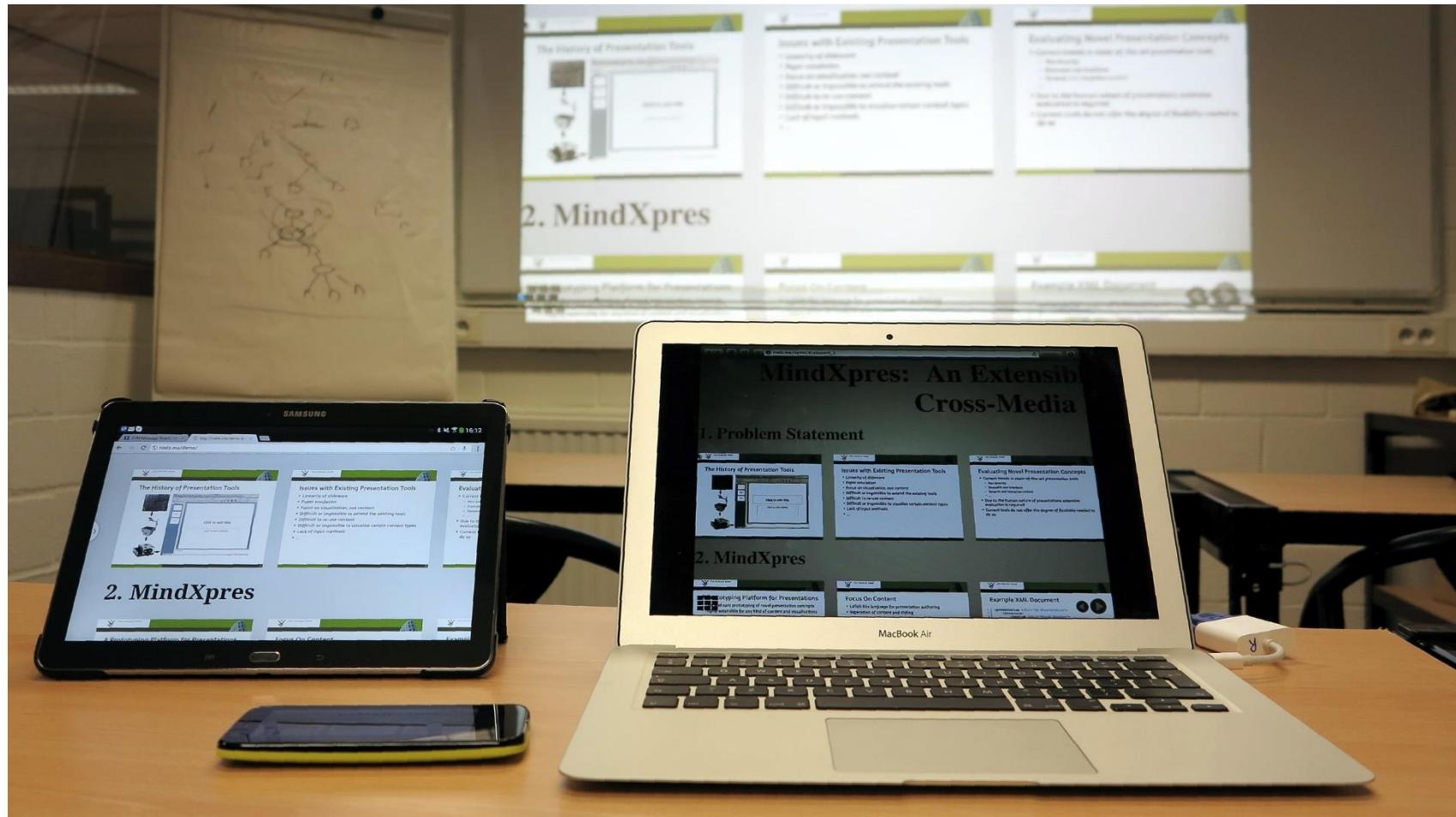


MindXpres Communication Platform



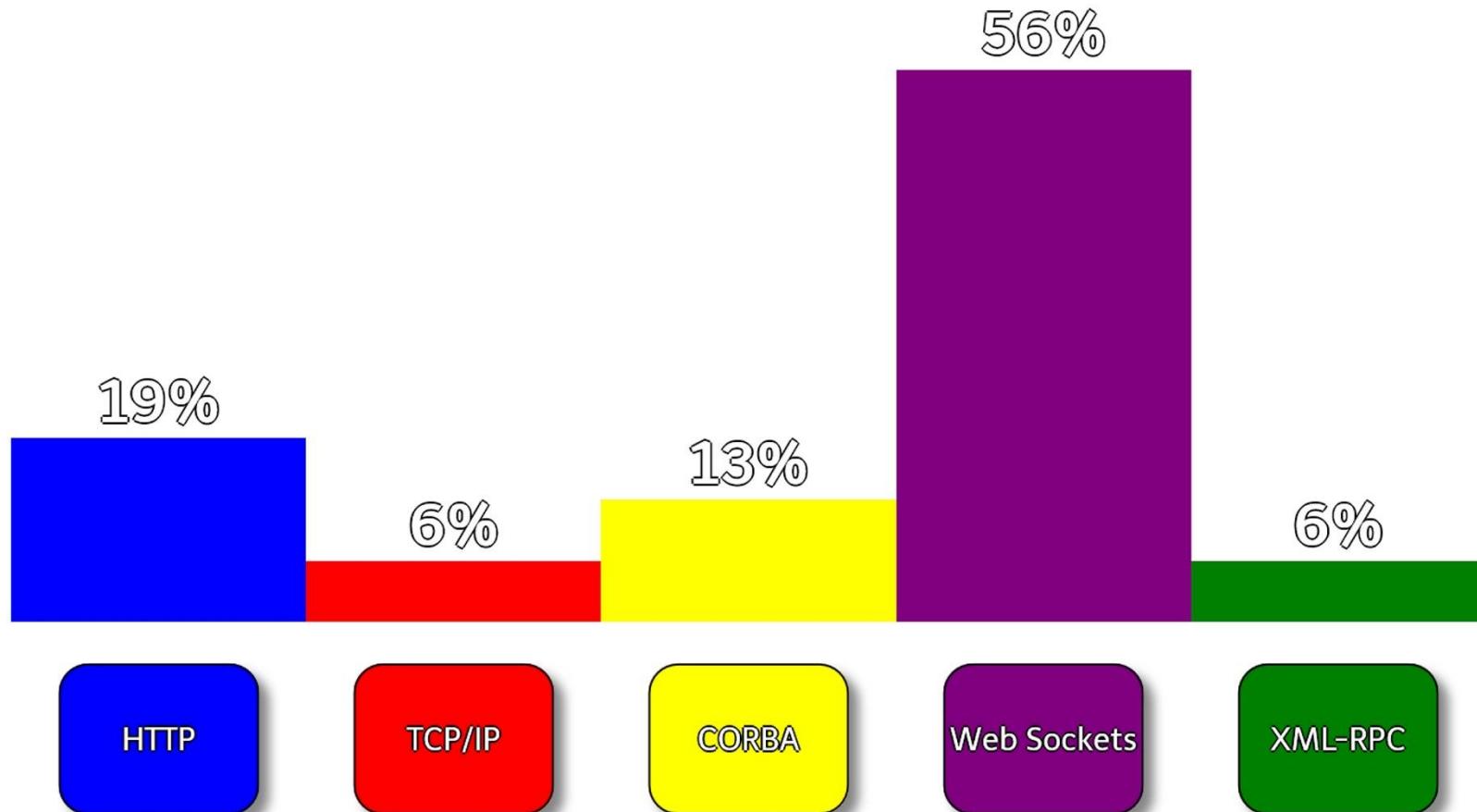


Navigation Mirroring Plug-in





Polls and Quizzes Plug-in



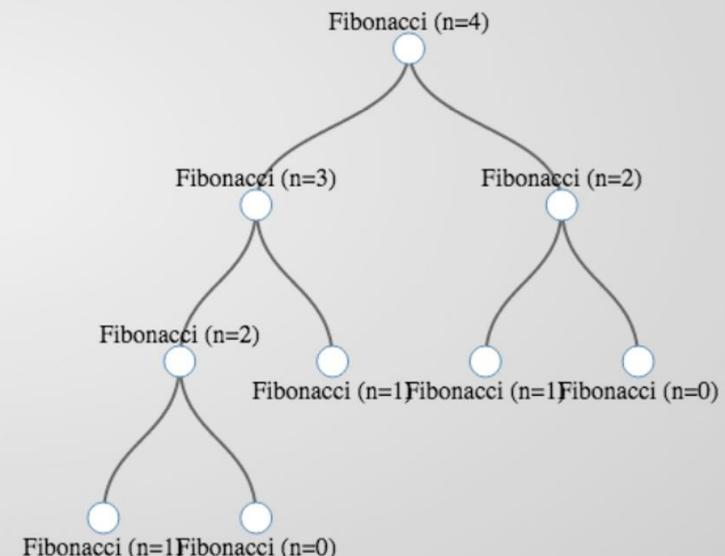


Interactive Source Code Plug-in

```
1 // include < stdio.h >
2
3 int Fibonacci(int);
4
5 int main()
6 {
7     int i;
8     i=4;
9     printf("%d\n", Fibonacci(i));
10    return 0;
11 }
12
13 int Fibonacci(int n)
14 {
15     int i,j,sum;
16     if ( n == 0 )
17         return 0;
18     else if ( n == 1 )
19         return 1;
20     else {
21         i = Fibonacci(n-1);
22         j = Fibonacci(n-2);
23         sum = i+j;
24         return sum; }
```

< Previous Step Step 46 of 60 Next Step >

Var Name	Before	After
i	32767	2
j	1	0
sum	2	1



Paul Mestereaga



MindXpres Video

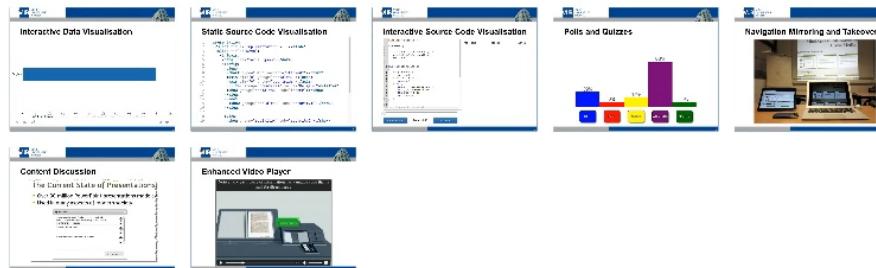
The MindXpres Presentation Tool

WISE Lab, Vrije Universiteit Brussel

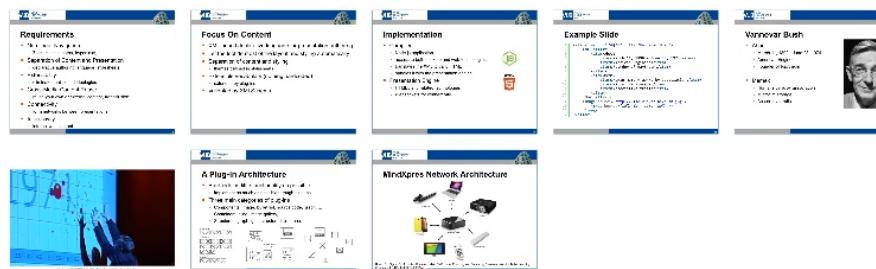
1 - Introduction



2 - Example Plug-ins

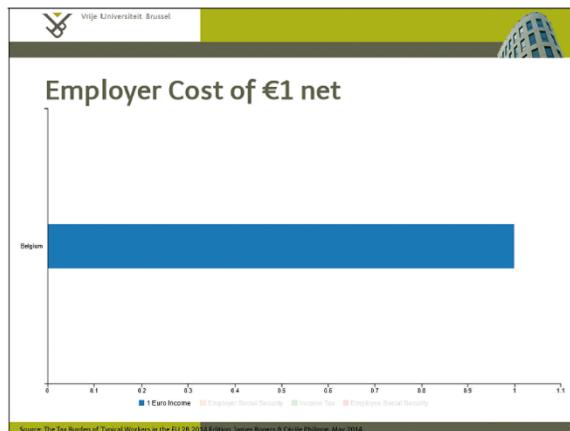


3 - Architecture

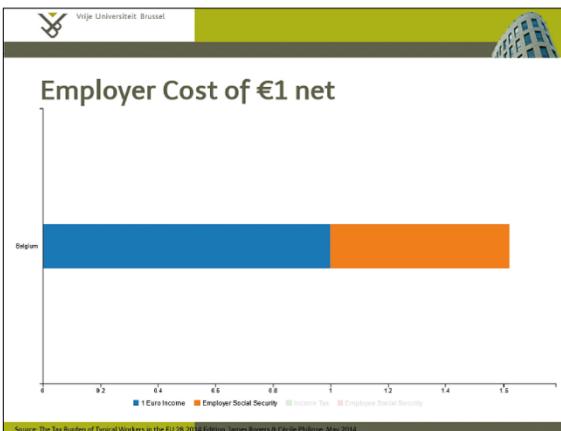




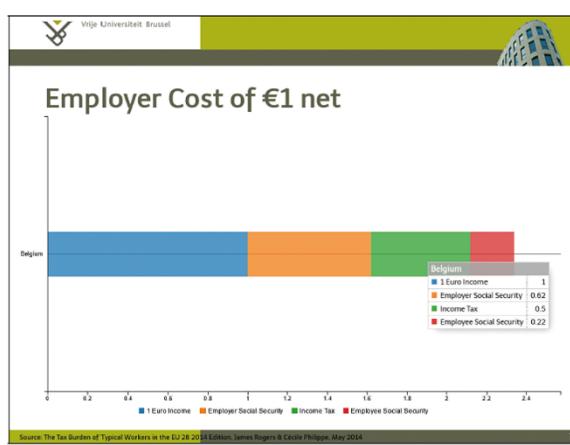
Interactive Data Visualisation



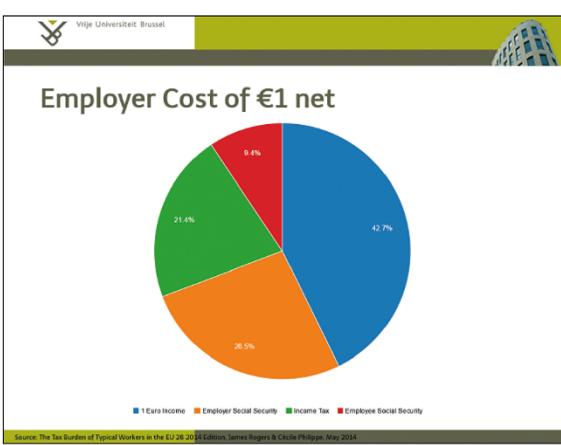
(a) One Euro received by employee



(b) Add employer social security



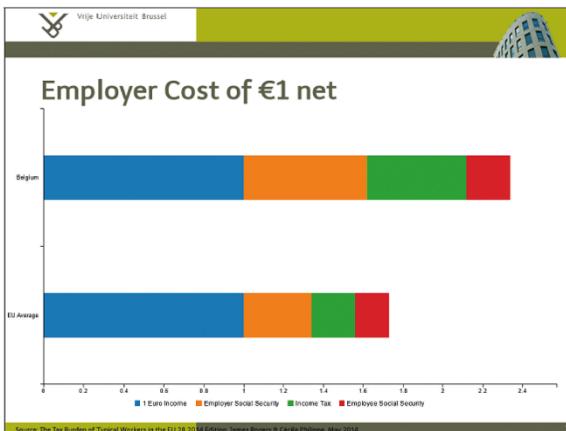
(c) Add income tax and employee social security



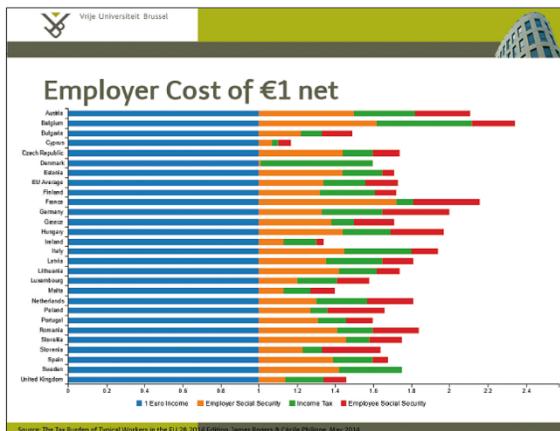
(d) Switch to pie chart



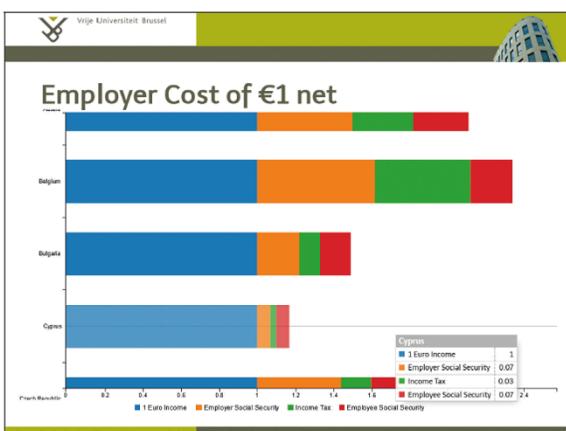
Interactive Data Visualisation ...



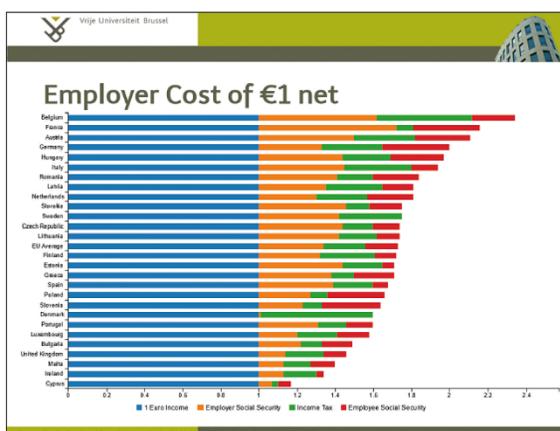
(e) Compare with EU average



(f) All countries (alphabetically)



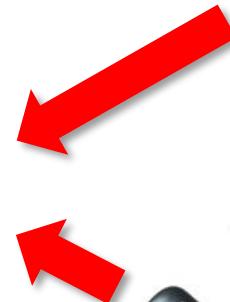
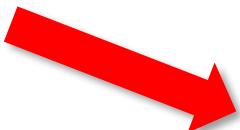
(g) Zoom in



(h) All countries (sorted by value)

Multimodal and Multi-Touch Interaction

Kinect, Microsoft



EPOC, emotiv

Echo Smartpen, Livescribe



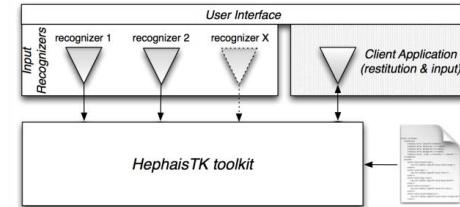
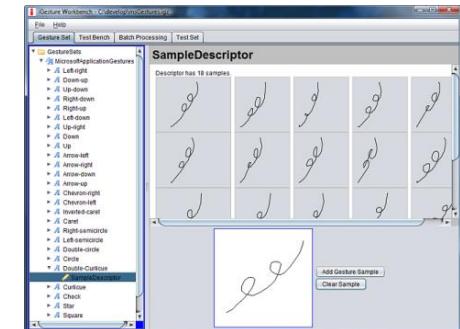
WISE Lab: Office of the Future





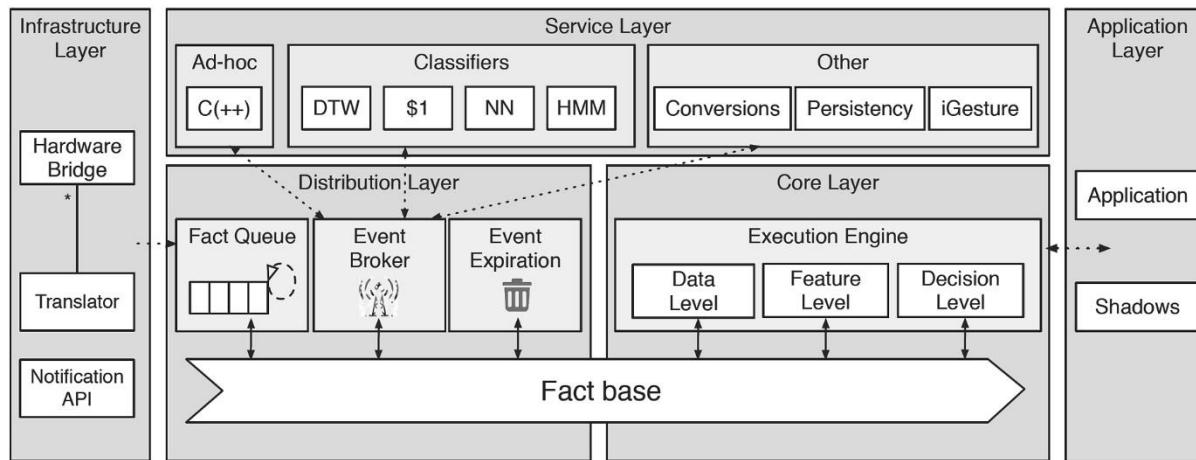
Multimodal and Multi-Touch Interaction

- Midas/Mudra Framework
 - *declarative definition* of multimodal and multi-touch interactions
 - *rule-based language* approach
 - *rapid prototyping* and application development
- iGesture Workbench
 - create and test *gesture sets and algorithms*
 - different modalities: digital pen, Wii remote, ...
 - open source (www.igesture.org)
- HephaistK Toolkit
 - domain-specific *human-computer dialogue language* (SMUIML) for multimodal I/O
 - speech recognisers, RFID readers, ...





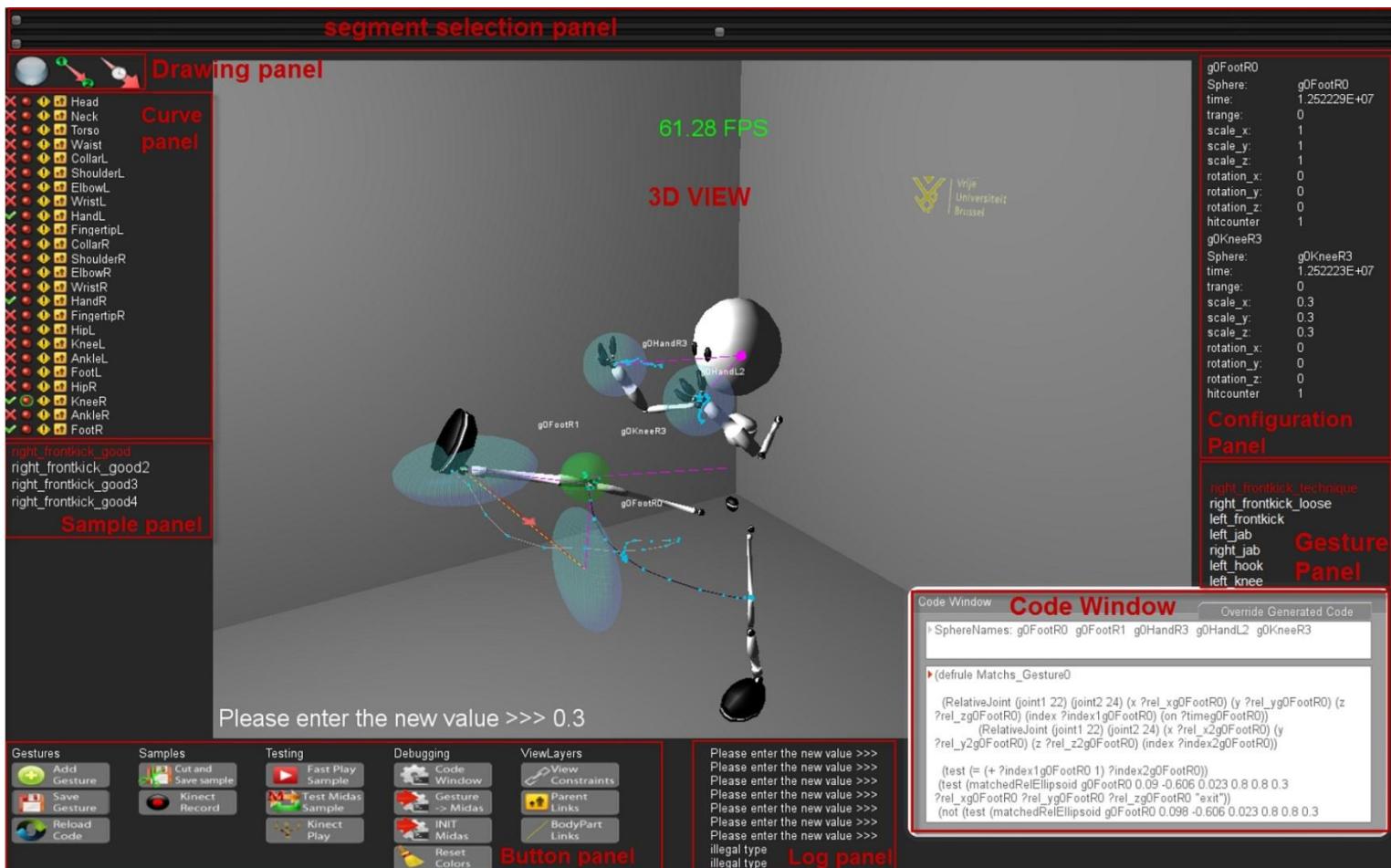
Mudra



- Declarative rule-based language
- Fusion across different levels of abstraction
 - fact base
- Rapid prototyping
 - simple integration of new input devices
 - integration of external gesture recognisers



VolTra



Brecht De Rooms



Video: Kinect Presenter

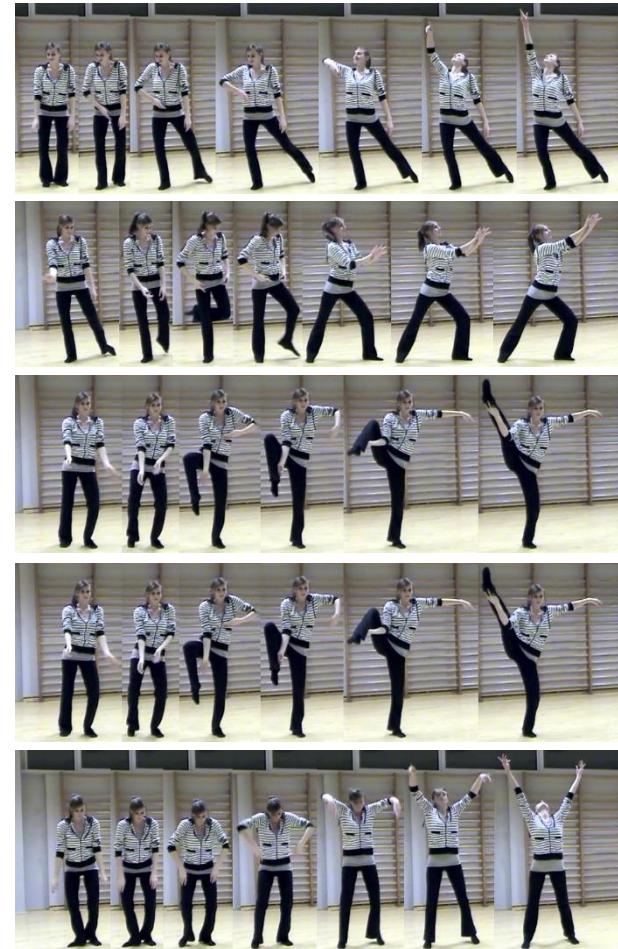




Video: Augmented Reality (Mental Nomad)

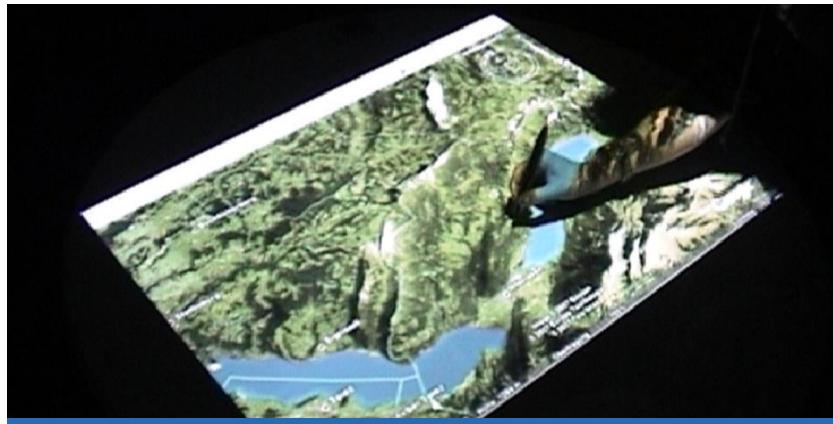


Toon Duwee





Interactive Tables



Pen-Based Google Earth Browser



Pen-Based Drawing Tool

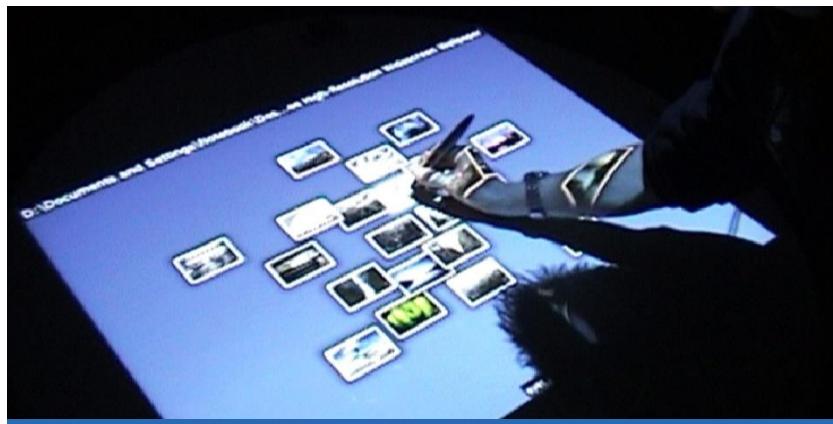


Photo Browser



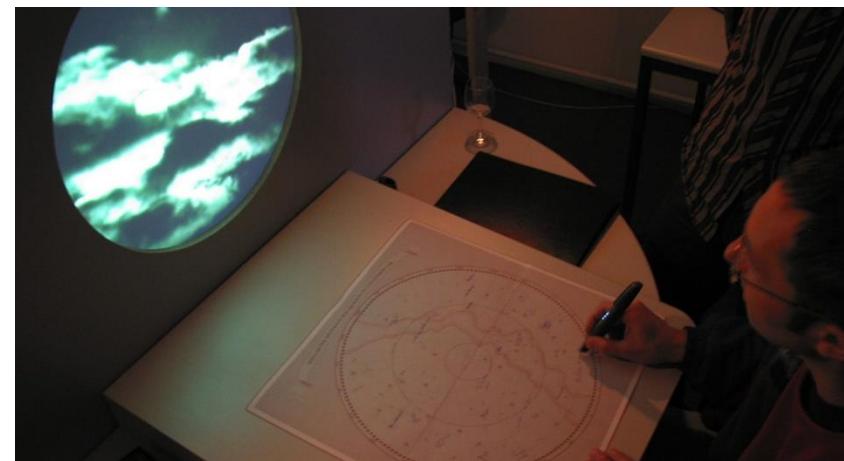
Photo Browser (Slider)

Global Information Systems Group, ETH Zurich



The Lost Cosmonaut

- Writing as a collaborative act of memory and storytelling
- Reading, writing and narrative as an act of making sense
- Handwriting as a tool for human-computer interaction



*In collaboration with Axel Vogelsang,
Artists in Labs Programme*



Are You Interested in a Thesis?

- Various possibilities for BA, MA and PhD theses
 - Tangible User Interfaces
 - Data Physicalisation
 - dynamic data physicalisation framework
 - big data exploration interfaces (e.g. via tangible holograms)
 - Innovative Mixed Reality Interfaces
 - e.g. for photography, museums etc.
 - Hybrid Positioning and Implicit Human-Computer Interaction
 - Smart Environments and Cross-Domain Internet of Things (IoT)
 - Next Generation Presentation Solutions (e.g. MindXpres)
 - Personal Information Management (PIM)
 - Interactive Paper Solutions and Guidelines
 - ...
- *Do you have your own ideas? Come along to discuss them...*



Conclusions

- Innovative cross-media document formats which go beyond *simulating paper* on desktop computers
- RSL-based representation of *open and fluid cross-media information spaces*
 - *interactive paper* and *data physicalisation* solutions
 - *personal information management* and *associative file systems*
 - MindXpres presentation tool
- Multimodal and multi-touch interaction
 - Midas/Mudra, HephaistK and iGesture
 - SpeeG2, Kinect Presenter
- Mixed reality and dynamic data physicalisation
 - ArtVis, Mental Nomad and Tangible Holograms (TangHo)



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