



UNIVERSITÄT PADERBORN
Die Universität der Informationsgesellschaft

Web Engineering

Winter Term 2009/10

Prof. Dr. Gregor Engels

Chapter I: Web Applications

Acknowledgements

- Prof. Dr. Gerti Kappel, TU Wien



<http://www.big.tuwien.ac.at/staff/gkappel.html/>

- G. Kappel, B. Pröll, S. Reich, W. Retschitzegger (eds.):
Web Engineering – The Discipline of Systematic
Development of Web Applications.
John Wiley & Sons 2006



Literature

- G. Kappel, B. Pröll, S. Reich, W. Retschitzegger (Hrsg.): Web Engineering – Systematische Entwicklung von Web-Anwendungen. dpunkt.verlag 2004
- G. Alonso, F. Casati, H. Kuno, V. Machiraju: Web Services – Concepts, Architectures and Applications. Springer 2004
- H. Wöhr: Web-Technologien – Konzepte, Programmiermodelle, Architekturen. dpunkt.verlag 2004
- R. Pressman: Software Engineering – A Practitioner's Approach, 6th Edition. McGraw-Hill Higher Education 2005
- A. Eberhart, St. Fischer: Java-Bausteine für E-Commerce-Anwendungen. Hanser 2001
- J. Conallen: Building Web Applications with UML. Addison-Wesley 1999
- M. P. Singh, M. N. Huhns: Service-Oriented Computing – Semantics, Processes, Agents. Wiley 2005



Outline

I. Web Applications



I.1 History and Notions

I.2 Categories of Web Applications

I.3 Characteristics of Web Applications

I.4 Quality of Web Applications

I.5 Web Engineering



Motivation

- The World Wide Web is omnipresent!
- Why?
 - global and permanent availability
 - comfortable and uniform access
 - anyone can produce and publish contents



Example: Search Engine



Example: Information

The screenshot shows the FC Schalke 04 website in a Mozilla Firefox browser window. The browser's address bar displays the URL <http://www.schalke04.de/>. The website's header includes the club logo, language options (Deutsch, English, Русский), and a search bar. The main navigation menu lists categories such as AKTUELL, SAISON, MANNschaften, NACHWUCHS, TICKETS, FANS, MUSEUM & TOUREN, VEREIN, and MARKETING.

The main content area features a large video player with the title "Felix Magath: Die Auswahl wird immer größer". Below the video player, there are several news articles and sections:

- S04 INTERN:** "Jerilynn Shantrice ist Gerald Asamoahs ganzer Stolz" - A news item about a player's daughter.
- BUNDESLIGA:** "Danny Latza wieder im Mannschaftstraining" - A news item about a player's return to training.
- NACHWUCHS:** "Drei Knappen werden beim U21-Länderpokal Zweiter" - A news item about a youth team's performance.
- NACHWUCHS:** "Testspiel: Schalke 04 II schlägt Mittelheinauswahl" - A news item about a youth match.
- WEITERE THEMEN:** "Zwei Knappen treten für die Westfalenauswahl an" - A news item about players competing for a regional team.
- VOTING:** "S04-Voting: Wer wird Spieler des Monats September?" - A voting section for the monthly player.

The right sidebar contains a large advertisement for Nivea For Men, featuring a man in a white shirt and dark trousers. The text of the ad reads: "IHR MÜSST DAS SPIEL IN DIE BREITE ZIEHEN, LEUTE." Below the ad, there are logos for VELTINS and S04-Shop.



Example: Course Announcement

The screenshot shows a Mozilla Firefox browser window displaying the website of the University of Paderborn. The address bar shows the URL: <http://www.cs.uni-paderborn.de/fachgebiete/fg-engels/lehre/ws0910/web-engineering/news.html>. The page title is "Universität Paderborn | News - Mozilla Firefox".

The website header features the University of Paderborn logo and the text "UNIVERSITÄT PADERBORN Die Universität der Informationsgesellschaft". Below the header is a breadcrumb trail: Home > Fakultäten > Fakultät für Elektrotechnik, Informatik und Mathematik > Institut für Informatik > FG-Engels > Lehre > WS0910 > Web-Engineering > News.

The main content area is titled "L.079.05711: Web Engineering (WS 09/10)". It includes a navigation menu with tabs for "News", "Lecture Notes", "Exercises", "Examinations", and "Literature". The "News" tab is currently selected.

Below the navigation menu is a section titled "Welcome to Web Engineering" with the following text: "Web Engineering is a subdiscipline of Software Engineering. It deals with concepts, languages, methods and tools to develop Web-based software systems. During the lecture, advanced concepts for developing those systems are studied. These comprise, e.g., standards to describe service-oriented architectures (SOA), Web services (WSDL), their retrieval (UDDI), their composition (BPEL) as well as ontology-based approaches to describe their semantics (RDF, OWL, WSMO, WSML). It will be shown how this is related to novel software development approaches as Model-Drive Architecture (MDS). The course will be rounded up by recent research results on describing and realizing Web service-based applications. Master: SWT&IS Modul III.1.2+III.1.5+III.1.6 i-m DPO4: 3. Studienabschnitt".

Below this is a "News" section with a table of announcements:

Date	News
2009-09-07	Please subscribe to the mailing list via https://lists.uni-paderborn.de/mailman/listinfo/webeng .
2009-09-07	The exercises start on 4th of November and will be held every second week.
2009-09-07	The first lecture will start on wednesday, 14th of October 2009.

Below the news section is a "Lectures und Exercises" section with a table of lecture and exercise times:

Code	Activity	Day	Time	Location
V2	Lecture:	Wednesday (in english)	09:00 - 11:00	D2
Ü1	Exercises:	Wednesday (in english)	11:00 - 13:00	
		Wednesday (in english)	14:00 - 16:00	D1.303

At the bottom of the page, there is a footer with the text: "Impressum | Webmaster | Letzte Änderungen am : 16.09.2009".



Example: www.bahn.de

The screenshot shows the homepage of the German railway website (www.bahn.de) in a Mozilla browser window. The browser's address bar displays the URL: <http://www.bahn.de/-S:PTVOR9:dBaNqNNMhF3r9NNNNEM/p/view/index.shtml>. The page layout includes a search bar at the top left, a navigation menu with links like 'Preise&Angebote' and 'Planen&Buchen', and several promotional banners. A prominent banner at the top right says 'einfach und günstig buchen!' with a 'Go' button. Below this, there are sections for 'Ihr Bahn- und Mobilitätsportal', 'Europa-Spezial' (highlighting a 19 Euro offer), 'Deutschland erleben!', 'Kurz- und Städtereisen', and 'Last-Minute-Tipps'. The 'Last-Minute-Tipps' section lists offers like 'Bahn & Bett HerbstHit' and 'Surf&Travel Special'. At the bottom, there are sections for 'SparNight', 'Angebots-Tipps', 'Reise-Tipps', 'Specials', and 'www.bahn.de präsentiert:'. The browser's taskbar at the bottom shows several open applications, including 'Start', '(SPAM){SPAMI} The ...', 'Die Bahn - Startseite ...', 'D:\jengels\Gregor\Leh...', and 'Microsoft PowerPoint ...'.

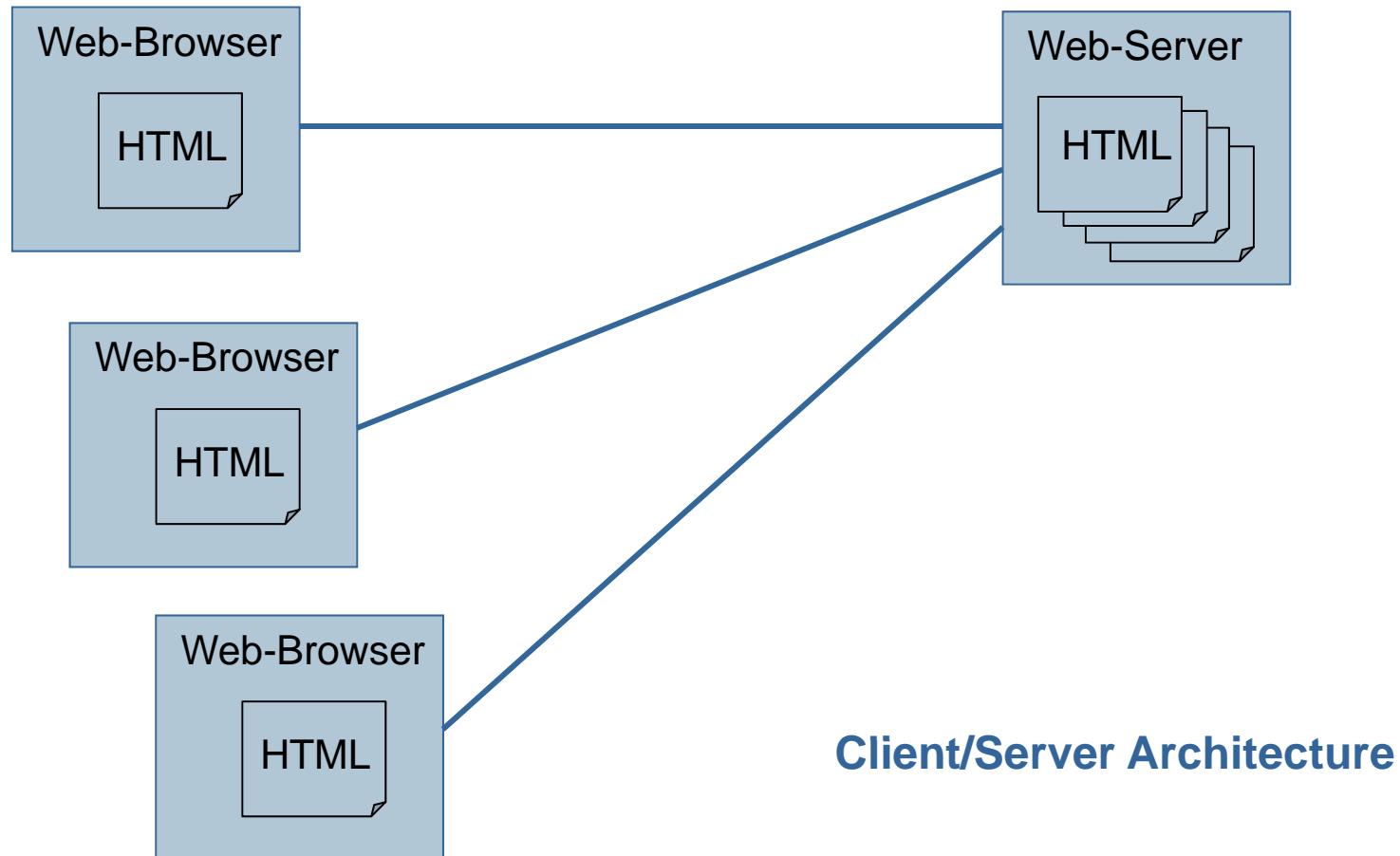


Basic paradigms

- Hypertext + Internet
- Hypertext: textual documents together with the ability to interconnect documents by links between them as part of the document contents
- HTML: HyperText Markup Language
- HTTP: HyperText Transfer Protocol



Conceptual Architecture

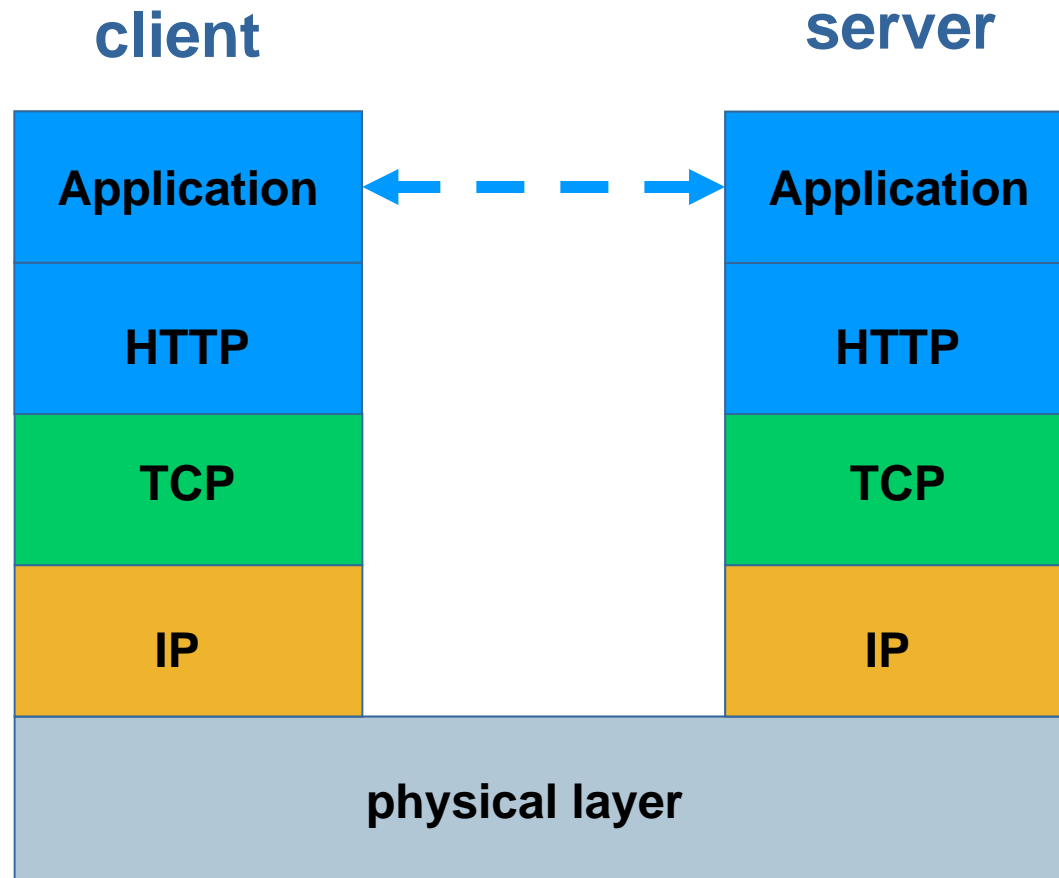


History of the Web

- 1969: ARPA (Advanced Research Projects Agency)
 - First small network: Stanford Research Institute, UCLA, UC Santa Barbara, Univ. of Utah
 - TCP (Transmission Control Protocol)
 - IP (Internet Protocol)
- 1972: Telnet protocol
- 1973: SMTP (Simple Mail Transfer Protocol)
- 1973: FTP (File Transfer Protocol)
- 1989: T. Berners-Lee et al.:
 - Word Wide Web (WWW)
- 1994: W3C (World Wide Web Consortium)
- 1996: HTTP (HyperText Transfer Protocol)



Protocol Stack



World Wide Web Consortium (W3C)

- international consortium where member organizations, a full-time staff, and the public work together to develop Web standards
- <http://www.w3.org>

W3C's mission:

- **to lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web.**



Web Application

Definition:

A **Web Application** is a software system based on technologies and standards of the World Wide Web Consortium (W3C) that provides Web specific resources such as content and services through a user interface, the Web browser.

[Kappel et al. 2004]



Outline

I. Web Applications

I.1 History and Notions



I.2 Categories of Web Applications

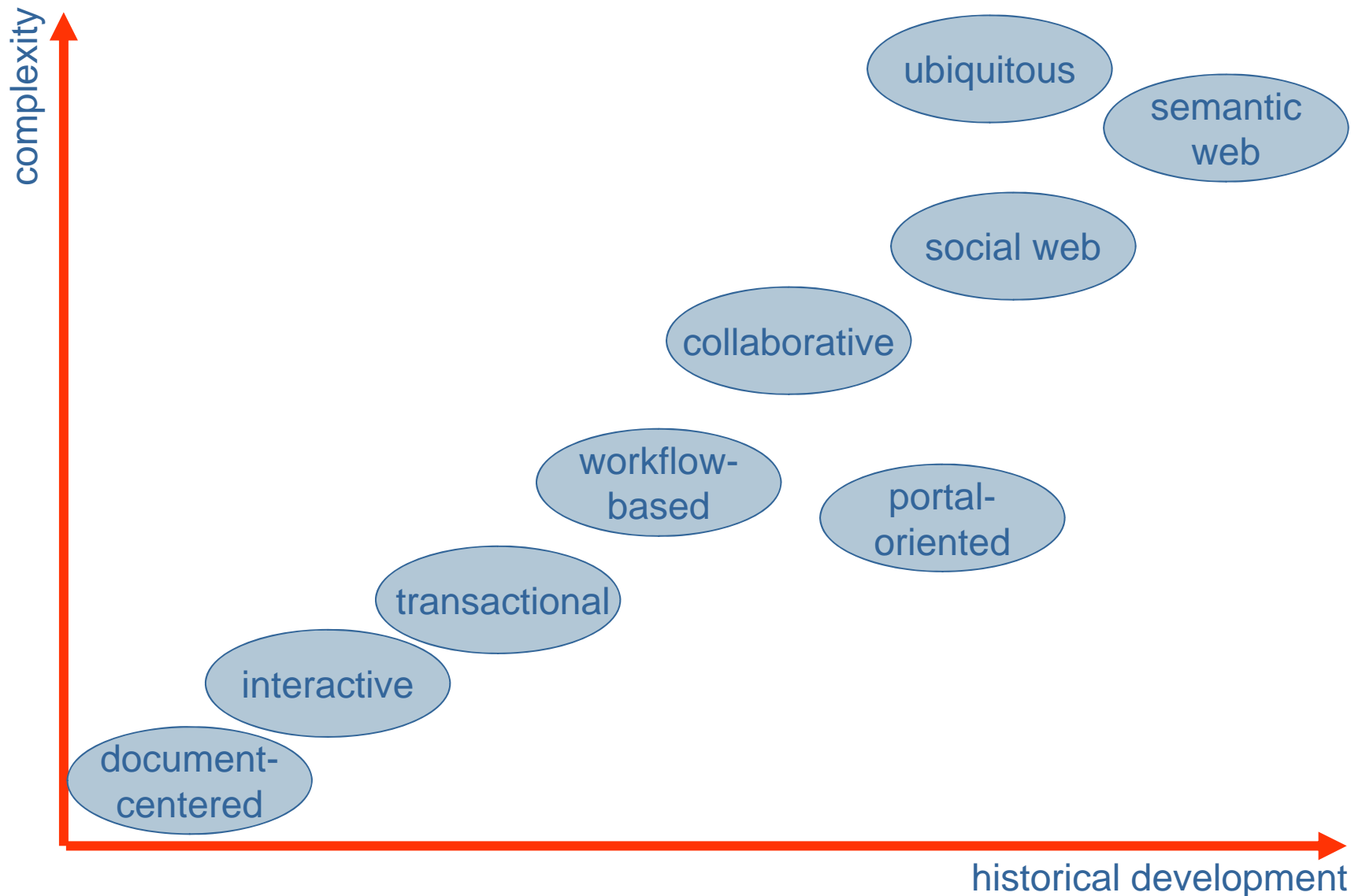
I.3 Characteristics of Web Applications

I.4 Quality of Web Applications

I.5 Web Engineering



Categories of Web Applications



Categories of Web Applications (1)

(cf. Pressman, p. 472, Kappel, p.5)

- **document-centered**

- Informational

- read-only content is provided with simple navigation and links

- Download

- a user downloads information from the appropriate server (ftp-server)

- Customizable

- the user customizes content to specific needs

- **examples:**

- static HTML-pages, „home pages“
 - web radio
 - simple presentations of companies/products



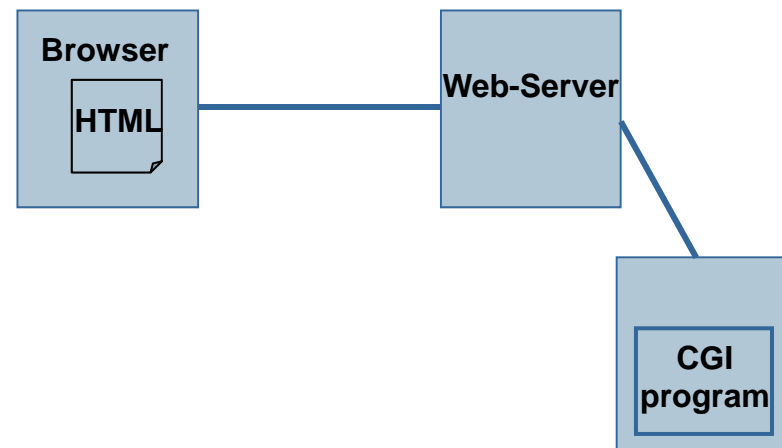
Categories of Web Applications (2)

- **interactive**

- content of a website is dynamically generated as response to a user request
- form-based input is the primary mechanism for communication between client and server
- usage of HTML-forms and Common Gateway Interface (CGI) techniques
 - radio button, string input, choice lists

- **examples:**

- dynamic HTML pages
- public transport schedules
- search engines



Categories of Web Applications (3)

- **transactional**

- complex interactions
- read and write actions
- atomicity / roll-back in case of problems
- usage of transaction management of database systems
 - efficient and consistent data management
 - structured data and queries
- **examples:**
 - online banking
 - e-shopping
 - reservation systems



Categories of Web Applications (4)

- **workflow-based**

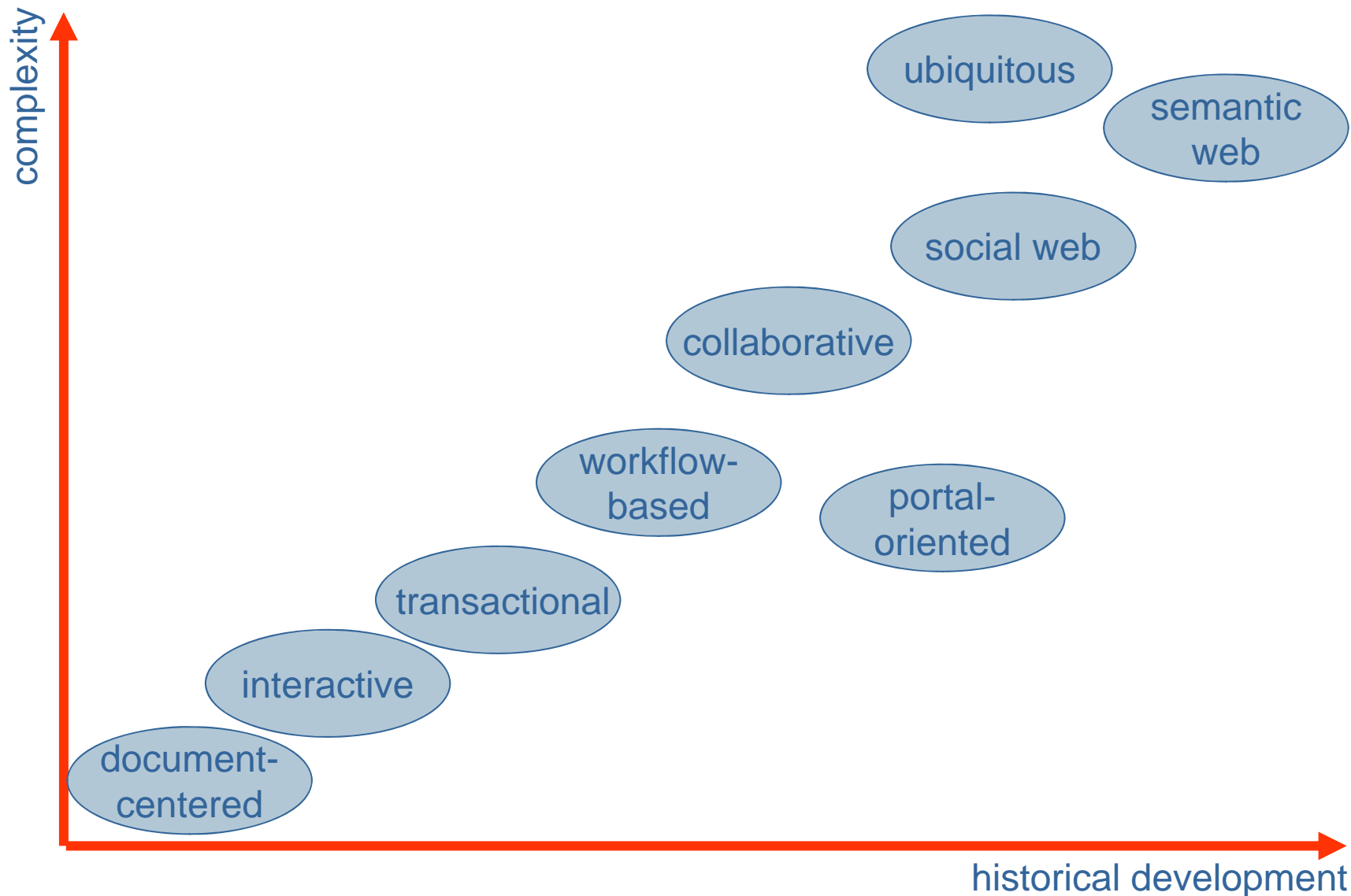
- support business processes („workflows“) within resp. between different enterprises or private users
- an application provides a complex service to the user, e.g. assists the user in determining the mortgage payment
- prerequisite: structured flow of activities

- **examples:**

- Business-to-Business (B2B) Integration Frameworks
- E-Government
- patient workflows in health care systems



Categories of Web Applications



Categories of Web Applications (5)

- **collaborative**

- **support cooperation in case of unstructured flow of activities and high degree of communication**

- „groupware“

- **examples:**

- support of shared information- and workspaces

- Wiki, <http://c2.com/cgi/wiki>

- BSCW, <http://public.bscw.de/>

- Microsoft Windows SharePoint Services

- chat rooms

- e-Learning platforms



Categories of Web Applications (6)

- **portal-oriented**

- the application channels the user to other Web content or services outside the domain of the portal application
- „single point of access“

- **examples:**

- community portals
 - dedicated user groups
 - customer profiles
- enterprise portals
 - Intranet, extranet



Categories of Web Applications (7)

- **social-web**

- people provide their identity to a community of others with the same interests
- serve the purpose of finding other people

- **examples:**

- weblogs
- networking platforms
 - XING, facebook, studivz
- virtual shared workspace



Categories of Web Applications (8)

- **ubiquitous**

- personalized services at every time at every location
- multi-platform delivery (PC, PDA, mobile phone)
- context-dependent information

- **example:**

- **display of today's menu on end-user devices while entering a restaurant**



Categories of Web Applications (9)

- **semantic web**

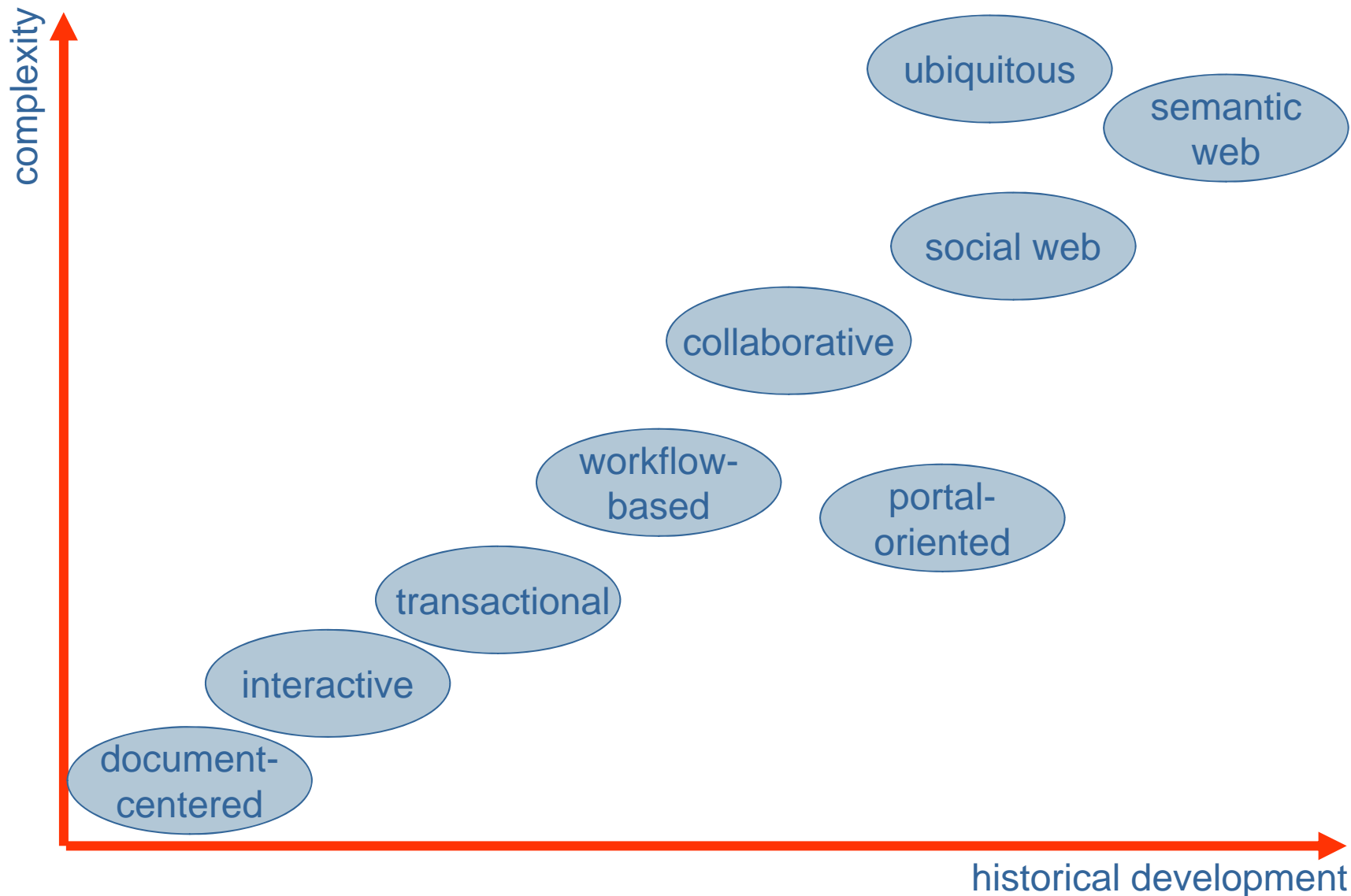
- information available on the web
 - adequate for human understanding and
 - adequate for automatic manipulation

- „knowledge management“
 - derivation of new knowledge
 - re-use of knowledge
 - based on ontology's

- Example:
 - Web 2.0
 - social software: wiki, Flickr, del.icio.us
 - Google



Categories of Web Applications



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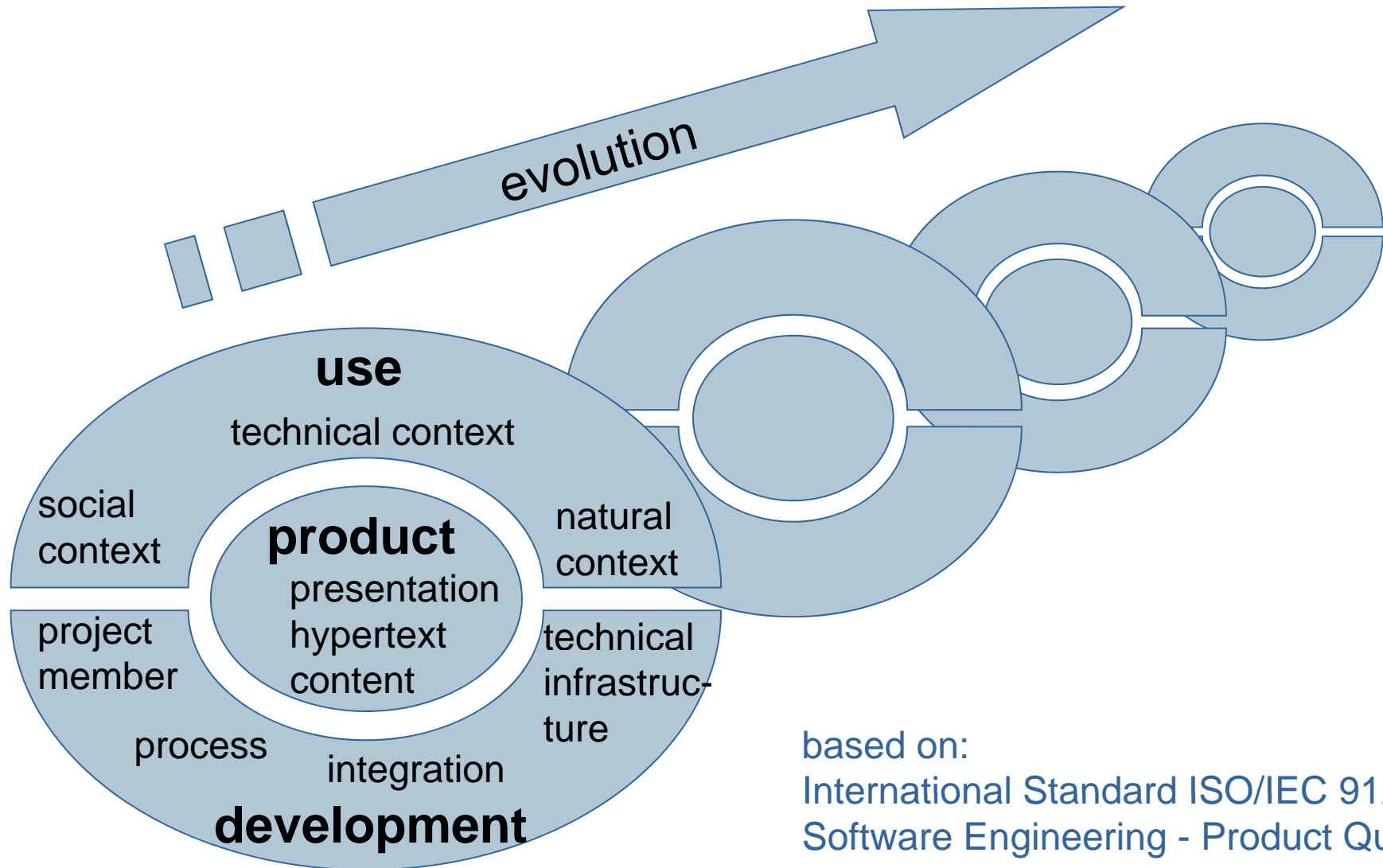
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Characteristics of Web Applications



based on:
International Standard ISO/IEC 9126:
Software Engineering - Product Quality



Characteristics of Web Applications

- **content**

- “content is king” in web applications
- document-centered and multi-media
 - text, tables, graphics, animation, audio, video
 - main objective of web applications is to communicate content
 - high usability demands
- high quality demands
 - actuality, preciseness, correctness, reliability, size
 - e-shopping: information about price, availability of products
 - quality is critical factor for acceptance of web applications

product
presentation
hypertext
content



Characteristics of Web Applications

- **hypertext**

- non-linearity

- main distinction to traditional software systems
 - systematic reading (“browsing, query, guided tour”)
 - navigation in information space depends on interest and previous knowledge of user
 - great challenge for web application authors

- risks

- disorientation: loss of sense of locality and direction
 - cognitive overload for users

product
presentation
hypertext
content



Characteristics of Web Applications

- **presentation**

- aesthetics

- look and feel
- depending on current fashion

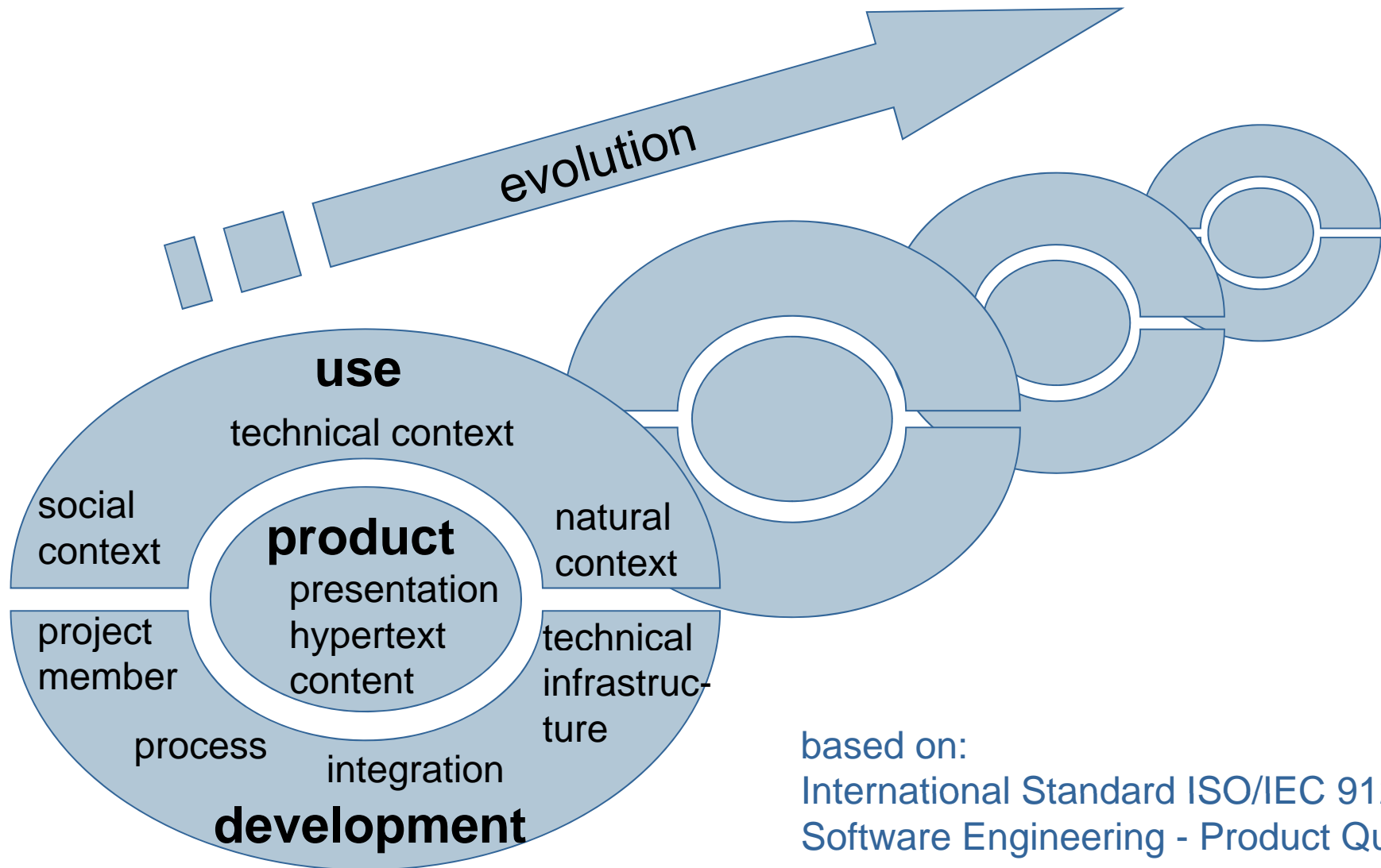
- self-explanatory

- intuitive use without reading any documentation
- uniform application logics

product
presentation
hypertext
content



Characteristics of Web Applications



based on:
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Characteristics of Web Applications

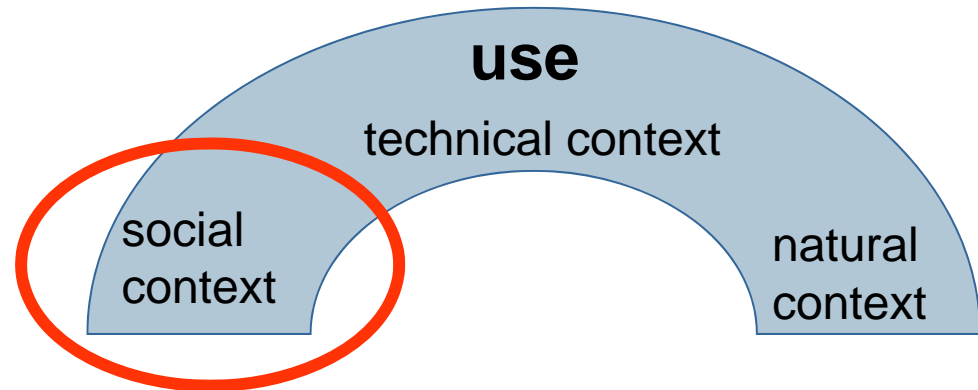
- **social context**

- spontaneity

- users come and go ..
- unknown number of users
- scalability important issue

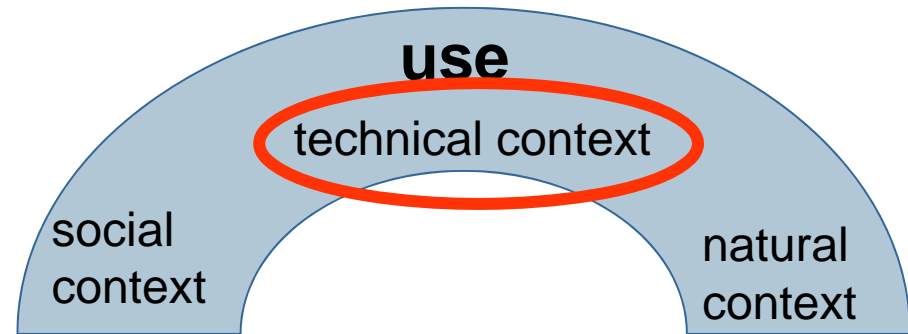
- multiculturality

- anonymous type of user
- limited knowledge about previous knowledge, handicaps, preferences of users
- desired adaptation of content and presentation



Characteristics of Web Applications

- **technical context**



- quality of service

- unknown network characteristics (e.g., bandwidth, reliability)

- multi platform delivery

- different types of devices (PC, PDA, BlackBerry, mobile phone)
- different versions of browsers
- different degree of functionality, performance, display size, ...



Characteristics of Web Applications

- **natural context**

- **place and time of access**

- **globality**

- internationalization of web applications

- regional, cultural, linguistic differences have to be taken into account

- demands on security

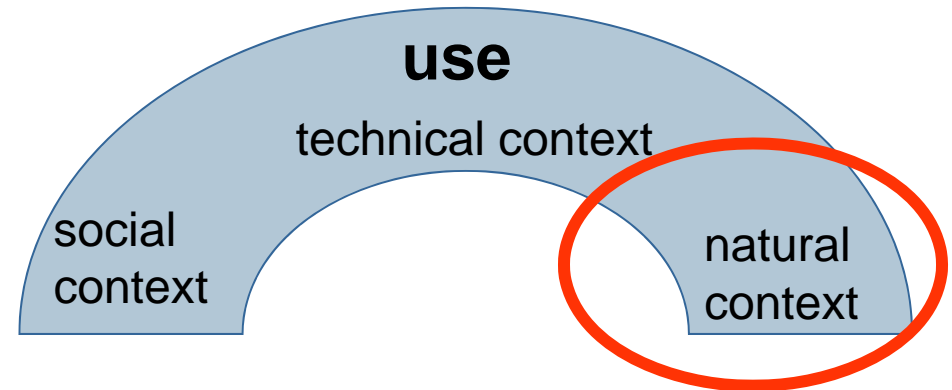
- prevent access to private or confidential data

- **availability**

- instant delivery mechanism (also in case of partial realizations)

- permanent (24/7)

- time-dependent services



Characteristics of Web Applications

- **project member**

- multi disciplinary

- mixture of

- print publishing and software development
- marketing and computer science
- art and technology

- IT-experts, hypertext experts, UI designer, domain experts, ...

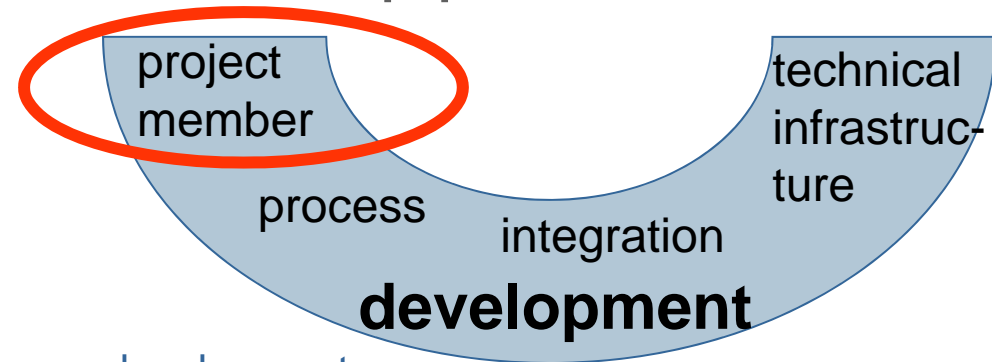
- young average age of developers

- “technology freak”, “nerd”

- community development

- open source

- open content



Characteristics of Web Applications

- **technical infrastructure**

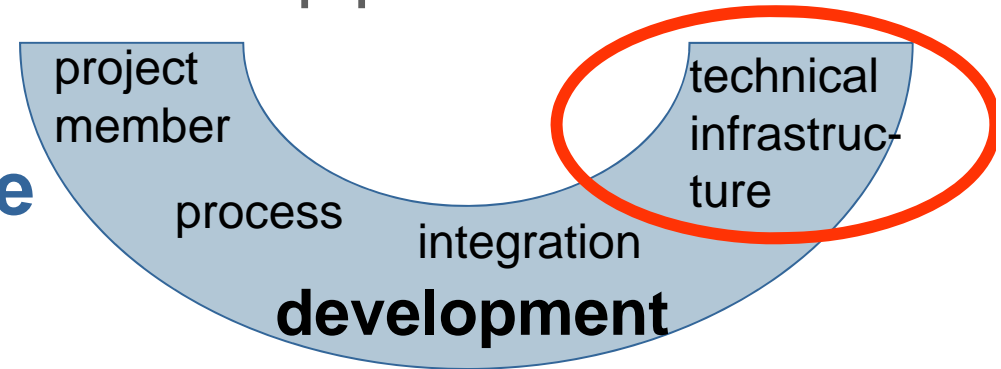
- inhomogeneity

- two essential components

- Web server (under control of developer)
- Web browser (out of control of developer)

- immaturity

- “buggy” components due to time-to-market pressure
- continuous evolution of base technology



Characteristics of Web Applications

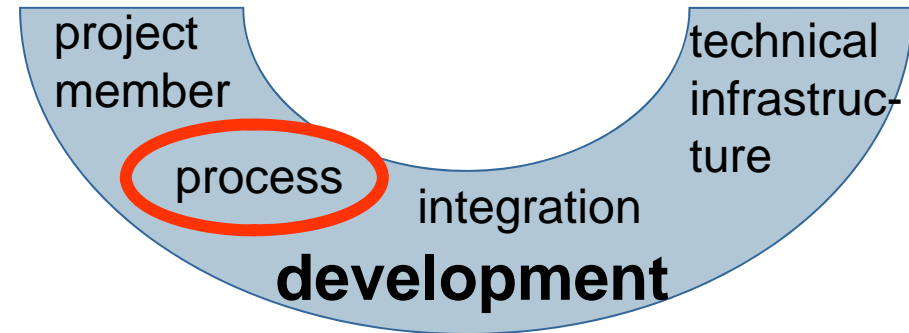
- **process**

- flexibility

- changing requirements
- changing context
- requires agile, light-weight processes

- parallelism

- of development of parts of web applications
- of development steps



Characteristics of Web Applications

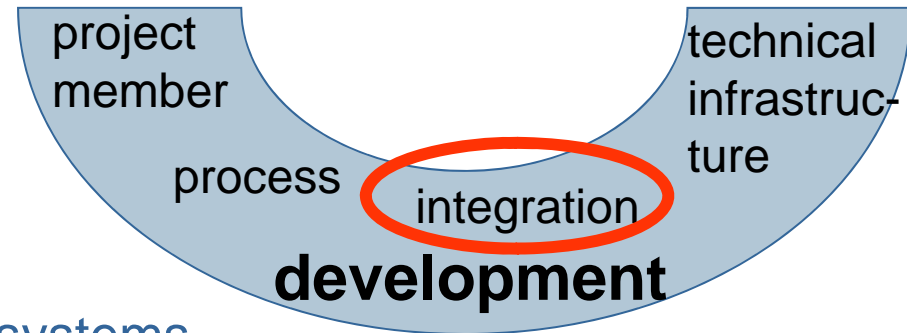
- **integration**

- internal integration

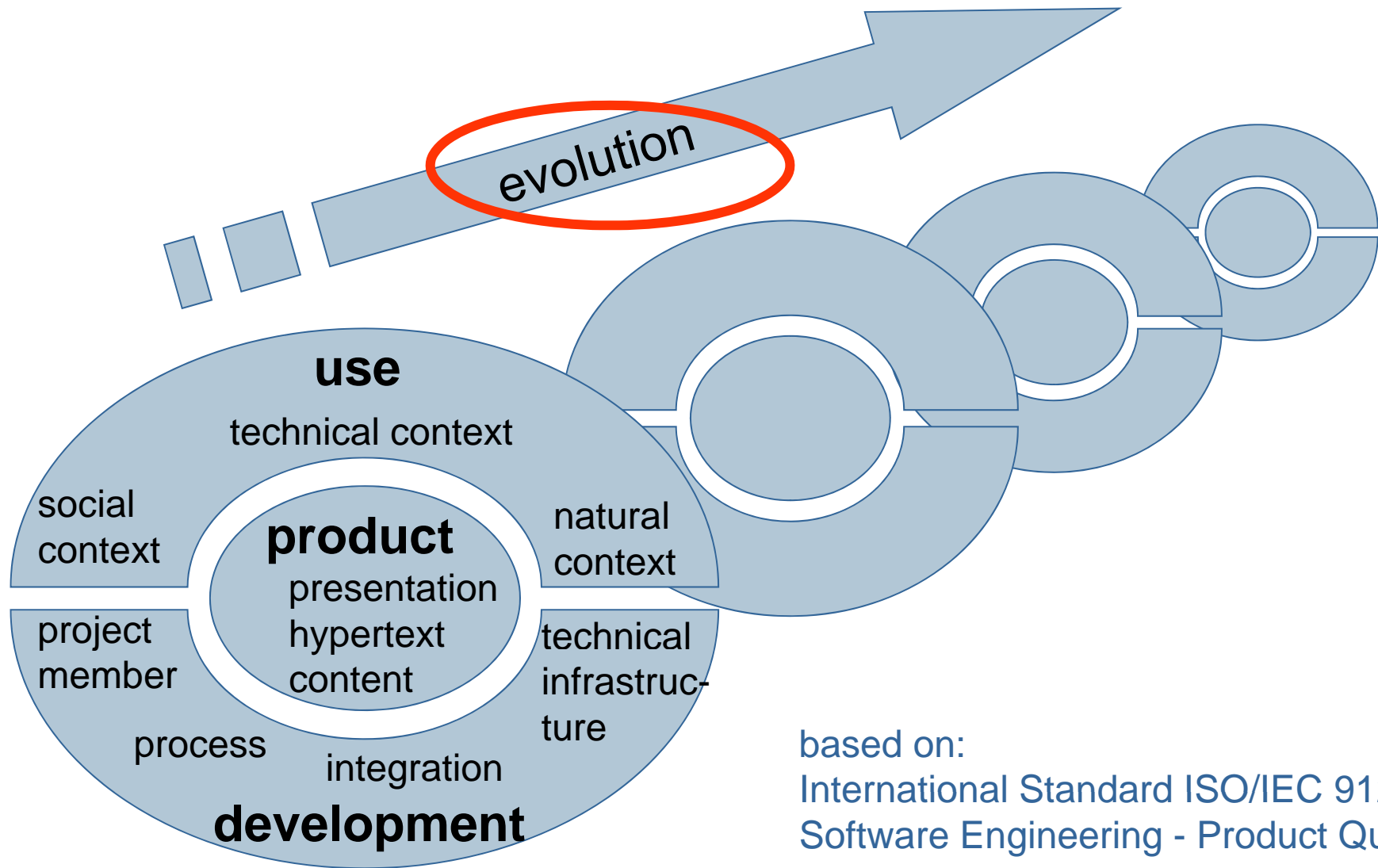
- add web access to legacy systems

- external integration

- of content and services of external web applications (“web services”)
- similarity to integration of heterogeneous database systems, but
 - high autonomy of sources w.r.t. to availability and change
 - few detailed information about sources
 - heterogeneity on different levels (data, schema, data model)



Characteristics of Web Applications



based on:
International Standard ISO/IEC 9126:
Software Engineering - Product Quality

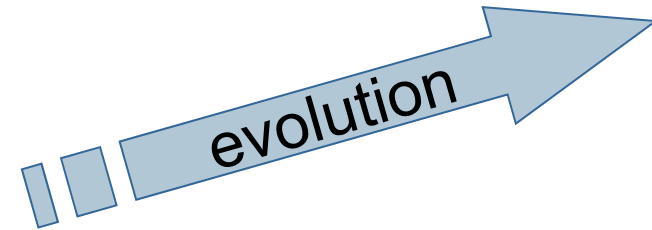


Characteristics of Web Applications

- **continuous change**

- permanent evolution

- changing requirements and contexts
- change of characteristics product, use, or development



- **competitive pressure**

- time-to-market
- necessity of web presence
- leads to shorter product life cycles
- leads to shorter development cycles

- **fast pace**

- “either you are fast or irrelevant”



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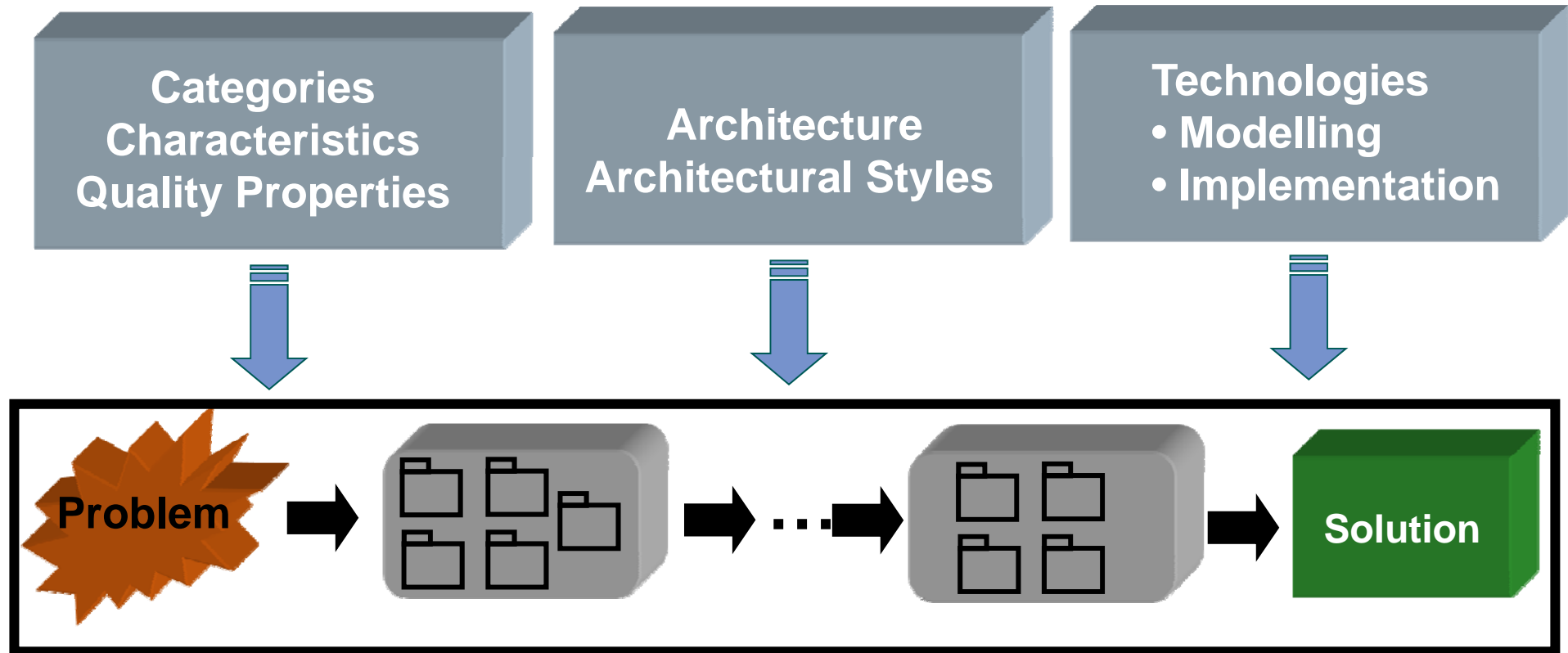


I.4 Quality of Web Applications

I.5 Web Engineering



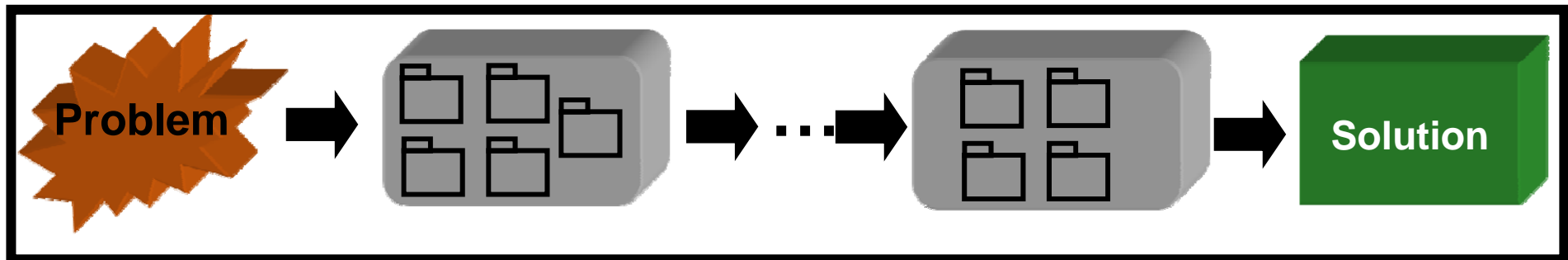
Support for Web Application Development



Model-based Development



Quality of Web Applications



Model-based Development

Kinds of quality properties

- *external* qualities are visible to the user
- *internal* qualities are visible to / concerning the developer



Quality of Web Applications

- external qualities:
 - correctness:
 - a web application is functionally correct if it behaves according to the specification of the application
 - reliability:
 - the probability that the software will operate as expected
 - occurring software errors are not serious
 - robustness:
 - software behaves reasonably even in circumstances that were not anticipated in the requirements specification



Quality of Web Applications

- external qualities:
 - actuality:
 - actuality of content must be guaranteed
 - user-friendliness:
 - easy to use by human (novice / experts)
 - efficiency:
 - economical handling of resources (time, storage space)
 - security:
 - system is protected from unauthorized access



Quality of Web Applications

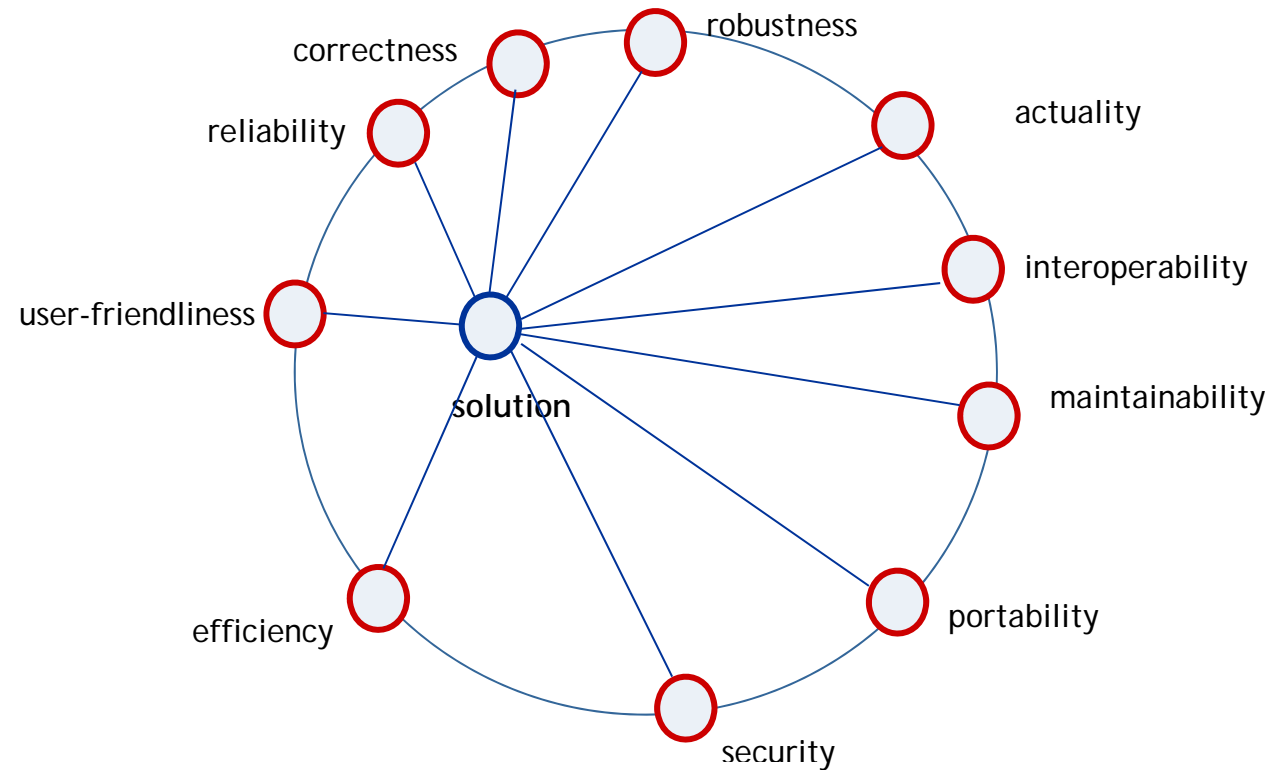
- internal qualities:
 - portability:
 - a web application is portable if it can run in different environments
 - interoperability:
 - refers to the ability of the web application to coexist and cooperate with other systems
 - maintainability:
 - ability to modify a web application after it has been deployed
 - correct errors
 - extend the web application



Quality of Web Applications

- each solution is a compromise
- choose / design your own solution

„trade-off circle“



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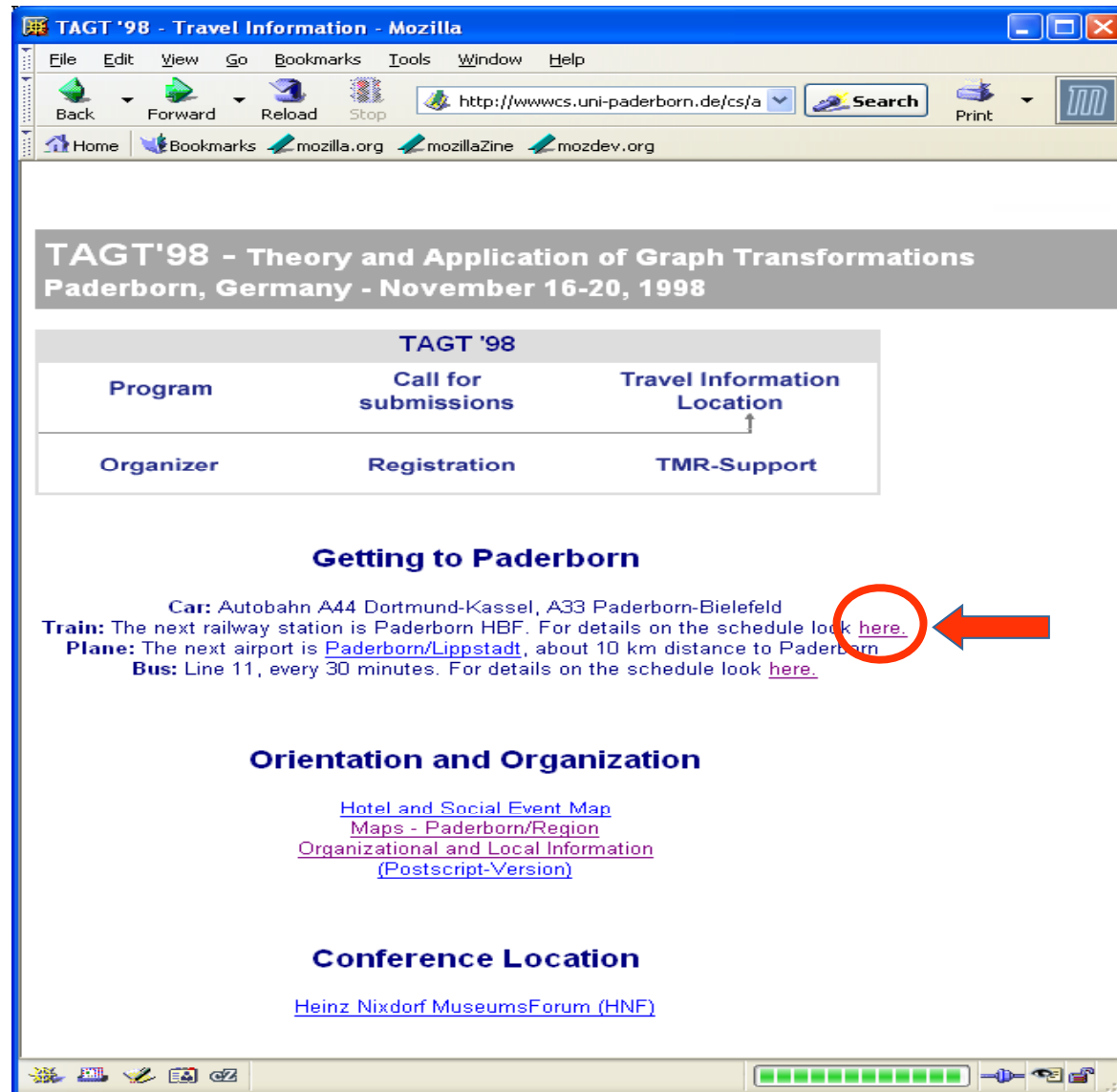
I.4 Quality of Web Applications



I.5 Web Engineering



Navigation in Web Applications (1)



Error! Link not found!



Navigation in Web Applications (2)

TAGT '98 - Theory and Application of Graph Transformations
Paderborn, Germany - November 16-20, 1998

TAGT '98		
Program	Call for submissions	Travel Information Location
Organizer	Registration	TMR-Support

Getting to Paderborn

Car: Autobahn A44 Dortmund-Kassel, A33 Paderborn-Bielefeld
Train: The next railway station is Paderborn HBF. For details on the schedule look [here](#).
Plane: The next airport is [Paderborn/Lippstadt](#), about 10 km distance to Paderborn
Bus: Line 11, every 30 minutes. For details on the schedule look [here](#).

Orientation and Organization

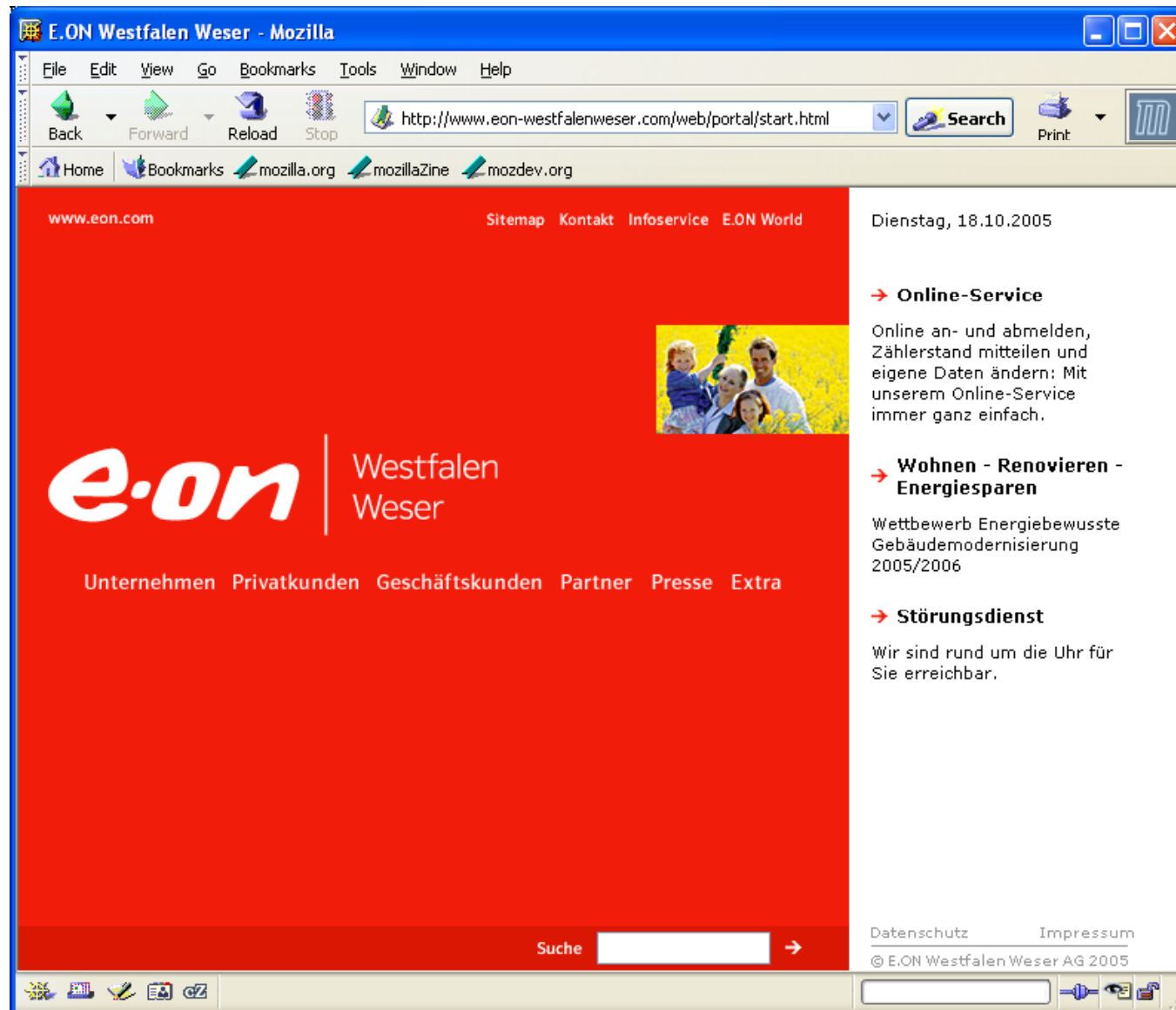
- [Hotel and Social Event Map](#)
- [Maps - Paderborn/Region](#)
- [Organizational and Local Information \(Postscript-Version\)](#)

Conference Location

[Heinz Nixdorf MuseumsForum \(HNF\)](#)



Error! Wrong Link!



Development of Web Applications: today's approach

- ad-hoc development
- based on knowledge, experiences and practices of **individual** developers
- reuse of existing applications by “copy&paste” approach
- insufficient documentation of design decisions
- isolated activity: no “design for change”
- missing methodical approach



Reasons for Quality Deficiencies

- **document-centered view**
 - development of web applications seen as editorial activity:
“ (textual) web pages, links and use of graphics”
- **misconception that web applications are simple**
 - due to availability of tools like HTML-editors and form generators
- **no use of know-how of relevant disciplines**
 - no use of software engineering know-how
 - no use of hypermedia or HCI (Human Computer Interaction) know-how





Web Crisis

- comparable to software crisis at the end of the 60'ies
- lead to origin of “software engineering” discipline
- “web engineering” is needed!



Difference to software systems?

- What are the differences of general software systems and web applications?
- Can we use the same techniques to develop web applications as we are using for developing software systems in general?

Web Engineering = Software Engineering



Difference to software systems?

- What are the **differences** of general software systems and web applications?
- Can we use the **same** techniques to develop web applications as we are using for developing software systems in general?



see I.3



adapted ones!

**Web Engineering
is specialization of
Software Engineering**



Web Engineering

Definition by Pressman (p. 469):

Web Engineering (WE) applies sound scientific, engineering, and management principles and disciplined and systematic approaches to the successful development, deployment, and maintenance of high-quality Web-based systems and applications.



Course Structure

- **Part I: Web Applications**

- Introduction to web applications

- categories, characteristics, quality
- web engineering

- Architecture

- Architectural styles (MVC, client-server, ...)

- Model-based development

- modeling approaches

- Technologies

- JavaScript, PHP, Servlets, Java Server Pages, XML, AJAX, ...



Course Structure

- **Part II: Service-oriented Architectures (SOA)**
 - SOA concepts
 - A SOA development method: Quasar Enterprise
- **Part III: Web Services**
 - Standard techniques
 - WSDL, BPEL, SOAP
 - Research approaches
 - visual contracts, model-driven monitoring

