Why Web Engineering Is Needed For Web Applications and Services

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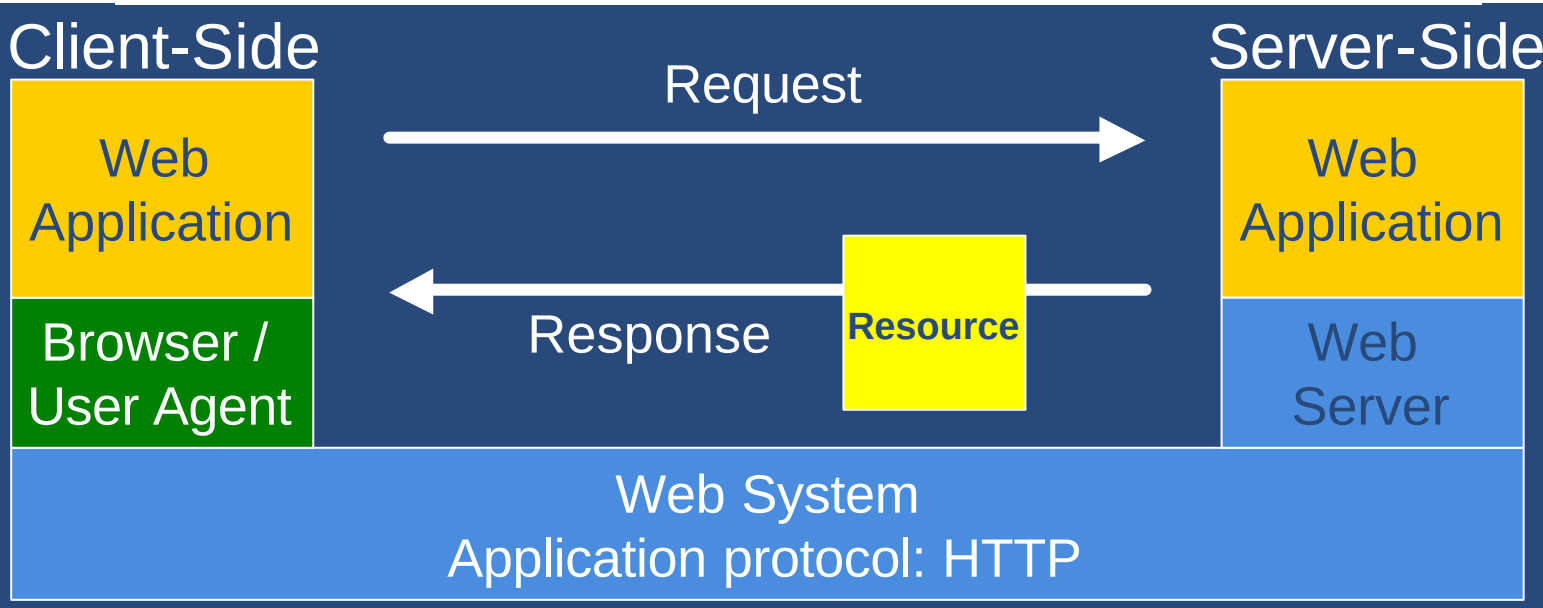
My Basic Premises

- Developing a Web-based system is no longer an event, it is a process
- Web-based systems are growing systems
- Web-based applications are adding a whole new dimension to software development

The Web Started Simple

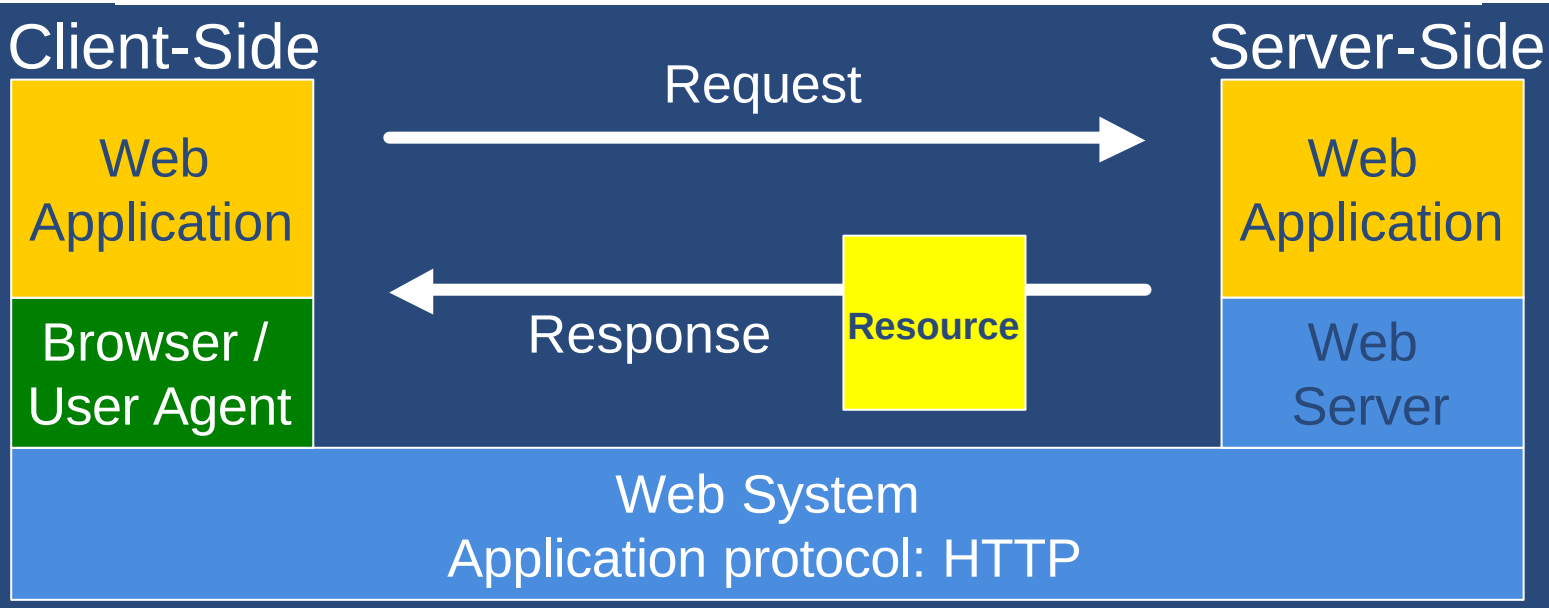
- “Even simple rules lead to complex behavior” – Wolfram, *New Science*, 2002
- “It is now technically possible and feasible to put the entire creative works of man online” – Kahle, The Internet Archives
- E-commerce (Web/Internet) accounted for 2% of US retail sales in 4Q, 2004 - $18.4 billion – US Census Bureau

1st Generation



- Browser
  - Mosaic
  - HTML
  - Images (GIF)
  - HTML-Forms
  - Helper
    - Audio, Video etc.
- Web System
  - HTTP
- Web Server
  - HTTP
  - CGI
    - Database
    - Information Systems

2nd Generation

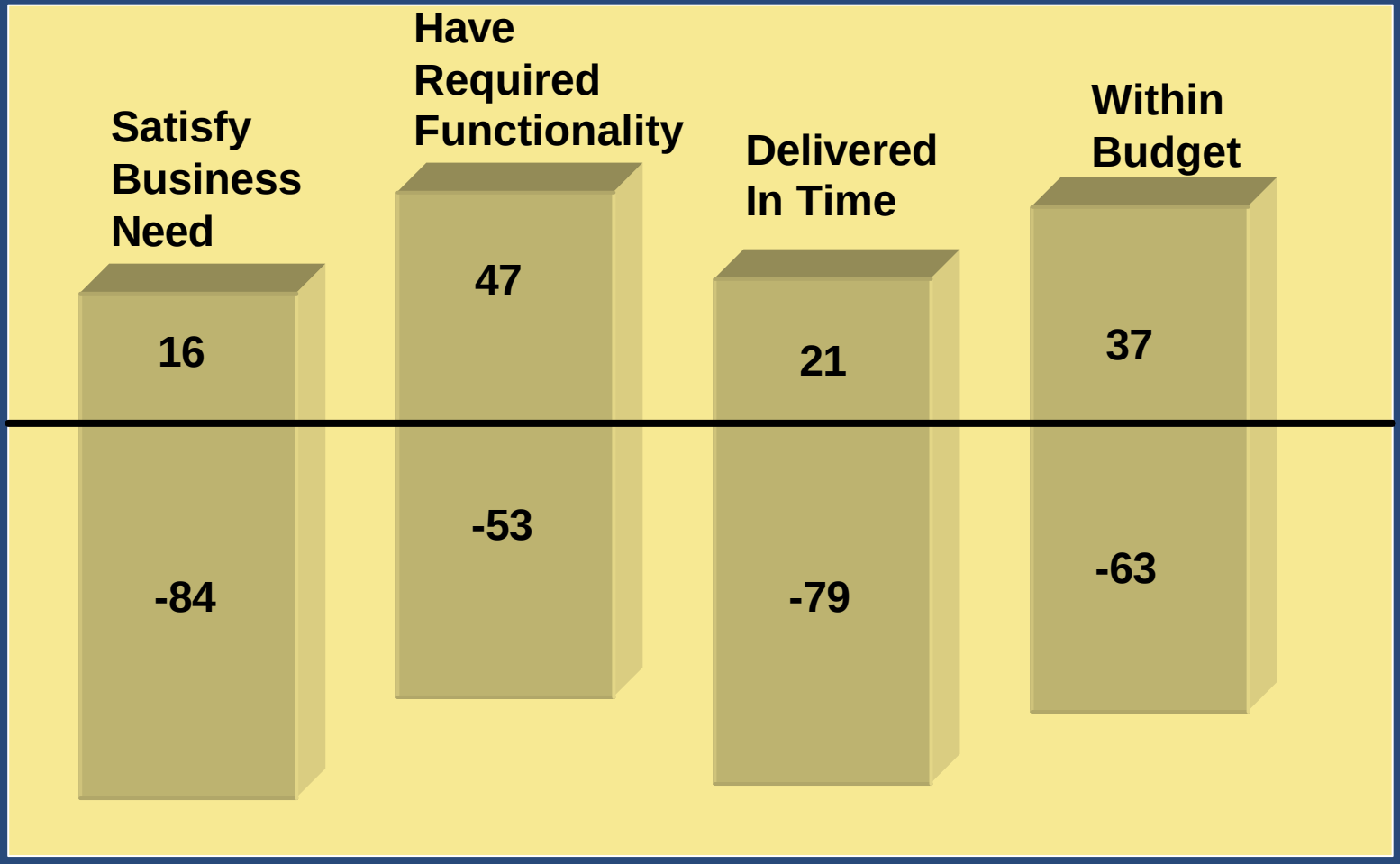


- Browser
  - Mosaic, Netscape
  - HTML, Frames
  - Images
  - HTML-Forms
  - Helper
    - Audio, Video etc.
- Web System
  - HTTP
  - Cookies
- Web Server
  - HTTP
  - Server-API & CGI
    - Database
    - Information Systems
    - Media Server

Some Definitions are in Order

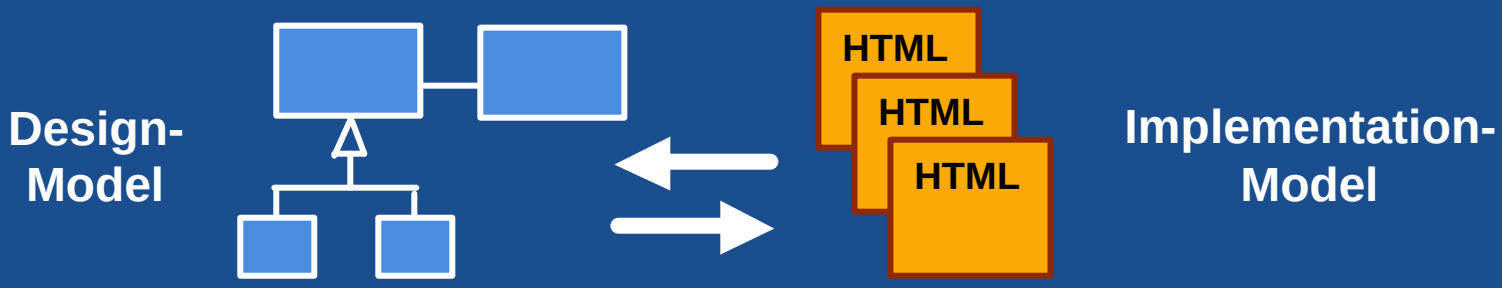
- **Web System** – an infrastructure or system enabling the operation of a Web Application
- **Web Application** – a distributed application that accomplishes a certain business need based on technologies of the World Wide Web and that consists of a set of Web-specific resources

Problems with Large Web-based Projects



(Source: Epner, M., Cutter Consortium, 7 November 2000)

Web Application Development



- Still Ad-hoc instead of a disciplined procedure
  - Copy-and-Paste Paradigm
- Lack between design-model and implementation-model
- Design-concepts get lost in the underlying model
- Many short lifecycle of a Web Application:
  Maintenance and Evolution problems → Reuse Problems

→ Web-Crisis

Web Application Development Current Practices

- Lacks rigor, systematic approach
  - The completed system is not what the user wants
  - System not developed on time, cost overruns
  - Lacks scalability and maintainability, hence a limited useful life
  - Does not meet performance requirements
  - Resources are wasted

Web Systems: Problems

- Problems
  - Inability to maintain
  - Unable to meet evolving needs and grow at the rate needed – scalability
  - Unreliable – crashes
- Web-dependent organizations cannot afford to have
  - Faulty systems – reliability, security issues
  - Frequent downtime – dependability
  - Wrong, inconsistent, or stale content/information
- Web systems problems are not easy to hide

Web Development Issues

- Many developers think that Web application development is just Web page creation using HTML, FrontPage, Dreamweaver, etc. with graphics design and/or simple hyperlinking
- They have been taught to think this way!
- Certain classes of applications do fit this simple generalization – e.g., personal Web pages, event brochures, etc.
- Many other Web applications go beyond simple content presentation/navigation

Web Development Issues (2)

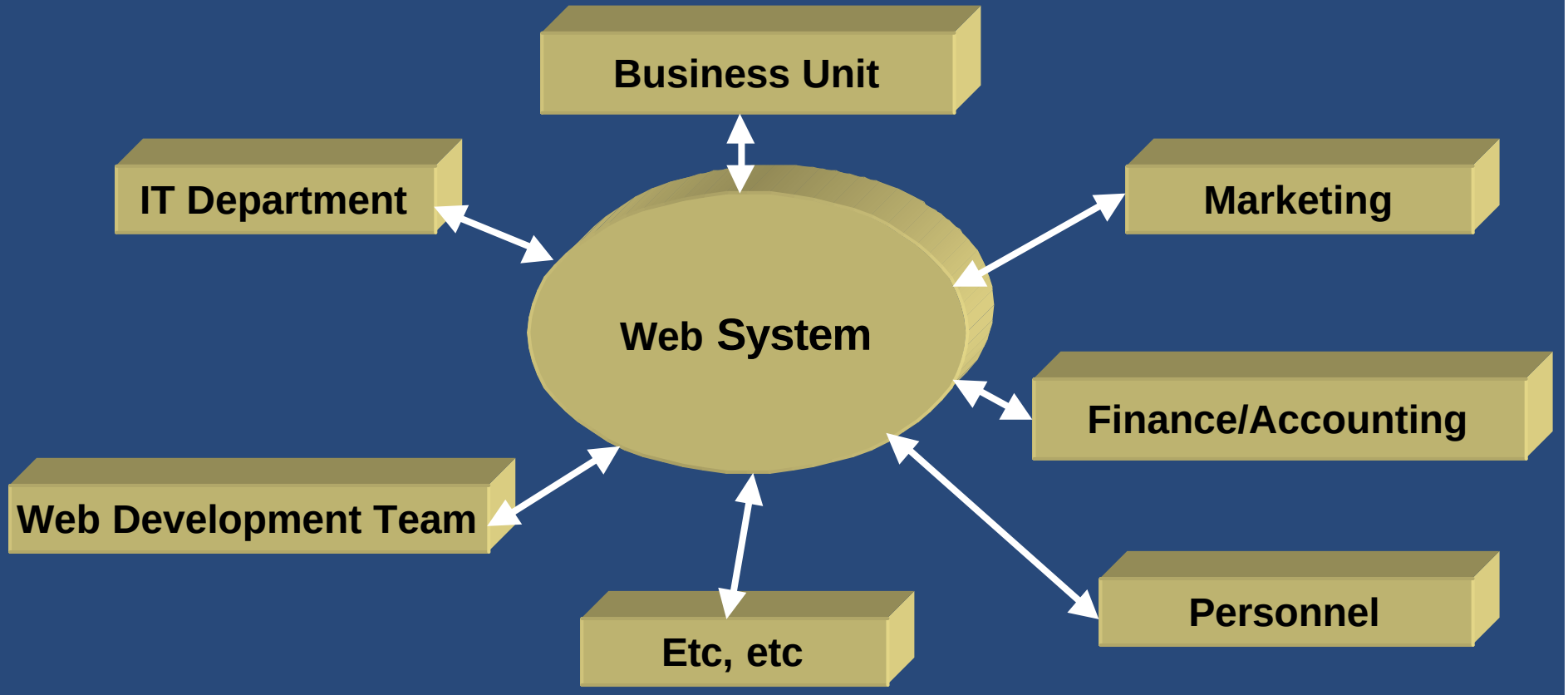
- “There is more to Web application development than visual design and user interface”
- Planning, system design, testing, continual maintenance, quality assurance, performance evaluation, scalability,…

Consideration to Quality?

- Lack of consideration to:
  - Navigation
  - Accessibility
  - Scalability
  - Reliability
  - Maintainability
  - Usability
  - Compatibility and interoperability
  - Security
  - Readability

Web Development – Political Challenge

- Anyone can be a Web content creator and maintainer!



(Adapted from Susan Dart, 2002)

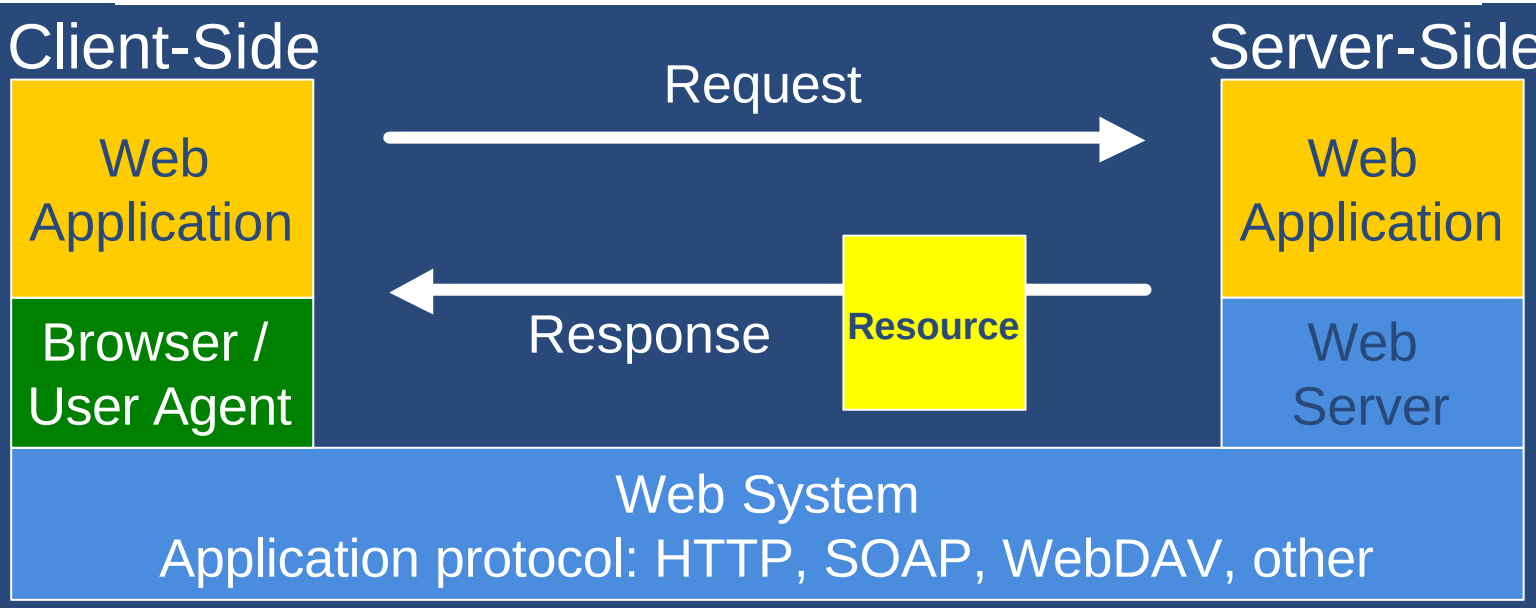
Web System Development: Summary I

- Less attention is given to development methodologies, testing and evaluation, quality assessment and control
- Largely relies on individuals' own development practices
- Lack of realization of its lifecycle
  - Analysis of needs, redesign, development (including coding), management, metrics, maintenance
  - Calls for significant system-level and design decisions
- It is an exercise – not an event
- Legitimate concern about the manner in which they are created and their long-term quality and integrity

Web System Development: Summary II

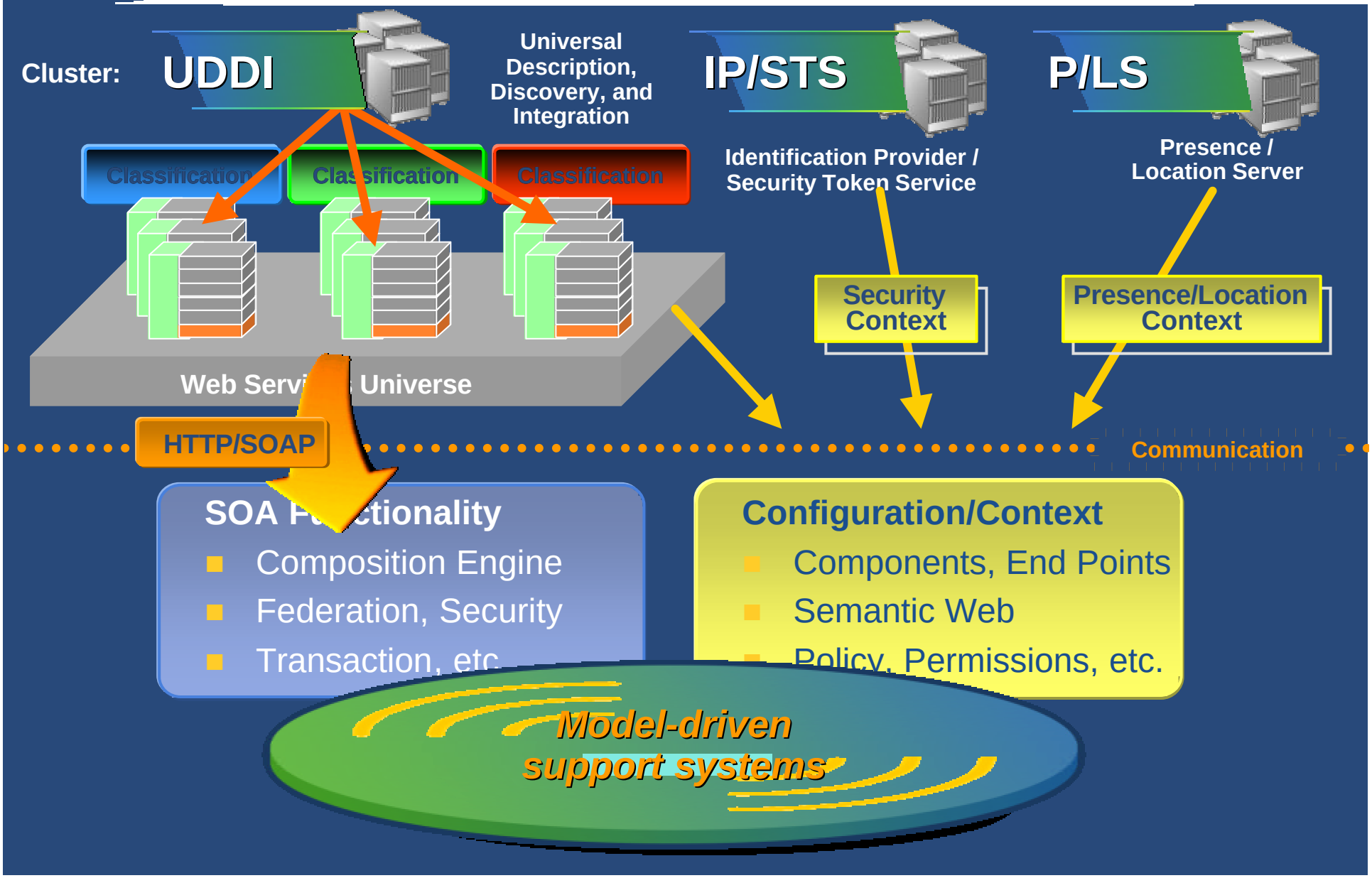
- In many cases, Web Development is:
  - Chaotic
  - Failure-prone
  - Unsatisfactory

3rd Generation (Multi-Tier)



- User Agent
  - Netscape, IE, and PDA-Browser etc.
  - Other Types of User Agent
  - Plug-Ins, Applets, ActiveX
  - Script-Code
  - DHTML, More...
- Web System
  - HTTP, WebDAV, SOAP, other
  - Cookies
  - UDDI
  - Other relevant protocols FTP, SMTP
  - More...
- Web Server
  - HTTP, more
  - Server-API & CGI
  - XML-Support
  - Component-Support
    - Servlets
    - Web-Services

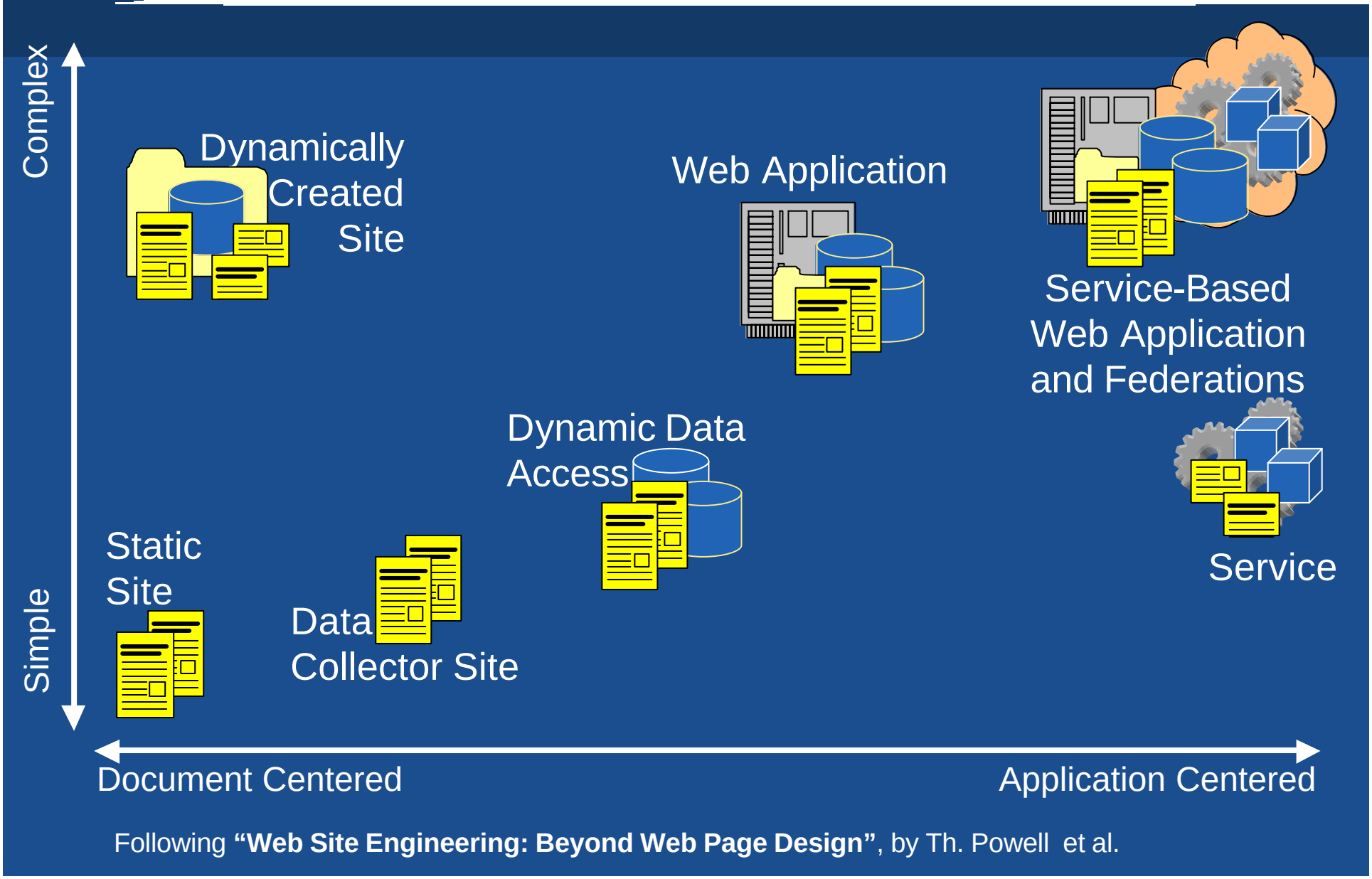
4th Generation?



Technology Drivers

- Computing power
  - Still doubling every 18 months
  - PC-based data centers
- Connectivity
  - Low cost, broad reach Internet
  - Wireless, broadband access
- Device proliferation
  - PDAs, cell phones, gas pumps
  - Towards a digital devices decade
- Internet standards
  - XML-based integration
- User Interface
  - Many (!) possibilities

Range of Complexity



Following **"Web Site Engineering: Beyond Web Page Design"**, by Th. Powell et al.

Characteristics

- Today's focus on large-scale and ubiquitously useable Web Applications
  - Many Users – many languages – many cultures
  - Different access mechanisms
  - Many User Agents
- Presents large volume of interrelated information (including different media) and processes
  - Appropriate presentation
  - Progression through activities – finish one thing before starting another
  - Often Asynchronous
- Growing and increasing complexity
  - Many product iterations/versions/refinements (calls for Reuse)
  - Many developers and operators, complex handling of temporal media (e.g. publishing of company news)
  - Customization, Personalization, Security issues

and a lot more...

- E.g. "Up-to-date" by following trends

All Aspects of Heterogeneity

Risks to Web-Based Business

- Long system delivery time
- Low responsiveness to business changes
- High project development and ongoing support costs
- Questionable system quality

Desires from Web-Based Business

- Project Delivery Time - ***Shortened***
- System Quality - ***Improved***
- Technology Investment - ***Optimized***

Need for Process

- Domination of the different requirements calls for a systematic approach
- Producing high-quality Products in a cost-effective way
- Goal – Product should be
  - Maintainable and evolvable
  - Reliable
  - Efficient
  - Appropriate for User Interface (also wrt Hypermedia)
  - Delivered in time with predictable cost

Or simply Software Engineering?

“Fundamental differences [between hypermedia and other disciplines] however, make a pure transposition of techniques both difficult and inadequate. An important part of hypertext design concerns aesthetic and cognitive aspects that software engineering environments do not support.”

(Nanard and Nanard, 1995)

Web Development vs. Software Development

- They are different due to the nature and distinct requirements of Web-based systems
- Even though Web-based systems often require programming and specialty software, the development of that software is often unique

Web-based Systems vs Software I

- Web-based systems:
  - Are document-oriented containing static or dynamic content
  - More emphasis on “look and feel”
  - Are “content-driven” – process is driven by the availability of content
  - Need to cater to users with diverse skills and capabilities
  - Are typically constrained to a short development time, making it difficult to apply the same levels of formal planning and testing as used in software development

Web-based Systems vs Software II

- Web-based systems:
  - Differ by means of their access and delivery medium
  - Have different lifespans
  - Have differing development requirements
    - Developers are vastly varied in terms of their background, skills, knowledge, and system understanding
    - Developers differ in their perception of Web systems

Web-based Systems vs. Software III

- Web-based systems:
  - Should be scaleable
  - Have varying performance requirements – must be able to cope with uncertain, random heavy demands on services
  - Must be secure
  - Are subject to various legal, social, and ethical scrutiny

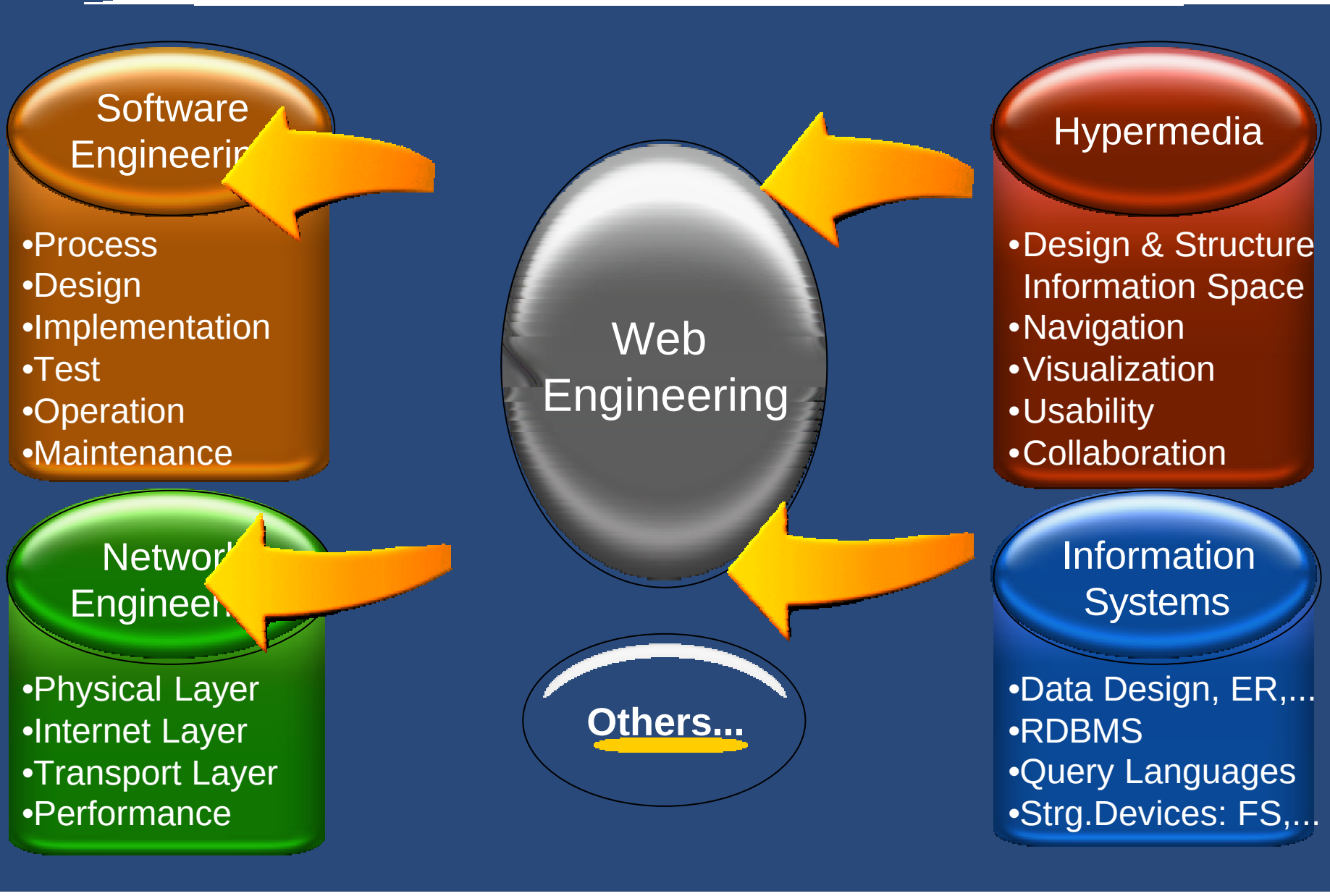
Why Engineering?

- Engineering is associated with scale-up. New issues arise when scaling by 2+ orders of magnitude
- Skills of architects and all kinds of engineers are different from those needed for designing and building simple structures and simple systems

Web Engineering

Web Engineering – is the application of systematic, disciplined, and quantifiable approaches to the design, production, deployment, operation, maintenance and evolution of Web-based software products. [Gaedke, 2000]

Key Knowledge Areas



Categories of Web-based Systems

Category	Examples
Informational	Online newspapers, manuals
Interactive	Registration forms
Transactional	Electronic shopping
Workflow-oriented	Status monitoring
Collaborative work	Distributed authoring
Online communities	Discussion groups
Web portals	Shopping malls
Web services	Enterprise applications

Essays on design, engineering and project management

#30 - Programmers, designers and the Brooklyn Bridge

By Scott Berkun, March 2004

Do engineers design? Can designers engineer? Looking back at great projects throughout history, it seems these kinds of questions never needed to be asked. There was a philosophy that surfaced in many great works that to do anything well required more than one skill set or discipline. On the contrary, unchecked specialization breeds fragile and shallow ideas. As technology has progressed, I think we've lost our connections with the great works of the past and the philosophies and attitudes that enabled their creation. The design and engineering of modern technology, software and the web has bred a hubris that anything older than a few years can't possibly be relevant, and I think it's a mistake. To argue this point, there is no better place to start as a basis of comparison and learning than the story of the Brooklyn Bridge.

http://www.uiweb.com/issues/issue30.htm

Modern web developer	Washington Roebling's team
3 week / month release cycle	14 year release cycle
Electricity	Horses
Coffee, doughnuts and air conditioning	Water and the elements (think muggy NYC summers)
Carpal tunnel syndrome	The bends
Layoffs	27 Deaths

Web Engineering I

- A holistic and pro-active approach to Web systems development
- Offers systematic approaches and disciplined processes for development
- Deals with the management of complexity and diversity of Web development
- Brings to Web-based system development
  - Control
  - Risk minimization
  - Enhanced maintainability and quality

Web Engineering II

- Other factors
  - Document orientation
  - Navigational design
  - Changing technology
  - Budget and time constraints
  - People and internal politics
  - Division between theory and practice
  - Lack of understanding…

Goals of Web Engineering

- Develop (high quality) Web Applications
  - Effective
  - Efficient
  - Achieve desired application
- **Maintain and Evolve**
  - **Plan for change** (Solution may change the problem!!!)

…using systematic, disciplined and quantifiable Approaches: Process Models

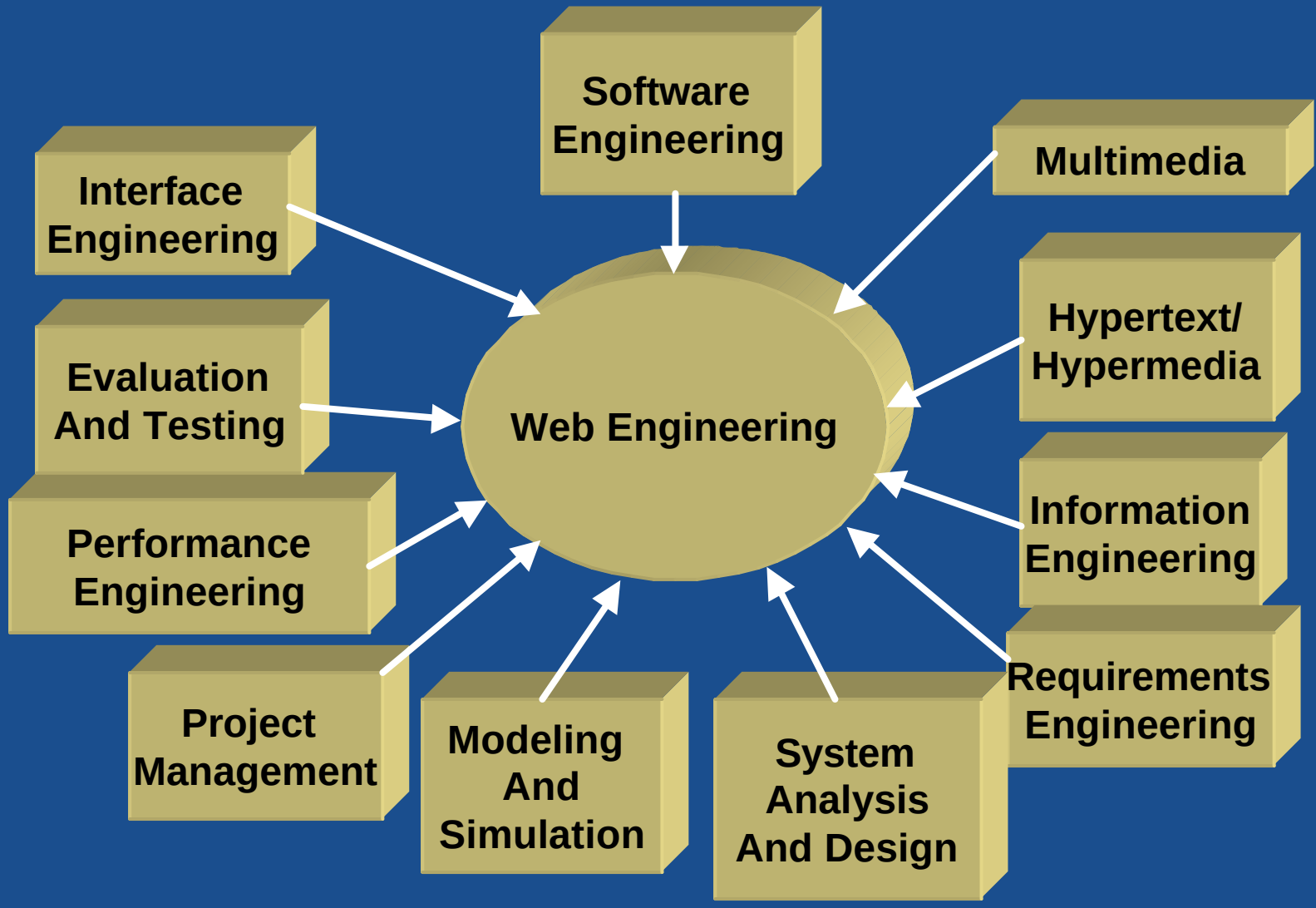
Web Engineering Activities I

- Requirements specification and analysis
- Web-based system analysis and design
- Web development methodologies and techniques
- Migration of legacy systems to Web environments
- Web-based real-time applications development
- Web-based multimedia application development
- Testing, verification and validation techniques and tools
- Quality assessment, control and assurance

Web Engineering Activities II

- Management of access to applications and privileges
- Configuration and project management
- “Web metrics” – metrics for estimation of development effort
- Performance specification and evaluation
- Update and maintenance
- Development models, teams, and staffing
- Human and cultural aspects
- User-centric development
- Graphics, animation, and streaming
- Copyright, legal and social aspects

Web Engineering is Multidisciplinary



Yesterday’s Webmaster has become tomorrow’s Web Engineer

Some Further Resources

- The Web Engineering Community Portal (http://www.webengineering.org)
- Journal of Web Engineering (http://www.rintonpress.com)
- International Conference on Web Engineering (ICWE) (http://www.icwe2005.org)

Thank You

Questions?

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