The WASP Framework: Bridging the Gap Between the Web of Systems, the Web of Services, and the Web of Semantics with Agent Technology

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ABSTRACT
Currently, we face a major gap between the reality of the Web — a disjoined and tangled mass of loosely coupled information resources — and the vision for the Web — a tightly integrated and openly structured information network with machine-readable data that allows autonomous agencies to create new applications empowered by this wealth of information. Current research shows that we can hope to achieve this goal, but there are many obstacles left to be mastered. We propose a framework to allow researchers and developers to choose the level of detail, the type of technologies, and the extent of computing power they want to utilize for their proposed solutions. We focus on a flexible abstraction layer, pattern-oriented architecture, and open interfaces to build on the successful foundations of the Web: ease of use, flexibility, and almost unlimited expression power. Agents are the central paradigm for software development using this architecture.

Keywords: agents; personalization; Semantic Web framework; Web services

INTRODUCTION: THE WEB — NOW AND THEN TO MOBILE AGENTS

The Semantic Web (Berners-Lee, Hendler, & Lassila, 2001; Berners-Lee; 2000) is a valuable vision pushed by the World Wide Web Consortium (W3C), and supported by vast research efforts to build the future foundation for a true information society.

Nonetheless, progress is slow, and even if research would yield results at a much greater speed (which does not seem reasonable since the open questions are truly awe-inspiring), the results still need to be implemented. Current research hints at much more expressive and, thus, a more powerful means to represent data and information (but the price is added complexity required to build the representations).

The World Wide Web was successful because, basically overnight, people were enabled to share information with
simple technology. This allowed for the enormous growth in information resources we now face, and this pattern most likely should be reproduced to guarantee the further growth of the Web (Berners-Lee, 2000).

The Web of Systems

Currently, the World Wide Web is the largest information system ever built by humans — probably also one of the least structured information systems built. There are billions of Web pages (not counting other resources like images, videos, sounds, CGI interfaces to large databases, etc.), and almost none of them are structured in a standardized way. These pages are built mostly with HTML and only loosely coupled — links lead into oblivion as often as they do not. Even existing links do not provide much semantic information (i.e., what is the meaning of a specific link except that someone thought two information resources should be connected in some way). Most information is presented in a way that allows humans to use it, although access to this information usually is a problem because it becomes harder and harder to find the few tidbits of information in the existing mess of data.

Thus, we argue that we need to find ways to evolve from the current World Wide Web (a Web of systems so named because there are many individual systems that usually are connected only by the simplest means, namely hyperlinks) to something more.

It would be foolish and dangerous to try too much at once. At the same time, it would be as foolish and dangerous to create artificial boundaries and introduce building blocks that limit our power of expressiveness. Thus, we propose to search for architectures and frameworks that support slow evolution without limiting the final goal. We find practical examples that support the viability of this approach: modular programming has spawned object-oriented programming to control complexity with more natural concepts. For certain problem areas, agent-oriented systems have been discovered to be an immensely powerful and very natural concept for defining solutions (Ciancarini & Woolridge, 2001). Now, the industry momentum offers a huge chance to solve one of the basic problems of agent societies: communication by Web services promises to do away with the artificial system boundaries currently inhibiting large-scale distributed autonomous agent systems.

The Web of Services

Web services (Christensen, Curbera, Meredith, & Weerawarana, 2001; Gottschalk, Graham, Kreger, & Snell, 2002), while surrounded by a lot of hype, for the first time in many years offers a standard means to communicate between disparate systems and applications with absolute disregard for programming languages, computer hardware, and system-specific communication protocols. Based on XML (extensible markup language; see Bray, Paoli, Maler, Sperberg-McQueen, & Paoli, 2000), this new and exciting standard promises a new way of defining interfaces without sticking to implementation details and basic technical questions. Together with HTTP (Hypertext Transfer Protocol; see Gourley & Totty, 2002) and SOAP (Simple Object Access Protocol; see Mitra, 2001) as protocols, we face an enormous opportunity to bring together previously separated building blocks for the next generation Internet. XML is the unifying data representation standard that
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