NISTIR 5500

Report on the Advanced Software Technology Workshop February 1, 1994

Editors:
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U.S. DEPARTMENT OF COMMERCE
Ronald H. Brown, Secretary

TECHNOLOGY ADMINISTRATION
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NATIONAL INSTITUTE OF STANDARDS
AND TECHNOLOGY
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ABSTRACT

On February 1, 1994, James H. Burrows, Director of the Computer Systems Laboratory of the National Institute of Standards and Technology (NIST), convened an invitational workshop attended by eleven executives for whom software is critical to business. The purpose of the workshop was to identify advanced software technology requirements for U.S. business and to identify opportunites that NIST might pursue in the area of advanced software technology. This report summarizes the deliberations of the workshop.

KEYWORDS

advanced software technology; distributed engineering; interoperability; reliability; reuse; security; standards

EXECUTIVE SUMMARY

On February 1, 1994, James H. Burrows, Director of the Computer Systems Laboratory of the National Institute of Standards and Technology (NIST), convened an invitational workshop attended by eleven executives for whom software is critical to business. The purpose of the workshop was to identify advanced software technology requirements for U.S. business and to identify opportunites that NIST might pursue in the area of advanced software technology. This report summarizes the deliberations of the workshop.

Three key business objectives were cited that advanced software technologies must support: 1) sustain and revitalize the U.S. manufacturing base; 2) ensure continued leadership and success of the U.S. software industry; and, 3) provide U.S. business with information access and dissemination on a world-wide basis.

The software industry consists of five distinct market segments which supply U. S. manufacturing and business with software systems, and themselves comprise a major industry. Each of these segments has different characteristics, problems, and strengths:

- Software Package segment such as word processors and spreadsheets.
- Embedded consumer segment such as in automobiles, telephones, and refrigerators.
- Large-scale government contractor (systems integrator) segment such as in the F-22 aircraft and the FAA's Advanced Automation System.
- Large-scale commercial segment such as in factory automation and factory process control systems.
- Service industries such as America On-Line® and CompuServe®.

Software, viewed as a base technology, is vital in all sectors of U.S. industry and critical to ensuring a global competitive advantage. The engineering of basic software components to meet current and future business requirements was viewed as the largest challenge facing this country if we are to maintain industrial and software leadership. The following advances in software technology are critical to meeting future business and government software needs. These include: 1) software components that can be used and reused and combined to build other software components; 2) software that adapts to work with other software, the user, and other systems; and, 3) interfaces and standards that enable software to work with other software.

The workhop addressed critical software problems and requirements facing U.S. industry and identified major future applications, key technologies needed by these applications, and barriers to progress. The issues were addressed in the context of the National Information Infrastructure (NII) as an emerging national resource that will be a major driver in the advancement of software technologies.

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1.0 INTRODUCTION

On February 1, 1994, James H. Burrows, Director of the Computer Systems Laboratory of the National Institute of Standards and Technology (NIST), convened an invitational workshop attended by eleven executives for whom software is critical to business. The purpose of the workshop was to identify advanced software technology requirements for U.S. business and to identify opportunites that NIST might pursue in the area of advanced software technology. This report summarizes the deliberations of the workshop.

In the morning, the workshop attendees provided statements of their individual perspectives on current and future software applications, on various problems and inhibitors impeding progress, and on the technology needed to support these applications. In the afternoon the group synthesized these thoughts and consolidated lists of applications and key technologies by major user categories, using the emerging National Information Infrastructure as a vehicle that will encompass users, applications and advanced software technology into the next century. This report presents a summary of the workshop and findings.

2.0 NEEDS AND PROBLEMS

The software industry consists of five distinct market segments which supply U. S. manufacturing and business with software systems, and themselves comprise a major industry. Each of these segments has different characteristics, problems, and strengths:

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- Service industries such as America On-Line and CompuServe..

The first segment, the software package segment, is what most of the country thinks of when they think of software. This is natural because that is the software most visible to them. This is also the healthiest segment of the software industry, in which the U.S. currently has unquestioned leadership.

In the other segments, which are less visible to the public, and perhaps to many government policy makers, the U.S. is strong, but not dominant. The Japanese have tended to dominate the consumer electronics market, which is highly dependent on software. Europe and Japan make

very high-quality telecommunications systems, aircraft, factory automation systems, and other high-value products in the large-scale government contractor and commercial segments. There is considerable risk to U.S. competitiveness in these important areas of the economy if improvements in software producibility are not made.

The workshop attendees were asked to present their individual perspectives on the following questions:

- What are the greatest software technology needs?
- What are the most serious barriers to progress in developing these technologies?
- What could NIST and government do to address these needs and problems?

Attendees of the workshop presented position statements and identified specific needs and problems for future applications within their business area and for their industry as a whole. Table 1 summarizes the requirements for achieving advanced software technologies.

TABLE 1. NEEDS FOR ADVANCED SOFTWARE TECHNOLOGIES

- Transparent frameworks, automation, reuse
- Distributed engineering of software
- "open to the future"
- Structuring a flexible software model
- Reduced cycle time / lowered costs (in application domain)
- Universal access
- Seamless integration of applications/ interoperability at all levels
- Intelligent information agents
- High reliability: quality requirements are going to be an order of magnitude greater than they are today because of the interaction of the components we are assembling
- Customizable software that adapts to user, rather than custom software
- Component (object) technology
- Security services
- Indexed meta data

The workshop attendees identified four major categories of users and future applications needed by each group.

TABLE 2. FUTURE SOFTWARE APPLICATIONS

EDUCATION

- Instantaneous language translation
- On-line services (e.g remote classes)
- College search by high schoolers
- Coordination of services (e.g., school security, fire protection)
- On the job training
- Surrogate travel
- Services for disadvantaged students

BUSINESS AND INDUSTRY

- Cheap, competitive intelligence
- Virtual corporations, rapid alliances
- Concurrent engineering
- Distributed enterprise process simulation
- Adaptive advertising
- Reusable technology
- Smart buildings, office
- Electronic Commerce

GOVERNMENT

- Large scale transaction processing (e.g. census-taking)
- Security-related applications (on-line elections, electronic town hall, legal & financial matters)
- Telecommuting, telemedicine, ...
- Crime prevention
- Economic, security surveillance
- Data superhighway patrol
- Delivery of benefits
- Audit trails for transactions

CONSUMER

- Generic email/ conferencing
- Consumer electronic commerce
- On demand: banking, entertainment
- Telemedicine, telelegal,...
- Electronic media creation
- Distributed simulation
- Smart autos (Intelligent Vehicle)
- Smart buildings, houses

The consensus of the workshop attendees was that computer software and advanced software technology are critical to the ability of the United States to sustain and revitalize the U.S. manufacturing base; to maintain world-wide competitiveness of U.S. business; to ensure the smooth and effective operation of both government and industry; and to ensure continued success of the U. S. software industry, a business entity in its own right. A requirement common to all groups was the ability to access and disseminate information on a world-wide basis.

The workshop attendees also addressed the perceived barriers to developing and effectively using future software applications. Many of these will be large and complex and will impose strong demands for advanced software technology. Table 3 lists barriers identified by the workshop attendees.

TABLE 3. BARRIERS TO ADVANCED SOFTWARE TECHNOLOGY
TECHNICAL BARRIERS
• Lack of technology for composable software components • Difficulty of building intuitive, easy to use software • Difficulty of building reliable, dependable software • Lack of seamless integration between software packages (e.g. to combine imaging, statistical, and word processing packages) • Often the situation is "no standards" or "late standards" • Requirements specifications • Inadequate methods for rigorous specifications • Inadequate methods for interactive requirements definition and simulation
ECONOMIC AND SOCIAL BARRIERS
• Software productivity is low • Too few universities have degree programs in software engineering • Computer science education inadequately addresses software engineering • Intellectual property rights not always clear for information and reusable software • High cost for industry to change work procedures • Time to market dominates quality concerns • Problem deciding who should pay for the technology • Geographic and economic universal access • Uncertainty of benefits of applications (e.g. in teaching) • Lack of confidence in software's ability to perform as desired • Potential loss of jobs (e.g. bookbinding) • Lack of comfort with high technology by workers

The workshop participants agreed that resolution of many of these problems is dependent on development and application of effective software engineering practices. The workshop participants stressed the importance of engineering software components as a prerequisite for "reuse" of software artifacts in building dependable applications, and for shortening the time to market without sacrificing quality and cost. The workshop participants stressed the need to develop open, distributed software engineering frameworks and environments for the production of high quality and reusable software components.

3.0 KEY TECHNOLOGIES

Software technologies considered important enablers for future applications and needs were discussed within the context of the NII as an emerging national resource. The workshop attendees believed that the success and full potential of the NII would be determined by the ability of advanced software technology to meet the demands of future applications. The workshop attendees identified technical software capabilities and key technologies needed for ensuring success of future applications, user needs, and the NII. These are shown in the Table 4.

TABLE 4. KEY TECHNOLOGIES
Intelligent agents (bi-directional)
Adaptable standards
Interface standards for reusable components
Software system re-engineering (reengineering vs extracting reusable system components)
Integrated SEE's in open, distributed environments
Simulation environment testbed (distributed)
Groupware
Virtual reality
Real-time distributed management
Mega-database management / administration/ distribution
Data compression
Imaging
Multi-media input/recognition (speech, written, etc)
Distributed, high speed data storage / collection / retrieval
Digital signatures
Information security
Reusable software components
Reusable software technology framework, discipline, tools, ...
Process modelling and enactment technology

4.0 CONCLUSIONS

The workshop attendees identified the following tasks that NIST/CSL might consider:

- Lead in establishing the NII software engineering technology infrastructure.
- Ensure open and adaptable standards to accommodate new technology.
- Assess technological change and the potential impact on existing and emerging standards.
- Develop new application development and usage models for developers and end users based on reusable components and open, distributed environments.
- Improve technology for software maintenance and re-engineering.
- Support promising advanced technology ventures where risk inhibits industry acting alone.
- Assume research responsibility for major issues (e.g., intelligent agent, reusable software).
- Fund non-profit ventures for the public good (e.g. digital libraries).

Standards are a critical requirement for NII and all other advanced applications, but they also serve as a potential barrier to these applications. The sophisticated applications of the future will require comprehensive and adaptable interface standards to work successfully and reliably with other applications. The workshop attendees suggested a need for standards that "protect the future" by being both rigorous enough for interoperability and flexible enough to allow for improvements in technology.

APPENDIX A. NIST Advanced Software Technology Workshop Attendees

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