Reflection on 20 Years of Architecture

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA  15213

Linda Northrop
May 9 2012
### Report Documentation Page

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

<table>
<thead>
<tr>
<th>1. REPORT DATE</th>
<th>2. REPORT TYPE</th>
<th>3. DATES COVERED</th>
</tr>
</thead>
<tbody>
<tr>
<td>09 MAY 2012</td>
<td></td>
<td>00-00-2012 to 00-00-2012</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. TITLE AND SUBTITLE</th>
<th>5a. CONTRACT NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflection on 20 Years of Architecture</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5b. GRANT NUMBER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>5c. PROGRAM ELEMENT NUMBER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>6. AUTHOR(S)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA, 15213</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8. PERFORMING ORGANIZATION REPORT NUMBER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>10. SPONSOR/MONITOR’S ACRONYM(S)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>11. SPONSOR/MONITOR’S REPORT NUMBER(S)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>12. DISTRIBUTION/AVAILABILITY STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved for public release; distribution unlimited</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>13. SUPPLEMENTARY NOTES</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>14. ABSTRACT</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>15. SUBJECT TERMS</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>16. SECURITY CLASSIFICATION OF:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. REPORT unclassified</td>
</tr>
<tr>
<td>b. ABSTRACT unclassified</td>
</tr>
<tr>
<td>c. THIS PAGE unclassified</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>17. LIMITATION OF ABSTRACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same as Report (SAR)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>18. NUMBER OF PAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>19a. NAME OF RESPONSIBLE PERSON</th>
</tr>
</thead>
</table>

Standard Form 298 (Rev. 8-98)
Prepared by ANSI X39-18
In 1992

flight simulator

SOFTWARE ARCHITECTURE

ADLs

QUALITY ATTRIBUTES

modifiability

performance

reliability

security
From Architecture Evaluation….

What if the quality requirements are not well-understood?
Quality Attribute Workshop (QAW)

What if there’s no architecture?
Attribute Driven Design (ADD)

What if I don’t know my system’s architecture?
Architecture Reconstruction using ARMIN

What information should be included in my architecture documentation?
Views and Beyond Approach (VaB)

Our scenarios tend to be incomplete or ambiguous.
Quality Attribute General Scenarios

What are some of the most important questions to ask?
Quality Attribute Tactics

Is there formal modeling support?
AADL, OSATE, Virtual Upgrade Method

How do I know if an organization has the ability to architect?
Architecture Competence Instrument

What about system and SoS architectures?
Mission Thread Workshop, System ATAM and SoS Arch Eval

Which risks should I work on first?
Cost Benefit Analysis Method (CBAM)
Architecture-Centric Engineering (ACE) is the discipline of using architecture as the focal point for performing ongoing analyses to gain increasing levels of confidence that systems will support their business and mission goals.

The SEI developed principles, methods, foundations, techniques, tools, and materials in support of creating, fostering, and stimulating widespread transition of the ACE discipline.

Architecture is of enduring importance because it is the right abstraction for performing ongoing analyses throughout a system’s lifetime.
Our View: ACE Requires One Must

- explicitly focus on quality attributes
- directly link to business and mission goals
- explicitly involve system stakeholders
- be grounded in state-of-the-art quality attribute models and reasoning frameworks
Trends in Institutionalizing Architecture Practices

- Architecture Initiative
- Architecture Books
- Training (SLEP, SEI Courses)
- ATAM, QAW Pilots
- Courses, Certificate Programs, Certifications
- SATURN Conference
- MTW, System and Software ATAM SoS Architecture Evaluation
- Army Impact Study
- Chief Systems Engineer Mandate
- Software Architect Mandate
- Raytheon
- Bosch
- Siemens
- Lockheed Martin
- Boeing

1998 - 2010

Commercial Organizations
Defense Contractors
U.S. Army
SEI
Epiphany in 2006

- Decentralization
- Inherently conflicting, unknowable, and diverse requirements
- Continuous evolution and deployment
- Heterogeneous, inconsistent, and changing elements
- Erosion of the people/system boundary
- Normal failures
- New paradigms for acquisition and policy
Today’s Challenges

• Scale and complexity

• Increased operational tempo

• Decentralization and distribution

• Disruptive technologies
Architecture Challenges

• What is the architecture of a socio-technical, cyber-physical system?
• What are the quality attributes that apply? And what are the underlying models?
• How can stakeholders be involved?
• ......
Contact Information

Linda Northrop
SEI Fellow
Director
RTSS Program
Telephone: +1 412-268-7638
Email: lmn@sei.cmu.edu

Web
www.sei.cmu.edu
www.sei.cmu.edu/about/organization/rtss/

U.S. Mail
Software Engineering Institute
Customer Relations
4500 Fifth Avenue
Pittsburgh, PA 15213-2612
USA

Customer Relations
Email: info@sei.cmu.edu
Telephone: +1 412-268-5800
SEI Phone: +1 412-268-5800
SEI Fax: +1 412-268-6257