

## Preparing the Ground for Next Generation Software Engineering

Don O'Neill

Email: ONeillDon@aol.com

### State of the Industry

The May 2005 Report of the 2nd National Software Summit (NSS2) entitled "Software 2015: A National Software Strategy to Ensure U.S. Security and Competitiveness" [1] lays out a ten-year concept plan with the vision: "Achieving the ability to routinely develop trustworthy software products and systems, while ensuring the continued competitiveness of the U.S. software industry." The plan includes 11 significant initiatives within four major program areas:

1. Improving Software Trustworthiness
2. Educating and Fielding the Software Workforce
3. Re-Energizing Software Research and Development
4. Encouraging Innovation Within the U.S. Software Industry

### New Issues and Challenges

New issues are now emerging surrounding the production, fielding, and operation of net-centric systems of systems that are [2], [3]:

1. Essential to the competitiveness and security of the nation's critical infrastructure,
2. Essential to the defense and security of the Global Information Grid, and
3. Essential to the offense and security of Cyber Power strategies.

### Unclaimed Benefits and Unmet Needs

However, there remain unclaimed benefits and unmet needs stemming from earlier neglect [4]. The immediate goal of practical Next Generation Software Engineering is to drive systems and software engineering to do *more with less... fast*. Four practical objectives are identified to advance the goal using smart and trusted technologies:

1. Drive user domain awareness
2. Simplify and produce systems and software using a shortened development life cycle
3. Compose and field trustworthy applications and systems from parts
4. Compose and operate resilient systems of systems from systems

More specifically:

1. *Driving user domain awareness* calls for integrating systems, software, and user needs and synthesizing mission needs in terms of systems, software and user; improving user domain awareness maturity and conducting user domain awareness assessments; and exploiting NGSE technology through interactive virtual user experience and simulation.
2. *Simplifying and producing systems and software using a shortened development life cycle* calls for eliminating bottlenecks through automation of labor-intensive activities; accelerating delivery through Wiki-based requirements, incremental development, and Agile approaches; exploiting NGSE technology through formality in requirements expression and smart compilers; and measuring speed and trustworthiness [5].
3. *Composing and fielding trustworthy applications and systems from parts* calls for managing rapid release through aspect-based commitment management, fact-based

aspect and attribute assurance, and real-time risk management; focusing on supplier assurance through process maturity, global supply chain management, and configuration management; exploiting NGSE technology through attribute-based architecture, smart middleware, interoperability, intrusion detection, intrusion protection, and intrusion tolerance; and measuring frequency of release and trustworthiness [5].

4. *Composing and operating resilient systems of systems from systems* calls for exercising control before, during, and after adversity; focusing on situation awareness through intelligent middlemen and information sharing; exploiting NGSE technology through coordinated recovery time objectives, distributed supervisory control, and operation sensing and monitoring; and measuring control and resilience [6], [7].

In managing the investment needed to meet these objectives, capability portfolio investments are organized by management, process, and engineering. For best results, the implementation transition through table 1 is to begin in the Northwest corner and move towards the Southeast. In this way user domain awareness, shortened life cycle, systems from parts, and systems of system from systems provide a natural spiral of incremental activities where current work in progress builds on preceding work accomplished.

Table 1. Practical Next Generation Software Engineering

<b>Practical Next Generation Software Engineering Goal</b> <i>Drive systems and software engineering to do more with less... fast</i>	<b>Management</b>	<b>Process</b>	<b>Engineering</b>
<b>Objective 1</b> <i>Drive user domain awareness towards more harmonious cooperation among people and machines</i>  Strategic Measures 1. <i>User satisfaction</i> 2. <i>Trustworthiness</i>	Integrate needs of systems, software, and user • Synthesize mission needs in terms of systems, software, and user • Apply team innovation management	User domain awareness maturity • Assessment of user domain awareness	NGSE technology • Simulation • Virtual user experience
<b>Objective 2</b> <i>Simplify and produce systems and software using a shortened development life cycle</i>  Strategic Measures 1. <i>Speed</i> 2. <i>Trustworthiness</i>	<b>Eliminate bottlenecks</b> • Automation of labor-intensive activities	<b>Accelerate delivery</b> • Wiki-based requirements • Incremental development • Agile approaches	<b>NGSE technology</b> • Formality in requirements expression • Smart compilers
<b>Objective 3</b> <i>Compose and field trustworthy applications</i>	<b>Rapid release</b> • Aspect-based	<b>Supplier Assurance</b>	<b>NGSE technology</b> • Attribute-based

<p><i>and systems from parts</i></p> <p><b>Strategic Measures</b></p> <ol style="list-style-type: none"> <li>1. <i>Frequency of release</i></li> <li>2. <i>Trustworthiness</i></li> </ol>	<p>commitment management</p> <ul style="list-style-type: none"> <li>• Fact-based aspect and attribute assurance</li> <li>• Real-time risk management</li> </ul>	<ul style="list-style-type: none"> <li>• Process maturity</li> <li>• Global supply chain management</li> <li>• Configuration management</li> </ul>	<p>architecture</p> <ul style="list-style-type: none"> <li>• Smart middleware</li> <li>• Interoperability</li> <li>• Intrusion detection, protection, and tolerance</li> </ul>
<p><b>Objective 4</b></p> <p><i>Compose and operate resilient systems of systems from systems</i></p> <p><b>Strategic Measures</b></p> <ol style="list-style-type: none"> <li>1. <i>Control</i></li> <li>2. <i>Resilience</i></li> </ol>	<p><b>Control</b></p> <ul style="list-style-type: none"> <li>• Exercise control</li> </ul>	<p><b>Awareness</b></p> <ul style="list-style-type: none"> <li>• Intelligent middlemen</li> <li>• Information sharing</li> <li>• Situation awareness</li> </ul>	<p><b>NGSE technology</b></p> <ul style="list-style-type: none"> <li>• Coordinated recovery time objectives</li> <li>• Distributed supervisory control</li> <li>• Operation sensing and monitoring</li> </ul>

In progressing through the dimensions of management, process, and engineering each industry sector, application, system, and system of systems brings with it its own context and culture. The manner by which a community of interest addresses these practical Next Generation Software Engineering objectives is influenced by the domain engineering paradigms, management and engineering processes, fielding and operating practices, government regulations, and public expectation to which it responds.

### Conclusion

Driving user domain awareness towards more harmonious cooperation among people and machines in systems acquisition is an imperative. Without this awareness throughout the life cycle and across the functional domains of acquisition management, program management, systems engineering and software engineering, the gap between user expectation and user satisfaction will continue to grow and mission execution will suffer. With this awareness user engineering, software engineering, and systems engineering will be better aligned; the synergy between user considerations and software will be better expressed in Next Generation Software Engineering approaches; and the intersectional innovation resulting from cross discipline clash will impact systems acquisition and the missions it supports.

### References

- [1] "Software 2015: A National Software Strategy to Ensure U.S. Security and Competitiveness", Center for National Software Studies, May 2005 <http://www.cnsoftware.org/nss2report/>
- [2] "Information Assurance", Defense Science Board Task Force, CrossTalk, The Journal of Defense Software Engineering July 2008
- [3] "Mission Impact of Foreign Influence on DOD Software", Defense Science Board Task Force, CrossTalk, The Journal of Defense Software Engineering May 2008
- [4] "Software Quality", Defense Science Board Task Force, CrossTalk, The Journal of Defense Software Engineering June 2008

- [5] Rhodes, Tom, "Trustworthy Information Systems- A New NIST Research Program", IEEE Computer Society Presentation, NIST Gaithersburg, MD, June 24,2008
- [6] O'Neill, Don, "Public Policy Strategy for Deploying Resiliency in the Critical Infrastructure", Build Security In web site, Operated by Software Engineering Institute and Sponsored by Department of Homeland Security, July 2008  
<https://buildsecurityin.us-cert.gov/daisy/bsi/articles/knowledge/business/1009-BSI.html>
- [7] O'Neill, Don, "Maturity Framework for Assuring Resiliency Under Stress", Build Security In web site, Operated by Software Engineering Institute and Sponsored by Department of Homeland Security, July 2008  
<https://buildsecurityin.us-cert.gov/daisy/bsi/articles/knowledge/business/1016-BSI.html>
- [8] "Future Directions in Software Engineering", Software Tech, Vol. 10 No. 3, October 2007  
<http://iac.dtic.mil/dacs>