Establishing Standards as the Basis for Effective Measurement and Affordability

Marc Jones  Federal Director, CISQ  (vol.)
marc.jones@it-cisq.org  / 703.863.9908
Legislative attempts to mitigate IT Application quality related risks still fall short

Current emphasis on software level cybersecurity targets only one part of the ‘quality’ issue – potentially at the expense of other risks that can yield similar outcomes

Pragmatic standards developed with Industry & Federal (Civil & DOD) collaboration are now available to be used by Acquisition, Program Management and IVV.

Standard automated functional **sizing** measurement exists that can now be used to correlate with existing models and risk management to validate affordability(dev & sustain) work and sprint/release throughput.
CISQ  Confidential


CISQ Existing Legislation Points to Standards...

- **Clinger Cohen Act recognizes that government must leverage commercial IT**
  
  1. Streamline the IT Acquisition Process
  2. Change business processes (BPR), not COTS
  3. Favor COTS/OSS over custom development (GOTS).
  4. Build business case and select based on lifecycle cost and business value
  5. **Adopt Commercial IT Standards of Practices (augmented by OMB A119)**

- **OMB 25 Point Plan Requires: “Align the Acquisition Process with the Technology Cycle”**

  Point 13. Design and develop a cadre of specialized IT acquisition professionals.
  
  Point 14. **Identify IT acquisition best practices and adopt government-wide.**
  
  Point 15. Issue contracting guidance and templates to support modular development
  
  Point 16. **Reduce barriers to entry for small innovative technology companies**

- **Federal IT Acquisition Reform Act (FITARA):**

  1. Agency Chief Information Officer (CIO) Authority Enhancements
  2. **Enhanced Transparency and Improved Risk Management in IT Investments**
  3. **Establish Portfolio Review**
  4. Federal Data Center Consolidation Initiative
  5. Expansion of Training and Use of IT Cadres
  6. Maximizing the Benefit of the Federal Strategic Sourcing Initiative
  7. Government wide Software Purchasing Program

- **EO13636 Recommends six acquisition reforms:**

  i. **Institute Baseline Cybersecurity Requirements as a Condition of Contract Award for Appropriate Acquisitions**
  
  ii. **Address Cybersecurity in Relevant Training**
  
  iii. **Develop Common Cybersecurity Definitions for Federal Acquisitions**
  
  iv. **Institute a Federal Acquisition Cyber Risk Management Strategy**
  
  v. **Include a Requirement to Purchase from Original Equipment Manufacturers, Their Authorized Resellers, or Other “Trusted” Sources, Whenever Available, in Appropriate Acquisitions**
  
  vi. **Increase Government Accountability for Cyber Risk Management**
DoD Mandates Software Quality...

2014 H.R. 3304

Directs the Secretary to provide for the establishment of a joint federation of capabilities to support the trusted defense system needs (security of software and hardware) of DOD. Requires the Secretary to determine whether the federation's purpose can be met by existing centers within DOD and, if not, to devise a strategy for creating and providing resources to fill such gaps.

2013 H.R. 4310

Directs the Under Secretary to: (1) develop and implement a baseline software assurance policy for the entire lifecycle of computer software acquired for DOD critical information, business, and weapons systems; (2) collect data on, and measure the effectiveness of, such policy; and (3) brief the defense and appropriations committees on additional means of improving software assurance and vulnerability detection.

SEC. 937. JOINT FEDERATED CENTERS FOR TRUSTED DEFENSE SYSTEMS FOR THE DEPARTMENT OF DEFENSE.

(a) Federation Required.--

(1) In general.--The Secretary of Defense shall provide for the establishment of a joint federation of capabilities to serve as a joint, Department-wide federation of capabilities to support the trusted defense system needs of the Department of Defense (in this section referred to as the ``federation'').

(2) Purpose.--The purpose of the federation shall be to serve as a joint, Department-wide federation of capabilities to ensure security in the software and hardware developed, acquired, maintained, and used by the Department to support policies relating to software assurance and supply chain risk management.

SEC. 933. IMPROVEMENTS IN ASSURANCE OF COMPUTER SOFTWARE PROCURED BY THE DEPARTMENT OF DEFENSE.

(a) Baseline Software Assurance Policy.--The Under Secretary of Defense (Personnel and Readiness) shall develop and implement a baseline software assurance policy for the entire lifecycle of covered systems. Such policy shall be included as part of the strategy for trusted defense systems of the Department of Defense.

(b) Policy Elements.--The baseline software assurance policy under subsection (a) shall...

...shall develop and implement a baseline software assurance policy for the entire lifecycle of covered systems..... (4) ...promote best practices and standards to achieve software security, assurance, and quality...
CISQ is a non-profit chartered to define automatable measures of software size and quality that can be measured in the source code, and promote them to become Approved Specifications of the OMG.

Current CISQ Sponsors:
- Accenture
- Atos
- CAST
- Huawei
- Wipro

Risk broader than Cyber ‘security’

Gov – Industry IT disasters

Can impact

POTUS, Cabinet PEOs, OCIOs, Warfighter

Corporate Customers Citizens Markets

accountable for

National Security/Critical Infrastructure
Customer/Citizen confidence
Agency/Corporate efficiency

Evaluation of IT System Quality with CISQ Measures
This is a Modern Gov. System...

Code / Unit Level Risk
- Typically open source or cheap IDE/Developer level
- Code style & layout focus
- Expression complexity
- Code documentation
- Class or program design
- Basic coding standards

Technology Level Risk
- Single language / technology layer
- Intra-technology architecture
- Intra-layer dependencies
- Design & structure
- Inter-program invocation

CISQ: System Level Enterprise Risk
- Integration quality
- Architectural compliance
- Risk propagation
- Application security
- Resiliency checks
- Transaction Integrity & Security around data access
- Automated Function point - Effort estimation / verification
- Data access control
- Calibration across technologies
- Enterprise Grade Solution Space

System Risk

System quality measures how well individual application components work together to make up the overall system – Whether system is a large single language or multi-tiered/ multi-technology.

Code Risk

Code quality is the measure of individual components for compliance with standards and best practices in the context of a specific language. These are typically developer tools.

“If your contractors tell you they are doing code quality, they mean “code” level quality - and they may not even be doing that consistently.”

- Fed Director of Enterprise Apps
Need to Measure SYSTEM Level Risk

“Tracking programming practices at the Unit Level alone may not translate into the anticipated business impact... most devastating defects can only be detected at the System Level.”

<table>
<thead>
<tr>
<th>Business Characteristic</th>
<th>Good Coding Practices @ Unit-Level</th>
<th>Good Architectural Practices @ Technology/System Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELIABILITY</td>
<td>Protecting state in multi-threaded environments</td>
<td>Multi-layer design compliance</td>
</tr>
<tr>
<td></td>
<td>Safe use of inheritance and polymorphism</td>
<td>Software manages data integrity and consistency</td>
</tr>
<tr>
<td></td>
<td>Resource bounds management, Complex code</td>
<td>Exception handling through transactions</td>
</tr>
<tr>
<td></td>
<td>Managing allocated resources, Timeouts</td>
<td>Class architecture compliance</td>
</tr>
<tr>
<td>PERFORMANCE EFFICIENCY</td>
<td>Compliance with Object-Oriented best practices</td>
<td>Appropriate interactions with expensive or remote resources</td>
</tr>
<tr>
<td></td>
<td>Compliance with SQL best practices</td>
<td>Data access performance and data management</td>
</tr>
<tr>
<td></td>
<td>Expensive computations in loops</td>
<td>Memory, network and disk space management</td>
</tr>
<tr>
<td></td>
<td>Static connections versus connection pools</td>
<td>Centralized handling of client requests</td>
</tr>
<tr>
<td></td>
<td>Compliance with garbage collection best practices</td>
<td>Use of middle tier components vs. procedures/DB functions</td>
</tr>
<tr>
<td>SECURITY</td>
<td>Use of hard-coded credentials</td>
<td>Input validation</td>
</tr>
<tr>
<td></td>
<td>Buffer overflows</td>
<td>SQL injection</td>
</tr>
<tr>
<td></td>
<td>Missing initialization</td>
<td>Cross-site scripting</td>
</tr>
<tr>
<td></td>
<td>Improper validation of array index</td>
<td>Failure to use vetted libraries or frameworks</td>
</tr>
<tr>
<td></td>
<td>Improper locking</td>
<td>Secure architecture design compliance</td>
</tr>
<tr>
<td></td>
<td>Uncontrolled format string</td>
<td></td>
</tr>
<tr>
<td>MAINTAINABILITY</td>
<td>Unstructured and duplicated code</td>
<td>Duplicated business logic</td>
</tr>
<tr>
<td></td>
<td>High cyclomatic complexity</td>
<td>Compliance with initial architecture design</td>
</tr>
<tr>
<td></td>
<td>Controlled level of dynamic coding</td>
<td>Strict hierarchy of calling between architectural layers</td>
</tr>
<tr>
<td></td>
<td>Over-parameterization of methods</td>
<td>Excessive horizontal layers</td>
</tr>
<tr>
<td></td>
<td>Hard coding of literals</td>
<td>Excessive multi-tier fan-in/fan-out</td>
</tr>
<tr>
<td></td>
<td>Excessive component size</td>
<td></td>
</tr>
</tbody>
</table>

**NUMBER OF ISSUES**
- 90% of violations
- 52% of repair workload
- 10% of production downtime

**BUSINESS IMPACT**
- 10% of violations
- 48% of repair effort
- 90% of production downtime

**SYSTEM LEVEL FLAWS**
- 92% Of all defects
- 48% Of total repair effort
- 52% Downtime caused by system-level flaws!

**UNIT LEVEL FLAWS**
- 10%
System-level defects visible in a transaction

No Risk in code checker

Good Quality in code checker

Good Quality in code checker

Bad Quality

Website UI

Remote Calls in Loop

Business Logic

Avoid using SQL queries inside a loop

SQL query on an XXL tables without indexes

Data Access & DB

Transaction
Focus on Attributes With Highest Impact

CISQ Quality Characteristic Measures

- **Security**: Ability to prevent unauthorized intrusions and data theft
- **Reliability**: Ability to avoid outages and to recover operations quickly
- **Performance Efficiency**: Ability to avoid response degradation, resource overuse
- **Maintainability**: Ability to understand and modify software quickly

Outcomes

- National Security, fraud, trust, damages
- Mission effectiveness, citizen satisfaction
- Mission effectiveness, cost, satisfaction
- Cost of ownership, agility, time to mission

http://it-cisq.org/standards/automated-quality-characteristic-measures

“30-50% of software level security findings are in ‘dead’ code or in code so fundamentally flawed it should not be secured, but re-factored.” - OMG Roundtable Survey, March 2014

“More than 50% of security problems have their root cause in structural quality flaws.” - Gary McGraw
CISQ Work Groups

- Automated Function Points
- Reliability
- Performance Efficiency
- Security
- Maintainability

OMG

Approved Measure Specifications

ISO Fast track

Deployment Workshops
How Do CISQ Measures Relate to ISO?

- Complies to international norms
  - (ISO = International Standards Org.)
- CISQ conforms to ISO 25010 quality characteristic definitions
- CISQ supplements ISO 25023 with source code level measures

ISO/IEC 25010 Quality Characteristic Hierarchy

CISQ defined automatable measures for quality characteristics highlighted in blue

Standards of Measurement Supported by FFRDCs, Government, Industry

MITRE

MITRE is a private, not-for-profit corporation that operates FFRDCs—federally funded research and development centers. If you’ve ever flown in a jet or used GPS, you’ve benefited from technology with roots in an FFRDC.

Consortium for IT Software Quality (CISQ)

- Goal:
  - Improve IT application quality
  - Reduce cost and risk
- Objective is to introduce a computable metrics standard for measuring software quality & size
- IT executives from Global 2000, system integrators, outsourced service providers, and software technology vendors

Object Management Group (OMG)

- Technology standards consortium
- Focuses on enterprise integration standards for a wide range of technologies and industries
- Modeling standards include Unified Modeling Language (UML) and Model Driven Architecture (MDA)

Software Engineering Institute

We research software and cybersecurity problems of considerable complexity, create and test innovative technologies, and transition maturing solutions to widespread use.

**Need to Leverage in Federal Acquisition**

- **Contracting**
  - Clarifies non-functional requirements

- **Monitoring**
  - Early detection, enhances QA, reduces rework

- **Accepting**
  - Demonstrates operational readiness
Now let’s discuss Automated Sizing Standards

(Presentation slide removed)
Looking Beyond SLOC (2014 SBIR example)

N141-055 TITLE: Automated Function Point Analysis

TECHNOLOGY AREAS: Information Systems

ACQUISITION PROGRAM: PEO IWS 1.0, Integrated Combat Systems, AEGIS

OBJECTIVE: Develop an innovative function point analysis software tool for program managers that achieves requirements for estimating software costs.

DESCRIPTION: The Navy uses estimates of software size such as Source Lines of Code (SLOC)) to determine software development efforts and their associated combat system development costs. There are significant variations in methods used for estimating SLOC, which introduce risk. Current SLOC estimates are a prediction of end-product code size that varies with code language (such as Java, C++) and software design approach. Estimates of new, modified, and reused SLOC to implement a capability are based upon a Subject Matter Expert’s (SME) judgment which makes the resulting estimate highly subjective (Ref 1).

Program Managers are required to prevent program cost overruns. They rely upon accurate cost estimates and software development metrics to ensure programs are executable and not at risk of cost overruns. The use of SLOC creates high risk cost estimates due to the potential for significant variation in methods for estimating end-product source lines of code.

The International Function Point User Group (IFPUG) has developed a Function Point based methodology to estimate software costs that is more accurate than the SLOC methodology. The Navy’s transition to the Function Point based methodology has been hindered because existing historical cost data is based upon SLOC. Significant manual effort is needed to transition from the current Navy SLOC practice to the current industry Function Point methodology. The Object Management Group (OMG) recently adopted an Automated Function Point (AFP) Specification. The standard defines how to count function points that can be used to ensure software counting consistency and will provide the standard required to enable transition from SLOC to Function Point based software estimation methodologies (Ref 2, 3). However
Automated Function Points

- An OMG Approved Specification
- Mirrors IFPUG counting guidelines, but automatable
- Specification developed by international team led by David Herron of David Consulting Group
- Growing commercial adoption

http://it-cisq.org/standards/automated-function-points
Automated Function Points is a technology agnostic metric, independent on the complexity and the quality.

Measure the number of transaction managed by the application in order to measure the amount of functionality.

Best used for overall functional size of application (Used on Run the Business)

Enhanced Function Points is a functional sizing unit that measures application enhancements and maintenance activities.

Measure the number of modifications (added, updated, deleted) between two measurements.

Best used to show changes (Add/Delete/Change) in releases
Software Sizing: Industry Use Case Profiles

Standardized & Benchmarking
Detect portfolio outliers, identify improvement opportunities and track evolution of size, risk, complexity and quality

IT focus: Productivity
Measurement & Improvement
Monitor, track and compare ADM teams’ utilization, delivery efficiency, throughput and quality of outputs

Business focus: Quantify
Effectiveness of Transformation Initiative
Optimize operating costs while preserving throughput and de-risking business transformation initiative

ADM Supplier Outcome Measurement
Provide visibility to management; manage risk, quality and throughput through enhanced Service Level Agreement

CLIENT NAMES REMOVED

CLIENT NAMES REMOVED
Removed
CISQ New CISQ Measures

- Automated Enhancement Points
- Quality Adjusted Productivity
- Effort & Cost

Must account for size of maintenance activities
Must add future effort to fix bugs into productivity
Must estimate the corrective costs in cost of ownership

- Productivity
- Estimation
- Benchmarks
- Value & ROI
- Etc.
Event March 15, 2016 www.it-cisq.org

CYBER RESILIENCE SUMMIT
Championing a Cyber Strategy & Implementation Roadmap

Hyatt Reston Town Center
March 15, 2016 Reston, VA USA

Phyllis Schnick
Deputy Under Secretary for Cybersecurity and Communications for the NPPD, Department of Homeland Security

Curtis Dukes
Director of Information Assurance, National Security Agency

Lucia Savage
Chief Privacy Officer, Office of the National Coordinator for Health Information Technology, Department of Health & Human Services

Dr. J. Michael Gilmore
Director of Operational Test and Evaluation, Office of the Secretary of Defense, Department of Defense

Paul Nielsen
Director and CEO, Software Engineering Institute at Carnegie Mellon University
<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Speakers/Details</th>
</tr>
</thead>
</table>
| 9:00am| Titans of Cyber Panel: Critical Insights from the Front Lines of the Cyber Risk Management Battle | Phyllis Schneck, Deputy Under Secretary for Cybersecurity and Communications for the National Protection and Programs Directorate (NPPD), U.S. Department of Homeland Security  
Curtis Dukes, Director of Information Assurance, National Security Agency  
Lucia Savage, Chief Privacy Officer, Office of the National Coordinator for Health Information Technology, U.S. Department of Health & Human Services  
Dr. J. Michael Gilmore, Director of Operational Test and Evaluation (OT&E), Office of the Secretary of Defense, U.S. Department of Defense  
Paul Nielsen, Director and CEO, Carnegie Mellon SEI  
| 10:30am| Refreshment Break                                                                 |                                                                                   |
| 10:45am| Ensuring the Resiliency of Software-Intensive Systems                             | Dr. Bill Curtis, Executive Director, CISQ  
David Zubrow, Senior Member of the Technical Staff, Carnegie Mellon SEI  
Dr. Vadim Okun, Computer Scientist, National Institute of Standards and Technology (NIST)  
Kris Britton, Director, NSA Center for Assured Software  
Dr. Robert Childs, Chairman, Technology Committee, Armed Forces Communications and Electronics Association |
| 11:30am| Certifying Software Against CISQ Automated Quality Measures                       | Dr. Bill Curtis, Executive Director, CISQ |
| 12:00pm| Lunch                                                                            |                                                                                   |
| 1:00pm| Executive Order 13636 and FITARA: Empowering CIOs to Drive Down Cyber Risk        | John Weiler, Vice Chair, IT-AAC  
Richard Spire, CEO, Resilient Networks, former CIO, U.S. Department of Homeland Security  
Tony Scott, Federal CIO, Office of Management and Budget (invited)  
Michael Hermus, CTO, U.S. Department of Homeland Security  
Honorable Peter Levine, Deputy Chief Management Officer, U.S. Department of Defense (invited) |
| 2:00pm| IT Acquisition Workshop: How to Write Risk Management and Cyber Resilience Requirements into Contracts | Joe Jarzombek, Global Manager, Software Supply Chain Management, Synopsys Software Integrity Group, former Director for Software & Supply Chain Assurance, U.S. Department of Homeland Security |
| 2:30pm| Refreshment Break                                                                 |                                                                                   |
| 2:45pm| IT Acquisition Workshop: How to Demonstrate Compliance with FITARA and Federal Directives | Joe Jarzombek, Global Manager, Software Supply Chain Management, Synopsys Software Integrity Group, former Director for Software & Supply Chain Assurance, U.S. Department of Homeland Security |
| 3:15pm| Case Study: Managing Cyber Risk from Development to Deployment                     |                                                                                   |
| 4:00pm| Networking Reception                                                             |                                                                                   |
THANK YOU!!

Marc Jones  Federal Director, CISQ  (vol.)
marc.jones@it-cisq.org / 703.863.9908