SYSTEMS ENGINEERING RESEARCH CENTER

USC Viterbi Information Sciences Institute

WRT-1012: Global Positioning Systems - Mission Engineering and Integration of Emerging Technologies

Sponsor: USAF Space and Missile Center

By

Dr. Michael Orosz

mdorosz@isi.edu

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FHI 360 CONFERENCE CENTER

1825 Connecticut Avenue NW, 8th Floor

Washington, DC 20009

www.sercuarc.org

Project Overview

- **Target:** Space-Based System acquisition process
- **Goal**: Improve current satellite acquisition processes
  - —Determine the mission engineering methods, analysis, and metrics to transition from a traditional DoD 5000 waterfall development to Agile DevOps processes
  - —Includes integration of emerging technologies and related education for the future workforce
- **Process**:
  1. Understand the current acquisition environment
     - Includes immersion into environment (become part of the team)
  2. Develop approaches to transition acquisition elements from DoD 5000 to Agile/DevOps
  3. Incorporate processes and “lessons-learned” into a transition process to apply to other domains

Project Overview

- **Partners**:
  - —SERC
  - —USC Information Sciences Institute (USC/ISI)
  - —Georgia Tech Research Institute (GTRI)

USC University of Southern California
Information Sciences Institute

Georgia Tech Research Institute

- **Funding agency**: USAF Space and Missile Center's Global Positioning Systems Directorate (SMC/GP)
- **Period of Performance**: 26 June 2019 – 25 June 2020
  - —Optional second year

Current Environment

- Three different (but linked) acquisition efforts underway:
  - **Project A** – Extends current space-based system to support communicating with new satellite systems
    - No new functionality added
  - **Project B** – Extends Project A by providing a limited capability that takes advantage of the new satellites
  - **Project C** – A completely new solution that will have full capabilities to take advantage of the new satellite systems

Project A

- Traditional DoD-5000 Waterfall acquisition method
- Delayed - Software development delayed by parallel sustainment software and infrastructure updates
- Experienced traditional "bow wave" of DRs (Discrepancy Reports) as the project neared completion
- Focused on requirements over fielding critical features
  - Developers were blocked by out-of-date, conflicting, or deprecated requirements; required configuration board process to correct requirements

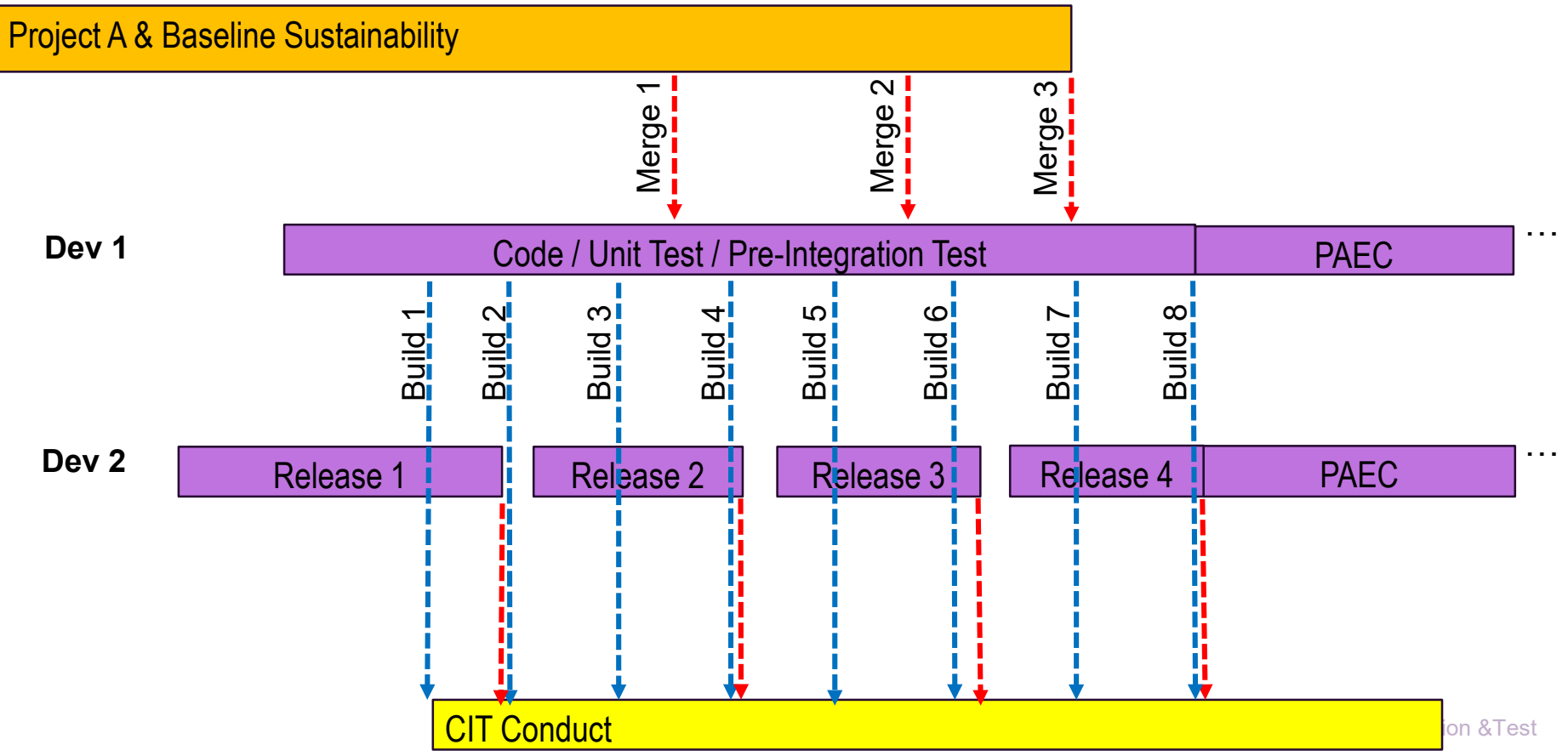
Project B

- Two code bases:
  - Dev 1: Traditional waterfall approach with limited DevOps
  - Dev 2: Hybrid approach (Agile with limited DevOps)
- Dev 1 Code: Traditional Waterfall.
  - Daily integration meeting to prioritize work across Dev 1, Dev 2, and test
  - Eight (8) software builds; early testing for problem discovery & risk reduction
  - Three (3) merges of Project A & baseline s/w with Dev 1 and Dev 2; full features not implemented until merge 3
  - Problems:
    - Limited user participation (lack of resources and time)
    - Suffers from "bow wave" of problems being discovered in I&T (Integration & Testing)

Project B – Dev 2 Code

- Dev 2: A hybrid Agile/DevOps approach
  - Daily SCRUMs; developers and testers collaborate in-person & are within same organization
  - Development structured into 5 releases, releases deliver useable features
  - Critical Problem Reports investigated and corrected quickly
  - Sprint cycles incorporate lessons learned from previous sprint
  - Follows general DevOps process, but doesn't use continuous integration (CI)/continuous deployment (CD) automation
  - Challenges:
    - Integrated Dev 1 and Dev 2 functions not fully testable until late in the development cycle
    - Limited user participation

Project B Schedule



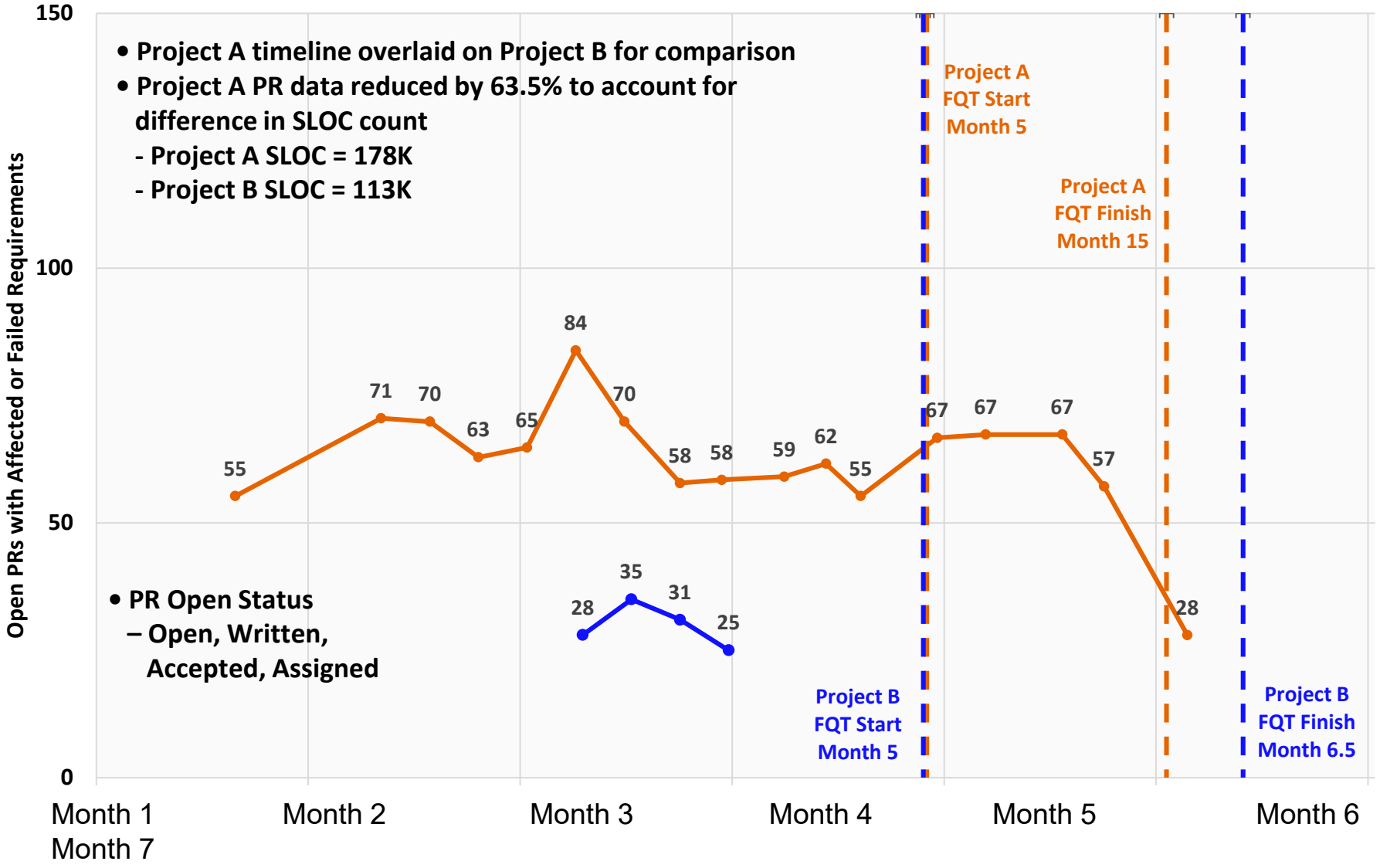
Project C

- Project C is attempting to implement true Agile/DevOps
- But like Project B, the program works within an acquisition management system that still relies on Waterfall metrics (lines of code written/tested, number of DRs reported and worked off, etc.).
- USC/GTRI team is just starting to immerse into this environment

Initial Results on Next Slide

- **Definitions**:
- PR – Problem Report (e.g., bugs)
- FQT – Formal Qualification Test (test to determine if system meets requirements
- RFR – Run For Record (final qualification test)
- SLOC – Source Lines of Code

Project A and B PR Comparison During FQT RFR as of 30 Sep 2019



More Findings To Date

- **Still collecting data and becoming part of the development team**.
  - —We have been making recommendations (tools to use, metrics to collect) and are developing tools that can report Agile/DevOps performance numbers in a form that DoD 5000 supports

- **Challenges:**
  - —Multiple project teams involved in different phases of the project at different times (impacts integration, training, etc.)
  - —Test beds and simulated satellites are shared by all three efforts – limiting availability (and multiple vendors involved)

Next Steps

- Continue data collection via embedded operations
- Summarize results of Project A, Project B (Dev 1 and Dev 2) and Project C efforts
  - Determine what worked and why (and what didn't and why)
  - Develop lessons learned
  - Develop approaches, recommendations and processes for transitioning from Waterfall to Agile/DevOps
- Work closely with SMC/GP on identifying elements to transition to Agile/DevOps on next development cycle (and apply to Project C where appropriate)

Conclusion

- Initial results from Project B (mixed Waterfall and Agile/DevOps) suggests that it is possible to improve the DoD system acquisition process
- However, many challenges to explore and address – including:
  - How do we get more user engagement into the development process?
  - These systems are not built in isolation, they depend on deliverables from other systems (e.g., Project B is dependent on Project A releases). These systems of systems environments are quite large involving multiple project teams and vendors
  - Availability of test beds and simulators