F-22 System Program Office

F-22 SAFe Implementation Intro

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Topics

• SAFe – Scaled Agile Framework:
  – Enterprise approach/process for Lean-Agile software and systems development
  – Lean-Agile oversimplified: Iterative planning, design and coding

• F-22 – Why change?

• Benefits to date

• Challenges/Cautions
**F-22 Development**

**Why we implemented SAFe/Agile**

- Find problems early with time to fix
- See what's being built before it's finished
- System level testing, especially flight testing, provides valuable user feedback sooner
- Able to refine requirements after seeing/using product in *real environment*

Software teams develop product independently, integrated product compiled and tested at each Iteration

*F-1 is where F-22 would start legacy style capability verification*
F-22 Process Evolution

A. Requirements
   - SRR
   - PDR
   - CDR
   - Design
   - Code/Integration/test
   - DT complete
   - OT
   - Field

B. Requirements
   - SRR
   - PDR
   - Design
   - Code/Integration/test
   - DT complete
   - OT
   - Field

C. Requirements
   - PBR
   - PDR
   - IPA
   - CDR
   - DT complete
   - OT
   - Field

SRR – System Requirements Review
PDR – Preliminary Design Review
CDR – Critical Design Review
FTRR – Flight Test Readiness Review
DT – Developmental Test
OT – Operational Test
PBR – Program Backlog Review
IPA – Iterative Planning Assessment
ICR – Iterative Capability Review
EMD – Engineering/Manufacturing/Development
Legacy development process – used in Increment 3.2A and earlier

- Issues can be discovered during design or implementation that points out gaps in requirements
- Returning to earlier phase can be expensive or costly rework
- Each completed phase has formal review and documentation
- Actual development comes late
  - Results/Issues revealed late

**Legend**

- SRR – System Requirements Review
- PDR – Preliminary Design Review
- CDR – Critical Design Review
- FTRR – Flight Test Readiness Review
- DT – Developmental Test
- OT – Operational Test
Software teams develop product independently, no integrated product to test until F-1

**Why this failed for us**

- No integrated, system level testing/demonstration until late in development
- Late discovery of costly interface issues
- Late discovery of implementation/design decisions not in line with customer expectations
- Out of runway to resolve defects or design corrections

*F-1 is where F-22 would start legacy style capability verification*
F-22 Iterative Development

Iterative Development – used in Increment 3.2B

- Follows waterfall approach up to PDR
- Begins Iterations of detailed design/code/test post PDR
- CDR completed iteratively (ICRs)
- Legacy type verification activity (F-Drops/P-Drop)
- Focuses on finding issues early and producing mature product to Development Test

PDR – Preliminary Design Review
CDR – Critical Design Review
FTRR – Flight Test Readiness Review
DT – Developmental Test
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PBR – Program Backlog Review
ICR – Iterative Capability Review
F-22 SAFe (agile) Development

Agile Development – Post Increment 3.2B

- Highly collaborative, transparent activity
  - Requires early involvement from all stakeholders
- Make decisions at the “latest responsible moment”
  - Reduce re-work
  - Make decisions once you’ve learned more
- Provide early feedback to the end user
  - Assures the design is in sync with stakeholder expectations
  - Promotes timely resolution of system design and documentation issues
- Early value delivery accumulates and accumulates

Agile Manifesto

Individuals and interactions over processes and tools
Working software over comprehensive documentation
Customer collaboration over contract negotiation
Responding to change over following a plan
The Official SAFe Big Picture

SAFe® 4.0 for Lean Software and Systems Engineering

Provided by Scaled Agile, Inc.
Scaling to the F-22 Enterprise

• We scaled from Agile Software model to an F-22 Enterprise framework
  – Adapted SAFe to F-22 needs
  – Requirements refinement
  – System design
  – Hardware and software development
• Heavy focus on alignment and coordinating dependencies
  – Tailored to our environment – some level of plan/roadmap developed up front
  – Tried as much as possible to maintain the SAFe Principles when tailoring the process
• Established structure and specific roles for managing both execution and requirements at all levels
  – Value Stream/Release Train/Agile Team
  – F-22 SPO engaged at Value Stream and Release Train

Leadership Support and Government Involvement is Critical
PI Planning Roadmap Example

**PI-xx**  
**Capabilities**
- Increment Production Rel  
- must have defects  
- error XX root cause analysis  
- S/W update 1 startup  
- datalink network selection  
- Tier 4 algorithm development  
- Tier 4 Key integration  
- encoder host on new processor  
- sustainment fix implementation  
- Contract UCA  
- Increment demo 1  
- Increment demo 2  
- automated test architecture develop  
- automated test legacy rehost  
- new navigation service  
- Increment B Phase B proposal  
- Increment C phase B proposal  
- ID new sustainment work

**Not just software**

**PI-xx**  
**Capabilities**
- S/W update System Test  
- Capability 1 (medium)  
- Capability 2 (large)  
- Capability 3 (small)  
- Capability 4 (small)  
- Capability 5 (small)  
- Capability 6 (large)  
- Capability 7 (medium)  
- Capability 8 (large)  
- Capability 9 (small)  
- Capability 10 (small)  
- Tier 4 algorithm 2  
- S/W update 1 Tier 4 algorithm  
- automated test system deploy 1  
- automated test demo  
- radio frequency test/analysis  
- lab STE integration 1  
- lab STE integration 2  
- New processor startup  
- radio demo  
- interface defintion done  
- firefly-class VTOL engine int  
- Lab STE integration 3  
- Increment B Phase B proposal

**PI-xx**  
**Capabilities**
- s/w update encryption test  
- s/w update system test  
- capability 11  
- capability 12  
- capability 13  
- capability 14  
- capability 15  
- capability 16  
- ground system update  
- high priority defect fixes  
- radio control  
- automated test deploy 2  
- Automated test deploy 1 demo  
- S/W update data analysis from system test  
- Increment A demo 1  
- Increment A demo 2  
- Increment A demo 3  
- automated test rehost 2  
- stretch: low priority DR fix  
- deployment

**Deliver value/functionality every Program Increment**
Benefits we’re seeing today

• We are finding defects early
  – Increment 3.2B found critical interface issues early with time to fix
    • If found under legacy process would have broken the program
  – Expanding our earlier testing we hope to expand on this
    • Adding automated test environment on non-target hardware for quick, software integration testing

• Using the Release Planning approach in SAFe, we’ve been able to highlight issues and align efforts
  – Staffing issues identified when we had time to do something about it
    • Added people from other efforts for temporary effort
    • Shifted work to other teams with more capacity
  – With a focus on common priorities provided by leadership our teams have a greater focus on what they should be working on
  – Added our business team – now we can plan in our contract support and funding needs
    • Hope to expand this where we can now tell in advance if the business teams can award contracts or not
  – Far better insight into capability progress and program execution – transparency is key

• Using the process to define the process
  – We’re adjusting the process continuously using SAFe
  – Make improvements every 12-14 weeks at the latest
Truth in Advertising

- 5000 and Contracting approach not in line with SAFe/Agile execution
  - Ex - Traditional EVM doesn’t fit – working with SEI, OSD
  - Contract req’s, incentive structures, Technical Reviews, etc.
- Contractor leadership has bought in; still hasn’t quite committed 100%
  - Concern still exists on how contractor will respond to “requirements refinement”
- Oversight is skeptical but coming around, can create difficult environment
  - Desires hard, defined process upfront
    - We’re learning, finding what works and what doesn’t – at worst we’re 12 wks out from fixing process problems
    - Using the process to refine the process is not favored
- Resource Intensive – requires alignment of all functions
- Transition is hard, leadership is critical
  - We’ve moved people’s cheese
  - Culture is stubborn – leadership/personality is key
  - Still early in transition, need to recognize and help through chaos

Leadership Support and Government Involvement is Critical
Questions?

Modernize and Sustain Raptor’s Unrivaled Combat Advantage…
On Time, On Cost, Affordable!

Take Care of Our Valued Teammates
Deliver Affordable Capability
Meet Commitments
Continuously Improve
One Team

Air Force’s Most Credible Acquisition Team Maintaining Our Nation’s War Winning Combat Advantage…Fly, Fight, and Win!