Air Force Materiel Command

Agile Software Course Expansion to DE

NDIA 25th Annual Systems and Mission Engineering Conference

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Agile Software Course Expansion to DE

- Agenda:
  - Team Members
  - Review of current course/workshop
  - Model Based Requirements
  - Model Creation & Vetting
  - Model Execution
  - Agile Workshop Expansion

DE – Digital Engineering

Agile Software Course Expansion to DE

- **Team members:**
  - **Nathan Erbe, KBR Systems Engineer**
  - **Curtis Jefferson, AFMC/ENST**
  - **Nabor “Felix” Cortez, AFSC 559 SWES/MXDPCE**
  - **John Myers, AFMC/ENST**
  - **Rhonda Oliver, AFLCMC/EZAS**
  - **Patrick Reynolds, KBR Systems Engineer**
  - **Pompei Orlando, AFRL/RYDT**

DE – Digital Engineering

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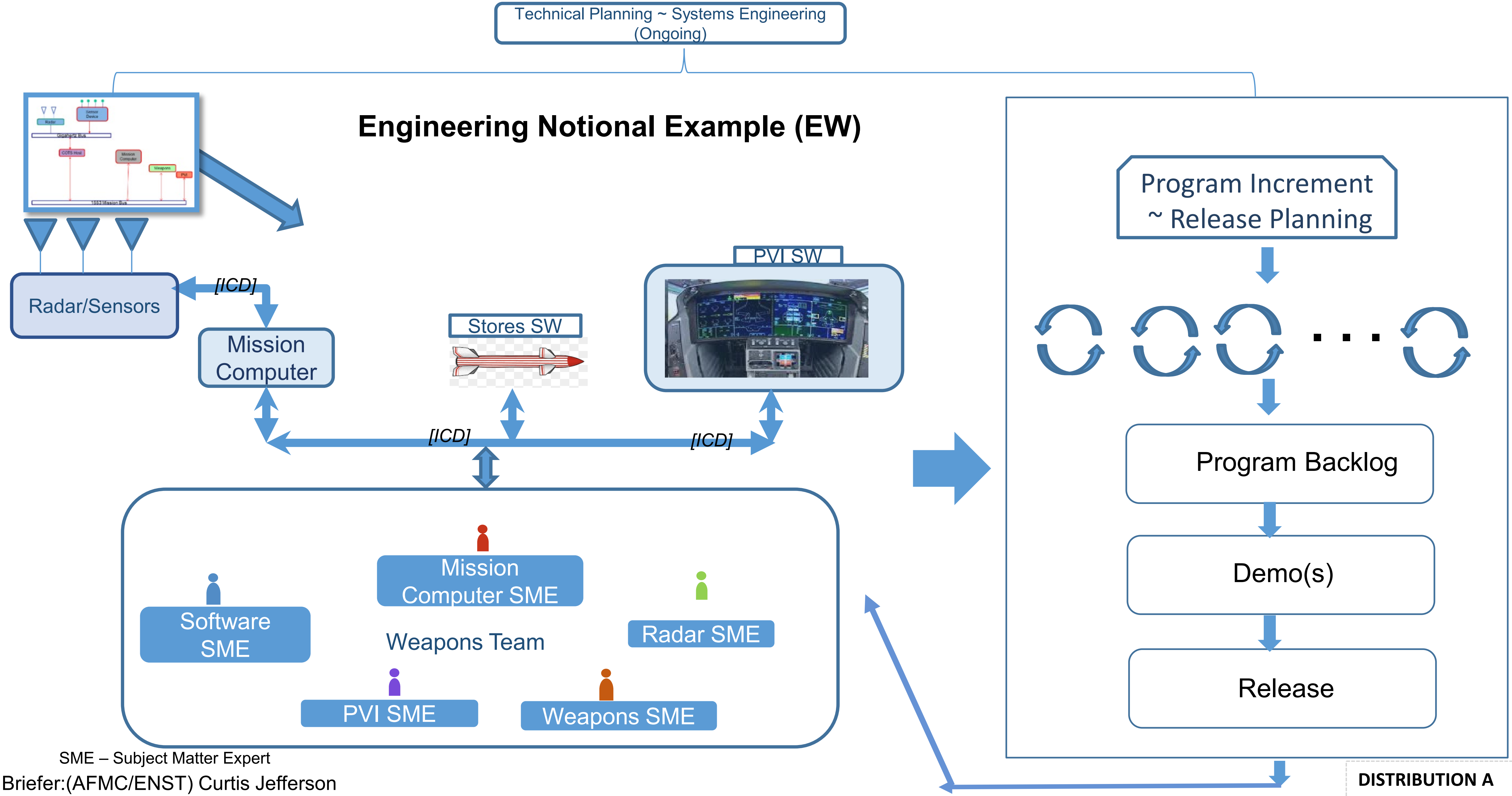
Agile Software Course/Workshop - Current



Technical Planning ~ Systems Engineering (Ongoing)

Engineering Notional Example (EW)

Radar/Sensors

[ICD]

Mission Computer

Stores SW

PVI SW

[ICD]

[ICD]

Mission Computer SME

Software SME

Weapons Team

Radar SME

PVI SME

Weapons SME

Program Increment ~ Release Planning

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Program Backlog

Demo(s)

Release

SME – Subject Matter Expert

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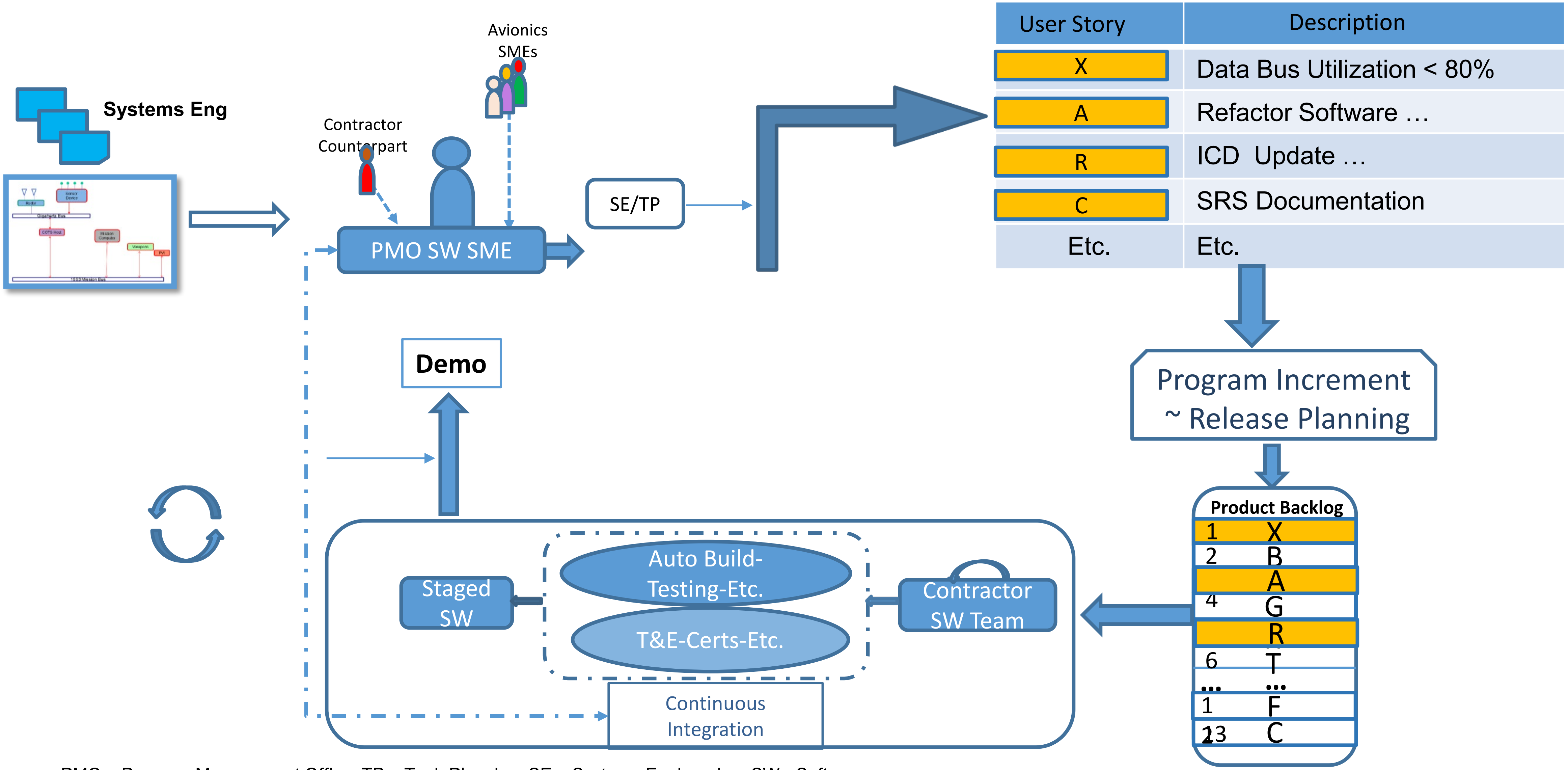
DISTRIBUTION A

Agile Software Course/Workshop - Current



User Story	Description
X	Data Bus Utilization < 80%
A	Refactor Software …
R	ICD Update …
C	SRS Documentation
Etc.	Etc.

Product Backlog

1	X
2	B
	A
4	G
	R
6	T
…	…
1	F
213	C

PMO – Program Management Office, TP – Tech Planning, SE – Systems Engineering, SW - Software

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Model Based Requirements Analysis

- **Textual requirements by themselves fail to result in usable, high-quality systems**
  - Air gap exists between *shall* statements and meeting the stakeholder needs
  - Natural language is ambiguous, imprecise, and only weakly verifiable
  - Text is still useful to communicate with non-technical stakeholders
- **MBSE captures requirements both in textual and formal means via modeling**
  - Model representation of the requirement is more formal and lends itself to more rigorous thought and analysis
- **Functional analysis improves requirements through analysis and generates high-quality requirements, use cases, and user stories**
  - Objective is to create an executable model to identify defects such as missing, incomplete, incorrect, or inaccurate requirements
  - Utilizes user stories, activity diagrams, state machine diagrams, sequence diagrams

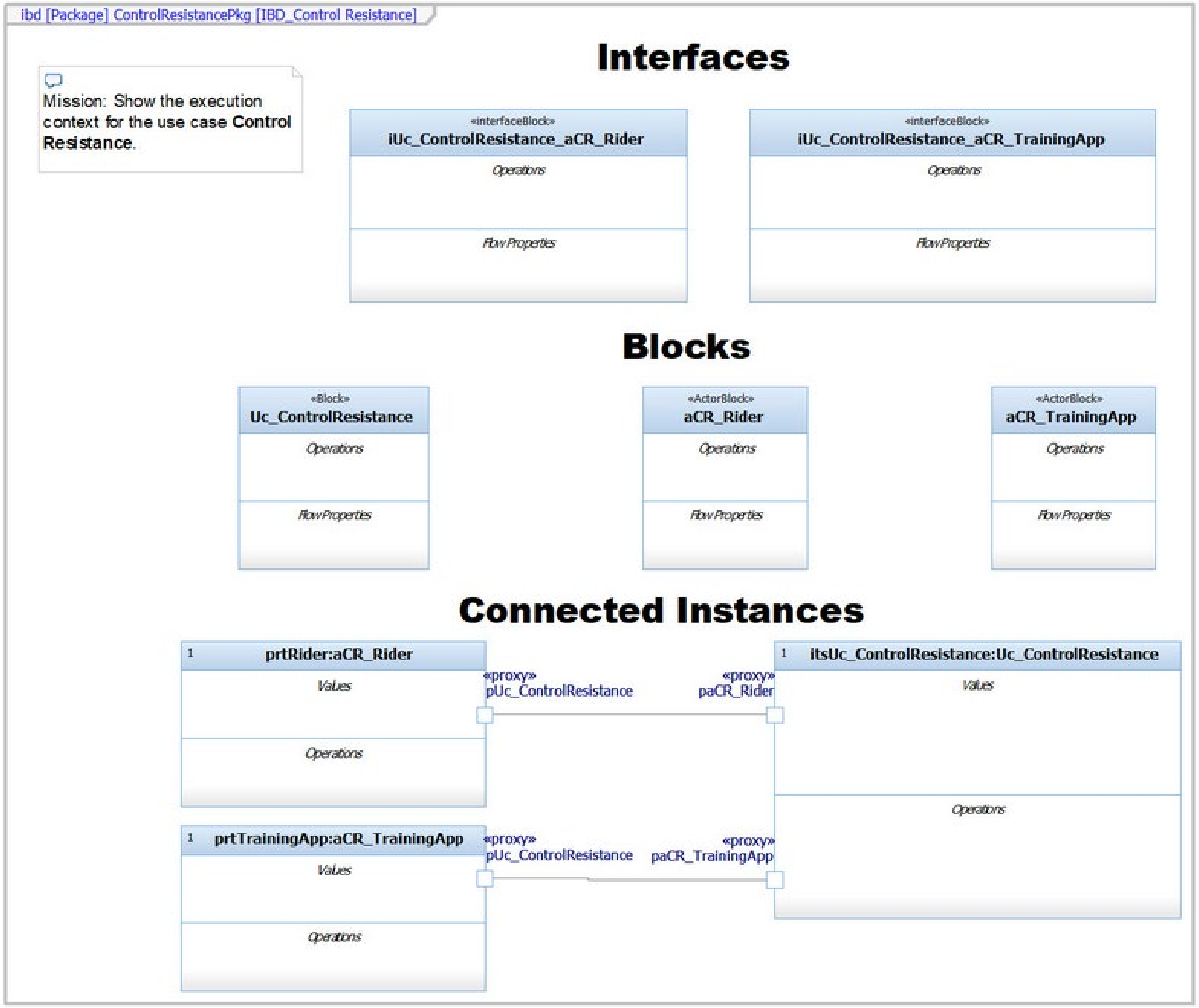
Model Based Requirements Analysis Overview

- Use Case Diagram
- Domain Model/Execution Context
- Functional Analysis
  - With User Stories
    - Allocate reqs to user stories
    - Verify & Validate via review
  - With ACT, SEQ, STM
    - Create Activity Diagram (Flow based behavior)
    - Create Sequence Diagram (Message based behavior)
    - Create State Machine Diagram (State based behavior)
    - Simulate to V&V reqs

ACT – Activity Diagram, SEQ – Sequence Diagram, STM – State Machine Diagram

Domain Model/Execution Context

- Establish system boundary and external actors
- Execution context is a kind of modeling sandbox that contains elements represented by use cases and actors
- Isolated simulation sandbox allows different systems engineers to progress independently on different use case analyses

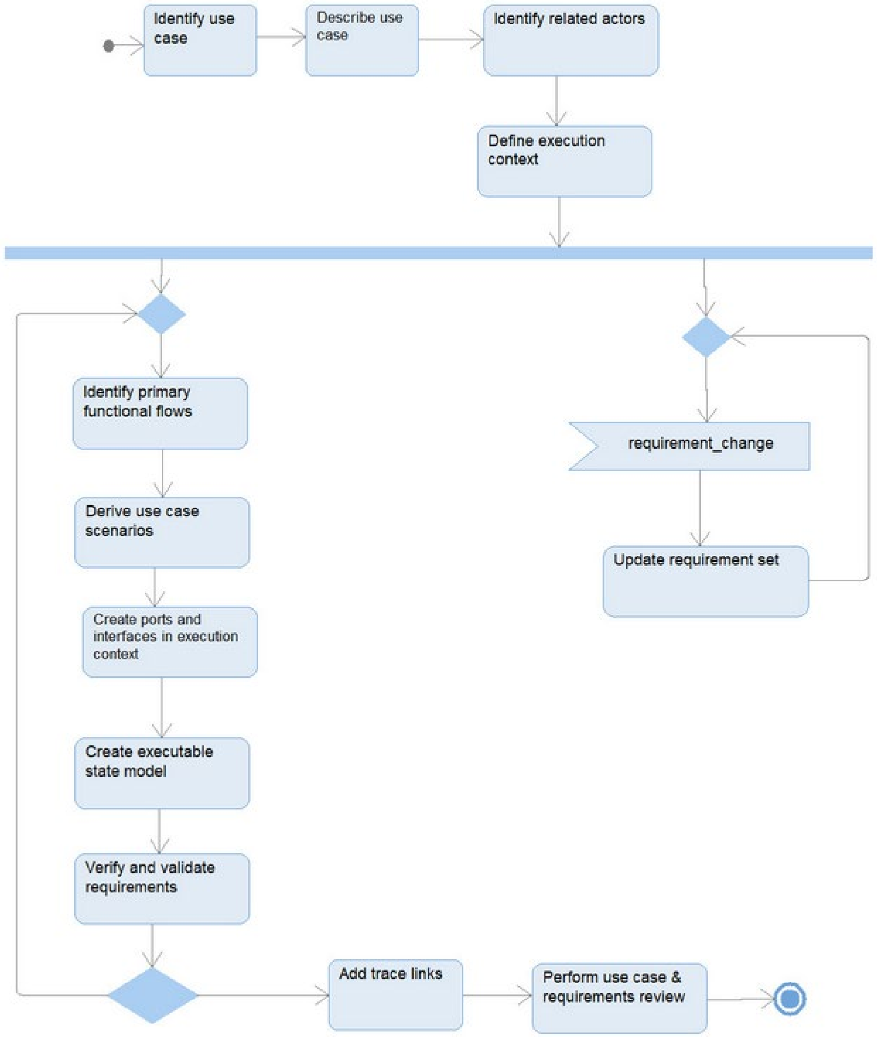


ibd [Package] ControlResistancePkg [IBD_Control Resistance]

Mission: Show the execution context for the use case Control Resistance.

Functional Analysis with ACT, SEQ, STM

- Fairly rigorous and use executable models to identify missing and incorrect requirements
  - The validation of the requirements can use a combination of subject matter expert review, testing, and even formal mathematical analysis prior to their application to the system design
- This is the most favored workflow among model-based systems engineers.



Identify use case

Describe use case

Identify related actors

Define execution context

Identify primary functional flows

Derive use case scenarios

Create ports and interfaces in execution context

Create executable state model

Verify and validate requirements

requirement_change

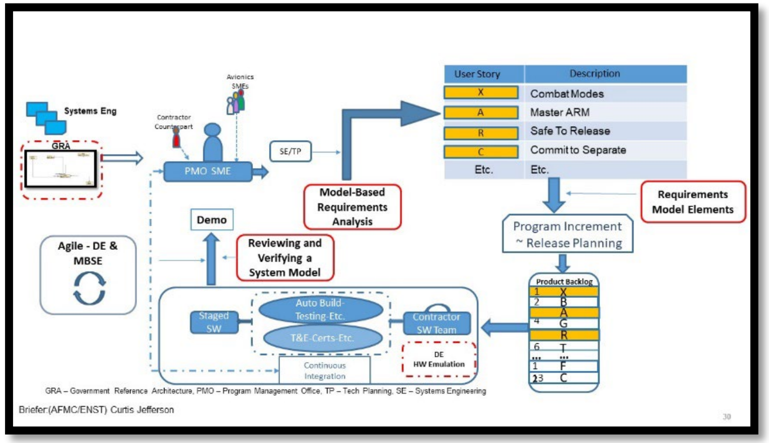
Update requirement set

Add trace links

Perform use case & requirements review

Agile Software Course/Workshop - Expansion

- Digital model added to enhance course
  - Model represents various avionics functions
  - Facilitates PMO-Developer communication & transparency
  - Amplifies approach to user story creation for SW functionality



User Story	Description
X	Combat Modes
A	Master ARM
R	Safe To Release
C	Commit to Separate
Etc.	Etc.

GRA – Government Reference Architecture, PMO – Program Management Office, TP – Tech Planning, SE – Systems Engineering

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Agile SW Development Process

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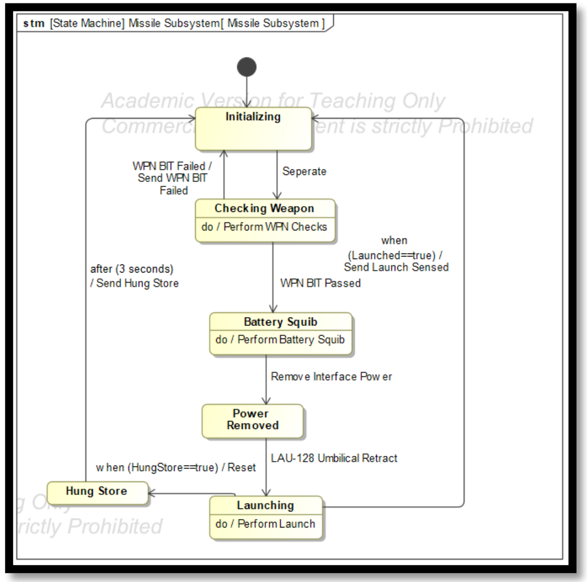

stm [State Machine] Missile Subsystem[Missile Subsystem]
Academic Version for Teaching Only
Commercial Development is strictly Prohibited
Initializing
WPN BIT Failed / Send WPN BIT Failed
Seperate
Checking Weapon
do / Perform WPN Checks
when (Launched==true) / Send Launch Sensed
after (3 seconds) / Send Hung Store
WPN BIT Passed
Battery Squib
do / Perform Battery Squib
Remove Interface Pow er
Power Removed
LAU-128 Umbilical Retract
w hen (HungStore==true) / Reset
Hung Store
Launching
do / Perform Launch

Vetted Model

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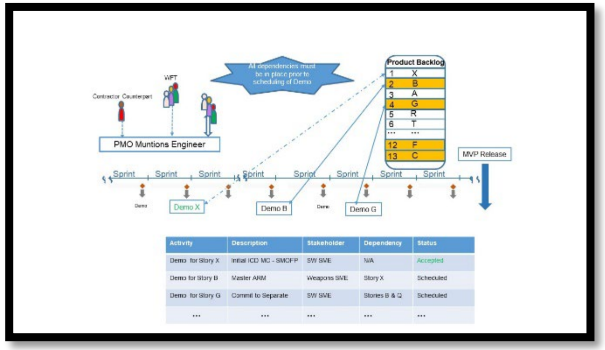

Activity	Description	Stakeholder	Dependency	Status
Demo for Story X	Initial ICD MC - SMOFP	SW SME	N/A	Accepted
Demo for Story B	Master ARM	Weapons SME	Story X	Scheduled
Demo for Story G	Commit to Separate	SW SME	Stories B & Q	Scheduled
...	...	...	...	...

Warfighter Capability

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Deliver and Support Agile War-Winning Capabilities

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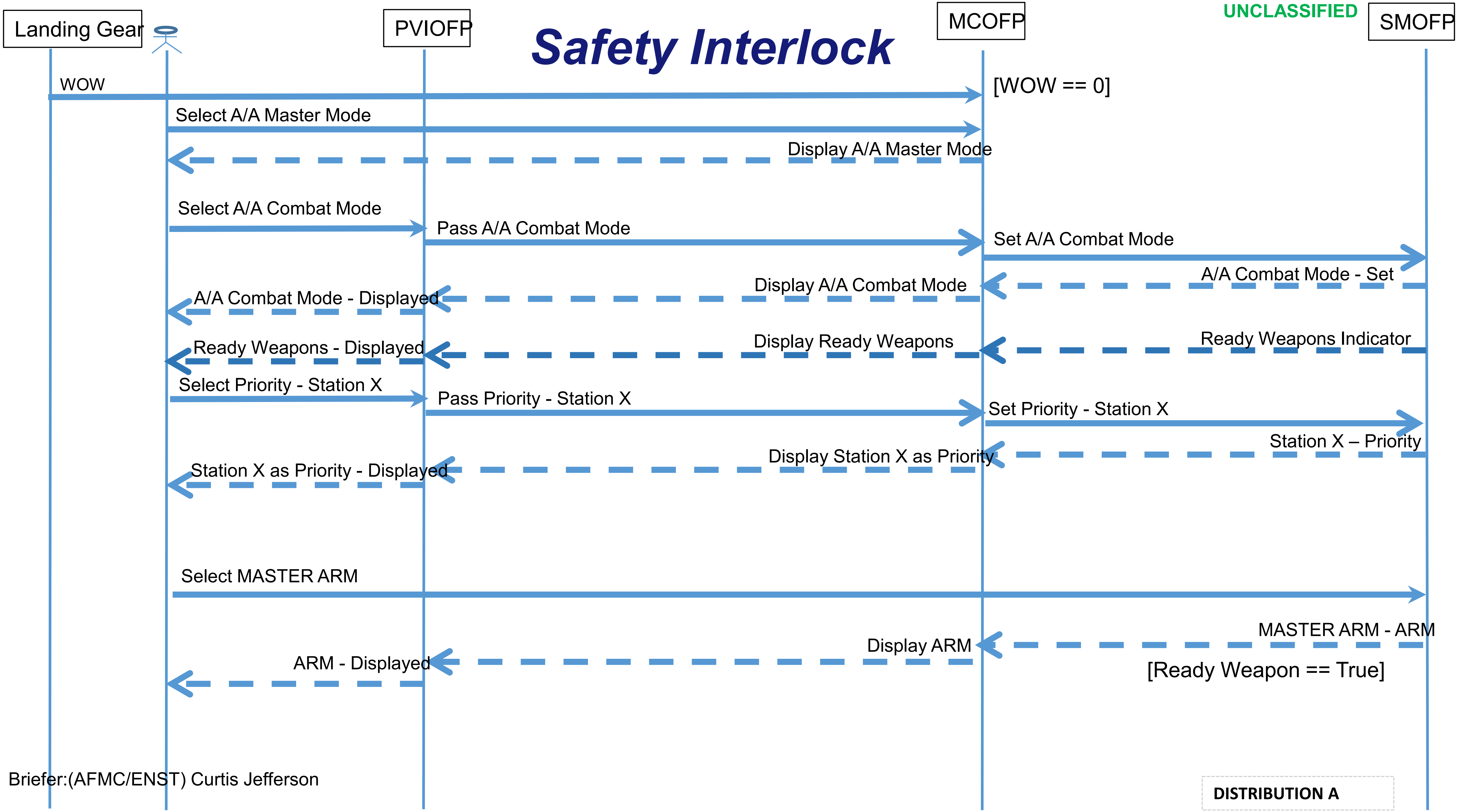
Safety Interlock



Landing Gear

PVIOFP

MCOFP

SMOFP

WOW

[WOW == 0]

Select A/A Master Mode

Display A/A Master Mode

Select A/A Combat Mode

Pass A/A Combat Mode

Set A/A Combat Mode

A/A Combat Mode - Set

Display A/A Combat Mode

A/A Combat Mode - Displayed

Ready Weapons Indicator

Display Ready Weapons

Ready Weapons - Displayed

Select Priority - Station X

Pass Priority - Station X

Set Priority - Station X

Station X – Priority

Display Station X as Priority

Station X as Priority - Displayed

Select MASTER ARM

MASTER ARM - ARM

Display ARM

ARM - Displayed

[Ready Weapon == True]

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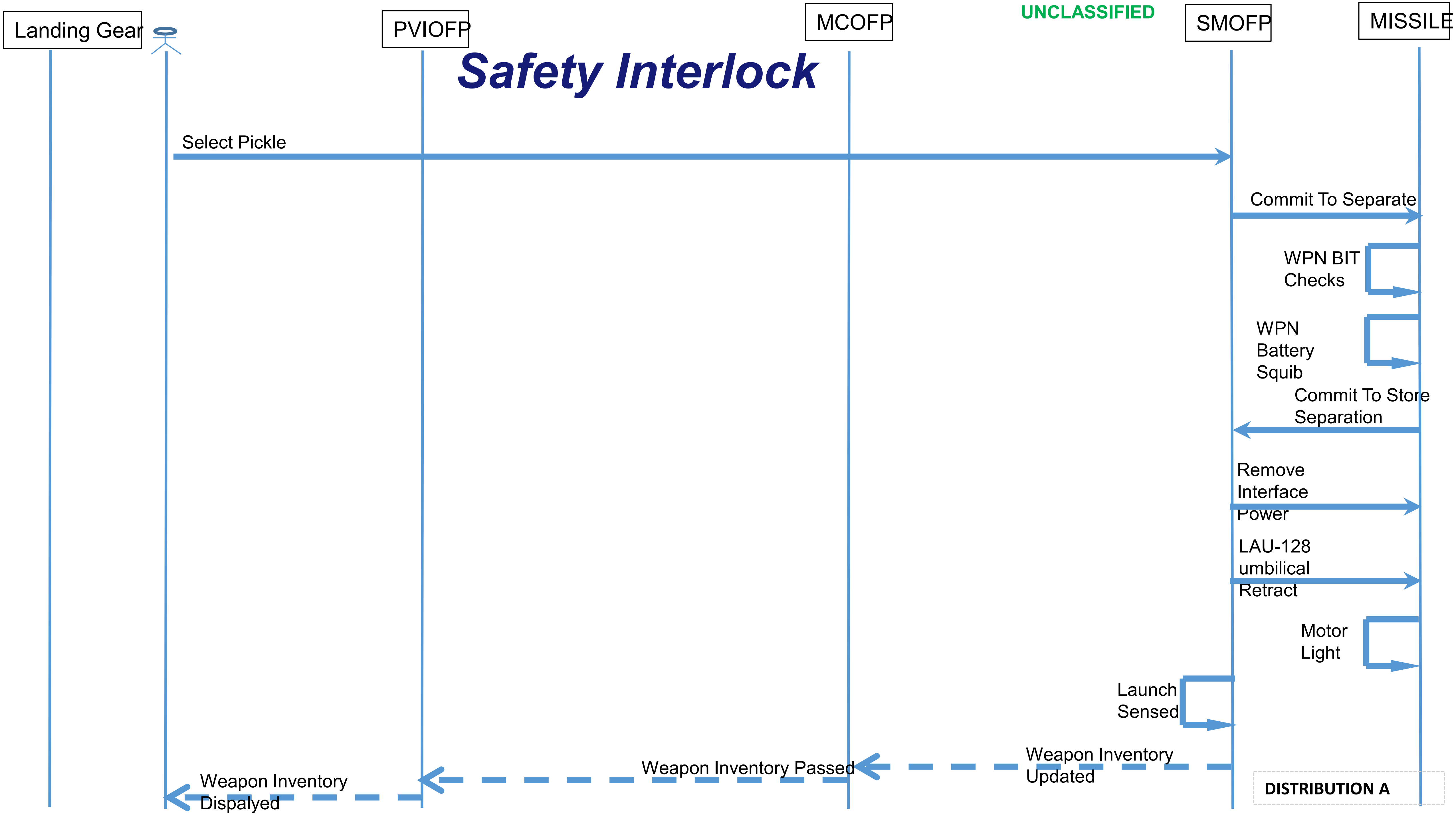
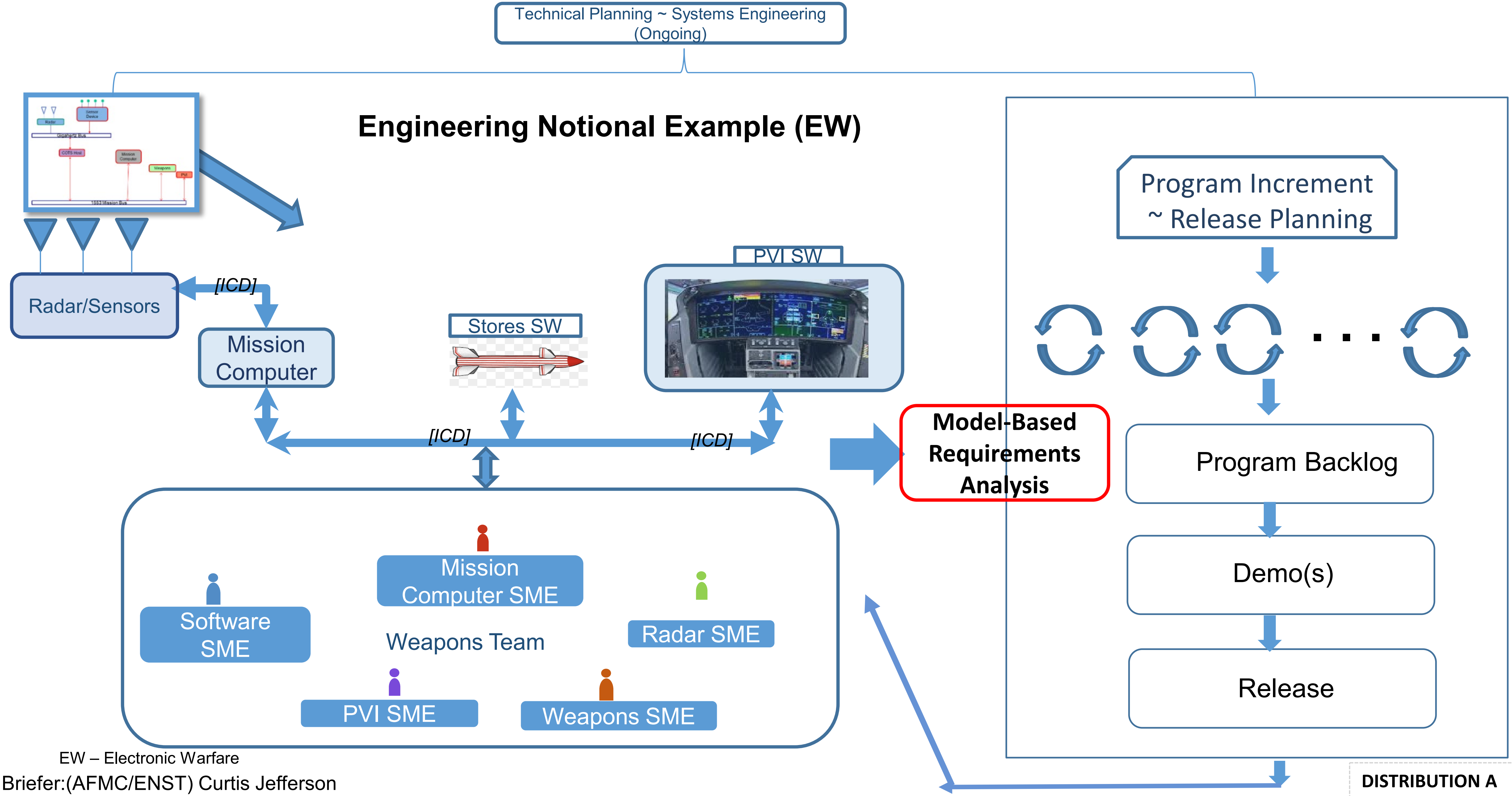


DISTRIBUTION A

Vetted Model

- Model exhibits acceptable level of correctness?
- Model contains proper level of detail?
- Is model readable/understandable?

Agile Software Course/Workshop - Current



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Model-Based Requirements Analysis

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EW – Electronic Warfare

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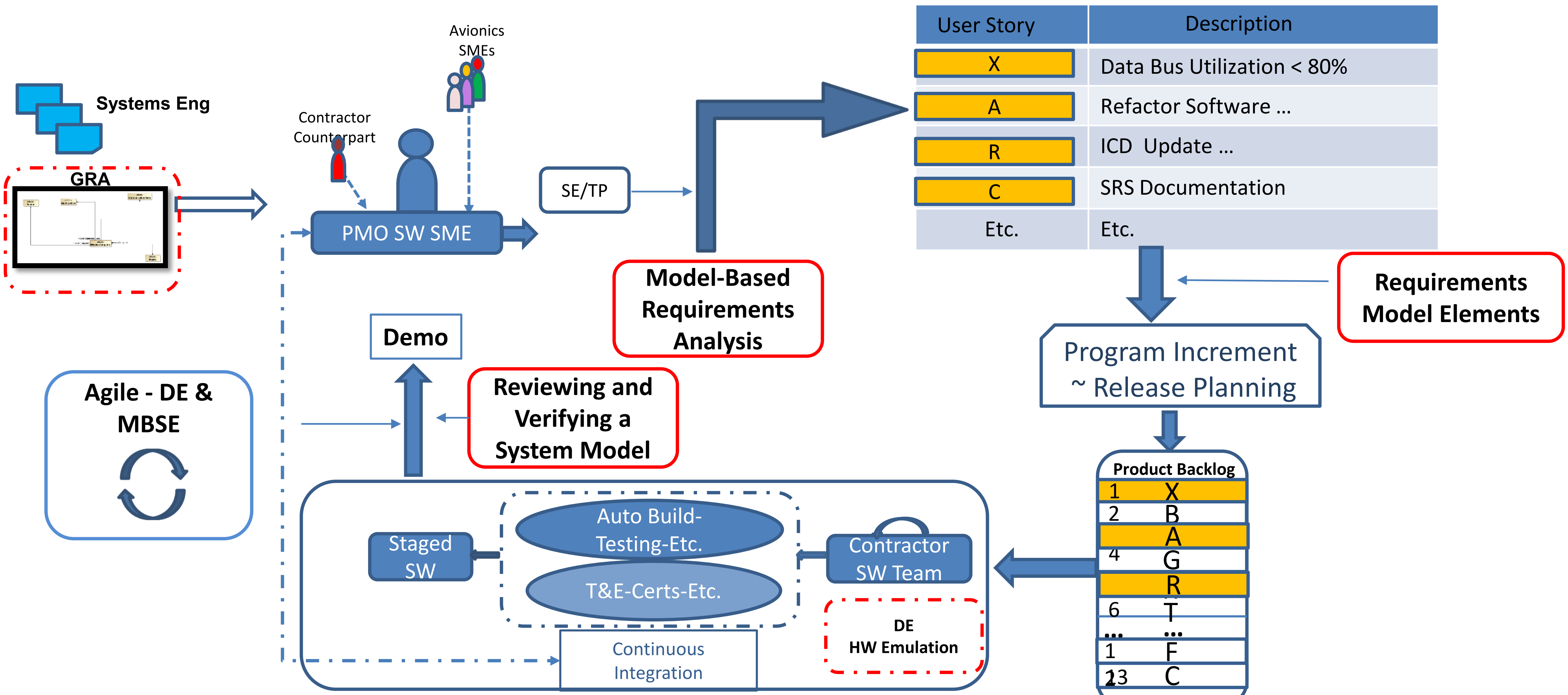
Model Execution

Agile Software Course/Workshop - Expansion



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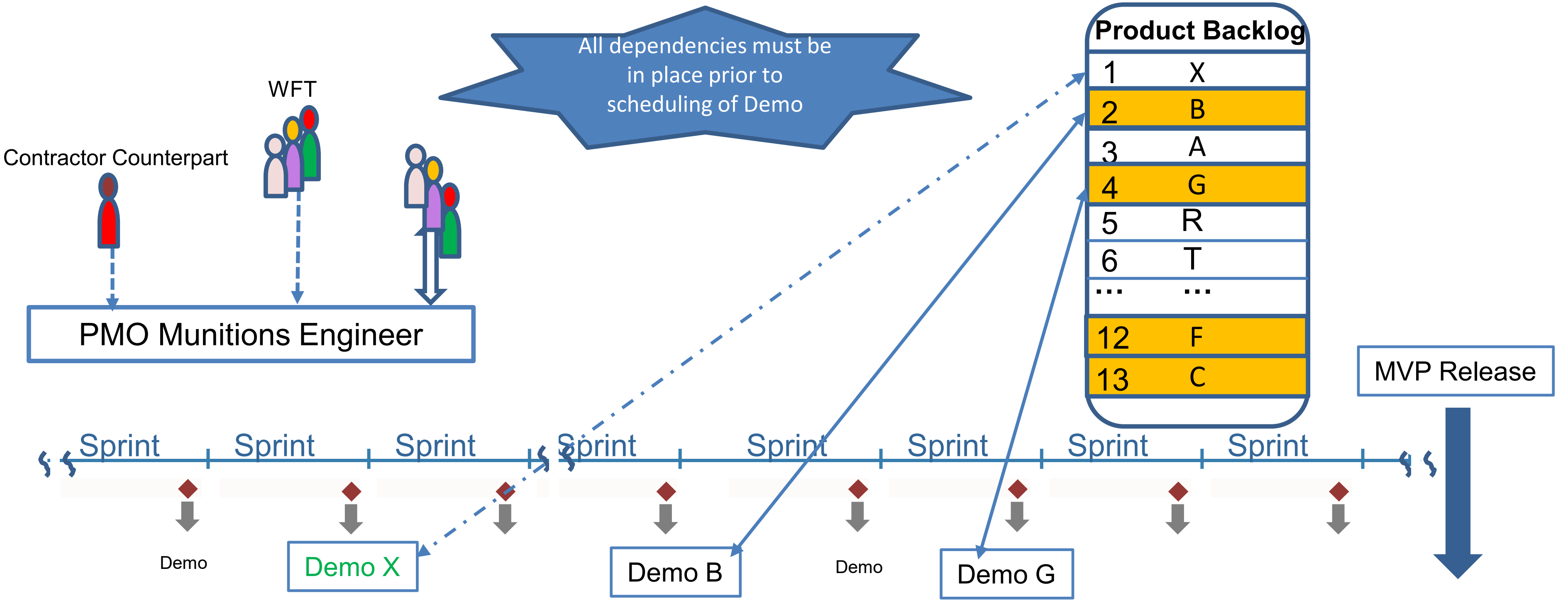
Production of Warfighter Capability



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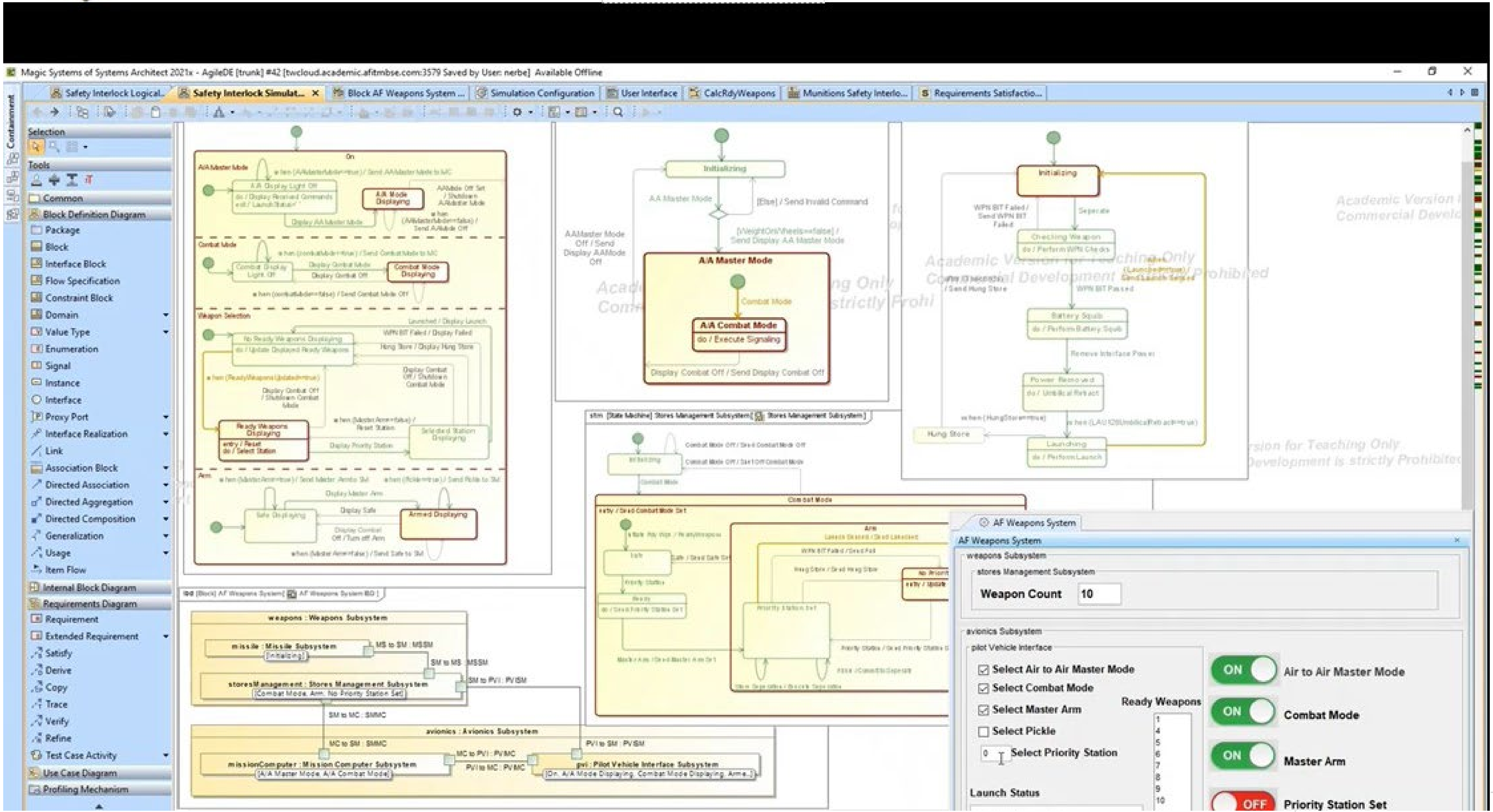
Questions?

Backup Slide

Model Execution



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AF Weapons System

weapons Subsystem

stores Management Subsystem

Weapon Count 10

avionics Subsystem

pilot Vehicle Interface

☑ Select Air to Air Master Mode

☑ Select Combat Mode

☑ Select Master Arm

□ Select Pickle

0 Select Priority Station

Ready Weapons: 1, 4, 5, 6, 7, 8, 9, 10

Launch Status

ON Air to Air Master Mode

ON Combat Mode

ON Master Arm

OFF Priority Station Set

TEST
SUSTAINMENT
NUCLEAR SYSTEMS
DISCOVERY
MISSION SUPPORT
LIFE CYCLE

ENGINEERING & TECHNICAL MGT