Aerospace Software Development

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About Me

Professional Experience:

- Senior Software Engineer at Raytheon for approximately 17 years
- Senior Full-Stack Developer at RevaComm for approximately 2 years
- Developed an iOS application and a restaurant website

Education:

- B.S. in Electrical Engineering & Computer Engineering from UCLA
- M.S. in Electrical Engineering from USC

Family:

- Met my wife at USC, and we have two sons

Interests:

- Enjoy music, web surfing, lion dance, and staying updated with new technologies
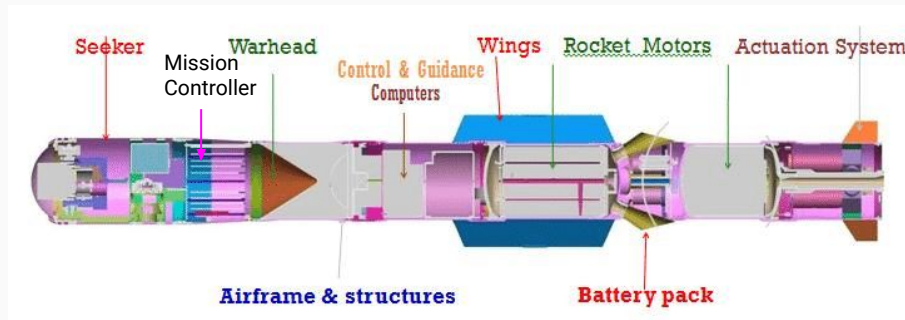
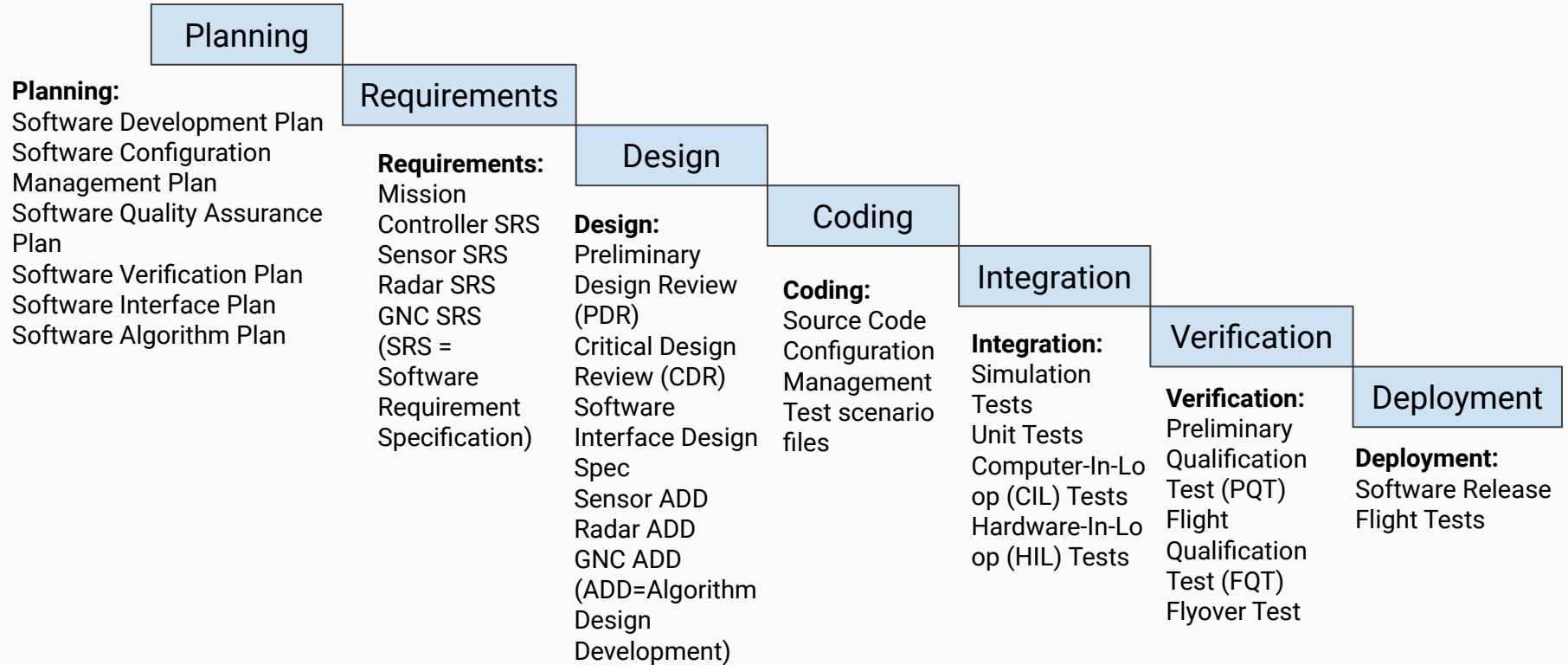# Software Development for Advanced Missile System

Definition:
- Missile defense is a weapon system involved in the detection, tracking, interception, and destruction of the targets
- A missile has several major components, including a seeker, radar, GNC (Guidance, Navigation, and Control), warhead, rocket motors, and a mission controller that manages and coordinates other systems via a messaging mechanism
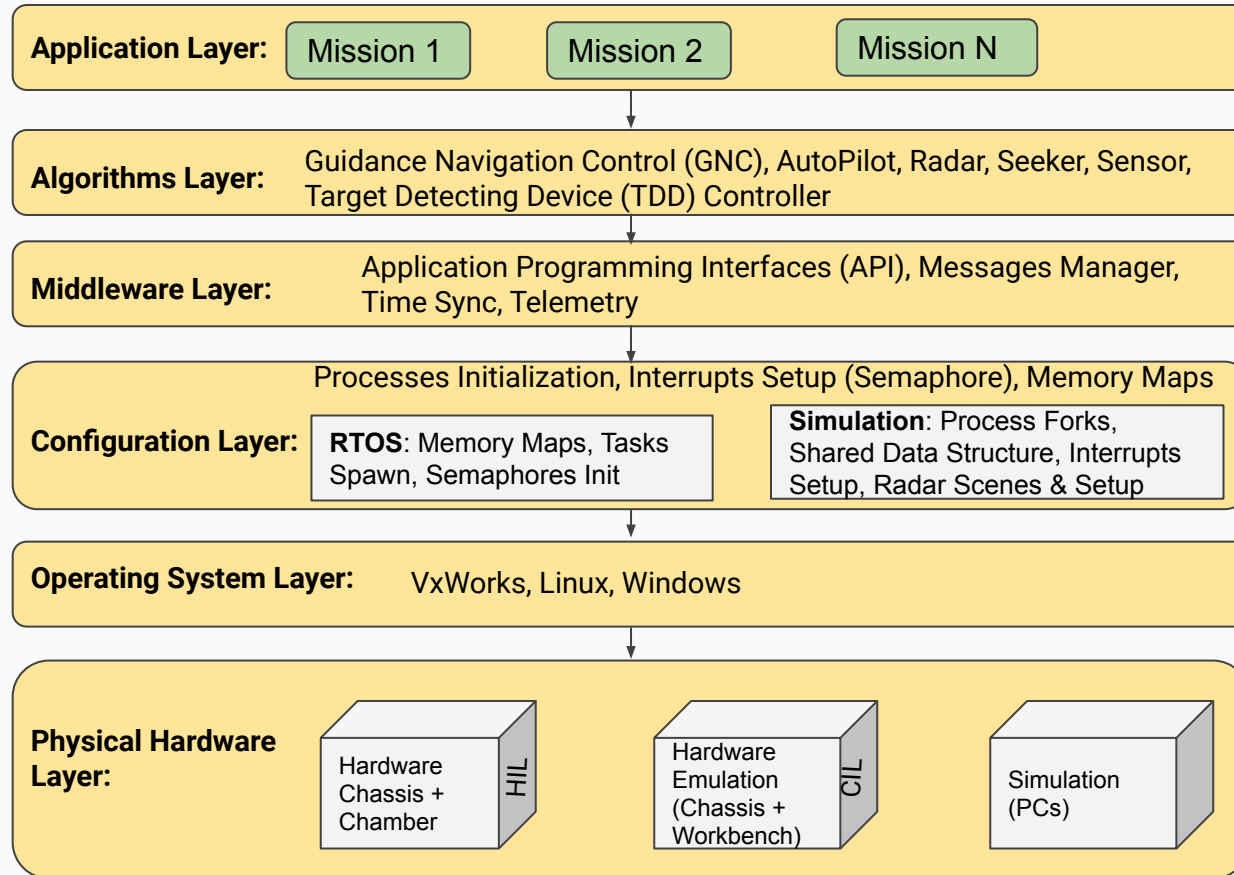
Development:
- Each subsystem has a team of engineers responsible for design and development
- Every team will present their preliminary design, conduct code reviews, verify software requirements, and perform performance analysis.
- During the development process, both the software and algorithm engineering teams hold meetings for design review, code review, and data analysis.

Software Development Life Cycle - Cascade/Waterfall Methodology

Planning

Requirements

Design

Coding

Integration

Verification

Deployment

Planning:
Software Development Plan
Software Configuration Management Plan
Software Quality Assurance Plan
Software Verification Plan
Software Interface Plan
Software Algorithm Plan

Requirements:
Mission Controller SRS
Sensor SRS
Radar SRS
GNC SRS
(SRS = Software Requirement Specification)

Design:
Preliminary Design Review (PDR)
Critical Design Review (CDR)
Software Interface Design Spec
Sensor ADD
Radar ADD
GNC ADD
(ADD=Algorithm Design Development)

Coding:
Source Code
Configuration Management
Test scenario files

Integration:
Simulation Tests
Unit Tests
Computer-In-Loop (CIL) Tests
Hardware-In-Loop (HIL) Tests

Verification:
Preliminary Qualification Test (PQT)
Flight Qualification Test (FQT)
Flyover Test

Deployment:
Software Release
Flight Tests

Software Architecture Overview

Application Layer: Mission 1   Mission 2   Mission N

Algorithms Layer: Guidance Navigation Control (GNC), AutoPilot, Radar, Seeker, Sensor, Target Detecting Device (TDD) Controller

Middleware Layer: Application Programming Interfaces (API), Messages Manager, Time Sync, Telemetry

Configuration Layer: Processes Initialization, Interrupts Setup (Semaphore), Memory Maps

RTOS: Memory Maps, Tasks Spawn, Semaphores Init

Simulation: Process Forks, Shared Data Structure, Interrupts Setup, Radar Scenes & Setup

Operating System Layer: VxWorks, Linux, Windows

Physical Hardware Layer:

Hardware Chassis + Chamber   HIL

Hardware Emulation (Chassis + Workbench)   CIL

Simulation (PCs)

Unit Testing:
- Run tests in the workbench to verify specific software components, functions, algorithms, and interfaces.

Computer-in-the-Loop (CIL) Test:
- Use software programs to emulate hardware functionalities and test missile software performance in the chassis.
- Primarily used for validating Radar or Sensor algorithms as well as nominal missile performance.

Hardware-in-the-Loop (HIL) Test:
- HIL testing involves testing electronic control units in a realistic simulated or controlled environment.
- Tests are usually conducted in the RF chamber, running through different Radar and Sensor scenarios to assess missile performance.
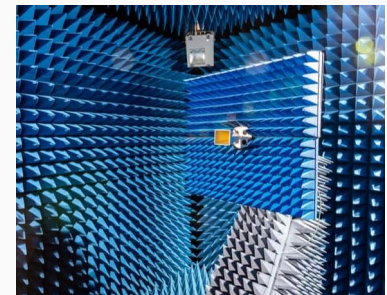- This facility setup can be utilized for Flight Qualification Tests (FQT) before releasing the missile program.

SIM Test:
- Simulation tests on desktop computers using a variety of Radar & Sensor scenarios to evaluate missile performance and DSP algorithms.

CIL

HIL

Telemetry: Data Collection & Analysis

Definition:

- Telemetry automatically collects and transmits data to a central location.

Real-time Telemetry Dataset and Analysis:

- A small set of data parameters is allocated for real-time telemetry.
- During flight tests, including flyover tests, engineers will monitor and analyze these parameters for system health checks and other performance statuses.
- Test operators may use this real-time feedback to make test adjustments if needed.

Post Data Analysis:

- During integration tests, test operators will conduct a quick-look analysis and make test adjustments if needed.
- Recorded telemetry will be organized and pre-processed, which may auto-generate plots and results for PowerPoint documentation.
- SME and REA will review and analyze telemetry data for missile performance analysis and software requirements verification.

Coding Standards and Best Practices

C++ Coding Standards:

- Always initialize variables
- Minimize the use of global variables and declare variables as locally as possible
- Avoid magic numbers
- Include comments in the code to enhance readability and understanding

Version Control System:

- Use Synergy for code and configuration management

Scrum Methodologies:

- Scrum is an agile framework comprising a Product Owner, a Scrum Master, and Developers, each with specific accountabilities
- Create stories for each sprint schedule, and developers work on them during the sprint

Technologies & Application

Embedded Software Development:
- C++, Matlab, RTOS, VxWorks, Ada
- Tools: WindRiver Product (IDE, Windview, memory analysis), databus analysis tool (Ethereal, VMEbus analyzer, RF link analyzer), JTAG reprogramming tool

Full Stack Software Development:
- Follow Agile Software Development Model with continuous release cycles - Use Kanban system
- Frontend: Javascript, Grapes.js, Vue.js, Vuetify, Pinia, CSS/SCSS
- Backend: Node.js, Sequelize.js, NGINX, MySQL
- Device Application: Swift, Objective-C
- Test Scripts: Python, Jest, ViTest, Cypress
- Tools: Chrome Developer Tools, Visual Studio Code, GitLab, DBeaver, PostMan

Microservice and Automation Development:
- Kubernetes, Dockers, ArgoCD
- YALM, JSON, NPM packaging

Recommendations For Job Search

Create A Profile:
- Maintain an active LinkedIn account with regular updates
- Showcase your projects within the GitHub community
- Utilize resume templates to craft a concise, 1-2 page resume
- Engage in coding practice through platforms like LeetCode or other online resources

Interview:
- Research about the companies
- Read Q&A for common interview questions
- Practices

Transition to workforce:
- Be open-minded and willing to work on a variety of tasks. Try not to be pigeonholed.
- If possible, seek out a mentor
- Present your work to the audience, which includes your team as well as internal and external customers
- **Challenges:** Technical debt, requirement scope creep, hardware failures, and teams miscommunications

Standard Missile 6 (SM6)

Thank You!