SAFe with MBSE

For System Engineers

Presented By:

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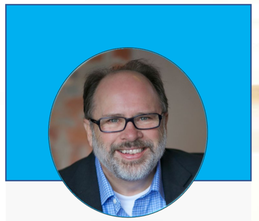
The Continuous Engineering Experts™

WHO WE ARE.



Peter Luckey

321 Gang helps organizations improve their ability to design and develop high- quality systems and software. Our team of experts will help you in adopting the best agile/lean or traditional practices and/or tools for your organization's unique challenges and ROI goals.

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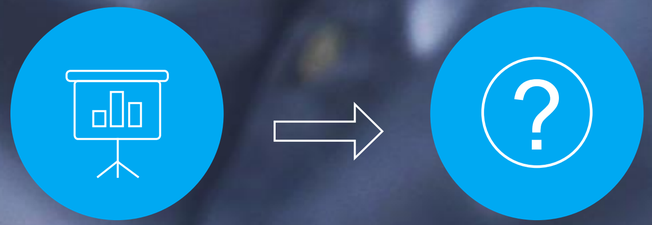
Premise

It is important to involve System Engineering in the identification of the features to be developed during each Program Increment (PI).

Model Based System Engineering (MBSE) enables the System Engineers to:

- ✓ Collaboratively create a shared understanding of system structure, behavior, and interfaces
- ✓ Record decisions as a single source of truth using standard notation
- ✓ Use emergent specifications to drive the agile development process

Today’s agenda



Presentation
40 minutes

Q&A
10 minutes

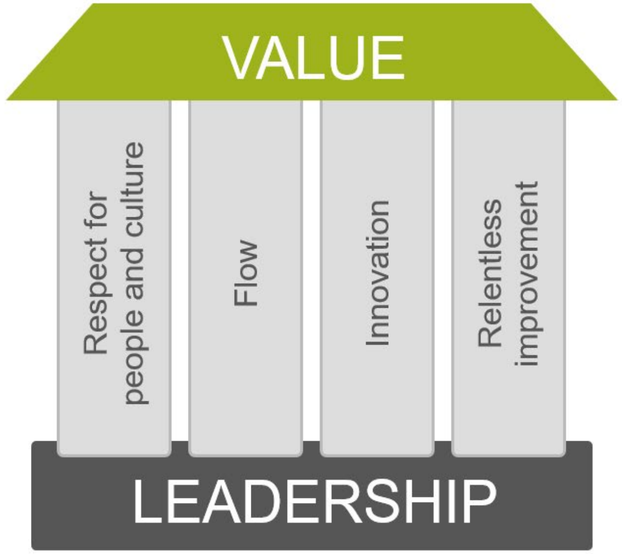
- Understand Lean-Agile principles, practices, and roles
- Know the characteristics of a specification workshop
- Detail a Systems Engineering workshop
  - Part 1 – Analysis
  - Part 2 – Design / Construction
- Making effective change

Understand Lean-Agile principles, practices, and roles

Lean-Agile Foundations

Information

SAFe House of Lean



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The Agile Manifesto

We are uncovering better ways of developing software by doing it and helping others do it.

Through this work we have come to value:

Individuals and interactions over processes and tools

Working software over comprehensive documentation

Customer collaboration over contract negotiation

Responding to change over following a plan

That is, while there is value in the items on the right, we value the items on the left more.

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Lean-Agile Foundations

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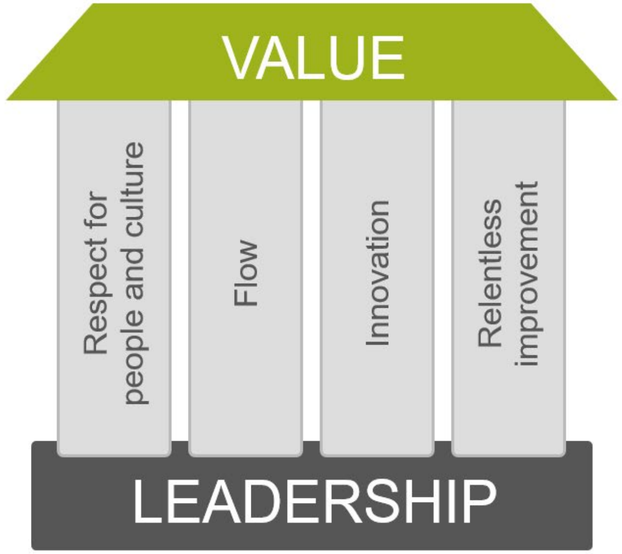

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SAFe Lean-Agile principles

#1 - Take an economic view

#2 - Apply systems thinking

#3 - Assume variability; preserve options

#4 - Build incrementally with fast, integrated learning cycles

#5 - Base milestones on objective evaluation of working systems

#6 - Visualize and limit WIP, reduce batch sizes, and manage queue lengths

#7 - Apply cadence, synchronize with cross-domain planning

#8 - Unlock the intrinsic motivation of knowledge workers

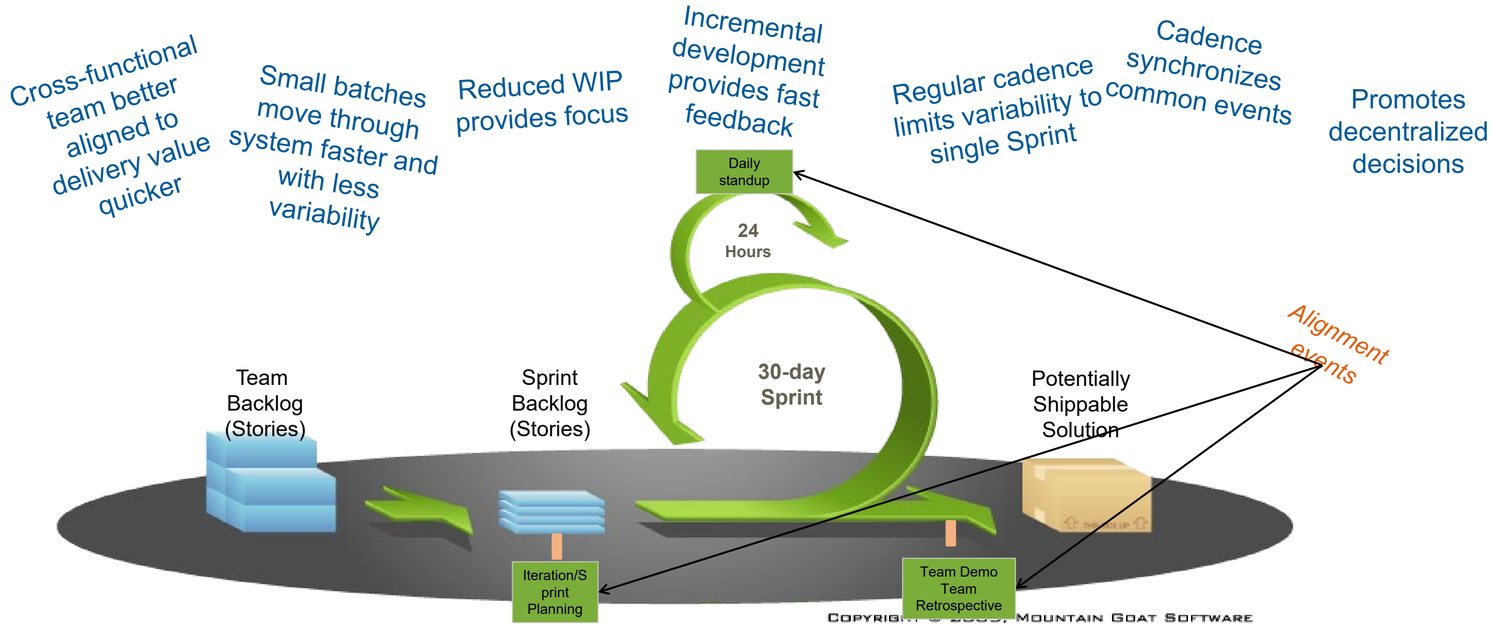
#9 - Decentralize decision-making

#10 – Organize around value

Agile Teams

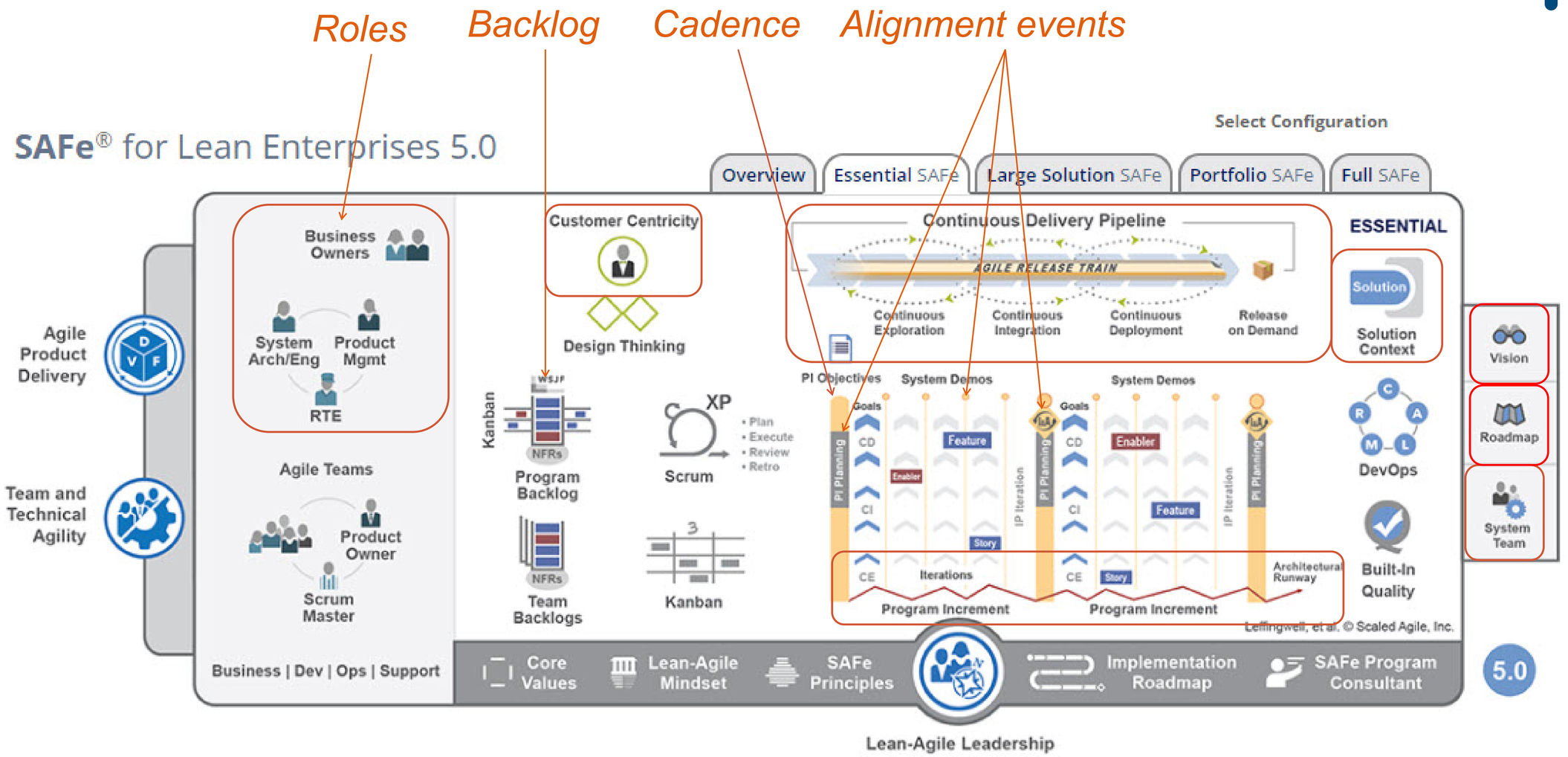
Information

- Product Owner
  - Serves as customer proxy to the team
  - Owns vision, and team's backlog
- Scrum Master
  - Helps team achieve its goals; remove impediments
  - Coaches team on lean-agile practices
- Other Team Members
  - Small, cross functional group that plans, commits, implements, demos, and continuously improves together
  - Self-organized, self-managed



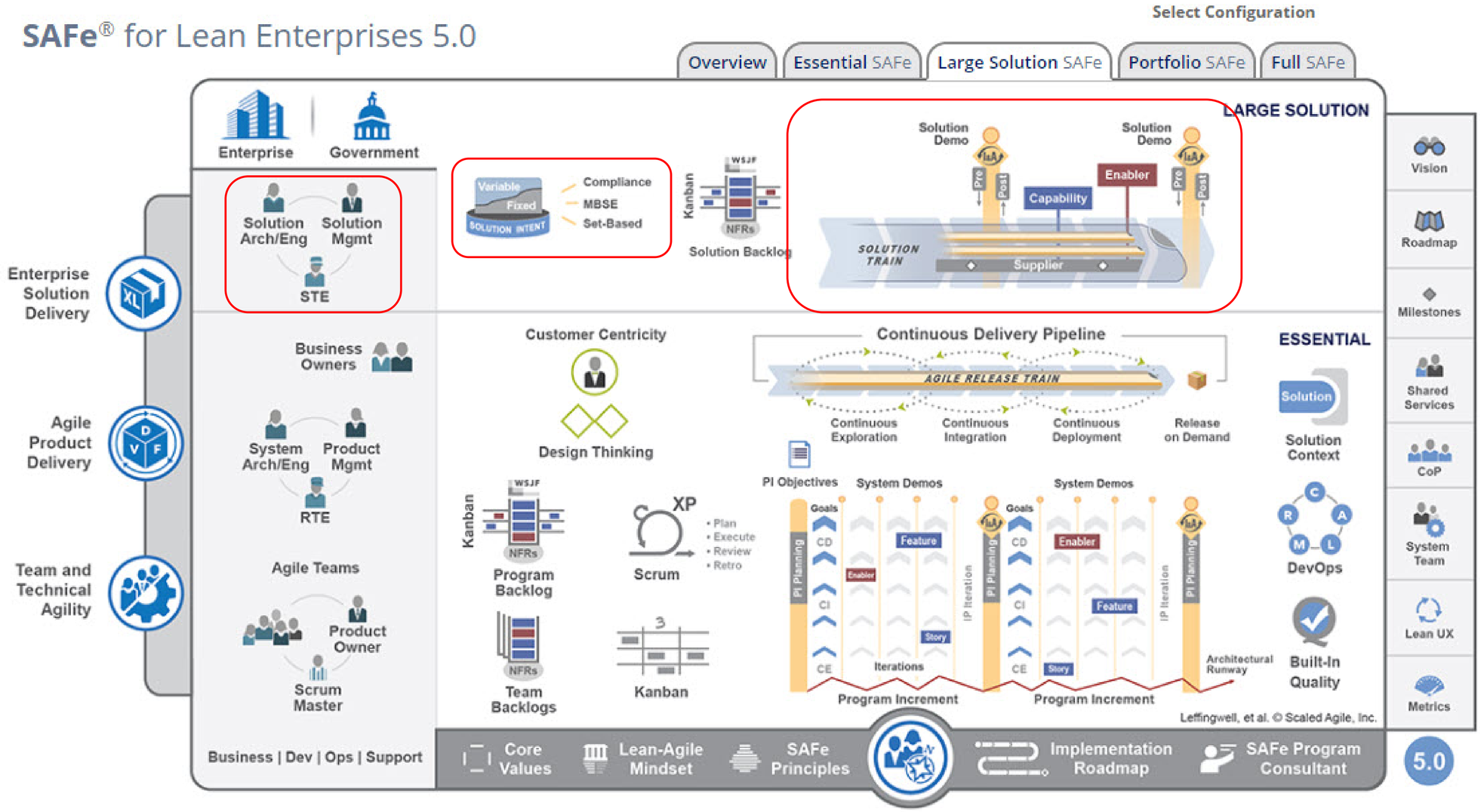
Scaling Agile to large systems or organizations

Information



Scaling Agile to (very) large systems and enterprises

Information



Know the characteristics of a specification workshop

Specification Workshops create alignment and shared understanding

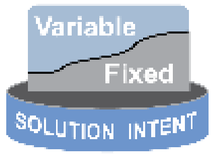
- Collaboratively discover and communicate solution's specification and prioritization
  - Create and maintain system's single source of truth
  - Socialize ideas from multiple experts
  - Perform engineering work continuously
  - Allow architectures to be defined incrementally
  - And designs to emerge
  - Record decisions in specifications

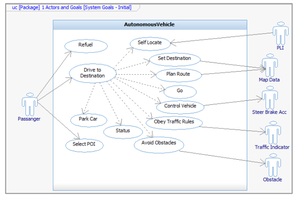
Use SE Workshops to create specifications and plans

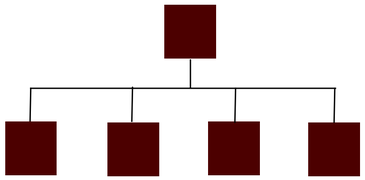
- Workshops elaborate the architecture and design over time
- Keep options open, elaborate detail at appropriate time
- Use MBSE to identify and model coarse-level system behavior and structure
- Define plan to realize solution

System structure and behavior

- Create coarse understanding of behavior, architecture
- Sets solution and technical vision, creates alignment

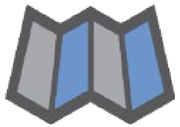






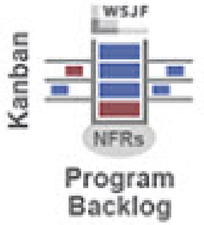
Development roadmap

- Plan to incrementally realize solution
- Focus teams on near term goals, learning



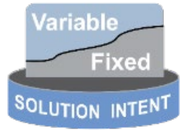
Program Backlog

- Incrementally define backlog items
- Features, Enablers, and NFRs



Use workshops to grow specifications and backlogs

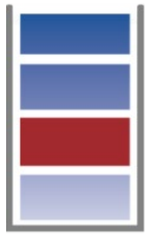
- Specify what needs to be built
- Defined work teams will perform to…
  - … build new features
  - … explore unknowns (analysis, design, etc.)
  - … build needed aspects of the Architectural Runway



System's specifications

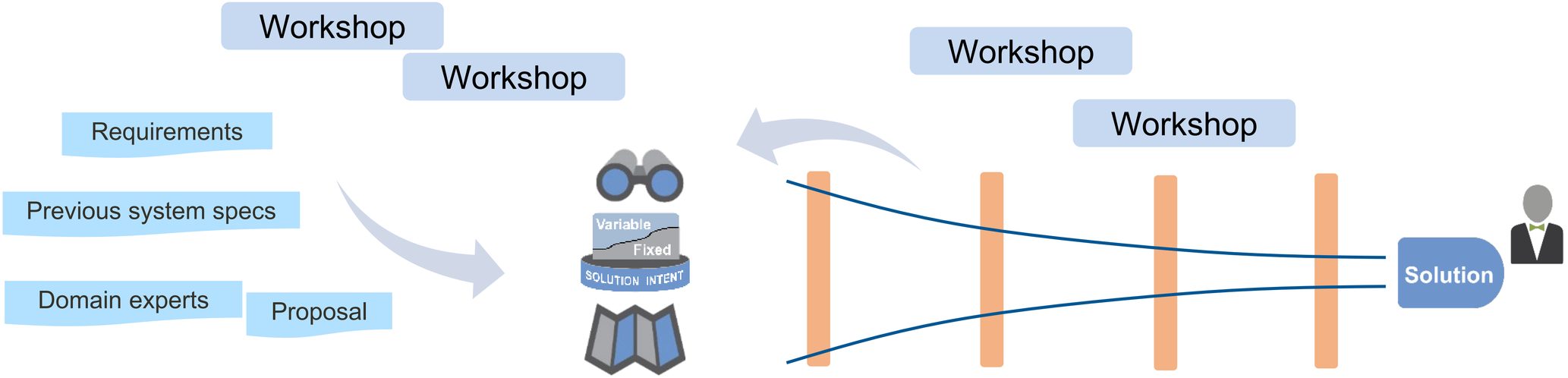
Feature

Enabler



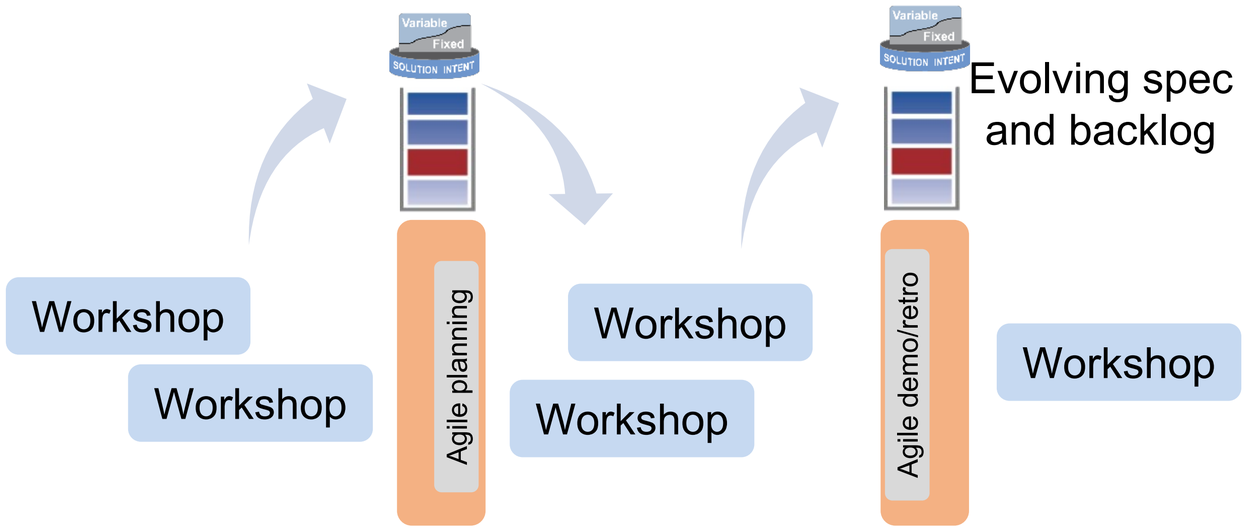
Project Backlog items

Architectural Runway

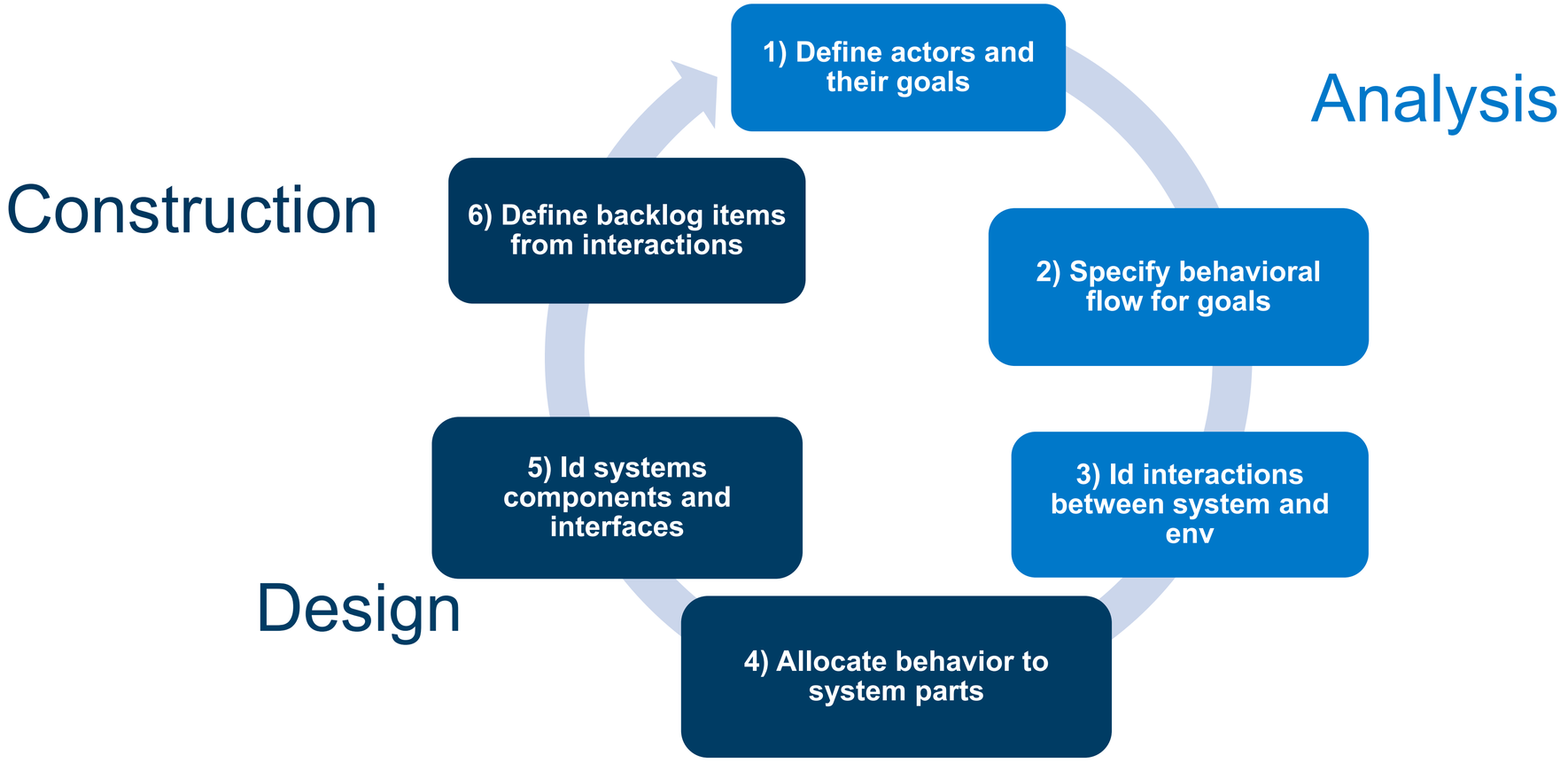


Make workshops part of cadence-based feedback

- Workshops provide focus on impending system needs – what to build and/or explore in near-term increments
- Regular cadence provides fast feedback on decisions
- Results in a more complete, consistent technical architecture
- *Workshops are in addition to regular agile and/or SAFe ceremonies*



Iteratively develop specifications

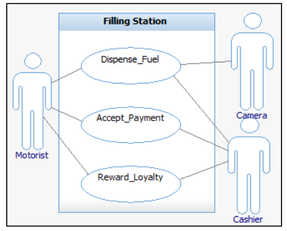


Use SysML for system specifications

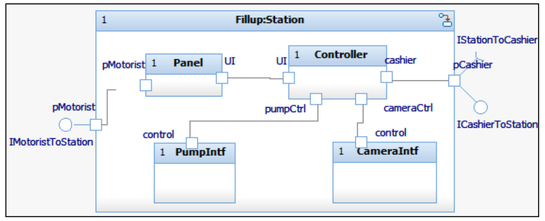
Architectural Runway

Product Backlog

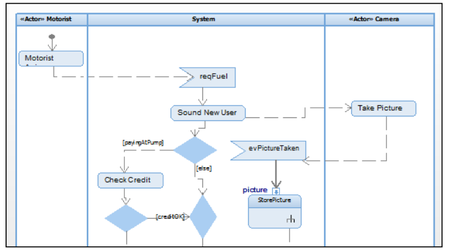
Define actors and their goals



ID components and interfaces



Specify behavioral flow for goals

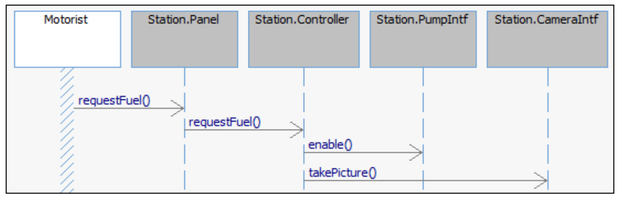


Variable

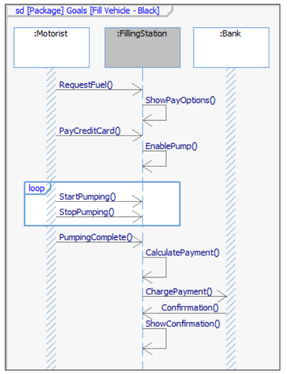
Fixed

SOLUTION INTENT

Allocate behavior to system parts



ID system and environment interaction



Roadmap

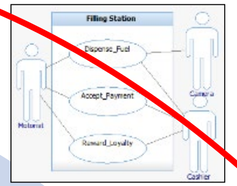
Let’s look at the Analysis Phase

Iteratively develop specifications

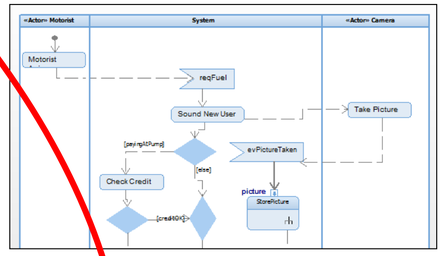
Architectural Runway

Product Backlog

1) Define actors and their goals

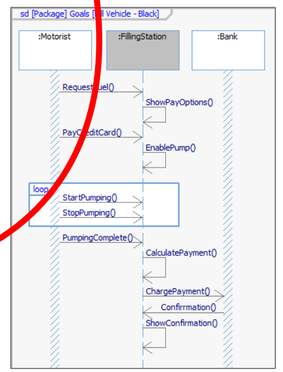


Analysis



2) Specify behavioral flow for goals

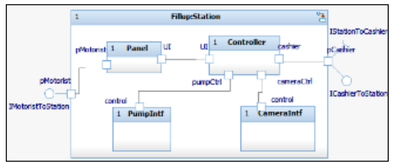
3) Id interactions between system and env



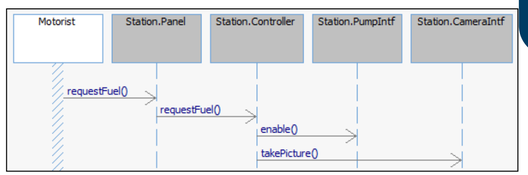
4) Allocate behavior to system parts

Design

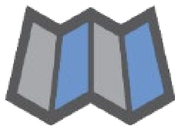
5) Id systems components and interfaces



6) Define backlog items from interactions



Construction



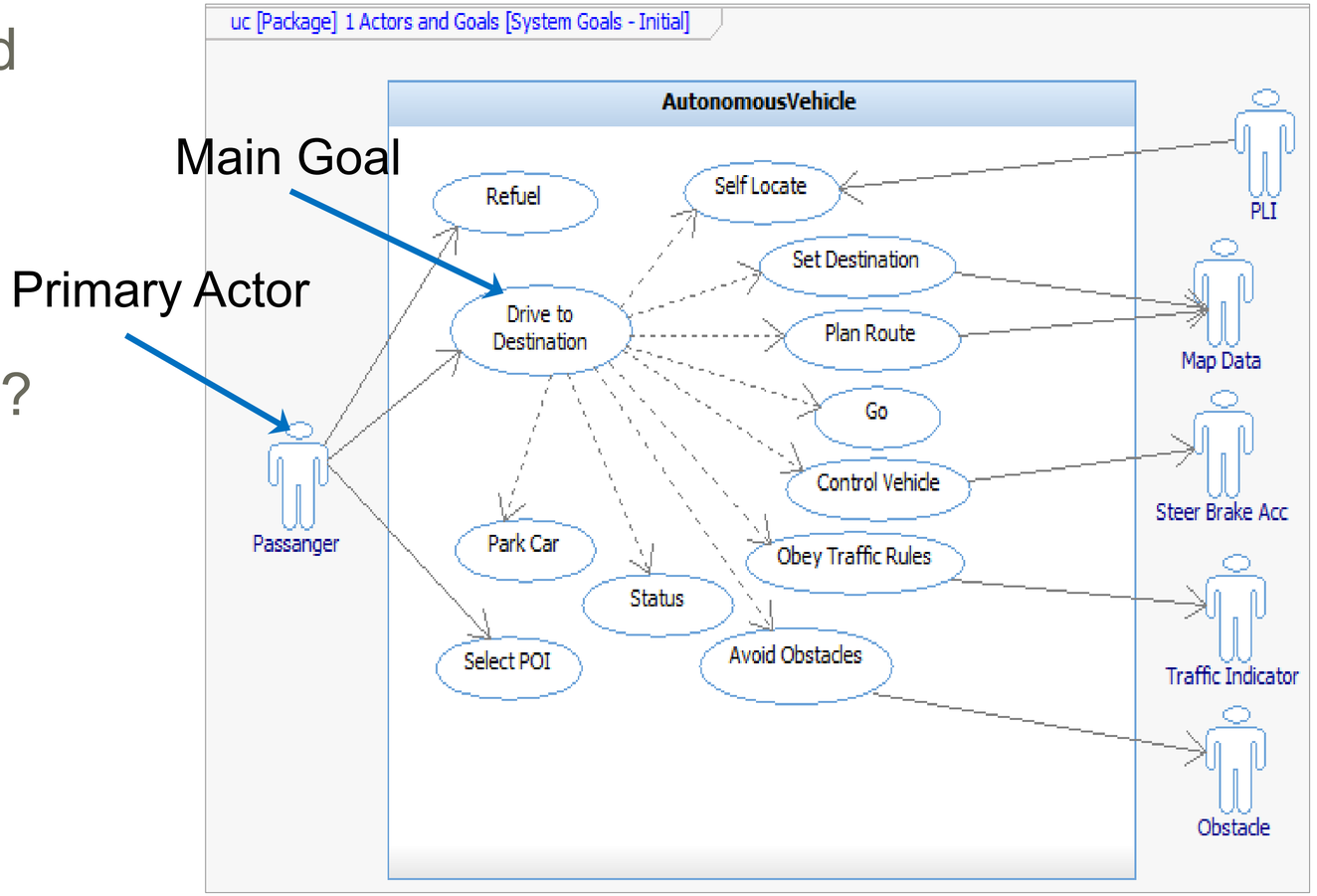
Roadmap

Analysis – Step 1
Define Actors and their Goals

Sample Solution

1) Apply Use Case modeling – actors and their goals

- ✓ Start with business value, which is commonly system's primary behavior
- ✓ Find the system's primary actor and that actor's main goal (the Alpha Thread)
- ✓ What are sub-goals of the main goal?
- ✓ With which actors do they interface?

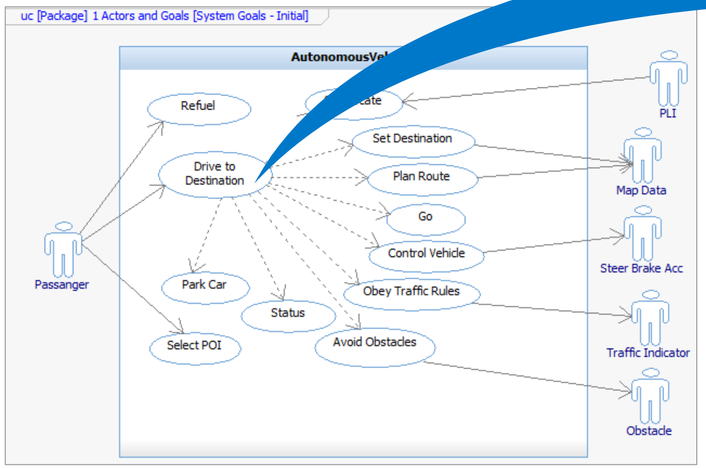


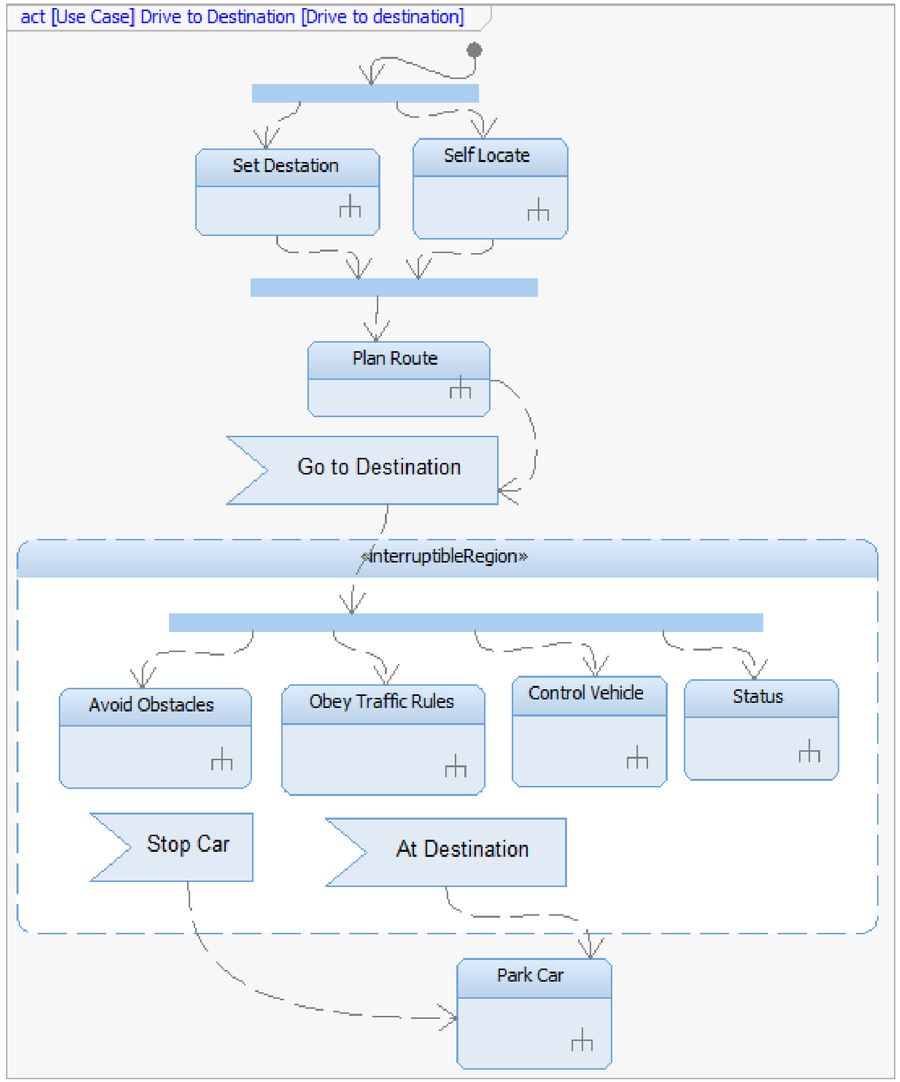
Analysis – Step 2
Specify Behavioral Flow for Goals

Sample Solution

2a) Specify behavioral flow for goals

- ✓ Describe behavior as an activity of sub-goals
- ✓ Defining the thread reveals additional sub-goals and actors
- ✓ Initially, stay focused on minimal, viable behavior
- ✓ Includes actors to show initiation

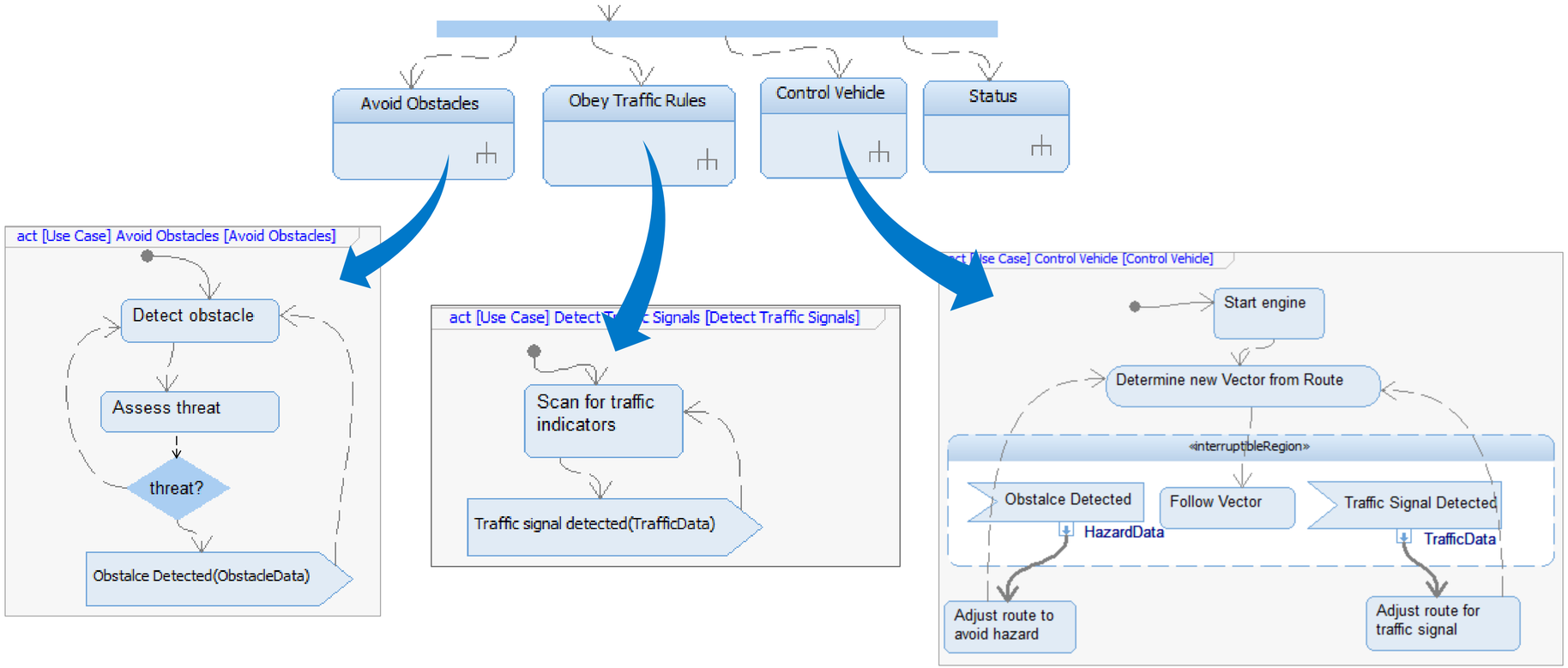




Sample Solution

2b) Specify behavioral flow for sub-goals

- ✓ Repeat the process for sub-goals
- ✓ In general, do not model below sub-goals

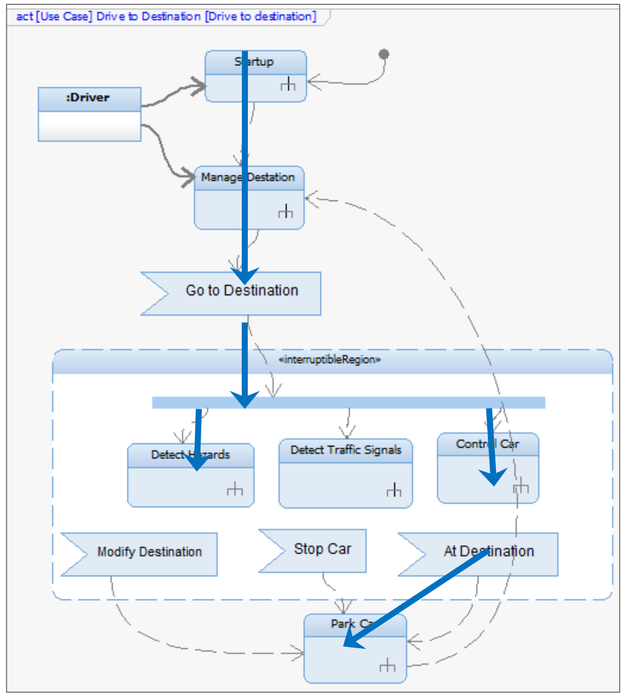


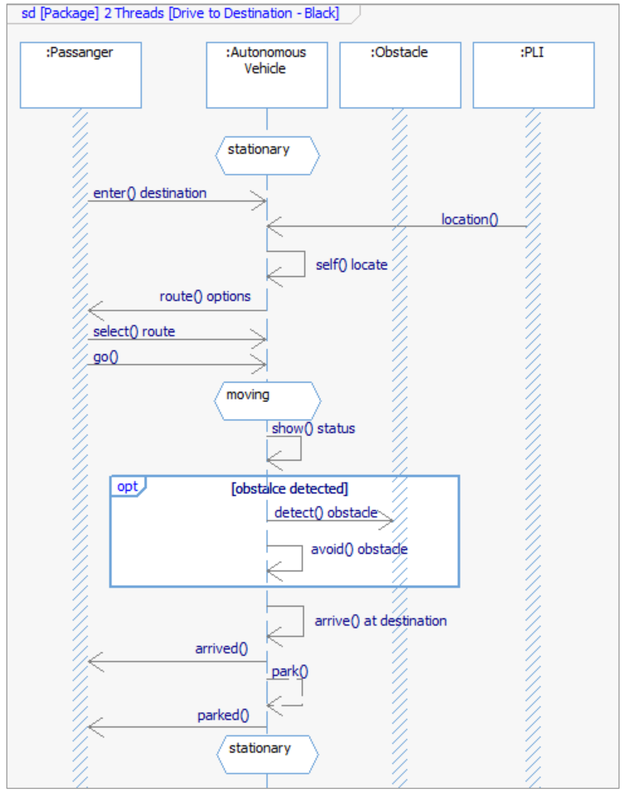
Analysis – Step 3
Identify Interactions between System and Environment

3) Create system threads from goals and sub-goals

Sample Solution

- ✓ Create black box (“skinny”) interaction flow for each Actor Goal
- ✓ Define the stimulus in and out of the system as a sequence of events
- ✓ “Highly visible” system responsibilities are shown as self-interactions
- ✓ System is a black box, no internal components
- ✓ Useful for system-level tests

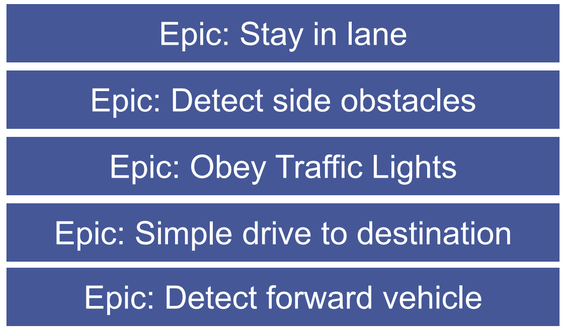




Post Analysis
Identify Epics and Build
The Epic Roadmap

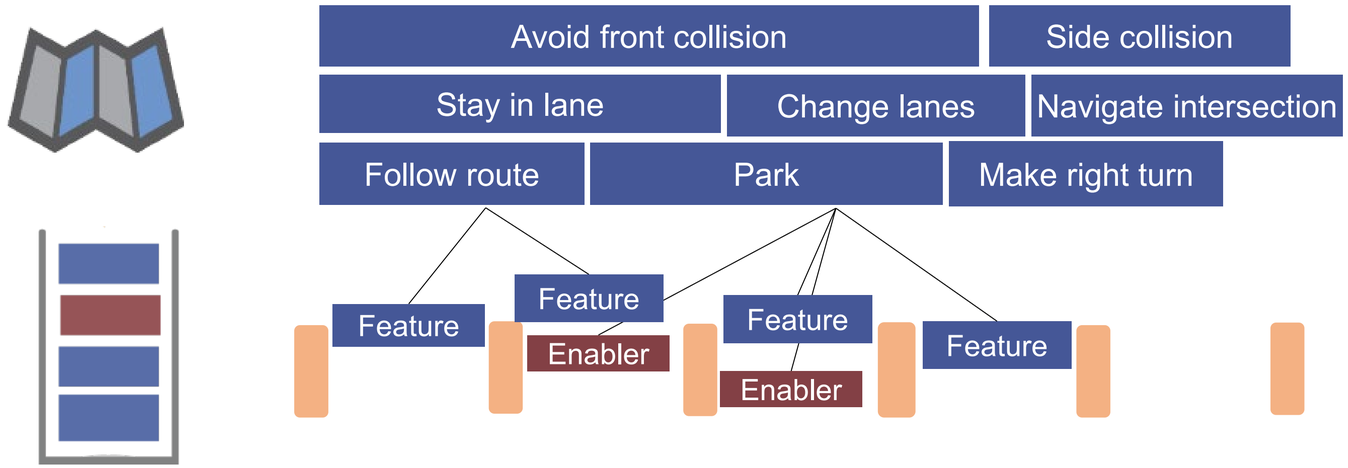
Consider threads as Agile Epics

- ✓ Epics are large, cross-cutting initiatives that deliver significant business value
- ✓ Strive for minimal viable Epics – small batches of value
- ✓ Each activity will have many Threads/Epics of varying scope



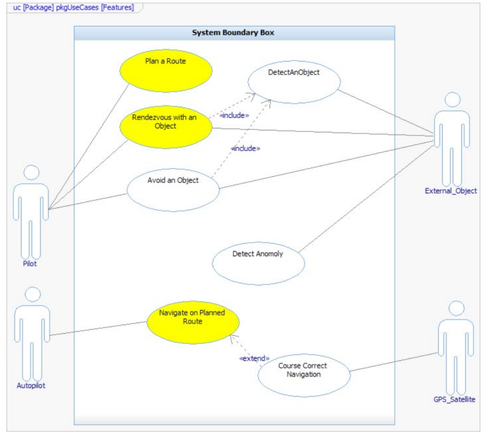
Roadmap forecasts Epics over life of program

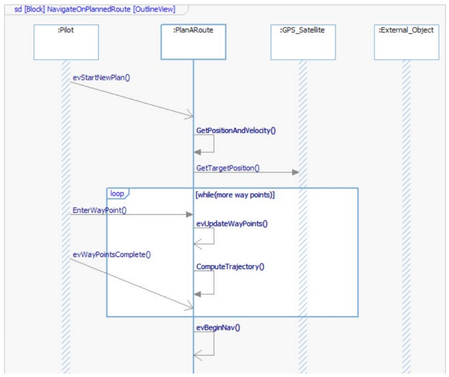
- ✓ Similar to planning packages that will be decomposed into time-boxed Features or Stories (described in next section)
- ✓ Order the Epics using either an MVP or WJSF approach to build the roadmap
- ✓ Use cadence to focus teams and provide feedback on progress and feasibility



Expand knowledge and decisions over time; manage change

- Discover and explore other actors and their goals
- Elaborate additional scenarios (exception, alternate, rainy)
- Each scenario creates new threads/Epics on the backlog

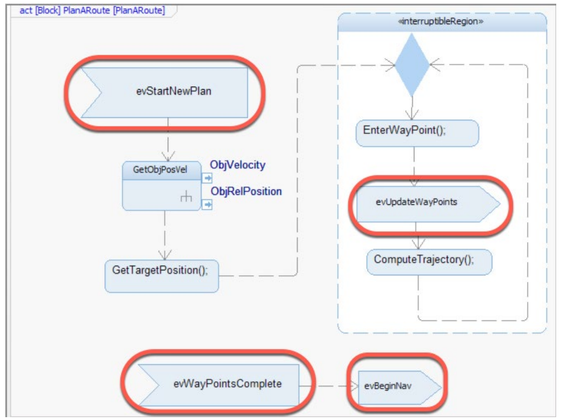




Define actors and their goals (Alpha first)

Specify behavioral flow for goals

Id stimulus between system and env



Prior to each Program Increment Planning Session go through the Design and Construction Phase

Iteratively develop specifications

Architectural Runway

Product Backlog

1) Define actors and their goals

2) Specify behavioral flow for goals

3) Id interactions between system and env

4) Allocate behavior to system parts

5) Id systems components and interfaces

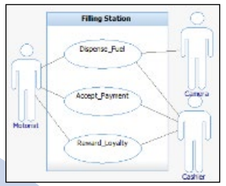
6) Define backlog items from interactions

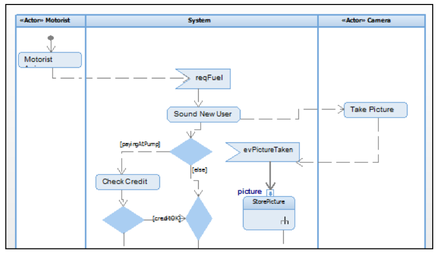
Analysis

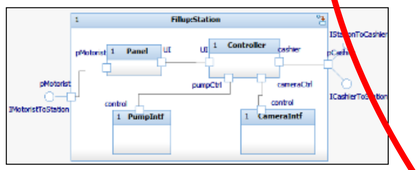
Design

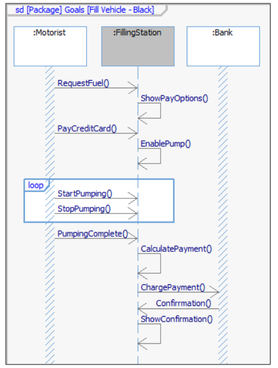
Construction

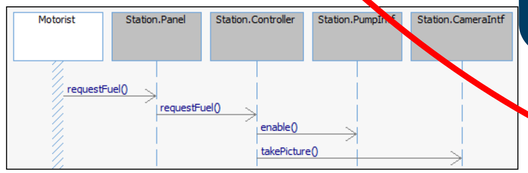
Roadmap









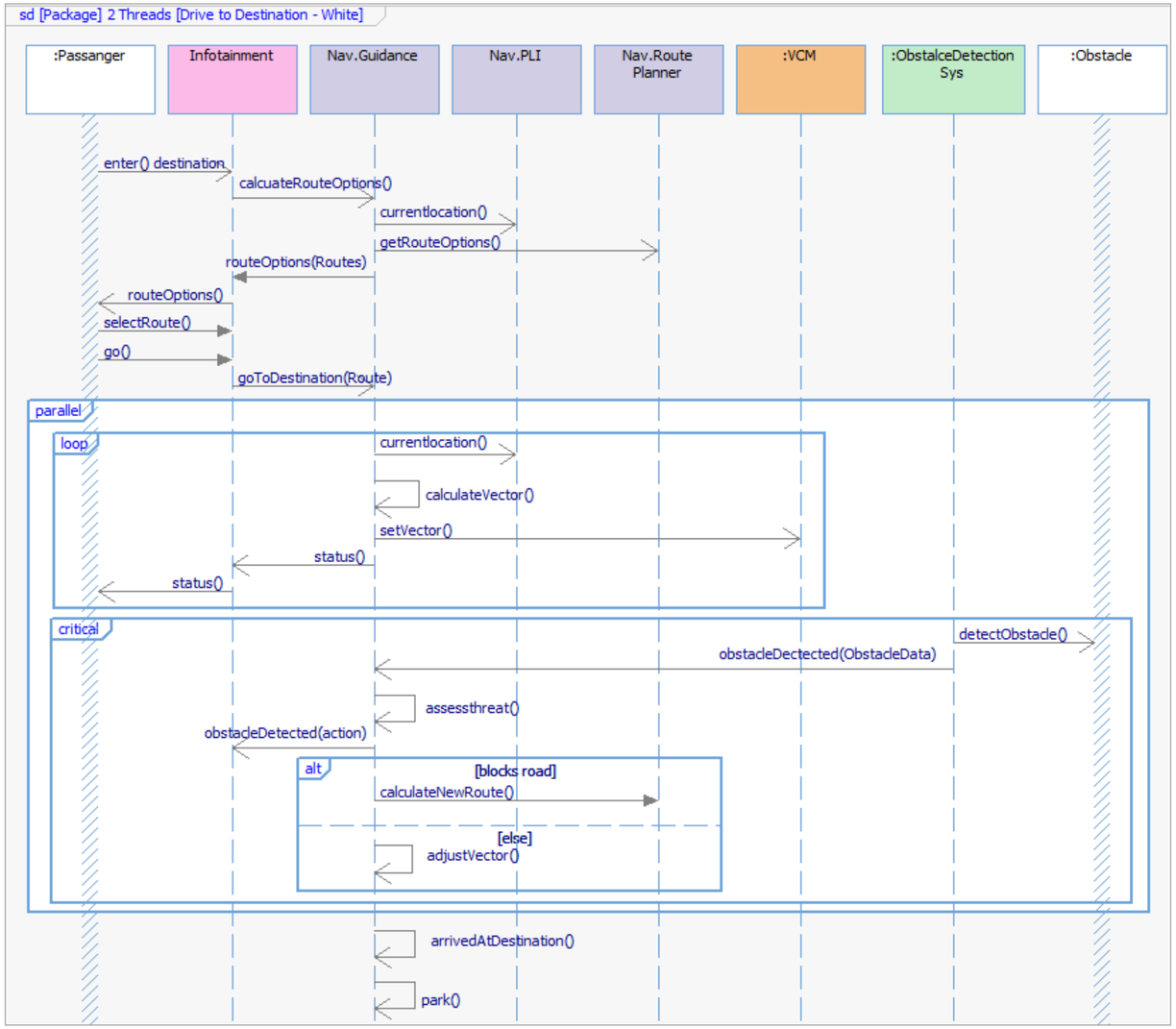


Design – Step 4
Allocate Behavior to System Parts

Sample Solution

4) Allocate behavior to system parts

- For each external interaction, decide how system elements realize the behavior
  - What system part receives the interaction and what is the system's response?
  - What system part sends the interaction and what led to system sending it?
- First step in design - determine how behavior is realized by system elements
- Discover system parts and allocate responsibilities to them



Design – Step 5
Identify System Components
And their Interfaces

5) Define system components and interfaces

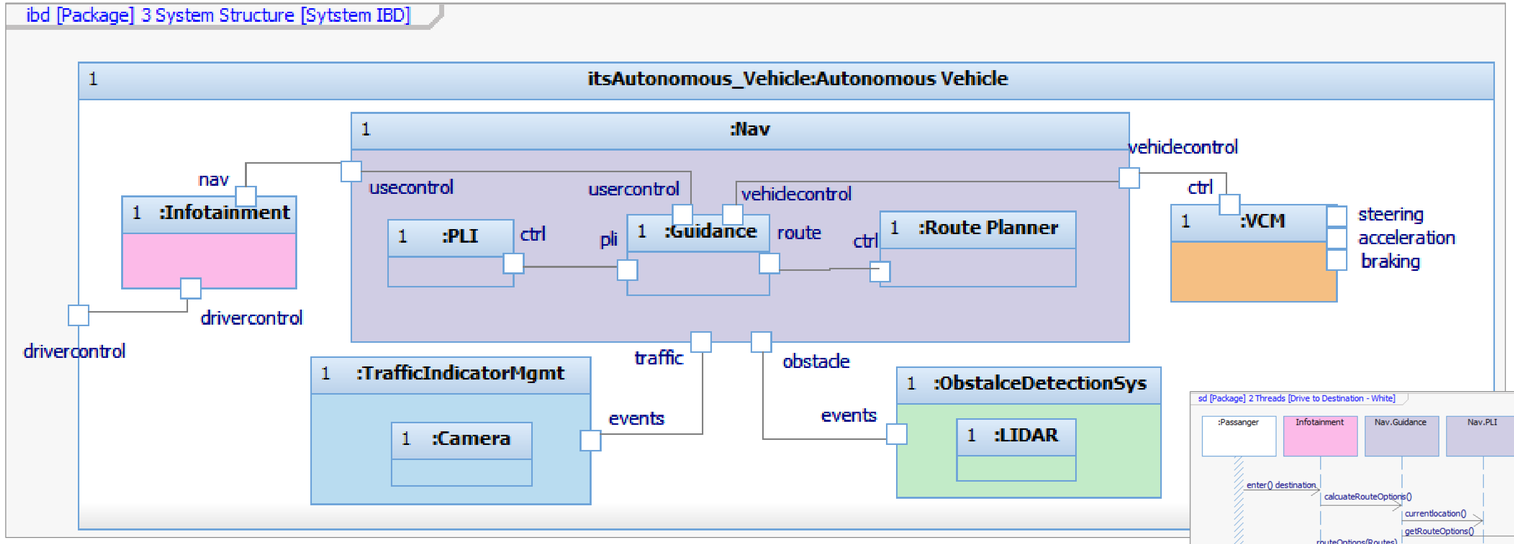
- Blocks decompose system's hierarchical structure
- Ports define interactions into and out of a block
- Interactions that must be consumed or provided
- Interfaces and behavior serve as requirements for block implementation (ICD)
- Decomposition scales to extremely large systems

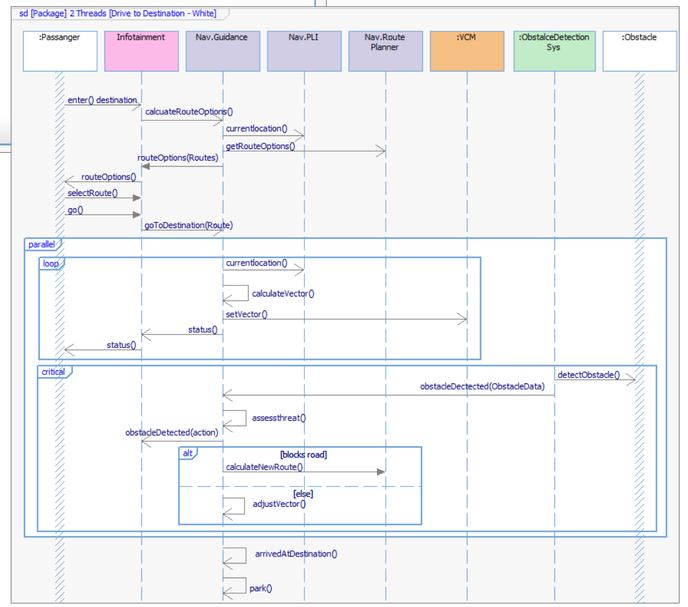
The purpose this exercise is not to build the ultimate block diagram with interface blocks and the like, but to decompose the SUD into its hierarchical structure. As well, the interfaces or connections among the blocks need to be identified.

Sample Solution

5) Define system components and interfaces

- Example includes internal components for Nav (optional, shown as example)





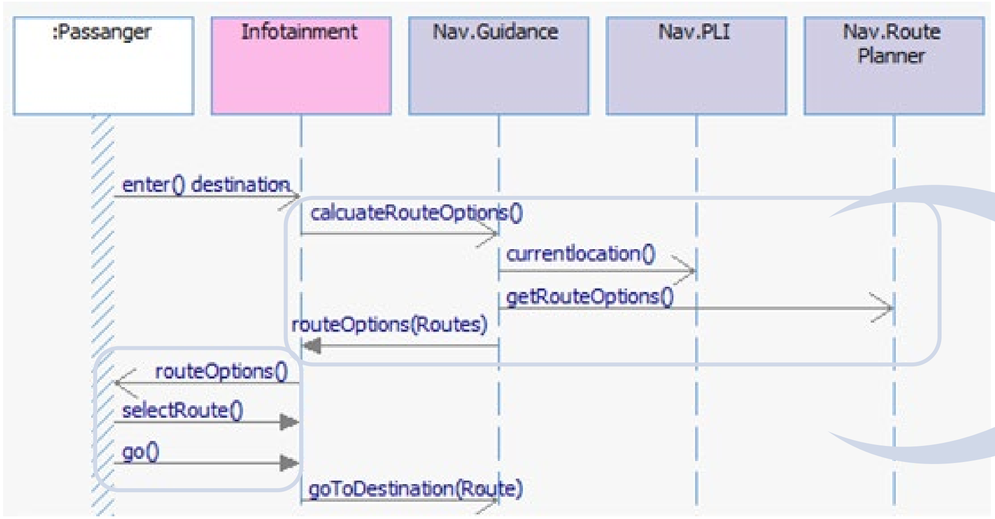
Construction – Step 6
Define Backlog Items from Interactions

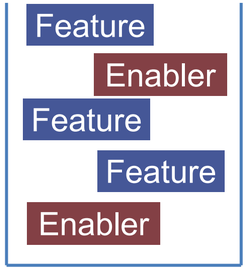
6) Define backlog items from interactions

- Discover Features from groups of interactions
- Some Features may require exploration work
- Focus on requests from UI and controller parts of system

As Infotainment, I want a set of route options so that the user can select the optimum route from their current location

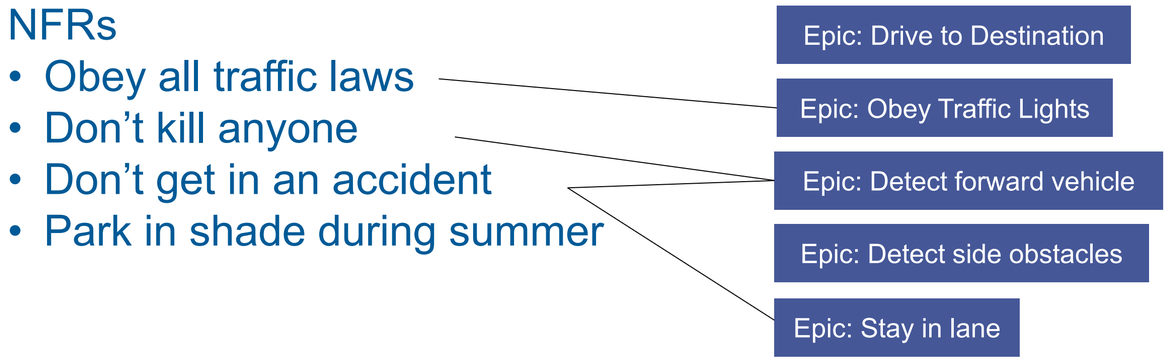
As a passenger, I want to select my route so that I can decide the optimal route to travel to my destination





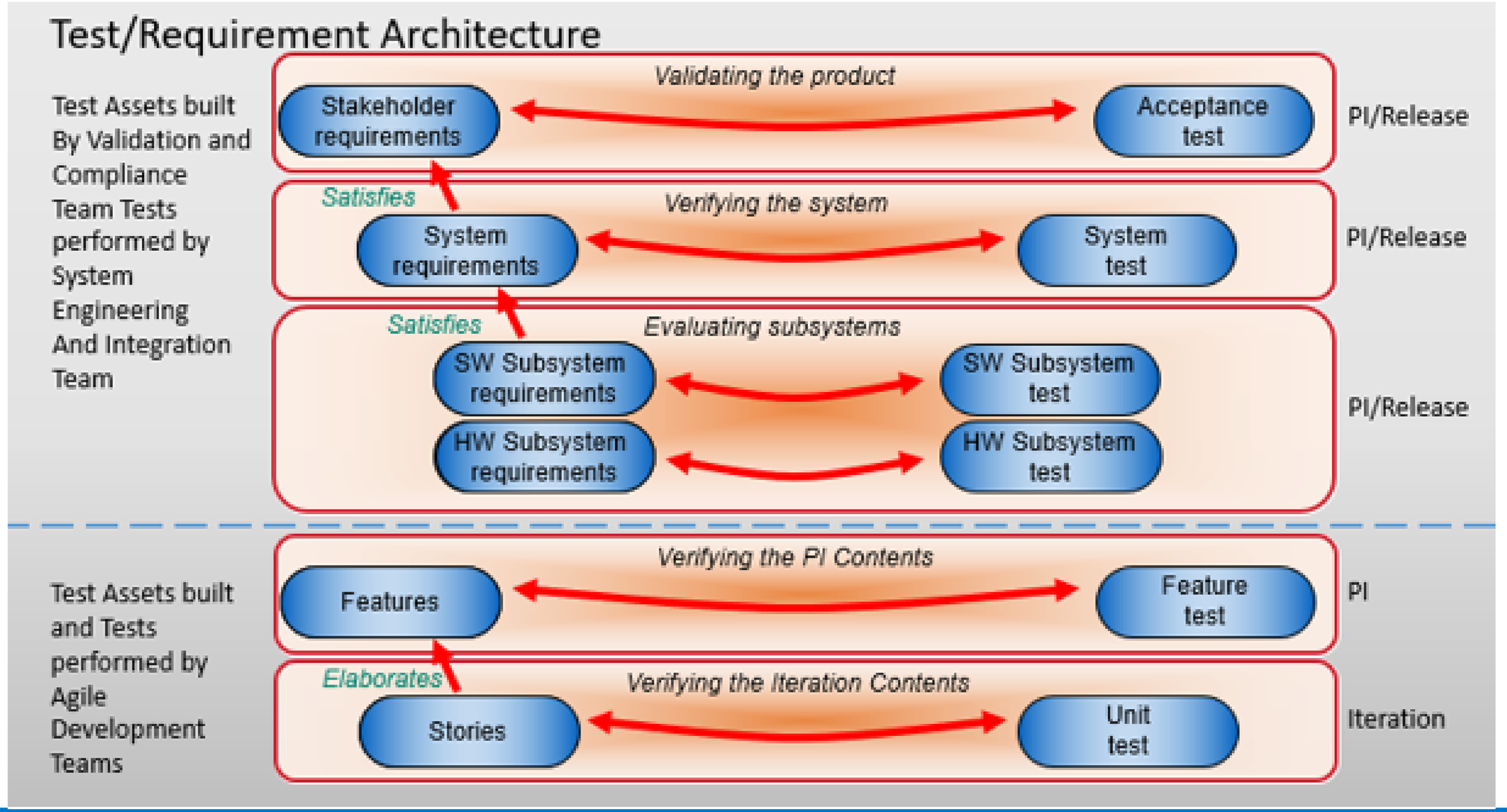
Manage non-functional requirements (NFRs)

- NFRs constrain backlog items' implementation; NFRs are not backlog items themselves
- Workshops will uncover both behaviors and constraints
- Record NFRs as they are found – trace for compliance later
- Enablers may be required to support features adherence to NFRs



Putting it all together

Requirements & Testing in a Regulated Environment within SAFe



Putting it all together

Proposal

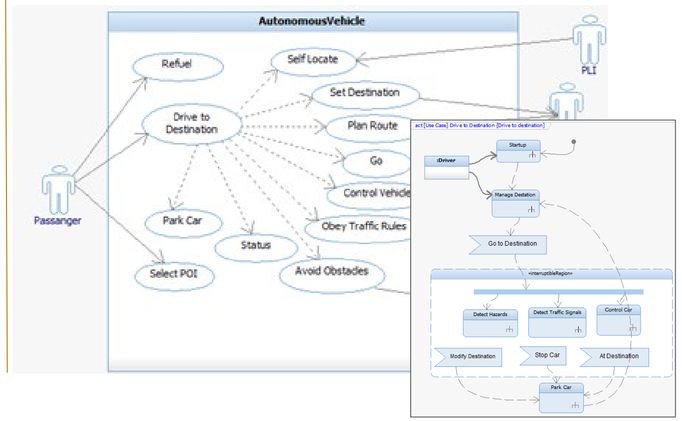
Inputs

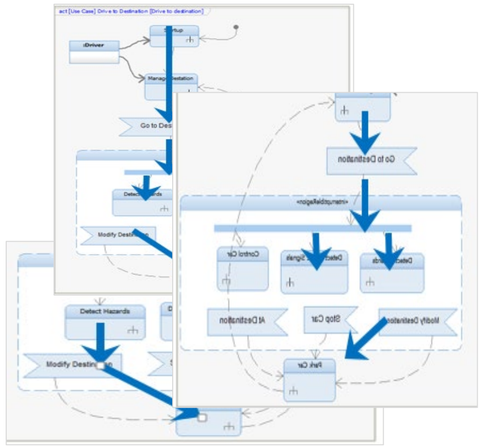
Stakeholder Needs

Proposal

Previous sys spec

Behavioral Analysis





Roadmap (Planning Packages)

Epic Epic Epic

Epic Epic

Epic Epic

Program Execution

Epic Epic Epic

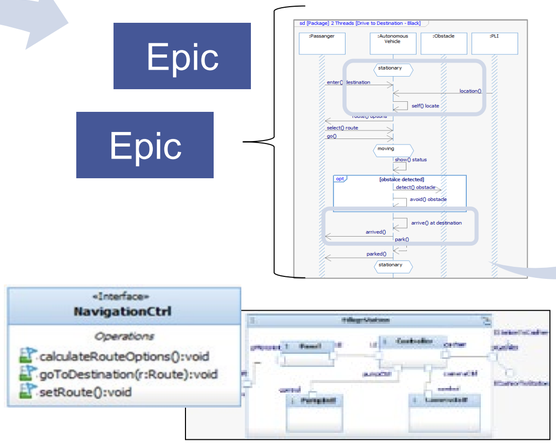
Epic Epic

Epic Epic

Analysis/Design

Epic

Epic



Implementing

Feature

Enabler

Feature

Feature

Enabler

Modeling role guidance

If solution is composed of one ART, what roles should be involved in the following activities?

- Create Use Case and Activity diagrams
- Create black box and white box sequence diagrams,
- Build the Epic Roadmap
- Identify the Features for PI
- Work on a daily bases on Activity diagrams, and with teams on sequence and block diagrams

How should System Engineers be incorporated into an ART?

Group discussion

- Single System Engineering Team
- Embedded with each Agile Team
- Hybrid model

Summarize the Value of the Workshop

System Engineering is actively involved in the identification of the features to be developed during each Program Increment (PI).

Model Based System Engineering (MBSE) is used by the System Engineers to:

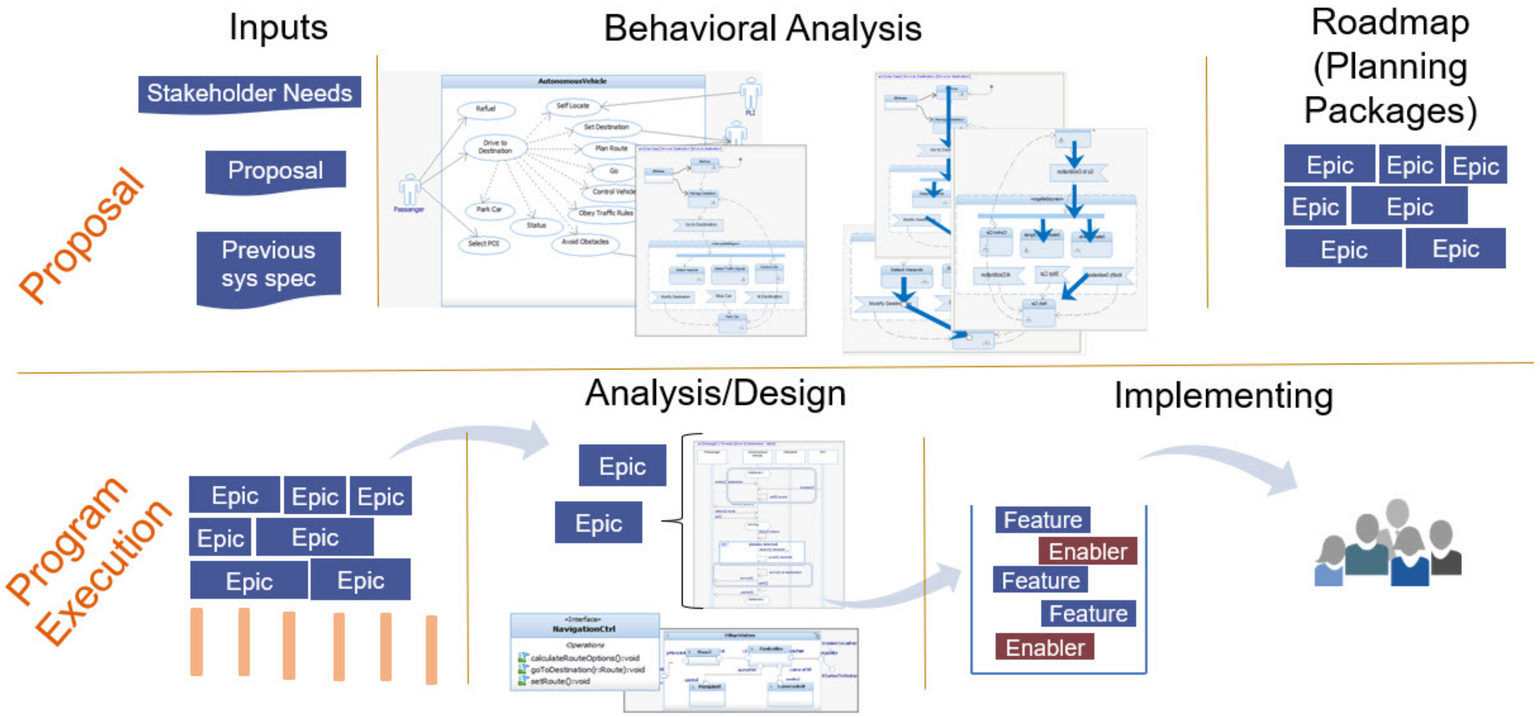
- ✓ Collaboratively create a shared understanding of system structure, behavior, and interfaces
- ✓ Decisions are recorded as a single source of truth using standard notation
- ✓ Emergent specifications are used to drive the agile development process

Contact us:
www.321gang.com
Peter@321gang.com

Questions?

Systems Engineer, Agile & SAFe

1 Day workshop: This courses teaches future workshop coaches and participants how to incrementally build system specifications that define system context, behavioral response to stimulus, structural design and interfaces. And it teaches the mechanics of running a workshop through a lengthy simulation and how to perform workshops as part of the regular agile development flow.



Additional Resources

- ✓ Getting Started with the Scaled Agile Framework (SAFe): bit.ly/321Gang-SAFe
- ✓ SAFe & Model-Based Systems Engineering: bit.ly/321Gang_MBSE_SAFe
- ✓ IT Revolution White Paper: Industrial DevOps (Contributors: NGC & LMCO)
- ✓ F-22 SPO Advanced Tactical Fighter & SAFe: bit.ly/F22-SAFe
- ✓ Don Reinertsen - The Logic of Flow: bit.ly/ReinertsenLogic-of-Flow
- ✓ AUTONOMY. MASTERY.PURPOSE: bit.ly/Autonomy_Mastery_Purpose