Supporting Systems Development Decisions Using Bi-Directional Simulation

David M. Raffo, Ph.D.
Professor, Portland State University
Visiting Scientist, SEI
Chief Technologist, Quantel, Inc.

Software Engineering Institute | Carnegie Mellon

Agenda

Motivation

What is Process Simulation?

What is Bi-Directional Simulation

Forward Simulation

Reverse Simulation

How they work together to achieve Quantitative Project Management

Conclusion

Motivation

Quantitative project management (QPM) is a critical best practice and is a requirement for high maturity organizations

Quantitative project management holds the promise for enabling organizations to better plan, track, and manage their projects enabling them to achieve better performance, more predictably

A critical part of QPM is to have quantitative indicators that alert project managers (PMs) when the project runs the risk of not achieving its targets.

We introduce a forward-looking approach called Bi-Directional Simulation that

- Provides dynamic tools to alert the PM as to when a project is going off track
- Provides the PM with the capability to re-plan the project in order to get back on track quickly in order to achieve success

This approach is based upon Forward and Reverse Process Simulation models. These models are performance models for high maturity organizations

Bi-Directional Simulation

We introduce Bi-directional Simulation to help project managers quantitatively plan, track, and manage projects

Bi-Directional Simulation models are composed of two parts

Forward Simulation Models

- Predict project outcomes based on planned/actual project conditions.
- Used to plan processes as well as predict the impact of process changes, tool introductions, quality assurance strategies, etc. *SEI Technical Report on Process Simulation* (Summer 2007)

Reverse Simulation Models

- Take desired project outcomes and work "backwards" to identify necessary project conditions in order for project to remain on track. (similar to Dynamic Programming)
- Dynamically predict Acceptable Performance Ranges (APRs) for individual process stages based upon desired project outcomes

What Is a Process Simulation Model?

A simulation model is a computerized model (*not a maturity model* designed to display significant features of the dynamic system it represents.

Simulations are generally employed when

- behavior over time is of particular interest or significance, and
- the economics/logistics or risk of manipulating the system being modeled are prohibitive

Common purposes of simulation models are:

- to provide a basis for experimentation,
- to predict behavior,
- to answer “what if” questions,

Process simulation models focus on the dynamics of ***systems*** development, maintenance and acquisition projects

Process Overview

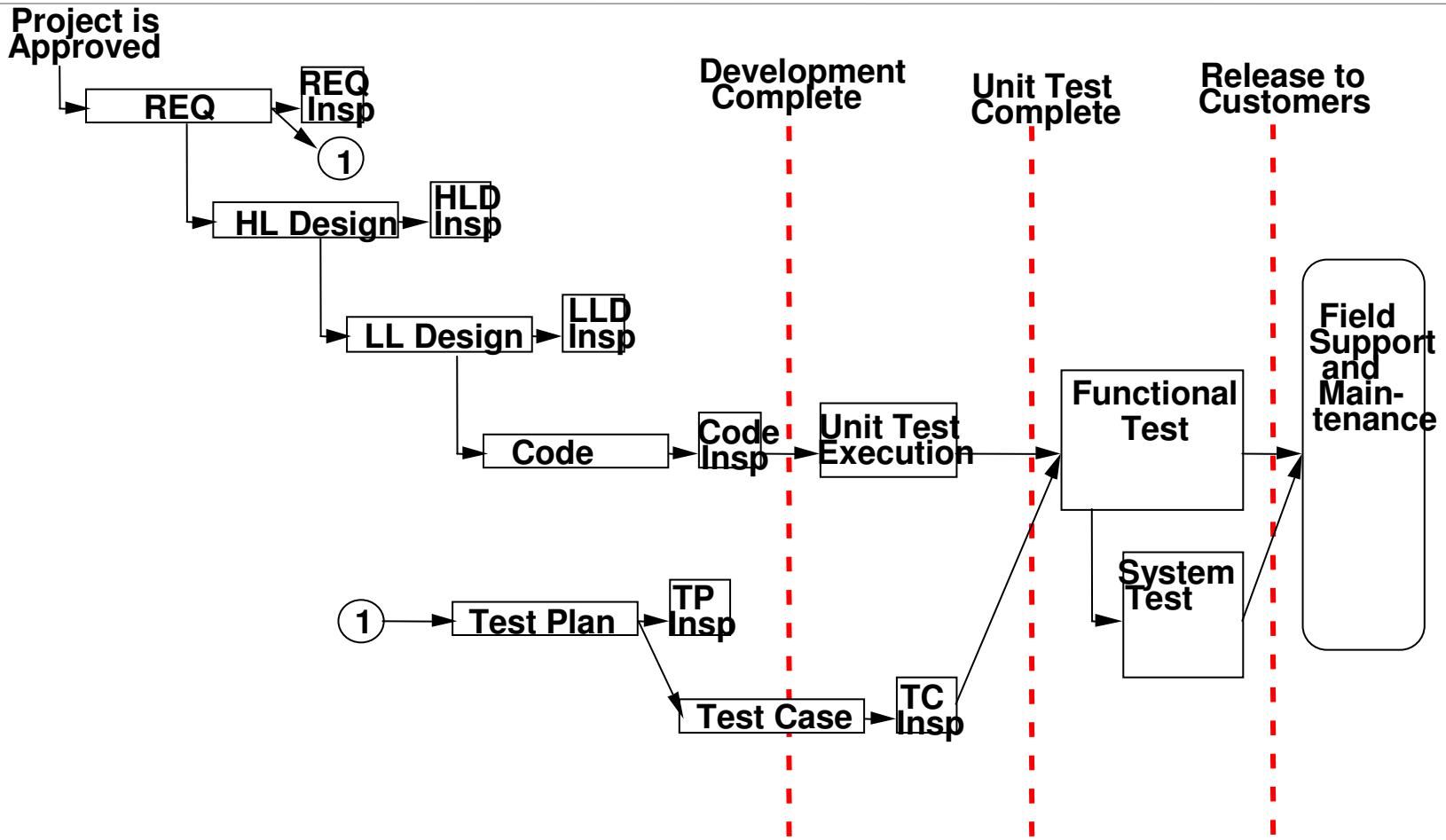
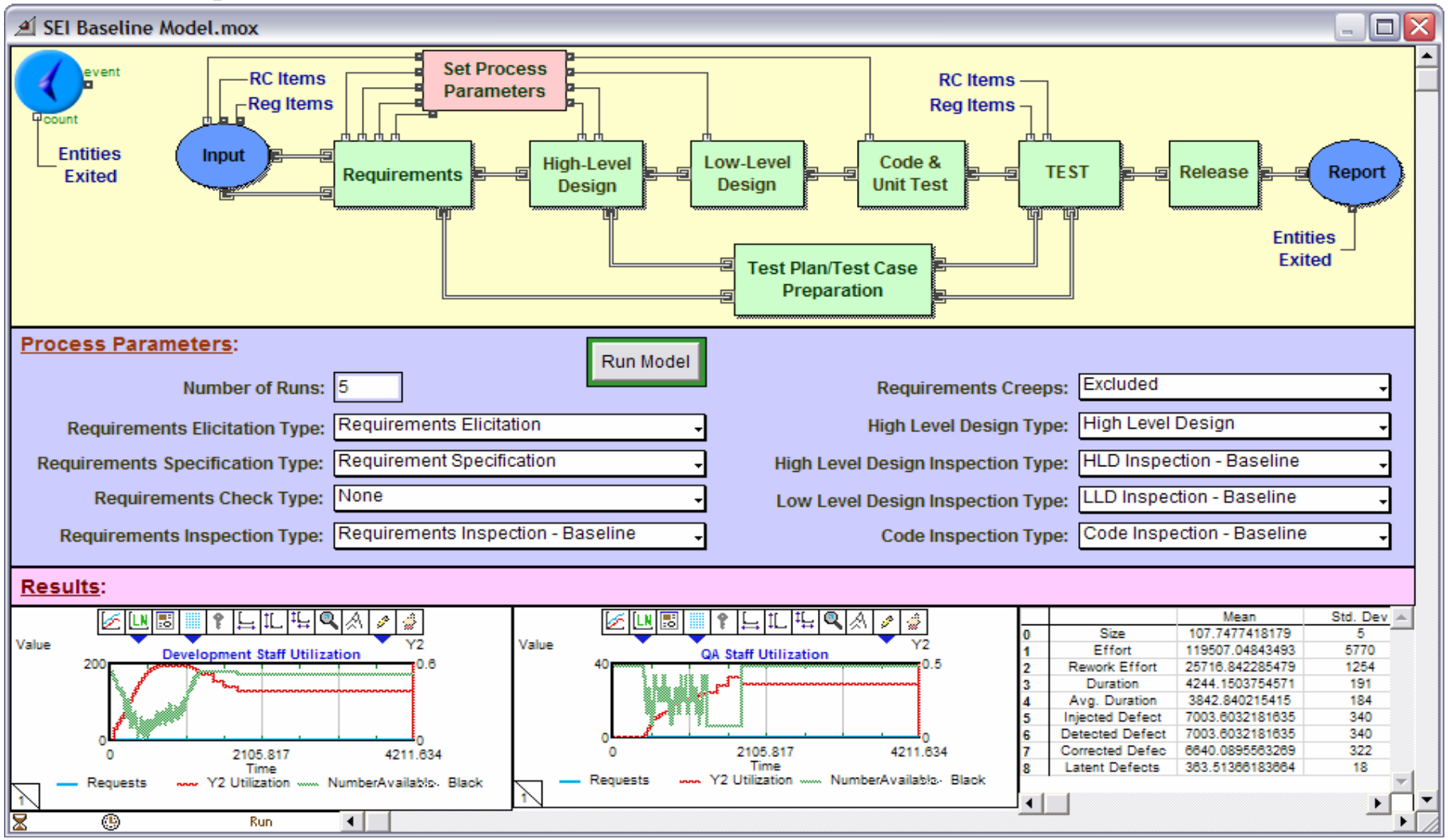
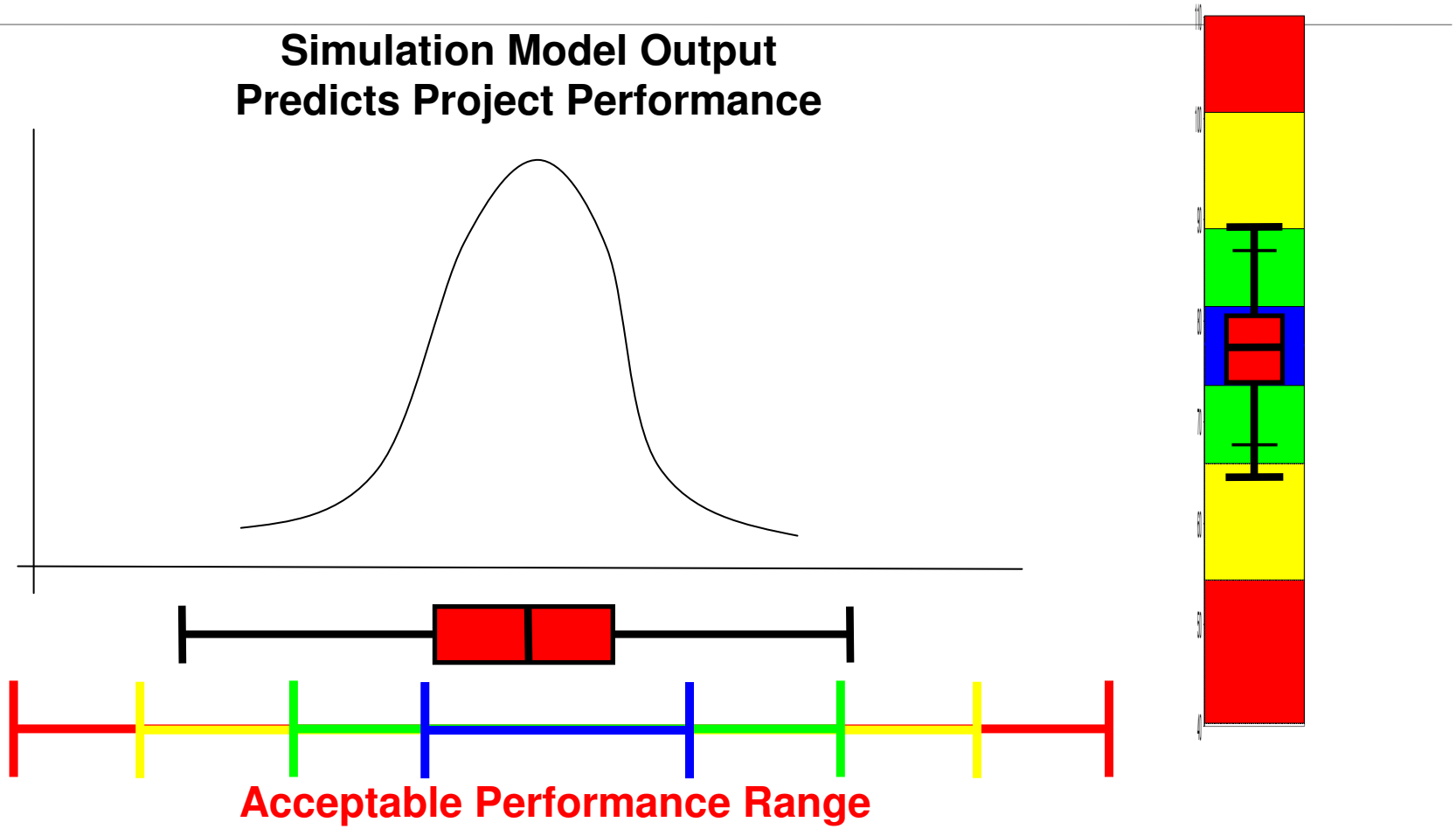


Diagram of the Field Study Life Cycle AS-IS Process

Forward Simulation of an Incremental Development Process

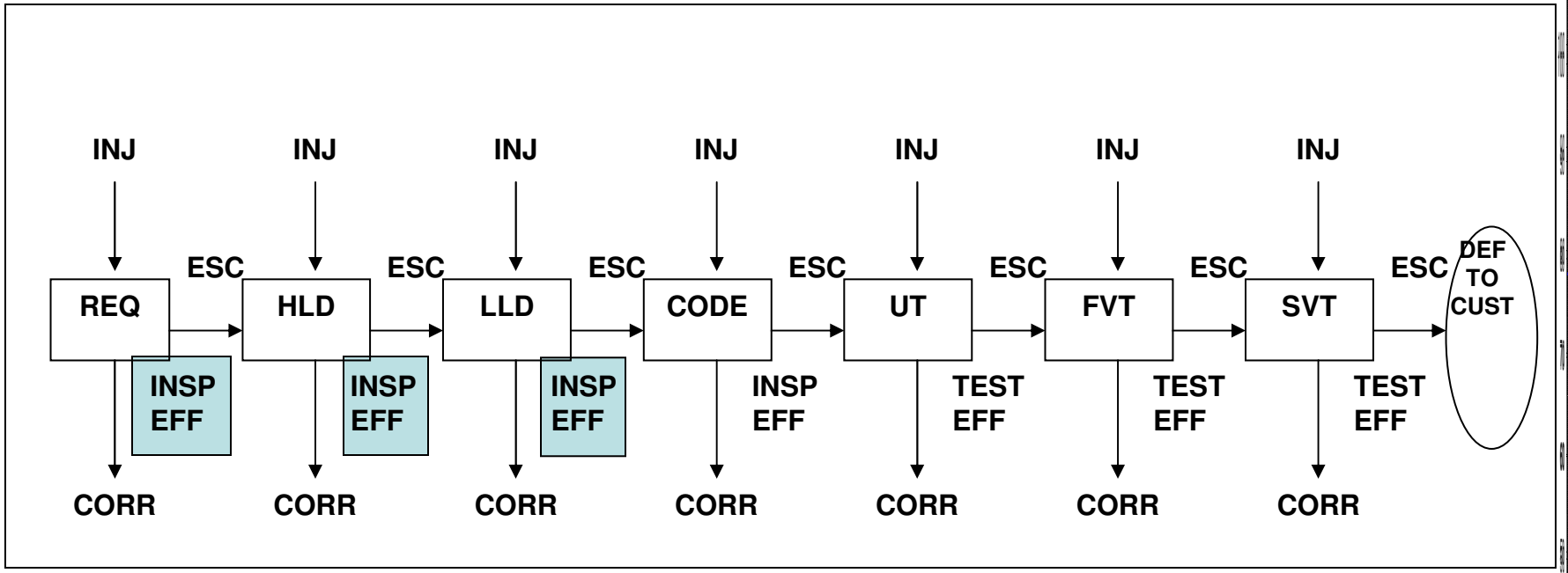


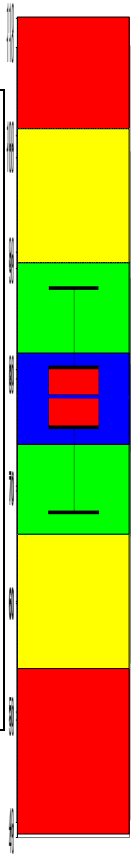
Simulation Output and Acceptable Performance Range



Forward Simulation

Predicts the Project Outcome based on Project Start Point

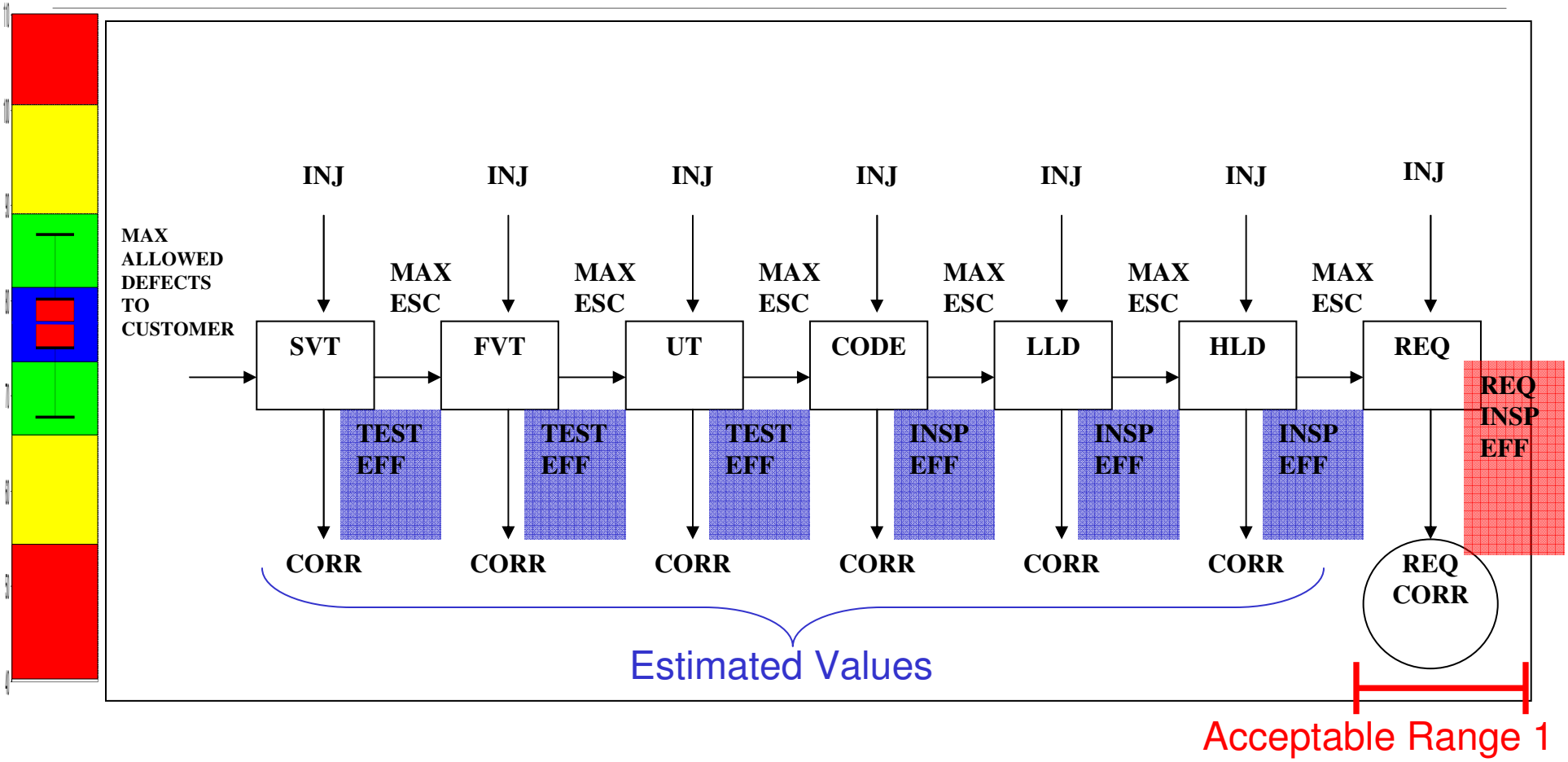




Enables better decisions about process improvements, technology or tool adoption, quality assurance strategies and more…
Supports CMMI, Six Sigma

Reverse Simulation

Predicts the Starting Point – Based on Desired Project Outcomes

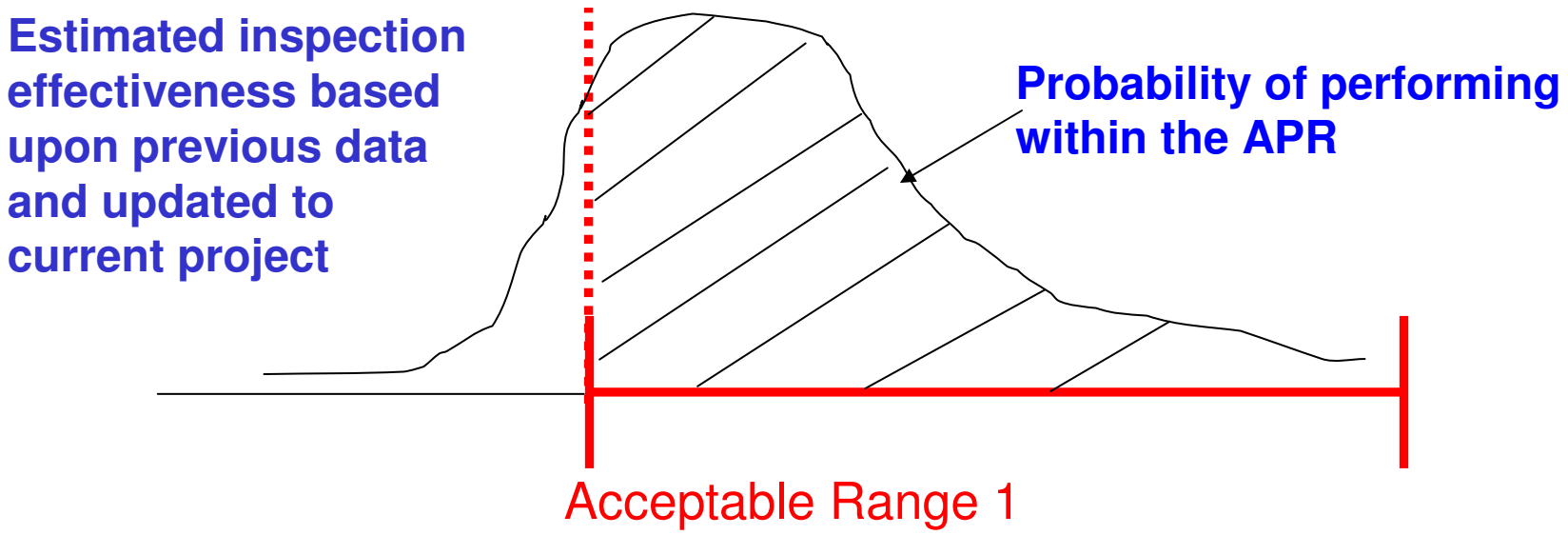


What level of performance is needed at this first step?

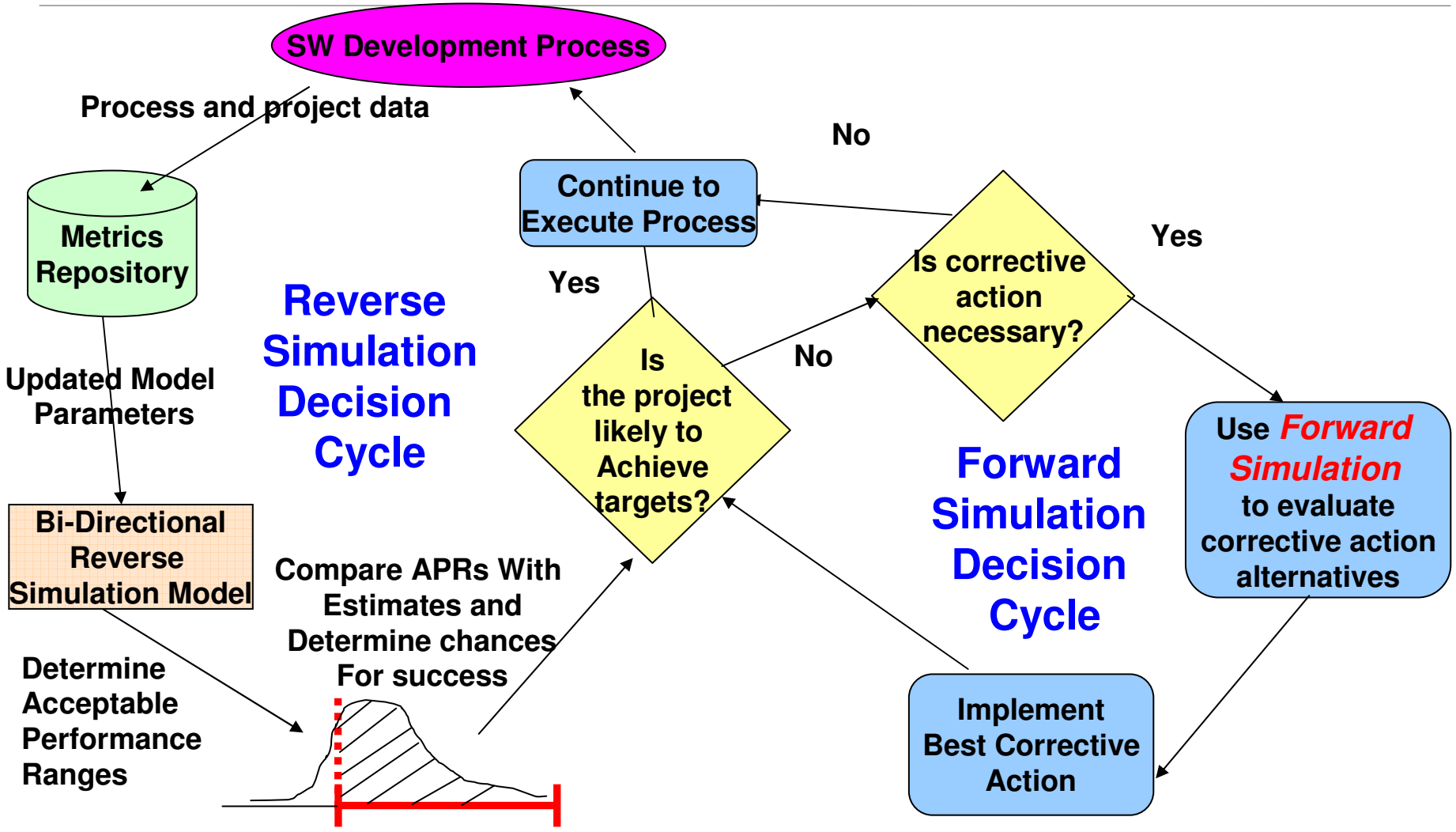
Is the Project on Track?

What is the likelihood that the project will be able to meet the Acceptable Performance Range (APR)?

If the probability of performing within the APR is too low, the PM re-plans using the forward simulation model.

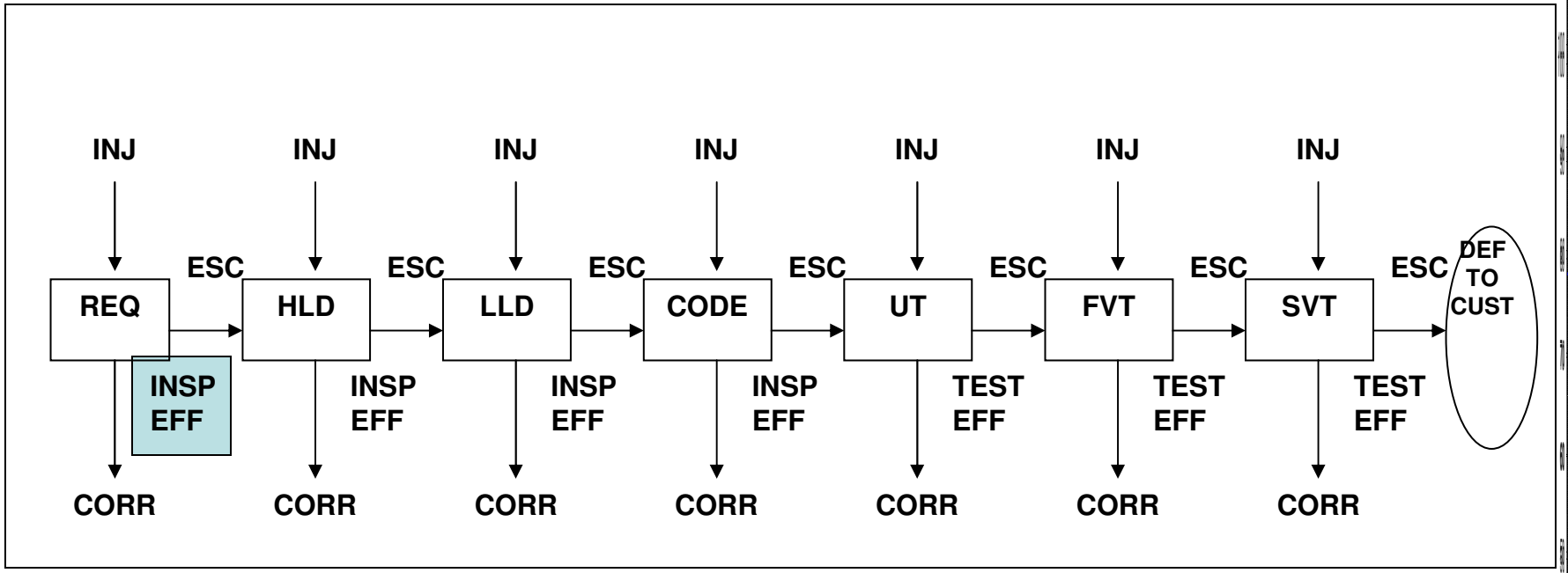


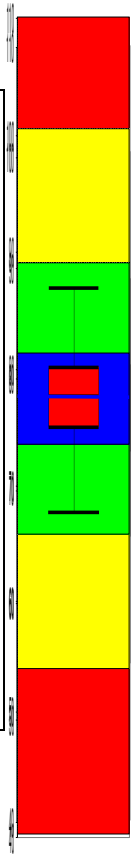
QPM Control and Feedback Loop



Forward Simulation

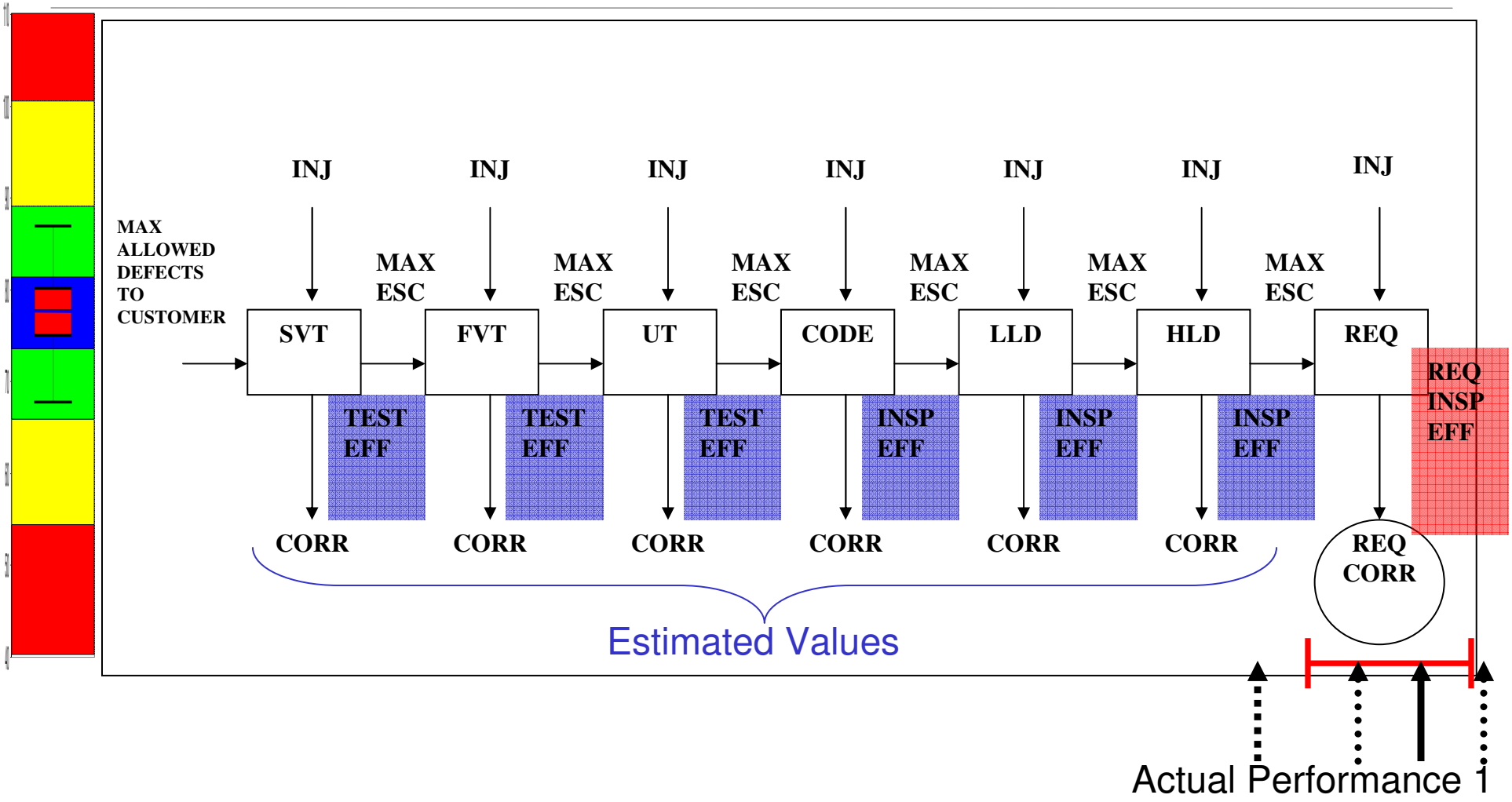
Use Forward Simulation to identify the best way to enable the project to achieve APRs





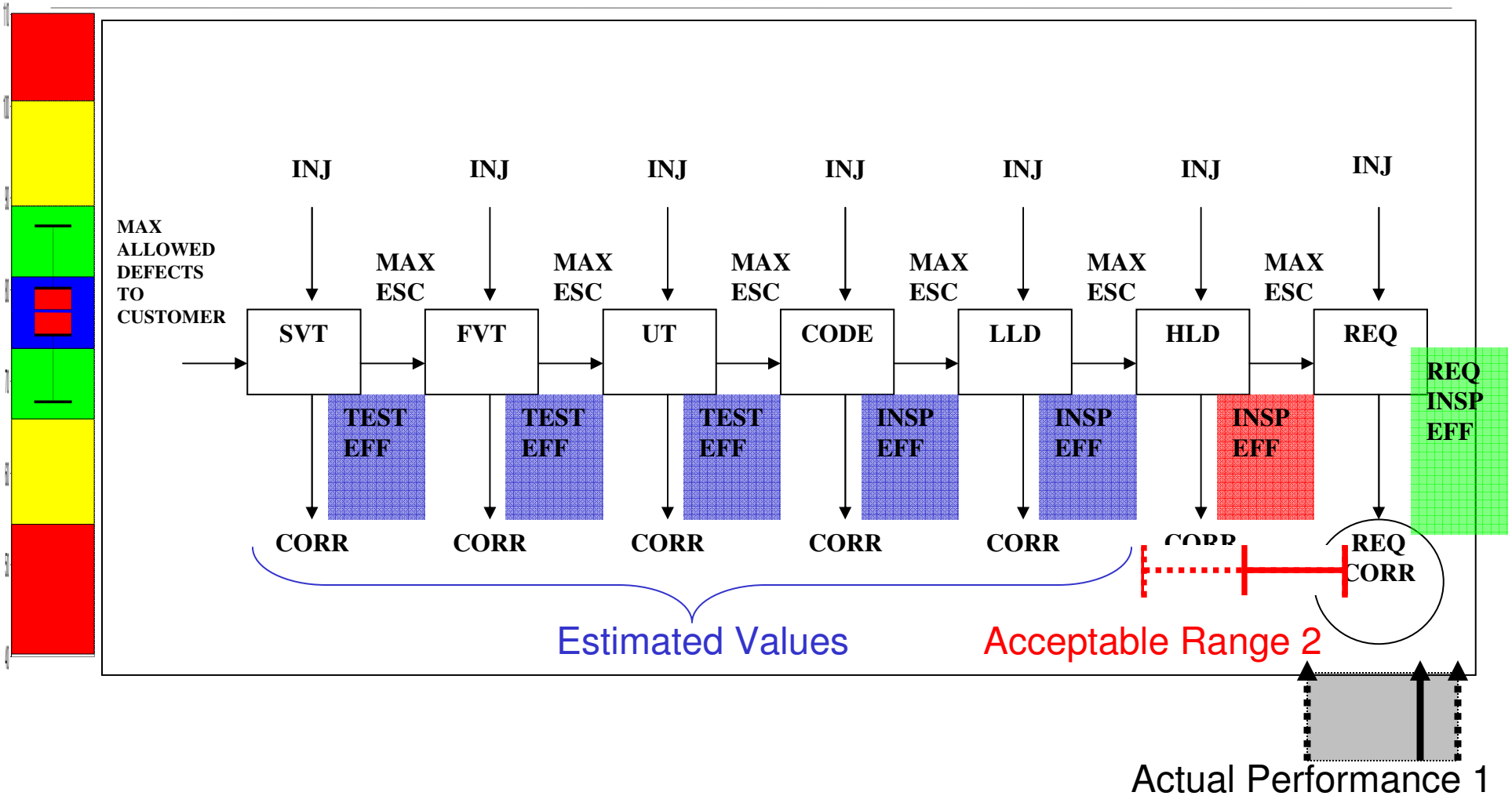
Reverse Simulation

Predicts the Starting Point – Based on Desired Project Outcomes



Reverse Simulation

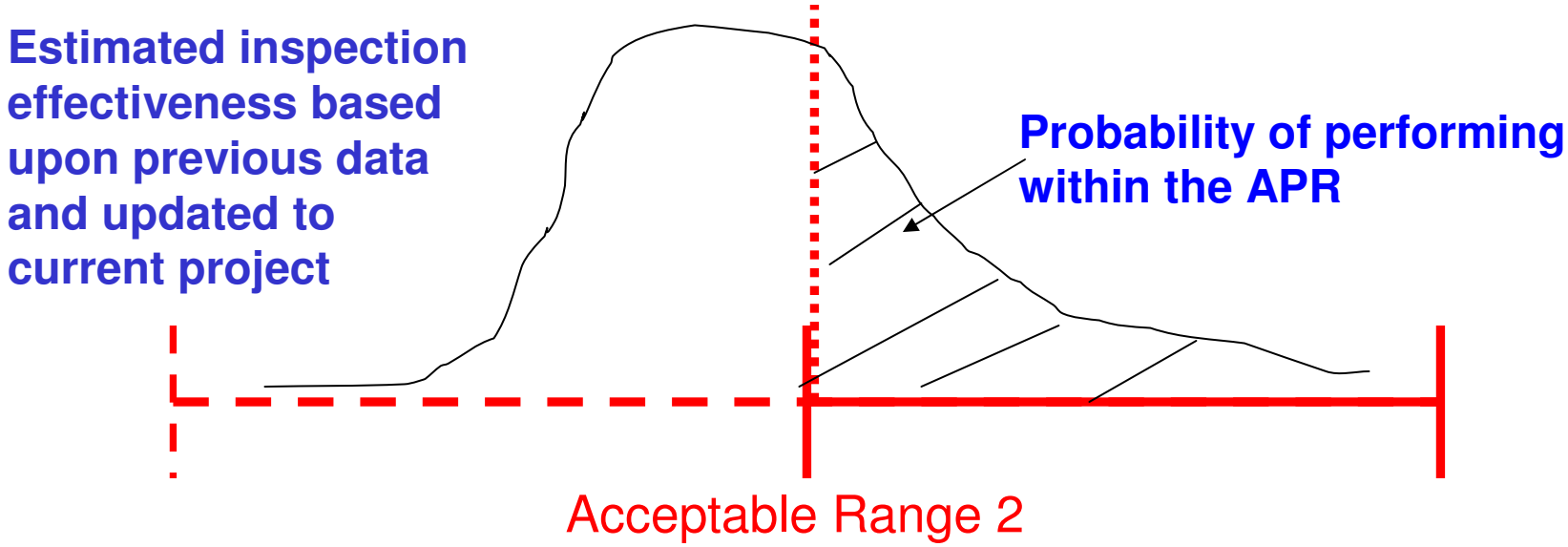
Predicts the Starting Point – Based on Desired Project Outcomes



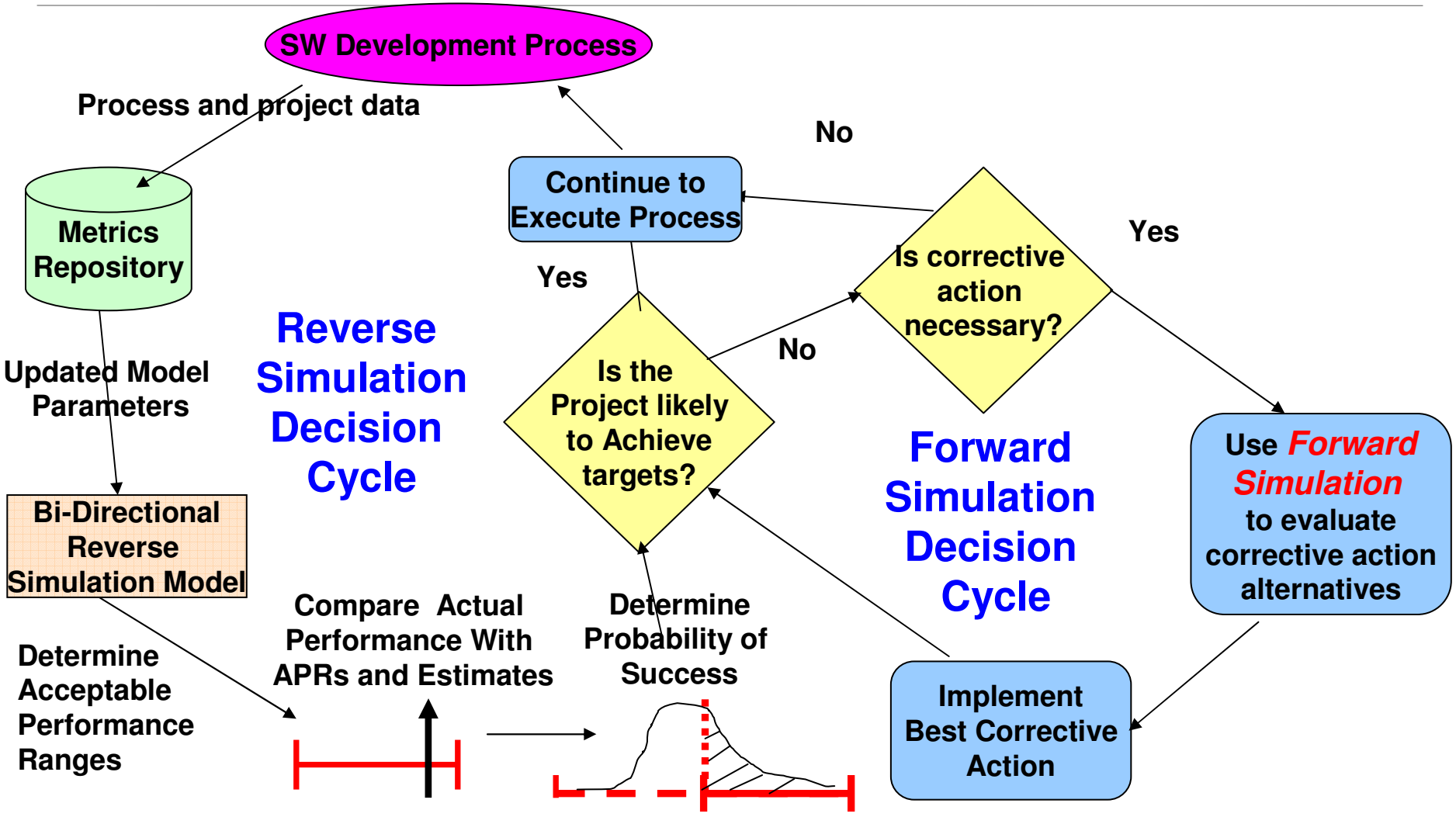
Is the Project on Track?

What is the likelihood that the project will be able to meet the Acceptable Performance Range?

When the probability of performing within the acceptable range is too low, the PM needs to re-plan the project using the forward simulation model.

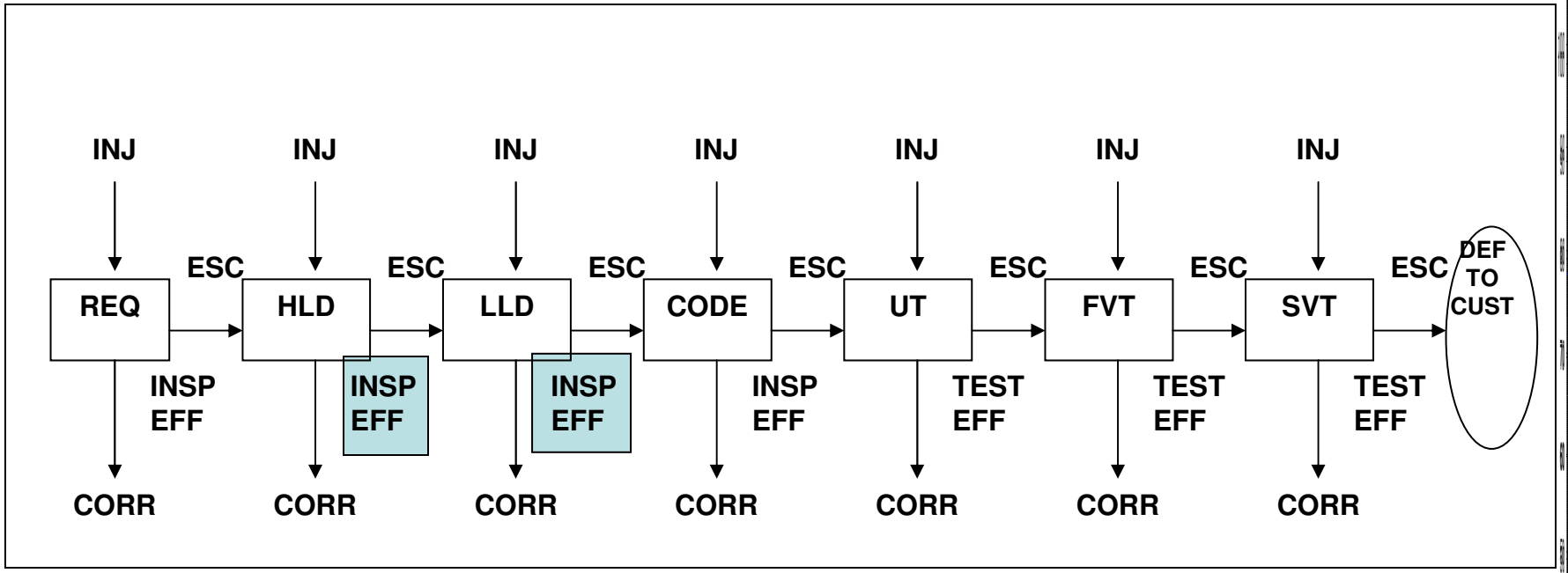


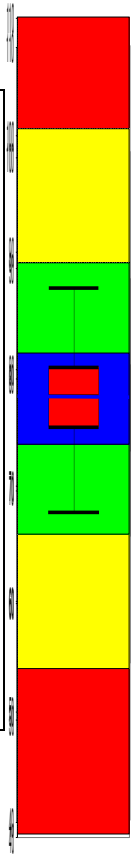
PROMPT Control and Feedback Loop



Forward Simulation

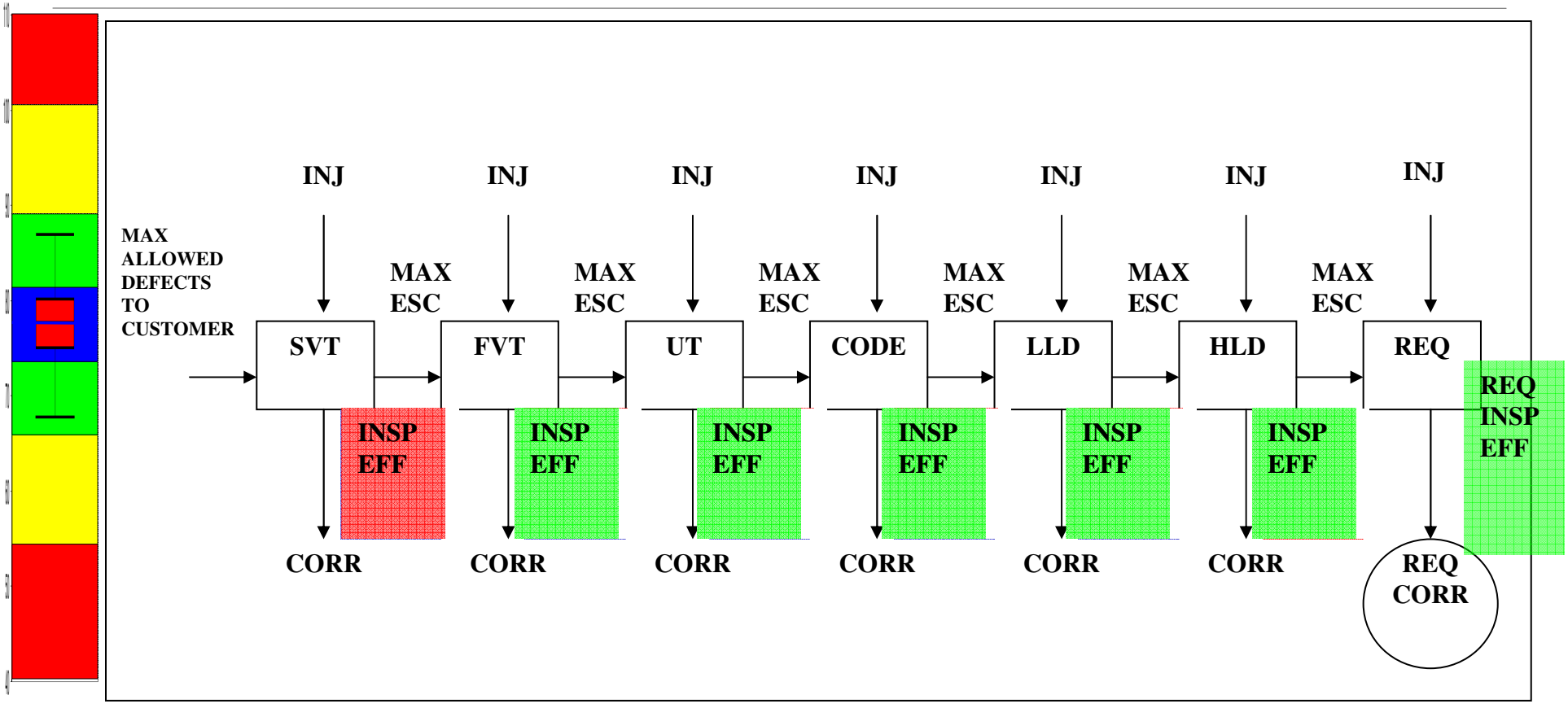
Use Forward Simulation to identify the best way to enable the project to achieve APRs





Reverse Simulation

Predicts the Starting Point – Based on Desired Project Outcomes



Summary

Bi-Directional Simulation links project outcomes with performance limits at each step along the process.

Using real time metrics, Acceptable Performance Ranges (APRs) are dynamically updated to show the project manager the level of performance required at each stage of the project

APRs can be compared to past performance to compute the likelihood the project will achieve the required performance at that stage.

Forward and Reverse simulation work together to keep the project on track and optimized to achieve project performance targets

Summary

Bi-Directional Simulation overcomes the weaknesses of other QPM frameworks by

- Linking Desired Project Outcomes with APRs for individual process steps and
- Dynamically updating these limits based upon real time project data.

Applying Process Simulation = High Value

Evaluate Strategic Issues

- Quality Assurance, V&V and IV&V Strategy for a project
- Globally Distributed Software Development

Assess the Costs and Benefits of Applying New Tools and Technologies

Plan Processes and make better Tradeoff Decisions

Evaluate Process Improvement Opportunities

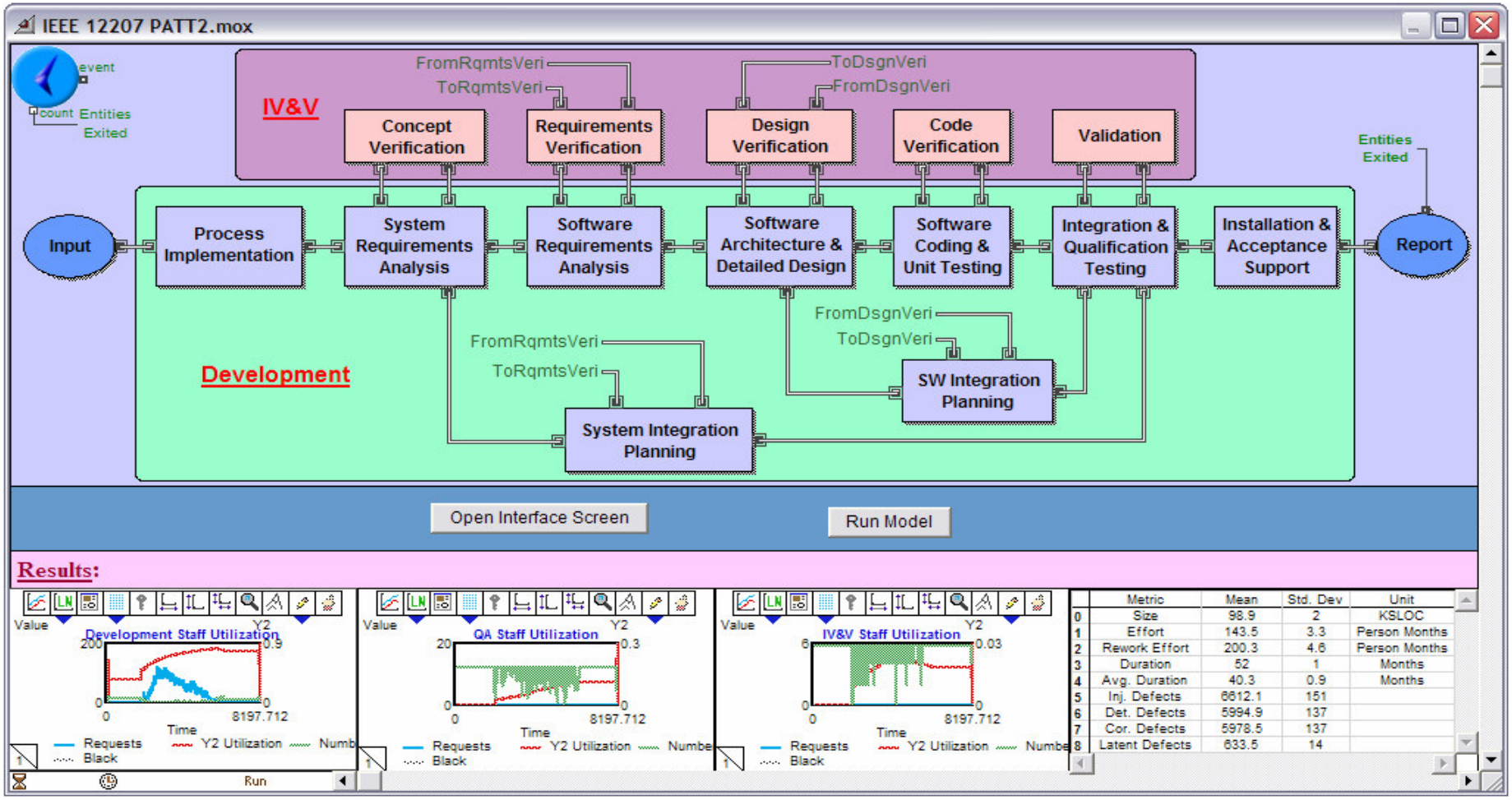
Architect, Design, and Document Processes

Estimate Project Costs from the Bottom Up

Manage Projects Quantitatively

Train Project Managers

Forward Simulation – IEEE 12207 SW Development LC with IV&V Layer



Benefits of Process Simulation

Decision Support and Tradeoff Analysis

- Sensitivity Analysis & “What if”

Supports Industry Certification and process improvement programs

- CMMI (in particular high maturity PAs)
- Six Sigma (Defect containment (COQ, COPQ)), etc.

Creates project performance models and Benchmarking

Provides a framework and direction for metrics programs

Reduces Risk by providing a quantitative risk assessment prior to the introduction of process changes

Optimizes benefits when deploying new tools, technologies and methods

Reduces cost and time to deploy new process improvements

Benefits of Process Simulation

Supports business case analysis of process changes

Obtains Management buy-in for process change and collection of further metrics

Bottom Line – Process Simulation

- Enables organizations to adapt to change and better manage projects – beating the competition
- Enables an organizations to design processes better, train employees faster, and implement more quickly = better performance, higher quality, faster

Contact Information

David M. Raffo
Professor, Portland State University
Visiting Scientist, SEI
Chief Technologist, Quantel, Inc.

Tel. 001-503-939-1720
Fax 001-503-725-5850

david@quantelsystems.com

www.quantelsystems.com

The End

Questions?