SIMULATION-BASED REQUIREMENTS ENGINEERING FOR ARMY ENTERPRISE XXI

John A. Hamilton, Jr., Ph.D.
Lieutenant Colonel, USA
Deputy Director, SPAWAR
CinC Interoperability Program Office

Jeanne L. Murtagh
Major, USAF
Director, AFIT/LSS
Software Professional Development Program

John C. Deal
Colonel, USA
Executive Officer, Office of the Director
Command, Control, Communications
and Computers

www.drew-hamilton.com(astc99)
From AOE to Army XXI to AAN

Capability

Time

SPAWAR

SIMULATION-BASED REQUIREMENTS ENGINEERING
FOR ARMY ENTERPRISE XXI

www.drew-hamilton.com/astc99
Rationale for Army Enterprise XXI

- **Information Superiority** is the key to successful operations on the 21st Century battlefield.

- Army Enterprise XXI provides a focused C4/IT approach to enable the Army to evolve from today’s *platform-centric force (Army of Excellence)* into a *network-centric force* in 2010 (Army XXI) and, finally, into the *knowledge-centric force* of 2025 (Army After Next).

- This evolution will provide soldiers with the ability to capitalize on knowledge capital obtained from unlimited access to a global, seamless, secure enterprise network to achieve information superiority.
Requirements Engineering

- **Requirements Engineering**: is a specification of needs as analysis components for use during systems development.
  
  (Ramamoorthy & Tsai *IEEE Computer*, Oct. 96)

- **Objectives of Requirements Engineering**:  
  Determine feasibility and cost of project.  
  Provide means to check consistency and completeness of requirements.

- **Achieved through**:  
  Prototyping  
  Simulation
Effective Requirements Engineering

- Effective requirements engineering is critical to the success of *Army Enterprise XXI*.
- Effective use of the spiral development model or any other iterative method requires specified requirements.
- Absent clear, concise requirements, it is impossible to determine when one development phase is done and the next phase should begin.

*How do you know when you are done?*
Bounding Software Requirements

Changing one side of the triangle upstream affects the other two downstream.

The further downstream changes are made, the more brittle the other sides of the triangle.

Time is a constantly increasing function.
From Prototyping to Requirements

- Time should not be wasted building significant functionality into a prototype.
- The prototype code MUST NOT be used as the basis for production code.
- Prototyping must continue until test users are satisfied with the front end they see.
- Move to next stage when the user is satisfied with the anticipated functionality demonstrated by the prototype.
Prototyping, Simulation and Requirements

Customer/User

Build candidate needs

Candidate Needs

User interaction with prototype GUI

Simulation generated inputs

Prototype

Engineered Requirements

Outputs from prototype used to generate next set of inputs

Consistent & Complete

Modify to reflect current candidates
Simulation-Based Acquisition

User interaction with prototype GUI

Customer/User

Prototype

Simulation

Simulation generated inputs

Consistent & Complete

Engineered Requirements

Specifications

Design

Outputs from prototype used to generate next set of inputs

www.drew-hamilton.com/astc99
Simulation-Based Acquisition

• Integrating simulation-based prototyping into a software engineering-based spiral development model is consistent with and supportive of Army Enterprise XXI.

• Simulation-Based Acquisition (SBA) is a key strategy outlined in Army Enterprise XXI:

  An industry best practice.

  SBA will allow all parties to interact during system development so that the resulting system reflects their combined interests with all necessary trade-offs reconciled in an optimal manner.

  Complimentary risk management strategy to spiral development.
The Emerging Digitized Battlefield

The Digitized Battlefield is Characterized By:

Situational Awareness and Battle Command

TACTICAL INTERNET
The Trend is to Push Information and Automated Systems Forward From Battalion to Fighting Platform

SIMULATION-BASED REQUIREMENTS ENGINEERING FOR ARMY ENTERPRISE XXI
www.drew-hamilton.com/astc99
Requirements Engineering for Distributed Systems

- Distributed systems are constrained both by bandwidth and cost.
- Military distributed systems can no longer be over-engineered to simply provide the maximum technically feasible throughput with maximum connectivity.
- Requirements engineering distributed software is challenging because of the non-trivial hardware and bandwidth issues as well as the stochastic nature of distributed system usage.
An Integrated Approach

- An integrated approach using analytical modeling, monitoring and reusable network objects ameliorates some of the challenges associated with network simulation.

-- Topology Builders
-- Obs. Traffic Patterns

Network Monitoring

Network Simulation

Data calculated by models returned to simulation

Selected events dropped in favor of analytical computation

Analytical Models
Simulating an Operational Architecture

1. Template against battlefield laydown
2. Determine system connectivity and traffic loads
3. Validate against doctrine
1. Built on standards specified in technical architecture

2. Determine system connectivity and traffic loads based on operational architecture

3. Validate against operational architecture
A modification to Knepell and Arangno’s validation framework

Does the model implementation correctly reflect the network?

Network of Interest

Operational Validity

Conceptual Model Validity

Data validity

Analysis & Modeling

Experimentation

Programming & Implementation

Software Verification

Software Verification

Network Simulation

Does the predicted approximate the actual results?

Does the software perform correctly?

SIMULATION-BASED REQUIREMENTS ENGINEERING FOR ARMY ENTERPRISE XXI

www.drew-hamilton.com/astc99
An Integrated Simulation/Software Engineering Framework For Distributed Simulation
Conclusions

• Human factors drive requirements engineering.
• Building software is **NOT** the same as building a bridge. 
  Software is interactive and as such, can be used in many more ways 
  than any civil engineering structure.
• **Army Enterprise XXI** requires aggressive use of 
  simulation-based prototyping in order to realize the 
  benefits of Simulation-Based Acquisition.
• Clearly specified requirements are needed to make 
  spiral development paradigms effective.
• Without clear requirement specifications, spiral 
  development devolves into simply going in circles.

www.drew-hamilton.com/astc99