Model Driven Architectures and UML Performance Modeling Capability – Design and Usage

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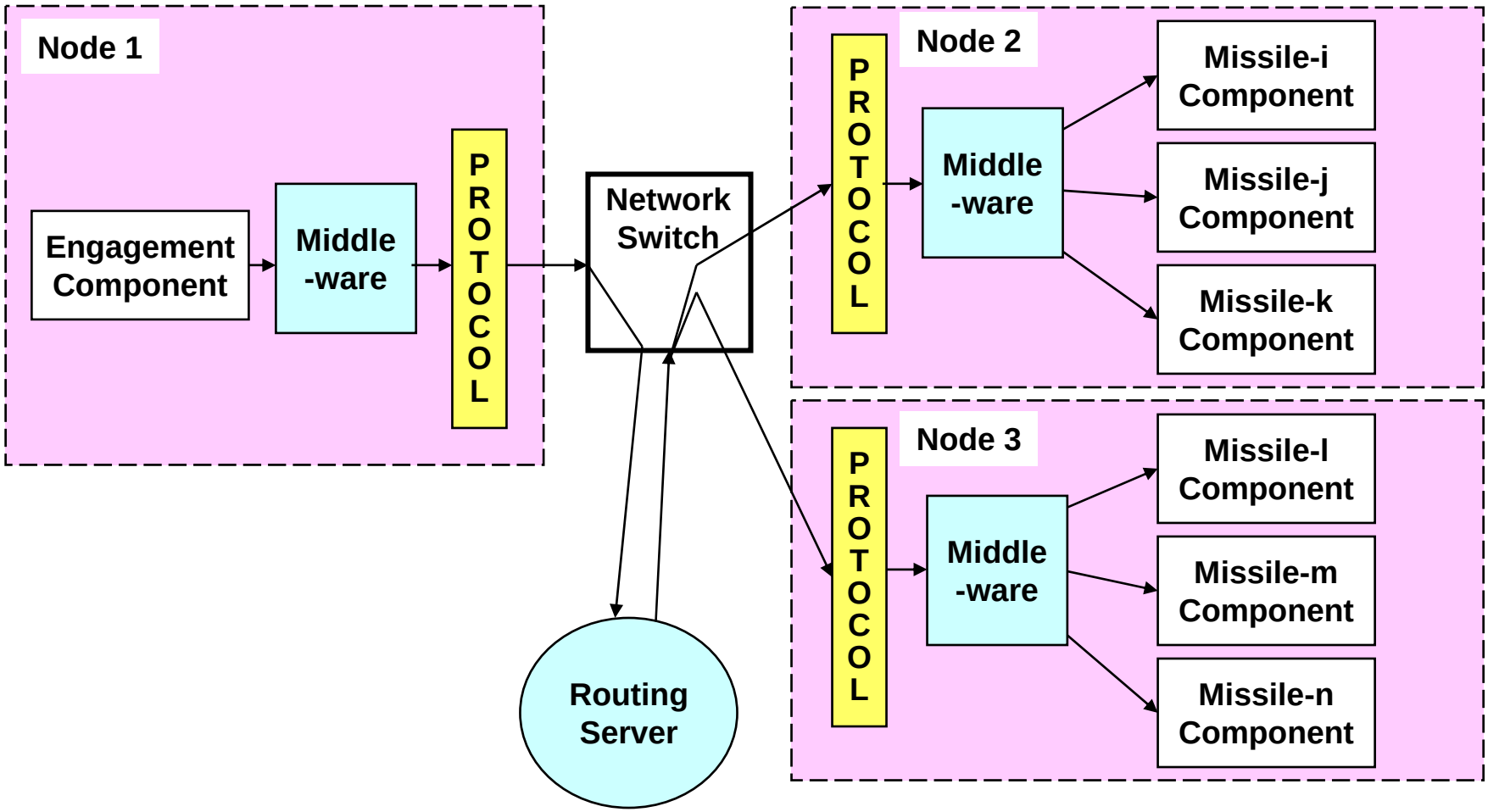
Introduction – Why is this Capability Important

- Lockheed Martin has more than 30 years experience in designing and building computing systems for U.S. Navy cruisers and destroyers
- Systems are large and demanding (12,000,000 SLOC in >50 computers)
  - Many use real-time O/S
  - Computer utilization >50 %;
  - Message latencies in the milliseconds
  - Automatic reconfiguration within seconds of failure
- Over the last eight years, event driven computing system architecture models have helped shape the computer program designs and to predict and map their performance on target systems
- For our next generation systems, we have begun development of the architectures using UML to analyze and document requirements
- For the future, we need to build a framework which makes it possible to quickly estimate and predict the dynamic performance of our future UML designed systems, and share these results with our technical community

Typical Computing Architecture Components and Communications

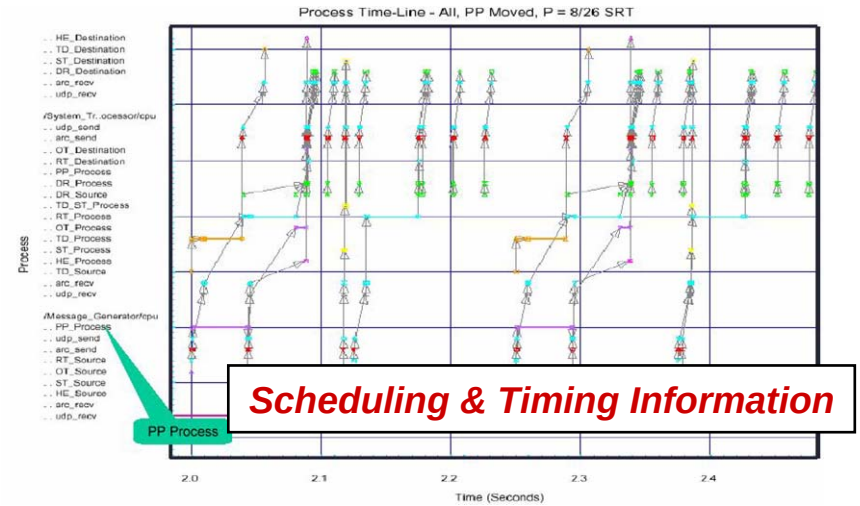


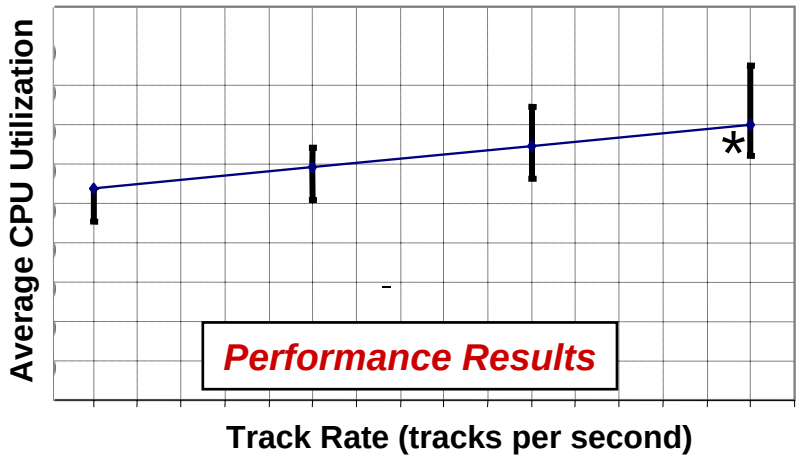
Capability of Our Performance Model

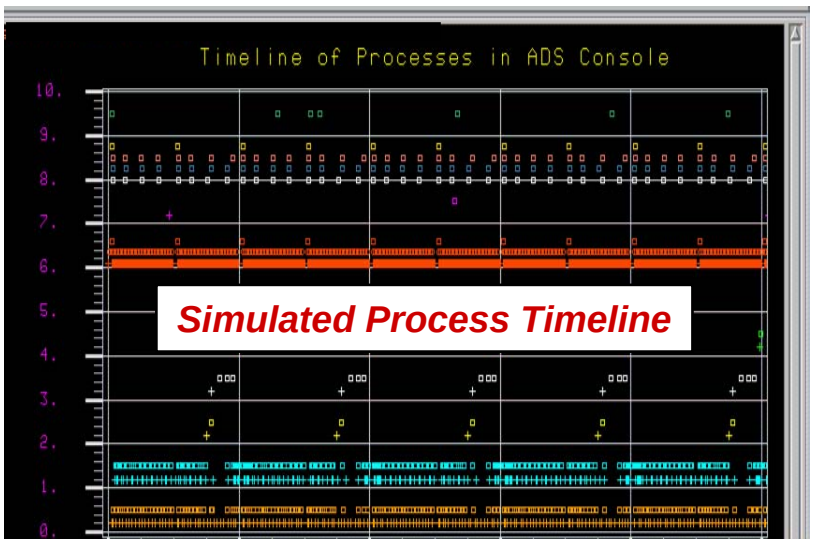
- Speeds and automates the design of performance modeling using pre-designed, off-the-shelf, large infrastructure components (modeling assemblies)
  - Eight general-purpose Infrastructure Modeling Assemblies (IMAs) were built to emulate any message's creation, flow and processing
  - The specific "personality" assumed by an IMA in a particular model is specified by completing approximately ten menu-based parameters
  - Assemblies are chosen and connected to represent any message flow
- Complies with the UML requirements modeling language
  - Our newly designed Export Conversion Program captures selected requirements and architectural information from the UML requirements models
- Incorporates a friendly front end, useable by the model designer, the system engineer and the customer
  - Sequence diagrams and spreadsheets provide the user with copies of UML requirements to build or view the performance model
  - The spreadsheet calculator also generates an estimate of model utilization and latency to help verify the performance model design

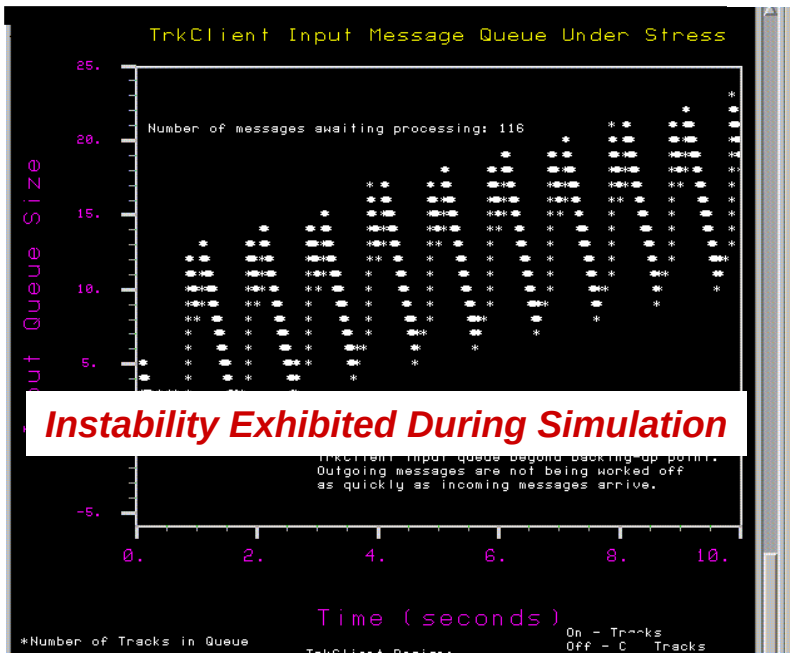
Lockheed Martin Uses the CSIM Modeling Tool

Typical Performance Modeling Results

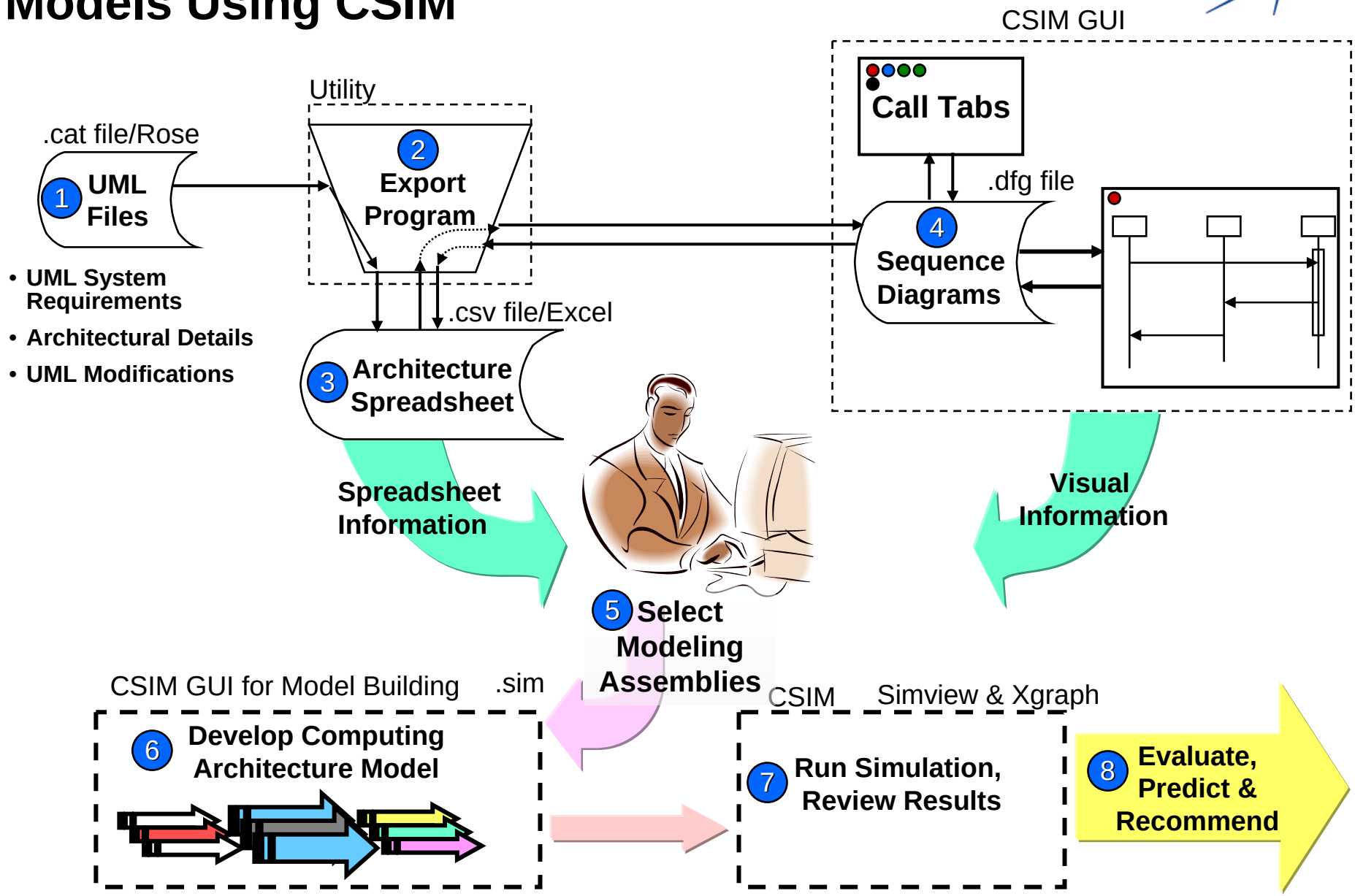




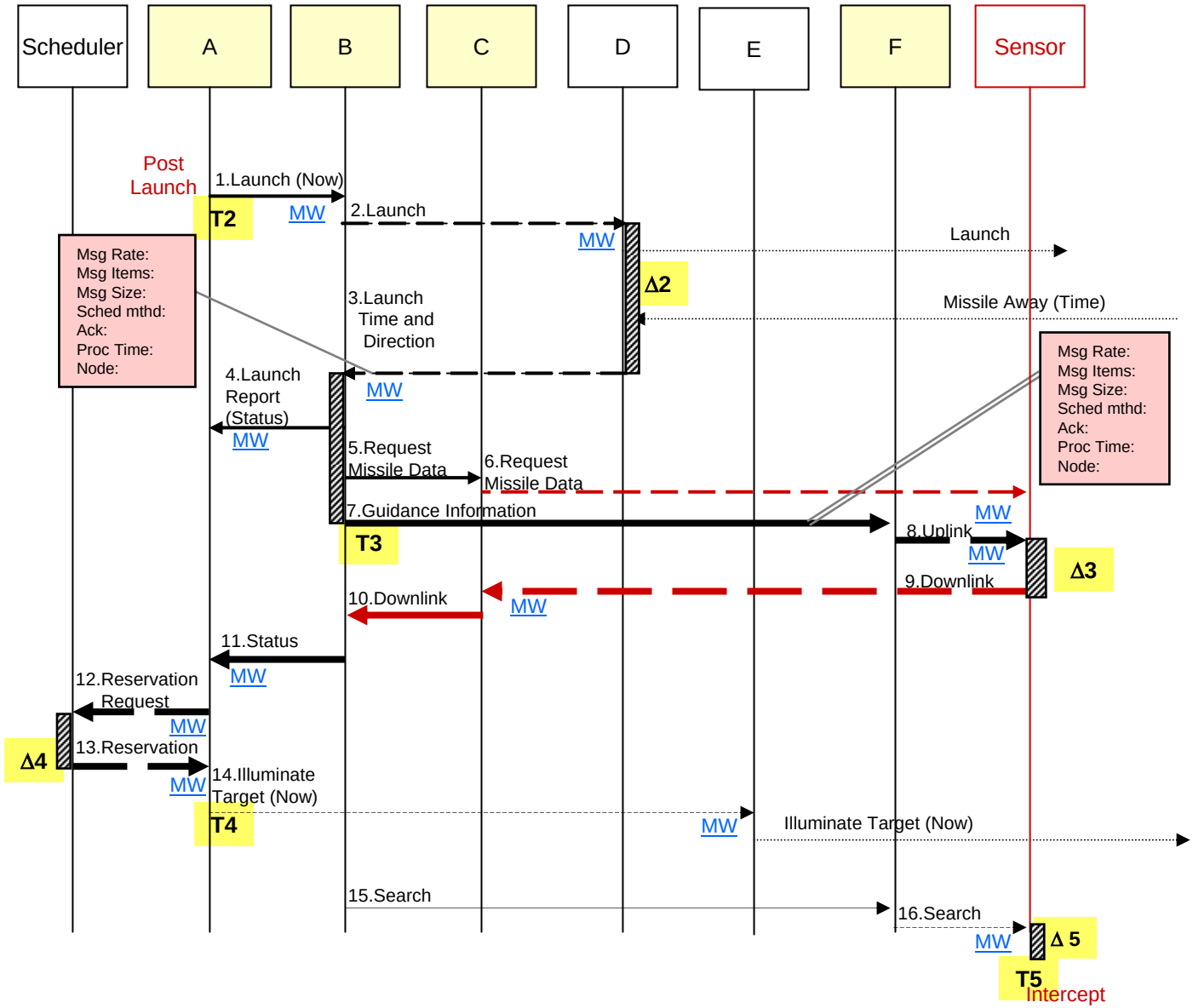




Building and Executing Performance Models Using CSIM



Example: UML Sequence Diagram with Added Architecture Detail

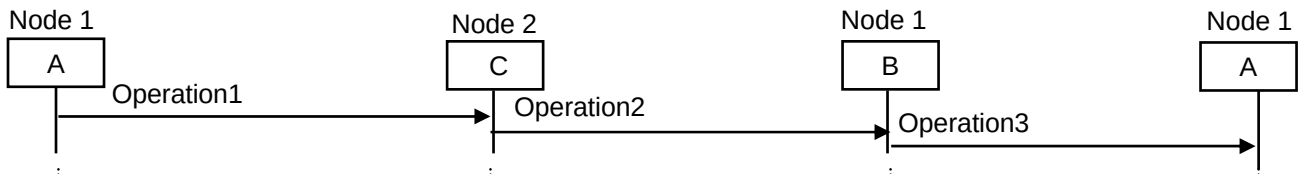


Architectural Information Used by the Performance Models

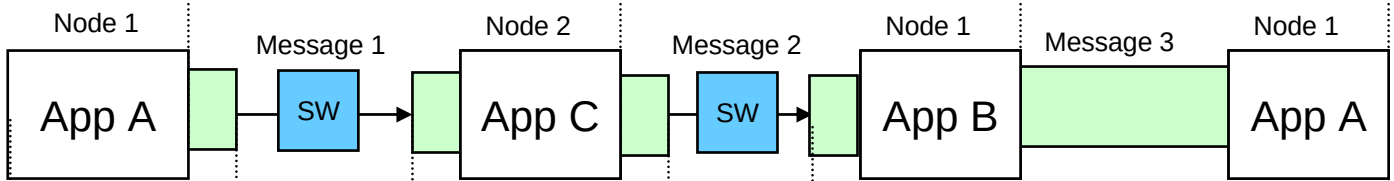
- Node Identification
- Sources and Destinations
- Message Name and Routing
- Message Size and Rate
- Message Acknowledgment
- Application Processing Time and Priority
- Software Component Scheduling Method: Real-time, Timeshare, FIFO
- etc

Sequence Diagram Flows can be Interpreted in Terms of Infrastructure Modeling Assemblies (IMAs)

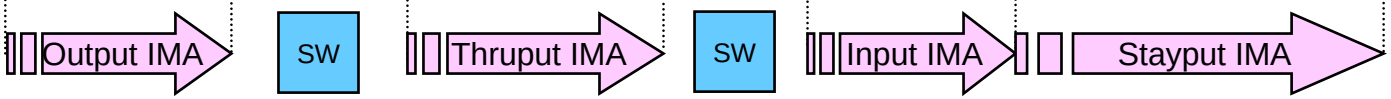
- **Operations on the sequence diagram:**



- **Infrastructure flow between applications:**



- **Model flow:**



Network Switch

Middleware &/or internet protocol

An Infrastructure Modeling Assembly (IMA)

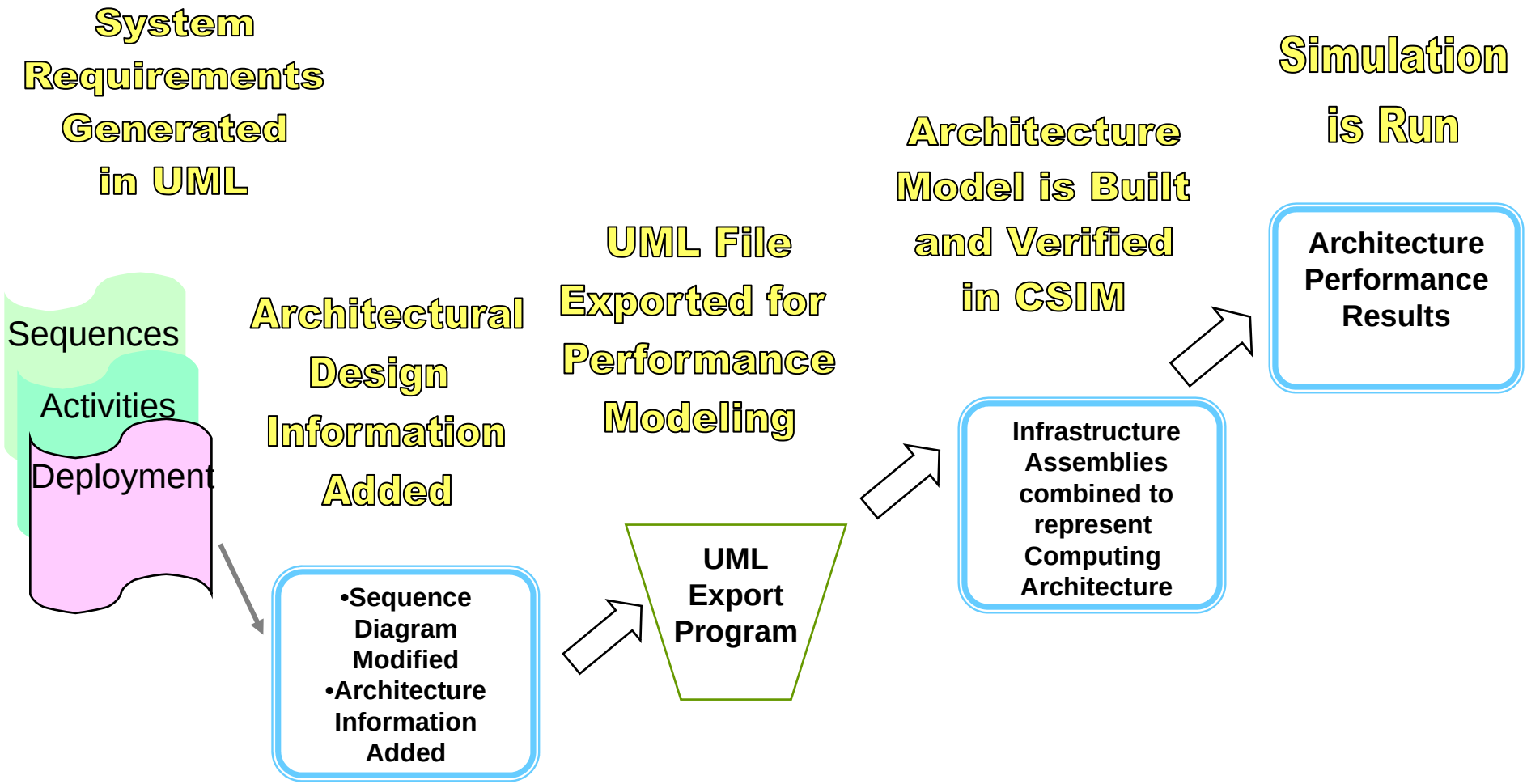
- The IMA is a model of a reasonably large infrastructure assembly, representing the processing flow initiated by the transmission of a single message
  - It may include processing by an application, middleware, and other infrastructure components and be governed by internet protocol, priority and scheduling rules
  - The IMA is built around a CPU-like resource allowing parametric control of such activities as scheduling, context switching, priority levels, managing queues, internal processing, and message input/output
- IMAs simplify building the performance model
  - We reuse these IMAs and give individual instances 'personality' by inserting a small number of menu-driven parameters to provide their architectural information
  - By connecting these IMAs, we emulate a Sequence Diagram of any complexity
  - Each sequence is built separately, and is independent of others until they are combined at simulation run time

We Use CMIS, a Lockheed Martin Event-Driven Simulation Tool

The Savings When Using IMAs

- **Experience indicates the large savings possible by modeling with and re-using Infrastructure Modeling Assemblies**
  - **For example, the Input IMA contains**
    - **~ 40 elementary blocks assembled once**
    - **~ 25 default parameters set once when built**
    - **~ 10 parameters set each re-use**

From UML Requirements to Computing Architecture Performance

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