Performance Modeling and Simulation of the Co-development for Test Waveform and JTR Architecture

Long V. Ho
Strategic Architecture Group
Integrated Defense Systems
Anaheim, California, USA
long.v.ho@boeing.com
(714) 762-0494

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Typical M&S Approach

- Descriptive Analysis
  - Problem formulation
  - Input source collection and analysis
  - Model development
  - Model verification, validation and calibration
  - Scenario simulation and performance evaluation
- Prescriptive Analysis and Post-prescriptive Analysis (Optional)
  - Optimization and sensitivity testing
- Issues
  - Scope of the model
  - Specific questions to be answered by the M&S results
  - System configuration to be modeled
  - Performance measures that will be used to evaluated the efficacy of different system configuration
  - Time frame for the development and the required resources

Problem Formation

- Capability Verification
  - Verify that the capacity of the hardware architecture satisfies the operational need of the radio and waveform software for a particular JTR Set configuration
- Performance Analysis
  - Analyze end-to-end latency, component throughput, data and control bottlenecks meets processor loading and critical timing requirements
- Portability Validation
  - Validate that a particular waveform is properly partitioned
    - to match the capacity of the available hardware resources
    - to maximize software portability while satisfying application performance

Input Source Collection and Analysis

- Source Collection
  - Documents
    - SCA, API Supplements, Security Supplement, Developer's Guide
    - RTOS, CORBA
    - Waveform application specification
    - Radio application specification
    - JTR architecture specification
  - Estimate and measure performance parameters
- Source Analysis
  - Identify controllable and uncontrollable inputs.
  - Identify constraints on the decision variables.
  - Define measure of system performance.
  - Develop a preliminary model structure to interrelate the inputs and the measure of system performance

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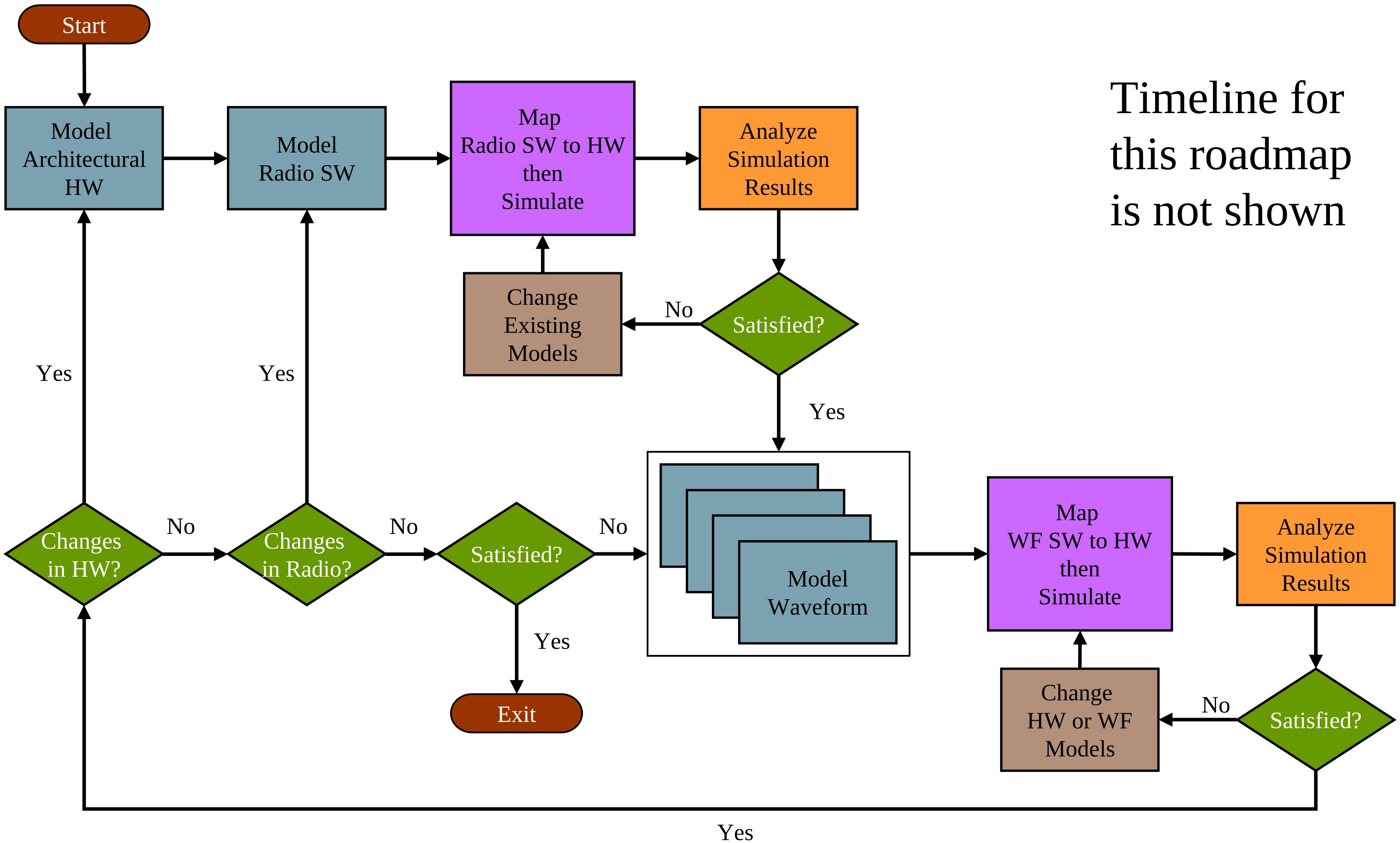
Model Development Roadmap

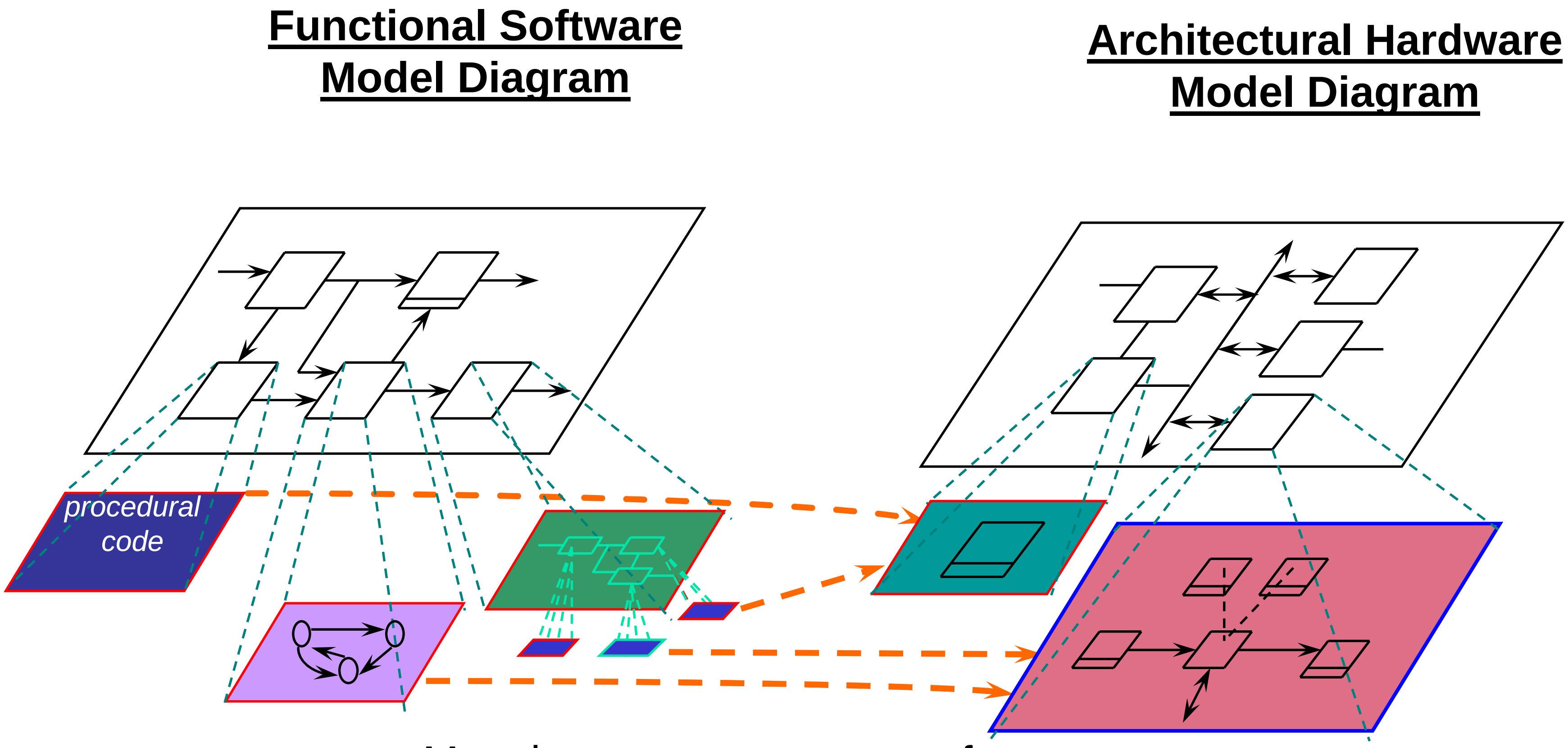


Timeline for this roadmap is not shown

Tool Selection

- Co-Design Tool by Foresight Systems
- Foresight – “A software product from Nu Thena providing graphical modeling tools for high level system design and simulation” – HyperDictionay.com
- The tool provides the two orthogonal views of the system – architecture and function – which are linked by a partitioning specification
- It also provide the system virtual prototype capability

Resource Mapping using Tool



Mapping resource request of

Modeling of Hardware Architecture

- The architectural model describes the hardware resources used in processing or transporting the radio and waveform application data
  - Create Models of Resource Building Blocks
    - Space-based and Time-based Resources
  - Build Models of HW Components
    - MEM, CPU, DSP, FPGA, I/O Devices
  - Build Models of HW Components and Architecture
    - Modem, Ethernet, Serial, Audio
    - Black, Red and Common General Purpose Processing (GPP)
- Inputs for M&S of hardware resources are hardware specifications
- Simulation parameters are component configuration, resource capacity

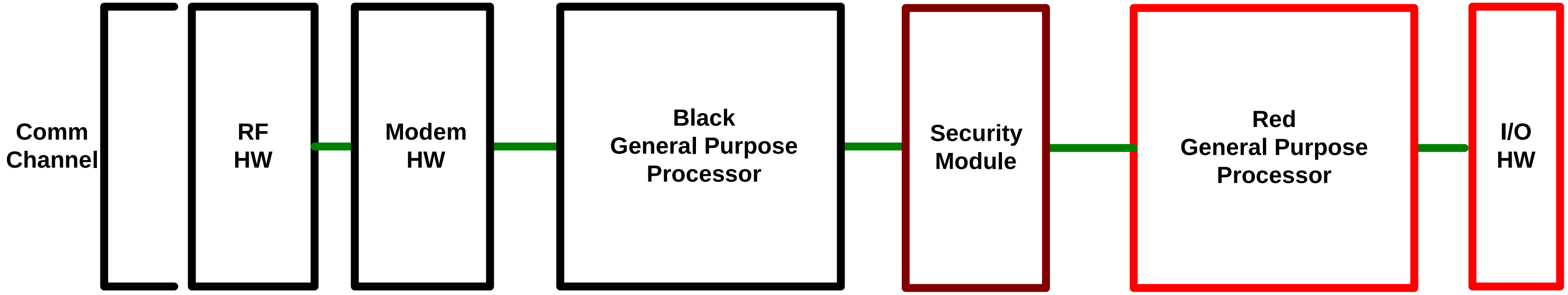
Space-based Resource Building Block

- A Basic Resource establishes the amount (capacity) of an asset available (e.g. memory) for all the competing processes to share.
- Foresight syntax to request a resource:
  - *aToken* := ***requestRes*** (string *name*, real *amount*)
    - *name* is a defined resource's name
    - *amount* is the amount of request (greater than zero)
    - *aToken* is an associated token with the request if successful. Otherwise, this token is a NOT_AVAILABLE token.
- Foresight syntax to release a resource that was requested:
  - ***releaseRes*** (*aToken*)

Time-based Resource Building Block

- A Process Resource establishes the work rate of an asset available (e.g. processor) for all the competing processes to share.
- Foresight syntax to request a resource:
  - *aResult* := ***requestProc*** (string *name*, real *amount*)
    - *name* is a defined resource's name
    - *amount* is the amount of request (greater than zero)
    - *aResult* is returned automatically AFTER process completes processing the requested amount. If preemption is desired a priority option may be supplied, then, *aResult* is an amount of resource that was requested but was not yet processed because of being preempted.

JTR Set Architecture

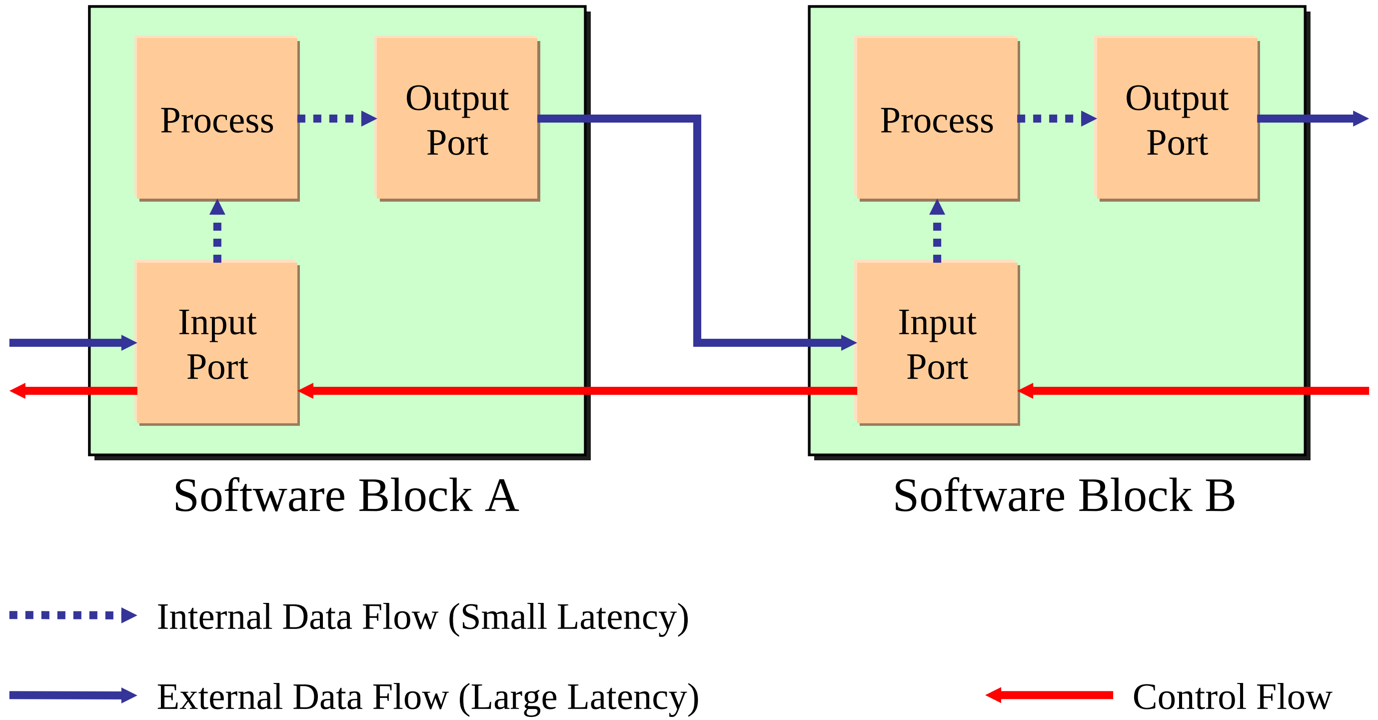


Modeling of Software Function

- The functional model describes the Radio and Waveform components and application that run on hardware resources
  - Create Models of Building Blocks
    - Generic Push Packet, Physical Real-Time, MAC, LLC, I/O
  - Build Models of SW Components
    - Radio Devices, Radio Services, Waveform Components
  - Build Radio and Waveform Application
    - Data Flow Diagram of Interconnected SW Components
- Inputs for functional models are radio and waveform functional specifications
- Simulation parameters are component configuration, resource utilization and latency performance

SCA Generic Packet API Building Block

- Based on SCA API Supplement Generic Packet Building Block (Appendix C)
- Provides a method to send user data between software entities and provides priority based flow control



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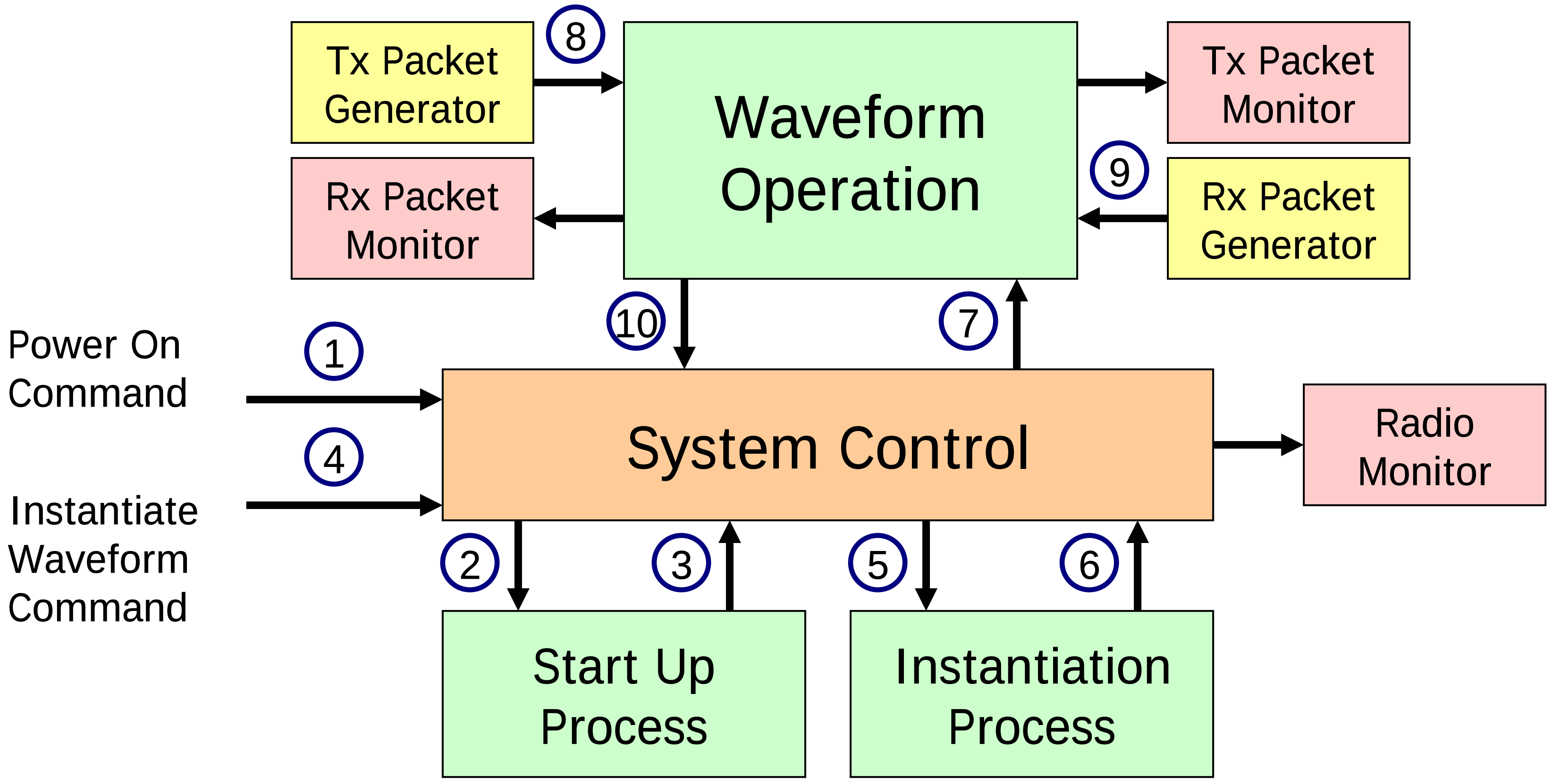
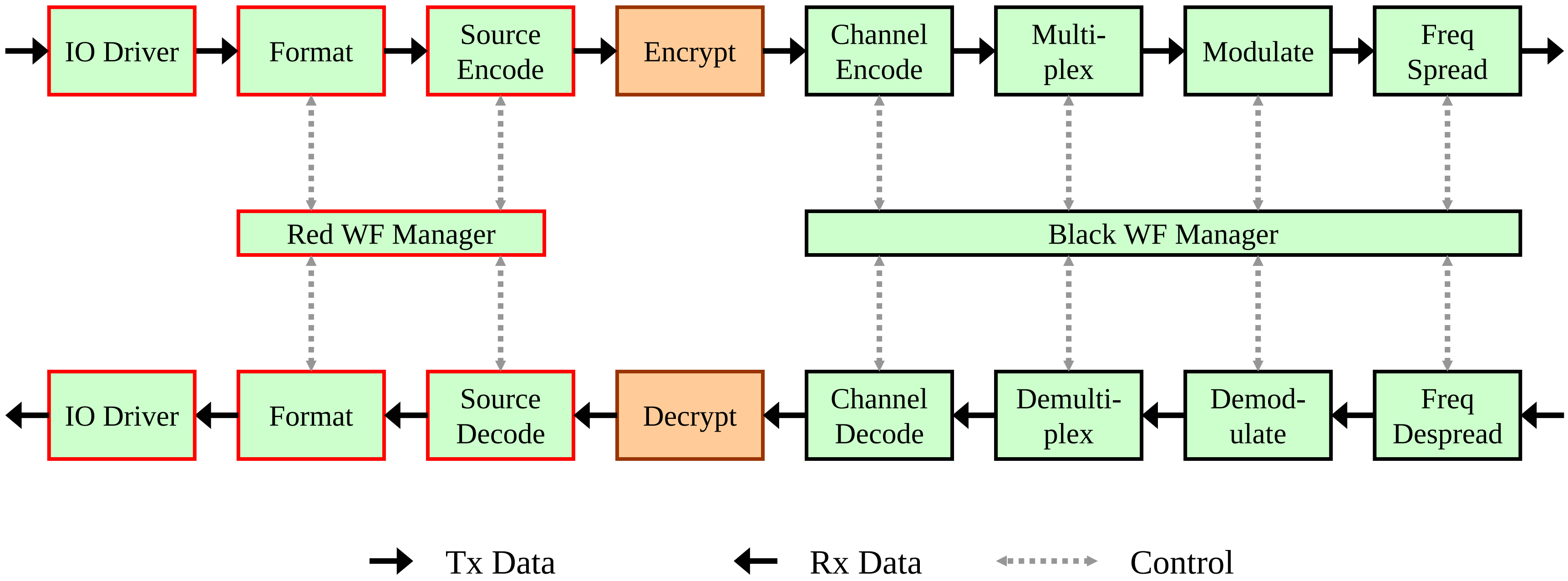
Radio and Waveform Application Control



Test Waveform Modeling



– Each block has zero to many CORBA and/or NON-CORBA Interfaces
– Transferring data among radio and waveform interfaces by message flows

Verification, Validation and Calibration

- Verification focuses on the internal consistency of the model
  - Ensure each WF Application, Radio Service, Radio Device, Driver Components are modeled with proper component building blocks
  - Ensure models of SW and HW components matched their functional specification
- Validation checks the correspondence between the model and the reality
  - Unit testing of model component behaviors
  - integration test of system behaviors
- Calibration checks that the data generated by the simulation matches real (observed) data
  - Study and evaluate Input , In-process and Output data

Scenario Simulation and Performance Evaluation

- "Power On" command
  - The Start Up Process is triggered
  - Each GPP is boot independently, POST is proceeded, CF and radio software are loaded and started.
- "Instantiate Waveform" command
  - The Instantiation Process is started if the Start Up Process is successful. External data for resource mapping, utilization parameters, and Input/Output port configuration are passing via component's configure ports.
- System enters Waveform Operation state after Instantiation Process is successful.
  - Start message generator
  - Monitor packet throughput (loss) and latency, resource usages
- Evaluate various strategies for the operation of this waveform

Conclusion

- Early Evaluation of Waveforms and Radio Sets results in lower risk and reduced cost
  - Evaluate the performance effectiveness of resource allocations for JTR system
  - Identify resource bottlenecks
  - Evaluate the probability of waveform/task execution success (as it relates to resource availabilities) for each waveform class, under priority based resource sharing and allocation policies
- Future Work
  - Make use of Domain Profile to configure model for simulation
  - Model additional APIs from SCA Extensions