Complex Networks Enabling Technologies Capability Development

2012 Annual IV&V Workshop

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IV&V Questions Addressed by CD

CD: Question addressed	Associated Tech Framework WBS	
Develop modeling / simulation techniques capable of verifying that user needs are addressed.	2.2	System architecture meets user needs
For performance requirements, establish boundary conditions of how the system performs and assess robustness i.e.: margin against those requirements.	5.2	Ensure design provides required capability, reliably meets user needs, sufficiently stable for implementation
Develop a simulation that operates at varying levels of abstraction to address decomposition, interfaces and integration.	3.2	In-scope parent reqts. represented in appropriate child reqts., no unneeded capabilties added
	3.4	Software interface reqts. adequate to meet needs of system
Define a data dictionary approach to address user scenarios that can feed into test analysis.	4.1.2	Ensure planned tests sufficient to confirm integrated system complies with system software reqts.

Scripting Products and Process Overview

The Data Dictionary captures a Use Case and feeds the Simulink and Layered Queuing Network (LQN) models. We pulled all variables out of the model and made this aspect table driven

Data Dictionary:
Parameters and Variables for a particular instance (Use Case)

GUI
Translates a use case to input data for each model.

C# based Graphical User Interface (GUI) takes the parametric Use Case and turns it into individual calls and attributes for Simulink, call rate and call type probabilities for LQN.

Architecture (Simulink Model)
- Varying levels of fidelity
- Allows concatenation of Use Cases
- Allows verification of interfaces

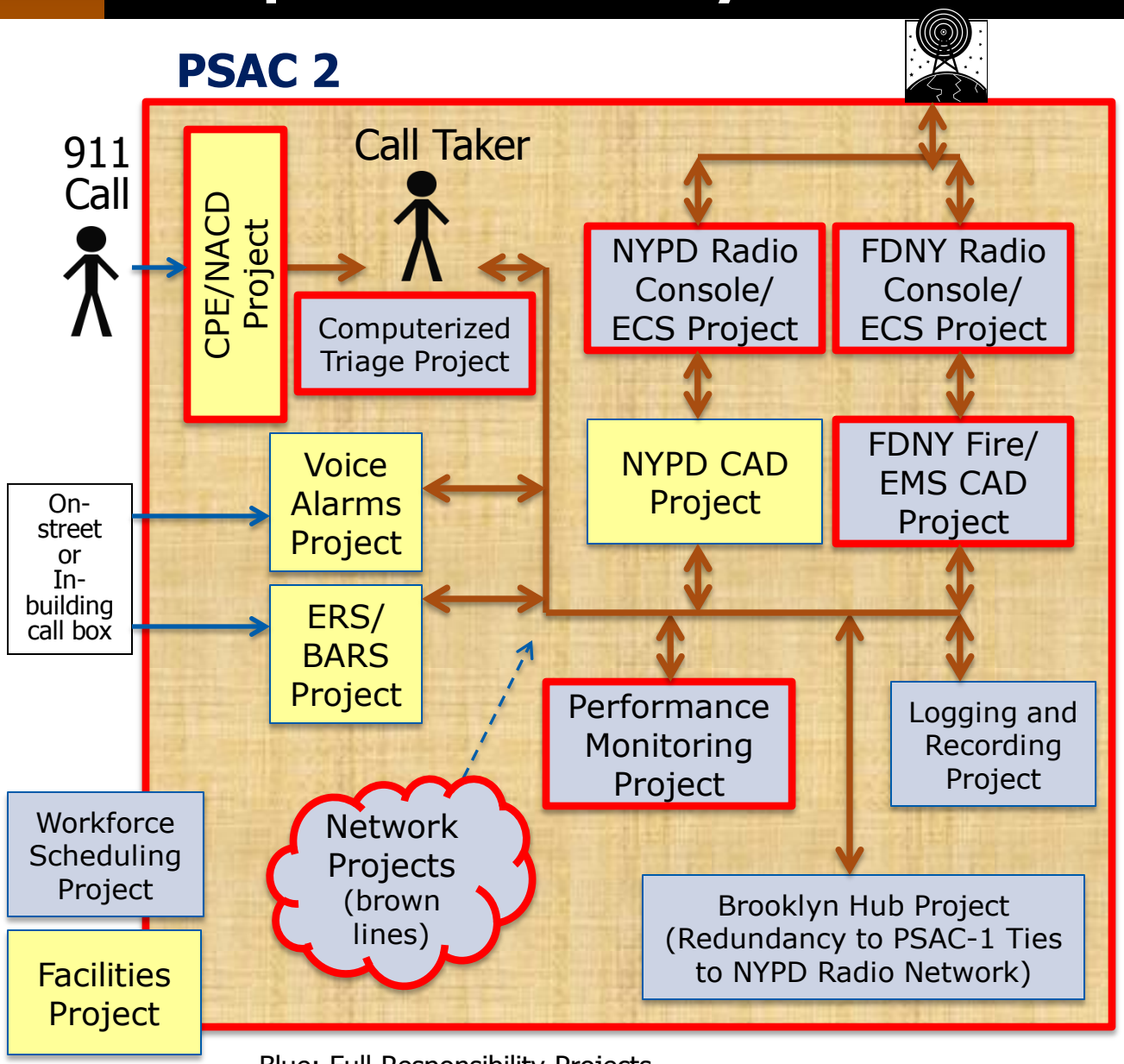
Performance (LQN Model)
- Performance across a time range
- Evaluate Boundary Conditions

The Simulink model reflects the system architecture at various levels of abstraction. Erlang distribution used for internal call processing parameters.

Models are validated against each other for correctness

The LQN model allows rapid prototyping and is a "process model". Inputs are parametric, characterizing the use case

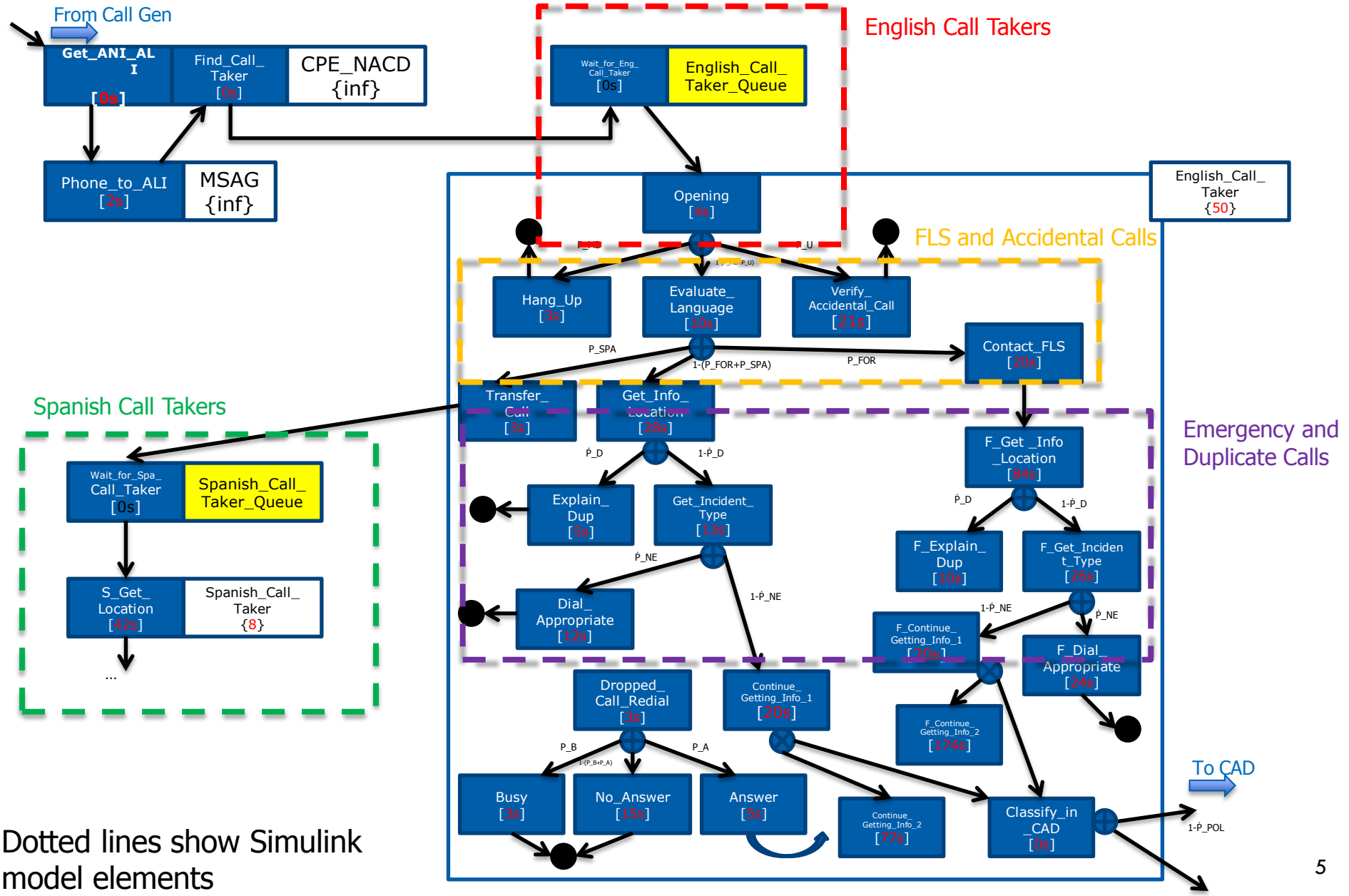
A Representative System



Blue: Full Responsibility Projects
Yellow: Oversight Coordination Projects

- **We will perform IV&V on the integration and performance of the entire system (Pri 1)**
  - As required, this effort will evaluate other ECTP projects
- **Additionally, there are seven projects which will receive "full" IV&V efforts**
  1. CPE/NACD (Pri 2)
  2. Network (Pri 2)
  3. NYPD Radio Console/ECS (Pri 3)
  4. FDNY Radio Console/ECS (Pri 3)
  5. FDNY Fire/EMS CAD (Pri 4)
  6. Performance Monitoring (Pri 5)
  7. Computerized Triage (Pri 6)

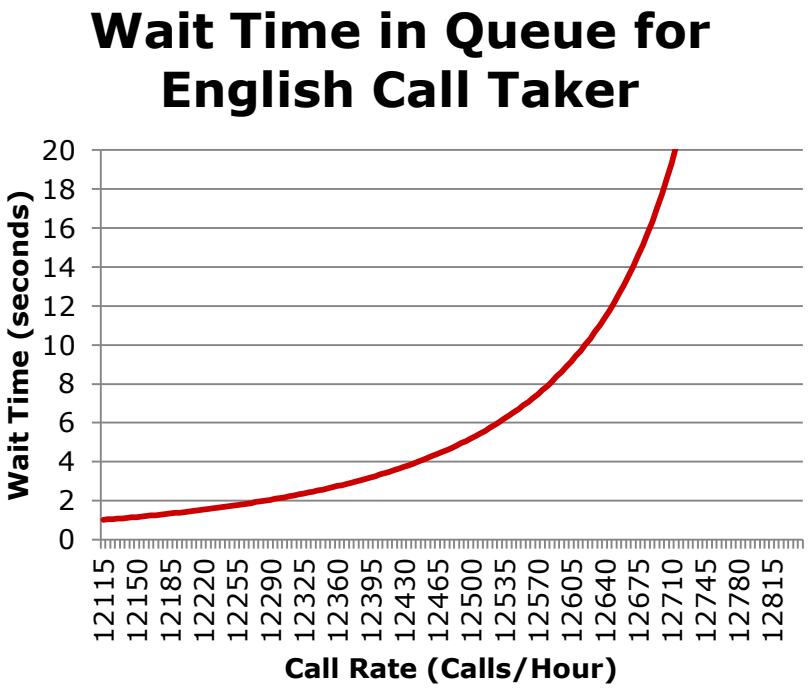
LQN of Police Department (stubbed out FD, EMS): Process Model

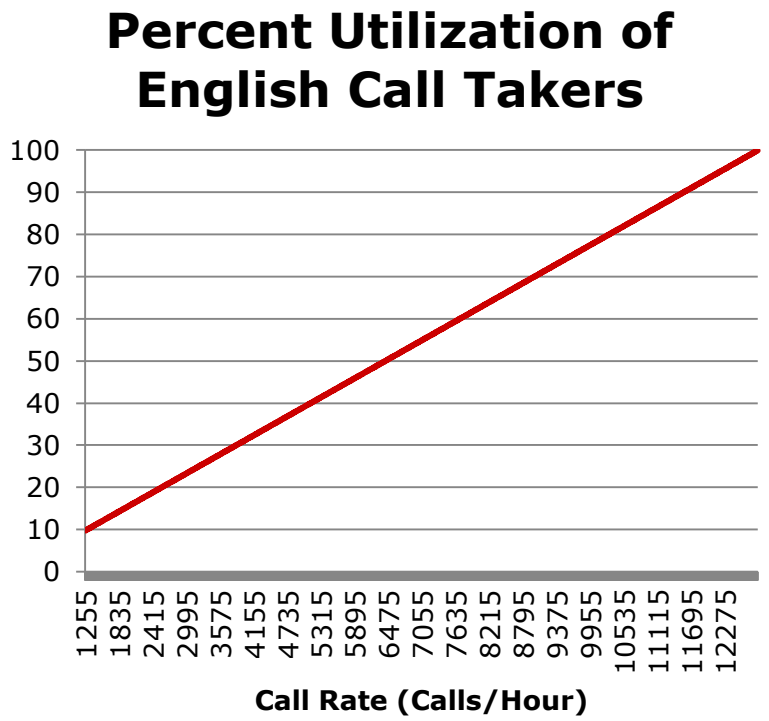


Dotted lines show Simulink model elements

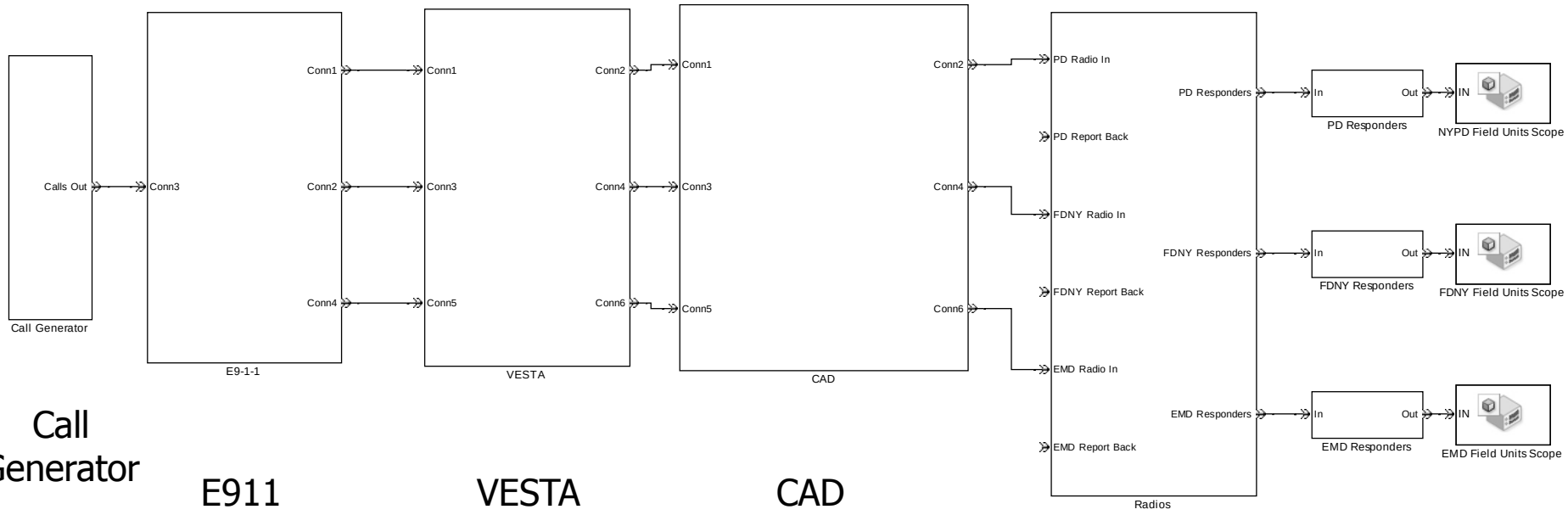
LQN Performance Demonstration – Waiting Time

- For the first test, all values with the exception of **Call_Rate** were held constant for steady state values as listed in **DataDictionary5**, and the system was modeled with only the first section of the ECTP model as described in **Design of the ECTP Layered Queueing Network10**
- The **Call_Rate** value was tested at different values from 1250 to 12845 calls/hour in increasing increments of five





Simulink Top Level Blocks (architecture model)



Call Generator

E911

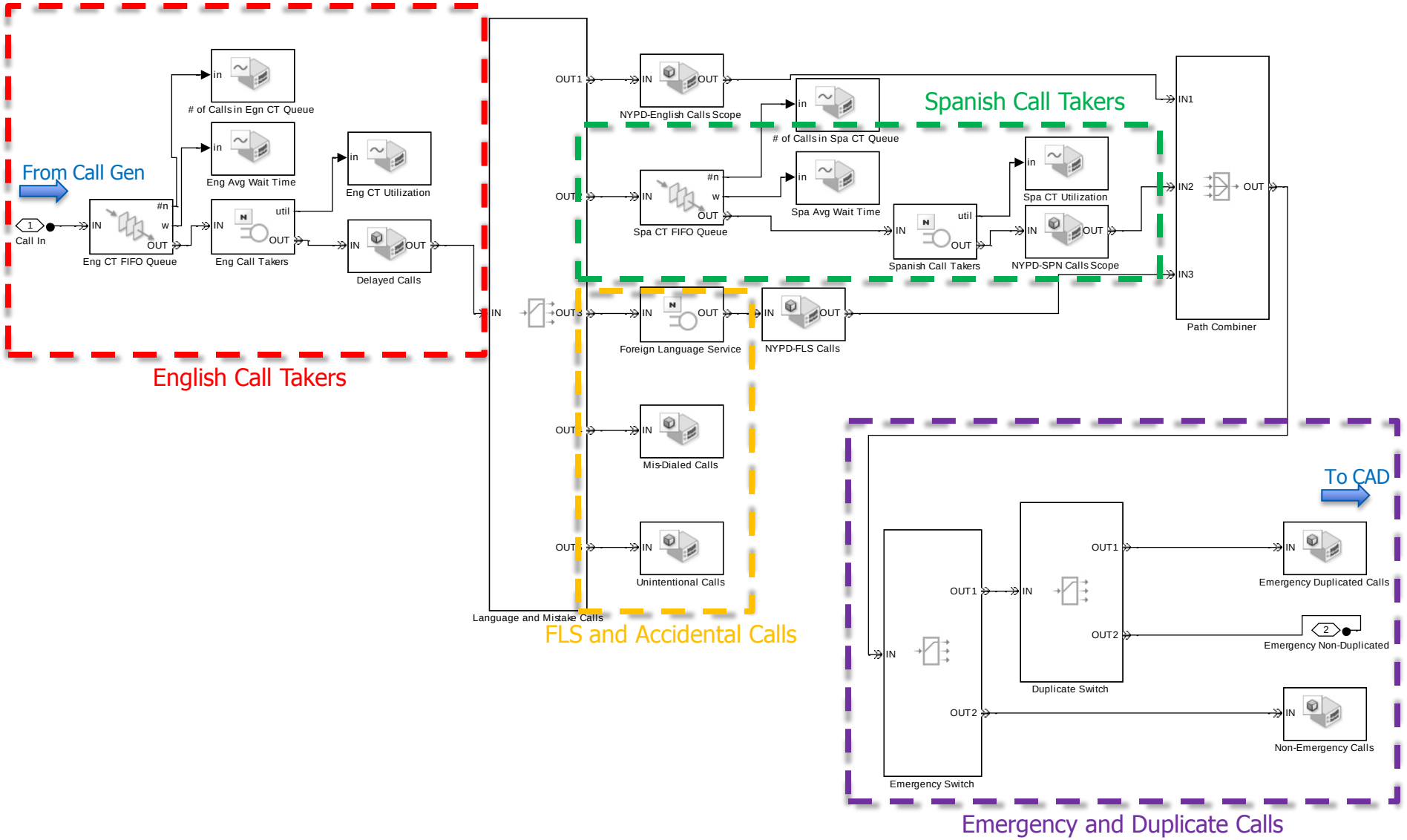
VESTA

CAD

Radios

Reponders/ Field Units

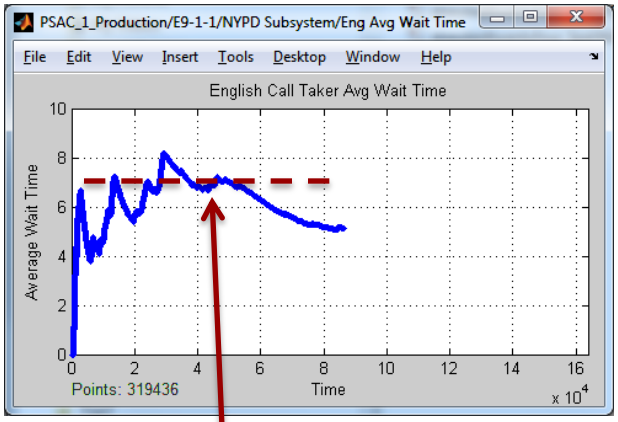
Model Comparison – Simulink L2 Complex Network

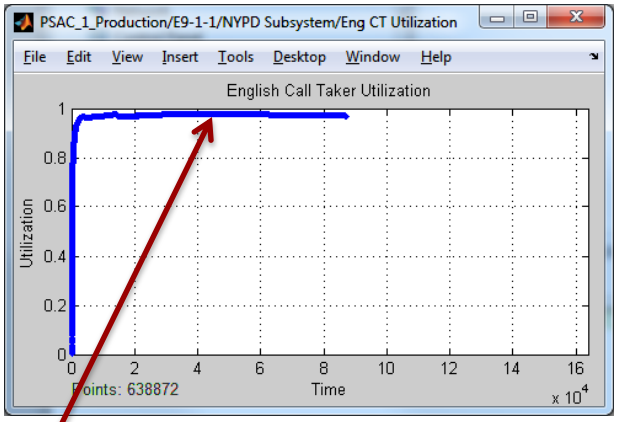


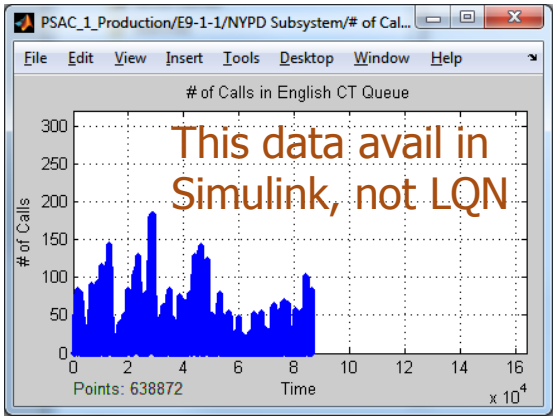
Dotted lines show LQN model elements

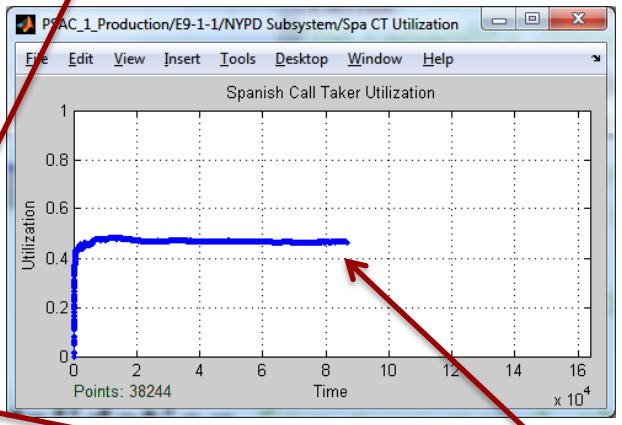
Simulink and LQN Results at 13k Calls/hour for 24 hrs (we wanted to make sure models were in sync)

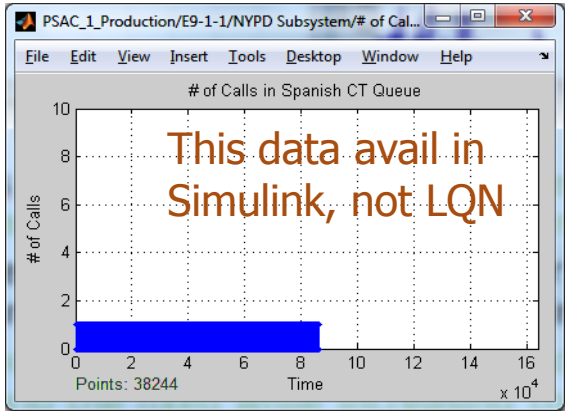
Simulink Results











LQN Results

CallRate	AvgECTQueueTime	ECT_Utilization	EngProbOfDelay	EngAcceptablePercent	AvgSCTQueueTime	SCT_Utilization	SpaProbOfDelay	SpaAcceptablePercent
13300	7.1544	0.97782	0.612330436	0.885415365	0.0001	0.465530556	6.55E-05	0.99999948

Note: some variation due to translation (e.g. LQN had 13300 calls and Simulink had ~13500 calls/hour in the 24 hour period)

Status, and Method Assessment

CD: Question addressed	CD Status and Method Assessment	Associated Tech Framework WBS	
Develop modeling and simulation techniques capable of verifying that user needs are addressed.	LQN and Simulink models were implemented by creating a custom data dictionary with a GUI to automatically draw from the dictionary and create input files for the two models. This is a new, demonstrated technique for IV&V.	2.2	System architecture meets user needs
For performance requirements, establish boundary conditions for how the system performs and assess robustness i.e.: margin against those requirements.	The LQN model was used to establish boundary conditions which adequately simulated performance to provide an assessment of system capability against requirements and provided an assessment of robustness. In addition the model revealed there was a high sensitivity to changes in the boundary conditions. This is a new demonstrated technique for IV&V	5.2	Ensure design provides required capability, reliably meets user needs, sufficiently stable for implementation
Develop a simulation that operates at varying levels of abstraction to address decomposition, interfaces and integration.	Significant progress has been demonstrated towards achieving this objective. The Simulink level 1 model has been completed which represents system architecture at the highest level, derived from the driving artifacts. The model also includes a lower level of abstraction which includes additional details of the system. The level 2 model elaborates architecture, with an increased focus on processes. The level 2 model has been defined and potential Simulink tool limitations evaluated.	3.2	In-scope parent reqts. represented in appropriate child reqts., no unneeded capabilties added
		3.4	Software interface reqts. adequate to meet needs of system
Define a data dictionary approach to address user scenarios that can feed into test analysis.	This has been accomplished by both the LQN and Simulink models. The LQN model can automatically vary the range of a parameter to produce a performance profile. The Simulink model can concatenate use cases to evaluate a complete scenario. This is a new demonstrated technique for IV&V.	4.1.2	Ensure planned tests sufficient to confirm integrated system complies with system software reqts.

We have drafted a method to cover the new techniques developed during this CD.