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Executable Architecture of Net Enabled Operations: State Machine of Federated Nodes

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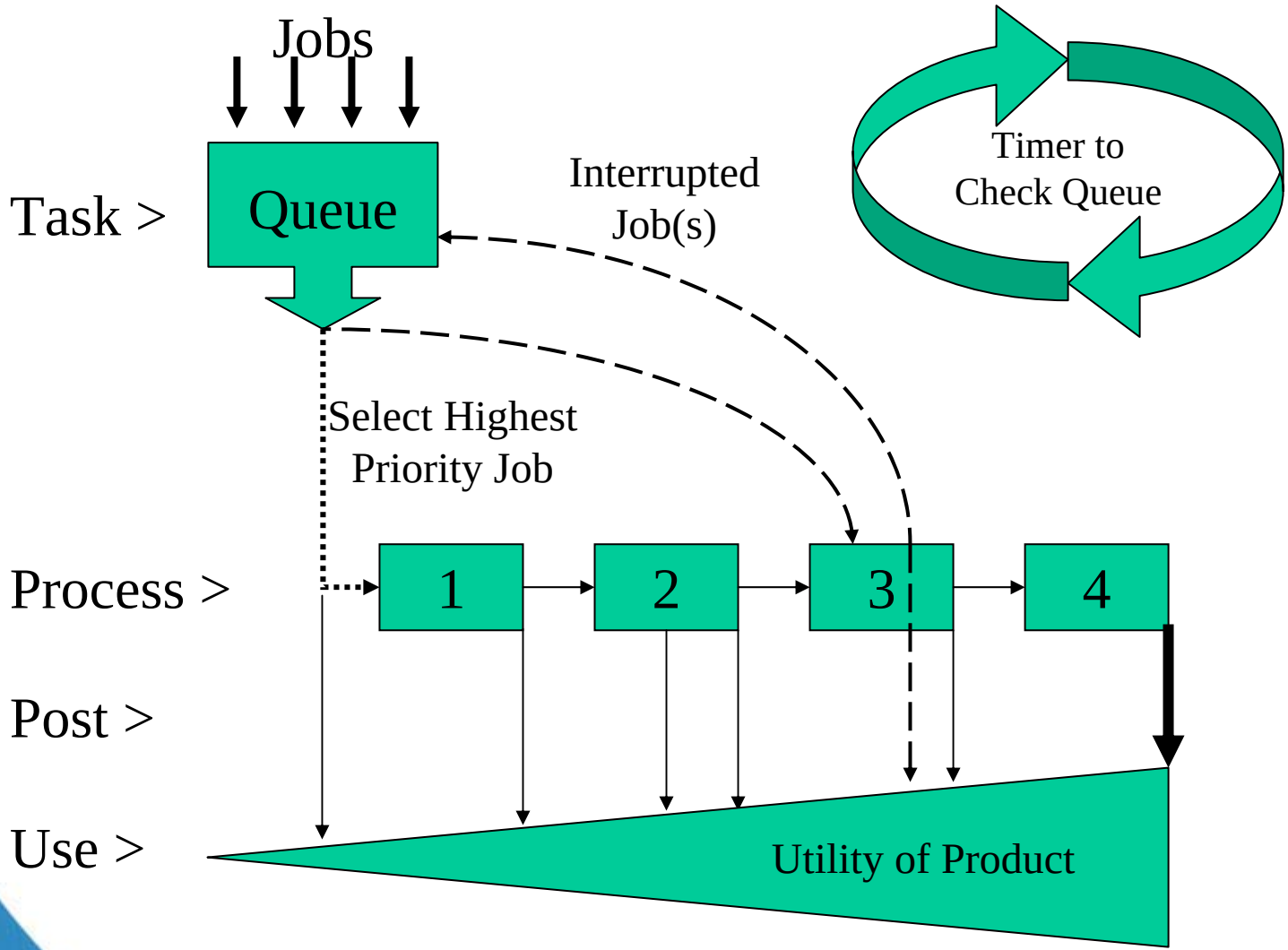
Outline

- Introduction
  - Background
  - How Work is Handled
- Conceptual Basis
  - Scale Free Design
  - Logic for Data Transfer
- Implementation
  - Input Data Files
  - Node Logic
- Results
- Way Ahead

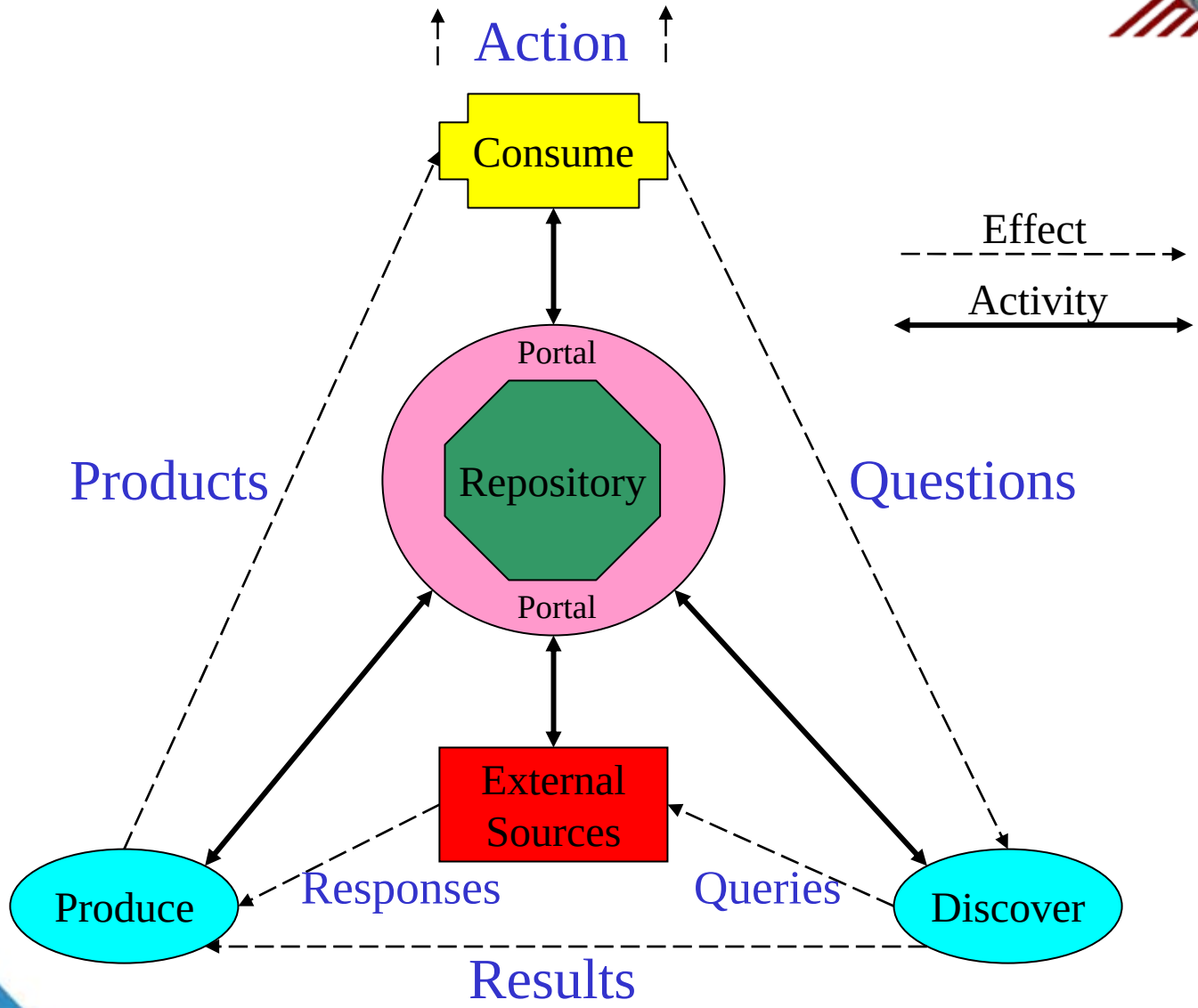
Quick Background

- Goal: develop capability-engineering analysis tools to support the building, demonstration, and analysis of executable architectures.
- OPCEN State Machine presented at 11th ICCRTS

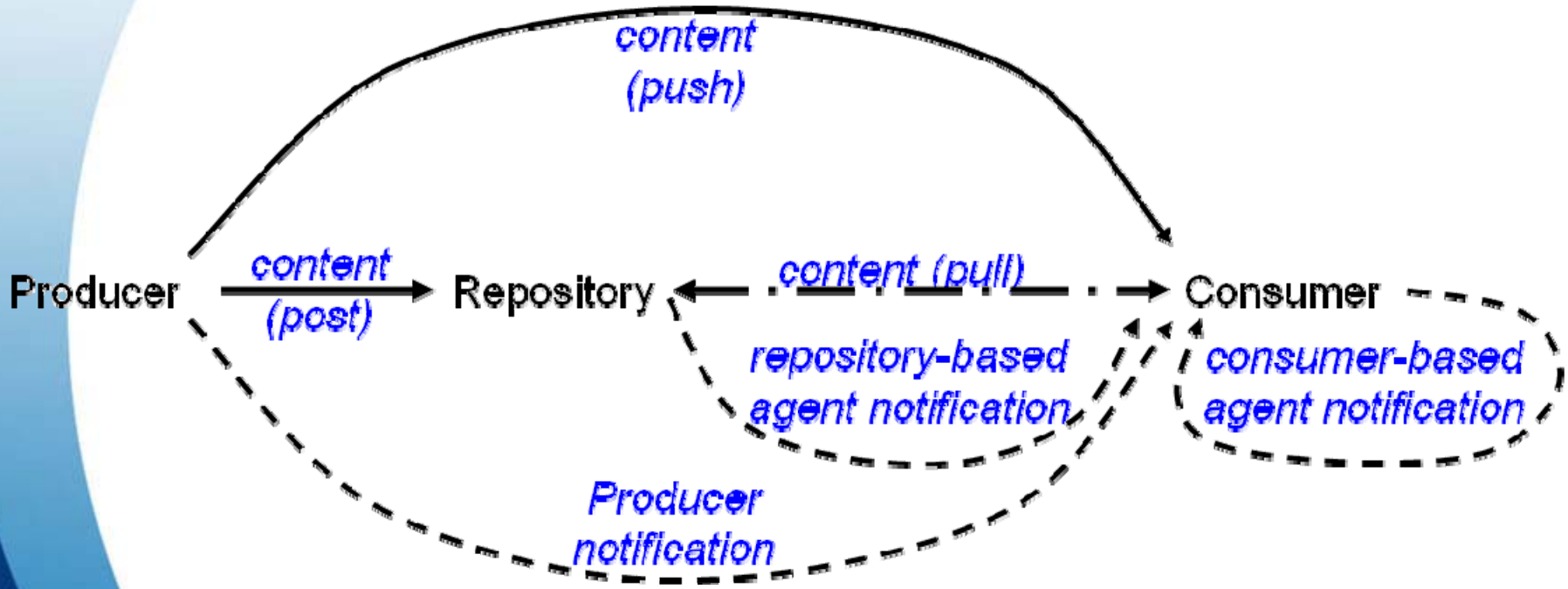
Task, Post, Process, Use (TPPU) Process – How We Handle Jobs



Scale Free Concept for SMOFN



Producer-Repository-Consumer (PRC) Model



What SMOFN Does That OPCEN SM Couldn't Do

- Nodes modeled beyond Producer
  - Questions can be asked/answered using discovery threads
  - Interaction of activity between nodes
- More flexibility in job steps
  - Now allows unlimited number
  - Complex processes built from simple steps
  - Steps defined by names, not numbers

What SMOFN Accounts For

- Data-driven simulation:
  - Uses files to build customized job workflows and configure any combination of nodes without affecting the business logic.
- Accounts for the following overhead activities:
  - Tracking consumer perception of product utility as it accrues and decays;
  - Consolidation of products into higher-level aggregated products; and
  - Triggering new jobs where needed whenever relevant data becomes available.

SMOFN Data Files

- Describe general characteristics of each thread
- Describe each step within thread
- Describe OPCEN configuration
- Describe product delivery
- Data remains outside model until runtime
  - Allows model to remain unclassified

What the Producer Does

- Only node modeled in the OPCEN SM
- Converts raw data into analyzed products
- Progress is tracked step by step
- Job state accounts for:
  - Utility accrued / decayed
  - Operators involved
  - Time spent / left

What the Repository Does

- Conduit to transfer required information between nodes
- Producer-Repository-Consumer (PRC) business logic used to select the way information is transferred
- Logical entity where data can actually reside anywhere
  - Can be centralized or distributed databases
- Bandwidth limitations accounted for here

What the Consumer Does

- Receives Products from Repository
- May generate Questions some time after receiving each Product
- Will eventually be able to initiate action to start other chain of activity (i.e. acts as external source demanding products from lower level OPCENs)

What the Discoverer Does

- Jobs defined similar to Producer
- Jobs start when Questions received
- Three possible results
  - All required data found
  - Some required data found
  - No required data found
- Found data triggers new analysis job at Producer
- Missing data triggers Query to External Sources

What the External Sources Do

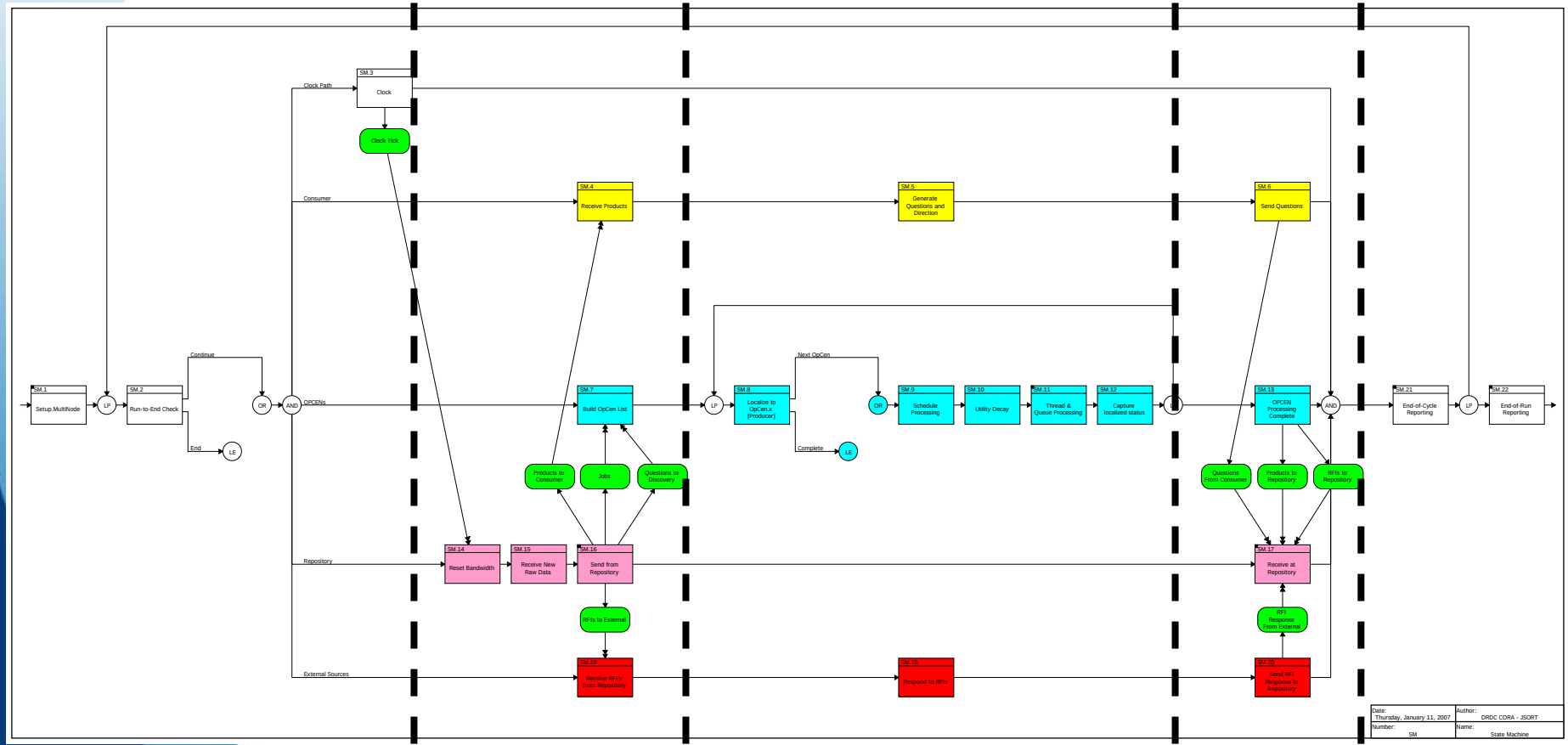
- Logic similar to Consumer
- Receives Queries from Repository
- Generates Responses some time after receiving each Query

SMOFN Execution

- Flowchart represents a moment in time
- Decision logic executes entirely for one time step
- Time steps forward, logic repeats, accounts for changes in job states

Top Level SMOFN Model (Implemented Using COREsim)

Simulation Control | Inputs | Activity Within Time Step | Outputs | Simulation Output

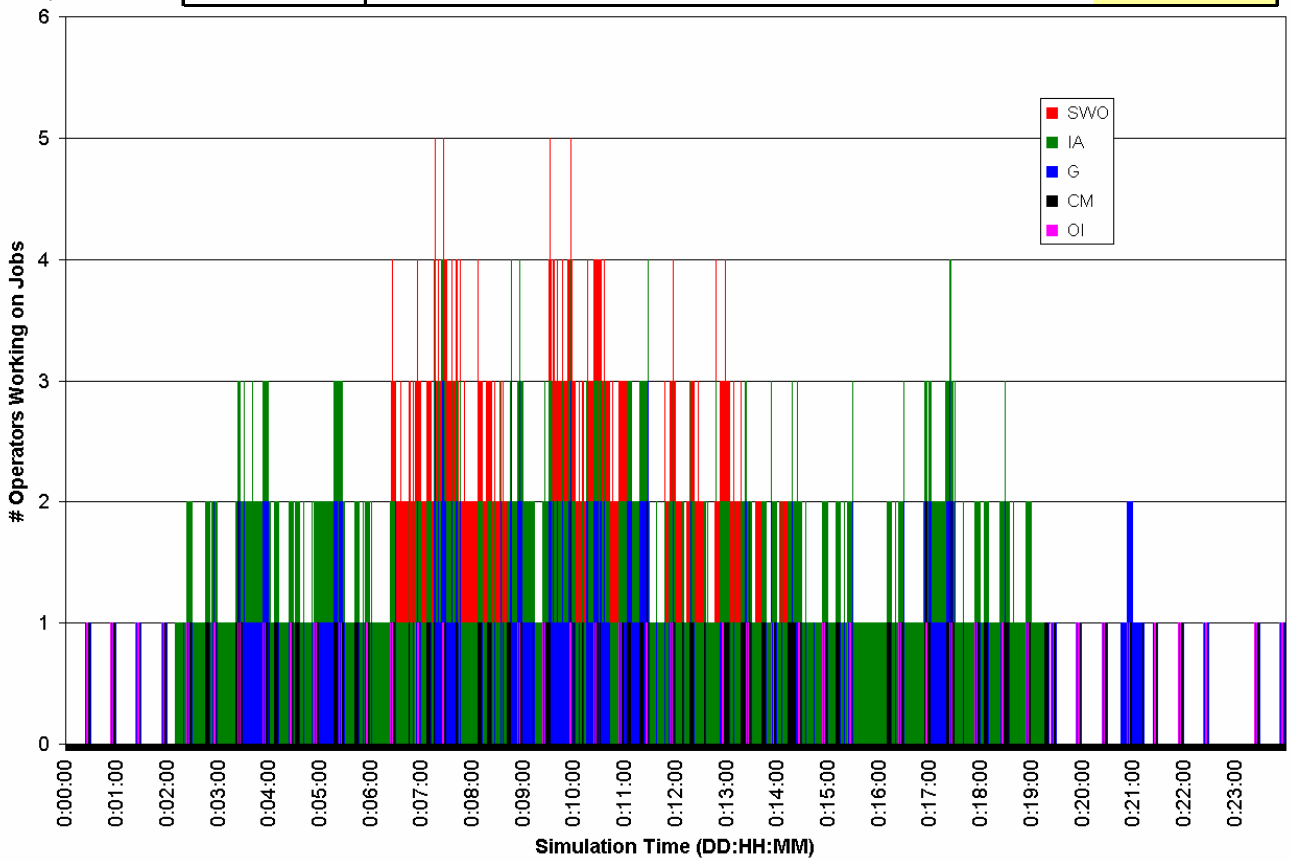


Examples of Results Analysis

- Operator utilization (example follows)
- Completion rate
- Product utilization and utility during its life cycle
- Bandwidth bottlenecks
- Effect of synchronizing OPCEN battle rhythms

Operator Utilization
- Single Skills Lead to Bottlenecks

Skill Used >>	*SA/UA*	*SWO*	*IA*	*OI*	*CM*	*G*
Average	**70.3**	**4.3**	**14.2**	**1.8**	**3.3**	**6.1**
Op 1 - SWO	**78.4**	21.6				
Op 2 - IA	**29.2**		70.8			
Op 3 - OI	**83.3**			9.0		4.1
Op 4 - CM	**74.0**				16.3	0.4
Op 5 - SS	**86.9**					26.0

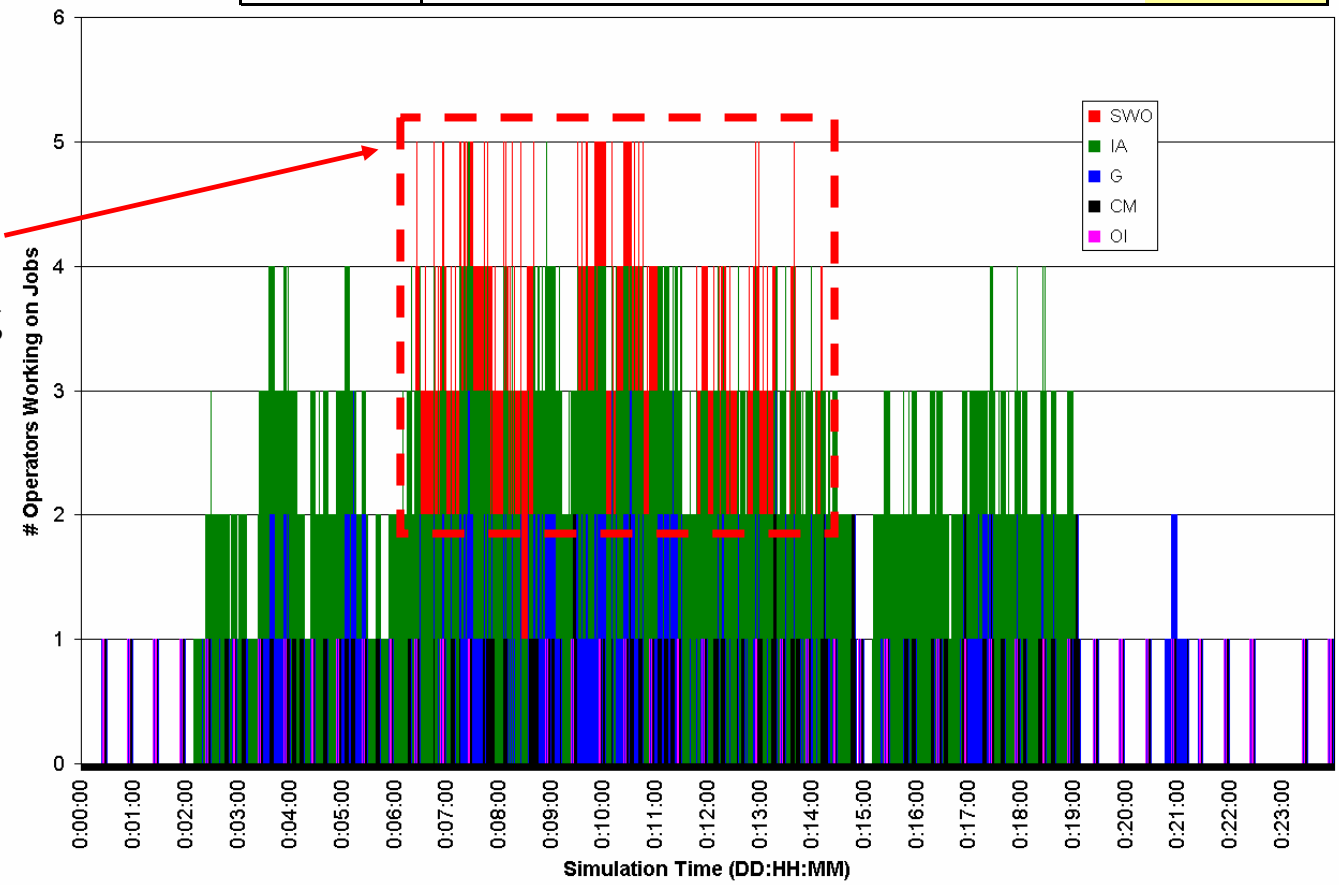


Operator Utilization – Multiple Skills Increase Flexibility

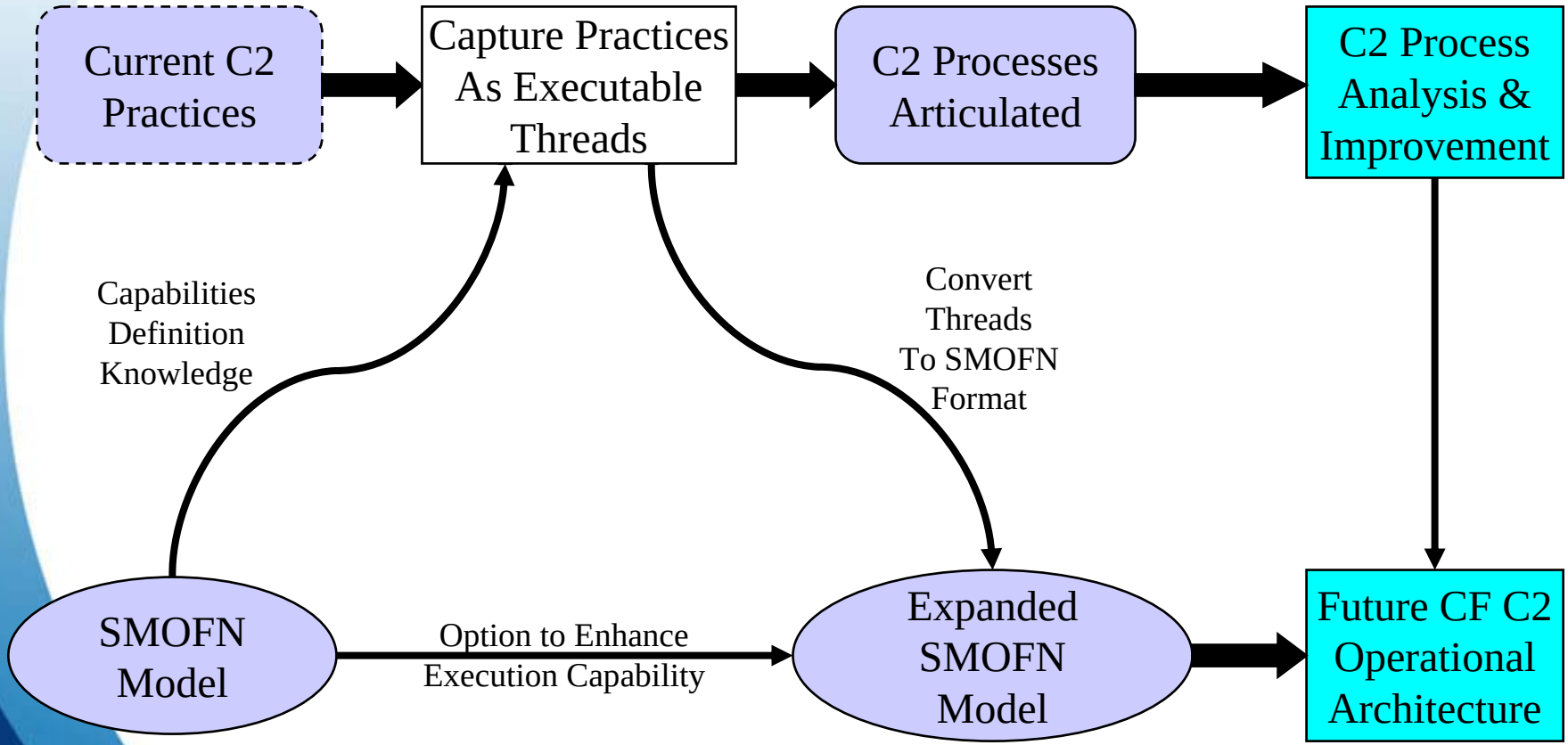
Skill Used >>	SA/UA	SWO	IA	OI	CM	G
Average	58.0	4.5	24.2	1.8	4.7	6.7
Op 1 - SWO	77.8	21.5		0.6		0.1
Op 2 - IA	33.7	1.0	65.3			
Op 3 - OI	70.8			8.4	15.0	5.8
Op 4 - CM	35.4		55.9		8.7	
Op 5 - SS	72.5					27.5

SWO Seems to have plenty of time for SA

BUT:
Work overload occurs in a critical period when SWO should be focusing on SA



C2 Modeling Path Being Used



Work in Progress

- Customization of SMOFN is underway to make data files representative of new Canadian Forces Command structure
- Currently modelling major threads that are key to any future C2 operational architecture:
  - Canada COM Battle Staff Rapid Response Action Planning Process
  - Combined Forces Air Component Commander National Aerospace Planning Process (CFACC NAPP)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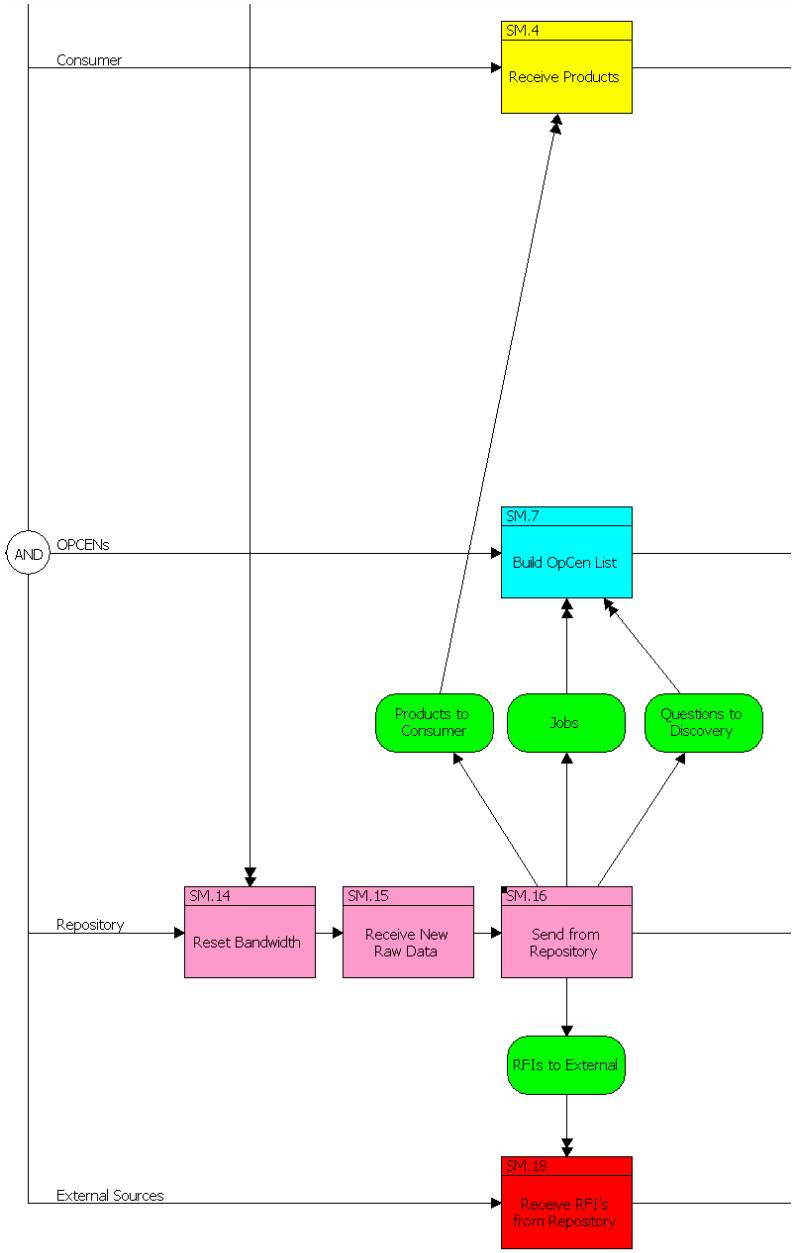
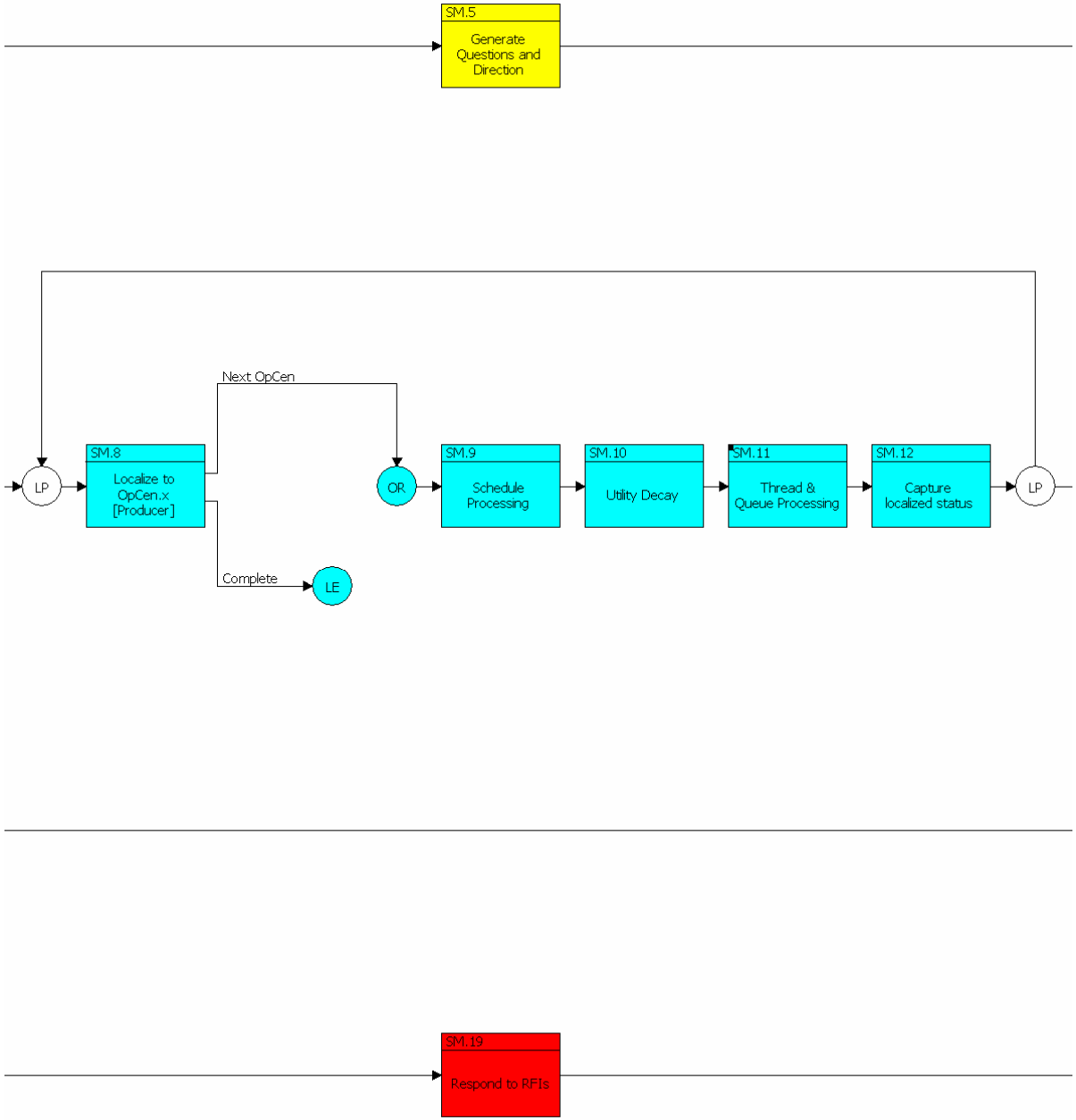
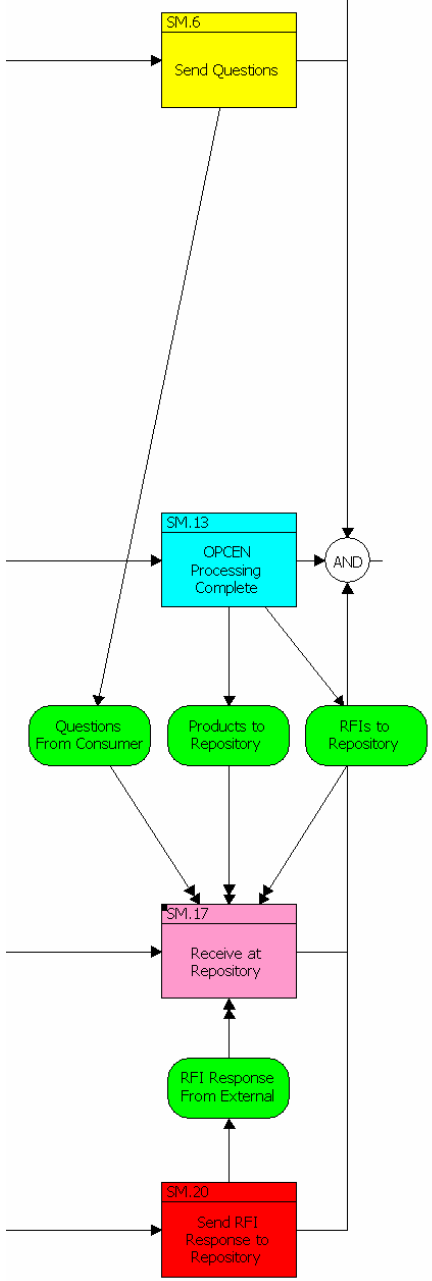

SM.4
Receive Products
Consumer
SM.7
Build OpCen List
AND
OPCENs
Products to Consumer
Jobs
Questions to Discovery
SM.14
Reset Bandwidth
SM.15
Receive New Raw Data
SM.16
Send from Repository
Repository
RFIs to External
SM.18
Receive RFI's from Repository
External Sources


SM.5
Generate Questions and Direction
Next OpCen
LP
SM.8
Localize to OpCen.x [Producer]
Complete
LE
OR
SM.9
Schedule Processing
SM.10
Utility Decay
SM.11
Thread & Queue Processing
SM.12
Capture localized status
LP
SM.19
Respond to RFIs


SM.6
Send Questions
SM.13
OPCEN Processing Complete
AND
Questions From Consumer
Products to Repository
RFIs to Repository
SM.17
Receive at Repository
RFI Response From External
SM.20
Send RFI Response to Repository