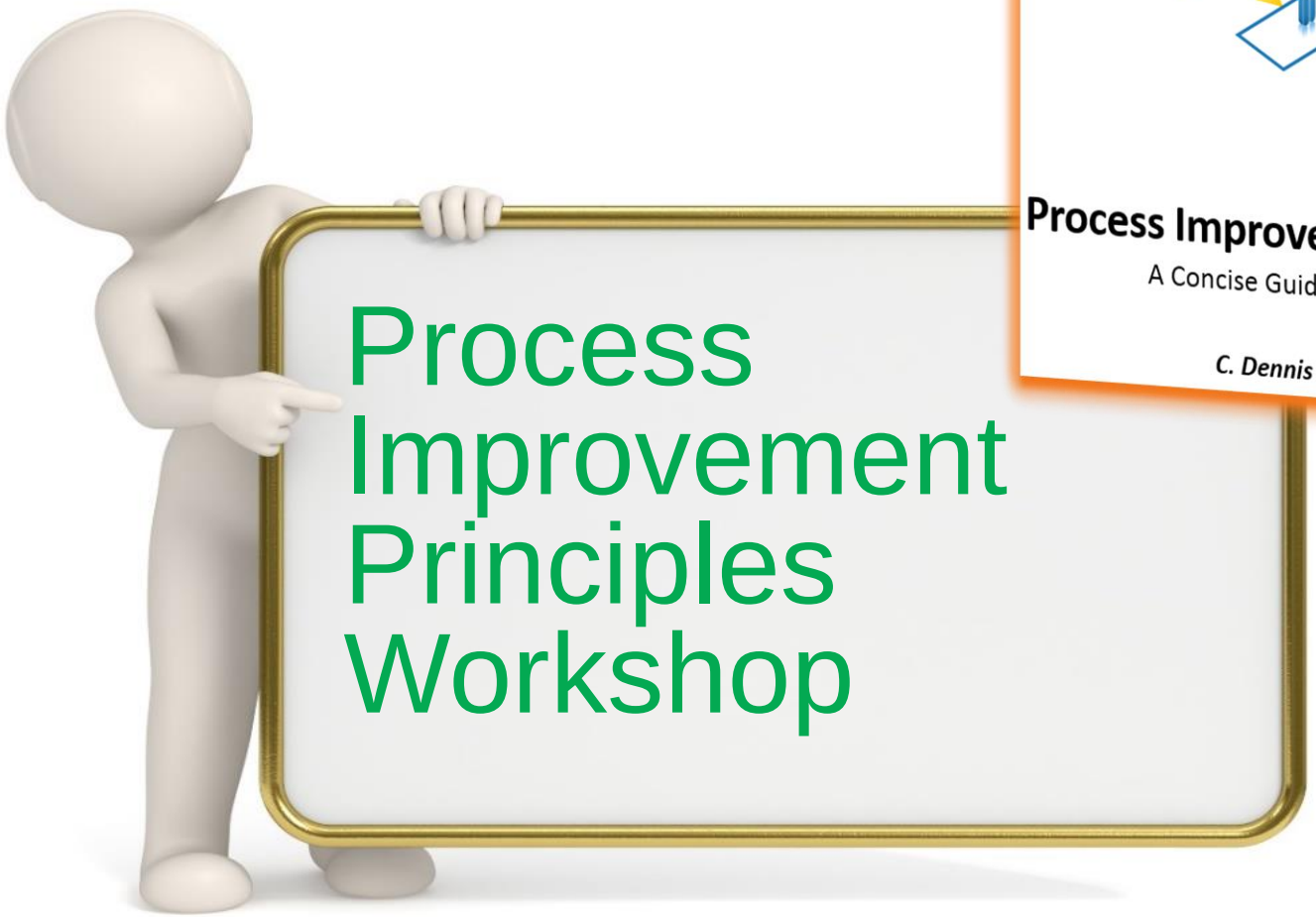
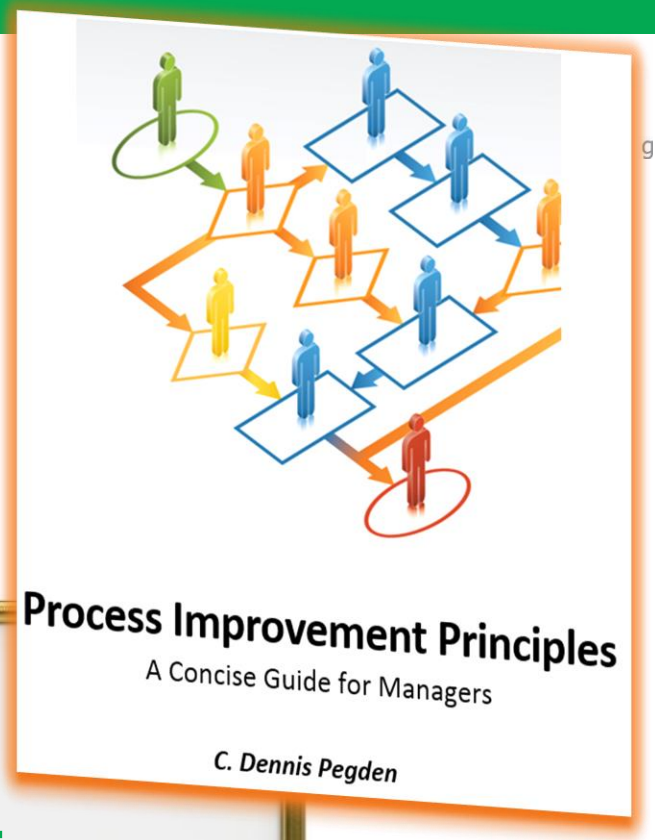
Module 5

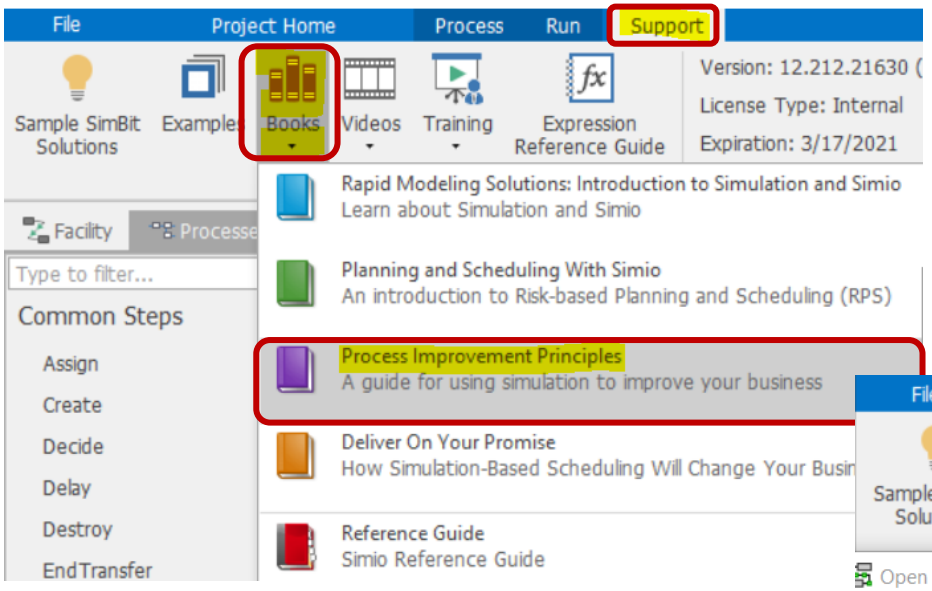


Process Improvement Principles Workshop

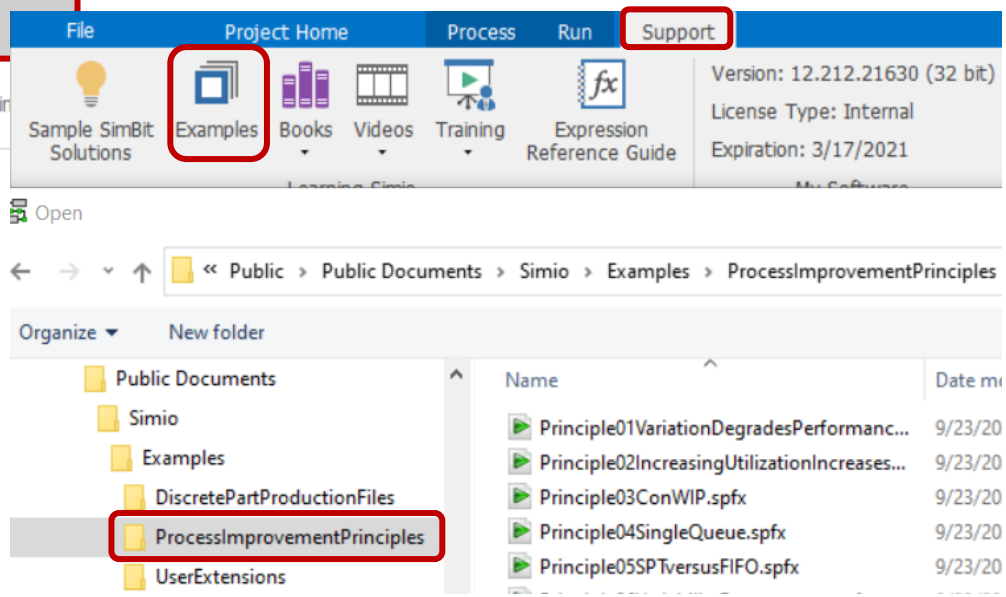


Process Improvement Principles

- E-book can be found in Simio: Support>Books



- Solutions can be found in Simio: Support>Examples



Learning from PIPs

- We will study a few PIPs to learn about the principles
- While doing that we will practice some Simio concepts we already know and learn a few more that we don't yet know.
- We will only do a few of these,

Simio
Forward Thinking

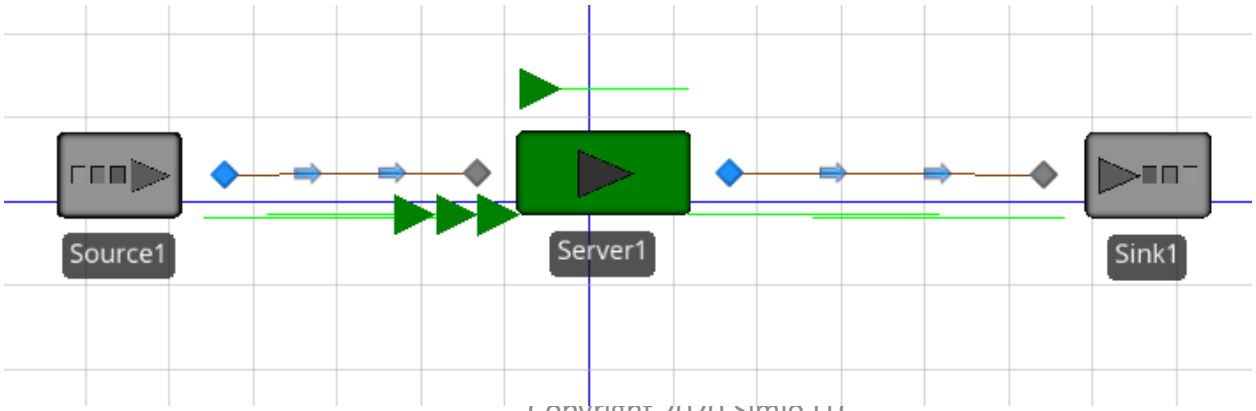
Variation degrades performance.

- Explore variability
- Interactive run
  - Simio Interface
  - Run/Fast Forward
  - Results/Interactive Pivot Grid
- Experimentation
  - Responses
  - Controls/Referenced Properties

Simio
Forward Thinking

Setup/Interactive Run

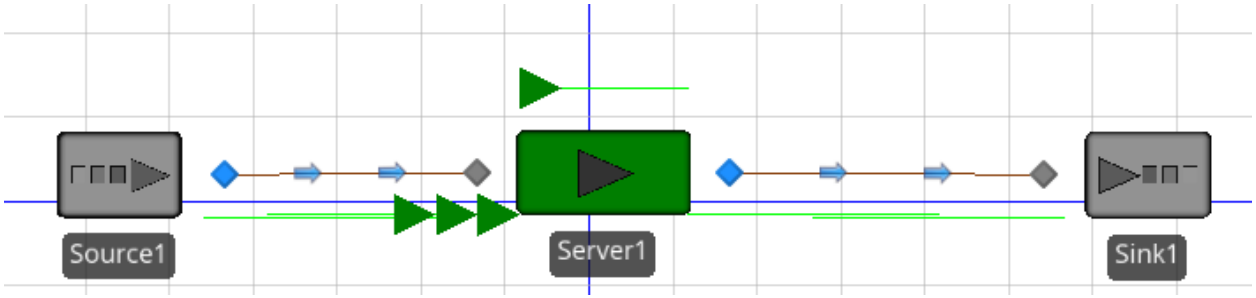
- Place Source, Server, Sink
- Connect with 2 Paths from blue to gray
- Source: Set Interarrival Time to 60 minutes
- Server: Set Processing Time to 55 minutes
- Run Ribbon: Set Speed Factor to 100



Simio
Forward Thinking

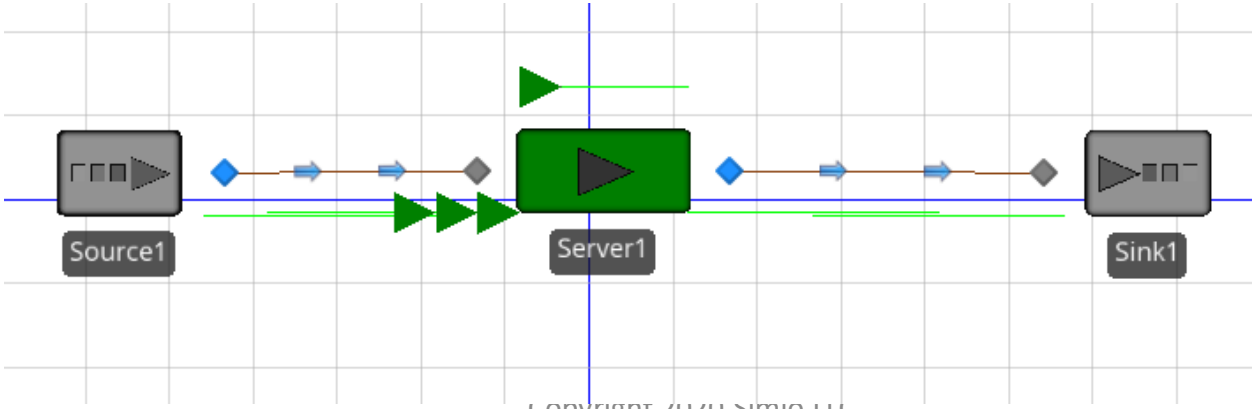
Explore Experiment Window

- Navigation > New Experiment
- Replications
- Experiment properties
  - Multi-processor support
- Run (Fast Forward)
- Enhanced Pivot Grid
- Did everyone get identical results?



Prepare for Experimentation

- Convert Paths to Connectors (right click)
- Source: Create referenced property named InterarrivalTime (right click)
- Server: Create referenced property named ProcessingTime (right click)



Simio
Forward Thinking

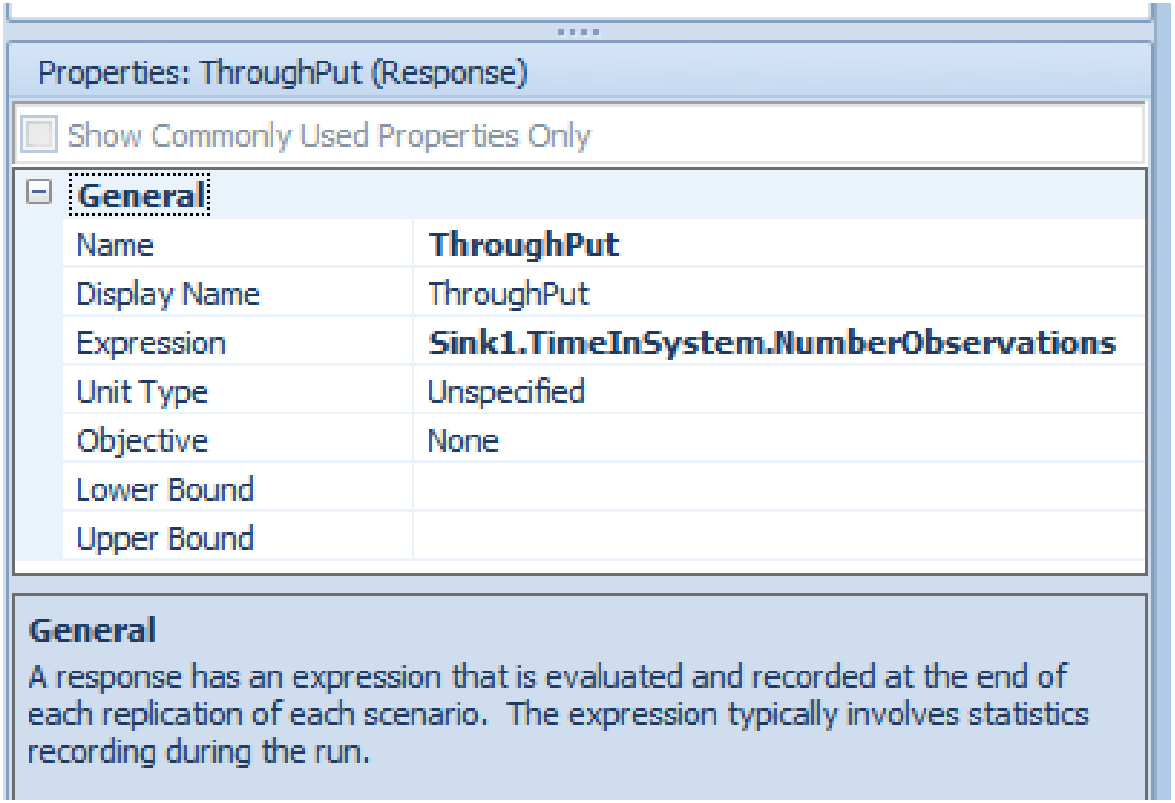
Setup Experiment

- Controls – It's magic!
- Create Scenarios
  - ConstantConstant, 60, 55
  - RandomConstant, Random.Exponential(60), 55
  - RandomRandom, Random.Exponential(60), Random.Exponential(55)

Scenario		Replications	Controls	
☑	Name	Completed	InterarrivalTime (Minutes)	ProcessingTime (Minutes)
☑	ConstantConstant	100 of 100	60	55
☑	RandomConstant	100 of 100	Random.Exponential(60)	55
☑	RandomRandom	100 of 100	Random.Exponential(60)	Random.Exponential(55)

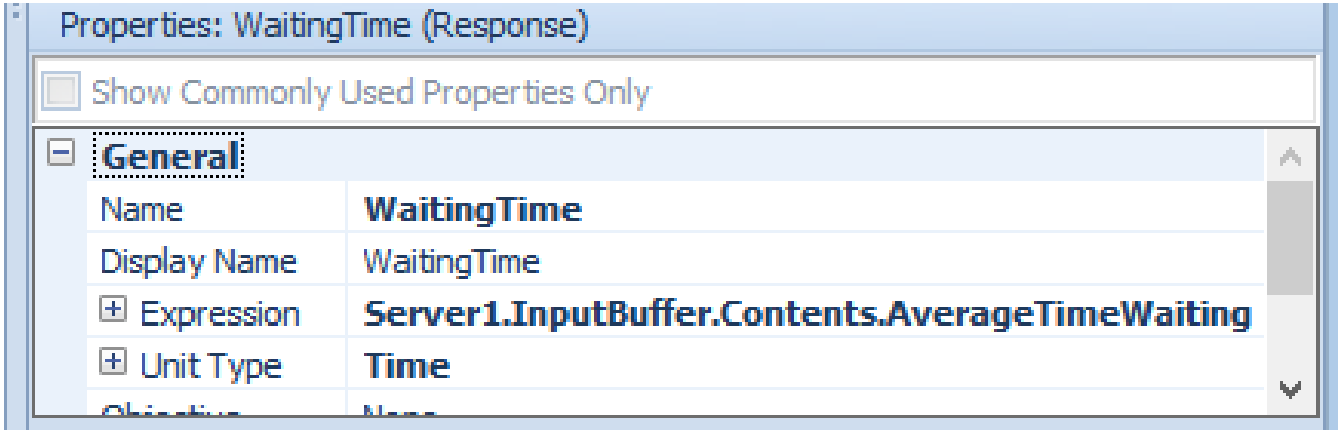
Create Responses

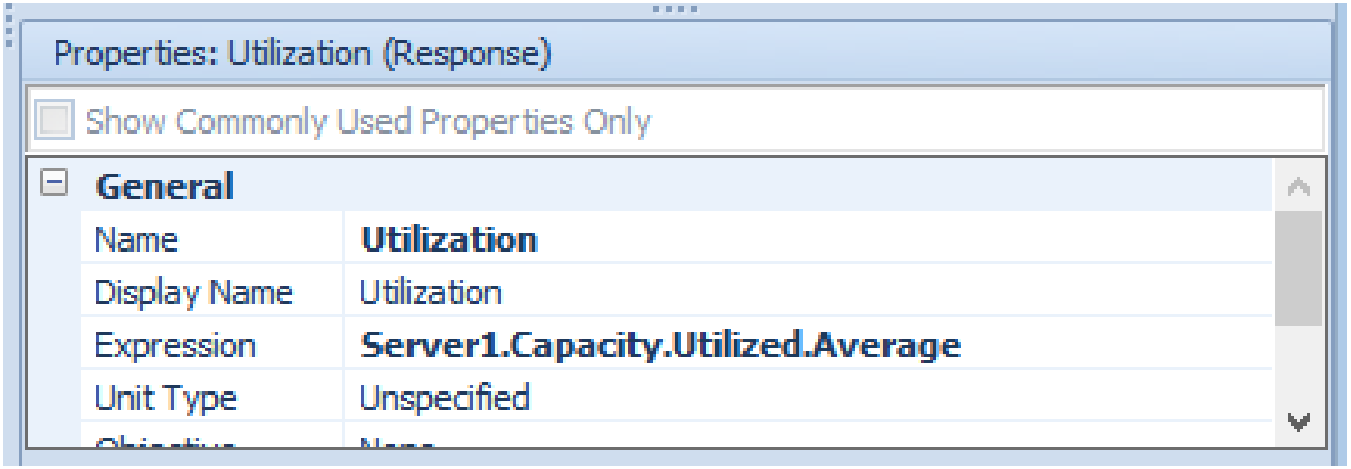
- Responses are KPIs
- Create Throughput Response



Create More Responses

- Waiting Time and Utilization Responses





Lessons Learned

- Run the experiment

Scenario		Replications	Controls		Responses		
☑	Name	Completed	InterarrivalTime (Minutes)	ProcessingTime (Minutes)	ThroughPut	WaitingTime (Hours)	Utilization
☑	ConstantConstant	100 of 100	60	55	1024	0	0.916667
☑	RandomConstant	100 of 100	Random.Exponential(60)	55	1018.44	4.57785	0.912119
☑	RandomRandom	100 of 100	Random.Exponential(60)	Random.Exponential(55)	1014.55	9.39315	0.913334

Search for and eliminate sources of variation in your system.

Simio
Forward Thinking

Higher utilization increases WIP & Waiting

- Explore effect of high utilization
- Predicting utilization for validation
- Pivot Grid Features
- Experimentation

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Forward Thinking

Verification & Validation

- Verification: Does your model work as you think it does? (Implementation errors)
- Validation: Does your model behave like the real system? (Bad assumptions)
- Estimated Utilization = ServiceTime/TimeBetweenCreations

Simio
Forward Thinking

Setup Experiment

- Set InterarrivalTime to Random.Exponential(.25) minutes
- Create scenarios with mean values for ProcessingTime of:
  - .14, .20, .22, .24
- What are expected utilizations?
- Run experiment

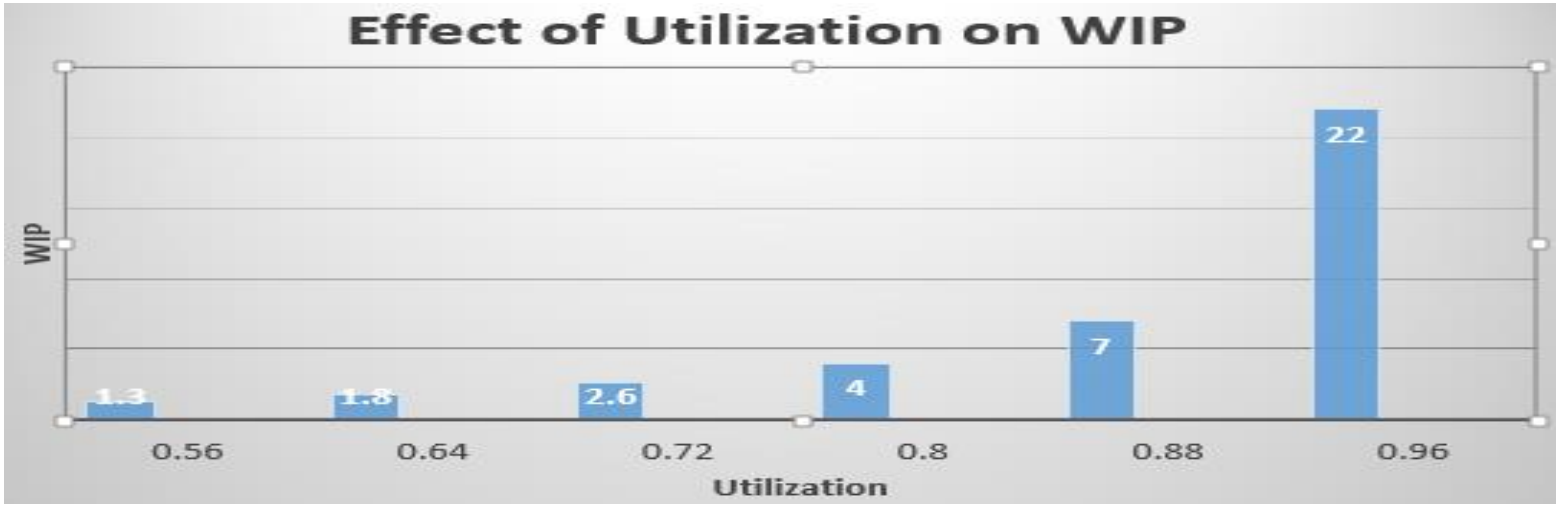
Pivot Table

- Filter
  - Any values in any column
- Sort, Categorize
- Name reports (views)
- Change units
- Export Summaries and Details

Simio
Forward Thinking

Lessons Learned

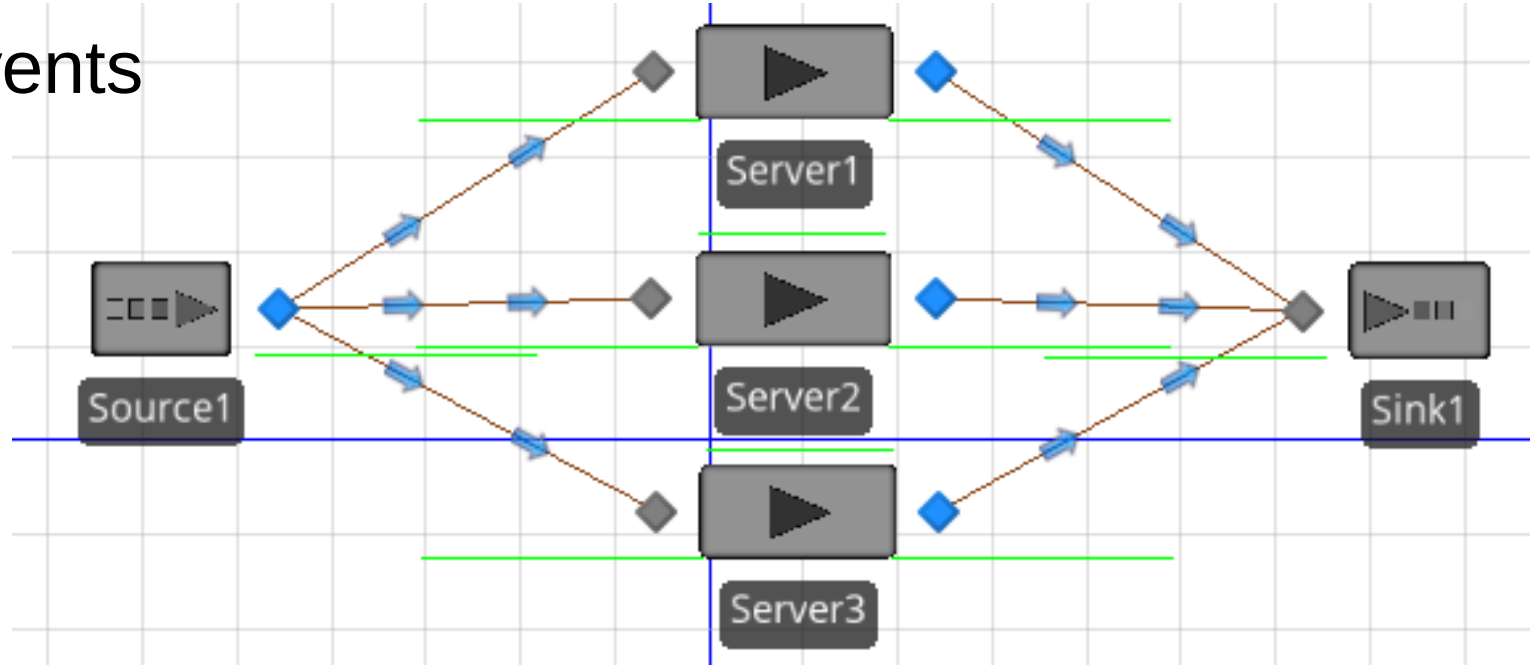
InterarrivalTime (Minutes)	ProcessingTimeServer (Minutes)	Throughput	WIP	Utilization
Random.Exponential(.25)	Random.Exponential(.14)	5752.27	1.27186	0.559607
Random.Exponential(.25)	Random.Exponential(.16)	5755.37	1.77788	0.640437
Random.Exponential(.25)	Random.Exponential(.18)	5749.94	2.56991	0.718976
Random.Exponential(.25)	Random.Exponential(.2)	5748.58	3.95511	0.798884
Random.Exponential(.25)	Random.Exponential(.22)	5746.45	7.26462	0.878532
Random.Exponential(.25)	Random.Exponential(.24)	5733.66	21.663	0.956261



Avoid driving high WIP through highly utilized resources.

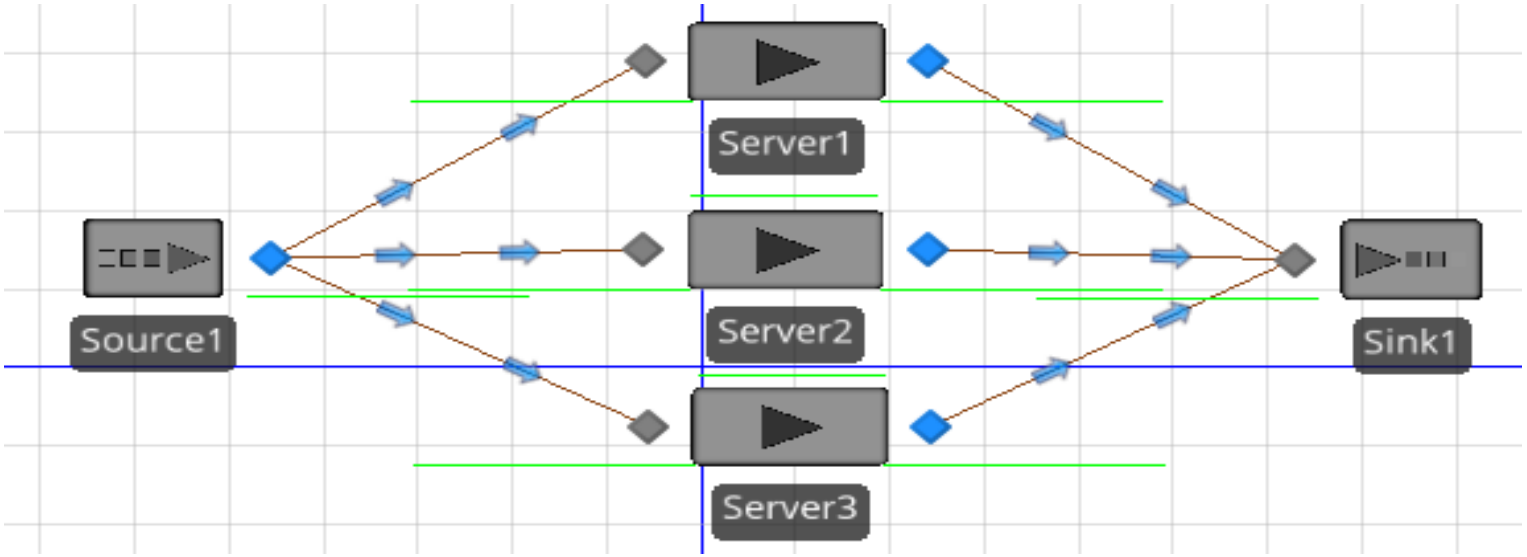
CONWIP strategy has less WIP for the same throughput

- Explore parallel servers
- Entity destination
- Routing choices
- Node Lists
- Events



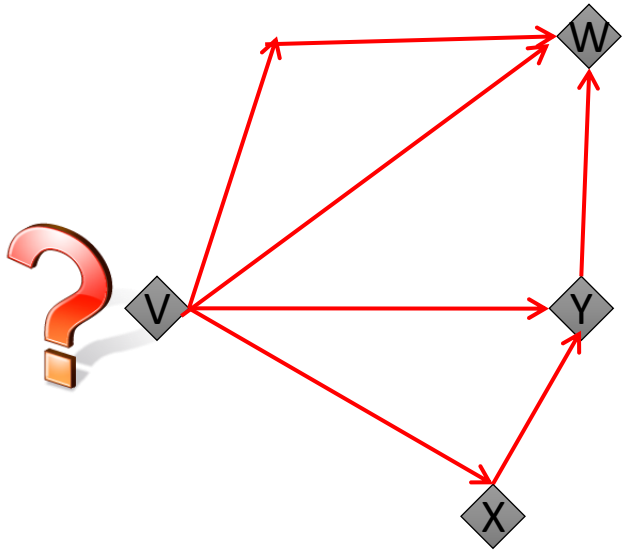
Problem setup

- Place Source, 3 Servers, and Sink
- Connect with Paths
- Source: Set Interarrival time to Random.Exponential(4) Seconds

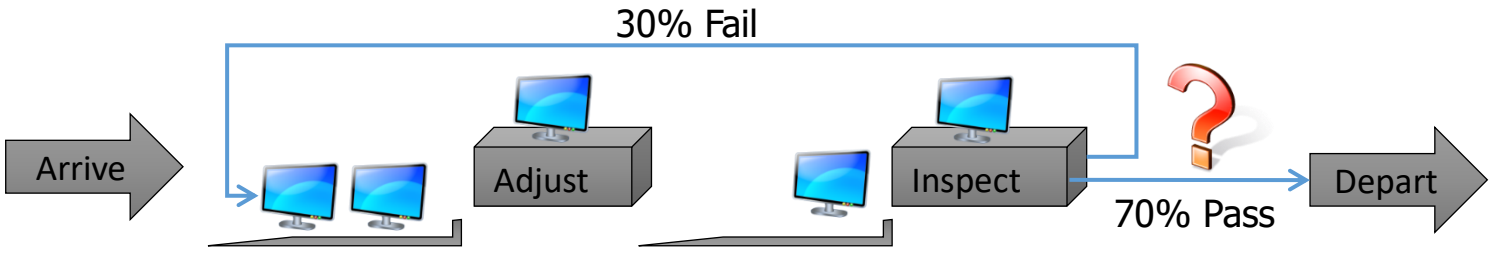


Node Routing

- **Shortest Path**
  Select the link that is on the shortest pathway to the specified destination (if any).

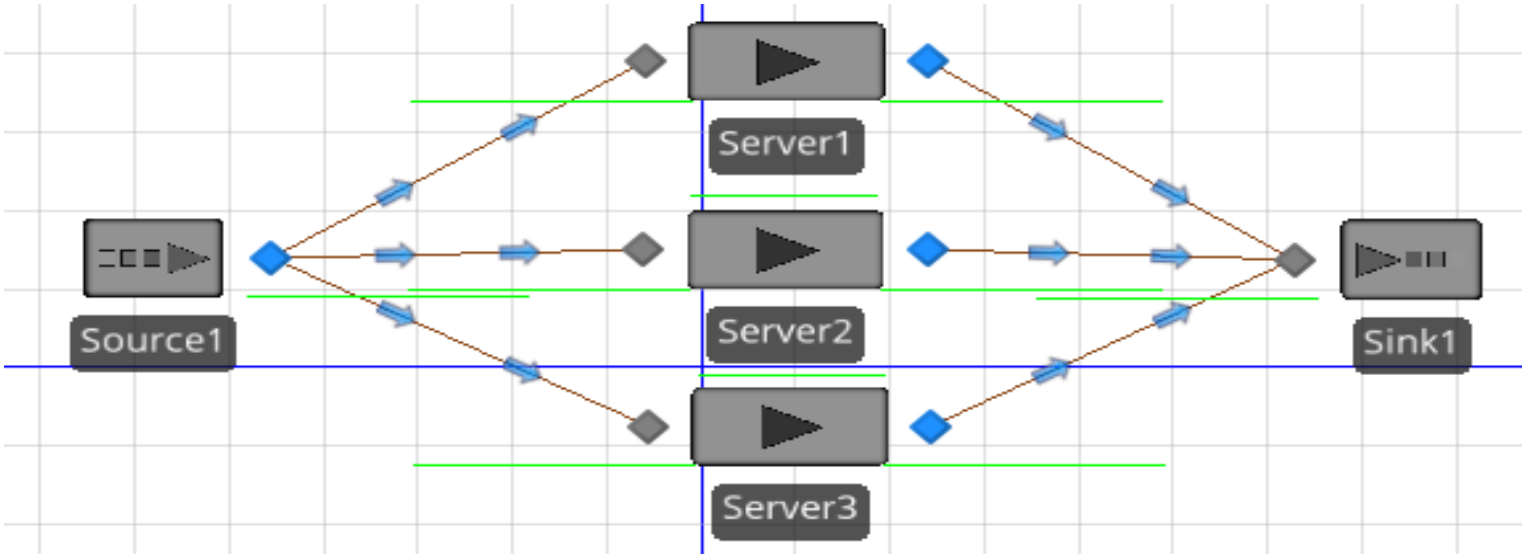


- **By Link Weight**
  Select the link randomly using Selection Weights assigned to each link. Probability = $w_i / \sum w$



Explore routing behavior with Link Weights

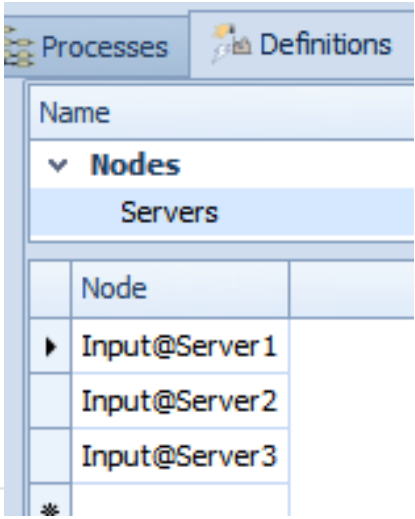
- Try Selection Weights of 5 for all 3 paths
- Try with Selection Weights of 1, 2, & 3
- What values would result in 10% to Server1 and 90% to Server3

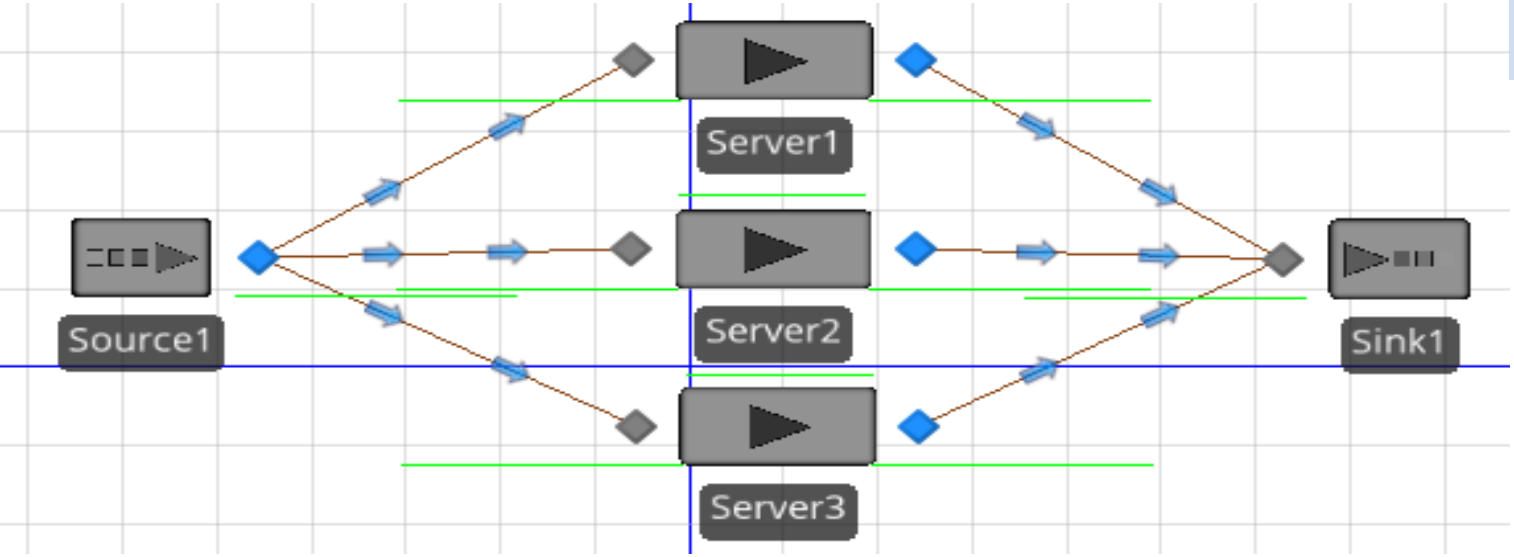


Simio
Forward Thinking

Create List for Destination

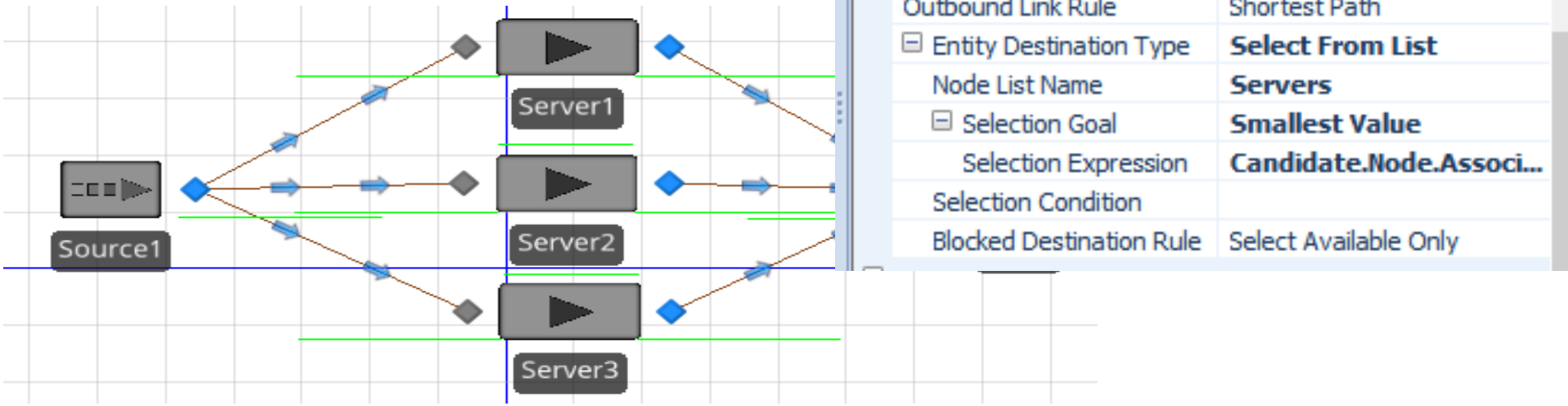
- Extended selection (using Ctrl-Click)
- Highlight 3 input nodes
- Right-click, Add to Node List named Servers





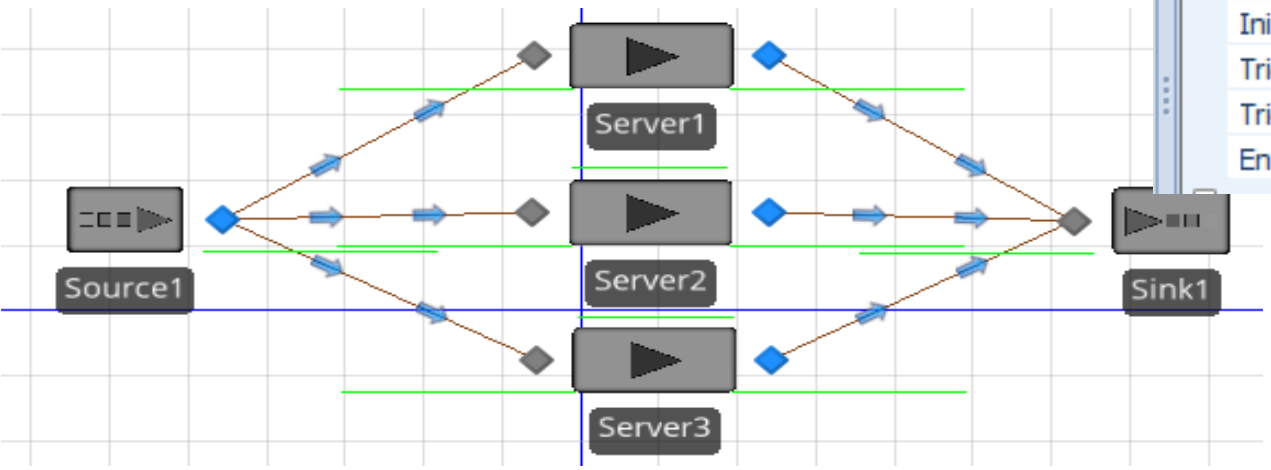
Explore routing behavior with Shortest Path

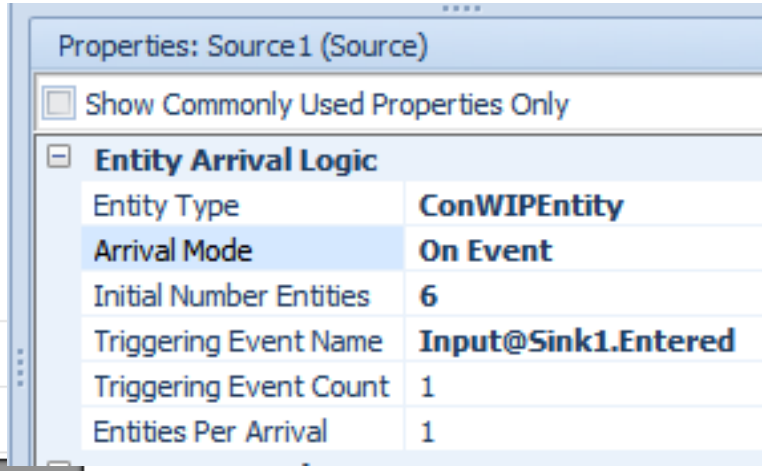
- Set Node List Name to Servers
- Examine Selection Goals (Cyclic, Random)
- Examine Selection Goal to Smallest Value



Convert to CONWIP System

- Source: Set Arrival Mode to On Event
- Source: Set Initial Number Entities to 6
- Source Set Triggering Event to Input@Sink1.Entered

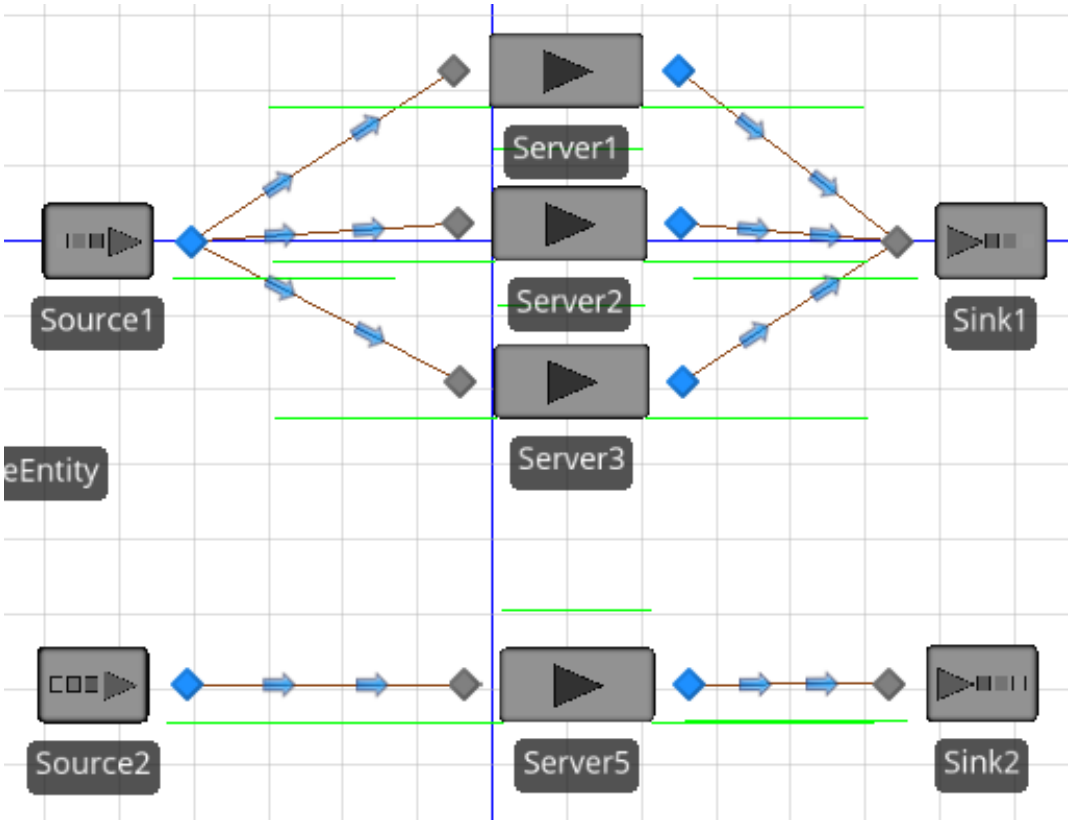




Simio
Forward Thinking

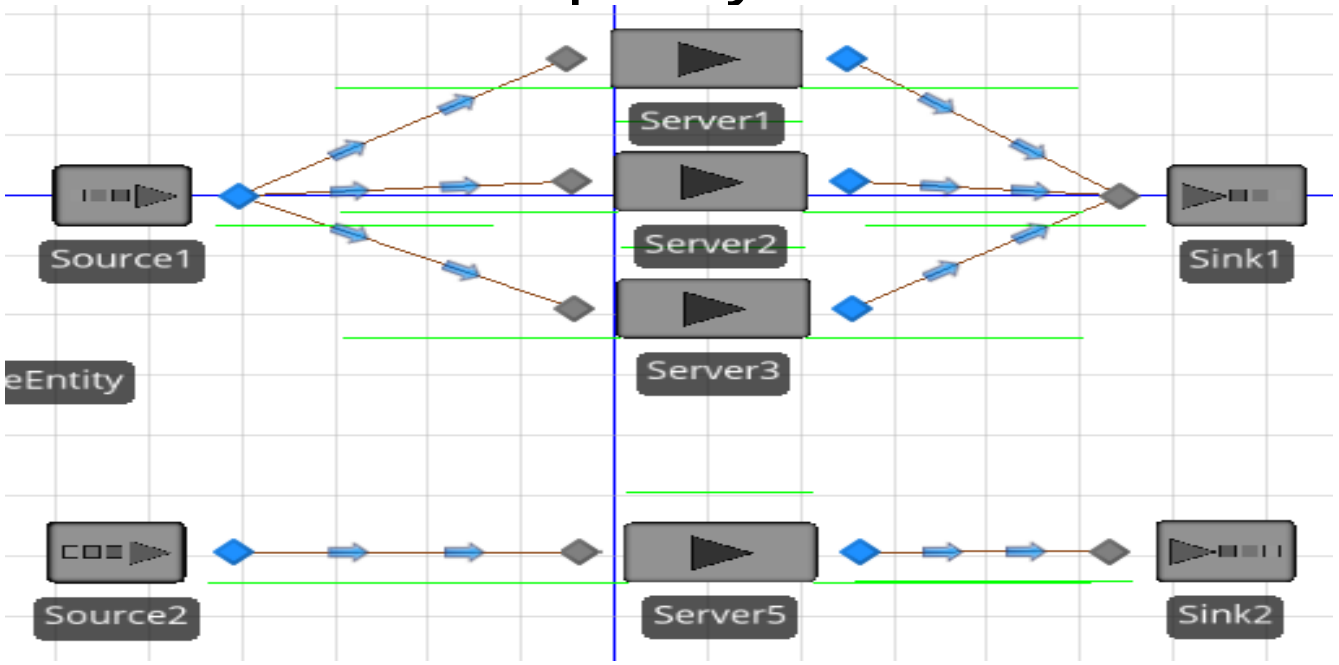
A single queue decreases WIP

- Compare parallel servers to multi-capacity server



Problem setup

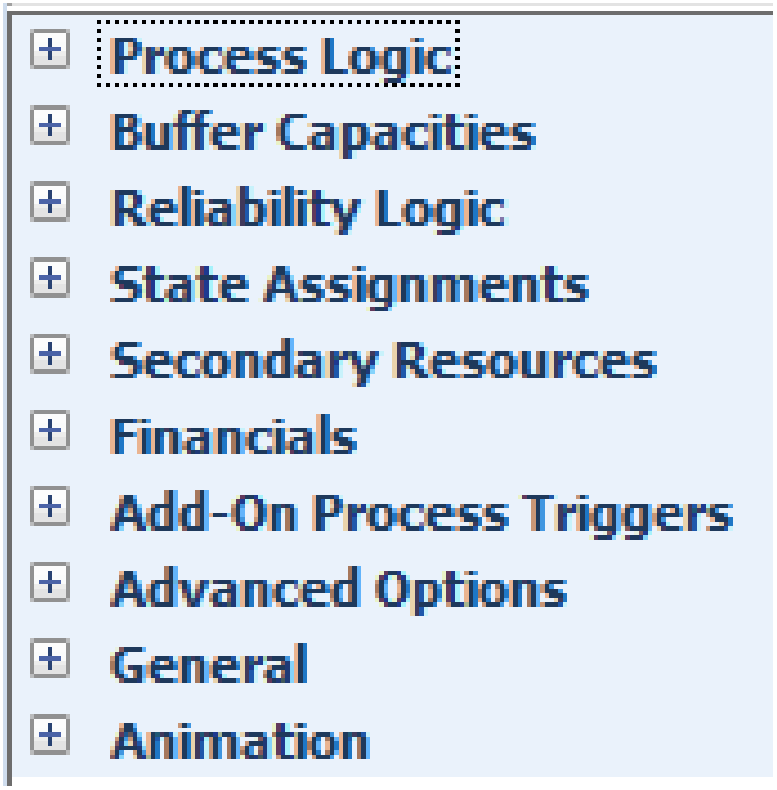
- Place Source, Server, and Sink
- Source: Set Interarrival time to Random.Exponential(4.5) Seconds
- Server: Set Initial Capacity to 3



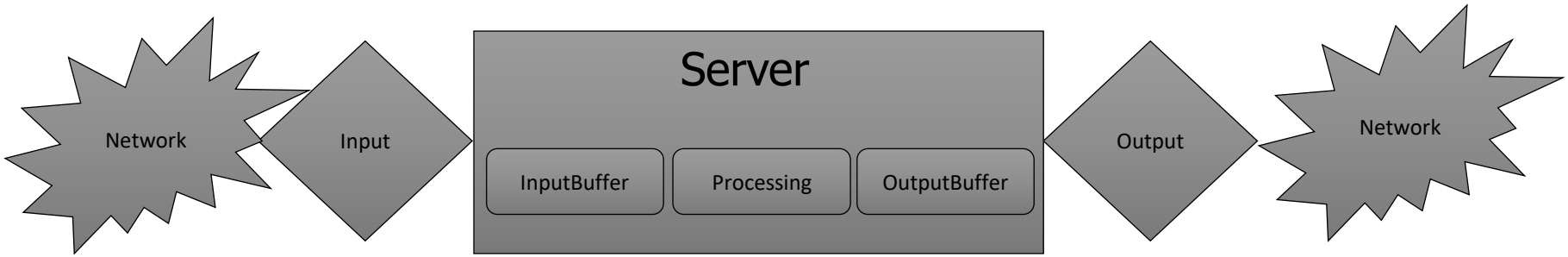
Simio
Forward Thinking

Buffer space in a flow line increases throughput and decreases WIP

- Explore use of buffers
  - Input, output
  - Finite/infinite/zero
- More Server options
  - Secondary resources
  - Financials
- Status animation



Server Capabilities



- Arriving entities seize/release the Server.
- The Server *Allocation Queue* is ranked; selection is based on first in queue or the *Dynamic Selection Rule*.
- The Server has a *Fixed* capacity or follows a *Work Schedule*.
- Failures include *Calendar Time Based*, *Usage Time Based*, *Usage Count Based*, and *Event Count Based*.
- *Secondary resource* during processing or individually seized/released.

Model setup

- Place Source, 3 Servers, Sink, connected by Connectors
- Ctrl-Select all servers and set Input and Output Buffers to 0
- Click on Server2, Status Pie > ResourceState and draw rectangle on facility view