Simulation Techniques

for

Queues and Queueing Networks

Terminology

System   The collection of interacting objects that need to be simulated

Entity   A particular object of interest in the System

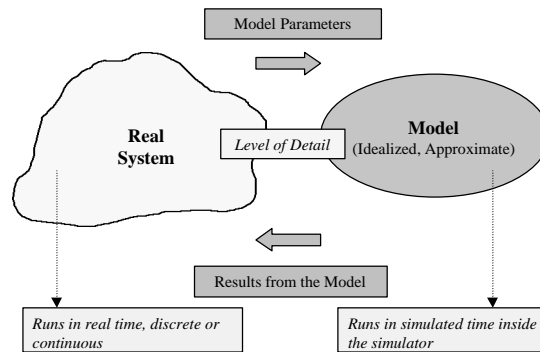*Attribute*   Some relevant property of an Entity that is sought to be studied through simulations

State   The set of variables that are required to describe the system

Event   The changing of the system from one state to another

Simulation Model of a Real System

Model Parameters

Real System

Level of Detail

Model
(Idealized, Approximate)

Results from the Model

Runs in real time, discrete or continuous

Runs in simulated time inside the simulator

System State may be Continuous or Discrete

Model should imitate the real system in as much detail as possible or in asmuch detail as needed

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• The Real System (*Queuing Network*) will have its

∗ functional entities (*queues, servers, routes etc.*)

∗ interactions and interdependencies between the entities as a function of time

• Model simplifies the system for study but its results must be such that it correlates well with the behavior of the Real System

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Simulation vs. Analysis ?

Advantages of Simulation

• usually closer to real system with fewer simplifying assumption

• model structure, algorithms and variables may be changed quickly to see how it affects the system

• may be able to provide performance results which are not obtainable through analytical models
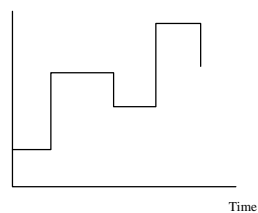
Disadvantages of Simulation

• simulators may take longer to construct and debug

• validation may take additional time and effort

• computationally expensive as a large number of long simulation runs may be needed

• relationships between model variables may be difficult to visualize

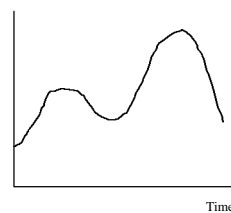• sensitivity analysis may be difficult

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Simulations may be Discrete/Continuous Time and/or Discrete/Continuous State

No. of Jobs in Queue

Time

Discrete State, Continuous Time

Water stored in a tank

Time

Continuous State, Continuous Time

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Simulated Times or **Event Times** are the times at which the simulation model's state undergoes a change. *Nothing changes in the model between these event times.*

In a Queue or a Queuing Network, these Event Times would be the various arrival/departure instants to/from the queue(s)

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Continuous Simulation

• Uses a continuous simulation clock which is typically incremented following a *fixed-increment-time-advance* approach

• The time increments should be as fine as possible and should at least be small enough to capture all state changes in the system

• Inefficient as there will be a lot of time instants when no change would be observed in the system

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More coming!…….please check back later.

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