CSE PhD Qualifying Exam, Fall 2014: Modeling and Simulation

1. Show the code for computing random variates that follow the triangle distribution (with probability density function \( f(x) \) defined below) using the inverse distribution function method. Assume there is a function \( \text{rand()} \) that returns random numbers that are uniformly distributed between 0 and 1. Show all work in deriving your solution.

\[
\begin{align*}
  f(x) &= x \text{ for } 0 \leq x < 1 \\
  f(x) &= 2-x \text{ for } 1 \leq x < 2 \\
  f(x) &= 0 \text{ otherwise}
\end{align*}
\]

2. The Chandy/Misra/Bryant (CMB) null message algorithm is used to compute the lower bound on time stamp (LBTS) of future messages that a logical process may receive. LBTS has some similarities to Global Virtual Time (GVT), a value computed in the Time Warp algorithm to enable operations such as memory reclamation and commitment of I/O operations. Propose a new GVT algorithm based on the CMB algorithm. Specifically:
   a. describe any changes or constraints that must be included in Time Warp to use CMB for this purpose
   b. show pseudo-code for your GVT algorithm, and
   c. briefly comment on the efficiency of this approach to computing GVT.

Note that the Time Warp system will still utilize rollbacks, anti-messages, etc., and CMB is used solely for the purposes of computing GVT.

3. Consider the grid-based implementation of the data distribution management services in the High Level Architecture where a grid-like structure is overlaid onto the routing space and used to implement the DDM services. Suppose we add a constraint that publication and subscription regions must be defined so that they cannot partially overlap with a grid cell, i.e., for each grid cell \( G \) and any publication/subscription region \( R \), either all of \( G \) is contained within \( R \), or none of \( G \) is contained within \( R \). Describe the impacts of this constraint on the efficiency of the DDM implementation.

4. Algorithms such as Chandy/Misra/Bryant or Time Warp are not used in distributed simulations used for training or video games, e.g., a collection of vehicle simulators used to train drivers. Explain why such algorithms are not used.