CDA6530: Performance Models of Computers and Networks (Fall 2010)

Project 4: Worm Propagation Discrete-time Simulation

(Assigned Nov. 16th; due: Nov. 24th; late submission: Nov. 28th with 10 points off)

To relieve some programming burden, project 4 is a group project that two students can form a group to do and submit one report. In your submitted report, please specify who is your partner. Of course, you can do this project alone if you have hard time to find a partner.

You are required to simulate simple worm propagation in a medium-scale network by using discrete-time simulation technique.

Assume that in an isolated network with $\Omega = 2^{32-n}$ IP address space (i.e., the network is assigned with /n IP prefix space), there are N vulnerable computers to a particular worm in this network. These vulnerable computers occupy the even number of IP addresses starting from the lower end of the address space of the network. For example, if the network has an IP space of 192.168.0.0/16 and there are 100 vulnerable computers, then the IP addresses of these vulnerable computers are: 192.168.0.0, 192.168.0.2, 192.168.0.4, ….., until 192.168.0.200.

Now the worm starts its infection within this network from 1 initially infected machine (randomly picked from those vulnerable computers). At each discrete time unit, a worm-infected computer can scan η randomly picked IP addresses within this network (the network has Ω IP addresses). If it finds a vulnerable computer, it infects the vulnerable computer and this newly infected computer can start infecting others from the next discrete time.

For such a worm propagation, we have introduced that it can be modeled by:

$$dI(t)/dt = \eta/\Omega I(t)[N - I(t)]$$

Where I(t) is the number of infected computers at time t.

Your assignments are:

1). Simulate a worm propagation with parameters n=18, N=400, η=2. You need to simulate the worm propagation for 100 runs in order to get the average values for I(t) for each discrete time t. Each of your simulation run should end when all vulnerable machines have been infected.

a). Draw a figure to compare the I(t) derived from the simulations (averaged value or called sample mean) and the above differential equation (i.e., the figure contains two I(t) curves). They should be matched with each other (with some statistical errors). The numerical result of the differential equation above can be derived by Matlab Simulink.

b). Draw a figure shows the I(t) from the first 3 simulation runs. This figure can show the statistical variance in worm propagation process (each simulation run the worm's propagation dynamic is slightly different).

2). **Simulate a worm propagation considering traffic delay**.

At time t when an infected machine scans and finds a vulnerable machine, the vulnerable one will be compromised and start to scan and infect others at time t+X, where X is a r.v. following Geometric distr. with p=0.3 (i.e., $P(X=k) = (1-p)^{k-1}p$, k=1,2,3,…). All other parameters are the same as in the first simulation task. Draw a figure shows the averaged I(t) (average over 100 simulation runs) for this worm propagation compared with the averaged simulated I(t) from the first simulation task.

<u>Submission</u>: Please submit your report document (a word file or PDF file), and your simulation codes. You can use Matlab or C or java to program your simulation code (but you must use Simulink to derive the numerical solution for the differential equation). Your report should explain how you design your simulation, what important variables you used in your code. Explain the meaning of each figure you draw in your report document. Also specify what each simulation code does.