Review of PhD Thesis of Chen Dan

This is a review of the PhD thesis submitted by Chen Dan on the research work entitled “Cloning Mechanisms for High Level Architecture Based Distributed Simulation”. According to the thesis, the objectives are:

1) To establish foundation theory of distributed simulation cloning.
2) To investigate and design an efficient, reliable mechanism to enable/support distributed simulation cloning.
3) To develop a generic approach to cloning federates at runtime.
4) To provide user transparency and reusability to existing simulation models while enabling cloning and other technologies.
5) To design alternative simulation cloning mechanisms, including entire and incremental cloning.

According to the reviewer’s understanding of the thesis, the achievements are:

1) Foundation theory of distributed simulation cloning has been established with specific terminology defined.
2) Investigated various distributed simulation cloning approaches and designed a comparatively efficient, reliable (?) mechanism to support distributed simulation cloning.
3) Designed a decoupled federate architecture to support federate cloning at runtime, achieving fault tolerance, user transparency and reusability.
4) Investigated and compared multiple- and single-federation solutions (with and without application of Data Distribution Management) to distributed simulation cloning. For cloning of federates, entire and incremental cloning has been studied.

Reviewer is unable to determine the following:
1) Whether effort to establish foundation theory is pioneering or not?
2) How having a decoupled architecture provides reusability?
3) Reliability of mechanism to support distributed cloning – what are the metrics used here to determine reliability?
4) Are research issues identified open problems – perhaps better to list as separate section what these are. Currently, there are issues cited in Chapters 3 and 4, for example. It would be informative if the candidate could sum these up in the conclusion what has been
identified (if issues are still open problems) and/or in Achievements (if candidate has solved them).

5) Is distributed simulation cloning same as federate cloning? Seems to be referring to the same thing.

Overall, the reviewer feels that this mechanism is an important contribution to distributed simulation as it allows the evaluation of alternative simulated scenarios concurrently. This is appreciably more efficient than repeating the entire simulation process for each individual scenario. Another important design factor considered by the candidate is that the cloning mechanism is intended to be reusable by existing simulation models, with little or no modification to the user’s code. The reviewer also finds that the candidate has performed a broad study of the contemporary research scenarios involving HLA as well as parallel and distributed simulation cloning and examined in detail the possible exploitations of the decoupled federate architecture in the support of fault tolerance; specific considerations include web/grid-enabled architectures and load-balancing issues.

Based on the quality and quantity of the work and the publications accepted, the reviewer recommends that the candidate be awarded the degree subject to some amendments in the thesis as suggested above as well as in the following:

Chapter 1: Introduction
This reviewer is unable to ascertain the candidate’s claim that the work pioneers the domain of distributed simulation cloning and provides theoretical basis to identify research issues (pg 7). Claims in a scholarly document must be properly substantiated e.g. by argument, focused evaluation of existing works etc.

Chapter 2: Literature Review
What is “system unavailability requirement” (pg 19).
Is $10^{-9}$ a probability value? Glasserman’s approach and candidate’s – seems like different views of the same strategy/approach..?

Chapter 4: Alternative Solutions for Distributed Simulation Cloning
State what is scope of experiment. Give constraints where necessary and how these might affect measurements during the experiment – pg 43.
MF solution surpasses in robustness (in what way wrt previous discussion) – pg 51?
Considering the reduction of implementation complexity and convenience ... (pg 52) – how do the previous graphs and discussion lead to this conclusion?
Chapter 6: Managing Scenarios
Who is responsible for the design of the two DDM-based solutions? (pg 71)
Did candidate develop recursive region and point region solutions? (pg 72)
Any overheads in point region solution? (pg 82)

Section 6.4 summary – since quantitative measures are already available, would be informative to add a table to this section presenting a concise form of the comparisons and evaluations done earlier, in detail in this chapter.

Chapter 7: Algorithms for Distributed Simulation Cloning
Would be intuitive for some complexity analyses for the algorithms described here.

Chapter 8: Experiments and Results
Figure 8.6 – Percentage Saved? (label in vertical axis)

Chapter 9: Exploiting the Decoupled Federate Architecture
Nicely written and comprehensive chapter.
Pg. 120 – “... facilitating simulation independency...” – independence from/for what?
Pg. 124 – Can you describe qualitatively how you intend to detect failures? This would impact the accuracy of the recovery point.

Chapter 10: Conclusions and Future Work
Scenario tree – is this the candidate’s own idea/approach or adapted from elsewhere?
Looks like a typical spanning tree...

Miscellaneous
The candidate should run the report through a spelling and grammar-checking tool. Edits are indicated/suggested in blue ink in the thesis itself.