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CLOUD-BASED HYBRID DISTRIBUTED SIMULATION FRAMEWORK

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ABSTRACT

For decades, Modeling & Simulation (M&S) have been the choice for Operations Research and Management Science (OR/MS) to analyze systems behaviors. The evolution of M&S brings the Distributed Simulation (DS) via High-Level Architecture (HLA), used mainly by defense applications, thus allowing researchers to compose models which run on different processors. As the cloud computing grows, its capabilities upgraded many applications, including M&S having the elasticity needed for DS to seed up simulation by bringing reusable models together with seamless interoperability. This paper presents a framework for composing and executing Hybrid Distributed Simulation in the cloud.

1 INTRODUCTION

The need for a faster way to compose and reuse models has attracted researchers to extends the Modeling and Simulation (M&S) boundaries. Notably, the M&S has evolved from running a single model on a single computer by a single analyst to parallel and distributed methods. These new methods enable modelers to compose models or divide the large model into smaller sub-models which runs on separate processors for speedy experiments. Since its advent, cloud computing offers remote access to high-performance computing resources without having to manage them on-premises. Distributed Simulation (DS) executes a simulation over computing platforms that span a much broader geographic extent than parallel computers (Fujimoto 2015). In theory, cloud, when combined with High-Level Architecture (HLA) - IEEE-1516, can be used to compose models in a distributed fashion with runtime infrastructure (RTI) technology. We presented a hybrid DS cloud framework detailed in section 3 below.

2 METHOD

From the literature, there are many tried-and-true methods used in OR/MS and engineering, including Distributed Simulation Engineering and Execution Process (DSEEP) to run local or networked simulation projects. DSEEP is a generalized framework that can be adapted to meet individual DS needs (Anastasia and Simon 2017). The work-in-progress framework presented here leverages the cloud infrastructure with DS components where we use open source resources; RePAST Symphony simulator and poRTIco RTI implementation of IEEE-1516. This work deployed the experimented framework to cloud environments Amazon Web Services EC2, CloudSigma, and DigitalOcean. We deploy Ubuntu 16.04 LTS instances and run the federation with a shell script which executes the models headless and output results in CSV format.

The process starts by setting up and running one instance as a Wide Area Network (WAN) router to support portico RTI cloud implementation. One federate (model) at each geographical location is configured as a local gateway. One federate creates the federation, initialize the environment, publish and waits for others

to join based on fulfilled specifications. When the simulation starts, the Ambulance federate (see Case Study section) takes data file as input and simulate according to parameter file instructions. The result is then output to the same directory as the model. This hybrid simulation experiment combined Type A.1 (entity transfer) and Type C (shared event) interoperability reference models (IRMs) (Taylor *et al.* 2009) as standardized by Simulation Interoperability Standard Organization. This combination facilitates the interaction between the two paradigms used in the study; Ambulance Service (ambulance model) being Agent-Based Simulation and a few Accident & Emergency Department (hospital models) which are Discrete Event Simulation.

3 CASE STUDY

For this cloud framework, the featured case study combines the two paradigms (ABS and DES) and presented here as published by Nouman *et al.* 2013. EMS systems consist of an ambulance service and several accidents and emergency (A&E) departments. The A&Es are located in the regional hospitals of the ambulance cover area. We, therefore, need several heterogeneous models to communicate with each other. That is the ambulance service model and several A&E models in the area of coverage. The ambulance service entities interact enormously with each other and their environment and have to make a decision depending on some parameters, such as, to allocate the appropriate ambulance for an incident, to decide whether there is a need for transfer to an A&E and to find the most suitable hospital. On the other hand, A&E departments are mainly process-oriented. The entities, e.g., patients, do not make decisions but rather are driven by hospital events. For the above reasons, the ambulance service is modeled using ABS, and the A&E departments are modeled using DES techniques, respectively.

4 CONCLUSION AND FURTHER WORK

The use of cloud resources and RTI middleware enable and promotes model re-usability and increases DS execution speed. We presented a hybrid DS framework to which the IRMs made possible the running of ABS-DES to analyze single system (EMS) over the cloud. Moreover, work is underway and required a check on cloud performance issues as compared to the single PC and networked versions of the same models. The comparison would then be used to validate the framework as the study progress.

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