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INVESTIGATING CLOUD-BASED DISTRIBUTED SIMULATION (CBDS) FOR LARGE-SCALE SYSTEMS

Nura T. Abubakar

Modeling & Simulation Group
Brunel University London
Uxbridge, UB8 3PH, UK

ABSTRACT

Distributed Simulation (DS) allows new or existing models to be composed together and form a larger model, which can run on geographically distributed locations. The High-Level Architecture (HLA) is one of the established standards used to run a DS. Cloud computing offers network resources that are beneficial to DS. However, combining these concepts in simulation to speedup experiments can be challenging. This paper proposes an approach to compose and execute large-scale Cloud-Based Distributed Simulation (CBDS). An Emergency Medical Service (EMS) model was used as a proof of concept, and the initial performance test results are presented as a work-in-progress.

1 INTRODUCTION

Distributed Simulation (DS) allows analysts to use new or existing models, composed together to form simulations of a larger model that execute on separate computing resources. DS benefits include model reuse and experiment speedup. DS enables simulation over computing platforms that span a broad geographic extent (R. Fujimoto, 2015). There are implementation standards designed to facilitate DS, such as the High-Level Architecture (HLA). Cloud computing refers to access to internet-based computing infrastructure as a utility without the associated high cost (Chaudhry et al., 2016). The cloud concept offers elastic delivery of user-configurable resources available via a "pay-as-you-go" payment model where users pay for the capacity used. DS often requires considerable resources to run and takes an enormous amount of time to execute. This time can be reduced by using multiple computing resources.

2 METHOD

2.1 Cloud-Based Approach

Until writing this paper, the literature has not given a formal definition of Cloud-Based Distributed Simulation (CBDS). Therefore, this research defined it as; *a technique that enables the distribution of a multiple simulation run across multiple, on-demand, and configurable cloud infrastructure, platform, and software for the user to use as a service via WAN and/or the Internet*. This paper used models from different cloud locations.

2.2 Case Study

A hybrid Emergency Medical Service (EMS) model was used consist of an ambulance service (ABS) and several accidents and emergency (A&E) departments (DES). The A&Es are located in the regional hospitals of the ambulance cover area and communicate with each other. The ambulance service entities interact and decide, depending on parameters, such as sending an ambulance to an incident or deciding to transfer the patient to an A&E. A&E departments are mainly process-oriented.

3 RESULTS AND DISCUSSIONS

The experiments use an open-source RePAST Symphony simulator and poRTIco middleware implementation of IEEE-1516e. The CBDS method is tested using CloudSigma, 17 instances of Ubuntu 18.04 LTS (1 CPU, 1GB RAM, 10GB each) connected via WAN IPv4 addresses. The test conducted with 17 federates generated results from five replications evaluate for evaluation and performance analysis.

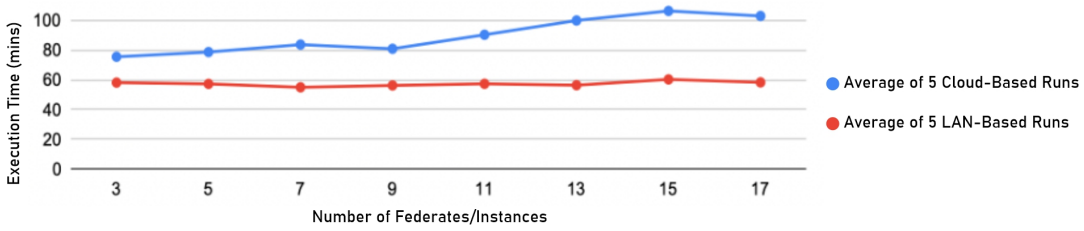

Figure 1: Federates and average execution time of each five runs for both cloud and LAN environments.

Figure 1 plots the average results of four weeks of simulation, first run is 75 minutes. The Y-axis represents execution time in minutes. The X-axis indicates the number of federates during each run. For the cloud-based, as the number of federates goes up, so does execution time. In the cloud, the execution time difference between the number of federates raises steadily with deviations. In performance analysis of distributed systems, the workload may increase communication overheads resulting in a longer simulation elapsed time. Likewise, the figure also shows the average execution time results of a DS executed on a networked PCs interconnected via non-dedicated LAN (Anagnostou and Taylor, 2017), which ran for about 60 minutes. here, as the number increases, the performance almost remains the same. This result shows that the cloud takes approximately 30 minutes longer on average as compared with the LAN.

4 CONCLUSION AND FURTHER WORK

In summary, an approach to cloud-based DS for a large-scale system was investigated. A preliminary result showing execution time performance were presented. From this experience, to run a DS project on the cloud, the user should use a defined methodology for the configuration and use of required computing resources. Communications and interference are some of the issues that could explain the difference between cloud and LAN. In the future, further work is required for rigorous testing with variant resources, cloud providers, and scenarios from the theoretical perspective.

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