# Mobile Simulation: Bringing Simulations to Smartphones

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## ABSTRACT

We introduce a new approach to running simulations on mobile devices. We discuss how to use Cloud servers to overcome some limitations that may be faced by using smartphones as simulation devices.

## Author Keywords

Simulation; smartphones; cloud computing; windows phone; RESTful; MSaaS; CloudRISE.

## INTRODUCTION

Mobile devices these days can be used for video calling, internet browsing, video streaming, gaming, map services, etc. Since the devices can handle semi-extensive data processing and have the ability to connect to the internet over LTE or WIFI, they can be used for simulation [1]. Nowadays, simulations can be run on laptops and desktops using a wide range of software, but there is no specific simulation software designed for mobile devices. Motivated by the idea of using mobile devices to run simulations, we have decided to develop an application for mobile phones to run simulations remotely.

Despite the major improvements to the mobile devices up to date, their computational capabilities are still limited. Trying to run a simulation with several parameters on a smartphone will result in major power consumption and will require time. We proposed a hybrid approach to take advantage of the processing speed of a powerful server alongside with the convenience of a mobile device [2].

In order to handle the issue of the limited CPU capacity and battery of the mobile device, we propose to run the simulation remotely in the Cloud. We proposed a new architecture for running simulations on smartphones. We will discuss the advantages and limitations the architecture, and will show how to build applications under that framework using the windows 7 operating system.

## FRAMEWORK

In order to simplify the deployment process of simulation resources as services in the Cloud, we deployed CloudRISE, a layered middleware that allows users to invoke M&S resources as services (MSaaS). Unlike most WBS frameworks (which are based on SOAP WS), CloudRISE uses RESTful WS as the WS framework and is derived from RISE (Restful Interoperability Simulation Environment) [3]. We use RESTful WS to expose every M&S resource as a unique URL that can be operated by the uniform HTTP methods. Furthermore, the concept of Modeling and Simulation as a Service (MSaaS) builds on Cloud services and it delivers web services related to M&S.

CloudRISE is responsible for deploying various M&S resources as services in the Cloud, using the IaaS APIs provided by the Cloud Layer. It uses Cloud services to share various M&S resources and reproduce experiments (for either the simulations or functions), and improves reproducibility, using a template for Experimental Frames, which cover the context of a model to reproduce experiments and supported functions. CloudRISE works as a repository interface for users to share and manage the M&S resources that are stored in Cloud Storage Units (e.g. AWS S3). CloudRISE can be launched in different Cloud Compute Units (e.g., EC2 instances).

CloudRISE can improve the process for mobile devices to run simulations by keeping an EF Template for each kind of experiment (Figure 1). Each EF Template maintains a URI structure with EF information for users to reuse and reproduce experiments. The related EF information is specified in a corresponding XML file. These files are stored in the Storage Units, allowing the users to configure experiments for the simulation models and supported functions dynamically, and then control their life cycles.

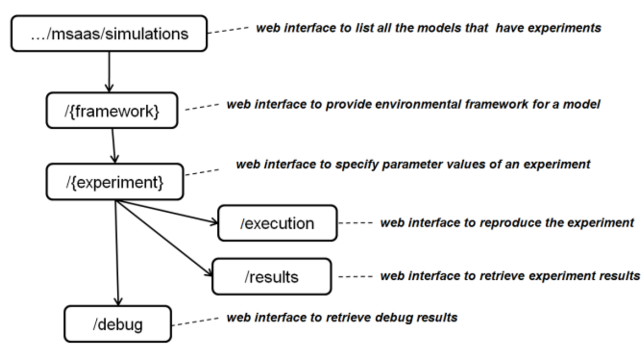



**Figure 1: URI hierarchy of the EF Template for Simulation**

CloudRISE makes the implementation much simpler, errors easier to find (due to the well-defined methods in the interface), and the development of a mobile simulation application more effective. Figure 2 demonstrates the proposed architecture for a mobile simulation application.

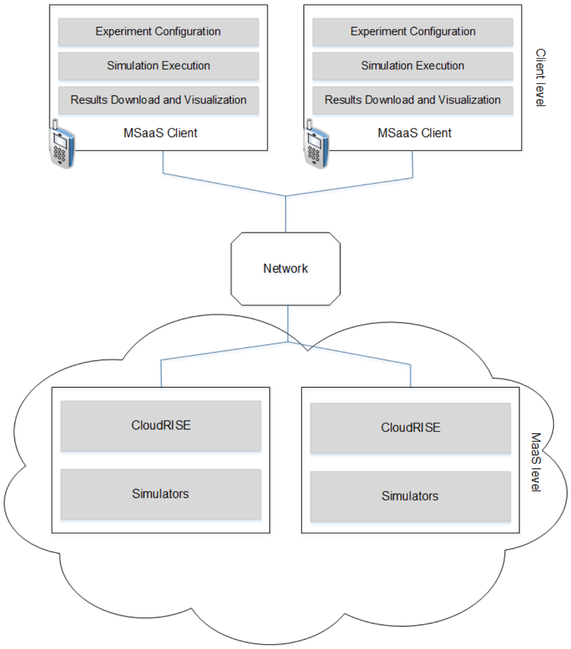



**Figure 2: Proposed Client/Server architecture**

## APPLICATIONS

We developed several applications on CloudRISE using the Windows phone 7 framework written in C# (using Silverlight and XNA frameworks). An application is responsible for initiating the operations on CloudRISE. After retrieving the simulation results from the server, the smartphone shows a graphical representation making it easier for the user to interpret. This graphical representation will differ for each individual experiment and will be based on the requirements of that specific experiment.

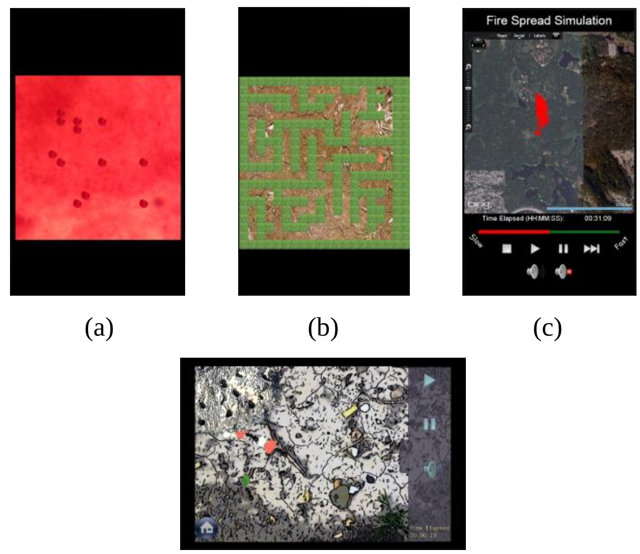
Four experiments have been developed for the windows phone. These experiments are simulations of real world events and they are as follows:

- Cancer growth experiment: this model shows the spread of a cancerous cell in a tissue. The rules defined will result in either a new cancer cell being created or a current cancer cell being dead (Figure 3a).

- Prey and Predator Experiment: it demonstrates how predators use scent to locate their prey. Walls are presented in the simulation and they both avoid crossing the walls using collision avoidance techniques. The predator will search for the scent of the prey left behind and will finally follow the trail to reach the prey (Figure 3b).

- Fire Spread Experiment: it is designed to allow the user to understand and predict a future state of a fire. This can help firefighters to see what will be the status of the fire at a specific time. This experiment takes into the particles properties (amount of heat, minerals and density), type of fuel (includes the size of the vegetation) and values involved with the natural environment (wind speed, territory inclination and humidity). The results of this simulation will depend on the defined initial conditions (Figure 3c).

- The Ant Colony Experiment: ants live in colonies thousands of ants living and foraging together. They exhibit swarm intelligence which is why the colony is sometimes referred to as a superorganism. Ants communicate with leaving behind traces of pheromone, which attract other ants making the group converge to a specific path from the nest to the food. The experiment shows how ants act in a random environment with random obstacles and random food locations, using collision detection (Figure 3d).




(a) (b) (c)

(d)

**Figure 3: Screenshot of the implemented experiments**

## CONCLUSION

Being able to run simulations on smartphones is an important step forward for making simulations more popular. Taking advantage of the mobility of the device and using cloud server to overcome its limitations proposes a promising future for running simulations on smartphones.

## REFERENCES

1. S. Taylor, P. Fishwick, R. Fujimoto, A. Uhrmacher, E. Page, G. Wainer. "Panel on Grand Challenges for Modeling and Simulation". In *Proceedings of Winter Simulation Conference*. Berlin, Germany. 2012.
2. E. Mancini, G. Wainer, K. Al-Zoubi, O. Dalle. "Simulation in the Cloud Using Handheld Devices". MSGC'12 Workshop. CCGRID 2012. Ottawa, ON. 2012.
3. Al-Zoubi, K.; Wainer, G. 2013. "RISE: A General Simulation Interoperability Middleware Container." Journal of Parallel and Distributed Computing, 73(5), 580–594.