

An Indian-Australian research partnership

Project Title:

Project in the area of Cloud Computing.

Project Number

IMURA0265



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Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

1. **Advanced computational engineering, simulation and manufacture**
2. Infrastructure Engineering
3. Clean Energy
4. Water
5. Nanotechnology
6. Biotechnology and Stem Cell Research

The research problem

This project admits several students in area of cloud computing.

Project Descriptions:

Cloud Computing

This overarching agenda is an umbrella concept for multiple research topics in the area of Cloud Computing, for example.

1. **Enable Practitioners – helping developers to build applications faster, with predictability**
Building a new application for the cloud platform or migrating applications to a cloud platform, as a service, bring a new set of software engineering challenges. Applications hosted on a cloud, run on virtual infrastructures, whose capacity grows and shrinks on-demand. On a cloud platform one can perform massively data and task parallel operations on petabytes of data. The objective of this research program is to perform a deep investigation on various challenges that hinders the software development community at large to i) adopt a cloud platform and ii) realize perceived benefits of the cloud. The outcome of this research program shall help in building tools that will enable practitioners to harness the power of the platform.

Specifically the Research Areas are

- a. **Improve non-functional characteristics** like application scalability that exploits elasticity of cloud
- b. **Product line paradigm**, specifically commonality and variability- to build an application as a service for cloud
- c. **Software Development Methodology**: What software development model should be used by an organization like Infosys to build applications for the cloud? Various research questions exist in each of the areas:
 - i. **Process**: Should it adopt the agile development methodology or continue to follow the traditional waterfall approach?
 - ii. **Requirement**: How do the practitioners capture requirements to build an application like facebook or a mashup?
 - iii. **Design and Development**: Future applications will see mix of multiple programming paradigms like SOA (for combining services), functional programming (for massive data processing), parallel programming (for task parallelism), and MDA (for supporting SaaS product-line). A presentation layer might be on Facebook, storage could be on Amazon.com's S3, and application logic could run somewhere else entirely. How does one design such a complex application for cloud? Interesting research questions in this area could be:
 1. **New architecture modeling paradigm** to model functional, data, and deployment architecture. The paradigm should consider the fact that the runtime infrastructure can be dynamically reconfigured.
 2. Applications can be asynchronous, collaborative, and stateful interaction. The design paradigm needs to be extended to capture such notions.
 3. New Domain Specific Languages to model and develop cloud specific applications.
 4. **New Programming paradigm** for data-centric computation for processing massive data
 5. Building new debugging techniques for cloud applications.
 - iv. **Testing**: Investigating new challenges in testing a cloud based application.

2. **Mobile Cloud**

With mobile computing becoming ubiquitous, much software made available through clouds is going to be accessed through devices such as smartphones and tablet PCs like the iPad. A mobile device, in addition to becoming a powerful computing machine, are also becoming a tool to collect various temporal and spatial information through sensors, GPS, camera and so on. In addition, such a device can be hooked onto a cloud whenever required. Since some of these mobile devices are expected to pack a great deal of computing power, that raises various interesting questions, such as

- a. Building applications/modules, distributed across various mobile devices that collaborate among each other. Many of these applications will be enterprise class applications and will be transactional. This will demand an assurance of eventual consistency of a distributed transaction.
- b. How to best divide different responsibilities of an application between what must truly be implemented in the cloud and what could easily be executed on the mobile device itself.

3. **Optimize Cloud Infrastructure – Making applications run faster and cheaper**

Objective: To improve existing of HPC/Cloud infrastructure with novel optimization techniques.

1. Data Center Optimization
2. Energy Optimization
3. Improvement of existing HDFS (e.g. Hadoop) scheduling/allocation infrastructure.

4. Exploit Cloud Infrastructure – New applications

To leverage the cloud computing and storage infrastructure to build novel domain specific and technology solutions that can achieve many-fold speed-up, many-fold scale-up coupled with an order of magnitude cost-performance improvement compared to a traditional supercomputing platform. Some of these areas are:

- a. Healthcare
- b. Education
- c. Finance
- d. Homeland Security
- e. Environment