Workflow Support for Volunteer Computing

Advisor: Cesare Pautasso
Mentor: Francesco Lelli

Abstract: Volunteer computing is a type of distributed computing in which computer owners donate their computing resources (such as processing power and storage) to one or more "projects". Successful applications that adopted this technique include SETI@Home [1] and Folding@home [2]. Toward this idea in this project the candidate will design and implement a generic Workflow plug-in for accessing one of the popular volunteer computing middleware. The software that will be targeted in this project are JOpera [3] as workflow system and ExtremeWebCH [4] as volunteer computing middleware. At the end of the project a working prototype is expected. The purpose of this work is to evaluate the status of the art of these developments proposing new architecture and design guidelines. In addition the candidate will contribute to existing open source projects in order to improve the present tools.

Knowledge and Skills: Web Programming, Java Programming and basic knowledge of Distribute Applications.


References:
[1] SETI@Home: http://en.wikipedia.org/wiki/SETI@home
[2] Folding@home: http://en.wikipedia.org/wiki/Folding@home
Web APIs for Devices

Advisor: Mehdi Jazayeri
Mentor: Francesco Lelli

Abstract: in the coming 10 years not only computers will be connected to the Internet but also small and heterogeneous devices will be part of the web too. These devices will support people in carrying their everyday life activities. Toward this idea in this project the candidate will design and implement a generic controller for an embedded device. Moreover this control system should expose its APIs in the web in order to allow remote access to the resource. The device that will be targeted in this project is the Lego Mindstorm robot [*] and at the end of the project a working prototype is expected.

In the past year libraries and framework have been proposed for the control of the Lego chip. The purpose of this work is to evaluate the status of the art of these developments proposing new architecture and design guidelines. In addition the candidate will contribute to existing open source project in order to improve the present tools.

The candidate will use:

- A Lego Mindstorm [*]
- The Lejos [*] library in order to access and control of the robot using java APIs.
- The Instrument Element [*] tools for exposing Web Service APIs.
- Any tool that she knows for the realization of a user interface.

The candidate can choose any configuration of the robot that she prefer such as car, arm, walking robot etc. She also will choose the User Interface according to the selected configuration. In this video an example of prototype is presented: http://www.youtube.com/watch?v=I8VvTENzPGI

This is just an example; the candidate is encouraged to propose a different prototype.

Knowledge and Skills: Web Programming, Java Programming and basic knowledge of Distribute Applications and Embedded Devices.

RESTful Service Mash-ups over Virtualized Data Centers

Traditional Data Centers (DC) use static allocation of resources to ensure satisfaction of Service Level Agreements (SLAs) under peak demand or in worst-case environment conditions (over-provisioning).

Virtualization allows system components to be decoupled from the underlying hardware enabling live migration of running components and server consolidation. Additionally, a Virtualized Data Center (VDC) can dynamically allocate resources as needed as a reaction to a changing workload.

In the context of the RESERVOIR FP7 project, USI is working with first-class industrial partners (IBM, SAP, Sun, Telefonica I+D) towards the definition of new generation VDCs.

Virtualization adds an additional abstraction layer resulting in a (non negligible) overhead in terms of performances.

The aim of this work is to deploy a mash-up service over a traditional and virtualized data center and to provide a mechanism for performance evaluation.

We are looking for a motivated student with previous knowledge on Java programming, basic shell scripting, and Web development. The student will have a chance to improve his/her knowledge on Web2 and Web services, Java, distributed systems, operative systems, virtualization and hypervisors.

The student will be coached while:

- Installing and configuring a pre-existing RESTful service mash-up implemented in Jopera on a distributed environment
- Instrumenting the code to log / monitor key performance indicators (KPIs)
- Designing and running a series of distributed tests using a model-driven tool for experiment automation (Weevil)
- Repeating the process for the virtualized version of the service
- Analysing collected data and produce a brief report

Mentors: Alessio Gambi, Giovanni Toffetti

Sponsor: Mauro Pezzè
In this project, you will use Ruby on Rails to develop a general document management system to be used by the faculty for various administrative and communication functions. The project will give you experience in real software engineering. You will have to interview the various stakeholders (secretaries, professors, students) to collect and classify the requirements before starting the design and implementation. The final application must be tested and accepted by the stakeholders. The first application to be developed is for Teaching Assistant Assessment. Other applications that are possible: PhD student applications; new faculty applications; PhD student progress;
Abstract: The aim of the project is to design and implement a MAC (Media Access Control) protocol for the infra-red based communication system for the e-puck robots.

The e-puck robots are small-size mobile robots, equipped with an infra-red communication system, called also range and bearing system. The robots can not only exchange packets through it, but also measure the distance and orientation to other robots.

The goal of this project is to implement a reliable MAC protocol to control the shared access to the infra-red communication medium by all robots. The main objectives of a MAC protocol are avoiding and handling of packet collisions and enabling high data traffic.

The e-puck robots have a well-designed programming and debugging interface (in C), which simplifies a lot the task. Extensive documentation, programming examples and a mailing list are available. The project will be under the supervision of Alexander Förster from IDSIA/USI and Anna Förster from USI. Together with them you will learn how to use the e-puck robots, how to program and debug them and will discuss the project details.

For more information, contact the advisors directly and/or check the following sources:

http://en.wikipedia.org/wiki/Media_Access_Control
http://zytrax.com/tech/wireless/802_mac.htm
Title: Swarm Robots Demonstration with e-puck robots  
Supervisor: Alexander Förster  
Sponsor: Luca Gambardella / UROP  
Keywords: swarm intelligence, e-puck, micro-controller, programming language C, infra-red based, range and bearing, computer vision  
Prerequisites: Programming in C/C++

Abstract: The aim of the project is to implement a demonstration for a intelligent swarm of robots. The robots can communicate and localize nearby teammates with an infra-red based range and bearing system. The localization of objects can be done by a small in-build camera.

The e-puck robots are small-size mobile robots, equipped with 8 infra-red proximity sensors which can be used also for communication as well as range and bearing measurements to other robots. The maximum communication range is around 25 cm.

The goal of this project is to implement a search and rescue scenario based on swarm intelligent behavior. This means that a robot takes decisions by its own environment and local communication information. There isn’t any global control instance coordinating the individual robots.

The e-puck robots have a well-designed programming and debugging interface (in C), which simplifies a lot the task. Extensive documentation, programming examples and a mailing list are available. You will learn how to use the e-puck robots, how to program and debug them.

For more information, contact the advisors directly and/or check the following sources:

Abstract: The aim of the project is to implement a demonstration for a computer vision based controlled robot arm. The computer vision system has to detect the position and orientation of colored wooden bricks (cylinders, squared blocks, cubes, gabled roofs). The control software has to rearrange the bricks and hast to build up a volatile construction.

The whole setup is designed to allow restricted human machine interaction. A visitor of an exhibition can destroy the construction by shaking a platform on which the bricks should be piled up by the robot arm. This implies, that the control software can start up from almost each random configuration of the bricks, because the root has to act autonomously for hours without a service interruption.

For more information, contact the advisors directly and/or check the following sources:

http://www.neuronics.ch/, http://www.qtsoftware.com/,
Security Service Negotiation Protocol for MANETs

- Undergraduate Research Opportunity Program (UROP)-

Alberto Ferrante, Antonio Vincenzo Taddeo
{ferrante, taddeo}@alari.ch

June 8, 2009

Abstract
Mobile Ad-hoc Networks (MANET) are composed of heterogeneous mobile systems. Securing their communications may be difficult due to differences in the supported algorithms and protocols. A protocol to negotiate security settings for the communications has been proposed. This protocol aims at minimizing the power consumption and at providing the highest possible security level associated with the communications. Goal of this summer project is to extend the proposed protocol and simulate its performance by extending the current prototype on SunSPOT device [1] as well as performing simulations through well-known networks simulators such as OMNET++ [2] or NS2 [3].

1 Motivations and Goals
Mobile Ad-hoc Networks (MANET) have been evolving quickly since a couple of years. Nowadays, MANETs can offer advanced services by exploiting their increased computational capabilities. Such networks are open systems that dynamically change their topology by means of node mobility. In this context, there are strong security requirements coming from the applications. Though, enforcing security may require an additional quantity of computational capability, but, in contrast, mobility and diversity in transmission means require low power nodes. In MANETs, nodes can be heterogeneous both in term of hardware and of services provided. Thus, there is the need of a protocol to cope with heterogeneous security services and communication means at run-time.

In [4], we present a novel negotiation protocol to deal with the selection of security services in MANETs. We propose to use a Linear Programming (LP) technique to select the best combination of services. The goal is to determine a set of services that minimize the price of the transmission between the two peers. The advantages of using such a solution are twofold. First of all, the selected security services pay the minimum price of data transmission. Secondly, it provides the highest security services at lower price for nodes with different security requirements.

Goal of this summer project is to extend and complete the current SunSPOT ([1]) prototype in order to analyze its performance as well as perform simulations through well-known networks simulators such as OMNET++ [2] or NS2 [3].
2 Expected Results

In particular, initial steps could be:

- setup of simulation environment;
- analysis of the current design and implementation of the prototype for service negotiation protocol;
- performance evaluation of the protocol through simulations;
- investigation of multi-hop communication, in which intermediate node act as bridge of services.

Moreover, the student has to contribute to the protocol with innovative ideas. Some possible extensions could be:

- definition of packet format and session parameters;
- optimization of the protocol to further reduce the price of transmission by exploiting re-use of already active services (may be extending the constraints of the Linear Programming problem);
- include a price for a group of security services. Use such price in the selection of the best set of services;
- how to bind multiple concurrent communication sessions with available resources, for example by using mechanism of resource reservation;
- comparison and/or integration of the proposed solution with existing ones.

3 Students Details

For this summer project background and acquired knowledge include:

- networking and telecommunication;
- distributed systems;
- C/C++ programming languages;
- linear programming;
- Linux Operating System;
- previous experience with SUNSPOT, OMNET++ and/or NS2 simulators is a plus.
References


Self-managing Multi-Agent Systems – Experimenting with Decentralized Control

June 8, 2009

Project mentor/sponsor: Alessio Gambi, Jochen Wuttke, Mauro Pezzè

Motivation

Self-managing systems typically rely on a global controller that is responsible for computing a globally optimal adaptation strategy. This approach becomes increasingly difficult when global optimality depends on many variables. Multi-agent systems with decentralized control and opportunistic local optimization could be a viable alternative to such global control. However, decentralized control can be inherently unstable and unreliable. This project aims at determining conditions under which opportunistic agents can achieve global system goals without centralized control.

Project Goals

The project requires the student to implement a complex simulation of multiple agents, each following its own specific goals, while all are competing for the same resources. The simulation should be used to determine conditions under which systems of opportunistic agents form a stable society, and how accurate goals can be specified and maintained by such a system.

The concrete example for such a multi-agent system is a data center, where different agents control power consumption, service delivery and virtualization of services.
An End User Programming Authoring Tool for the Web

Mentor: Navid Ahmadi
Advisor: Mehdi Jazayeri

Objective: RistrettoMobile is a Web-compliant compiler for end-user developed applications built in AgentSheets. Ristretto Mobile has a Web-based architecture, which not only enables seamless integration of it into other Web 2.0 applications, e.g., Social Networks, but also addresses the lack of unified programming platform for end user development. Figure 1 depicts an iPhone running a game called Sokoban in the iPhone’s Safari using RistrettoMobile. Sokoban was developed using AgentSheets, an end-user development environment, which enables end-users to develop their own games as well as simulations based on a graphical rule-based programming language. The ultimate vision is to build an infrastructure that enables end-users to collaborate through complex applications such as games and simulations. For more information, take a look at RistrettoMobile Web page1.

Approach: We have implemented RistrettoMobile as an engine to run end-user created interactive content such as simulations and games in a Web browser. As a UROP project, we propose the development of an extensible Web-based client-side authoring environment in which end users develop their applications, directly from inside the Web browser. The development process requires a combination of both server side and client side Web programming.

Learning opportunities: Besides becoming familiar with research areas such as Web 2.0, end-user development, and visual languages, you will be trained in both client side and server side of writing Web-based applications, by exploiting JavaScript, XML, JSON, AJAX, and one of the client-side programming languages, such as PHP or Ruby on Rails.

Bio: Navid Ahmadi is an Informatics Ph.D. at University of Lugano since November 2006, under supervision of professor Mehdi Jazayeri. His main research interests include End User Programming, World Wide Web, Web 2.0, Service-Oriented Computing, Computer Supported Cooperative Work, and their application in social and pedagogical environments.

1 http://www.inf.unisi.ch/phd/ahmadi/RistrettoMobile/index.html
Design and implementation of a traffic-adaptive medium access protocol for wireless sensor networks
Professor: Antonio Carzaniga
Assistant: Anna Förster
Expected duration: 6-8 weeks

Introduction
Medium access (MAC) protocols are a crucial instrument in minimizing communication and energy expenditure in wireless sensor networks. Many different protocols and protocol families exist, TDMA (time division multiple access) being one of the most widely used paradigms. In TDMA, each node is assigned its own slot during which only this node can send data. Thus, interference between nodes and packet collisions are minimal. However, the slot assignment mechanism usually only makes sure that each node has a unique slot and does not take into consideration the communication delay caused by inappropriate slot assignment for neighboring nodes. For example, if some node forwards data to one of its neighbors and this neighbor is assigned a slot just before the node’s one, it will need to wait nearly a full round of slots to be able to forward the data itself. Thus, a traffic-aware and adaptive TDMA scheduling mechanism is desired.

Project Description
The goal of the project is to design and implement a traffic-aware adaptive TDMA-based MAC protocol for wireless sensor networks. The starting point of the project will be an existing TDMA MAC protocol like LMAC or SMAC. The designed protocol will monitor the routing traffic in its neighborhood and flexibly change the slot assignment to minimize delay. Machine learning techniques like reinforcement learning or decision tree learning may be used if appropriate.

Project Requirements
Atelier V: Introduction to Wireless Sensor Networks. Willingness to implement and test the protocol on a WSN hardware testbed.

Expected Outcome
An WSN testbed implementation of the designed protocol with comparative experimental results against a non-adaptive MAC protocol. The design and experimental results will be summarized in a research publication for a workshop or a conference.

Acquired Experience/Knowledge
Excellent understanding of medium access protocols, design and implementation of communication protocol for wireless sensor networks. Research experience in independent problem analysis and solutions, design and implementation of a novel and non-trivial communication protocol.

Project Organization
The project will be under the supervision of Anna Förster and Antonio Carzaniga. Together with them you will analyze the problem, design a solution, implement it and test it on the already existing WSN hardware testbed at the Faculty of Informatics.