



MiNEMA First Workshop

Trinity College Dublin, Ireland,

29th – 30th January 2004

Scientific Report

Luís Rodrigues (ed.)

U. Lisboa

Foreword

MiNEMA is an European Science Foundation (ESF) Scientific Programme aiming to bring together European groups from different communities working on middleware for mobile environment. The programme intends to foster the definition and implementation of widely recognized middleware abstractions for new and emerging mobile applications.

The programme includes the following planned activities:

- Short term visit exchanges among the programme participants (PhD students).
- Organization of a "closed" workshop for programme participants, to allow the dissemination of early research results and experiences.
- Sponsoring of workshops and conferences in the area of MiNEMA.
- Organization of a summer school on the subjects covered by the programme.

This documents collects the abstracts from the talks given at the First MiNEMA workshop, 29th – 30th, Trinity College Dublin, Dublin, Ireland.

Luis Rodrigues

For more information about MiNEMA, please consult the programme Web page:
<http://www.minema.di.fc.ul.pt/>

List of participants

- Araújo, F. - *U. Lisboa, Portugal*
- Baehni, S. - *EPFL, Switzerland*
- Biegel, G. - *TCD, Ireland*
- Boszormenyi, L. - *U. Klagenfurt, Austria*
- Cahill, V. - *TCD, Ireland*
- Charalabous, C. - *U. Cyprus, Cyprus*
- Fellrath, S. - *ESF*
- Ferscha, A. - *U. Linz, Austria*
- Grace, P. - *U. Lancaster, U.K.*
- Joosen, W. - *K.U. Leuven, Belgium*
- Kaiser, J. - *U. Ulm, Germany*
- Koldehofe, B. - *Chalmers, Sweden*
- Liu, C. - *U. Ulm, Germany*
- Meier, R. - *TCD, Ireland*
- Miranda, H. - *U. Lisboa, Portugal*
- Mitadieri, C. - *U. Ulm, Germany*
- Pochon, B. - *EPFL, Switzerland*
- Raatkainen, K. - *U. Helsinki, Finland*
- Riva, O. - *U. Helsinki, Finland*
- Rodrigues, L. - *U. Lisboa, Portugal*
- Schougaard K. - *Aarhus University, Denmark*
- Truyen, E. - *K.U. Leuven, Belgium*
- Tsigas, P. - *Chalmers, Sweden*
- Vandervoid, Y. - *K.U. Leuven, Belgium*

Program

Thursday, 29th :

Session 1: 9:00 - 10:30 :

- *Exploiting Proximity in Event-Based Middleware for Collaborative Mobile Applications*, René Meier, Trinity College, Dublin, Ireland
- *Towards event-based middleware for predictable interaction of mobile components*, Jörg Kaiser, U. Ulm, Germany
- *Preventing selfish behavior in MANETs*, Hugo Miranda, U. Lisboa, Portugal

Break: 10:30 - 11:00

Session 2: 11:00 - 12:30 :

- *Location Based Services in Wireless Networks*, Charalambos D. Charalambous, University of Cyprus, Cyprus.
- *The Driving Philosophers*, Bastian Pochon, EPFL, Switzerland.
- *Managing multiple customizations in a distributed application*, Eddy Truyen, Wouter Joosen, K. U. Leuven, Belgium.

Luch break: 12:30 - 14:00

Session 3: 14:00 - 15:30 :

- *Research on Distributed Multimedia Systems at the University Klagenfurt*, Laszlo Böszörmenyi, University of Linz, Austria.
- *Overall presentation of the (MiNEMA-related) research of the Distributed Computing and Systems group at Chalmers University*, Philippos Tsigas, Chalmers University, Sweden.
- *Contextware*, Alois Ferscha, University Linz, Austria

Break: 15:30 - 16:00

Session 4: 16:00 - 18:00 :

- *A Framework for Developing Mobile, Context-aware Applications*, Gregory Biegel, Trinity College, Dublin, Ireland
- *ReMMoC: A Reflective Middleware to support Mobile Client Interoperability*, Paul Grace, Lancaster University, UK.
- *An Extendible Component Runtime that Supports Dynamic Replacement*, Yves Vandewoude, Yolande Berbers, Wouter Joosen, K. U. Leuven, Belgium.
- *Buffer management on probabilistic dissemination systems*, Boris Koldehofe, Chalmers University, Sweden.

Friday, 30th :

Session 5: 9:00 - 10:30 :

- *Data Aware Multicast*, Sebastien Baehni, EPFL, Switzerland.
- *On the monitoring period in Ad Hoc networks*, Filipe Araujo, U. Lisboa, Portugal.
- *Content and Cell based Predictive Routing (CCPR) Protocol for Mobile Ad Hoc Networks*, Changling Liu, U. Ulm, Germany.

Break: 10:30 - 11:00

Session 6: 11:00 - 12:00 :

- *Wireless Internet: Challenges and Solutions*, Kimmo Raatikainen, University of Helsinki, Finland.

Exploiting Proximity in Event-Based Middleware for Collaborative Mobile Applications

René Meier

Trinity College Dublin, Ireland

Abstract

Middleware supporting event-based communication is widely recognized as being well suited to mobile applications since it naturally accommodates a dynamically changing population of interacting entities and the dynamic reconfiguration of the connections between them. STEAM is an event-based middleware designed for use in ad hoc networks. STEAM differs from other event-based middleware in that its architecture does not rely on the presence of any separate infrastructure, event notification filters are distributed, and filtering may be applied to functional and non-functional attributes. In particular, filters may be applied to either the subject or the content of an event notification, or to non-functional attributes, such as location and time. Filters may be used to define geographical areas within which event notifications are valid, thereby bounding the propagation of these notifications. Such proximity-based filtering represents a natural way to filter events of interest in mobile applications. This presentation describes the architecture and implementation of STEAM and its use of proximity-based filtering. In particular, we show how proximity-based filtering can be used to reduce the number of events delivered to collaborative mobile applications.

Towards event-based middleware for predictable interaction of mobile components

Jörg Kaiser

U. Ulm, Germany

Abstract

The presentation will provide a survey over recent research at the CORE group of the University of Ulm. The activities center around mobile systems which interact with each other and their physical environment. Therefore, the ability for dynamic interaction and a certain degree of predictability for communication is required to allow coordinated activities. At the moment we focus on networks of tiny devices as smart sensors and actuators. We developed an event-based middleware which considers resource constraints as performance, memory and network bandwidth and allows to specify the quality of communication. The talk will address problems encountered during our work and highlight future research plans.

Preventing selfish behavior in MANETs

Hugo Miranda

U. Lisboa, Portugal

Abstract

An interesting characteristic of ad hoc networks is their self-organization and their dependence of the behavior of individual nodes. Until recently, most research on ad hoc networks has assumed that all nodes were cooperative. This assumption is no longer valid in spontaneous networks formed by individuals with diverse goals and interests. In this scenario, open MANETs will likely resemble social environments: a group of persons can mutually benefit from cooperation as long as every participant contributes with approximately the same share. We are concerned with the resources invested in forwarding messages and in the participation on routing protocols. To extend the life of their devices, users may feel compelled to exhibit a selfish behavior, by benefiting from the resources

provided by the other nodes without, in return, making available the resources of their own devices. This behavior may be motivated by an unfair load balancing policy enforced by the routing protocol.

Selfish behavior threatens the entire community. Optimal paths may not be available and cooperative nodes may become overloaded and be forced to abandon the community. In order to effectively support open and spontaneous communities, MANETs should complement routing protocols with additional mechanisms and algorithms that 1) promote load-balancing and 2) discourage selfish behavior. A novel algorithm that meets these goals will be presented. The algorithm penalizes users that are intentionally selfish. Additionally, the algorithm is tolerant to malicious attacks and communication failures.

Location Based Services in Wireless Networks

Charalambos D. Charalambous
University of Cyprus, Cyprus

Abstract

"Accessing the right information anytime anywhere" is becoming part of the driving force of the information technology evolution. The "right" information is information that is relevant based on the user's profile and his/her current position and/or time. This presentation, which consists of two parts, represents a collaborative project between the University of Cyprus and the Cyprus Telecommunication Authority (CYTA). The first part is concerned with the development of algorithms and technologies installed at the mobile terminal, which lead to automatic location identification of mobile users. The second part is concerned with the development and deployment of pilot location based services (LBS), which will allow service providers to disseminate information based on the subscriber's location. A number of LBS will be developed including a service for identifying the exact location of an emergency mobile call.

The Driving Philosophers

Bastian Pochon
EPFL, Switzerland

Abstract

We introduce a new synchronization problem in mobile ad-hoc systems: the Driving Philosophers. In this problem, an unbounded number of driving philosophers (processes) try to access a round-about (set of shared resources, organized along a logical ring). The crux of the problem is to ensure mutual exclusion and starvation-freedom at the level of each particular resource, as well as traffic jam-freedom at the level of the set of resources. The problem captures explicitly the very notion of process mobility and the underlying model does not involve any assumption on the total number of (participating processes) or any shared memory, i.e., ad-hoc environment. We present a generic algorithm that solves the problem in a synchronous model (e.g., based on GPS receivers at every process). Instances of this algorithm can be fair but not concurrent, or concurrent but not fair. We derive the impossibility of achieving fairness and concurrency at the same time as well as the impossibility of solving the problem in an asynchronous model. We also conjecture and impossibility on the Driving Philosophers problem in a model with local communication.

Managing multiple customizations in a distributed application

Eddy truyen, Wouter Joosen
K. U. Leuven, Belgium

Abstract

This presentation addresses client-specific customization of systems that implement an on-line Internet service in the presence of simultaneous client-specific views. The problem is that each client must be able to customize the running system for use in its own context, without impacting the service behaviour that is delivered to other clients. To solve this, we propose to customize the system on a per client request basis, where the system itself consists of a stable core and several extensions that are injected into the core as needed. However, this approach brings on its own several consistency management problems that must be dealt with in order to make the approach viable. We give an overview of these problems and present a management architecture that deals with these problems.

Research on Distributed Multimedia Systems at the University Klagenfurt

Laszlo Böszörményi
University Klagenfurt, Austria

Abstract

The Department for Information Technology (ITEC) at the University Klagenfurt has been doing intensive research for several years on Distributed Multimedia Systems, with a special emphasis on the Adaptation Principle. About 15 researches are cooperating in the context of the same major project, called ADMITS (Adaptation in Distributed Multimedia IT Systems). In our work, we strongly rely on available standards. We are active members of MPEG (Motion Picture Experts Group, a working group of ISO/IEC). We are contributors - in cooperation with Siemens Corporation - to the emerging MPEG-21 Digital Item Adaptation standard. We also make intensive use of metadata in MPEG-7 format.

The talk introduces the notions of offensive and defensive adaptation. It presents a bunch of projects exploring the adaptation principle in areas such as multimedia servers, proxies, active network components, network protocols and multimedia databases. The talk also touches issues for ongoing research, such as multimedia brokering and multimedia middleware, needing substantial effort to reach a level of general consensus and to be able to serve as a solid basis for valuable technologies. Adaptation has a special importance in heterogeneous systems, incorporating stationary and mobile clients, wired and wireless network protocols, predefined and ad-hoc service locations. A natural extension of the ADMITS project is to provide a Quality-of-Service aware multimedia middleware, which abstracts the heterogeneity underneath. This is the basis of our interest on the MiNEMA project.

Overall presentation of the (MiNEMA-related) research of the Distributed Computing and Systems group at Chalmers University

Philippas Tsigas
Chalmers University, Sweden

Abstract

The distributed computing and systems research group at Chalmers focuses its research on efficient ways that can be used for different concurrent computer processes to share information and get coordinated (Interprocess Synchronization) and also on efficient and fault-tolerant methods for sharing general resources in networks and peer-to-peer systems (Communication, Resource Allocation and Sharing).

I will concentrate on the following research activities that are currently running at our group:

1. Multipeer information dissemination and consistency support.
2. Resource allocation and sharing in mobile communication networks.

3. Efficient visualization techniques for wearables (mobile) devices.
4. Non-blocking concurrent data-structures.

Contextware

Alois Ferscha
University Linz, Austria

Abstract

Services delivered through pervasive computing environments demand to be adaptive to "context", particularly to the person, the time and the place of their use.

The aim for seamless service provision to anyone (personalized services), at any place (location based services) and at any time (time dependent services) has brought the issues of software framework design and middleware to a new discussion: it is expected that context-aware services will evolve, enabled by wirelessly ad-hoc networked, autonomous special purpose computing devices (i.e. "smart things"), providing largely invisible support for tasks performed by users. It is further expected that services with explicit user input and output will be replaced by a computing landscape sensing the physical world via a huge variety of electrical, magnetic, optical, etc. sensors, and controlling it via a manifold of actuators. To ease the development of applications and services that have to be greatly based on the notion of context, so called "context frameworks" are of high demand in the embedded systems software development scenarios.

I will explore the software engineering issues, challenges and enabling technologies associated with the provision of context aware services able to:

1. describe, gather, transform, interpret and disseminate context information within ad-hoc, highly dynamic and frequently changing computing environments,
2. dynamically discover, inspect, compose and aggregate software components in order to identify, control and extend context, as well as overcome context barriers (like time, position, user preference, etc.),
3. allow for dynamic interactions among software components in a scalable fashion and satisfying special requirements such as fidelity, QoS, fault-tolerance, reliability, safety and security,
4. integrate heterogeneous computing environments and devices with different functionality, ability, form factor, size and limited resources wrt. Processing power, memory size, communication, I/O capabilities, etc.
5. support the adaptation of novel forms of sensitive, situative, non-distracting user interfaces not limited to particular modes and styles of interaction, input- output devices or service scenarios.

In an analogy to the term "middleware- generally understood as software technologies that serve to mediate between two or more separate (and usually already existing) software components - we introduce the term "contextware" as the core of software technologies mediating services and the context of their use.

I will present contextware "in operation" with our demonstrators: the "WebWall", "Internet Luggage", "Interaction Tracer" and "Automotive Peer-to-Peer".

A Framework for Developing Mobile, Context-aware Applications

Gregory Biegel
Trinity College Dublin, Ireland

Abstract

The emergence of truly ubiquitous computing, enabled by the availability of mobile, heterogeneous devices that supply context information, is currently hampered by the lack of programming support for design and development of context-aware applications.

We have developed a framework which significantly eases the development of mobile, context-aware applications. The framework allows developers to fuse data from disparate sensors, represent application context, and reason efficiently about context, without the need to write complex code. An event based communication paradigm designed specifically for ad-hoc wireless environments is incorporated, which supports loose coupling between sensors, actuators and application components.

ReMMoC: A Reflective Middleware to support Mobile Client Interoperability

Paul Grace
Lancaster University, UK

Abstract

Mobile client applications must discover and interoperate with application services available to them at their present location. However, these services will be developed upon a range of middleware types (e.g. RMI and publish-subscribe) and advertised using different service discovery protocols (e.g. UPnP and SLP) unknown to the application developer. Therefore, a middleware platform supporting mobile client applications should ideally adapt its behaviour to interoperate with any type of discovered service. Furthermore, these applications should be developed independently from particular middleware implementations, as the interaction type is unknown until run-time. In this talk we present ReMMoC, a reflective middleware platform that dynamically adapts both its binding and discovery protocol to allow interoperation with heterogeneous services. Furthermore, we present the ReMMoC programming model, which is based upon the Web Services concept of abstract services.

An Extendible Component Runtime that Supports Dynamic Replacement

Yves Vandewoude, Yolande Berbers, Wouter Joosen
K. U. Leuven, Belgium

Abstract

The embedded systems group of DistriNet has participated in a project named SEESCOA to develop a component methodology. In the component model all inter-component communication is based on asynchronous message passing through ports. Components can be composed by linking ports using connectors. The SEESCOA methodology is supported by a set of tools: a design tool in which compositions can be defined (CCOM), a pre-processor that translates component implementations into standard Java, and a middleware environment to support execution of applications that aggregate SEESCOA components. In this presentation we focus on the runtime environment: Draco. We discuss the general architecture and introduce the concept of message handlers that provide the hooks for extensions to the middleware environment. We illustrate the power of this technique by extending the runtime environment with distribution and with functionality for dynamically replacing components at runtime.

Buffer management on probabilistic dissemination systems,

Boris Koldehofe
Chalmers University, Sweden

Abstract

In the context of group communication probabilistic dissemination systems have received a lot of attention because they can scale to many users and are robust against failures in the communication traffic. This talk gives an overview on current work on designing lightweight dissemination systems for group communication. The dissemination system of our scope is required to provide a predictable guarantee for successful delivery of disseminated events. Moreover, the dissemination system has to perform well when the amount of resources is restricted. Important sources of resource restrictions are the amount of members known by a group member and the size of buffers.

The size and the management of buffers has several interesting consequences on how disseminated events can be delivered to the application. We look at buffer management:

1. to prevent multiple deliveries of the same event to the application;
2. to give ordering guarantees among events, for instance causal ordering, and its application to maintain shared replicated objects.

In particular, we show that a dissemination system based on a balls and bins game can guarantee message stability for a high percentage of events while at the same time only a low number of events with multiple deliveries occur.

Data Aware Multicast

Sebastien Baehni
EPFL, Switzerland

Abstract

This paper presents a multicast algorithm for peer-to-peer dissemination of events in a distributed topic-based publish-subscribe system, where processes publish events of certain topics, organized in a hierarchy, and expect events of topics they subscribed to. Our algorithm is “data-aware” in the sense that it exploits information about process subscriptions and topic inclusion relationships to build dynamic groups of processes and efficiently manage the flow of information within and between these process groups. This “data-awareness” helps limit the membership information that each process needs to maintain, preserves processes from receiving messages related to topics they have not subscribed to and provides the application a means to control, for each topic in a hierarchy, the trade-off between the message complexity and the reliability of event dissemination. We convey this trade-off through both analysis and simulation.

On the monitoring period in Ad Hoc networks

Filipe Araújo
U. Lisboa, Portugal

Abstract

In the last few years, position-based routing algorithms have emerged as an important paradigm for wireless *ad hoc* networks. Excellent routing performance, often achieved by these algorithms in exchange of little or almost no control information, make them a very suitable choice for an environment where available resources, like memory, CPU or energy, are scarce and topology changes may be frequent.

Hence, this presentation will overview some of the research topics, in position-based routing algorithms for wireless *ad hoc* networks that we are investigating, namely, energy conserving techniques, routing using spanner subgraphs, utilization of non-unitary disk graph models and memory requirements for competitive routing. In particular, we will present one cell-based energy conserving algorithm, called Sleep-Query-Active (SQA) that tries to put nodes asleep to maximize network lifetime. More specifically, we study the optimal setting for the monitoring period of nodes, under the presence of faults and given limited energy resources.

Content and Cell based Predictive Routing (CCPR) Protocol for Mobile Ad Hoc Networks

Changling Liu
U. Ulm, Germany

Abstract

Providing communication predictability is hard in mobile ad hoc networks, but on the other hand, it is extremely desirable in applications such as search and rescue, teams of cooperating mobile robots or traffic scenarios. The presentation will give an introduction of our work on improving communication predictability in mobile ad hoc networks and describe the Content and Cell based Predictive Routing (CCPR) Protocol. The talk will focus on the communication model, main operations of CCPR and finally will discuss the problems of using CCPR with different MAC protocols.

Wireless Internet: Challenges and Solutions

Kimmo Raatikainen

University of Helsinki, Finland

Abstract

More than ten years ago Mark Weiser presented the vision of invisible computing and ubiquitous computing. Later similar ideas have been proposed under concepts of nomadicity, pervasive computing, and ambient awareness. There may be some minor differences in emphasis between those concepts but the core and major challenges are similar. We address the issues as the Wireless Internet.

We have identified four major research issues: Service Architectures, Reconfigurable Systems, Context Modeling, and Programming Models. Some important issues, although they are present as research topics in our research challenges, may not receive the attention they deserve. Such issues include trust and privacy, mobile data management, and light-weight distributed management of state. In addition, the operating systems will meet the challenges of frequent interrupts from local sensors and cacophony of radio signals from surrounding sensors. In Open APIs we meet the cross-over problem of implementing same interfaces both in hardware and software. Finally, it is not obvious how we should produce the software artifacts for future mobile computing.

In the solutions part we present our contributions to Internet Protocol Suite and Mobile Middleware:

- TCP enhancements: RFCs (2757,3135,3150,3155), Internet drafts, and Linux kernel.
- IP QoS in access networks and Localized RSVP
- Wireless CORBA: OMG standard (OMG document formal/2003-03-64)
- Wireless JAVA RMI: standardization under evaluation
- Efficient Agent communication: FIPA standards
- TCP-friendly Adaptive Link Layer protocol for satellite links
- SOAP for wireless links
- Reference Model of Wireless World Research Forum