

Scientific Report of the 5th MiNEMA Workshop

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Abstract — *MiNEMA Workshops intend to bring together a mixture of young and senior European researchers working on middleware for network eccentric and mobile applications. They help to foster further collaboration between existing MiNEMA members, with special emphasis on PhD students, to advertise and widen participation in the MiNEMA network and to establish links with the industry. This document reports the organisation of the 5th MiNEMA workshop by the Otto-von-Guericke University of Magdeburg.*

1 SUMMARY

The 5th MiNEMA workshop was held in Magdeburg, Germany, from September 11th to September 12th, 2007. Accommodations and meeting rooms had been arranged at the Herrenkrug Hotel Magdeburg¹. The workshop had six sessions dedicated to different fields of research (*one reserved for reports on previous MiNEMA workshops*). The detailed program of the workshop is presented in Appendix A.

The scientific organisation of the workshop was separated from the local organisation. The local arrangements were prepared by Thomas Kiebel, Sebastian Zug and Michael Schulze from the Otto-von-Guericke University of Magdeburg, Francois Taïani from the University of Lancaster was responsible for the scientific program.

The workshop had 28 participants from 12 countries and from 18 distinct institutions.

2 SCIENTIFIC CONTENT

The workshop followed the same model as previous MiNEMA workshops (*e.g. 4th MiNEMA workshop in Sintra*) briefly outlined here. The scientific program was formed by research papers presented and discussed during the workshop. Submission of papers presenting early results, namely from PhD students, were encouraged in order to foster discussion and provide feedback to the authors. Each paper was reviewed by the workshop program committee in order to be accepted.

Contributions could be submitted to one of the following categories:

Research Paper Submissions in this categorie should present new, still preliminary research on middleware for mobile environment. The recommended length of submission was between 3 and 5 pages.

Study Topic Adressing students relatively new to the world of middleware for mobile applications, or researchers with unanswered questions. It identifies potentially open questions in the domain, and based on a presentation sets out a plan as how to answer those questions during the workshop. Submissions to this categorie could not exceed 3 pages.

Lessons Learned Submissions summary of complete research tracks and/or projects. This work can be submitted by sending a position paper optionally complemented with a report or reference to an existing publication describing the work. Recommended length of submissions of this category was between 3 and 5 pages.

MiNEMA PhD workshop report Presentations reporting on the result of workshops among PhD students sponsored by the MiNEMA program.

One author for each accepted submission was invited to give a 30 minute presentation at the workshop. The authors of accepted submissions were requested to revise their contribution by considering the feedback of the reviewers. The proceedings of the workshop composed of all submissions accepted were published as a technical report of the Department of Distributed Systems at the Otto-von-Guericke University[1]. The abstracts of the papers accepted are presented in Appendix B.

¹<http://www.herrenkrug.de/>

2.1 PROGRAMME COMMITTEE

The program committee was responsible for the evaluation of submitted contributions. It was chaired by Francois Taiani from the University of Lancaster and composed by:

- Jeppe Brønsted, Aarhus Universitet
- Danny Hughes, Lancaster University
- Nico Janssens, Katholieke Universiteit Leuven
- Boris Koldehofe, Universität Stuttgart
- Sam Michiels, Katholieke Universiteit Leuven
- Hugo Miranda, Universidade de Lisboa
- Aline Senart, Trinity College, Dublin
- Michael Schulze, OVGU Magdeburg
- Alexander Tyrrell, DoCoMo Euro-Labs
- Kari Heikkinen, Lappeenranta University

The workshop received a total of 14 submissions, which were all classified as research papers. The program committee decided to accept 13 of the 14 submissions and to hold 4 reports on previous MiNEMA workshops.

3 CONCLUSIONS

The workshop had a significant number of submissions and participants from many different institutions. Furthermore, presentations raised fruitful discussion that are likely to contribute in the future for joint projects between different members. Therefore, we can state that the workshop has achieved its goals entirely.

A FINAL PROGRAMME

Monday, 10th September

19:00 Welcome reception

Tuesday, 11th September

09:30 - 10:45

Opening and Session 1: P2P Systems and Overlay Networks

GossipKit: A Framework of Gossip Protocol Family, Shen Lin, François Taïani, Gordon Blair (Lancaster University)

Enabling Cyber Foraging for Mobile Devices, Mads Kristensen (University of Aarhus)

Coffee Break

11:15 - 12:45

Session 2: Streaming and Multicast

Building multicast trees in ad-hoc networks, Raphaël Kummer, Peter Kropf, Pascal Felber (University of Neuchâtel)

A Gambling Approach to Scalable Resource-Aware Streaming, Mouna Allani (University of Lausanne), Benoît Garbinato (University of Lausanne), Fernando Pedone (University of Lugano), Marija Stamenković (University of Lugano)

Removing Probabilities to Improve Efficiency in Broadcast Algorithms, Hugo Miranda (University of Lisbon), Simone Leggio (University of Helsinki), Luís Rodrigues (University of Lisbon), Kimmo Raatikainen (University of Helsinki)

Lunch

14:00 - 15:00

Session 3A: Report on Ph.D Student Workshops

Service Description and Discovery for MANETS, Sep 19–21 2006, UK: Raphaël Kummer (University of Neuchâtel)

Supporting Context-aware Collaborative Applications in Mobile Ad Hoc Networks, Sep 15–16 2006, Finland: Boris Koldehofe (University of Stuttgart)

Coffee Break

15:30 - 16:30

Session 3B: Report on Ph.D Student Workshops

Middleware and Programming Models for Embedded and Resource Constrained Systems, Jun 8 2007, Italy: Jeppe Brønsted (University of Aarhus)

A Scalable Adaptive Multimedia Delivery Middleware, Jun 13–15 2007, Austria: Marc Schiely (University of Neuchâtel)

16:30 - 18:30

Meeting Steering Committee

19:00

Workshop Dinner

Wednesday, 12th September

09:00 - 10:30

Session 4: Publish/Subscribe

Strategies for implementing Peer-to-Peer Publish/Subscribe with Persistent Events in Wireless Settings, Eugster Patrick (Purdue University), Benoît Garbinato (University of Lausanne), Adrian Holzer (University of Lausanne), Jun Luo (University of Waterloo)

Probabilistic Publish/Subscribe in Mobile Ad Hoc Networks, José Mocito, José Côrte-Real, Luís Rodrigues (University of Lisbon)

Predictive Publish/Subscribe for Delay Tolerant Mobile Ad Hoc Networks, Paolo Costa (Vrije University), Cecilia Mascolo (University College of London), Mirco Musolesi (University College of London), Gian Pietro Picco (University of Trento)

Coffee Break

11:00 - 12:30

Session 5: Architectures and Frameworks

Towards a Peer-to-peer Middleware for Context Provisioning in Spontaneous Networks, Tuan Dung Nguyen, Siegfried Rouvrais (GET / ENST Bretagne)

Semantic Middleware for Designing Collaborative Applications in Mobile Environment, Lamia Benmouffok (Universite Pierre et Marie Curie), Jean-Michel Busca (INRIA - Rocquencourt), Marc Shapiro (INRIA - Rocquencourt)

Handling membership dynamicity in service composition for ubiquitous computing,
Jeppe Brønsted (University of Aarhus)

Lunch

14:00 - 15:00

Session 6: Wireless Sensor Applications

End-to-end middleware for distributed sensor applications, Nelson Matthys, Sam Michiels, Wouter Joosen, Pierre Verbaeten (Katholieke Universiteit Leuven)

Using COSMIC – A real world case study combining virtual and real sensors, Michael Schulze, Sebastian Zug (OvGU Magdeburg)

Coffee Break

B ABSTRACTS OF THE ACCEPTED PAPERS

GossipKit: A Framework of Gossip Protocol Family
Shen Lin, François Taïani, Gordon Blair

A large number of gossip algorithms have been developed in the last few years to address a wide range of functionalities. By contrast, however, very few software frameworks have been proposed so far to ease the development and deployment of these gossip protocols. To address this issue, this paper presents GossipKit, an event-driven framework that provides a generic and extensible architecture model to support the development of a configurable and reconfigurable gossip protocol middleware. GossipKit is based on a generic interaction model for gossip protocols and relies on a fine-grained event mechanism to facilitate configuration and reconfiguration and promote code reuse.

Enabling Cyber Foraging for Mobile Devices
Mads Kristensen

This paper presents the Locusts framework. The aim of the Locusts project is to enable easy use of cyber foraging techniques when developing for small, resource-constrained devices. Cyber foraging, construed as “living off the land”, enables resource poor devices to offload tasks to nearby computing machinery, thereby enabling the small devices to 1) save energy and time, 2) take on tasks that would normally not be possible on such small devices, and 3) co-operate to perform tasks.

This paper is concerned with foraging for processing power, i.e. remote execution of tasks, and discusses how distribution and migration of tasks can be done in a highly mobile environment. The main contribution of Locusts is the focus on highly mobile cyber foraging. Here highly mobile means two things: 1) that the mobile devices are physically moving through the environment, which calls for task migration, and 2) that this mobility moves the devices into unknown environments where they would still like to be able to perform cyber foraging, which calls for the use of mobile code.

Building multicast trees in ad-hoc networks
Raphaël Kummer, Peter Kropf, Pascal Felber

Publish-subscribe and multicast are related approaches to efficiently distribute content to a subset of interested nodes. Many systems have been proposed with centralized or distributed knowledge of the members. Some of them use different kinds of structured overlays to build a distribution infrastructure, others broadcast connection requests and service announcements throughout the network. In both cases, those propositions do not deal with the problem of nodes implicated to relay messages but not interested in the provided content.

In this paper we propose a distributed hash table (DHT) based multicast / publish-subscribe tree building algorithm for ad-hoc networks. Our approach aims to build an efficient distribution tree by minimizing the number of non-member relays needed and by balancing the degree of implicated nodes relaying the multicast messages. We rely on physical proximity, multicast distribution and the DHT to, respectively, improve the tree structure and efficiently discover the root of the tree. We demonstrate the efficiency and scalability of our algorithm by simulating various network sizes and configurations.

A Gambling Approach to Scalable Resource-Aware Streaming
Mouna Allani, Benoît Garbinato, Fernando Pedone, Marija Stamenković

In this paper, we propose a resource-aware solution to achieve reliable and scalable stream diffusion in a probabilistic model, i.e., where communication links and processes are subject to loss and crash probabilities respectively. Our solution is resource-aware in the sense that it limits the memory consumption (by strictly scoping the knowledge each process has about the system) and the bandwidth available to each process (by assigning a fixed quota of messages to each process). We describe our approach as gambling in the sense that it consists in accepting to give up on a few processes sometimes, in the hope to better serve all processes most of the time.

That is, our solution deliberately takes the risk not to reach some processes in some executions, in order to reach every process in most executions. The underlying stream diffusion algorithm is based on a tree-construction technique that dynamically distributes the load of forwarding stream packets among processes, based on their respective available bandwidths.

Removing Probabilities to Improve Efficiency in Broadcast Algorithms
Hugo Miranda, Simone Leggio, Luís Rodrigues, Kimmo Raatikainen

Although frequently used, broadcast is a costly operation in Mobile Ad Hoc Networks as it consumes both bandwidth and power of the devices. This paper describes an algorithm to reduce the number of retransmission of a broadcasted message. The algorithm improves previous results by removing some of the randomness associated with the selection of the nodes required to retransmit.

Strategies for implementing Peer-to-Peer Publish/Subscribe with Persistent Events in Wireless Settings
Eugster Patrick, Benoît Garbinato, Adrian Holzer, Jun Luo

In this paper, we compare two peer-to-peer implementation strategies for persistent publications in location-based publish/subscribe. Both approaches use a scoped flooding algorithm to effectively disseminate data through the network – the first naive alternative propagates only published events, while the second smarter approach disseminates subscriptions during a warm up phase and then routes matching publications with a multisend communication primitive. We show in preliminary performance evaluations that depending on the applicative scenario, the cost of the warm up phase cannot be covered and the seemingly naive approach can outperform the smart one.

Probabilistic Publish/Subscribe in Mobile Ad Hoc Networks
José Mocito, José Côte-Real, Luís Rodrigues

This paper proposes a probabilistic publish-subscribe approach for Mobile Ad Hoc Networks (MANETs). In our approach publishing and subscribing are implemented using random walks in the network. This strategy avoids the cost of continuously maintaining complex routing structures that are unstable due to node mobility. While previous research on gossip based publish-subscribe for MANETS assumed the collaboration of all nodes in the network our solution operates on an overlay constructed on top of DSR, allowing for only a small fraction of the nodes to participate in the publish-subscribe system.

Predictive Publish/Subscribe for Delay Tolerant Mobile Ad Hoc Networks
Paolo Costa, Cecilia Mascolo, Mirco Musolesi, Gian Pietro Picco

Many infrastructure-less mobile applications demand the ability to withstand long-lasting network partitions and disconnections. Solutions supporting opportunistic communication have been studied in the context of delay-tolerant mobile ad hoc networks. However, they typically assume that the sender determines the intended recipients, using a unicast or multicast address. Instead, several applications require a form of publish/subscribe, where it is the receiver that specifies the messages it is interested in; the sender simply injects messages into the network, which routes them based on their content. Although publish/subscribe protocols and systems exist for fixed and mobile networks, to the best of our knowledge no proposal addressed highly partitioned and intermittently connected MANETs. In this paper we report about our experience with SocialCast, a routing framework for publish-subscribe that exploits predictions based on metrics of social interaction (e.g., patterns of movements among communities) to identify the best information carriers. The protocol takes into account contextual information (e.g., connectivity changes) to produce estimates about the network evolution. These estimates are used to forward messages not only to the intended receivers, but also towards good message carriers, i.e., hosts with a high probability to deliver messages across partitions. We highlight the principles underlying our protocol, illustrate its operation, and evaluate its performance using a mobility model validated with real mobility traces.

Towards a Peer-to-peer Middleware for Context Provisioning in Spontaneous Networks
Tuan Dung Nguyen, Siegfried Rouvrais

Context-awareness has been widely considered important for applications to provide adaptable services to changes in dynamic environments. Classical approaches have mainly focused on gathering and representing internal contextual information from integrated sensors. Recent work has shown that useful external contexts can also be acquired from the surrounding environment in a distributed manner. However, the dynamicity and heterogeneity of spontaneous

networks raise new challenges for the provisioning of such information. This paper describes our ongoing work on a peer-to-peer middleware for abstracting contexts as logical peers in independent overlay networks. Context data retrieval then becomes transparent to applications and other middleware services. The proposed middleware will support efficient construction and maintenance of these overlays and offer common interfaces to applications. We discuss in detail its architecture and the open issues to be resolved.

Semantic Middleware for Designing Collaborative Applications in Mobile Environment

Lamia Benmouffok, Jean-Michel Busca, Marc Shapiro

The Telex middleware facilitates the design of collaborative applications in a mobile environment. It provides optimistic replication, tentative execution and disconnected work. It solves conflicts based on semantic information provided by applications.

We study in particular a Shared Calendar (SC) application, whereby mobile users can create and manage meetings in a collection of shared calendars. The application provides Telex with objects representing (1) meeting creation and modification operations (actions), (2) dependence or conflict information between actions (constraints). When a conflict occurs, Telex proposes solutions to users.

The advantage of this approach is a clean separation of concerns. The SC application writer concentrates on application logic, whereas Telex takes care of replication, consistency, conflicts, and commitment across all applications.

Handling membership dynamicity in service composition for ubiquitous computing

Jeppe Brønsted

In ubiquitous computing, as more and more devices are introduced into the environment, new applications are made possible that exploit device capabilities in new ways. Currently, however, there is a mismatch between the effort involved in implementing these applications and the benefit they provide. Furthermore, there is a risk that the user loses the understanding of the system and although this is usually not a problem during normal use, it can be problematic if a breakdown occurs. A proposed solution that handles these problems is to use a service oriented architecture and implement applications as composite services and let information about the structure of the composites be available to the user at runtime.

As long as the set of services that constitute the composite is static, traditional techniques can be used to specify the composite. But if the member set is dynamic it is problematic to specify which nodes partake in the composite and how they interact. In this paper we introduce mechanisms for handling membership dynamicity in service composition specifications. We demonstrate how an application scenario developed in cooperation with users can be implemented using the mechanisms and sketch how a decentralised interpretation can be realised.

End-to-end middleware for distributed sensor applications

Nelson Matthys, Sam Michiels, Wouter Joosen, Pierre Verbaeten

Many industrial applications, such as supply chain logistics, may considerably benefit from the use of wireless sensor networks, as their involved logistics services (product tracking, localization, or asset monitoring) require real-time sensor information. However, developing such distributed sensor applications is a complex process, as these applications are distributed in an end-to-end fashion across a huge amount of heterogeneous platforms, and deployed in dynamic operational environments. Therefore, a middleware platform is needed which offers on the one hand generic services and enables the integration of application-specific plugins, while on the other hand offers support for the composition of those services under various scenarios. In this paper, we present the key research challenges in developing and managing distributed sensor applications. We describe the main components of the middleware architecture and show their relation to the identified key challenges. This analysis and design of a middleware architecture is an important step towards using WSNs in a realistic business context.

Using COSMIC – A real world case study combining virtual and real sensors

Michael Schulze, Sebastian Zug

The cooperation of distributed nodes in sensor networks forms a dynamic structure of information providers and information consumers termed as sources and sinks. Often, the used nodes differ by the available performance,

network capabilities, operating system, applications etc. although, all of them have to be integrated in an appropriate network structure. Hence, a middleware is necessary to provide a common communication interface for the network in the whole system to cover the heterogeneity. To enable the integration on different platforms and into different systems the COSMIC middleware itself is designed flexibly and adaptively.

In this paper we present a cross platform case study, which shows the information exchange via COSMIC between microcontrollers and PCs on different network types by C applications and Matlab/Simulink. The case study illustrates, apart from other features, the possibility for an experimental setup combining virtual and real sensors/actuators in the sense of hardware in the loop scenarios.

REFERENCES

- [1] Francois Taiani, editor. *Proceedings of the 5th MiNEMA Workshop*, Magdeburg, September 2007.