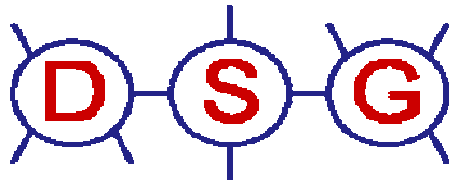
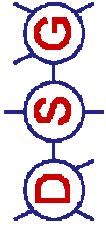


A Service-Oriented Framework Supporting Ubiquitous Disaster Response

MOBILWARE 2009, Berlin April 28-29



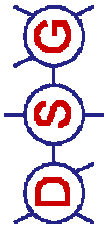
Michele Amoretti, Maria Chiara Laghi, Gianni Conte
Distributed Systems Group – Università degli Studi di Parma



Outline

2-27

- Introduction
 - ▣ Emergency Management & Ubiquitous computing
 - ▣ Novel middleware paradigms
- Technological framework
- JXTA-SOAP middleware component
 - ▣ Standard Edition
 - ▣ Mobile edition
- Application example: Disaster Response
- Conclusions and future work



Introduction

- Emergency Management
 - ▣ preparing for disaster before it happens
 - ▣ disaster response
 - ▣ supporting and rebuilding society after natural or human-made disasters have occurred
- Four key phases:
 - ▣ Mitigation
 - ▣ Preparedness
 - ▣ Response
 - ▣ Recovery





Introduction

- ICT support is very important during the Disaster Response (DR) phase → **Mobile and Ubiquitous Computing**
- State-of-art projects:
 - WORKPAD (funded by the EU)
 - response and short-term recovery: Public Safety Systems (PSS) use computer programs to give instructions to the rescue teams
 - AID-N
 - real-time data communication between three deployed systems: a pre-hospital patient care reporting software system, a syndromic surveillance system and a hazardous material reference software system
 - AELPS
 - agent-based modeling to describe the behaviour of basic elements in an emergency-logistics system



Introduction

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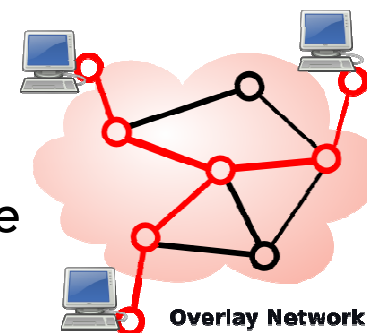
- Starting from the integration of:
 - Service Oriented Architecture (SOA)
 - Interoperability
 - Standards (e.g. Web Services, OSGi)
 - Peer-to-Peer paradigm
 - Flexible and scalable resource sharing
- Novel paradigms for regulating interactions among software entities: *peer-to peer service sharing with self-organization and self-adaptation principles*



Introduction

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- A **peer-to-peer architectural model** defines protocols and policies enabling scalable decentralized applications based on resource sharing among peer participants.
- Services offered by peers are usually **consumable resources**, i.e. resources that cannot be acquired (by replication), but may only be directly used upon contracting with their hosts.
 - ▣ Distributed services (e.g. resource sharing, lookup)
 - ▣ Local services, allowing access to local resources

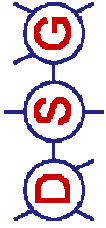




Technological Framework

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- The envisioned framework focuses on the problem of **identifying matching resources in response to disasters**, in particular human resources:
 - ▣ Civil Protection volunteers
 - ▣ Red Cross doctors and medical attendants
 - ▣ Firemen
 - ▣ Policemen and army officers
- Another purpose of our work is **to support back-end operators**, improving the ICT infrastructure that must allow not only communications among actors, but also automated gathering, elaboration and delivery of the huge amount of data collected by each actor.



Technological Framework

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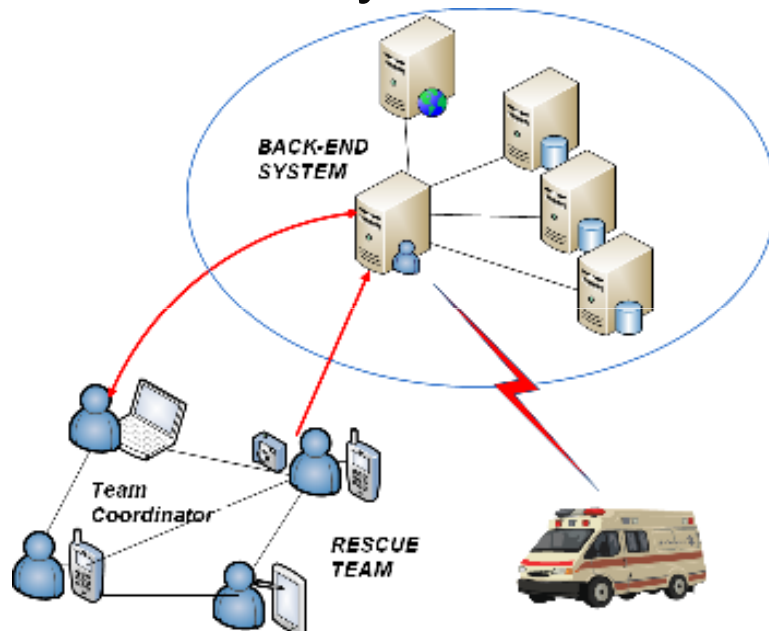
- For example, in case of flooding, first volunteers arriving at the disaster location may notice that some roads are interrupted. If they are equipped with a mobile device including a camera, they may
 - ▣ send short alert messages, including their coordinates obtained by means of GPS/GIS
 - ▣ take and send photos to provide a more detailed description of the environment.
- The back-end system collects and filter these data, and sends useful advices (such as the best route to be followed) to rescue vehicles which are directed to the disaster place.



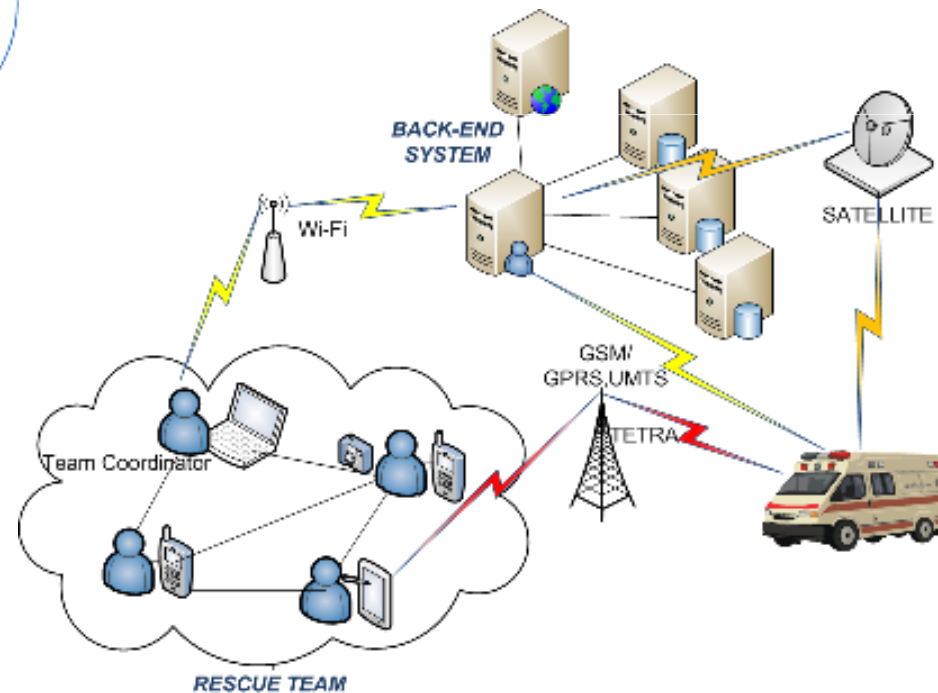
Technological Framework

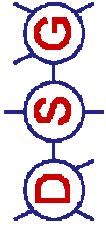
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Overlay Network



Physical Network





Technological Framework

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- A **lightweight middleware** is required in order to enforce this framework to systems that include
 - high performance nodes (e.g. back-end nodes)but also
 - resource constrained devices (e.g. smartphones and PDA carried out by rescuers).



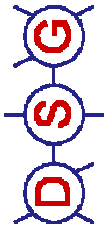
JXTA (by Sun Microsystems)

11-27

- A set of open peer-to-peer protocols
- A middleware (J2SE, J2ME, C/C++/C#)
- Supporting interactions among peers:
 - ▣ Discover each other
 - ▣ Self-organize into peer groups
 - ▣ Advertise and discover *network services*
 - ▣ Communicate with each other
 - ▣ Monitor each other



<https://jxta.dev.java.net>



JXTA-SOAP

12-27

- JXTA-SOAP is a component which extends the JXTA middleware (Java version).

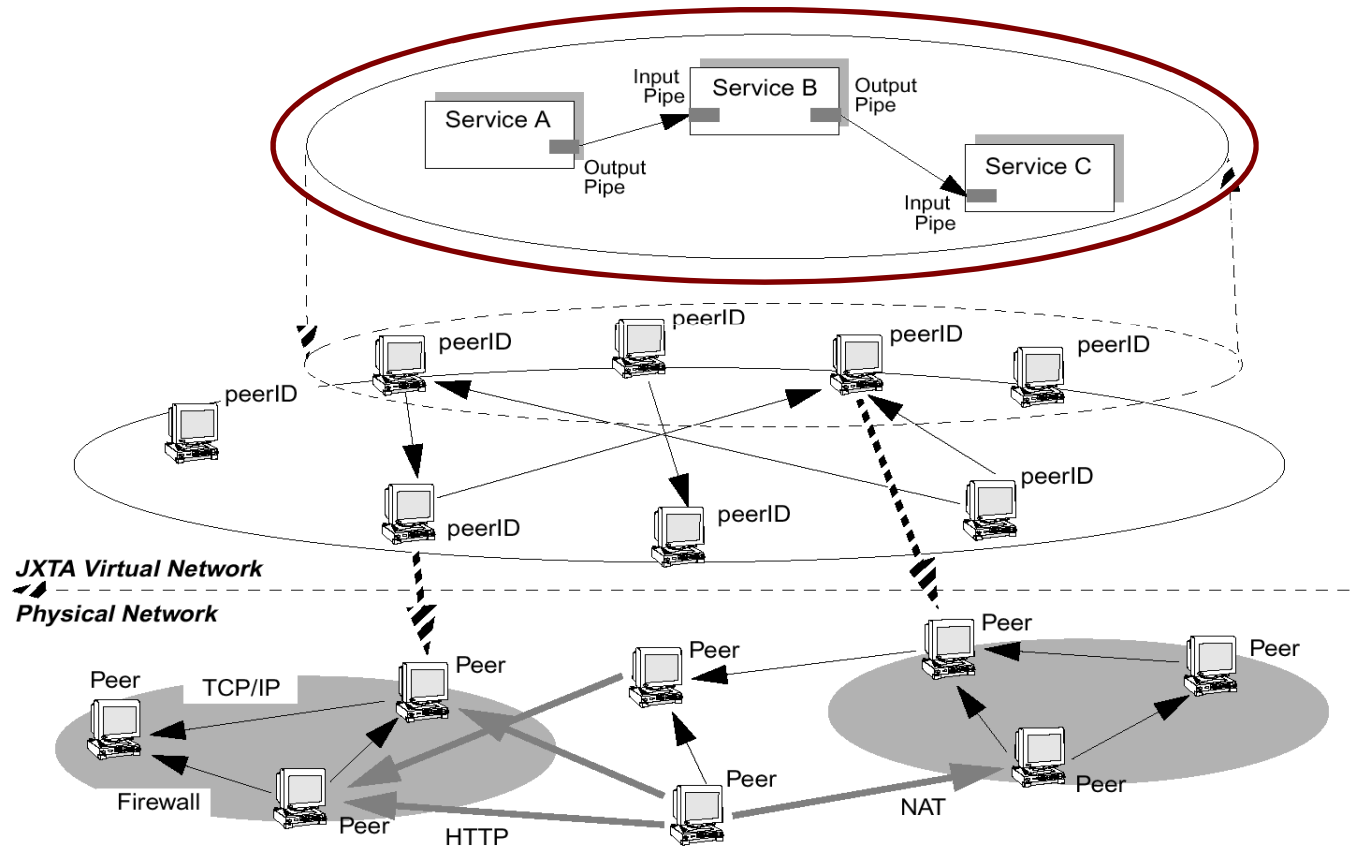
<https://soap.dev.java.net>

- Design goals:
 - ▣ Wrapping Web Services in JXTA services
 - ▣ Using JXTA for Web Service discovery and SOAP message transport
 - ▣ Allowing a vast class of networked devices to communicate and collaborate



JXTA-SOAP

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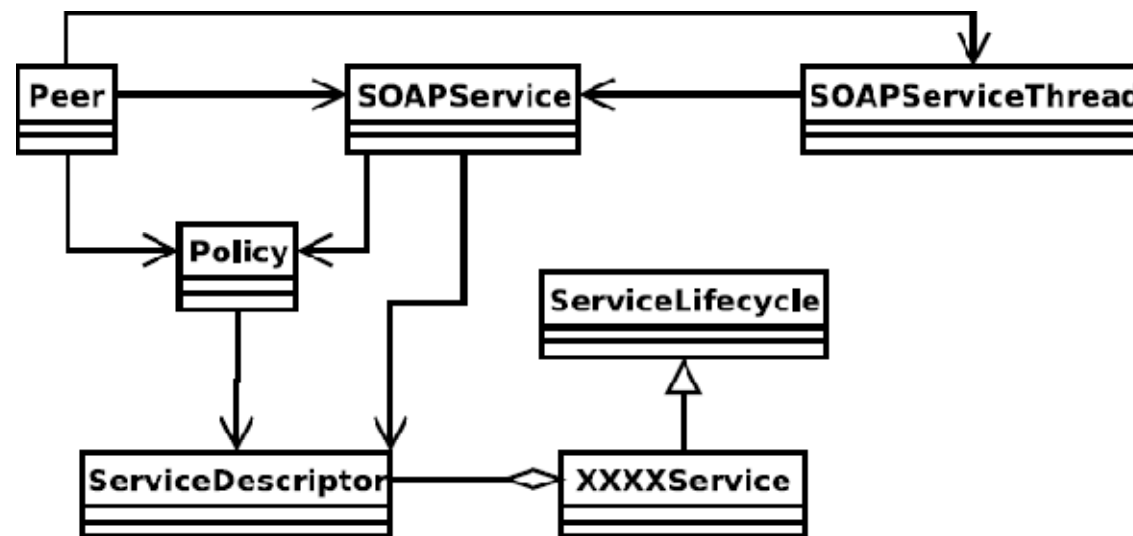




Service deployment

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- In order to deploy its services, a peer has to instantiate and configure the related *SOAPService* objects (one for each hosted service), and to advertise the service interfaces in the network.

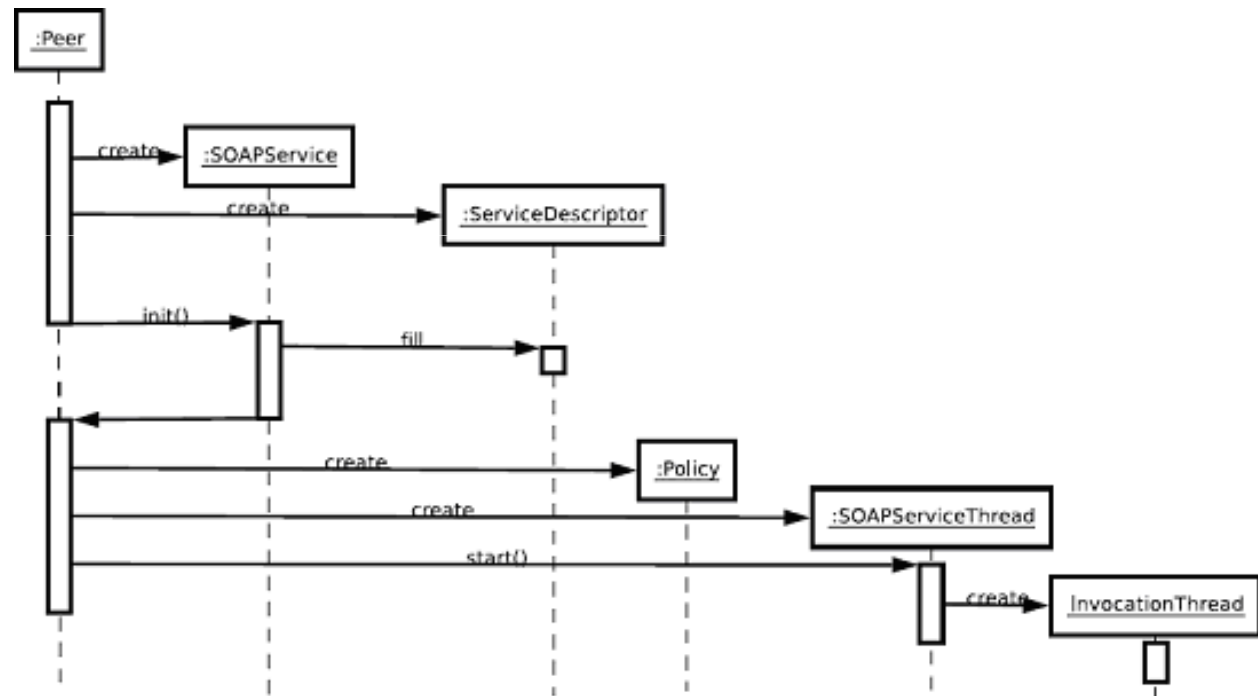


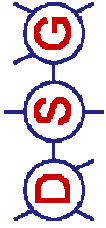


Service deployment

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- A service can be associated to a *security policy*
- Threadpool of invocation threads





Service publication and lookup

16-27

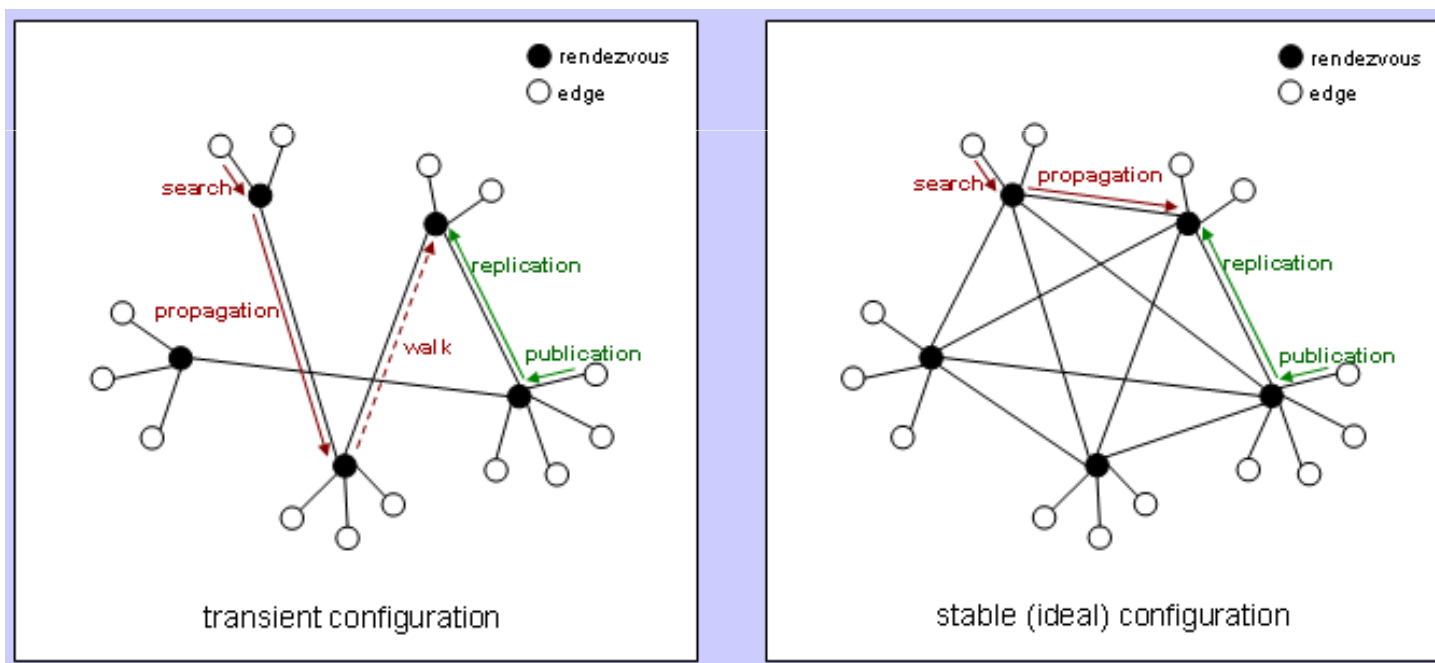
- JXTA-SOAP allows to encapsulate WSDL interfaces in JXTA advertisements
- Service publication and lookup are distributed processes, which use *peer nodes as a distributed repository* (on the contrary, traditional UDDI registries are centralized interface description repositories).



Service publication and lookup

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- Default message routing strategy: **SRDI**
 - Shared Resource Distributed Index (SRDI) of $\langle \text{attribute}, \text{value} \rangle$ pairs extracted from the advertisement, maintained and searched with a DHT+Walker approach.

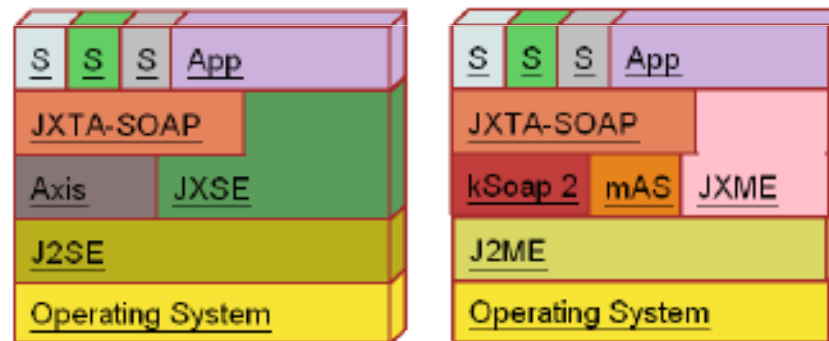




Service invocation

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- SOAP is the most widely used Web Service protocol for message enveloping.
- SOAP message management in JXTA-SOAP is based on **Apache Axis** (J2SE) and **kSoap2 + μ AS** (J2ME).



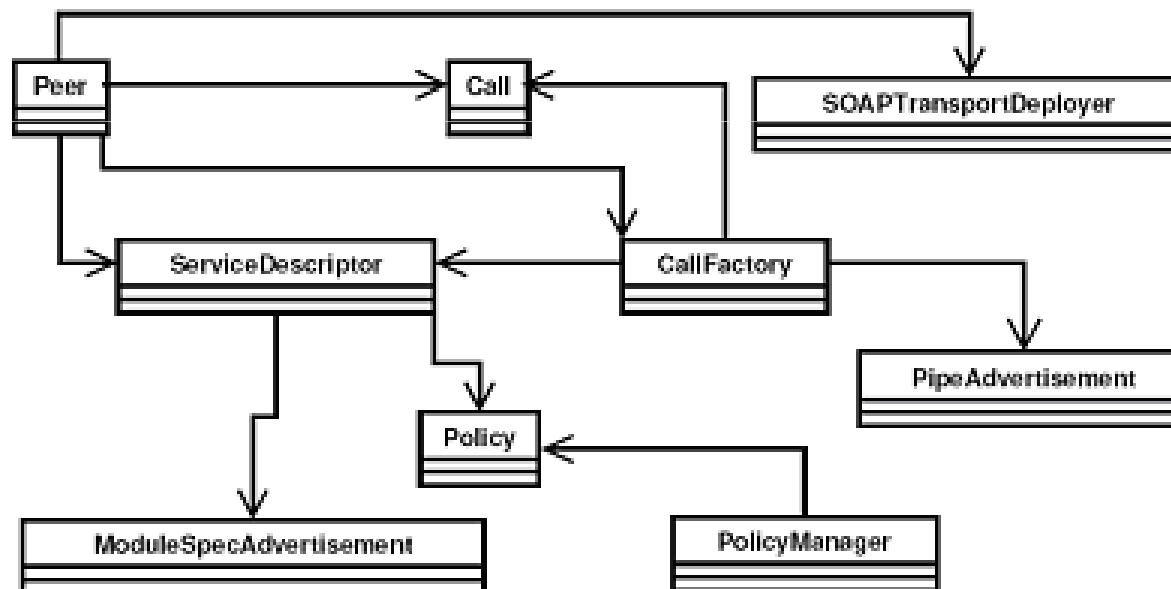
- Instead of URLs as absolute service references, JXTA-SOAP's uses the public pipe advertisement of the service.



Service invocation

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- Associations among classes which are involved in the service invocation task, performed by a generic Peer





Example DR application

- Using JXTA-SOAP mobile, we developed a GUI-based application that allows to join a JXTA-based P2P network to share services for supporting disaster response activities.

- Local services

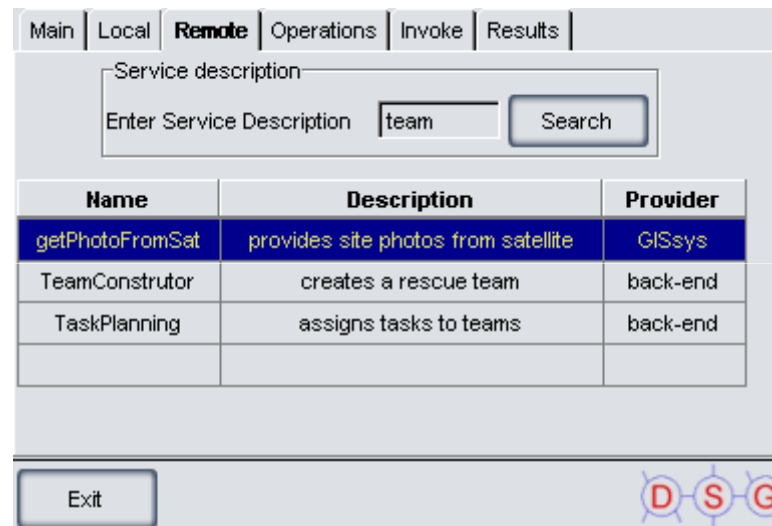
The screenshot shows a GUI window with a menu bar at the top containing 'Main', 'Local', 'Remote', 'Operations', 'Invoke', and 'Results'. Below the menu bar is a table with three columns: 'Name', 'Description', and 'Address'. The table contains three rows of data. Below the table is a 'Share' button, and at the bottom left is an 'Exit' button. The DSG logo is visible in the bottom right corner of the window.

Name	Description	Address
PhotoService	provides photo and site description	LocalOperator
MedicalRequestor	requests for medical support	LocalOperator
TaskManagement	manages tasks completion	LocalOperator



Example DR application

- Remote services

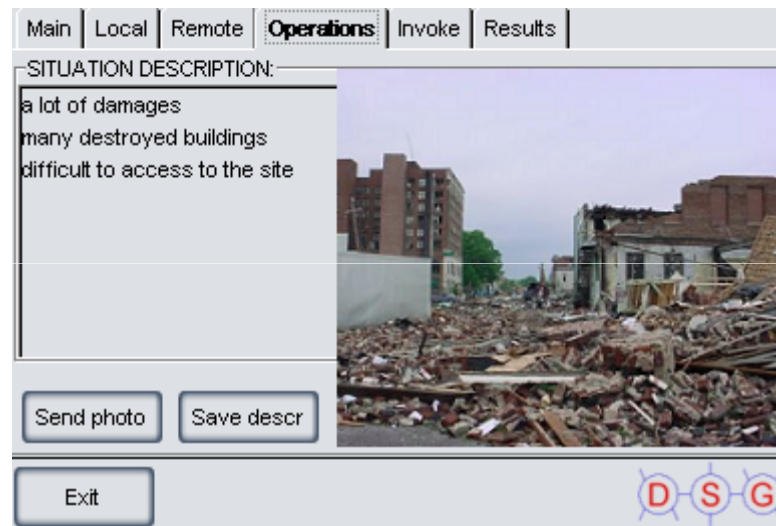


- It is possible to search for services in the P2P network (offered by other rescue operators), and to select one of them from the resulting list, in order to see all the operations it offers.



Example DR application

□ Operations



- A photo of the disaster location is taken, and a short description written, both ready to be sent to the back-end upon request, or proactively by the rescue operator.



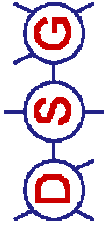
Example DR application

□ Tasks

The screenshot shows a web application interface with a navigation menu at the top containing 'Main', 'Local', 'Remote', 'Operations', 'Invoke', and 'Tasks'. The 'Tasks' tab is selected. Below the menu, there is a section for 'TEAM MEMBER n°1' with a text input field for 'Operator equipment:' and a 'Submit' button. Below this is a table with two columns: 'Assigned tasks' and 'Status'. The table contains three rows of data. At the bottom of the interface, there is a 'Completed' button and an 'Exit' button. The DSG logo is visible in the bottom right corner.

Assigned tasks	Status
Take photos of the road	COMPLETED
Check access for ambulances	COMPLETED
Check for injured people	ACTIVE

- The rescue operator can see its tasks (decided by the back-end) and flag them as executed, when they are



Conclusions and future work

24-27

- JXTA-SOAP as a powerful solution for building service-oriented, peer-to-peer ubiquitous applications to support disaster response activities.
- JXTA-SOAP: standard edition and mobile edition
- Introducing WSRF to provide peers the ability to access and manipulate state, *i.e. data values that persist across, and evolve as a result of Web Service interactions*. This is particularly important for services like Disaster Location Monitoring
- *Location Awareness + Service Mobility*