Peer-to-Peer Resource Discovery in Mobile Grids

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Outline

- Introduction
- Related Work
- MoGrid Middleware
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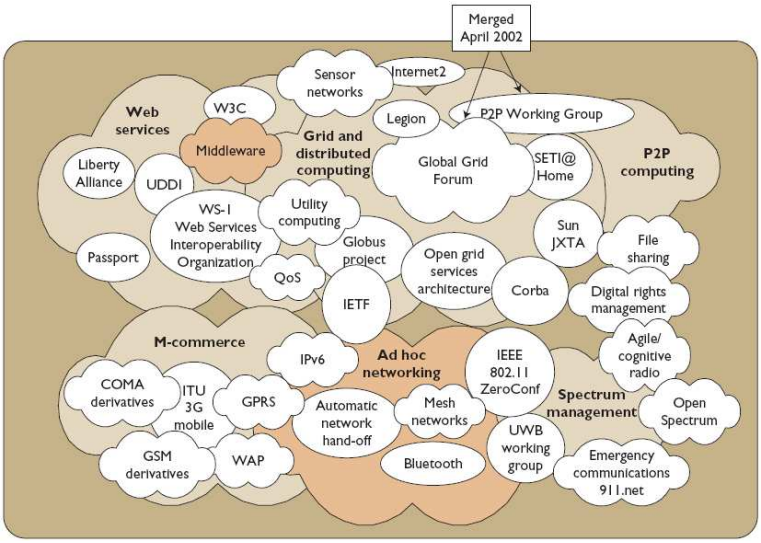
Big Picture



James Howison – Syracuse University
[McKnight, L.W. et al. (2004) "Wireless grids: Distributed resource sharing by mobile, nomadic, and fixed devices", IEEE Internet Computing]

Mobile Grid Project

- **MoGrid builds upon two convergent projects**
  - **MoCA (mobile collaboration)**
  - **Integridade (grid)**
- **MoGrid orchestrates the distribution of grid tasks in a P2P fashion among mobile collaborators in an *ad-hoc* network**

P2P Resource Discovery

Related Work (1/2)

ISAM / GRADEp (http://www.inf.ufrgs.br/~isam/English/)
This project proposes the integration of three main concepts—**context-awareness**, **mobility**, and **grid computing**—in a pervasive computing environment. This environment supports the development of distributed mobile applications that have adaptive behavior.

Kurkovsky et al.
(http://csc.colstate.edu/kurkovsky/ Research/Grid/WirelessGrid.asp)
This project proposes a **grid-based** problem-solving environment for **mobile devices**, which are viewed as **collaborative agents** in a multi-agent system. Such an environment addresses the issues of distribution, coordination, and assembly of complex grid tasks.

Related Work (2/2)

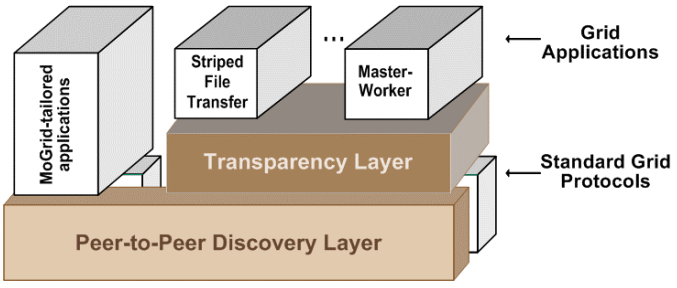
K*GRID (http://gridcenter.or.kr/MobileGrid/)
This project aims at providing a comprehensive research environment for both industry and academia through a nationwide grid in South Korea. K*Grid envisions the use of idle resources in a large number of mobile devices to form **pervasive mobile grids**.

AKOGRIMO (http://www.mobilegrids.org/)
This is an European-funded project aiming at architecting and prototyping a next generation grid (NGG) based on **OGSA**. AKOGRIMO focuses on devising novel grid applications over evolving **mobile IPv6**-based infrastructures. The domain of such applications range from e-health, through e-learning, to disaster handling and crisis management.

MoGrid
MIDDLEWARE

MoGrid Architecture

- P2P Discovery Layer (P2PDL)
  This layer allows **resources to be discovered** among the participating devices according to their resource availability and their willingness to participate
  - **Tasks are submitted to selected participants through standard grid protocols (e.g. GridFTP)**
- Transparency Layer (TRANS)
  This layer **masks issues related to irregular connectivity**—which is inherent to mobile environments—during resource discovery and task submission



P2P Discovery Layer

- **Discovery API**
  - Operations for **registering** and **discovering** resources

```
resID = register( resourceDescriptor )
deregister( resID )
reqProfile = createRequestProfile( ctxtInfo, numMaxReplies, maxReplyDelay )
repList = discover( resourceQuery, reqProfile )
```

- **Discovery Entities**
  - **Collaborators** are available to run grid tasks
    - **Monitors** collect context device information (ctxtInfo)
    - **Context Listeners** process ctxtInfo to deduce the resource availability of devices
  - **Initiators** submit application requests for task processing
  - **Coordinators** select the most suitable collaborators based on initiator requests for resource discovery
- **P2P Discovery Protocol (P2PDP)**
  - A **resource discovery** mechanism for **ad-hoc** mobile grids

P2PDP Messages

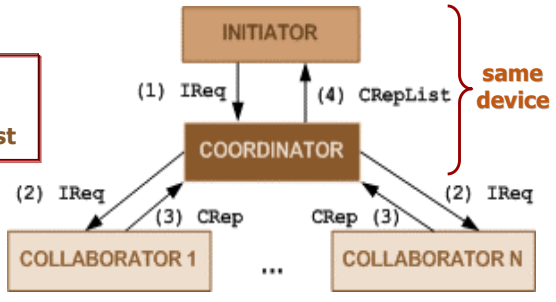
(1) IReq messages inform the **resource profile** requested by an initiator

(2) The coordinator distributes the IReq messages to collaborators

(3) Each collaborator replies with a CRep message declaring its **resource availability** according to the initiator´s resource profile (IReq message)
- **Monitors and Context Listeners help collaborators to determine their resource availability**

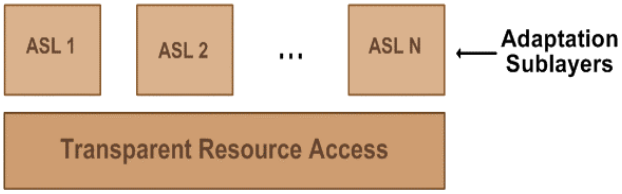
(4) The coordinator sums up **selected replies** from collaborators in a CRepList message, which is sent to the initiator

IReq	**Initiator Request**
CRep	**Collaborator Reply**
CRepList	**Collaborator Reply List**



TRANS: Transparency Layer

- Transparent Resource Access Sublayer (TRAS)
  This sublayer handles periods of (voluntary or involuntary) disconnection during the task submission or execution
- Adaptation Sublayers (ASLs)
  These sublayers provide application-independent transparency mechanisms for resource utilization. Their main purpose is to **handle mobility and connectivity-related events** in a way that it is more adequate for each type of grid application

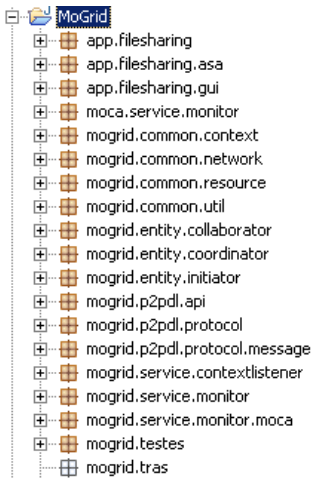


IMPLEMENTATION

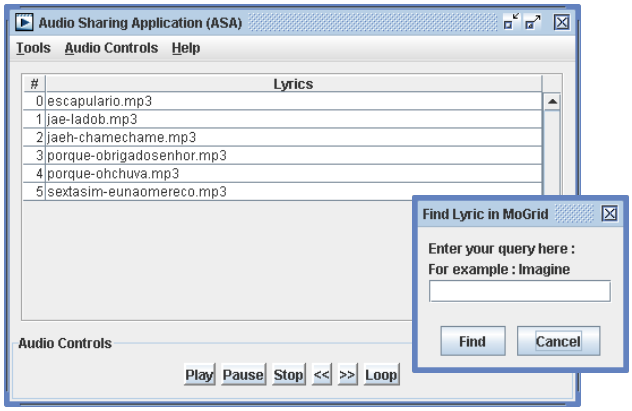
Implementation

- IP Multicast groups
  P2PDP messages exchanged between coordinators and collaborators are sent through IP multicast group address
- Reference implementation platform: CDC/J2ME
  CDC profiles are largely based on J2SE 1.3.1
- Reply Timer
  - Determine **how fast** a collaborator **will reply** to the initiator request
  - It is set based on the **suitability** of the collaborator **to participe** in an initiator requested task
    - **Timeout inversely proportional to the suitability of each collaborator**
    - **The first replies supresses additional replies, reducing the amount of P2PDP messages exchanged among devices**
- Monitor Service: "borrowed" from MoCA implementation
  The MoCA monitor is deployed as a daemon running on each mobile device, being responsible for **collecting state information** such as RF signal strength, energy level, CPU usage, and free memory

Example Application



- ASA Discovery API (Adaptation Sublayer):
  - `registerFile()`
  - `deregisterFile()`
  - `getFile()`



Notebook GUI using J2SE

Discussion

- This work corresponds to an **initial stage in the effort to develop a fully-fledged mobile grid middleware architecture**. A central point that we envision as needing further developments is the description of resources. Currently, there is no standardized support for such descriptions in our implementation, which are left completely to the application. To address this issue, we plan to use an XML-based resource description language.
- Other future work will involve the implementation of proxies that allow devices in **mobile grids to interoperate with conventional grids**. We are starting to investigate such integration through the use of Globus components.
- A key aspect not covered in our implementation is **privacy and trust establishment**. Social relationships based on reputation mechanisms have constantly been pointed out as a possible solution to this problem.

Conclusions

- ✓ In this work we have proposed a middleware architecture that allows the **collaboration among devices in a mobile grid**.
- ✓ Central to the proposed architecture is a **P2P resource discovery protocol**. We have implemented a prototype of the architecture and also a simple test application to evaluate the correctness of the protocol and to trial some main features of the design, such as the criteria for collaboration suitability.
- ✓ Fundamentally, P2PDP helps in coordinating such a distribution among the **most suitable** (i.e. resourceful and available) mobile devices, while **mitigating the overhead of control messages** exchanged among them.
- ✓ We are aware of the need for conducting more comprehensive experiments to **evaluate the performance and scalability of our approach**. One specific problem that we plan to tackle in the context of the transparency layer is the **migration of tasks among collaborators**, for example when a device infers that it is losing connectivity with a mobile grid.

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