ICT INFRASTRUCTURES FOR COLLABORATION
= Overview of approaches =

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BASIC NEEDS

- Information exchange
- Information sharing
  - Common workspaces
- Safe communications
- Coordination
- Collaboration support services
Support services consist of (vertical) application tools above the horizontal ICT infrastructure.

- Plays the intermediary role as the enabler of interoperation among organizations and support services involved in the VO.
- Base enabler for safe and coordinated interactions among the VO members.
- Plays the role of VO "operating system" or executor, hiding the details of the collaborative network "machinery."

Why separating them?

- Different purpose
- Different actors
- Different business models
Fast evolution of ICT technologies with reduced life cycles and the need to cope with technologies with different life cycles and at different stages of the corresponding life cycle represent a major difficulty.

Enabling and disabling technologies? => some efforts are too biased by short-term technologies, which might represent an obstacle for non-ICT SMEs.

TCP/IP, CORBA-IOP, HTTP, RMI, SOAP
J2EE Framework, CORBA Framework, ActiveX Framework EJBs, OAG and
OMGs Business Objects and Components
UML, UEML, WfMC XML-based Business Language
JDBC, WfMC, OMG-JointFlow, XML-WfMC standards
ODBC, JDBC, FIPA, OMG-MASIF, Mobile Objects
JMS, MS-Message Server, MQSeries, FIPA-ACC
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TRADITIONAL LAYER-BASED INTEGRATION

Safe communication
Information exchange
& sharing
Coordination

PRODNET example
1999

VE INFRASTRUCTURE EXAMPLE - PRODNET

Communication
Infrastructure
**FEDERATED INFORMATION MANAGEMENT**

- Intra-enterprise information
- Inter-enterprise information exchange
  - Federated cooperative architecture
  - Provision of access rights
  - Preserving the security/visibility of shared data

**FEDERATED DB SCHEMA MANAGEMENT**

- Several schemas represent every federated node
  - **local schema**: models the data stored locally
  - **import schemas**: model information accessible from other nodes
  - **export schemas**: model information that the node wishes to make accessible to other nodes
  - **integrated schema**: represents a coherent view on all accessible local and remote information

- Federated cooperative architecture (no data-redundancy, no centralization of data/control)
- Provision of access rights based on individual role of every other enterprise
- Preserving the security/visibility of shared data through the export schema management
**SAFE COMMUNICATIONS**

<table>
<thead>
<tr>
<th>PCI</th>
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<tr>
<td>PICM</td>
<td>SECURITY</td>
</tr>
<tr>
<td>PRODNET Intelligent Communication Manager</td>
<td>Message Class Identifier</td>
</tr>
<tr>
<td>Multi Protocol Access Control</td>
<td>Web Proxy</td>
</tr>
<tr>
<td>TCP/IP</td>
<td>SMTP/POP3</td>
</tr>
</tbody>
</table>

**SECURITY**

- Symmetric and Asymmetric **Cryptography**
- **Authentication** based on Signed Certificates
- Follows Security (emergent) Standards
- **Digital Signature** & Certificate Management
- Tunable Security Level

**LOCAL COORDINATION**

- Graphical Workflow Editor
- WPDL

**PRODNET example**
**Key facets:**
- Safe communications
  - Cryptography, symmetric & asymmetric keys, digital signature, certificates
  - VPN
- Information sharing and exchange
  - Distributed/federated information management
  - Specification of access rights / visibility
- Workflow-based coordination
- Standards for exchange of some classes of information
  - EDIFACT, STEP
  - More recently XML based structures
- Various approaches for remote objects & services access
  - RPC, CORBA, RMI, EJB, Jini

**Current limitations:**
- No common reference model
- Need to integrate different technologies (from different vendors)
  - Technical complexity
  - Unclear responsibilities
- Infrastructure is complex, difficult to configure and poor interoperability
- Limited support for distributed business process management
- Limited mechanisms for tracking and auditing

**SERVICE ORIENTED APPROACHES**

![Diagram showing service-oriented approaches](Image)
SOA - EXAMPLE

General model

Portals

CNOs vertical services

Platform Independent Services

Horizontal Services

Human Collaboration services

Knowledge Sharing services

BP Interoperability services

Basic Services

User’s Representative Management Services

QoS Management Services

Services Behaviour Management Services

Services Management Services

Services Brokerage Services

Reporting Management Services

Knowledge Management Services

Users Interface Management Services

Resources Virtualization Management Services

Platform Specific Services

Legacy Systems Services

ECOLEAD

An implementation

SOA - EXAMPLE

ECOLEAD
Key facets:
- Basic architectures for service federation
- Mechanisms for remote service invocation
- Preliminary standards for service description, cataloguing, invocation: UDDI, WSDL, SOAP, ...
- Basic service search mechanisms
- Preliminary mechanisms for Value Added Service composition

Current limitations:
- Poor integration of service federation and VO concept ... Mostly e-B, B2B
- Poor integration of security / privacy mechanisms
- Search mechanisms still too basic
- Ad-hoc concept of portal
AGENT-BASED APPROACHES

Enterprises modeled / represented by agents
CNO -> MAS

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Facilitator-based agent federation

- **Facilitator** agents provide communications between a local collection of agents and remote agents through:
  - Routing messages to appropriate destinations (via other facilitators)
  - Translating incoming messages for the local agents

- **Local agents** give up part of their autonomy to facilitators and in turn the facilitators satisfy their requirements.

- **Local agents** use a restricted subset of an ACL to inform Facilitators about their needs and offerings

- **Facilitators** use this information as well as their knowledge of the global MAS network to transform local agents’ messages and route them to other facilitators
BROKER-BASED AGENT FEDERATION

Brokers are agents similar to facilitators, but with the following differences:

- Support some additional functions such as:
  - monitoring
  - notification

- Any agent may contact any broker in the same system for finding service / information agents necessary for a particular task

  - While a facilitator is only responsible for a designated group of agents

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SOME MAS PLATFORMS

Examples

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<tr>
<th>Platform</th>
<th>Java Based</th>
<th>Open Source</th>
<th>Arch. &amp; ACL</th>
<th>Inference</th>
<th>User Friendly</th>
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Table 7 – Survey of MAS development platforms

Large number of open source platforms

The use of MAS in VO projects is increasing

Most platforms still suffer from lack of robustness and proper security mechanisms to operate in a VO environment

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in elderly care

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TeleCARE APPROACH & TECHNOLOGIES

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TeleCARE APPROACH

Value-added services

TeleCARE Platform

Intelligent home appliances
Sensors / monitoring devices

Ubiquitous computing
Networking

Interoperability
Sharing
Openness
Adaptability

CORE MAS INFRASTRUCTURE

Platform for distributed, remote supervision

TeleCARE Community

Vertical Services

Basic Platform

Mobile / Stationary agents
Federated information management
Multi-level security
Flexible addition of new resources
Also applicable in other domains

Core MAS Platform Level

Platform Manager
Agent Factory
Resources Managers

Inter-platform Mobility
Agent Reception & Registration
Agent Exit Control

Basic Multi-Agent Platform
Persistance Support
Ontology Manager
Inference Engine

Resource Catalog Manager
Federated Information Management
Ontology-based Schema generator
Federated Query Processor

External Enabler Level
Safe Communications infrastructure
Devices abstraction layer

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Key facets:
- Support for VE creation
  - Partner search and selection based on negotiation
  - Virtual market places and brokers
  - Preliminary steps towards e-contracting
- Some support for VE operation
  - Dynamic scheduling functions
  - Combination of inter-agent communication and federated information management
  - First steps in contract management

Current limitations:
- There are many development platforms for MAS, namely some FIPA compliant (e.g. JADE, FIPA OS) but they are not robust enough when operating over Internet
- Security and persistence mechanisms are not yet well integrated with MAS
- Lack of integration between AI and BP communities (e.g. there is a need to integrate ACL with BP languages)
- Developments mostly at prototype level; real demonstration cases missing

FEDERATED DB APPROACH AND MAS

Example:
MASSYVE — applying MAS and Federated databases to scheduling

- A MASSYVE agent (enterprise) has a tandem architecture:
  - a HOLOS agent and its FIMS component
- Interoperation of the HOLOS agent and its FIMS layer is transparent to the other agents in the community
MASSYVE – applying MAS and Federated databases to scheduling

Exchanging information via the “Pull strategy”
1 Agent-B informs Agent-A about the availability of order_status
2 Agent-A queries this info from its integrated schema at FIMS-A
3 FIMS-A access FIMS-B using federated query mechanisms
4 is the response to this query
5 FIMS-A returns the info to Agent-A

Remote Operation & e-Science

Key facets:
- Various mechanisms to connect equipments to the web
- Application of mobile agents to increase autonomy and independence of network characteristics
- First attempt to use GRID as a general infrastructure for resources management
- Preliminary mechanisms for collaborative experiments management
- Specialized tools for data visualization and data mining
- First attempt for heterogeneous data integration for multi-disciplinary research

Current limitations:
- Limited integration of access rights/visibility mechanisms
- The “business perspective” including intellectual property rights is not addressed yet in this context
- Lack of extensive and robust demonstration cases
- Poor understanding of cooperation processes
- Poor error recovery mechanisms

Internet of Things
RFID
As a parallel and distributed system, grid computing (or the use of a computational grid) is applying the resources of many computers in a network to a single problem at the same time - usually to a scientific or technical problem that requires a great number of computer processing cycles or access to large amounts of data.

... Nowadays GRID seems to be an attempt to “catch all” ideas from other areas (SOA, Collaborative Networks, etc.)

**Globus Toolkit** is an open source software toolkit used for building grid systems and applications.
GLOBUS TOOLKIT

Globus Toolkit® version 4 (GT4)

- Community Scheduler Framework
- Grid Telecontrol Protocol
- VOMDS
- WS Core
- Java WS Core
- C WS Core
- Python WS Core
- Grid Resource Allocation & Management
- Monitoring & Discovery (MDS)
- C Common Libraries
- GridFTP
- Grid Resource Management
- Replica Location
- Pre-WS Authentication Authorization
- Deprecation: not supported, will be dropped in a future release
- Core: GT Component: public interfaces frozen between incremental releases; best effort support
- Contribution: Tech Preview; public interfaces may change between incremental releases

Support Service

Implementations: ebXML, RosettaNet, BizTalk, ...

MAS

INTERCHANGE INFRASTRUCTURES

B2B: Grid, Oceano ...
Origin of the term:
“Comes from the early days of the Internet where we drew the network as a cloud... we didn’t care where the messages went... the cloud hid it from us” – Kevin Marks, Google

SaaS
Software as a Service
PaaS
Platform as a Service
IaaS
Infrastructure as a Service

Jiaheng Lu, 2009
CLOUD COMPUTING

Size of clouds and overlap shown is not to scale
Source: Gartner (July 2008)

HYPE CYCLE FOR EMERGING TECHNOLOGIES

Plateau reached in:
① <2 years ② 2-5 years ③ 5-10 years △ >10 years

Source: Gartner, July 2008