

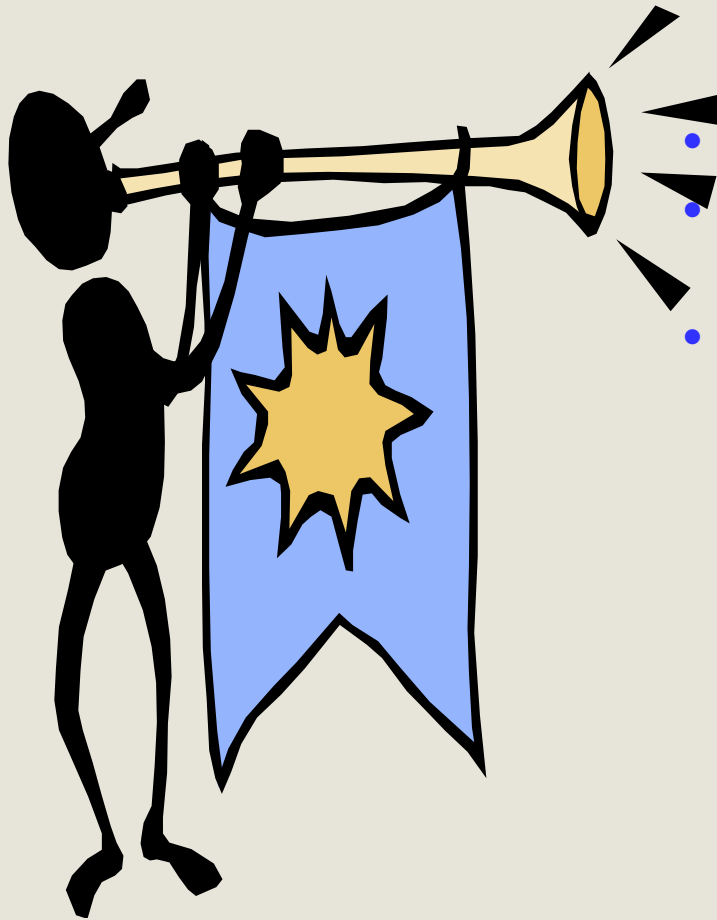
Mobile Agent - Based Architectures

INSE 7110 – Winter 2005

Value Added Services Engineering in Next Generation Networks

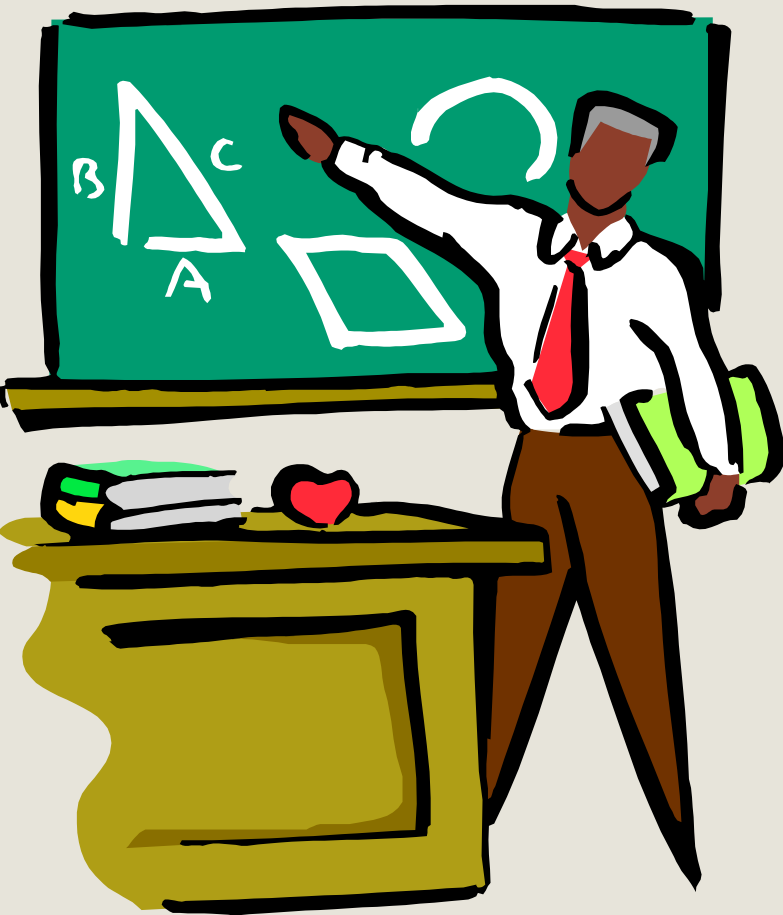
Week #12

Outline



- Mobile code basics
- Mobile agents for meeting “hard to meet” requirements
- Mobile agent based - services

Mobile code Basics (based on reference [1] – Fuggetta et al.)



1. Mechanisms ...
2. Mobile code classification
3. Expected benefits for service architectures

Informal definition of code mobility ...

Capability to dynamically change the binding between code fragments and the location

- Not really new – Examples from the “past”
 - Batch job submission
 - Postscript for controlling printers
 - Process migration ...

A virtual machine for code mobility ...

Execution Units (EU)

- Code segment
- State
 - Data state
 - Execution state

Resources

- Can be shared by several Eus (e.g. files)

Computational environments: Host execution units and resources

Mobility mechanisms ...

Strong mobility ...

- Migration of code segment and state
- Very rare in practice

Weak mobility ...

- Migration of code segment without state
- More common

Mobile code classification ...

Remote evaluation ...

- Code segment at site A, but resources at site B
- Site A ships code segment to site B where it is locally executed
- Site B sends back result to site A

Code on demand ...

- Resource at site A, but code segment at site B
- Site A downloads code segment from site B
- Site A executes code

Mobile agent ...

- Code segment at site A, resources scattered over site A and possibly many other sites (e.g. B, C, D ...)
- Site A executes code, then carry (intermediate results if any), then move to B, executes code there, then carry (intermediate results if any), then move to C, D and so on ..

Mobile code classification ...

More on mobile agent ...

- Autonomous and identifiable program
- Can migrate between physical nodes (e.g. have an itinerary)
- Not necessarily intelligent (could be very smart or mentally impaired)

Platform

- Environment for mobile agent execution
- Key enabling technology: Java
- Examples: Jade, Grasshopper

Expected benefits in general ...

Examples of benefits generally associated with mobile code

...

- Scalability
- Customization
- Flexibility
- Reduction of network load (specific to mobile agent)

Expected benefits in service engineering ...

Beyond scalability ...

1. Hard to meet service engineering requirements

- Universal access

- How can end users have access to their services with the same look and feel wherever they roam?
- Mobile agents could carry these services and follow end users.

- Tailored services

- Each end user can have her/his own mobile agent carrying her/his customized services

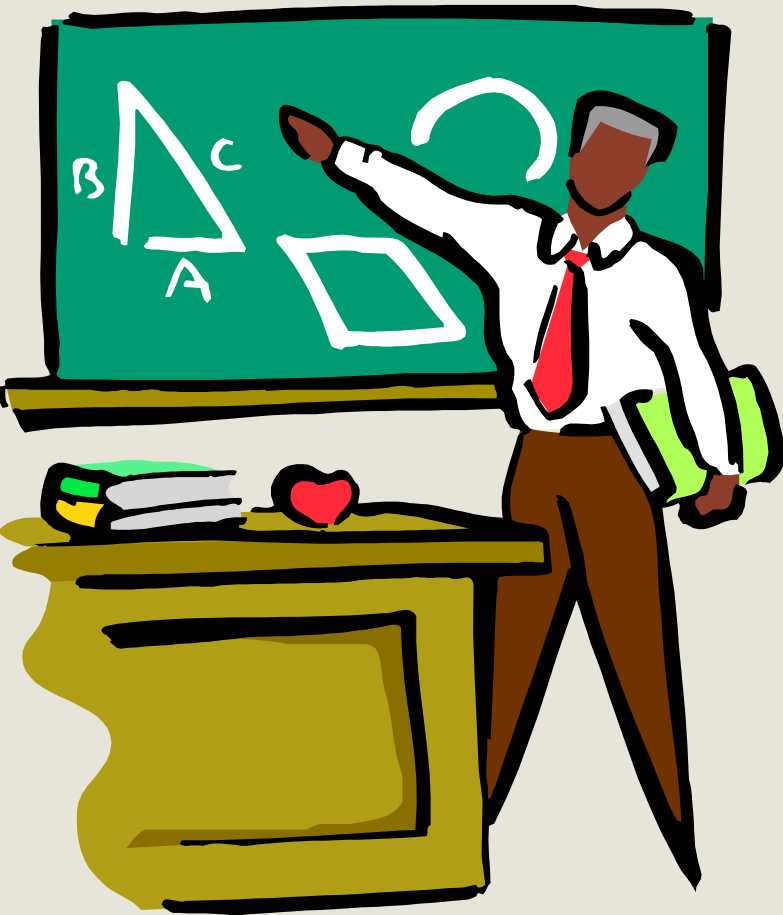
2. Reduction of network load / response time / CPU consumption at client side for some classes of services

To probe further ...

- A. Fuggetta et al, Understanding Code Mobility, IEEE transactions on software engineering, Vol. 24, No5, May 1998
- D. Chess et al., Mobile Agents: Are They a Good Idea?, IBM Research Report, RC 19887 (88465), 1994
- A. karmouch and V. A. Pham, Mobile Software Agents: An Overview, IEEE Communications Magazine, July 1998, Vol.36, No7

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Mobile agents for meeting hard to meet requirements



1. Netchaser

- Marita

Netchaser ...

Universal access with Netchaser ...

Possibility for the user to access her/his services from any terminal in the network while maintaining her/his own environment settings

- Mobile agents as wrapper layer between internet clients / servers and the network
- Follow end-users when end-users change terminals

Netchaser ...

Universal access with Netchaser ...

Examples of servers

- Information servers (handle services such as email, FTP)
- Proxy servers (bridge user workstations and information servers)
- User servers (Store user profiles)

Netchaser ...

Universal access with Netchaser ...

Examples of static management agents

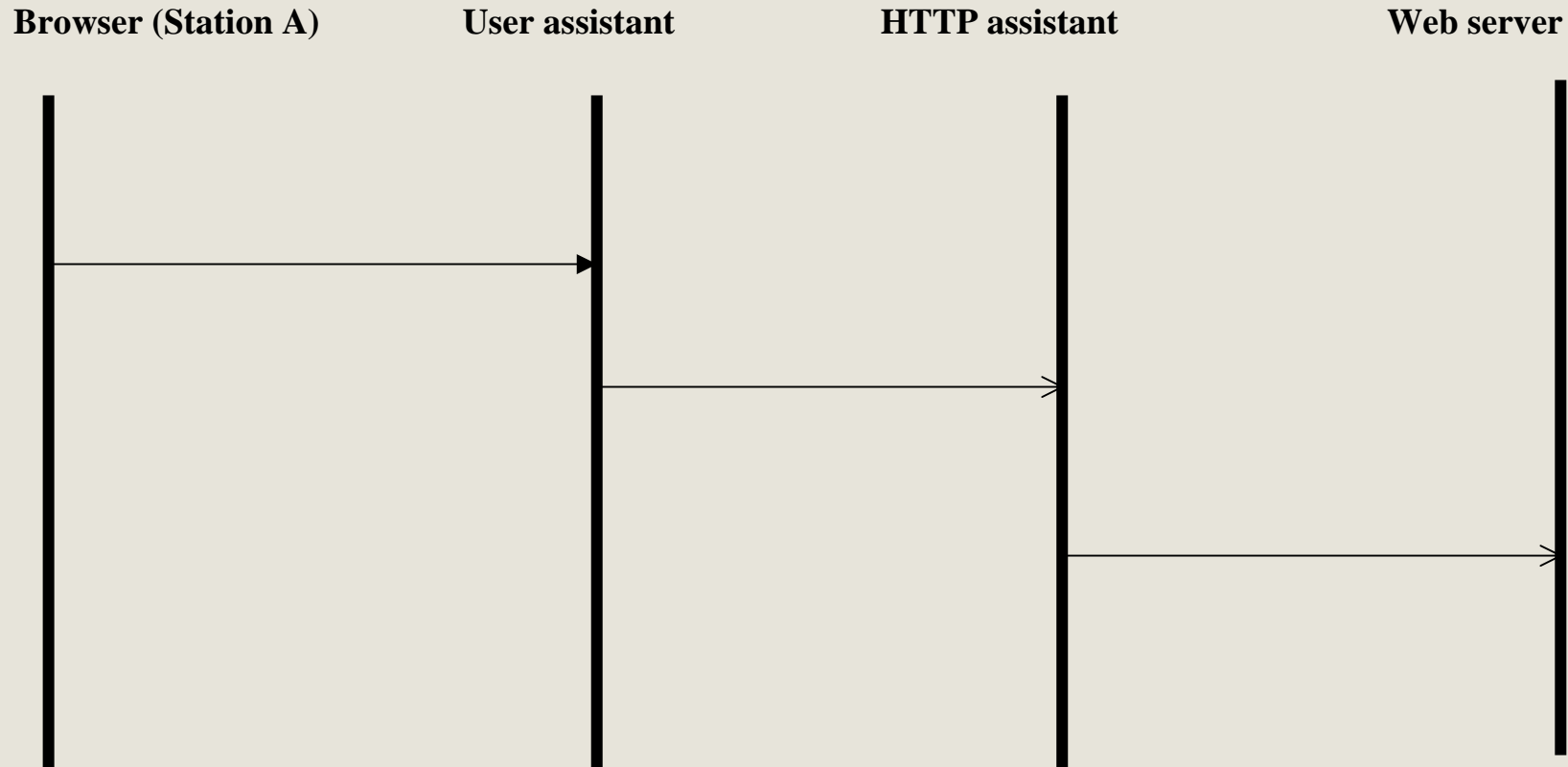
- User assistant (interface between the browser and Internet)
- User profile managers

Examples of mobile agents

- HTTP assistant and Mail assistant
 - Run on proxy server nearest to the host station and maintain working session status

Netchaser ...

User logs in Netchaser at station A



Netchaser ...

User logs in Netchaser at station B ...

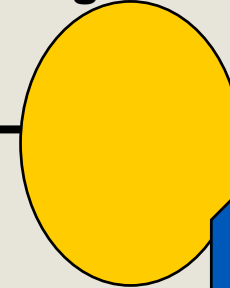
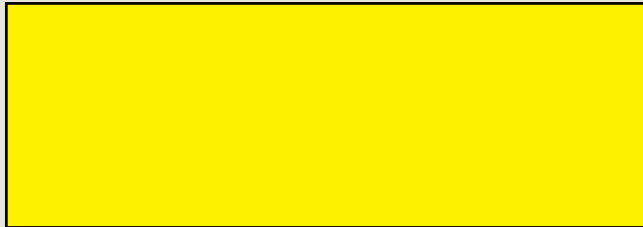
HTTP assistant moves to the proxy nearest to station B, with the following:

- Recently accessed URLs
- Cached copies of visited Web pages
- Copies of cookies ...
- User profile managers

MARITA

Service Creation Unit (SCU)

Subscription Management Unit (SMU)



MA Platform

Mobile service agent



Mobile service agent



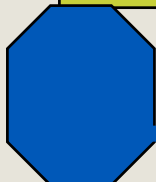
TERMINAL

SIP server/
H.323 GK

Mobile service agent



MA Platform



MA Platform

MARITA ...

MARITA

Mobile service agent (MSA)

- Act as folder and carry services (or pointers to services)
- Can carry one or several service(s) depending on instantiation
- One or several per subscriber(s) depending on instantiation

Service Management Unit (SMU)

- MSA life cycle management
(creation, upgrading, adaptability to host)
- Subscriber life cycle management

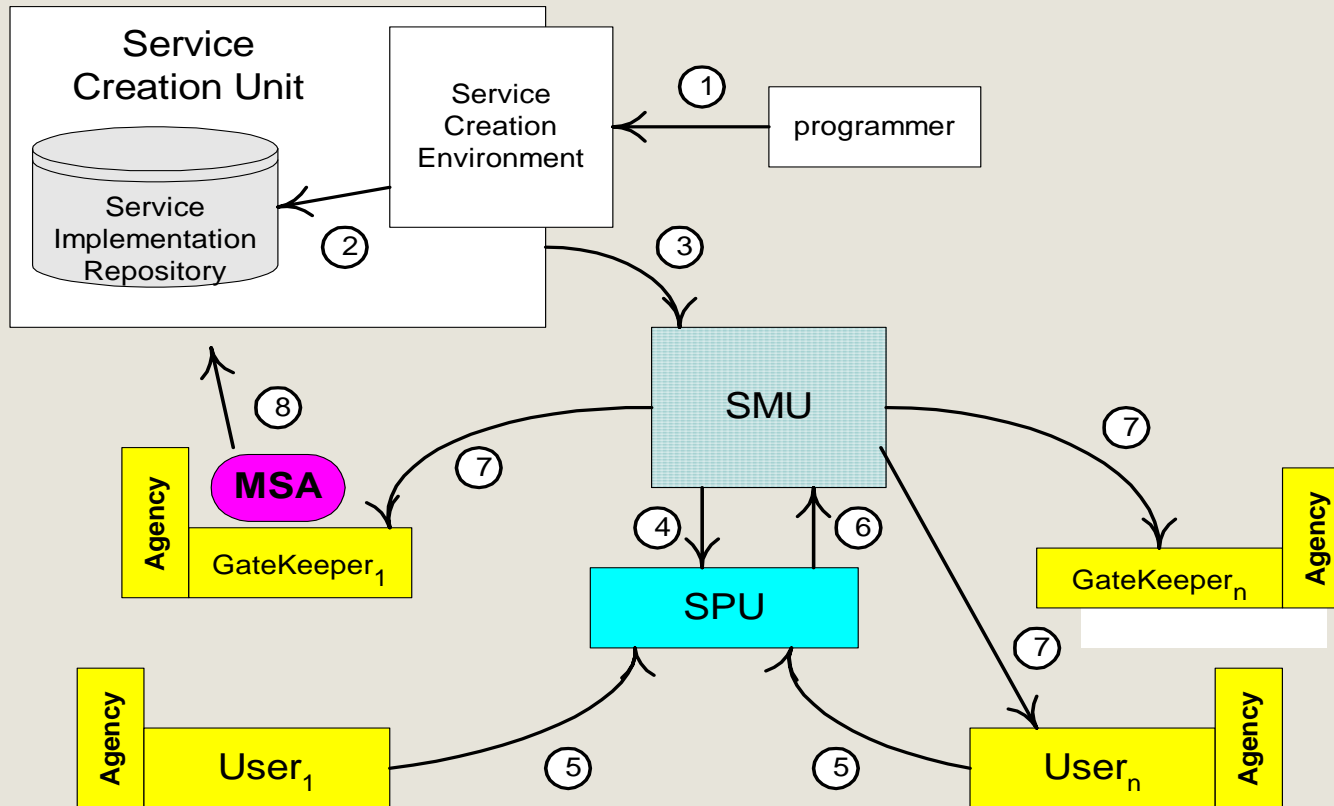
MARITA

MARITA

Service creation unit (SCU)

- Services could be implemented using the service creation paradigms of existing architectures (e.g. CPL, SIPLETS, SIP CGI)
- Services could be implemented using mobile agents or any other service creation paradigms that may emerge.

MARITA ...



To probe further ...

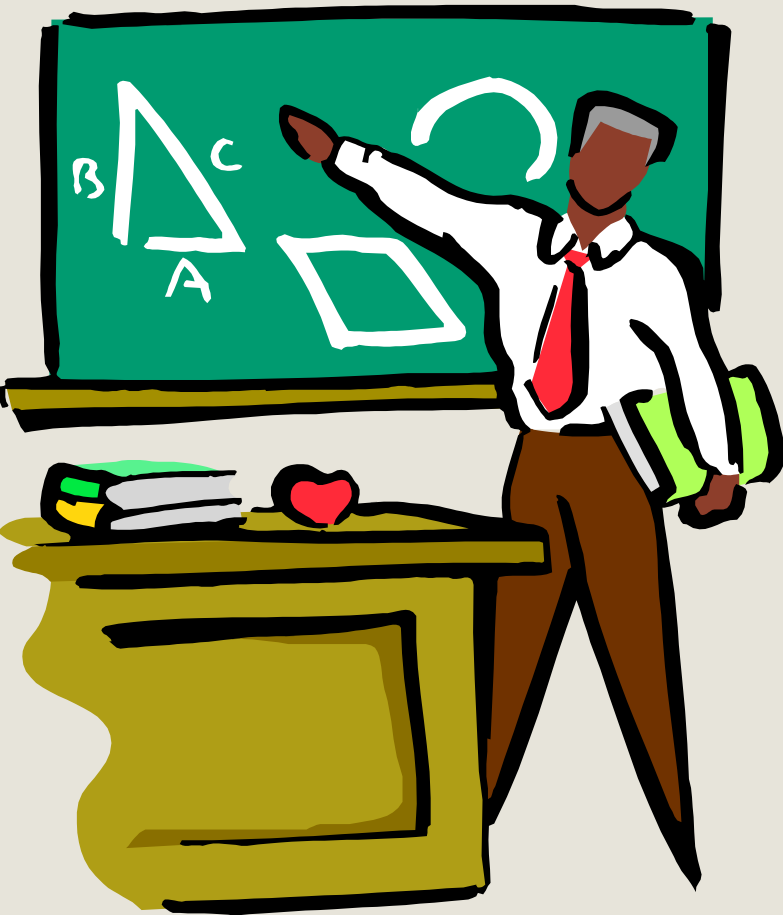
On mobile agent based service architectures

- D. Stefano and C. Santoro, Agent support for personal mobility, IEEE Internet Computing, Vol.4, No2, March/April 2000, pp. 74-79
- B. Emako, R.H. Glitho and S. Pierre, A Mobile Agent based Advanced Service Architecture for Wireless Internet Telephony: Design, Implementation and Evaluation, IEEE Transactions on Computers, Vol. 52, NO. 6, June 2003

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Mobile agent Based Services



A Case Study

Mobile agent based services ...

Mobile agent infrastructure could be used to develop services as mobile agents –

Expected benefits

- Performance
- Easy customization
- New types of services?

A sample of services

- Search engines
- Telemedicine
- Weather forecast

Issue

- Performance evaluation usually biased in favour of mobile agents

A Mobile agent based service ...

Multiparty event

- events involving more than 2 persons
 - Social events: (e.g. family gathering)
 - Business events (e.g. face-to-face meetings)
 - Electronic multiparty sessions (e.g. teleconferences)

Multiparty event scheduling: State of the Art

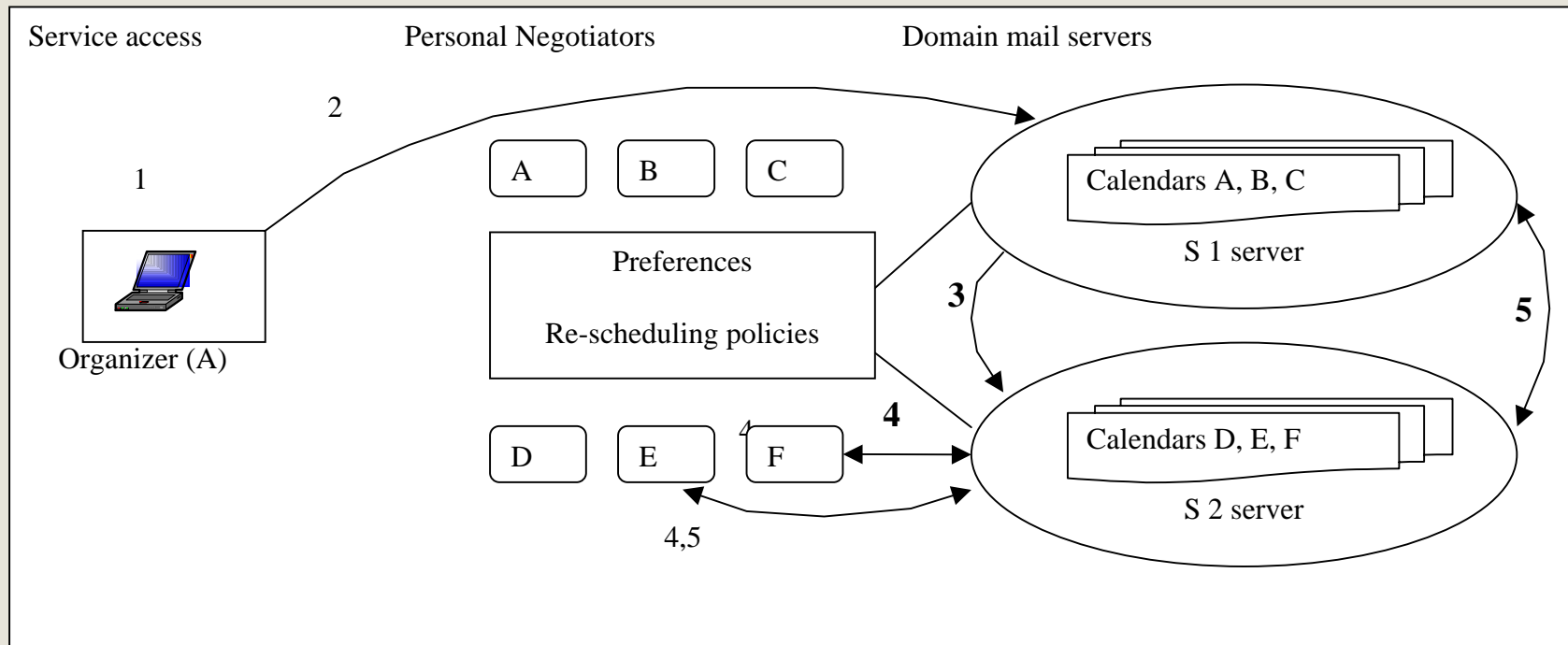
- Tools based on client/server offered by MS Outlook (You download from the server(s) the calendars of all participants on your machine and search “manually”)

A Mobile agent based approach

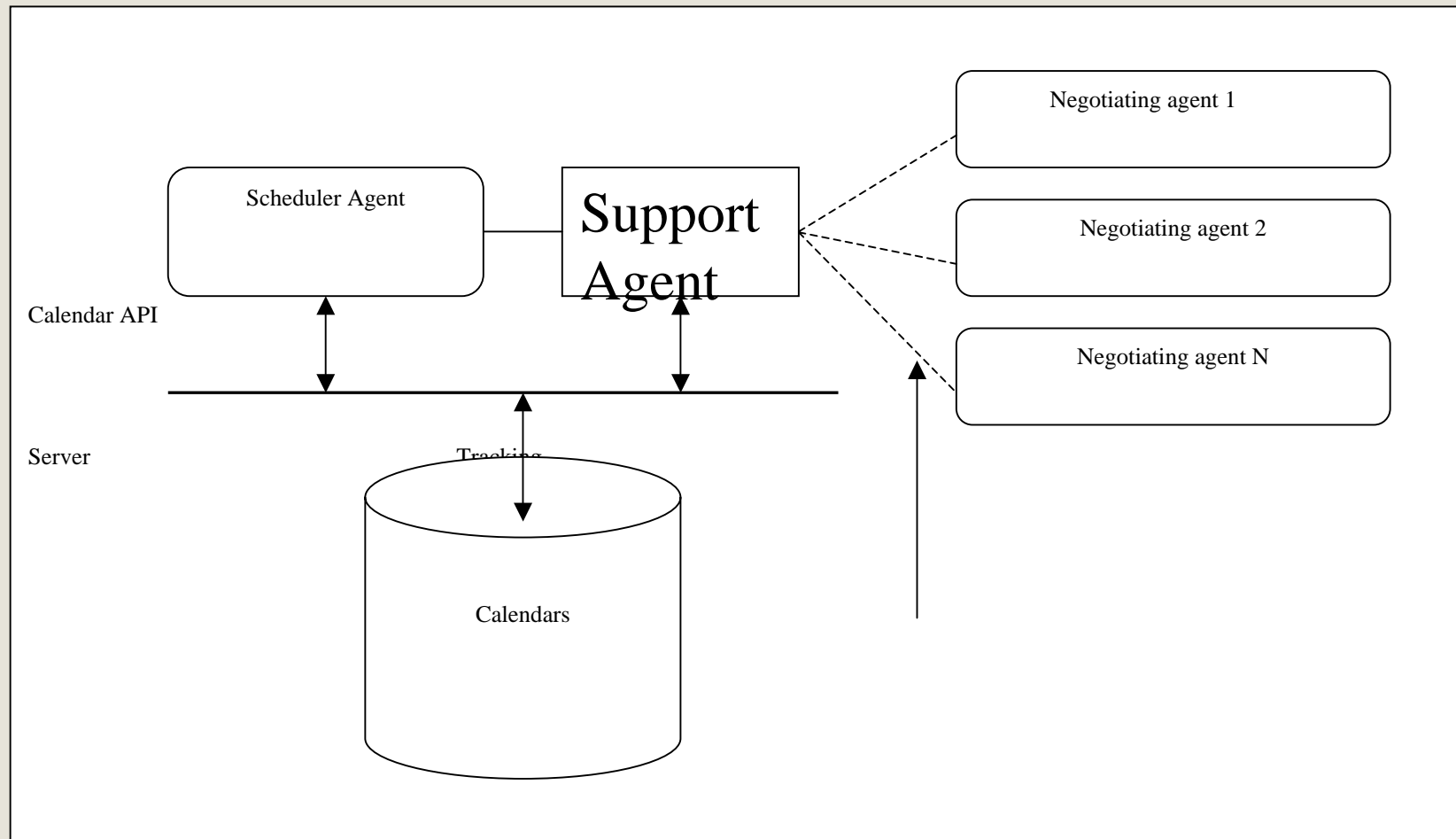
- Dispatch the agent(s) in the network. The agent visits the servers and identify the date(s) locally

A Mobile Agent Based Service ...

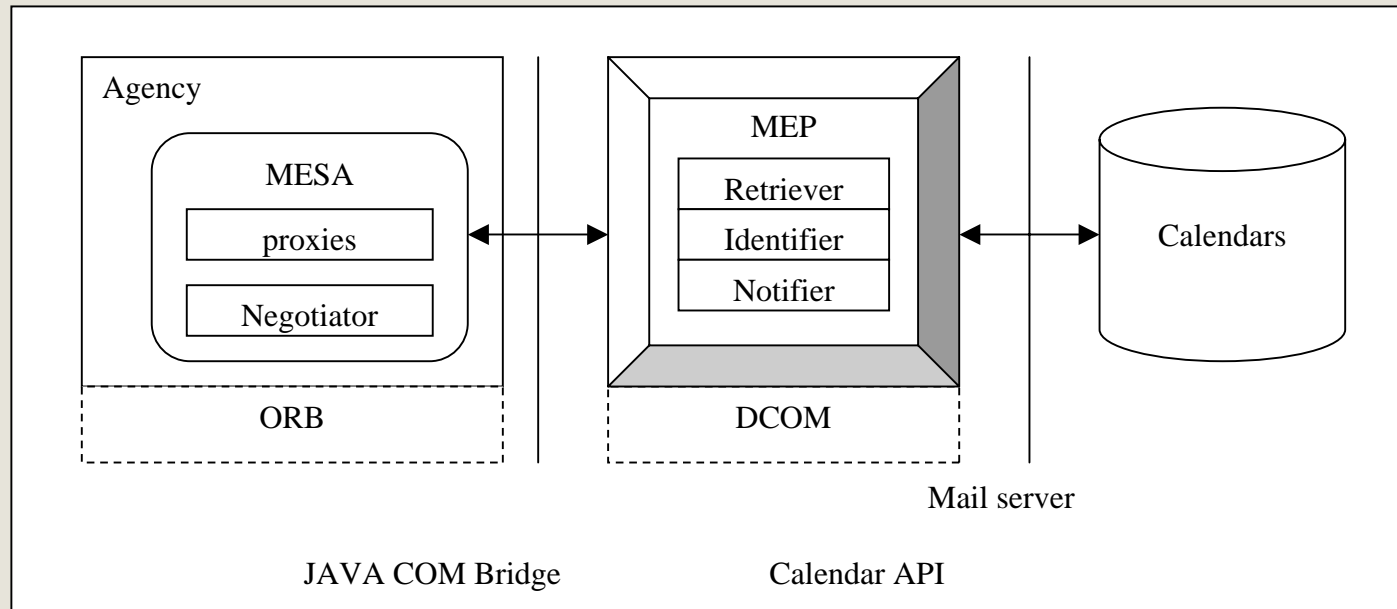
Quorum of 4 is required, F could not reschedule ..



A Mobile Agent Based Service ...



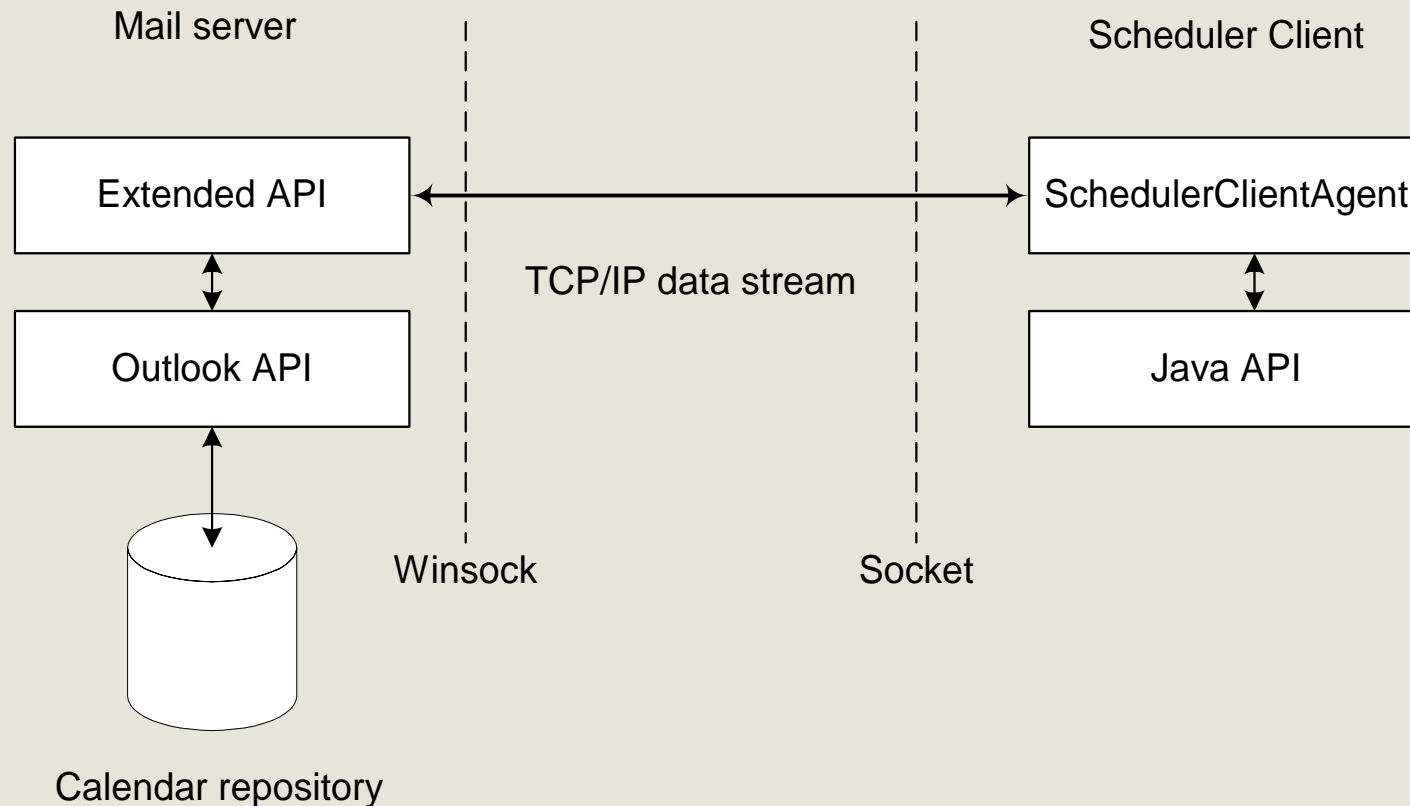
A Mobile Agent Based Service ...



MESA = Mobile Event Scheduler Agent

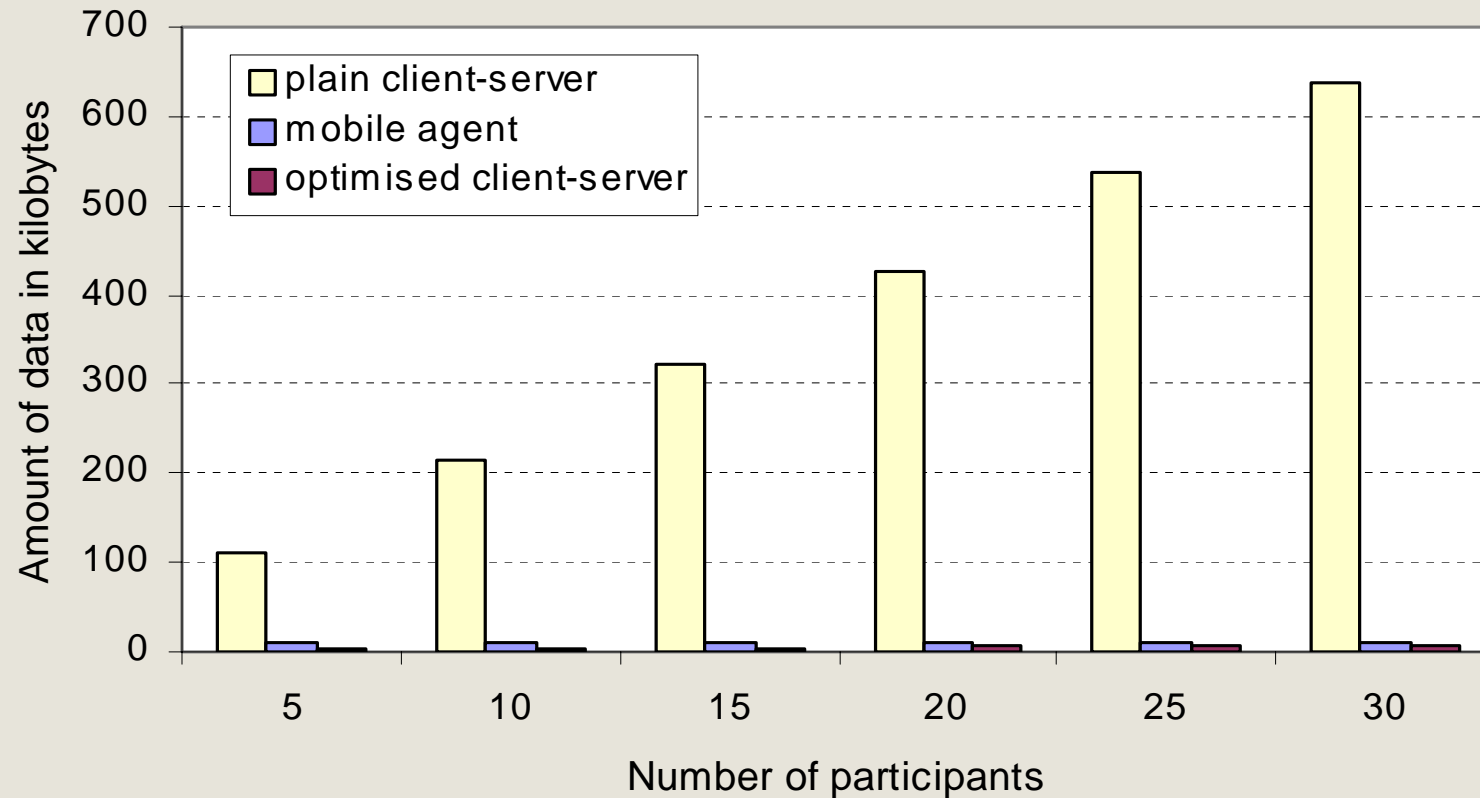
MEP = Master Event Planner

A Mobile Agent Based Service ...



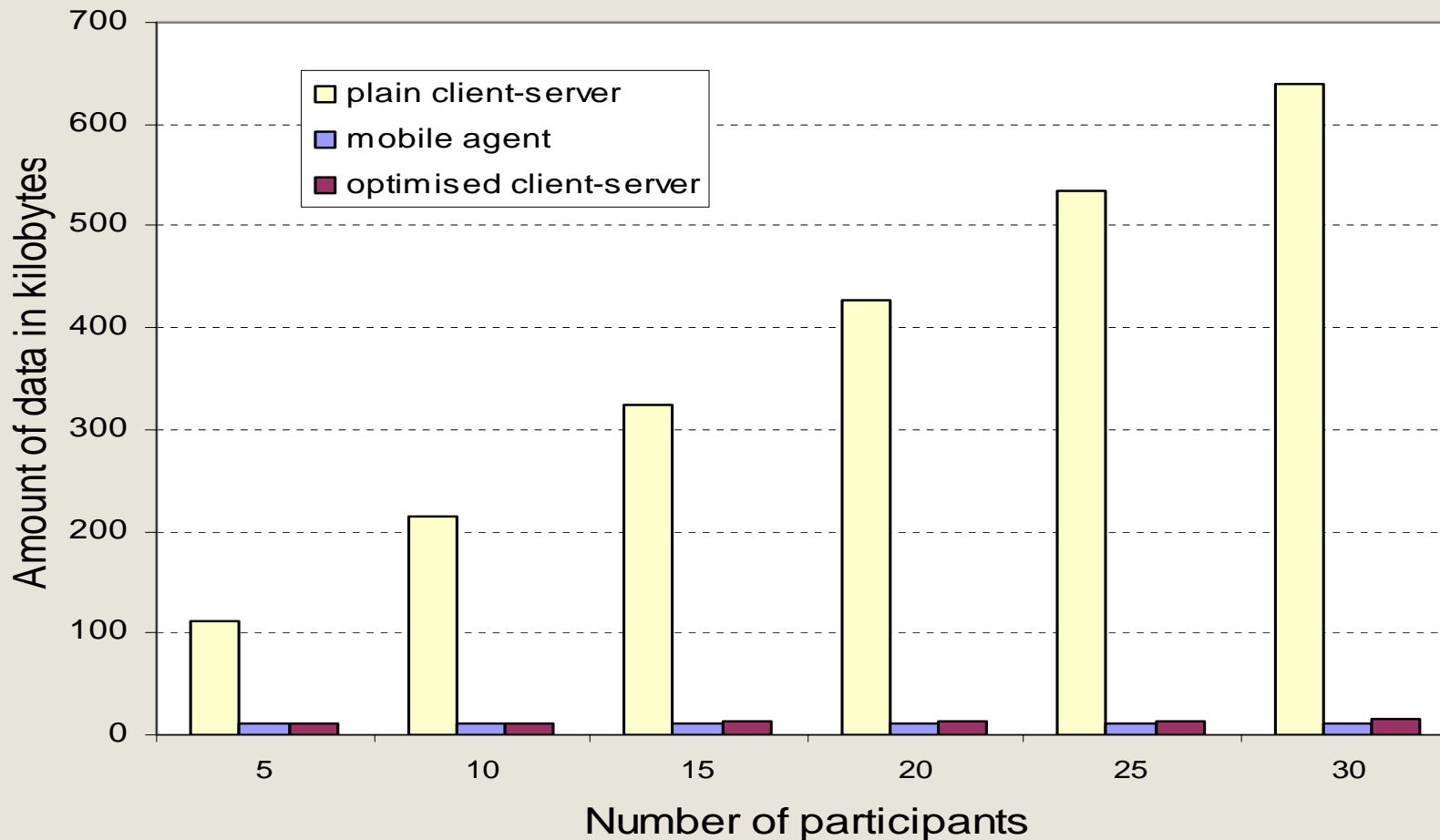
A Mobile Agent Based Service ...

Communication cost : event scheduled on day 1



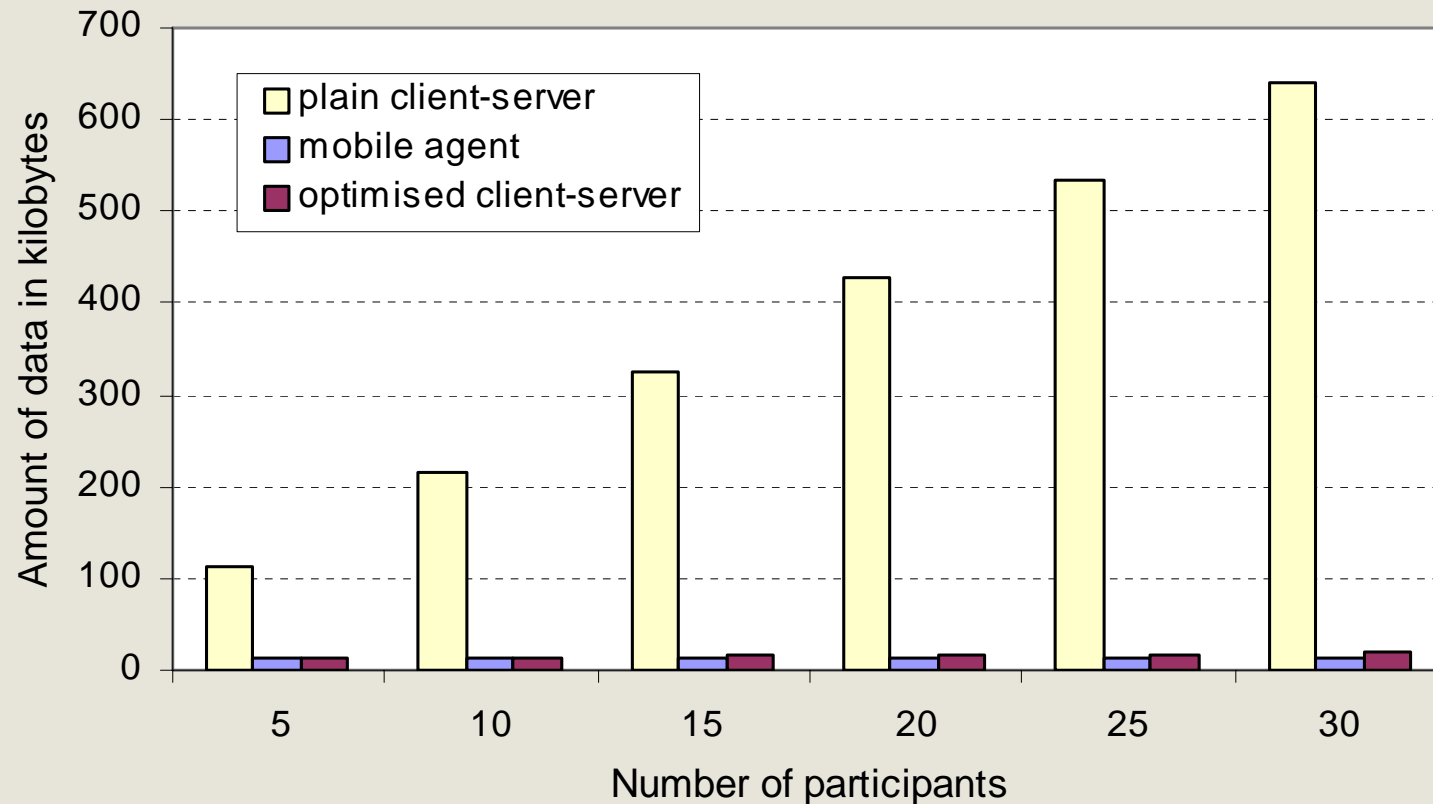
A Mobile Agent Based Service ...

Communication cost : event scheduled on day 15



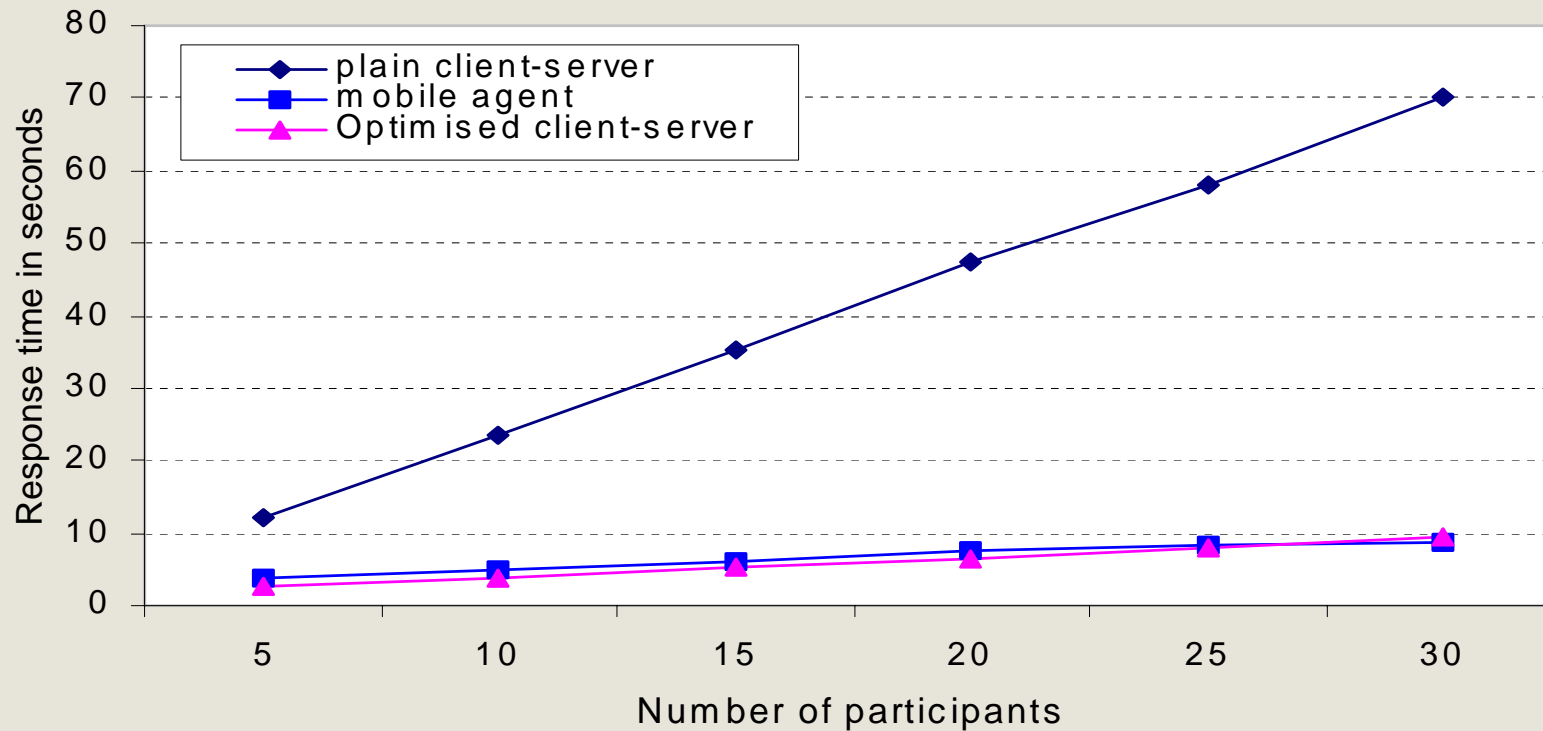
A Mobile Agent Based Service ...

Communication cost : event scheduled on day 30



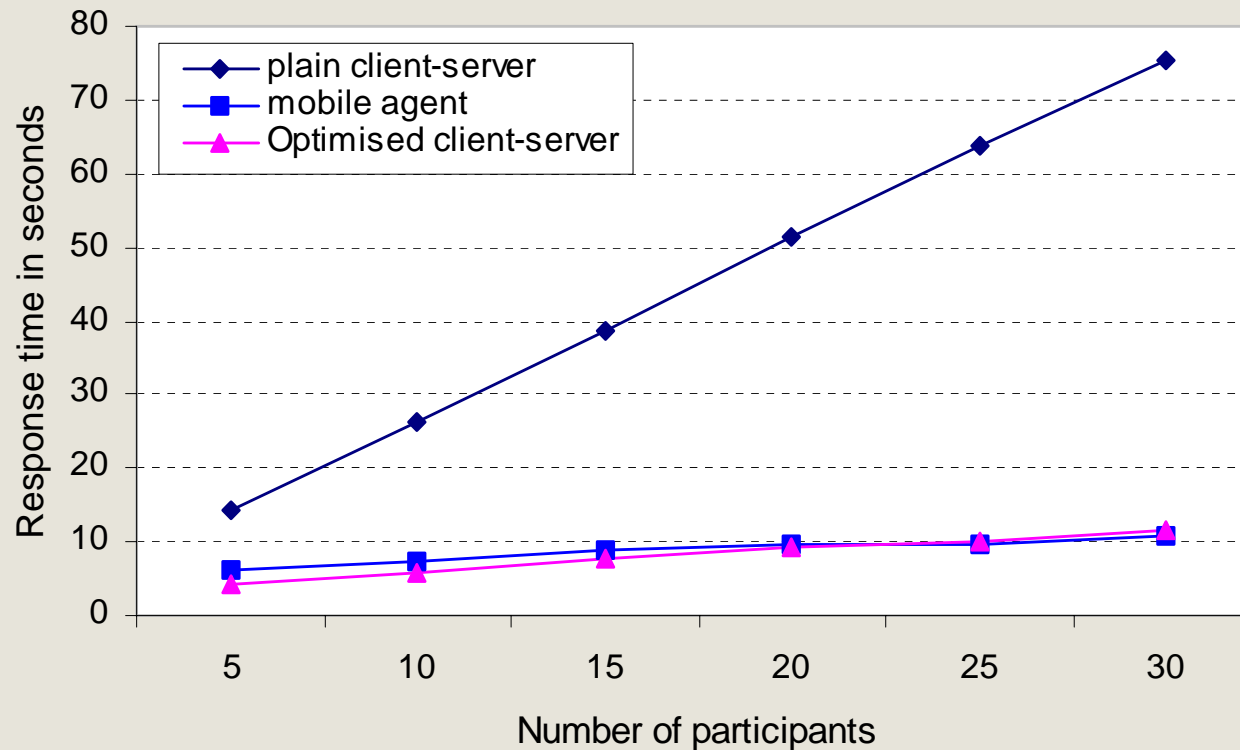
A Mobile Agent Based Service ...

Session scheduled on day 1



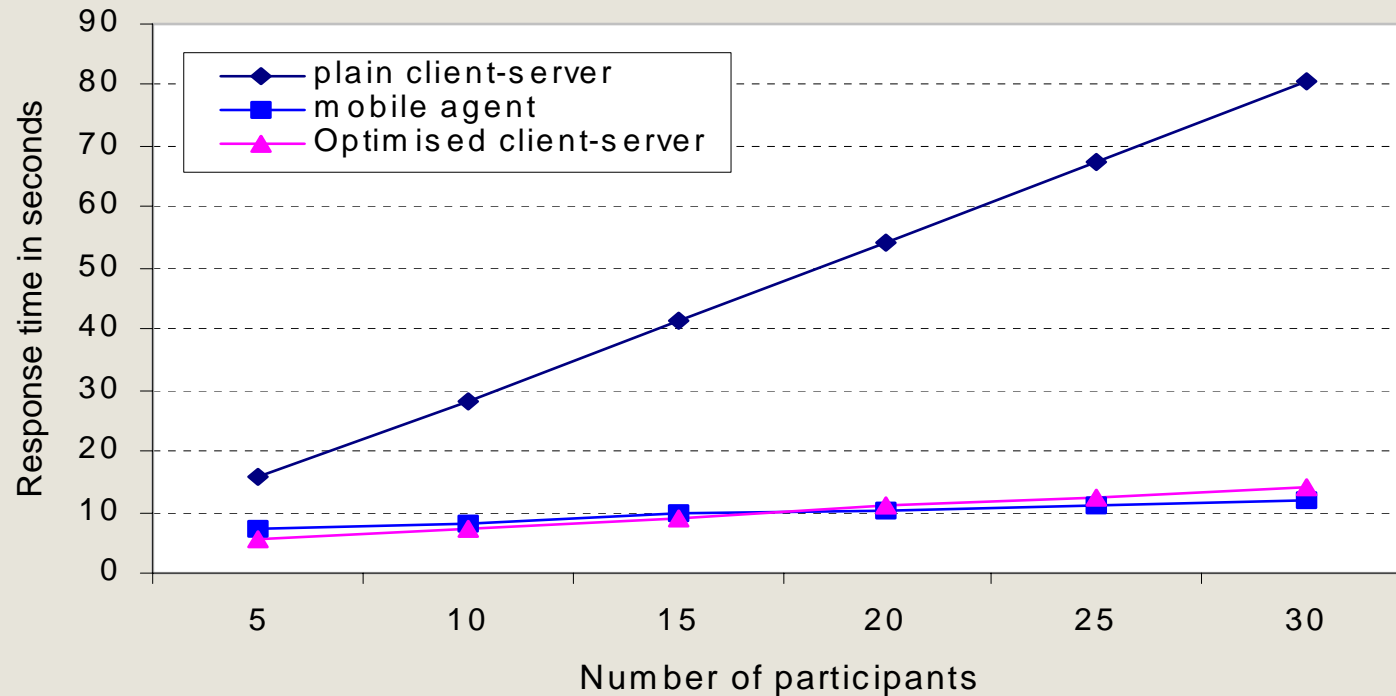
A Mobile Agent Based Service ...

Session scheduled on day 15



A Mobile Agent Based Service ...

Session scheduled on day 30



To probe further ...

On mobile agent based information retrieval applications

- Dag Johansen, “Mobile Agent Applicability,” Proc. MA’98: Second International Workshop on Mobile Agents, Lecture Notes in Computer Science, No. 1477, Springer-Verlag, 1998, pp. 80-98.
- R.H. Glitho, E. Olougouna and S. Pierre, Using Mobile Agents for Information Retrieval: A Brief Overview and an Elaborate Case Study, *IEEE Network Magazine*, January/February 2002, pp .34-41 –

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