

Fault Tolerance Support of Smart-M3 Application on the Software Infrastructure Level

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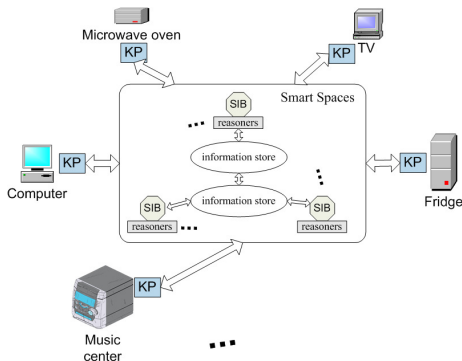
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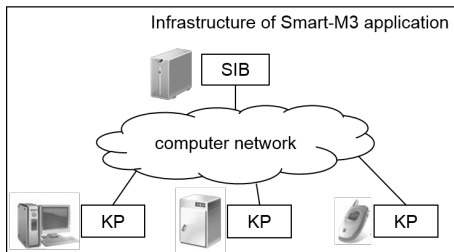
Smart-M3 platform

- Semantic information brokers (SIBs) maintain smart space content in low-level RDF triples
- Application consists of several knowledge processors (KPs) running on various devices
- An agent sharing ad-hoc knowledge across numerous domains
 - ▶ join, leave
 - ▶ insert, update, remove
 - ▶ (un)subscribe
- Interaction between KPs is implemented using publish/subscribe mechanism



Software Infrastructure of Smart-M3 Applications

Software infrastructure: the means for application operation



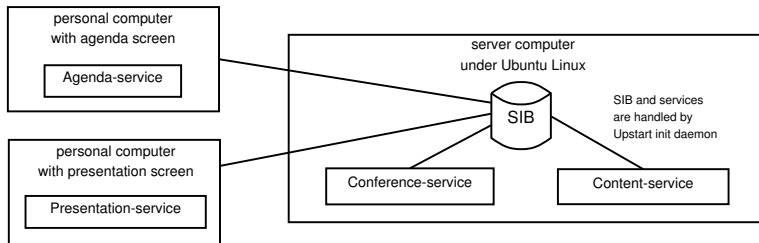
Infrastructural KP deployment options:

- 1 Clustering near the SIB
- 2 Device-aware location
- 3 Server-oriented location (non-SIB)

Infrastructural KPs are responsible for service construction and delivery

Example: SmartRoom system

- holding conferences, meetings, and lectures
- personalized interaction with room participant
- participating using mobile devices



- SIB is deployed either locally or on a remote machine
- Conference-service: conference runtime management
- Presentation-service: slide show of current speaker
- Agenda-service: visual activity agenda
- Content-service: storage of participants' materials

Application Dependability

Dependable application: “reliance can justifiably be placed on the service it delivers” (M.R. Lui et al., 1996)

- Availability: readiness for usage.
- Reliability: continuity of service.
- Safety: nonoccurrence of catastrophic consequences on the environment.
- Confidentiality: nonoccurrence of unauthorized access.
- Integrity: nonoccurrence of improper alterations of information.
- Maintainability: ability to undergo repairs and evolutions.

Fault tolerance: application is capable to deliver its services in the presence of faults

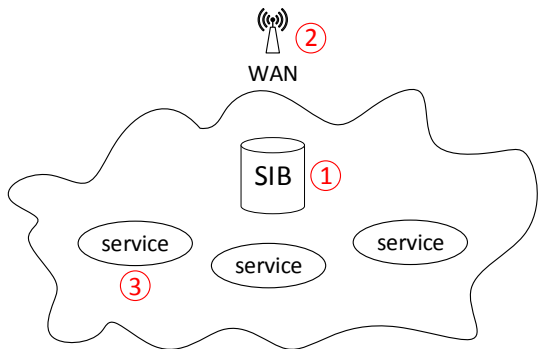
Smart-M3 Application Dependability

Lacks of reliability and integrity

Subscription the most failure-sensitive operation

Failure reasons:

- 1** SIB: software error (freezing, crashing); lost subscription connection with KPs; data loss (overload)
- 2** Wireless network: subscription connection breaks; data packets loss
- 3** Infrastructural KP: lost network connection with the SIB; software error (crashing)



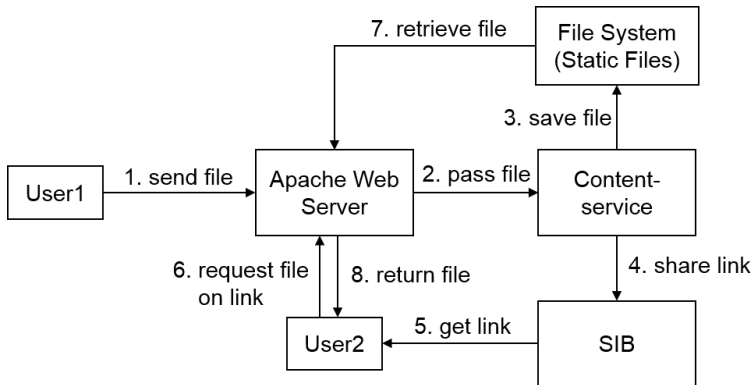
We propose:

- service for volumetric data storage
- mechanisms for subscription control and service restart

Content-service

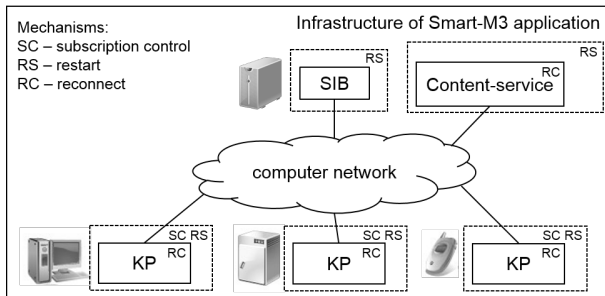
Persistent storage of volumetric data

- presentations
- images
- audio
- video



Mechanisms for Fault Tolerance of Subscription

- Subscription control mechanism: active regular checks for subscribed data
- Restart/reconnection: KP reestablishes network connection with the smart space



Subscription Control

- Failure situations:
 - ▶ subscription indication was lost
 - ▶ subscription connection was disrupted
- Proactive check (subscription) is augmented with active checking
- If subscribed data are changed — failure has occurred
- Challenges:
 - ▶ how to detect information changes,
 - ▶ no clear criterion on identifying breaks in subscription,
 - ▶ check intervals.
- Usage notification model introduced in I. Galov and D. Korzun, “Notification model for Smart-M3 applications”, NEW2AN/ruSMART 2014, LNCS 8638.
- Not implemented yet: more applicable for mobile clients (A. Vdovenko).

Restart/Reconnection

- Restart: application is shut down and launched again
- Reconnection: application is still running but connection to SIB is re-established

Usage in SmartRoom:

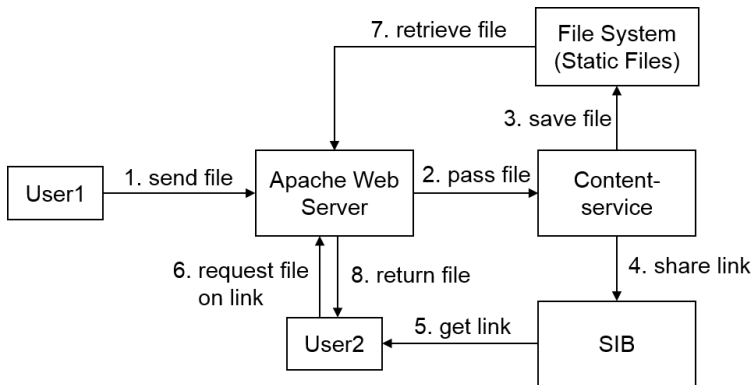
Infrastructure element	Restart	Reconnection
SIB	+ (auto)	–
Conference-service	+ (auto)	–
Agenda-service	+ (manual)	+ (manual)
Presentation-service	+ (manual)	+ (manual)
Content-service	+ (manual)	–

Restart implementation: launching on the server computer with Upstart (configuration files):

redsibd → sib-tcp → conference-service

Performance Evaluation: Content-service

Server computer: Ubuntu Linux, Intel Xeon 2.30GHz, 4GB RAM



Content-service file (10M) upload time:

- Apache: 1.814 sec. (standard deviation is 0.014)
- nginx: 1.842 sec. (standard deviation is 0.030)

Performance Evaluation: Restart/Reconnection

- Server computer: Ubuntu Linux, Intel Xeon 2.30GHz, 4GB RAM (SIB, Conference-service, Content-service)
- Personal computer: Windows, Intel Core 2 Quad 2.40GHz, 8GB RAM (Presentation-service, Agenda-service)
- Time between service terminating and starting (until readiness) was measured

Infrastructure element	Restart (sec)	Reconnection (sec)
SIB	1.045	—
Conference-service	2.023	—
Agenda-service	1.350	0.134
Presentation-service	0.230	0.075
Content-service	2.193	—

Conclusion

- Software infrastructure for the case of Smart-M3 applications
- Solutions for Smart-M3 applications fault tolerance:
 - ▶ Content-service to control volumetric factual data
 - ▶ Mechanisms for subscription control (fault detection) and recovery (when fault has happened)
- Experimental evaluation on SmartRoom system

Thank you for attention

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