

Smart Spaces

Project Recommendations:

M3 Applications: Architectures and Designs

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Outline

- §1. Design of M3 Application
- §2. Architectural patterns
- §3. Examples and case studies
- §4. Student projects

M3 = **MultiDevice** + **MultiDomain** + **MultiVendor**

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§1. Design of M3 Application

- ▶ Multi-Agent scenario (execution steps)
 - ▶ Shared knowledge (smart space)
 - ▶ Cooperation of multiple agents (KPs): indirect interaction
 - ▶ Event-based model: subscription
 - ▶ Reasoning: deducing new knowledge
- ▶ Application Layout (hardware & software)
 - ▶ Devices, services (processing), end-users (UI)
- ▶ Ontology (problem domain)
 - ▶ Knowledge structure model
 - ▶ Smart space composite model
- ▶ KP design
 - ▶ List of all KPs and their mapping to the layout
 - ▶ KP implementation template (fill for each KP)

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Application layout

Devices, services, end-users

- ▶ **Scale:** embedded, mobile, stationary, ...
- ▶ **Owner:** personal, multi-user, public, ...
- ▶ **Processing:** sensor/producer, consumer, reasoner, a combination
- ▶ **Role:** functions in the smart space
- ▶ **Interaction:** human, machine
- ▶ **Platform:** Linux, Android, Windows, ...

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Ontology

- ▶ Ontology class graph
 - ▶ Classes and properties
- ▶ Ontology instance graph
 - ▶ Individuals and properties
- ▶ Support for reasoning (query-based)
- ▶ Context awareness
- ▶ Your ontology development toolkit

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Smart Space Content: Knowledge Base

- ▶ Problem domain and environment
- ▶ Knowledge and its classes
- ▶ Relations among classes
- ▶ Providers, consumers, ...
- ▶ Derivative knowledge and reasoning
- ▶ Space compositions:
 - personal space, multi-user space, application space, ...

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KP Design

- ▶ Function (in scenario)
- ▶ Devices and platforms
- ▶ Processing type (architectural role, user)
- ▶ External interfaces (e.g., UI)
- ▶ Knowledge used (shared & local) and algorithms
- ▶ CASE tools

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Simple project: steps

1. Idea (brief description)
2. Architecture: cooperation of KPs
 - ▶ smart space + KPs + devices
 - ▶ scenarios + data flows + presence detection
3. Ontology and knowledge base
 - ▶ class graph + instance graph
 - ▶ reasoning: query-based
4. KP design
 - ▶ Plan of implementation
5. **Simple code and demo**
 - ▶ **labs**

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Characteristic Properties

- ▶ **Not a database or a web service**
- ▶ User localization: “space concept”
 - ▶ Surrounding devices
 - ▶ External services if needed
- ▶ Smart services: when, what, to whom, how, ...
- ▶ Use of shared data as a system
- ▶ Semantic linking: “hub property”

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Service Intelligence (“Smartness”)

- ▶ Multitude of scenarios (non-fixed priority)
- ▶ Context-awareness
- ▶ Adaptability
- ▶ Personalization
- ▶ Dynamic join/leave of participants

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§2. Architectural patterns

- ▶ Participating KPs
 - ▶ Different roles in application
 - ▶ Different knowledge interpretation
 - ▶ Different cooperation strategies within the multi-agent system
- ▶ Challenges
 - ▶ Dynamics: joining and leaving the space
 - ▶ Smartness of services:
 - ▶ Knowledge reasoning (over the shared content)
 - ▶ Service personalization and context-awareness
 - ▶ Proactive service delivery

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Knowledge producers and consumers

- ▶ Accumulation and provision
- ▶ Similarly to a shared database with readers and writers
- ▶ No “smartness” (intelligence)
- ▶ **Do not use in your projects in its pure form**

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Knowledge interaction chains

- ▶ Pipes: linear chains
 - ▶ E.g., a simple weather application
- ▶ Tree-based
 - ▶ Each fact produces several new facts
 - ▶ One-to-many synchronization
 - ▶ Epidemic dissemination
- ▶ Network flows
 - ▶ Cycles are possible
 - ▶ Iterative processing
 - ▶ Feedback

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Knowledge mediators

- ▶ Smart space analyzers
 - ▶ Big Brother approach (for proactivity)
 - ▶ Services and their composition (see also knowledge interaction chains)
- ▶ Function delegation
 - ▶ Mobile client has low capacity
 - ▶ Ideal case: client shares small piece of personal info and consume the service

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§3. Examples

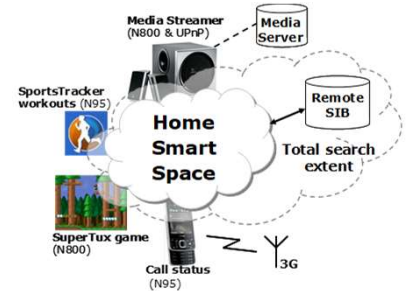
1. SuperTux game example (NRC, Helsinki)
2. Smart Conference System (SPIIRAS)
3. SmartScribo System for multi-blogging (PetrSU)
4. Smart Room (PetrSU)
5. Social Networks service (FRUCT)
6. SmartDiet: Personal Wellbeing Assistant and Diet Planner Mobile Service (TUT, Tampere)
7. Open International M3 Semantic Interoperability Workshop, <http://www.fruct.org/eit-m3>

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Traditional user services

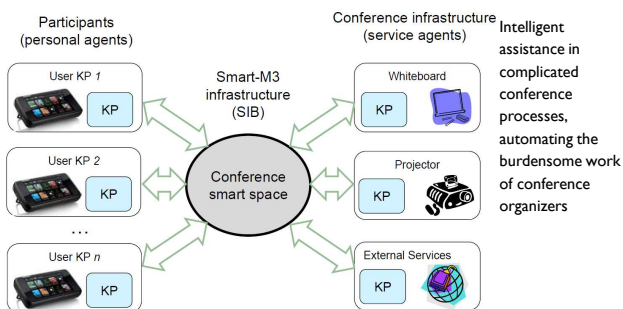
- ▶ Personalization and functionality expansion of the popular user services
- ▶ SuperTux game example
- ▶ Simple service composition



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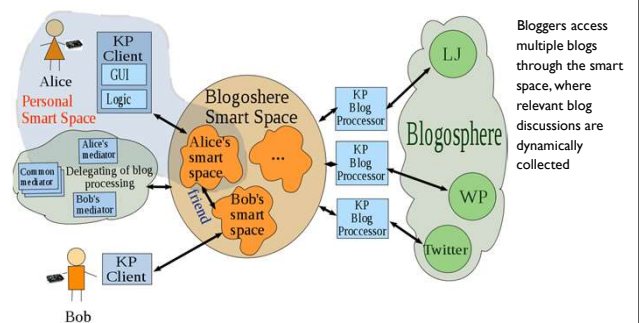
Smart Conference System



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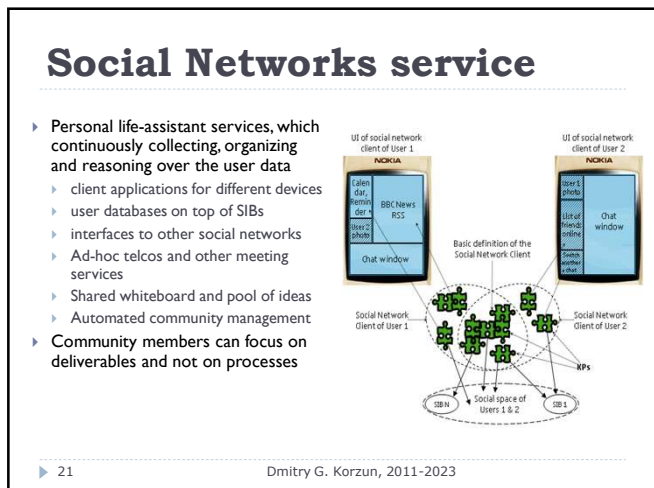
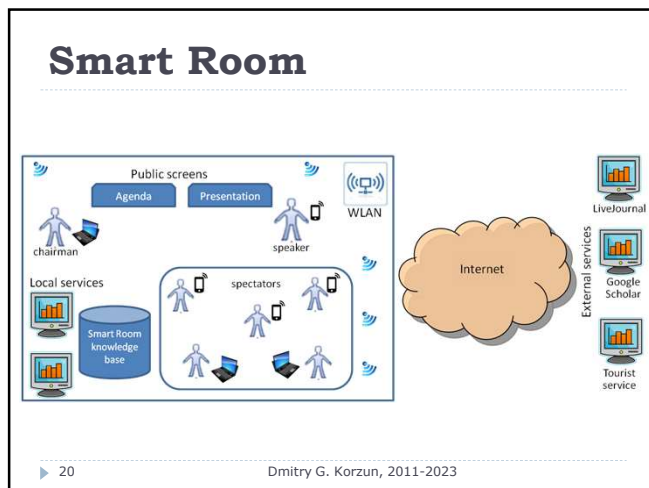
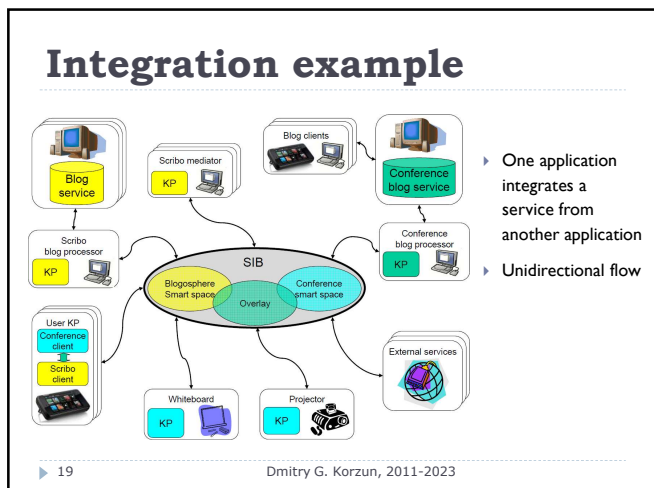
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SmartScribo System



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§4. Student Projects

- Students show their projects
- Focus is on the scenario, architecture, and design
- Making “smartness” (personalization, proactivity, etc.)

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Часть 1 проекта

Постановка задачи

- Концептуальная модель (визуальная схема).
- Основные функции (сервисы для пользователя).
- Построение сервисов взаимодействующими агентами (сценарии построения сервиса).
- Используемая аппаратура для запуска агентов.
- Близкие существующие решения по умному приложению.
- Как проявляется интеллектуальность.
- Размерность приложения (количественный состав агентов, пользователей, объемы данных).

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Часть 2 проекта

Многоагентная архитектура и детальное проектирование

- Детализация требований в сценариях использования (шаги по получению и обработке данных, алгоритмы обработки и виды информации).
- Какую информацию надо делать общей для агентов (общее информационное пространство).
- Анализ интеллектуальности в рамках разработанных сценариев использования.

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Часть 3 проекта

Онтологическое моделирование

- ▶ Интеллектуальное пространство как база знаний (БЗ).
- ▶ Какая информация становится доступной всем (описать в сценариях).
- ▶ Онтология как логическая структура БЗ (граф онтологических классов).
- ▶ Семантическая сеть как фактическая информация, хранимая в БЗ в некоторый момент времени (граф онтологических индивидов).

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Часть 4 проекта

Процессоры знаний

- ▶ Действия каждого агента (процессора знаний) в каждом сценарии построения сервисов.
- ▶ Диаграммы последовательности (для сценариев) или высокоуровневый алгоритм действий агента (как параллельный вычислительный процесс).
- ▶ Действия по доступу к интеллектуальному пространству.
- ▶ Действия (алгоритмы) по анализу данных.
- ▶ Действия по доставке сервиса пользователю

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