

## 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

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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

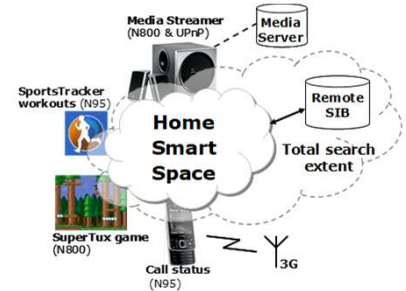
1. SuperTux game example (NRC, Helsinki)
2. Smart Conference System (SPIIRAS)
3. SmartScribo System for multi-blogging (PetrSU)
4. Smart Room (PetrSU)
5. Social Networks service (FRUCT)
6. SmartDiet: Personal Wellbeing Assistant and Diet Planner Mobile Service (TUT, Tampere)
7. Open International M3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

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### Traditional user services

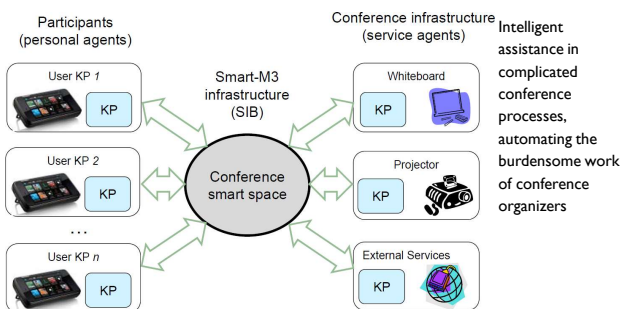
- ▶ Personalization and functionality expansion of the popular user services
- ▶ SuperTux game example
- ▶ Simple service composition



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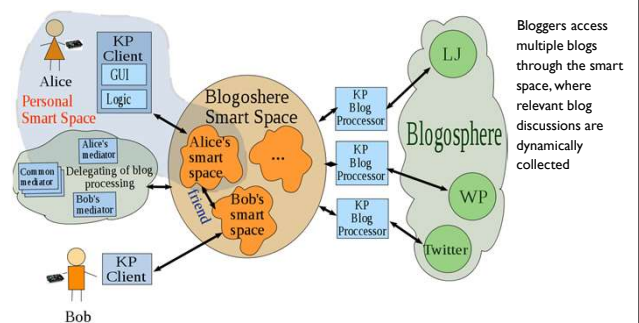
### Smart Conference System



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### SmartScribo System

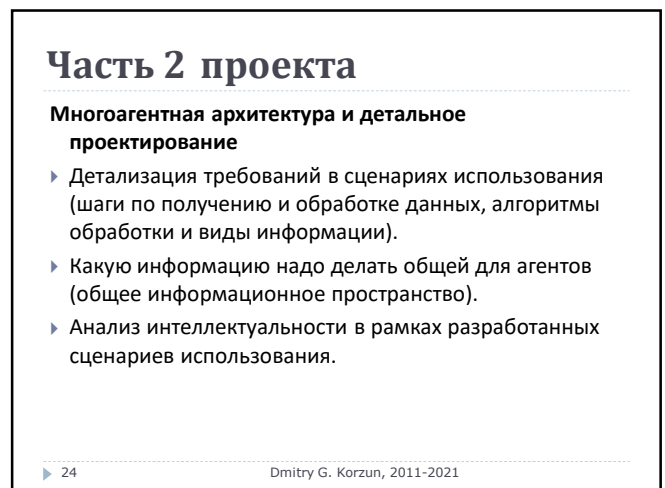
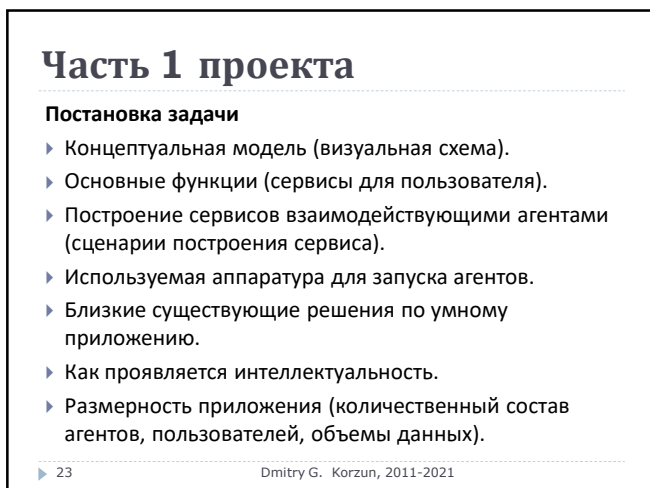
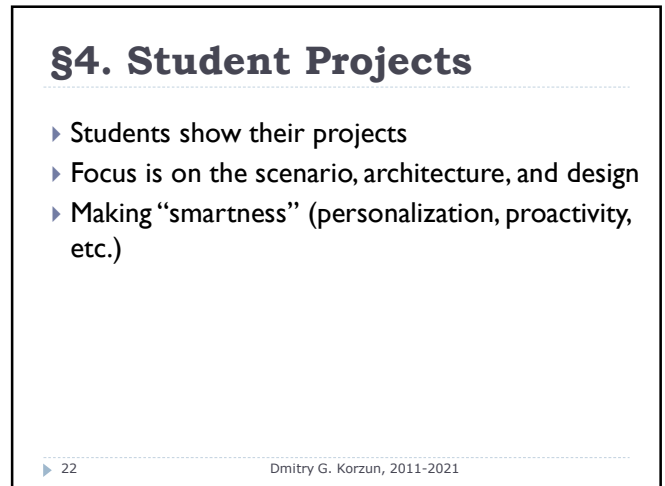
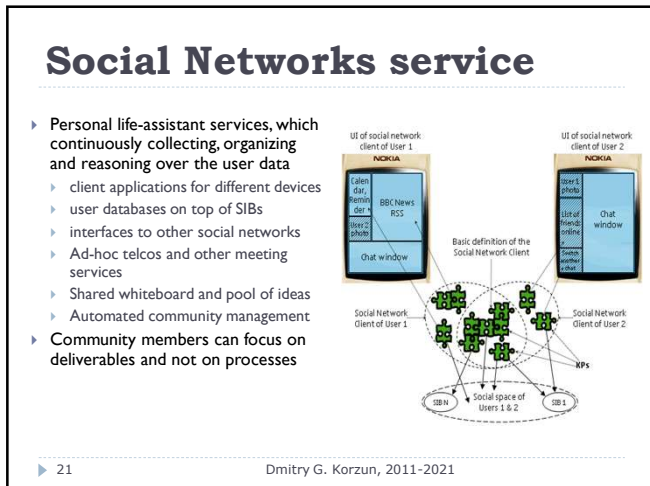
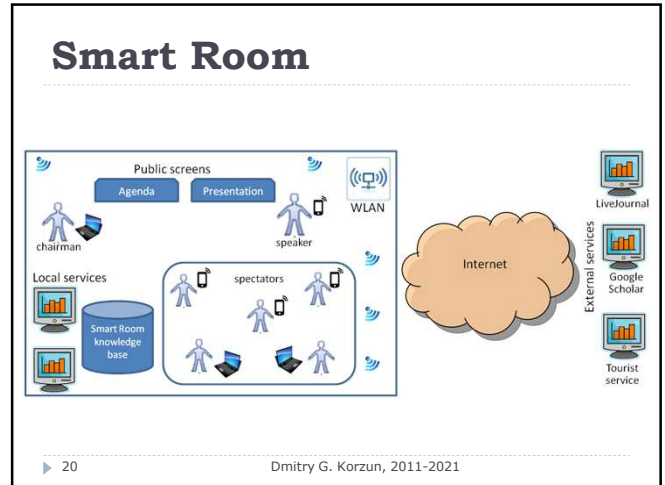
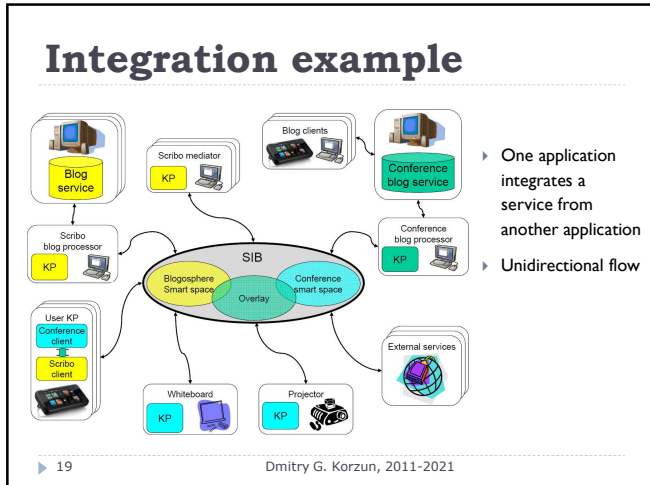


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# Smart Spaces. Ch.5: M3

## Applications: Architectures and Designs



### 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).

### 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