Towards 3D Geoinformatics and Computational Civil Engineering Support for Cooperative Tracks Planning

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Research work of the following team

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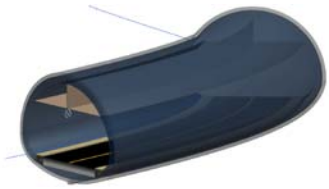
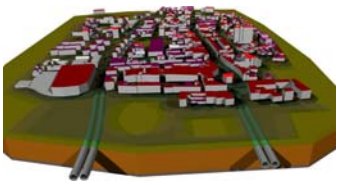
http://www.3dtracks.kit.edu/

Problem description: planning of inner-city subway track

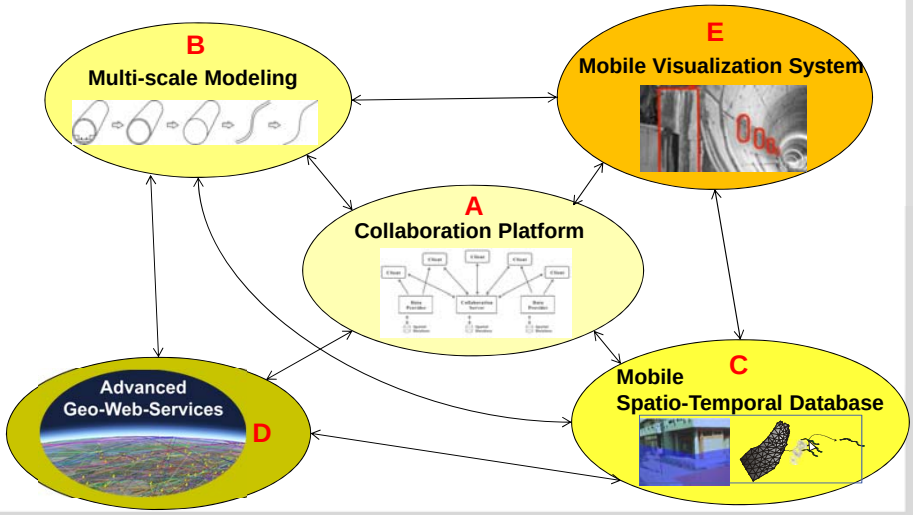
- highly complex planning task on different levels of details
- multitude of stake holders
  → demands collaborative planning
  → high risks (time, quality, costs)
  → collaboration hardly supported by IT
- planning mostly 2D-based
  → conflicts are hard to detect
  → in-situ comparisons not realizable
- insufficient incorporation of available spatial data sources and building models



- consequent use of 3D/4D models for planning inner-city subway track
- multi-disciplinary, collaborative work
  → platform for synchronous collaboration
  → methods for ensuring model consistency on different levels of detail
  → involvement of experts on site

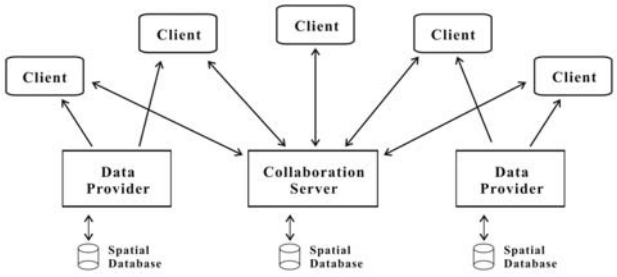


Connections between different components



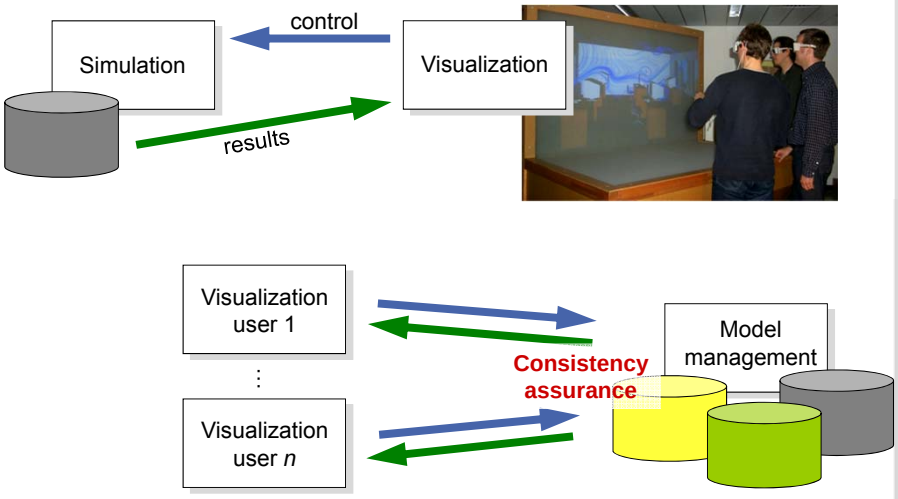
The central component (A): Collaboration platform

- goal: distributed multi-user system with centralized data management



- development of methods for synchronic collaboration
- integration of external (also unknown) data sources during runtime

Collaborative Computational Steering



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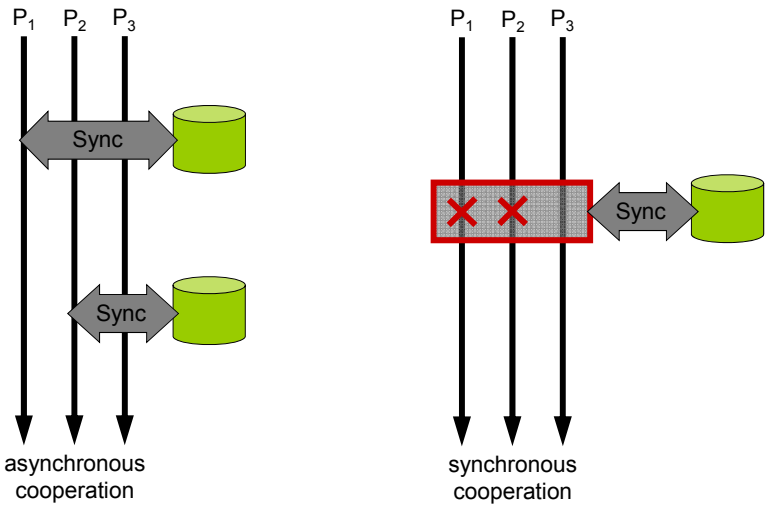
Synchronous cooperation



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The modeling component (B): Multi-scale modeling

Background

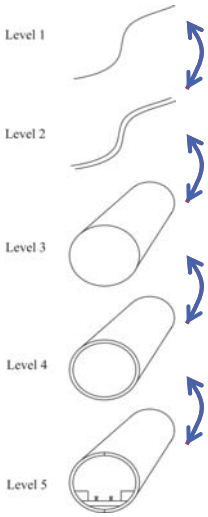
- different scales of the observed levels of planning
- concept of multi-scale geometric model
- highly dynamic models in planning processes

- **Research needs:**

  - consistency assurance
  - maintenance between models at different LoDs

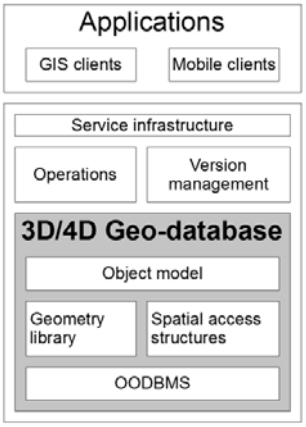
Methods

- multi-scale modeling in subway track planning
- definition for levels of detail
  → formal description
- check consistency between levels-of-detail
  → mapping functions
- automatic geometric and topological consistency assurance
- definition of a multi-scale parametric product model



The data management component (C): Mobile Spatio-temporal database

- spatio-temporal database for storage of
  - → multi-scale models on different LoDs
  - → time-dependent information (4D models)
- **database solution**
  - → as backend of the collaboration platform
  - → supporting visualization and data access
  - → access via advanced geo web-services



Research needs

1) **Model integration for spatio-temporal databases**
   - management of different LoDs of the 3D city- and building model
   - database representation for time-dependent 3D models
2) **Data models for 2D / 3D / „4D“ databases**
   - “switching” from 2D to 3D and from 3D to 4D (geometry + topology + properties)
   - updates and database views for “integrated models”

3) New graphical output for 3D/4D results of the database

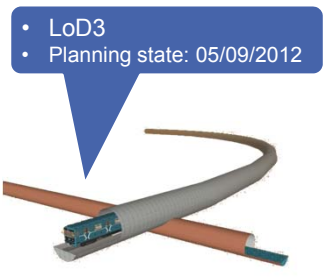
→ coupling of the geo-database with Augmented Reality (AR) techniques

- Coupling real-time scenario with stored 3D/4D models and database query results visualized by the AR system

3D cave at KIT

The data access component (D): advanced geo web-services

- planning of subway tracks relies on information about
  - → underground infrastructure or soil properties
  - → GIS-analysis functions, e.g. “all tracks under certain surface”
- advanced geo web service protocols for
  - → accessing multi-scale 4D data on different LoD
  - → advanced geo analysis, e.g. test of collision with built environment in 4D
  - → semantic transformation capabilities



Goal:
development of geo processing services and -chains

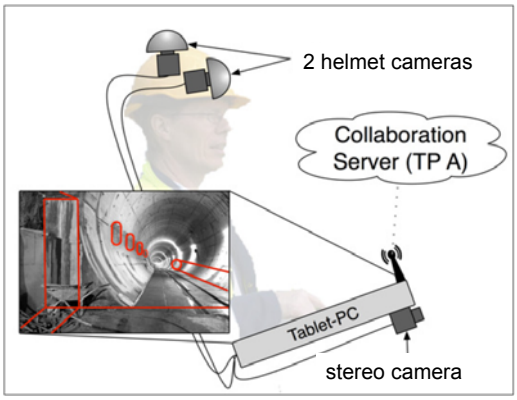
Research questions:

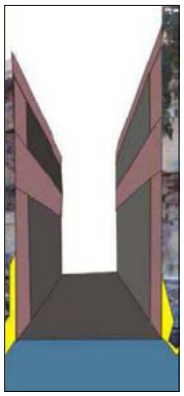
- conceptual model for geo porcessing services and –chains
- geo processing chain as special case of semantic transformation
- integration of the concepts *"fuzziness"* and *"propagation of errors"* in the model
- propagation of errors for 3D/4D operations

The visualization component (E): Mobile visualization system

- support of collaborative planning by on-site analysis and Augmented Reality (AR)
- extension of planning data by current visual information
- visual to-be / as-is comparisons
- automatic 3D inspection and measurement methods

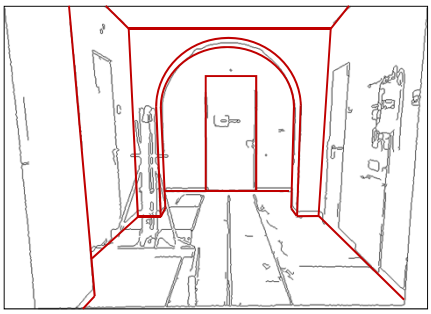
- conception of a comfortable, **mobile multi-camera**- und **visualization system**





- automatic detection of **landmarks** in complex environments for **the localization and 3D orientation** of the camera (s).
  - comparison of planned and real objects
  - development of robust estimation techniques

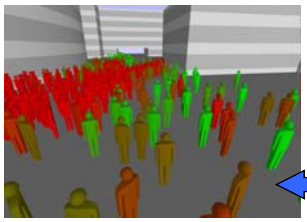
- **simulation of a subway tunnel**

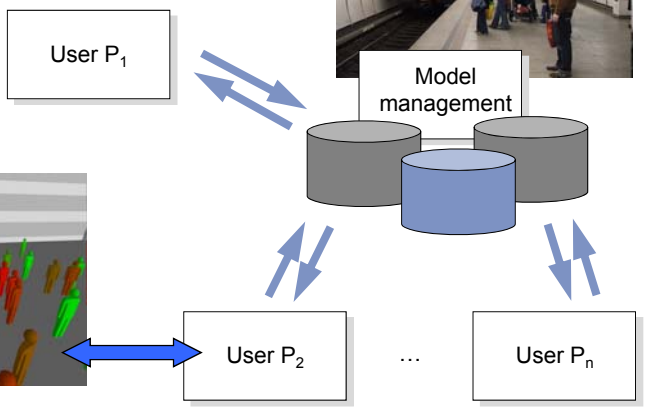


Objective:

Prototypical demonstrator

- example: subway station





Summary and Outlook

- **new research group,** 3+3 years, started on 1st Mai 2011

  "Computer-Aided Collaborative Subway Track Planning in Multi-Scale 3D City and Building Models"

- supporting multi-scale modeling
- developing spatio-temporal database and mobile visualization system
- developing 3D geo-services
- evaluation in real-world construction project (City of Munich, Germany)

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