



German
Research Center
for Artificial
Intelligence GmbH

Safe and Secure Cognitive Systems

Safe and Secure Cognitive Systems or *BKB's Pushout*



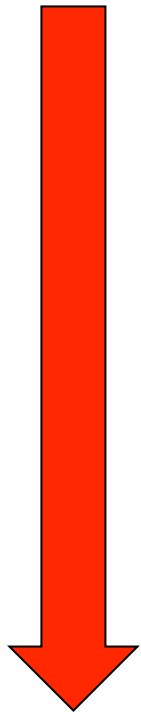
Sichere Kognitive Systeme



Bernd Krieg-Brückner
Lutz Schröder, Till Mossakowski
Christoph Lüth, Dieter Hutter
Udo Frese, Thomas Röfer, Hui Shi
et al.

Safe and Secure Cognitive Systems

CASL



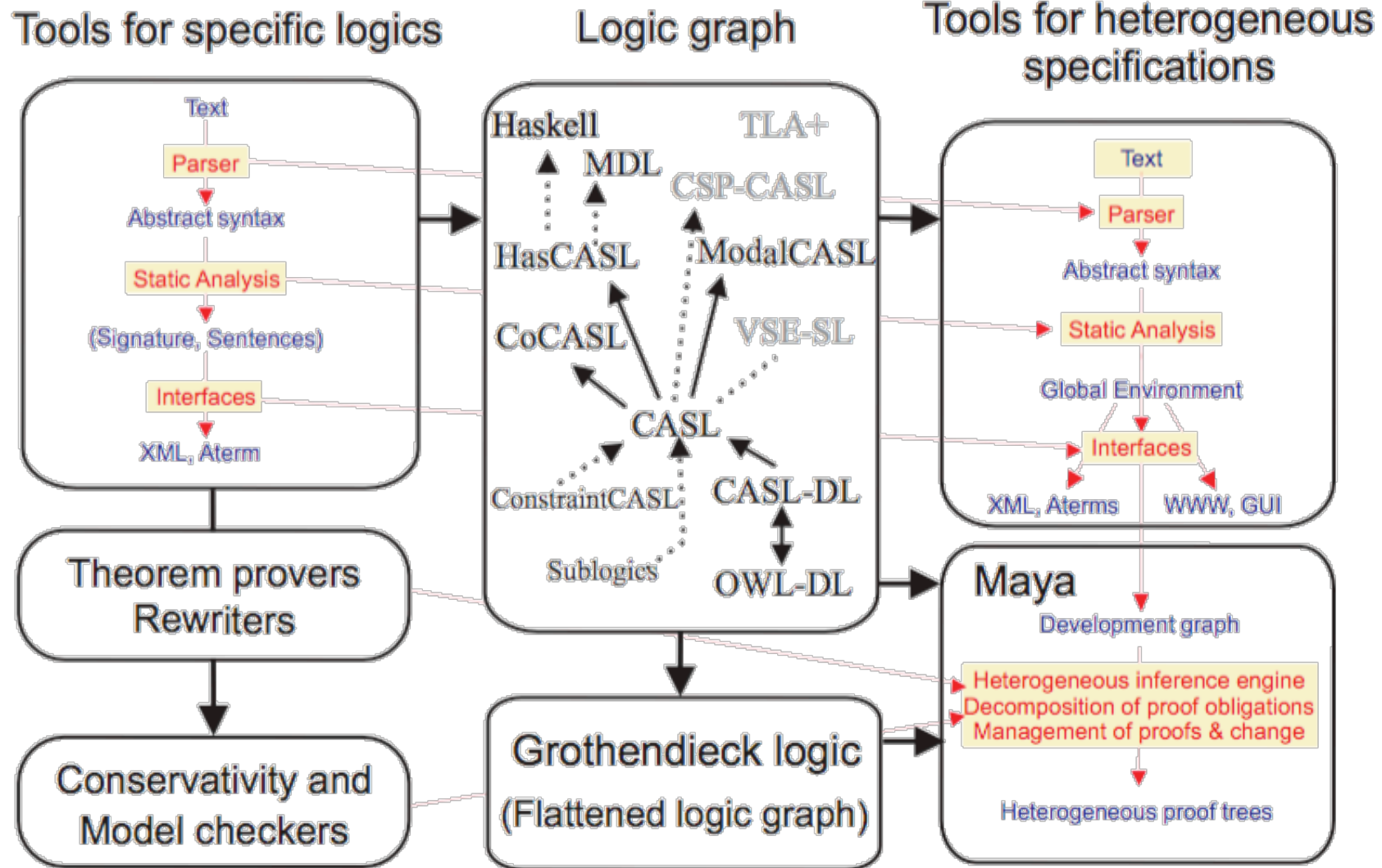
Safe & Secure
Systems

Formal Development Technologies

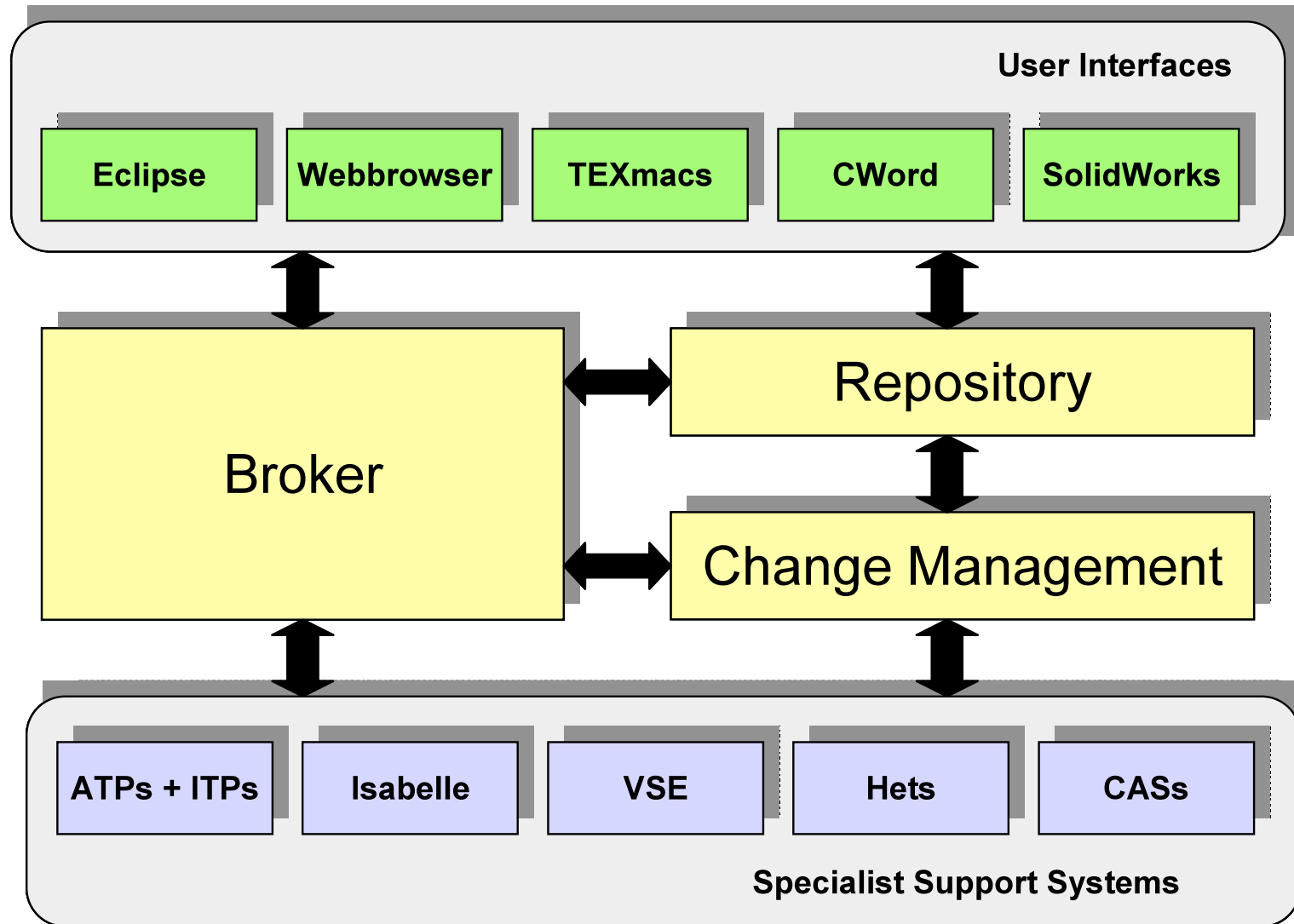


- Semantic Modelling
 - Semantic Dependencies, Modular Ontologies
 - Integration of Heterogeneous Domains
- Developments, Processes
 - Decomposition, Refinement
 - Parallel, Heterogeneous Developments, Views
- Reuse
 - Formalisation of Developments
 - Abstraction for Reuse, Variants
- Semantic Change Management
 - Ontology of Document Types, Consistency
 - Requirements Tracing

Heterogeneous Tool Set, HeTS



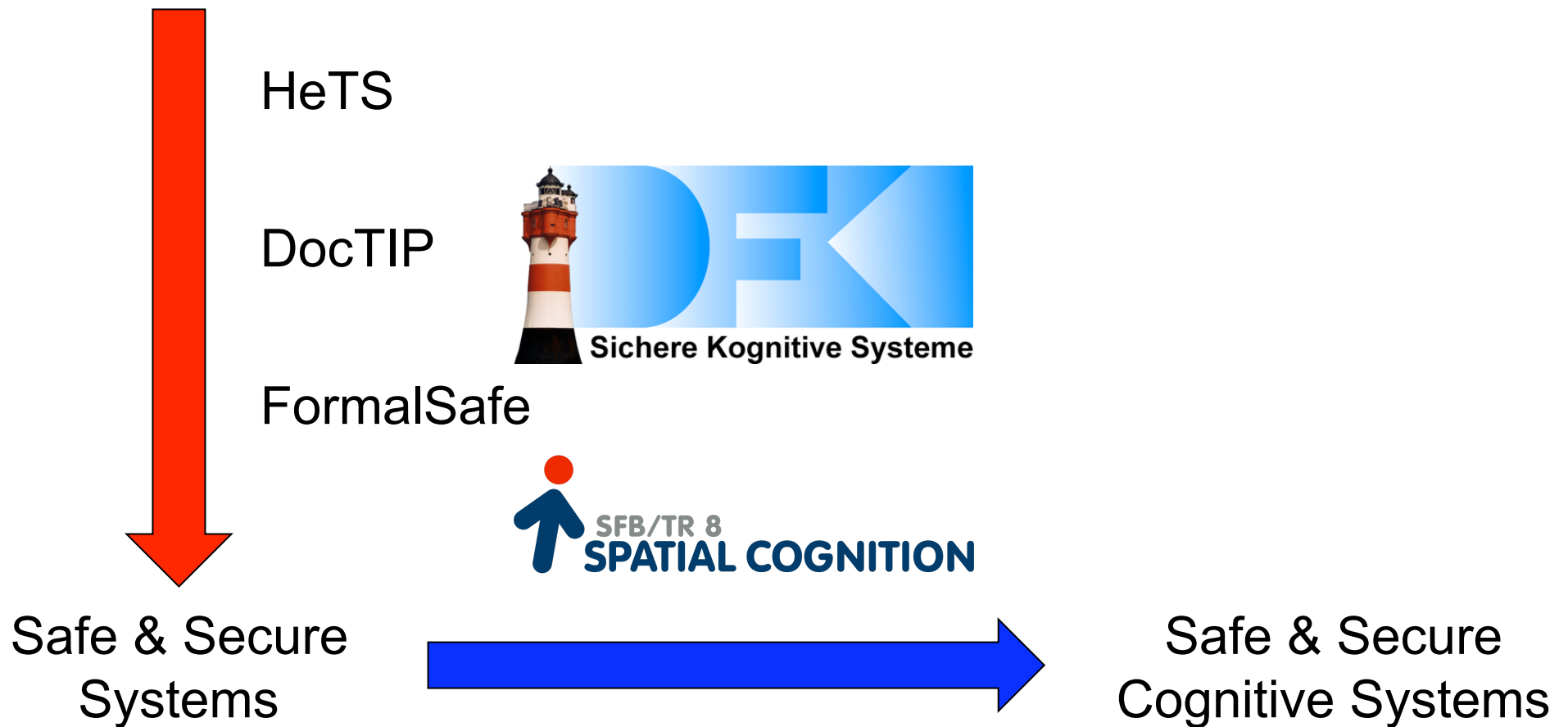
DocTIP Broker



FM: Development | Application



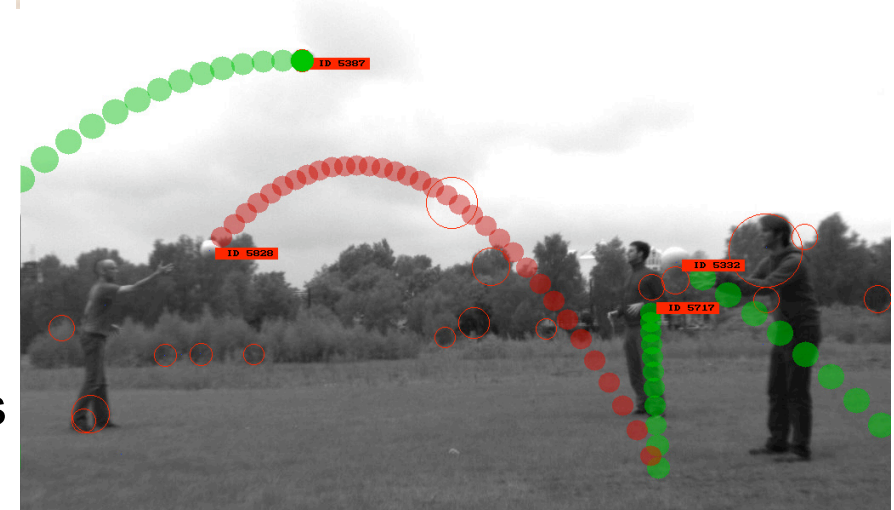
CASL



Probabilistic Modelling of Sensor Data



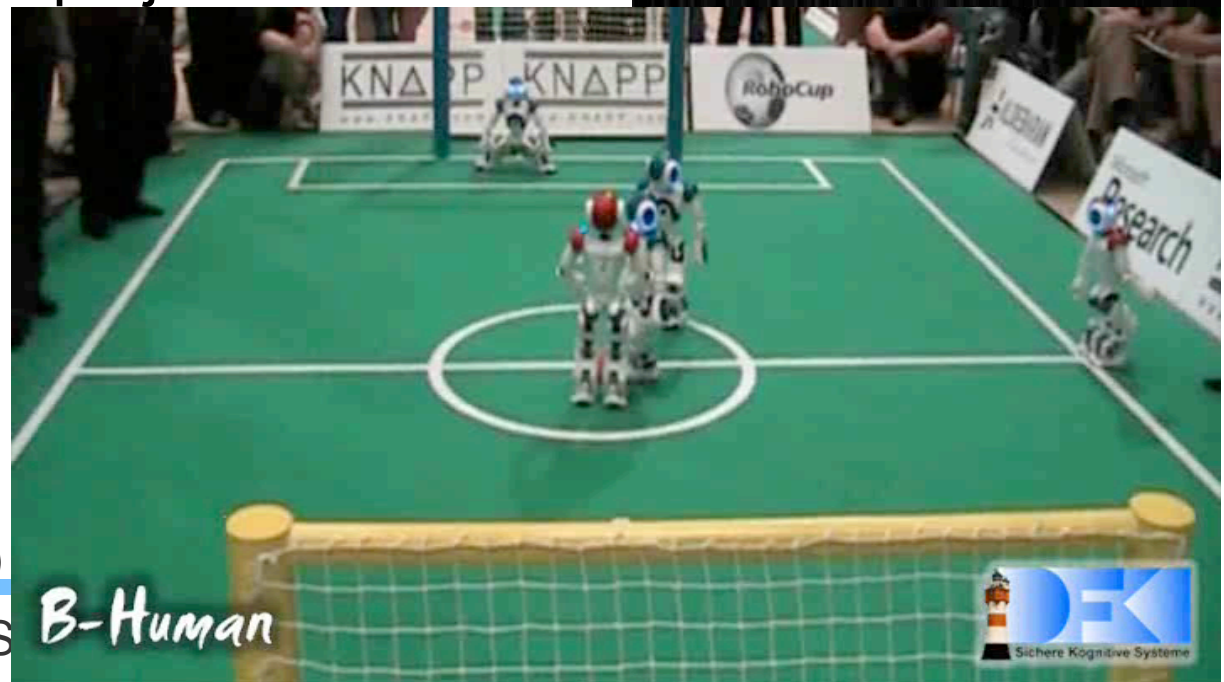
- SLAM Application
 - „active endoscope“ to rescue earth-quake victims
 - build 3D model from 3D sensor to support operator
- Example Computer & Sport:
 - understand soccer scenes from the player's perspective
 - track flying balls with a moving camera
 - computer vision and inertial sensing
 - difficult multi-modal distributions
 - but rather low-dimensional



Four-Legged and Humanoid Robots



- RoboCup Four-Legged League
 - German Team: **World Champion** '04, '05, '08
- RoboCup Standard Platform League
 - Aldebaran Robotics *Nao*
 - 3 vs. 3 soccer matches, full autonomy
- **B-Human** Student project
 - Student project
- Winner in 2009
 - Technical Challenges
 - German Open
 - **World Champion**
 - 64:1 (8 games)



Spatial Reasoning in GIS



Suppose you know:



Where is **Santa Monica Beach** as seen from **Hollywood Sign**?

Cognitive Assistance Systems



- Mapping and Localisation (SLAM) in 2D and 3D
- Real-Time Image Processing
 - **Tele-Operation** in Guardian Angel Perspective, 3D endoscope
- Spatial Reasoning
 - **Spatial Ontologies**
 - **Spatial Calculi**
- Application in Navigation
 - **Route Graph**
+ **Spatial Reasoning**
 - **Multi-Modal Interaction**
with the User



- Technology for Seniors-to-be

www.baall.net



- Assistance Systems for the Compensation of Physical and Cognitive Impairments with Natural Interaction





- Functional Apartment
 - Trial Living, **Everyday Usability**
- Mobility Assistants
 - **iWalker, Rolland** (Otto Bock)
- Integrated Control, Intelligent Furniture
 - Light, shades, temperature, sliding doors ...
 - Kitchenette, refrigerator, wardrobe, bed, ...
- Integrated Environment Assistance
 - Complex scenarios, added value services, interoperability
- Natural Multi-Modal Interaction
 - Head-joystick, RollScroll, Touch Screen,
 - Language, clarification dialogues, intention

BAALL: Kitchen

- Intelligent Furniture
 - Kitchenette, cupboards



Mobility Assistants



- Xeno *Otto Bock*[®]
QUALITY FOR LIFE

IntelligentWalker

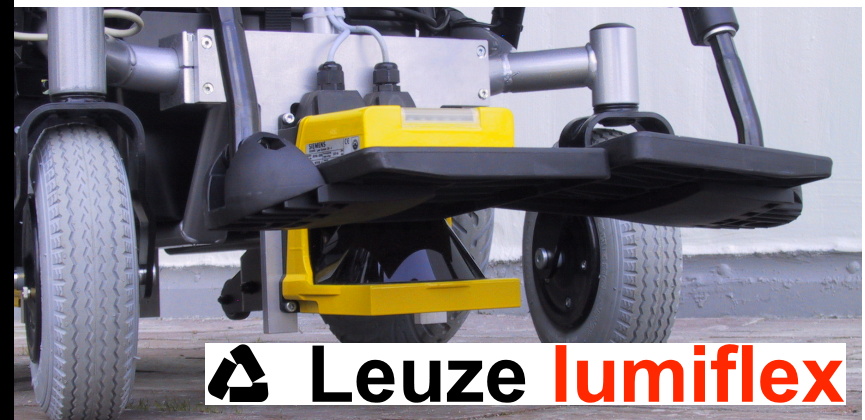
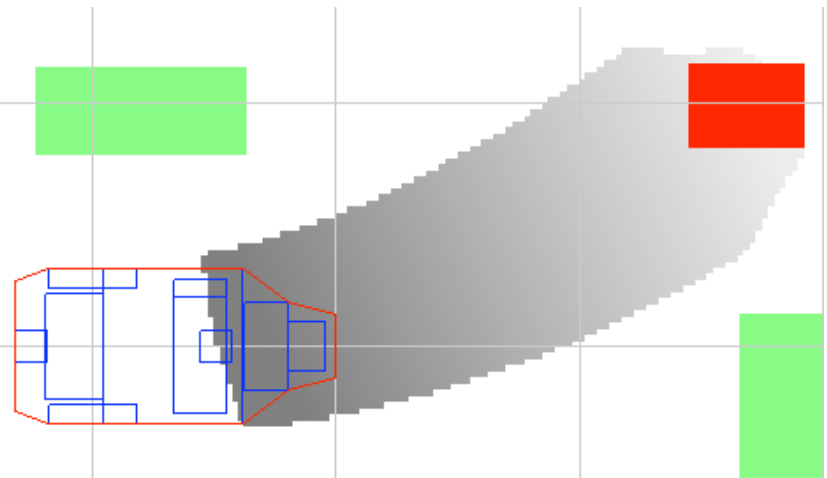


Safe Service Robotics



- Safe Autonomous Mobile Systems (BMBF)
 - Brakes safely

Dynamic safety zone



Head-Joystick



- Avoids obstacles
- + door jambs
- Safe U-turn



iWalker Walking Assistant



- Avoids obstacles
- + door jambs
- Brakes



iWalker Walking Assistant



- Avoids obstacles safely



iWalker Route Assistant



- Guides to goal
- Arrow | Brakes
- Language
- Goal Selection in Menue
- *RollScroll*



Xeno Route Assistant



- Autonomous Driving
- Environment Control



- Natural Language Interaction



Cognitive Assistance Systems



- Safe **Cognitively Appropriate** Interaction
 - Formalisation of **Dialogue Control**
 - Safe **Multimodal Interaction**
 - Detection of **Shared Control** Ambiguities
 - **Clarification** Dialogues
- Application in Pro-Active **Environment Control**
 - Bremen **Ambient Assisted Living Lab**
 - **Monitoring** Activities of Daily Living
- Building Automation
 - Semantic Self-**Configuration**
 - **Interoperability**, Standardisation

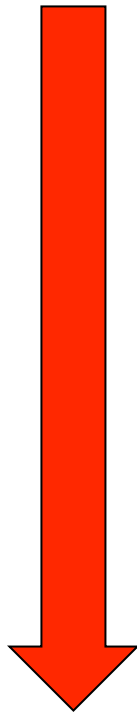
FM: Development | Application



CASL



Cognitive
Technical Systems

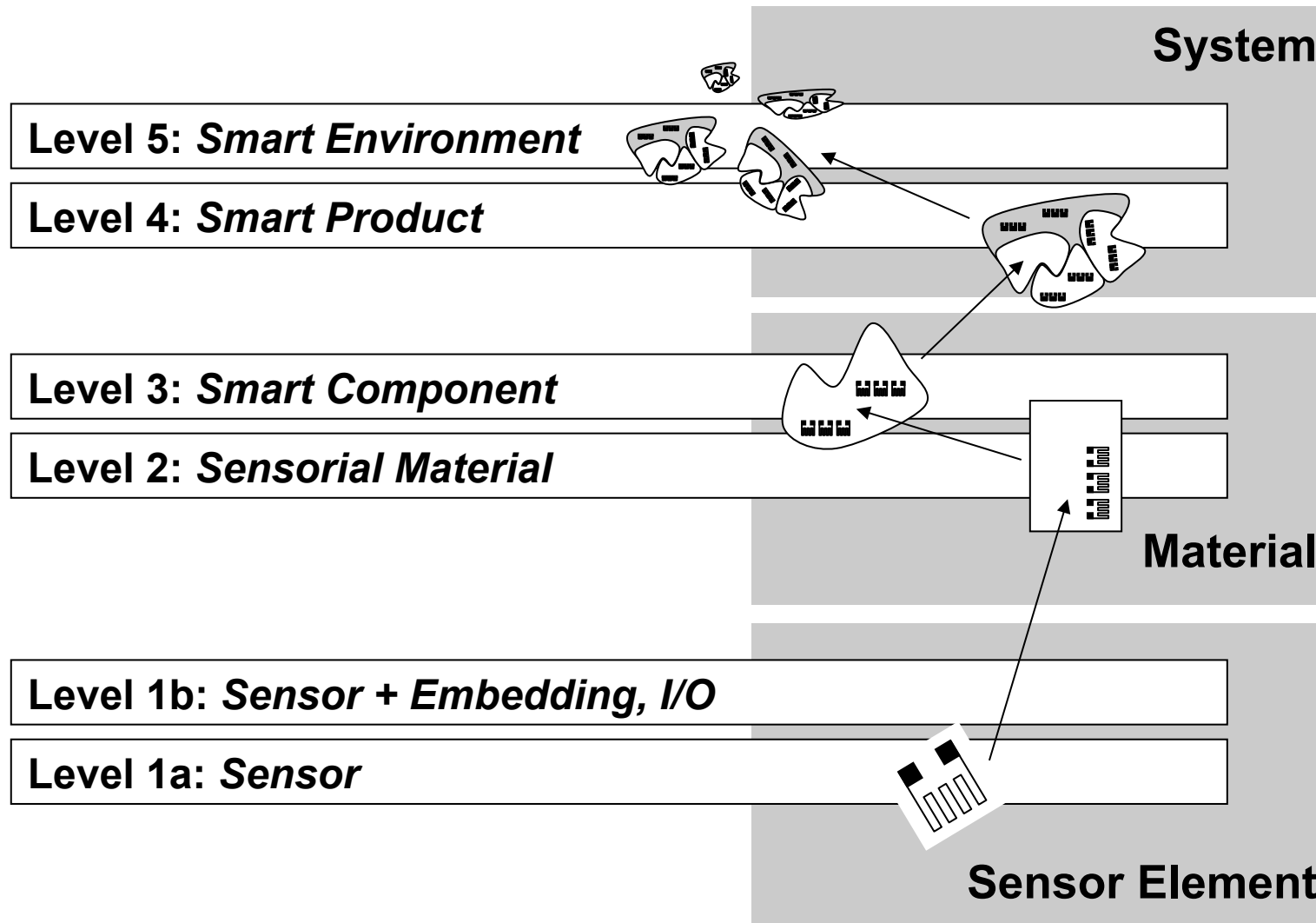


Safe & Secure
Systems



Safe & Secure
Cognitive Systems

Integration of Sensorial Materials





- Sensorial Material \Rightarrow IT-System
 - Micro-View Analogous to Macro-View, Global \Leftrightarrow Local Behaviour
 - Highly Distributed, Large-Scale Network
 - High, Last Minute Flexibility, Adaptation to Individual Requirements
- Complex Processes, Autonomous Decisions
 - Coordinate in Society of Interacting Autonomous Agents
 - Monitor Status, Negotiate Common Environmental Conditions
 - Detect Anomalies \Rightarrow Reconfigure Service and Control Processes
- Sensorial Material \Rightarrow Cognitive System
 - Situated Agents: Spatial and Temporal Awareness, Embodiment
 - Spatial Neighbourhood, Spatial Map, Spatial Computation
 - Sensorial Perception, Learning, Reasoning, Interaction
 - Reflection of Situation to Make Complex Decisions, Explanation



- Ubiquitous Computing
- Semantic Product Memory
- Smart Items in Intelligent Environments
 - Smart Appliances, Furniture, Kitchen Tools, Wallpaper, Fabrics
 - Smart Home, AAL, Smart Office, AAW, Smart City
 - Smart Containers \Rightarrow Transport Logistics
 - Smart Factory \Rightarrow Production Logistics
- Spatial and Temporal Awareness, Embodiment
 - Smart Skin in Robotics
 - Smart Airplane Wings
 - Temperature, Pressure, Gyros \Rightarrow Location, Stability



Spatio-Temporal Processes

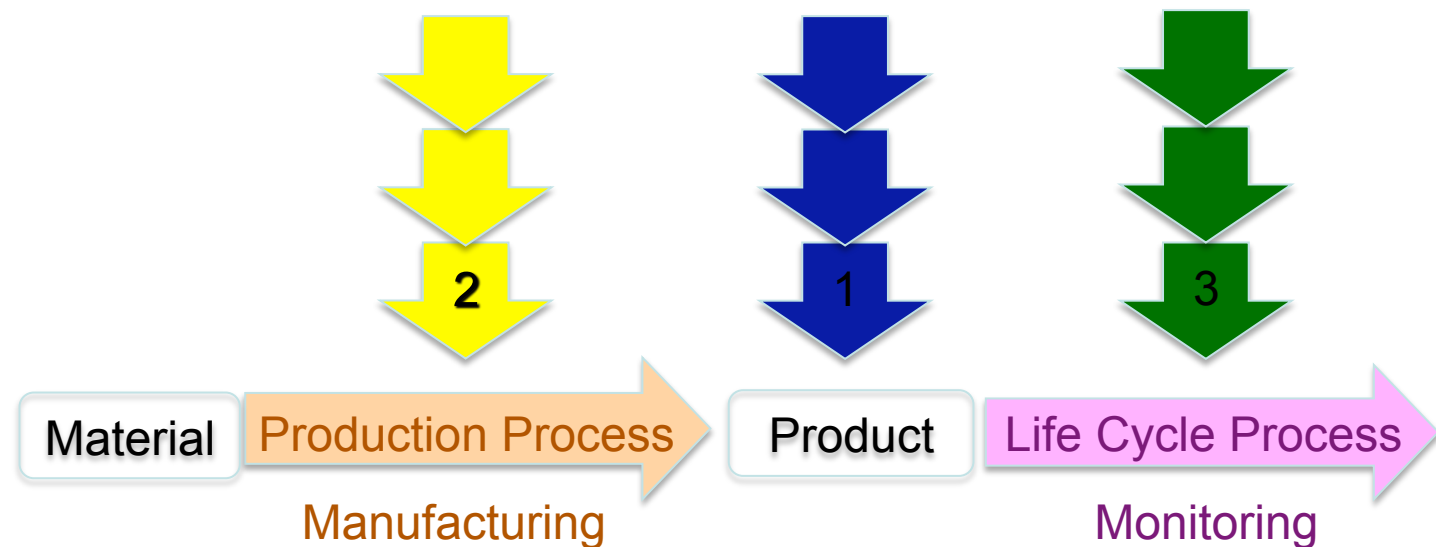


- Complex Processes with Spatial Intelligence
 - Smart Units, Variety of Heterogeneous Data + Processes
 - Safe and Secure Transitions
- **Autonomy**
 - High, Last Minute Flexibility of Processes
- Safety and Security through Formal Methods
 - Better Understanding of Interrelations and Transitions
 - Proved Safety and Security Properties
 - Correctness w.r.t. Requirements
 - Consistency, Deadlock-Freeness, Liveness
 - Role-Based Access Control During Mobility
 - Monitoring and Prediction, Reaction to Anomalies

Simultaneous Development Processes



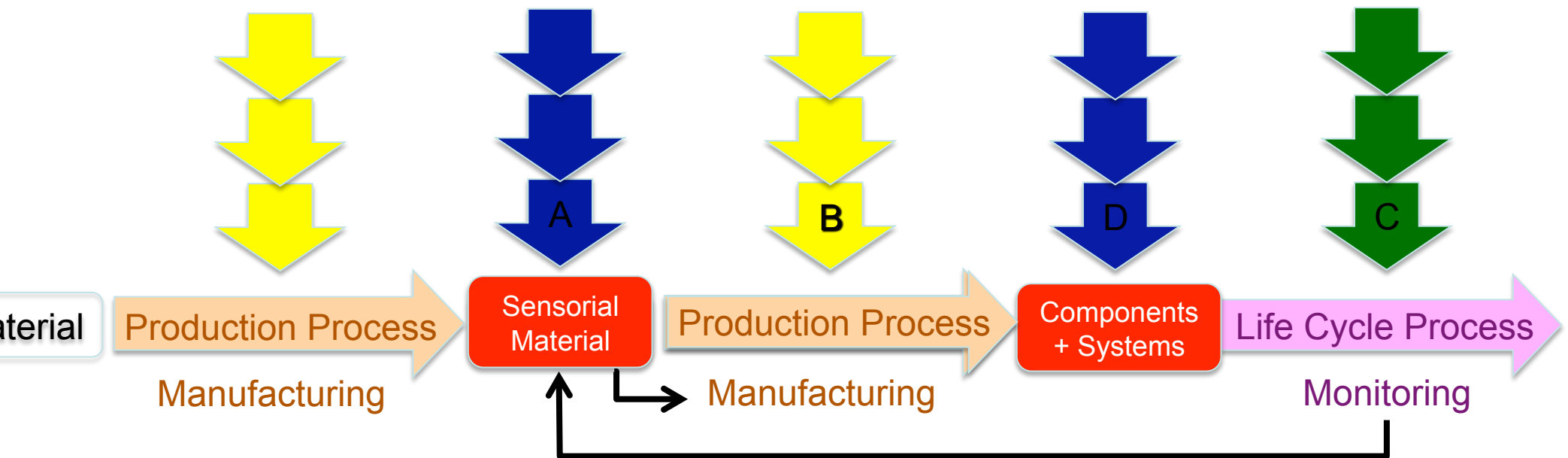
1. Development of the Product
2. Development of the Production Process
3. Development of the Life Cycle Process



Research Areas



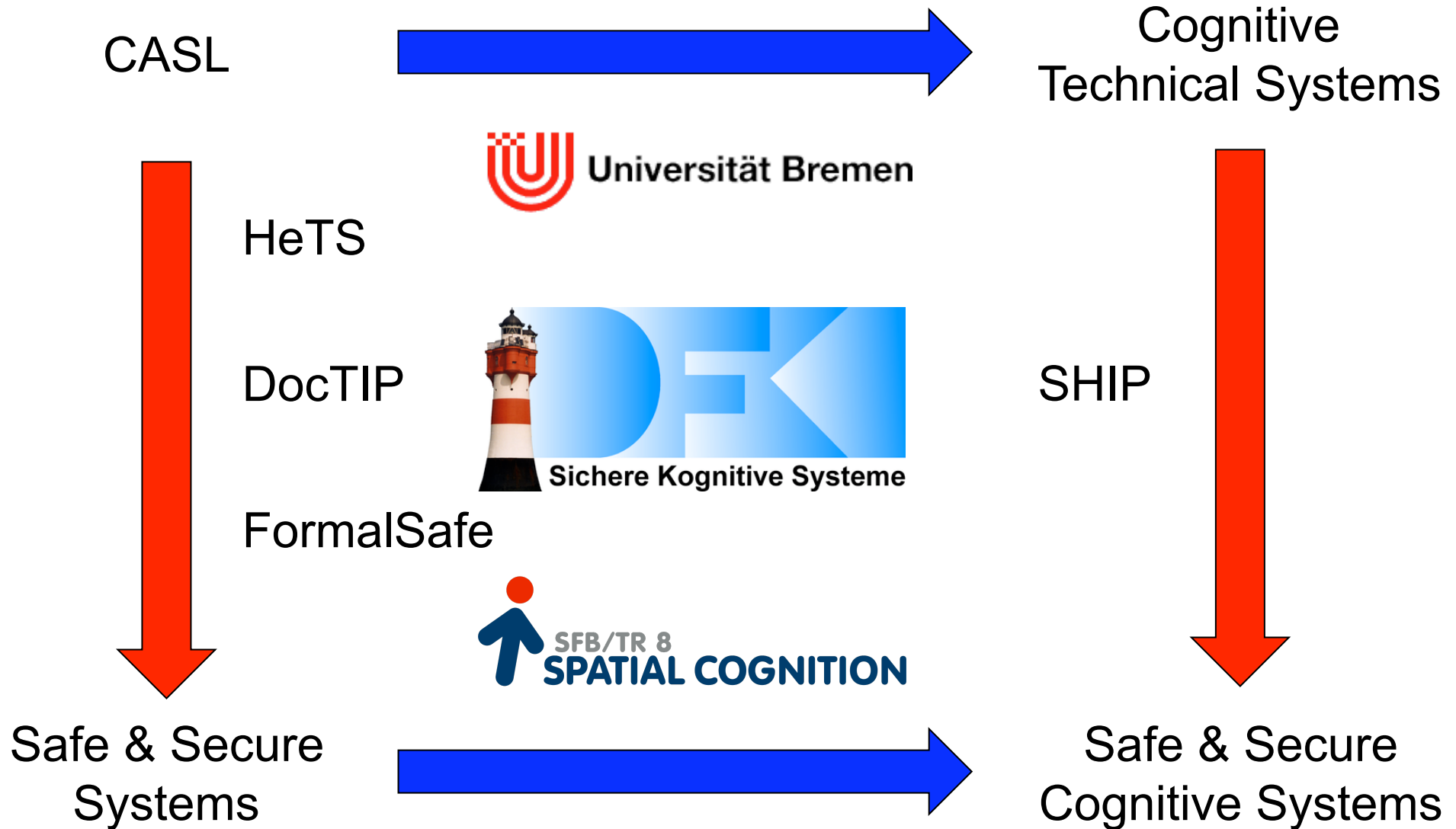
- A. Development of Sensorial Materials
- B. Production with Sensorial Materials
- C. Cognition for Intelligent Decisions
- D. Smart Components and Systems





- Control Processes
 - Interaction among Objects, with Users, with the Environment
- Monitoring Processes
 - Properties of Objects, Users, Environments
 - Difference w.r.t. Prediction According to Model
 - Expected Behaviour, Degeneration => Maintenance, Repair
- (Re-)Configuration (Meta-)Processes
 - Additional Objects, Functionality, Higher Services (“Plug-and-Play”)
 - Added Value for Existing Product in New Application Context
 - Mobility of Objects
 - Preservation of Properties, Semantic Product Memory
 - Mobility of Users
 - Preservation of Profiles: Preferences, Medical Data, Status

FM: Development | Application



Safe and Secure Technical Systems



- Safety in Robotics
 - Verification of Safe and Secure Mobile Systems
 - Re-Certification (Change Management for Certificates)
- Security
 - Reliable and Confidential Interaction, *SOKNOS*
 - Certificates for Reliable Security
- Semantics of Heterogeneous Development Processes
 - Heterogeneous Semantic Integration of Processes (SHIP)
 - Sensorial Materials Enabling Intelligent Products
 - Semantics in Technical Developments & Production Processes

BKB's Pushout

