Webinar:

AI-supported requirements management

Development of Requirements Engineering (1/2)

1968 – The „Software Crisis"

From Software Crisis to Formal Specification:
1968/1969 NATO Conferences on Software Engineering **introduced the term *Software Engineering*** as a response to large-scale project failures.
Recognition that unclear or missing requirements were a root cause of failure.

1993 – Requirements Engineering becomes a discipline

Requirements Engineering as an Independent Discipline:
1993 – First IEEE International **Symposium on Requirements Engineering** (RE'93) establishes RE as its own research and practice domain.
1997 – UML Standardization (OMG) Model-based representation of requirements and system behavior.

1998 – Standardization of SRS quality (IEEE 830)

1998 – IEEE 830-1998 (Software Requirements Specification):
Defined: Structure of SRS documents, Quality attributes (correct, unambiguous, complete, consistent, verifiable, traceable, etc.)
→ Became a global reference for "good requirements".

2001 – Agile Requirements Engineering

2001 – Agile Manifesto
- Shift from heavy documentation to working software
- Emphasis on collaboration and adaptability

2011 – ISO/IEC/IEEE 29148

Systems Engineering and Compliance-Driven RE:
ISO/IEC/IEEE 29148:2011 defines **consolidated requirements engineering processes** and characteristics of high-quality requirements.
Introduction of Functional Safety & Regulated Domains

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Development of Requirements Engineering (2/2)

2018 – Systems perspective strengthened

2018 – ISO/IEC/IEEE 29148 (2nd Edition):
- Strengthened **integration into systems engineering lifecycle**
- Key Shift: Requirements Engineering became central to safety, compliance, and system integration.

2023–2025 – AI-supported and Continuous RE

Continuous and AI-Supported Requirements Engineering:
Continuous Requirements Engineering – integration with DevOPS, Continuous Integration, MBSE
AI and LLMs: Research and early adoption in Requirements elicitation, automation, traceability support, check for completeness

2026- 2030: (Forecast): Autonomous & Knowledge Centric Requirements Engineering

Autonomous & Knowledge Centric Requirements Engineering
Based on current research: AI Agents as Requirements Co-Engineers; Semantic knowledge graphs replace static documents; MBSE integration; Continuous certification & Compliance automation

Researches and current studies indicates not just better text generation, but **machine-reasonable requirements ecosystems!**

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Typical Challenges within Requirements Management

- **Increasing System Complexity:**
  - Systems are interdisciplinary (software, hardware, mechanics)
  - Multiple abstraction levels (stakeholder → system → subsystem → software)
- **Change Volatility**
  - Agile iterations
  - Customer feedback loops
  - Regulatory updates
- **Traceability Overhead**
  - Bidirectional traceability required in regulated environments
- **Inconsistency & Ambiguity**
  - Contradictory requirements
- **Siloed Toolchains**
  - Requirements tools separate from: Architecture tools; Test management systems; DevOps pipelines
- **Scalability in Large Organization**

Understanding the **impact of changes** across the systems **becomes difficult.**

Requirements are frequently updated → **risk of inconsistency** and **outdated artifacts**.

Manual maintenance is time-consuming and error-prone.

Errors propagate into design and test phases.

Governance, alignment, and visibility become **difficult.**

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Characteristics of Modern Requirements Management

- **Lifecycle Integration**
  - Integrates requirements across: Engineering, Architecture, Testing, Operations
  - Supports continuous refinement
- **Continuous Traceability**
  - Impact analysis capabilities
  - Bidirectional traceability across abstraction levels
- **Versioned & Incremental Requirements**
  - Baselines
  - Variant management
- **Quality Governance & Review Mechanisms**
  - Standardized requirement templates
  - Formal review workflows
- **Model-Based & Structured Representation**
  - Integration with MBSE
  - Structured attributes instead of pure text

Complexity
Tool silos

Traceability
Overhead

Change
Volatility

Ambiguity
Inconsistency

Complexity
Scalability

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AI-Augmented Requirements Management (Emerging)

From Manual Control to Intelligent Assistance

AI Use Cases:

- **Automatic Ambiguity Detection**
  - Detects vague terms (“fast”, “user-friendly”, “sufficient”)
  - Identifies missing measurable criteria
  - Suggests reformulations based on predefined requirement template

- **Higher** requirement **quality** before review
- **Reduced rework** in later phases

- **Semantic Similarity Checks**
  - Embedding-based similarity detection across large requirement sets
  - Identifies:
    - Duplicate requirements
    - Overlapping statements
    - Potential contradictions

- **Prevents redundancy**
- Reveals **hidden inconsistencies**
- **Supports harmonization** across teams

- **Consistency Verification**
  - Cross-checks requirements across abstraction levels (Stakeholder → System → Software → Test)
  - Detects logical contradictions
  - Identifies missing refinements or broken trace links
  - Supports compliance validation (e.g., safety constraints)

- Reduced **hidden inconsistencies**
- Improved **traceability integrity**

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AI-Augmented Requirements Management (Emerging)

From Manual Control to Intelligent Assistance

AI Use Cases:

- **Requirement Derivation Support**
  - Automatically derives:
    - System requirements from stakeholder requirements
    - Software requirements from system requirements
    - Initial test cases from requirements
  - Highlights missing decomposition steps

- **Smart Impact Analysis**
  - Analyzes change requests semantically
  - Identifies potentially affected:
    - Requirements
    - Architecture elements
    - Test cases
    - Risk items
  - Prioritizes impact probability

- **Reduced manual effort**
- **Accelerated** engineering **workflows**
- **More complete requirement** hierarchies

- **Faster change evaluation**
- Reduced **review bottlenecks**
- **Improved decision support**

AI-supported requirements management

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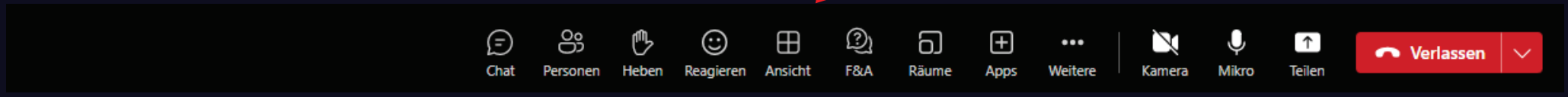
Organizational Topics

- Participants shall be muted during presentation
- We use “F&A” (Q&A) functionality to collect questions. Questions will be discussed at the end of the presentation.



- Please note that the webinar will be recorded!

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Innovigate GmbH

Innovative product development and process optimization

As a management consultancy, we accompany product developments and processes through project support, workshops and training courses in the direction of innovation, quality and cost reduction.

In doing so, we rely on the combination of specialist knowledge and proven methods, which you can learn about in our practice-oriented courses and workshops and apply directly in your projects.

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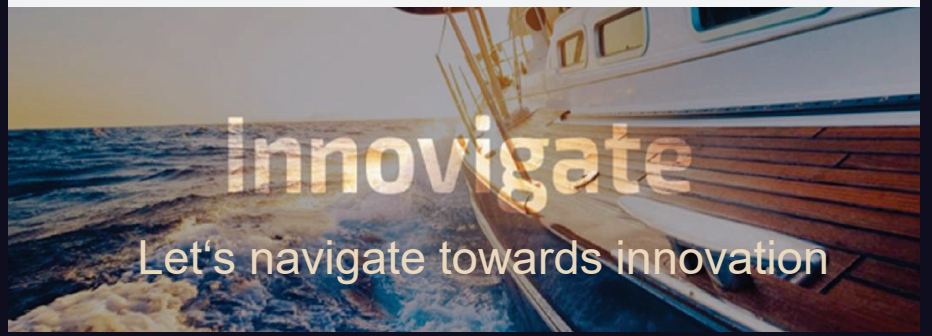
Our formats:

- Trainings
- Consulting & Workshops
- Project support
- Coaching



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Innovation & Business Excellence

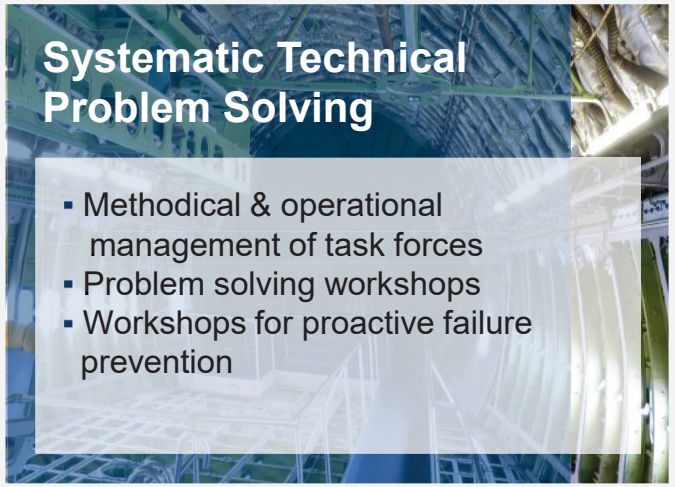
Consulting Support

Advanced Development and Series Development

- Design for Six Sigma (DfSS)
- TRIZ Innovation Methods
- Design Thinking
- Lean Development
- System Architecture
- Product verification & validation

Series Ramp-Ups

- Six Sigma (DMAIC)
- TRIZ Innovation Methods
- Lean Manufacturing
- Risk Management
- Problem Solving & 8D Reporting



Systematic Technical Problem Solving

- Methodical & operational management of task forces
- Problem solving workshops
- Workshops for proactive failure prevention

AI-Powered Innovation and Design for Excellence

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Team

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Managing Director Innovigate GmbH
Dipl.-Ing. Electrical Engineering

Six Sigma Master Black Belt
TRIZ-Level 3 Expert

- Innovation & Methodology Consulting
- AI-Driven Innovation & Product Development
- Lean Six Sigma & Design for Six Sigma
- Training, Workshops & Change Management

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Softwareengineer
B.Sc. Business informatics
M.Sc. Artificial Intelligence

- Full-Stack Software Engineering
- Data-Driven Applications & Systems
- Autonomous & Intelligent Systems
- DevSecOps & Secure Infrastructure

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Tracelane motivation + history

- Many smaller companies still manage requirements using Excel spreadsheets
- Existing tools are often too complex and too expensive
- Clear need for a simple and affordable requirements management solution
- Vision: Combine a modern affordable, easy-to-use requirements engineering tool with AI

- 2025-02: Start of development
- 2025-03: First MVP
- 2025-04: Integration of first AI features
- 2025-07: AI Agent mode
- 2025-08: Version Control and Baselining
- 2025-10: Start of cooperation with Process Fellows
- 2026-01: First public on-prem release
- 2026-02: Ollama Integration

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Tracelane principles

Cloud-Native

Access Tracelane instantly in your browser. No installation, no setup headaches, fully containerized.

On-Prem Focus

Deploy on your own infrastructure for full data control, compliance, and security, without sacrificing usability.

AI integration

Leverage AI to accelerate requirement creation, identify logical conflicts and analyze consistency across system levels

Affordable

Requirements management at a fraction of the cost of traditional tools. Save small companies from being stuck with Excel!

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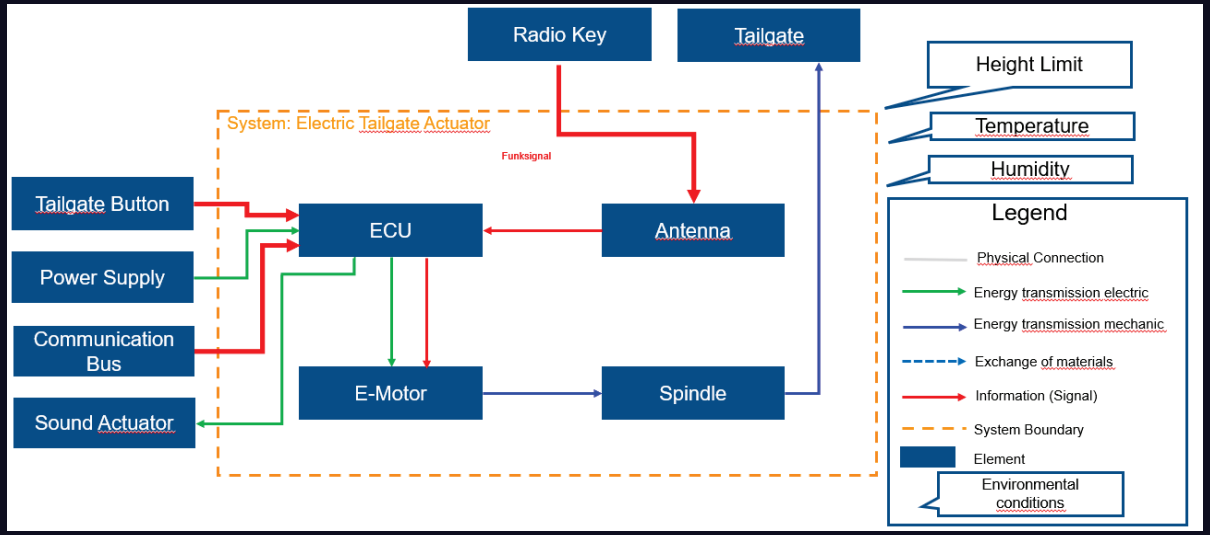
ETG Example

Electronic Tailgate

- Our dummy project is about developing a electronic tailgate for a car
- The system consists of multiple system elements
- We create use cases and requirements on (sub-)system and domain level



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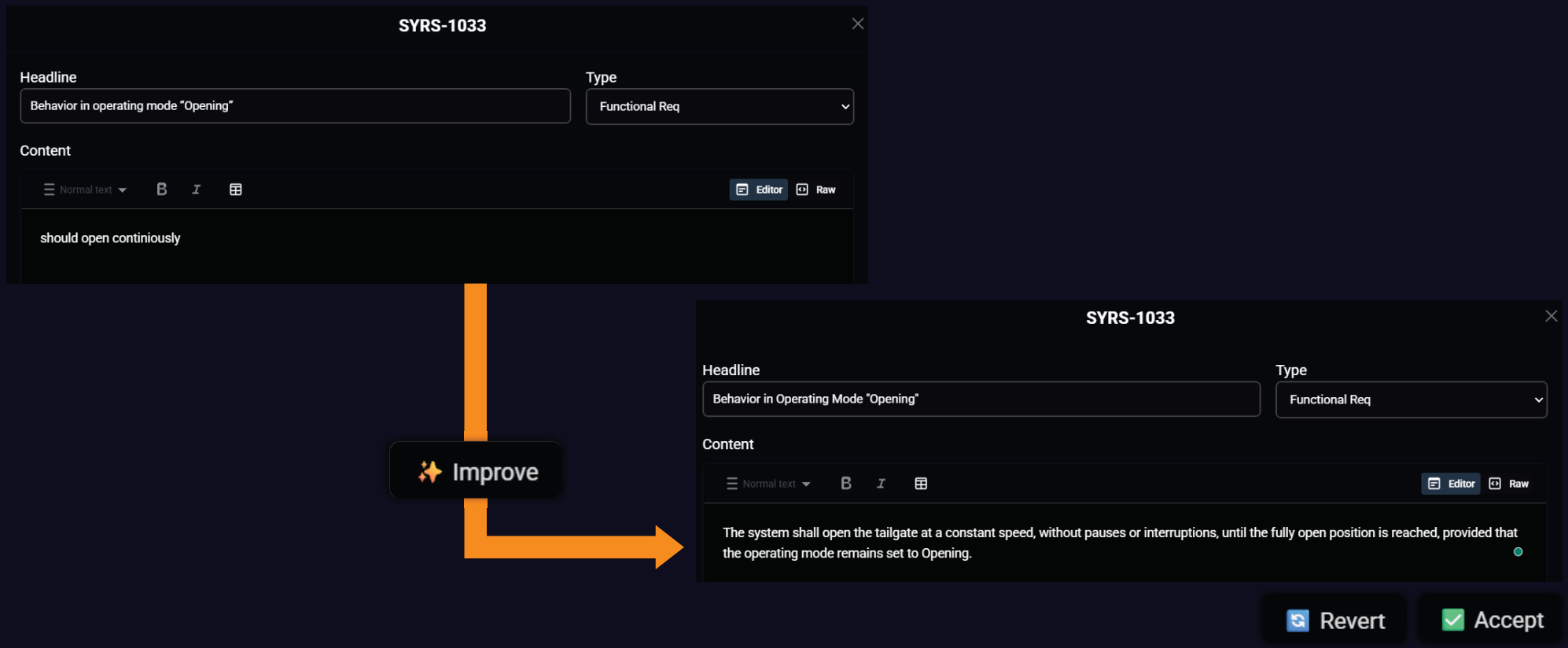
UC1 – Ambiguity Detection and Correction

- The AI rewrites a poorly written requirement, makes it measurable and specific.



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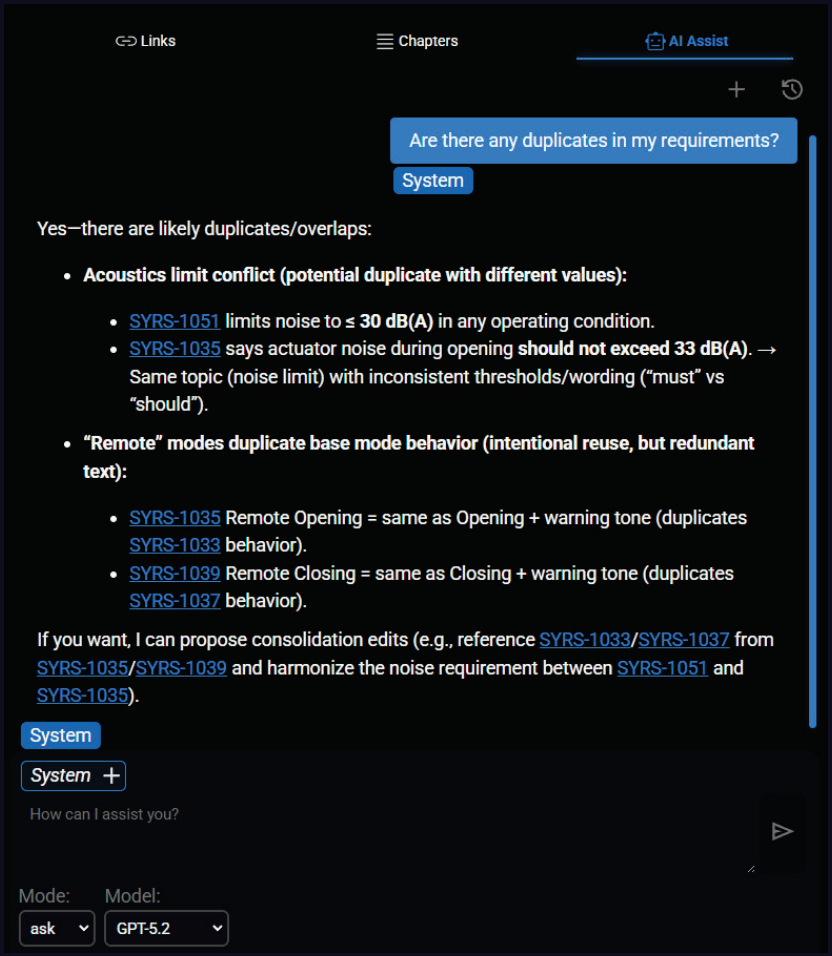
UC2 – Semantic Similarity Checks

- The AI can identify duplicate requirements, overlaps and ambiguities

- It successfully detects that acoustic limits for the ETG actuators are defined twice in this example



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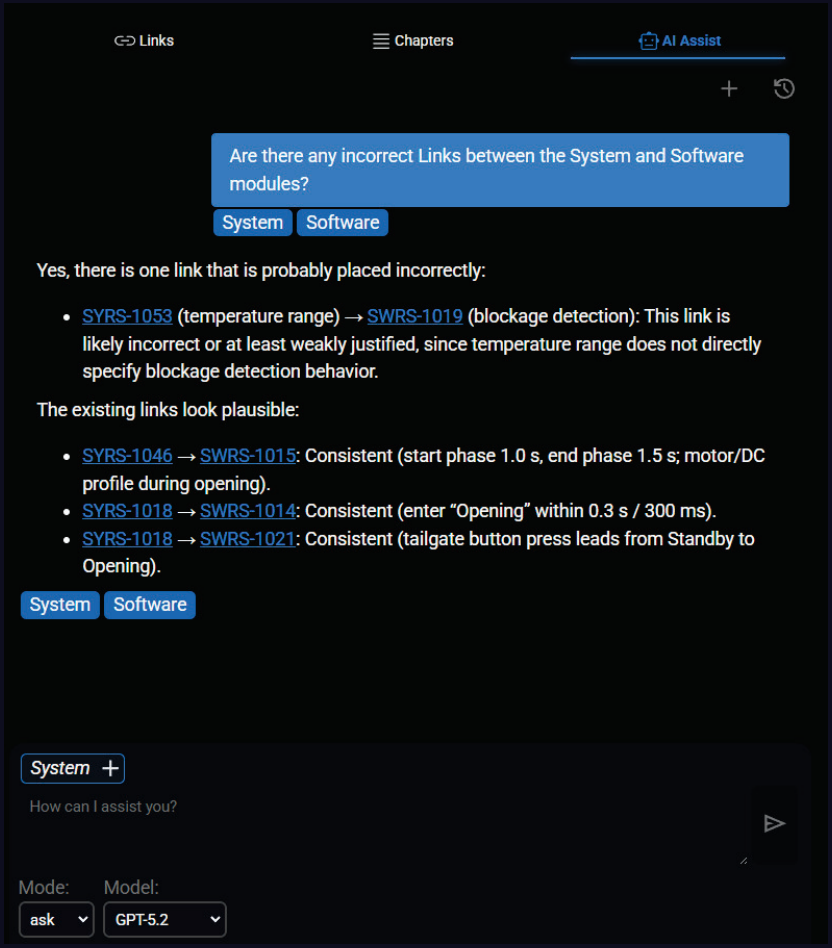
UC3 – Consistency Verification across System levels

- Tracelane can analyze existing links between requirements semantically and point out links which might be incorrectly set

- It successfully detects, that environmental system requirement was linked to a software requirement about blockage detection



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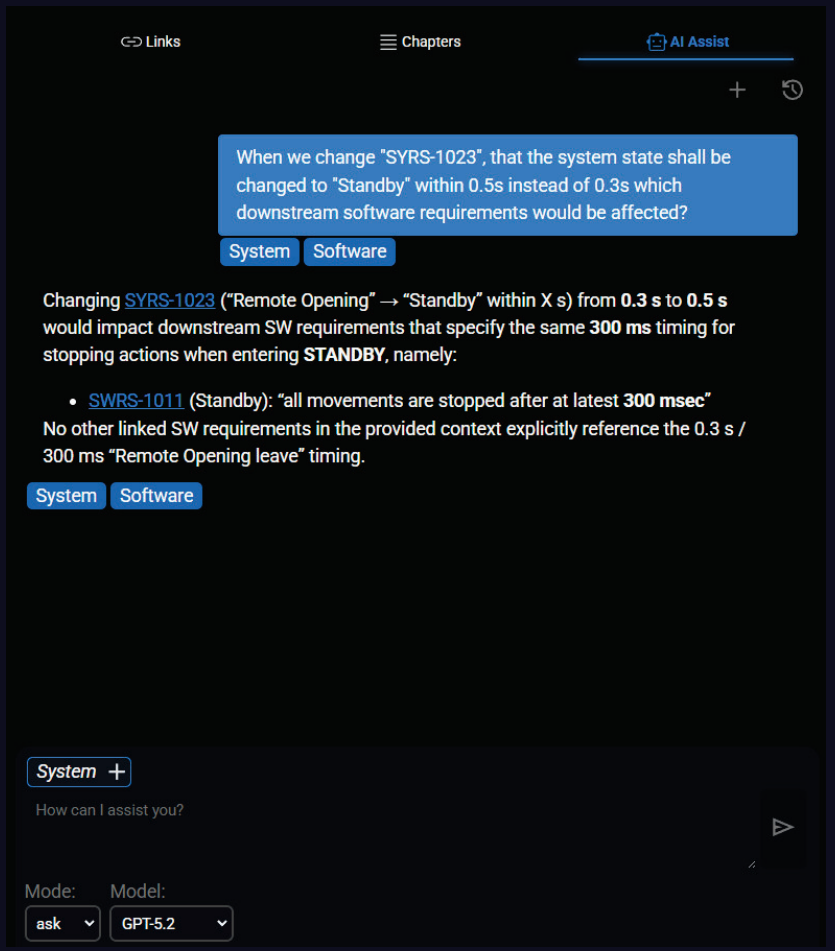
UC4 – Smart Impact Analysis

- Tracelane can analyze semantically which lower level requirements would be affected by a requirements change.
- Traditional systems in contrast would just flag all downstream requirements which are actively linked

- In this case, it successfully detects that the Software Requirement regarding the “Standby” mode would be affected by the change on system level.



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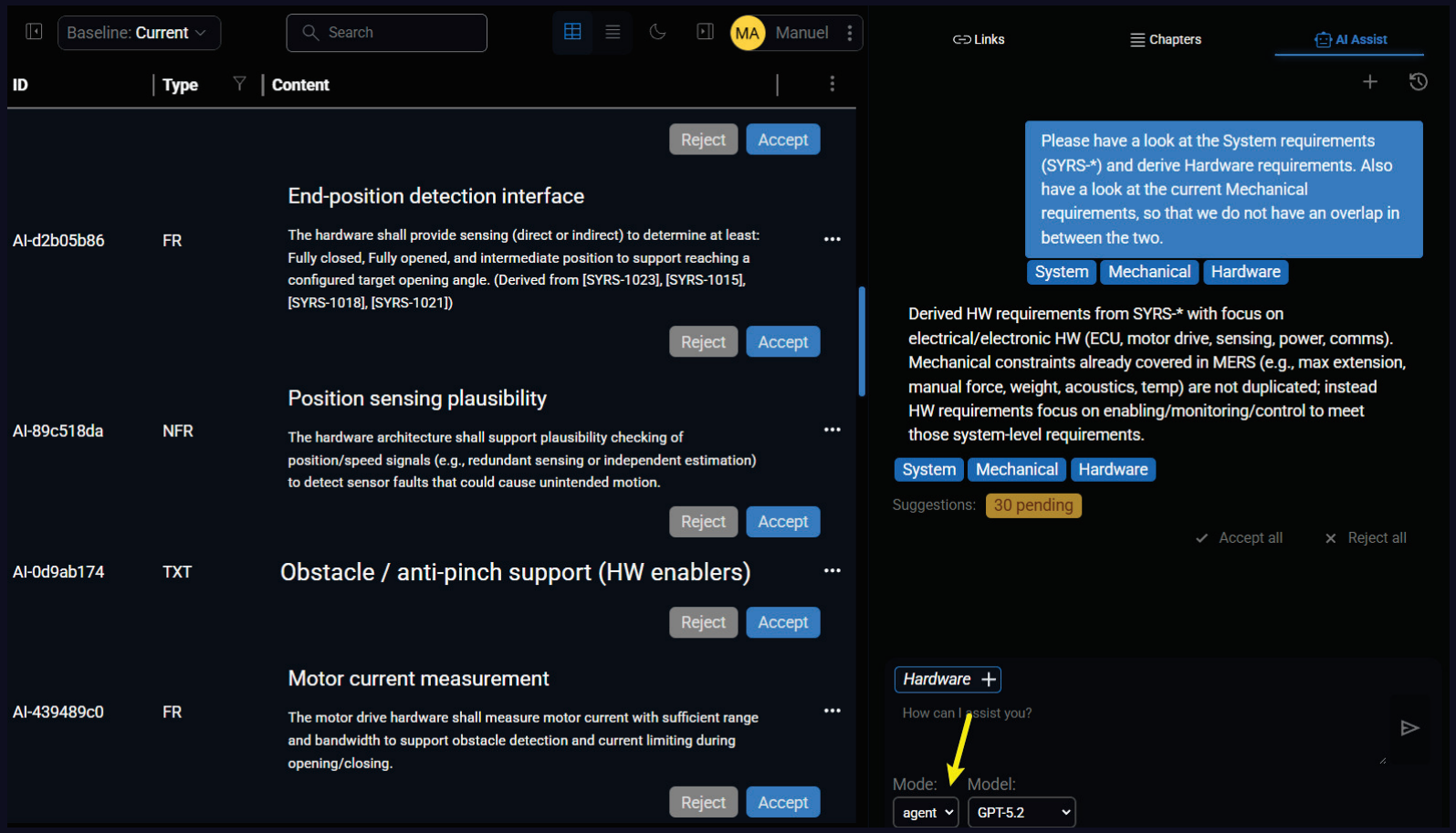
UC5 – Requirements Derivation support

- When the user enables “Agent” Mode, the AI is able to derive Sub-System requirements from higher level requirements which can be used as starting point to accelerate the requirements breakdown



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Tracelane outlook

- ReqIF import/export for full compatibility with DOORS, Polarion, Jama Connect
- Integration with Jira
- Integration with Git
- Proactive AI suggestions and analysis
- Review and approval workflows

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Thank you for your Attention!

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Let's navigate towards innovation

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