OECD NEA
Halden HTO
Project

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AI and operational boundaries: How human-in-the-loop enables faster deployment

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W9 - Me, Myself, and AI: New Frontiers in the Age of Human-AI Operations

Outline

- AI in nuclear: where and for what?
- Challenges
- Dimensions in human-AI teaming
  - Explainability, trust, trustworthiness
  - Automation – remote
  - Role of humans
- Early analysis -> faster deployment
  - Cannot challenge safety
  - ION
- What are the questions that need to be addressed before and during deployment of AI in nuclear?

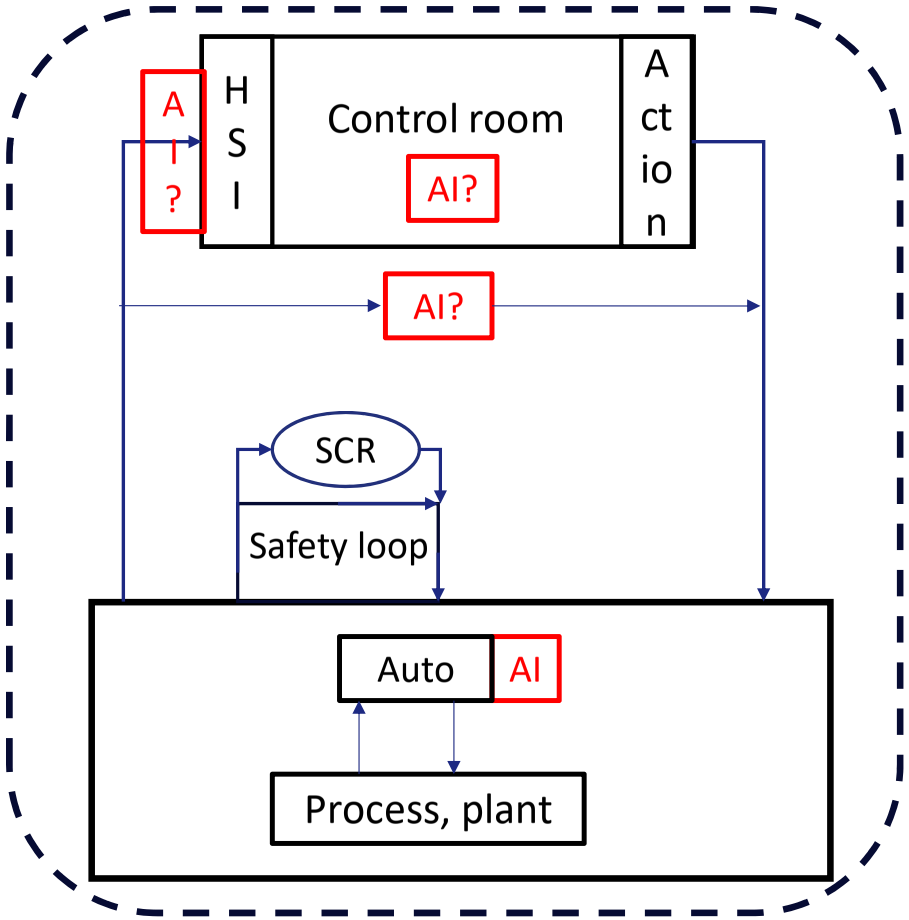
HAMMLAB, Halden human-machine laboratory

AI and Operational Boundaries

- Three years ago: AI and nuclear? NO
- Two years ago, RIC: Skeptical HF people, enthusiastic tech guys
- Now: We embrace the technology, and begin to ask the right questions: *«AI and autonomous technologies redefine operational boundaries»*
  - What are these boundaries?
  - Are the same questions and challenges relevant for all of them?

- AI in the loop?

AI in the control loop?



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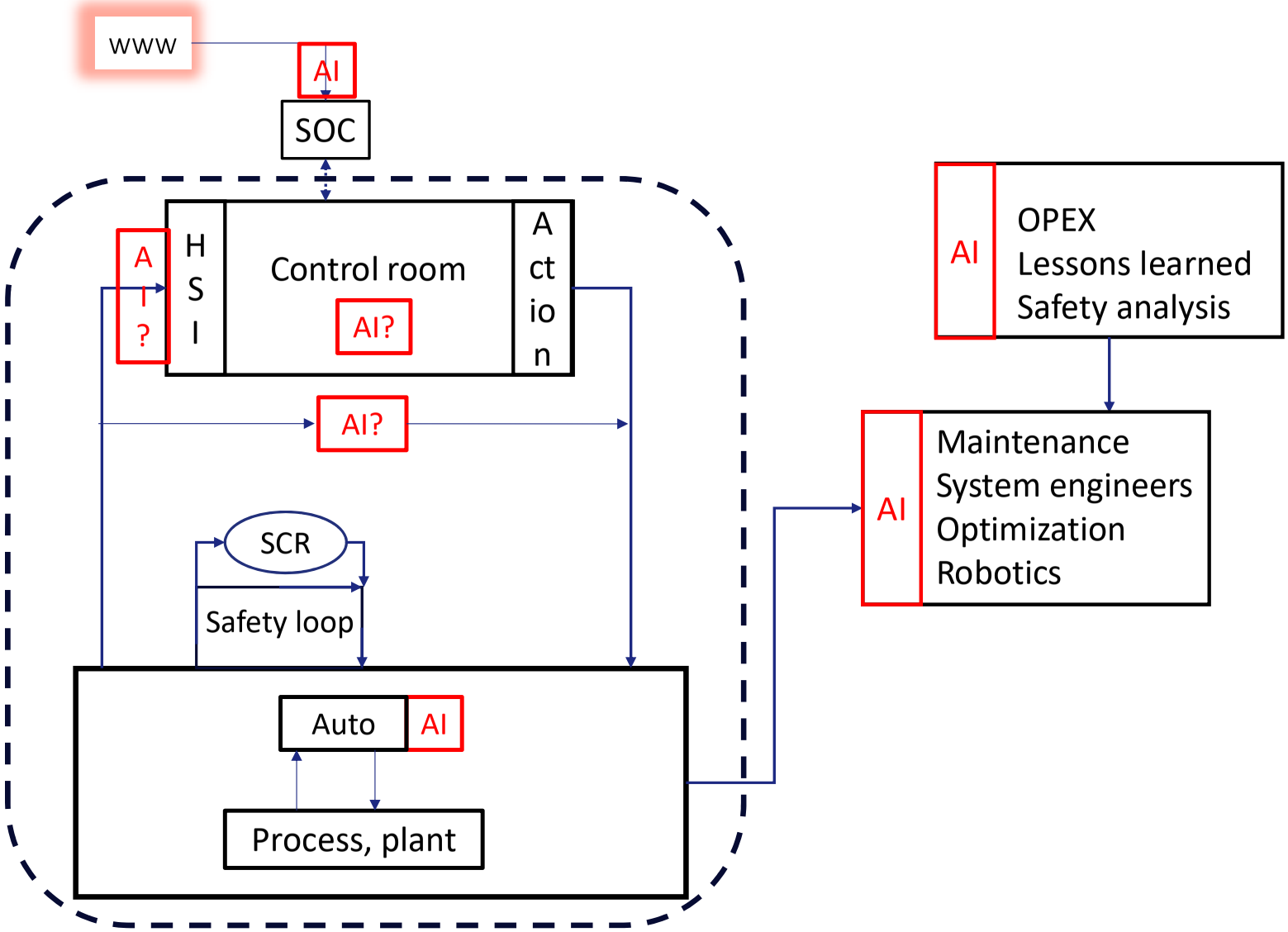
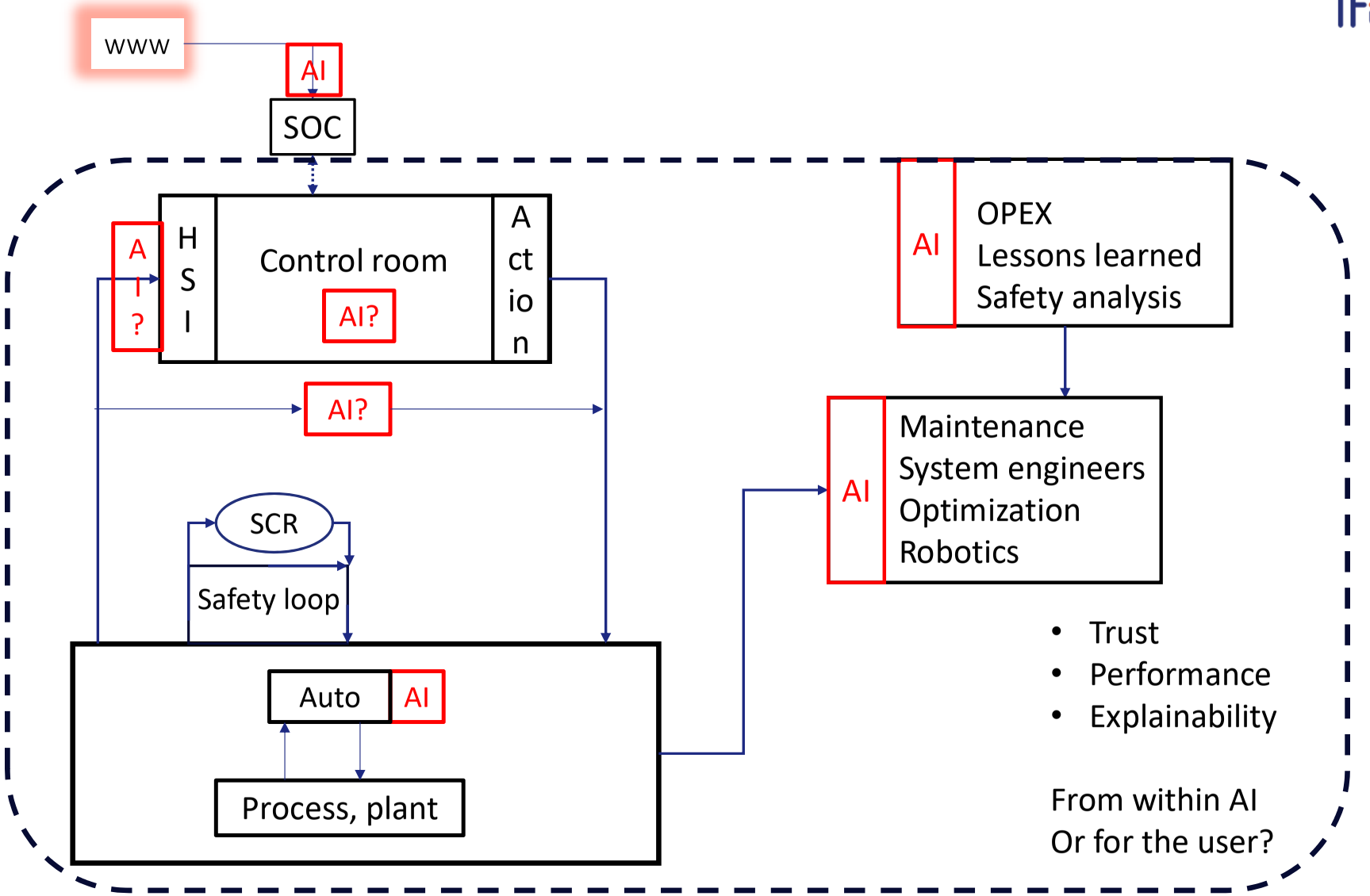
AI in the loop?



AI in the loop?



AI and Operational Boundaries, Qs

- AI is not AI, technologies are different:
  - Large Language Models (LLMs) vs Machine Learning (ML)
- When are we «in the loop»?
  - Are there hidden links?
  - What about confinement?
- What are the dimensions to look into for the various loops?
  - Explainability
  - Performance
  - Risk
  - Human oversight
  - Trust vs trustworthiness
    - From within AI: Trustworthiness (e.g., objective hallusination rate for LLMs, accuracy for ML)
    - For the user collaborating with AI: Trust (this may be miscalibrated)

The role of Human, Technology and Organization (HTO) in the future needs of the nuclear industry

Is there a role for humans in the safe operation of future plants?

- Inherent, passive safety
- Higher degree of automation, autonomous plants, AI?

- Yes.
- Automation: there will always be a role for the human in 24/7 safety related operations (ref Boeing Max8 accidents)
- However, the role of the human will change
  - From manual operation to monitoring and review

Reimagining Human-in-the-loop

- Many ways to succeed
  - Passive monitoring with active AI?
  - Active monitoring with passive AI?
  - Active monitoring with active AI?
- Link to automation
  - Advanced automation?
  - More transparent automation?
  - Finally a possibility to make automation collaborative and exchange views and strategies?
- Different requirements in the various operational boundaries
  - In the control loop and outside the control loop
  - Safety systems vs non-safety
  - Support for detection vs support for diagnosis
- Different technologies – different requirements?
  - Machine learning (ML) can be used if well confined?
  - Large Language Models (LLM) can be used if human oversight, to take care of halluzinations?

How to succeed

- Establish Concepts of Operations early
  - Cannot challenge safety
  - A pure technology-driven approach will thus not work
- Look to ION, Integrated Operations for Nuclear
  - Collaboration with Idaho National Lab
  - A model for implementing fleet-wide integrated operations
  - May include O&M control rooms working together with the control room
  - Can and will include AI systems
  - Utilized in the Petroleum sector (Norway)
  - Establishes a model and concept of operations early
    - What are the different requirements in the control loop, outside the control loop, for remote control
- Makes it possible to do it right the first time, cutting deployment time

How human-in-the-loop enables faster deployment, conclusions

- AI has so much potential, great opportunities
- AI cannot be let loose on safety systems or in the control loop without human oversight and control
- The way to include AI is then to design good human-AI teaming solutions
- And test these before implementation

- Make the concept of operations early
- Test it in simulated conditions
- Verify and validate
- All before or in parallell with technology development
- In short: Good Human Factors Engineering and risk-informed and performance based processes

Thank you!
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