

Thales-Bristol Partnership in Hybrid Autonomous Systems

(T-B PHASE)

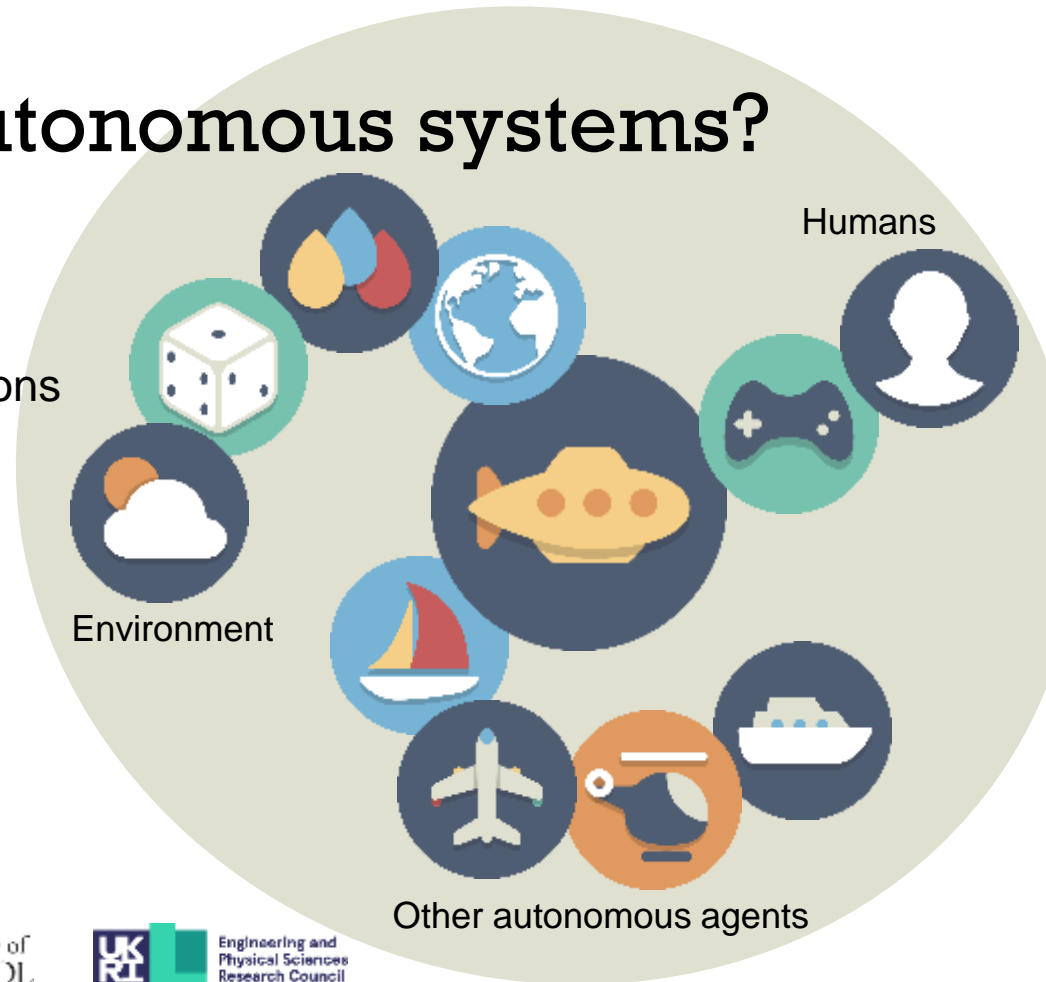
T-B PHASE by Numbers

- £4M Prosperity Partnership
 - £2M EPSRC + £2M Thales
- 5.5 years
 - October 2017 → March 2023
- 20 core staff
 - Thales and Bristol PIs
 - 4 Bristol CIs + Manager
 - 5 Thales BL/Researchers
 - 4 Bristol Researchers
 - 4 PhD Students

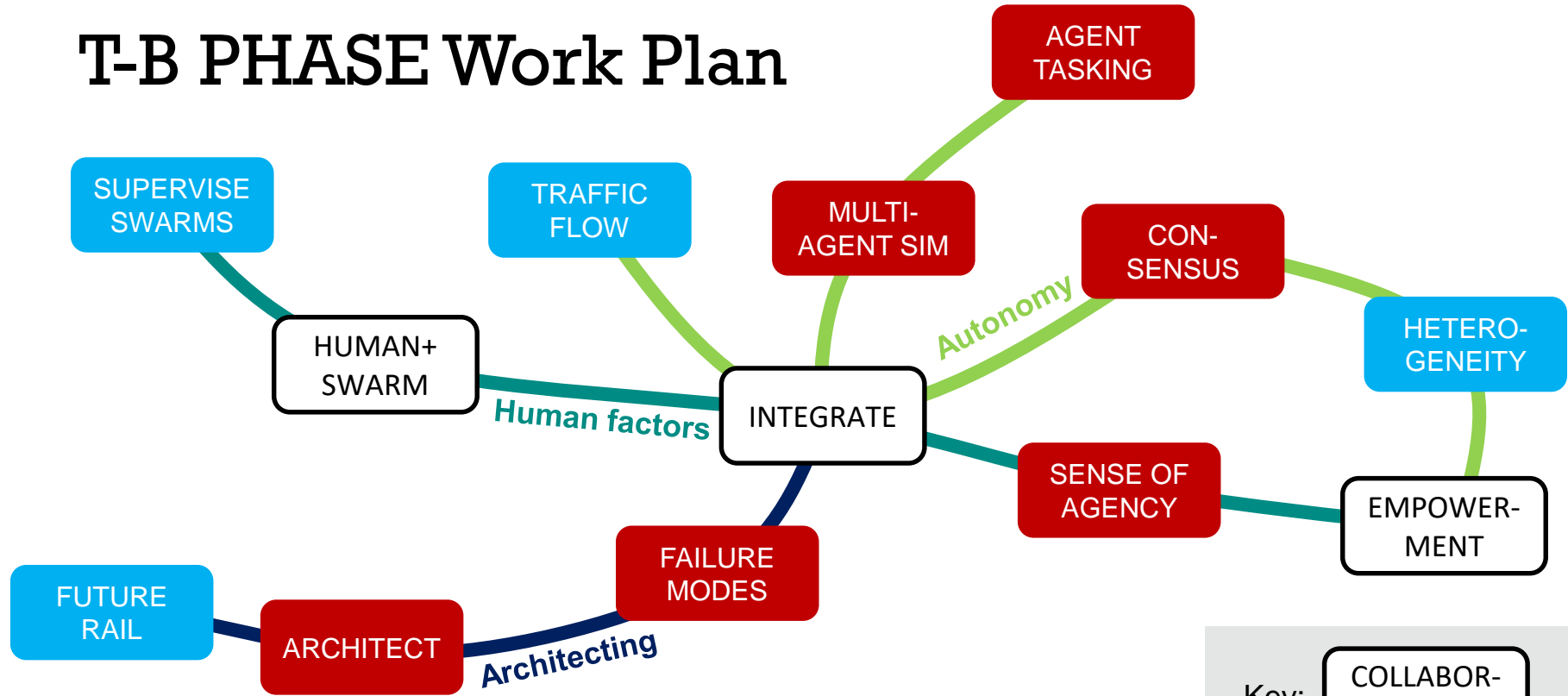


What are hybrid autonomous systems?

- *Autonomous* implies behaviour shaped by interactions
 - Not just following fixed instructions
- Here, *hybrid* means three key interactions:
 - Humans
 - Environment
 - Other autonomous agents
- *System* covers multiple agents



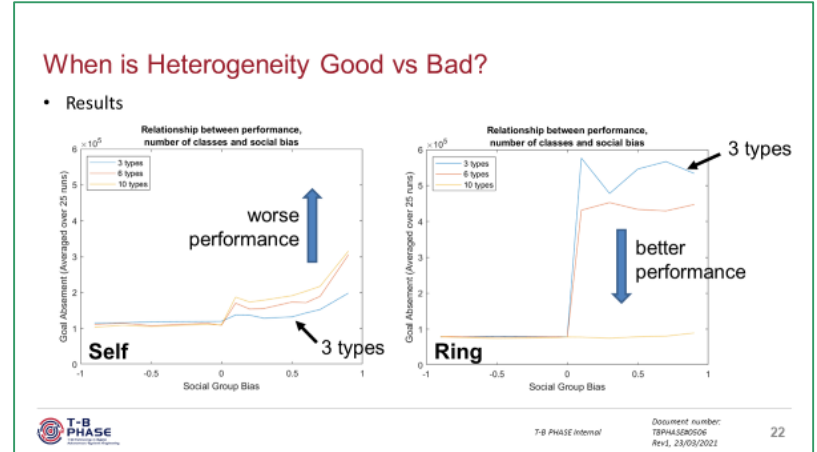
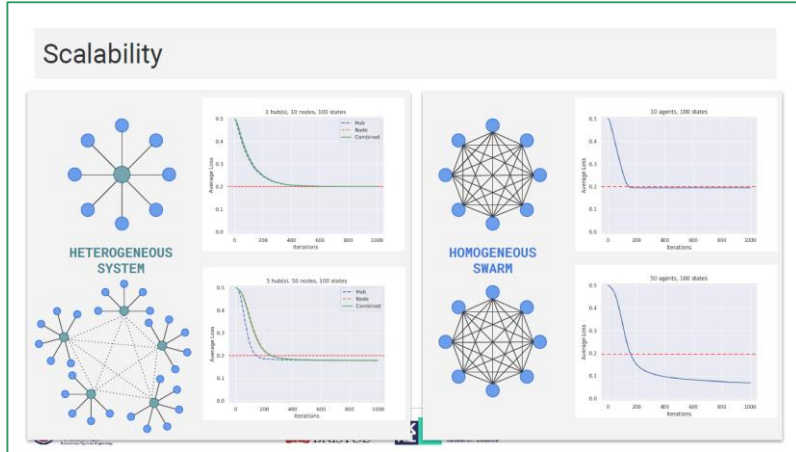
T-B PHASE Work Plan



Key:

- COLLABORATION (white box)
- PHD STUDY (blue box)
- RESEARCH PROJECT (red box)

Summary: Research Projects



Summary: Research Projects

Sense of Agency in Human-Machine Interaction (where are we?)

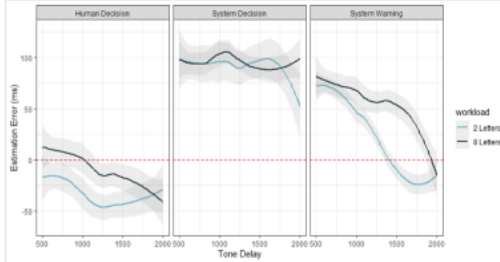
Reproduction of time interval between an action and an acoustic tone:
- Human decision (self-generated action)
- System decision (computer-generated action)
- System warning (self-generated action with computer warning)

Secondary memory task to manipulate workload (2/8 letters to remember during each task)

Time delay manipulation (500-2000 ms)

Two hundred and fifty-three participants

Sense of agency is both automation and workload sensitive. Time plays a key role in improving it in HMI (over 1400 ms).



THALES

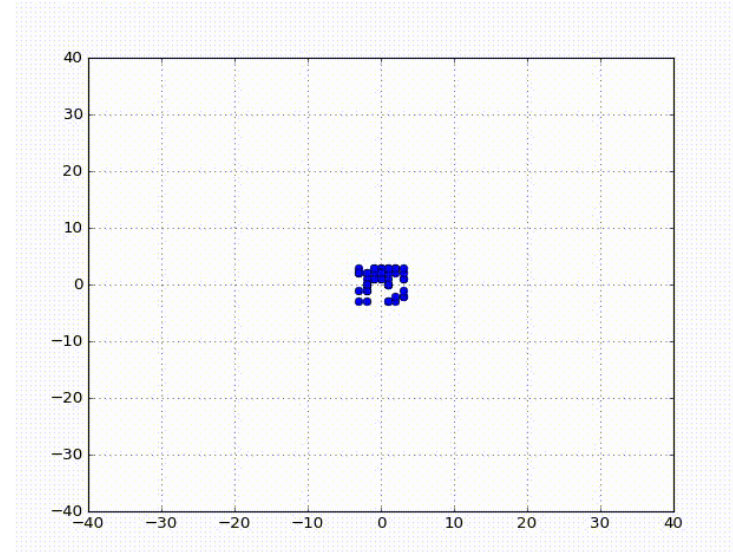


Engineering and
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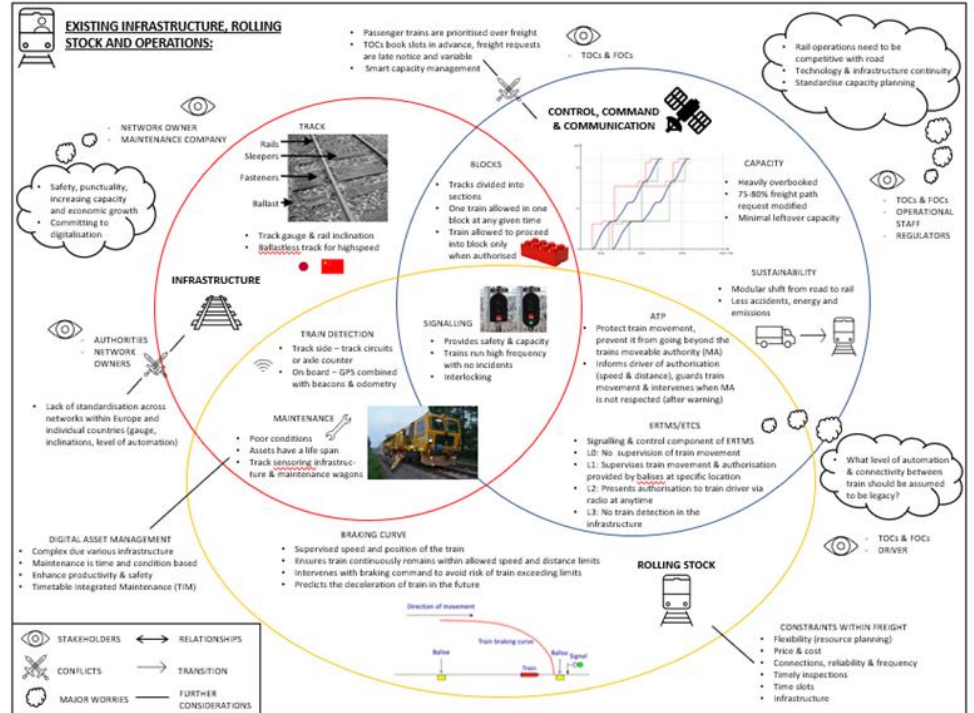
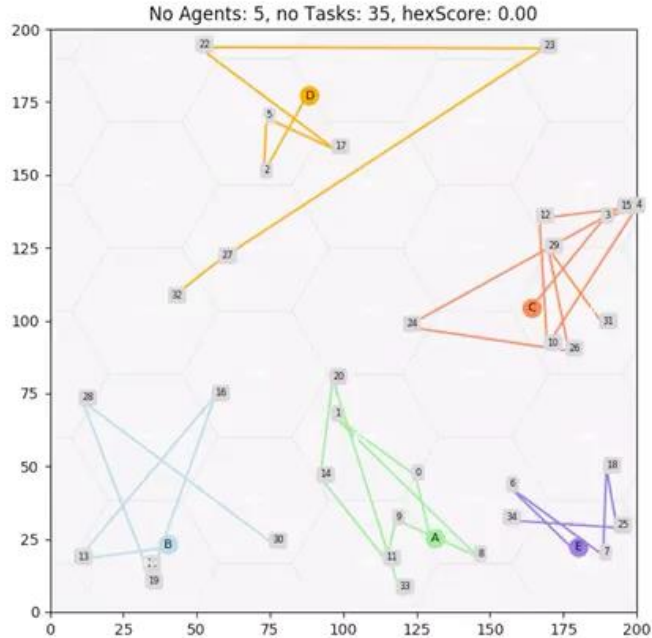
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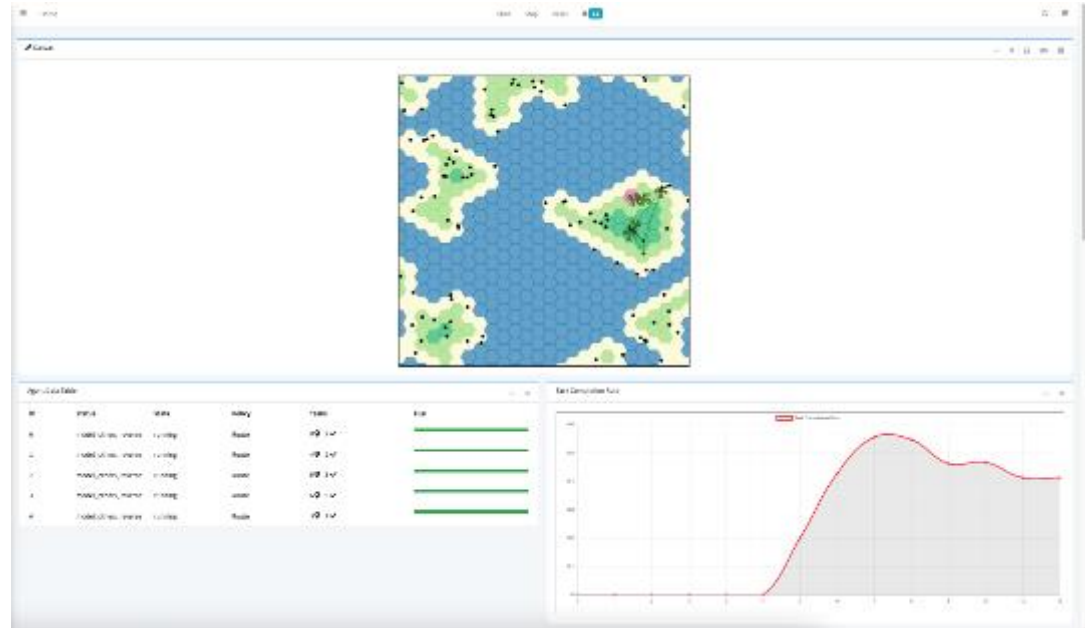


Summary: Research Projects



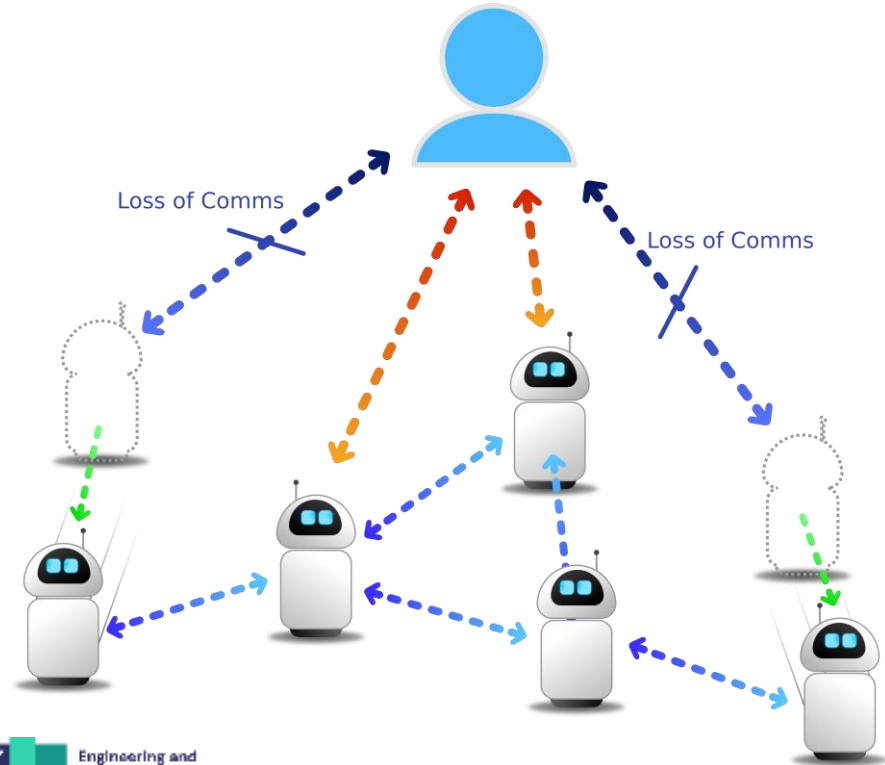
Collaborative Projects: Integrate

- Put existing technology modules in **common software framework**
 - Using T-B PHASE sim
- Evaluate compatibility
 - Define metrics
 - Add failure cases



Collaborative Projects: Human+Swarm

- Conduct formal *participant trials* of swarm supervision
 - Explore use of automated approach
 - Sense of agency as metric
 - Investigate impact of limited information
 - If time, include failures



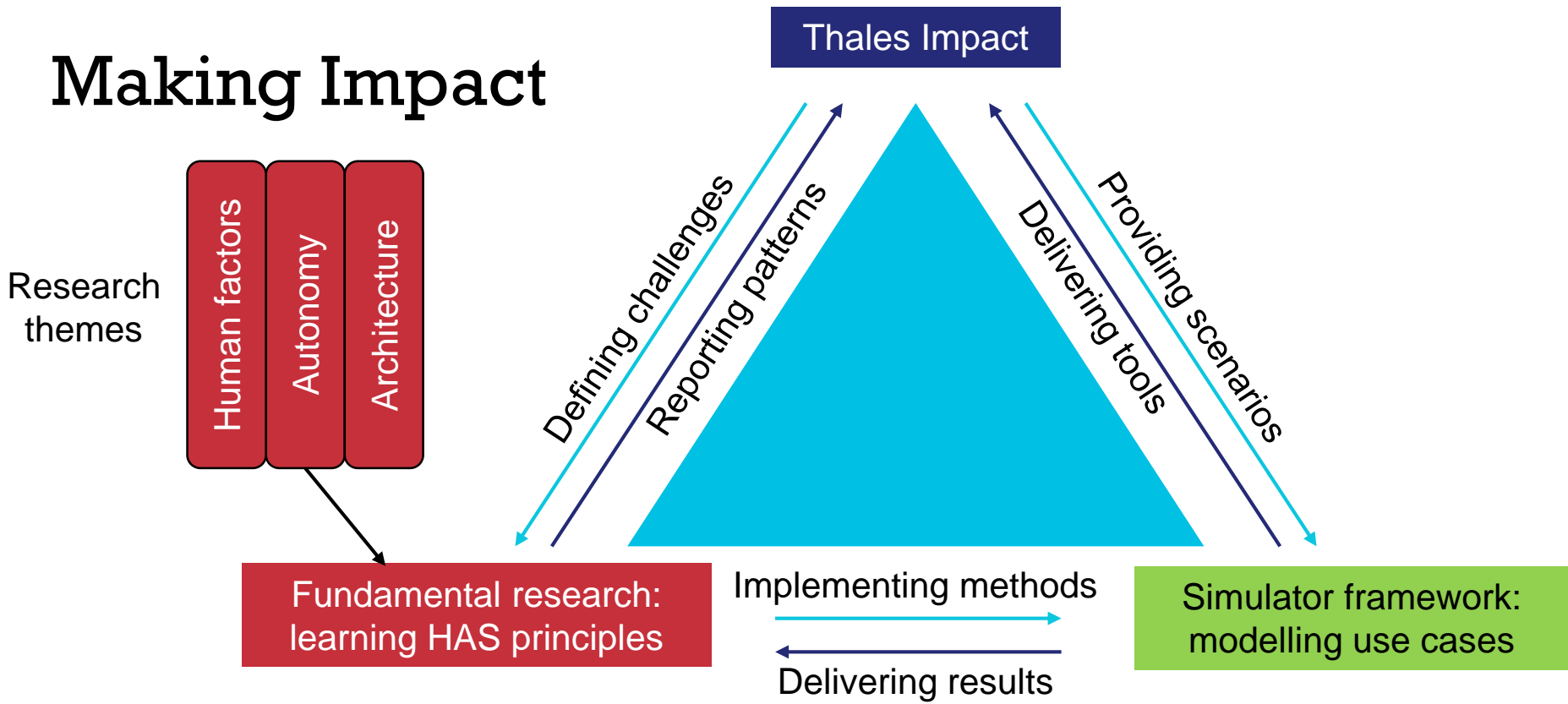
Collaborative Projects: Empowerment

- Formally, **empowerment** is a statistical measure of an agent's ability to effect its environment and to sense that effect
 - A route to integrity monitoring for autonomous systems?

$$\max_{p(a_t)} I(S_{t+1}; A_t)$$

- In human factors, it is analogous to **sense of agency**
 - Overloading of the word “empowerment”, but...
- Are the two related? Correlated? Is there a **matching** issue?

Making Impact



More Collaborations on Autonomy

More Collaborations on Autonomy

- PhD in Explainable AI
 - Student Tom Bewley
 - Producing qualitative explanations of learning from trajectory histories
 - Crowd-sourcing feedback on learning *with Thales Canada*
- PhD in Verification and Validation of AS
 - Supervisor Kerstin Eder
- PhD on Evaluating Complexity of Engineering Systems
 - Student Matt Potts
 - *Recently completed*

Conclusion

Closing Remarks

- Enabling technologies for autonomous systems are racing ahead
- T-B PHASE is helping with guidelines and rigor on system design
- Human factors challenges remain significant
- Regulations and safety are unfashionable questions
- “Social” factors are bigger than “human factors” and neglected

Questions