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Requirements Assurance in Machine Learning (ML) Applications

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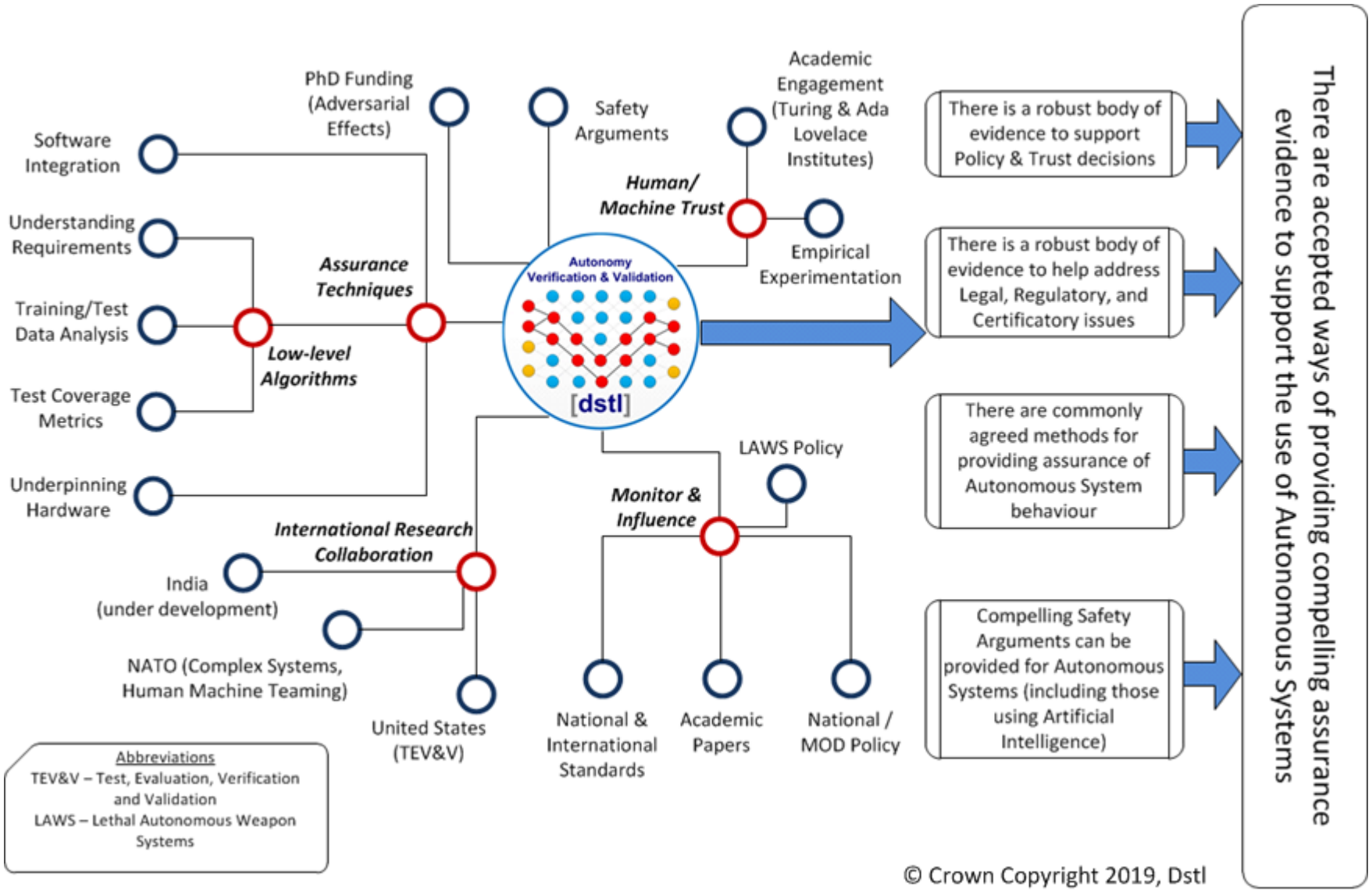


Starting Out, The"4+1" Principles[1]

P1: Software safety requirements shall be defined to address the software contribution to system hazards.	**Define system-level requirements**
P2: The intent of the software safety requirements shall be maintained throughout requirements decomposition.	**Refine into something you can code against**
P3: Software safety requirements shall be satisfied.	**Code what you intended - verification**
P4: Hazardous behaviour of the software shall be identified and mitigated.	**Look for new system-level hazards**
P4+1: The confidence established in addressing the software safety principles shall be commensurate to the contribution of the software to system risk.	**Target resources at highest risks**

P1 - Principle 1 (and so on)

[1] Hawkins, R, Habli, I, Kelly, T., 2013. The Principles of Software Safety Assurance.

ML Challenges the "4+1" Principles[1], [2]

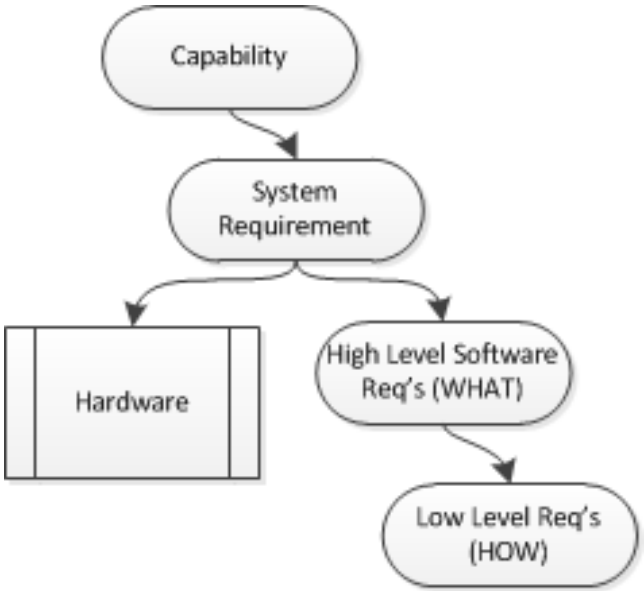
P1: Software safety requirements shall be defined to address the software contribution to system hazards.	Define system-level requirements	OK
P2: The intent of the software safety requirements shall be maintained throughout requirements decomposition.	Refine into something you can code against	?
P3: Software safety requirements shall be satisfied.	Code what you intended - verification	?
P4: Hazardous behaviour of the software shall be identified and mitigated.	Look for new system-level hazards	OK (ish)
P4+1: The confidence established in addressing the software safety principles shall be commensurate to the contribution of the software to system risk.	Target resources at highest risks	OK (ish)

P1 - Principle 1 (and so on)

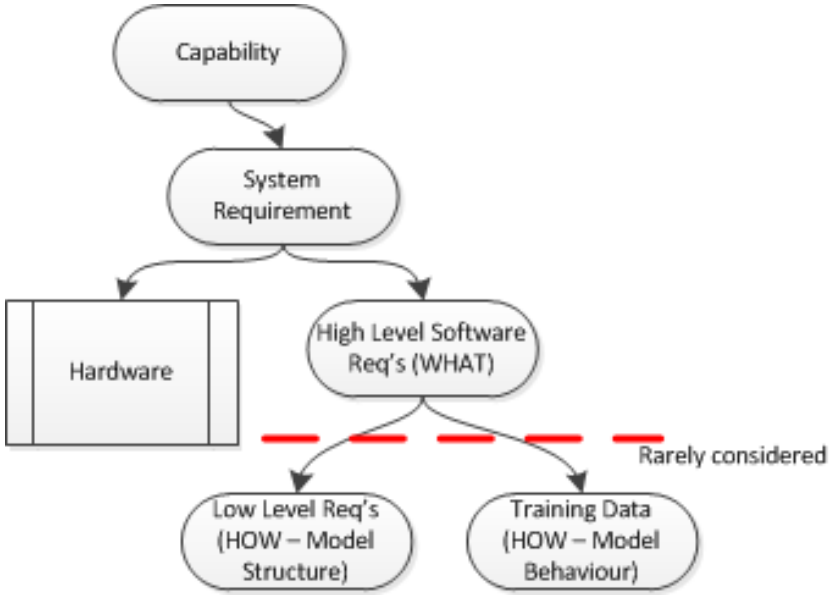
[1] Hawkins, R, Habli, I, Kelly, T., 2013. The Principles of Software Safety Assurance.
[2] Ashmore, R, Lennon, E., 2017. Progress Towards the Assurance of Non-Traditional Software.

Requirements Refinement

- Traditional Systems



- ML Systems



Existing Considerations for Requirements Assurance

Using RTCA DO-178C[3] as an example, requirements should be:

- R1. Compliant with High Level Requirements
- R2. Accurate and consistent
- R3. Compatible with target computer
- R4. Verifiable
- R5. Conforming to standards
- R6. Traceable
- R7. Algorithmically correct

THESE WILL STILL APPLY! For example to the training algorithm

[3] RTCA, 2011. Software Considerations in Airborne Systems and Equipment Certification. DO-178C.

Considerations for the Assurance of ML Training Data

Training Data abstractly forms a significant component of Low Level Requirements. We propose that it should:

- D1. Relate to the intent of the HLR (R2 and R7)
- D2. Not contain bias (R7)
- D3. Be sufficient (R1)
- D4. Be syntactically and semantically correct (R2 and R7)
- D5. Address normal and robustness behaviours (R1)
- D6. Be self-consistent (R2)
- D7. Conform to Standards (R5)
- D8. Be compatible with the target computer (R3)
- D9. Be verifiable (R4)

The Indicative Example

- Each of the training data assurance considerations are ‘coloured’ using an unmanned air vehicle landing system as an indicative fictional example.
- We believe that the approach is domain agnostic.

- Finally, the workshop may be interested to note that the Safety of Autonomous Systems Working Group (SASWG) are publishing algorithmic-level framework guidance for autonomous system safety[4].

[4] Safety of Autonomous Systems Working Group, 2019. Autonomous Systems — Algorithm-Level Objectives.

References

[1] Hawkins, R, Habli, I, Kelly, T., 2013. The Principles of Software Safety Assurance. 31st International System Safety Conference, Boston, Massachusetts USA, 2013.

[2] Ashmore, R, Lennon, E., 2017. Progress Towards the Assurance of Non-Traditional Software. In Developments in System Safety Engineering, ISBN 978-1540796288.

[3] RTCA, 2011. Software Considerations in Airborne Systems and Equipment Certification. DO-178C.

[4] Safety of Autonomous Systems Working Group, 2019. Autonomous Systems — Algorithm-Level Objectives. Available from: https://www.amazon.co.uk/Safety-Assurance-Objectives-Autonomous-Systems/dp/1790421225 (or free PDF, from Feb 2019, https://scsc.uk/publish.html)

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