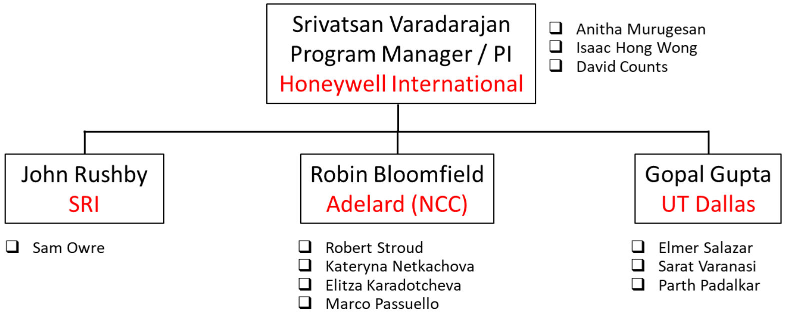
DARPA AUTOMATIC RAPID CERTIFICATION OF SOFTWARE (ARCOS)

Consistent Logical Automated Reasoning for Integrated System Software Assurance (CLARISSA)

ARCOS Technical Area 3



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Disclaimers: This research was developed with funding from the Defense Advanced Research Projects Agency (DARPA). The views, opinions and/or findings expressed are those of the author and should not be interpreted as representing the official views or policies of the Department of Defense or the U.S. Government.

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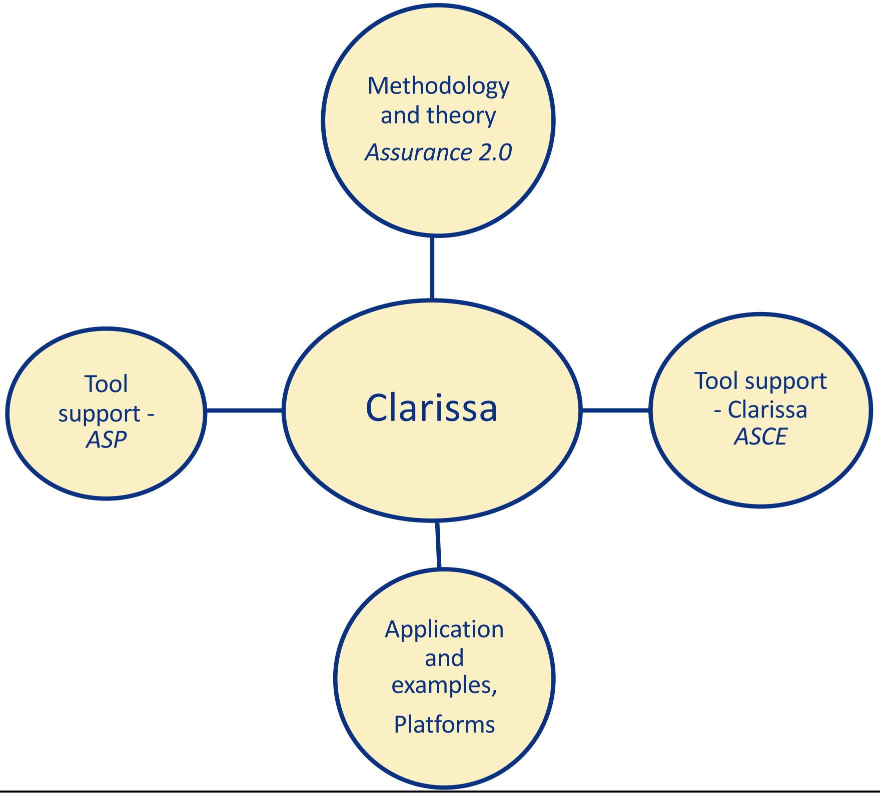

Clarissa

Methodology and theory *Assurance 2.0*

Tool support - *ASP*

Tool support - Clarissa *ASCE*

Application and examples,

Platforms

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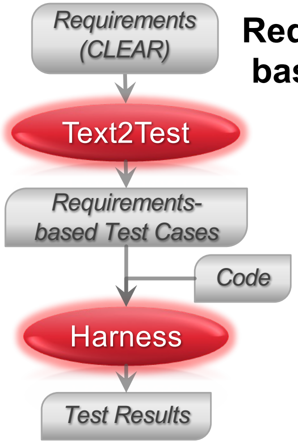
THEORIES

A PRINCIPLED APPROACH TO DEFINING REUSABLE ASSURANCE FRAGMENTS



Requirements (CLEAR)

Text2Test

Requirements-based Test Cases

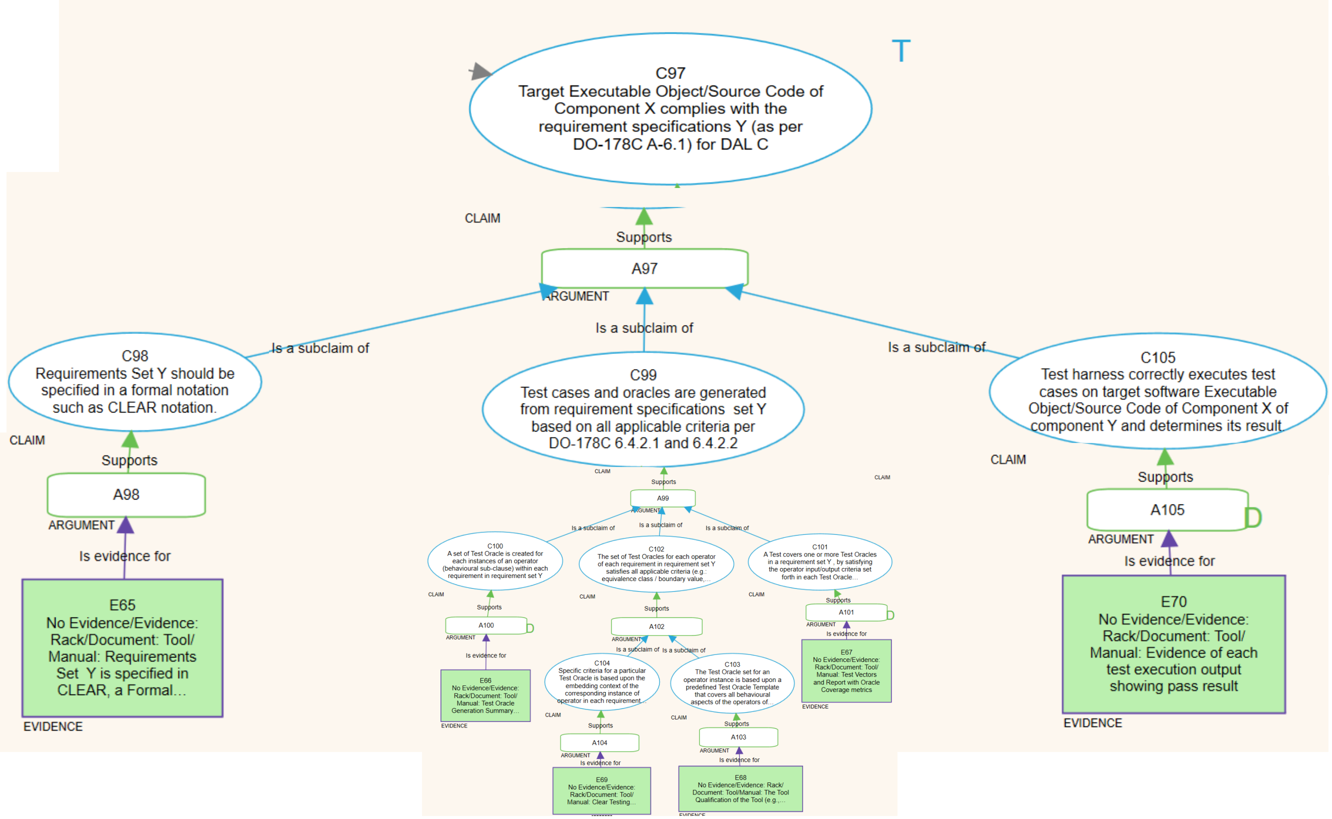
Code

Harness

Test Results

Requirements-based testing theory

Implementation conforms to requirements



T

C97
Target Executable Object/Source Code of Component X complies with the requirement specifications Y (as per DO-178C A-6.1) for DAL C

CLAIM

Supports

A97

ARGUMENT

Is a subclaim of

Is a subclaim of

Is a subclaim of

C98
Requirements Set Y should be specified in a formal notation such as CLEAR notation.

CLAIM

Supports

A98

ARGUMENT

Is evidence for

E65
No Evidence/Evidence: Rack/Document: Tool/ Manual: Requirements Set Y is specified in CLEAR, a Formal…

EVIDENCE

C99
Test cases and oracles are generated from requirement specifications set Y based on all applicable criteria per DO-178C 6.4.2.1 and 6.4.2.2

CLAIM

CLAIM

Supports

A99

ARGUMENT

Is a subclaim of

Is a subclaim of

Is a subclaim of

C100
A set of Test Oracle is created for each instances of an operator (behavioural sub-clause) within each requirement in requirement set Y

CLAIM

Supports

A100

ARGUMENT

Is evidence for

E66
No Evidence/Evidence: Rack/Document: Tool/ Manual: Test Oracle Generation Summary…

EVIDENCE

C102
The set of Test Oracles for each operator of each requirement in requirement set Y satisfies all applicable criteria (e.g.: equivalence class / boundary value,…

CLAIM

Supports

A102

ARGUMENT

Is a subclaim of

Is a subclaim of

C104
Specific criteria for a particular Test Oracle is based upon the embedding context of the corresponding instance of operator in each requirement…

CLAIM

Supports

A104

ARGUMENT

Is evidence for

E69
No Evidence/Evidence: Rack/Document: Tool/ Manual: Clear Testing…

C103
The Test Oracle set for an operator instance is based upon a predefined Test Oracle Template that covers all behavioural aspects of the operators of…

CLAIM

Supports

A103

ARGUMENT

Is evidence for

E68
No Evidence/Evidence: Rack/ Document: Tool/Manual: The Tool Qualification of the Tool (e.g.,…

EVIDENCE

C101
A Test covers one or more Test Oracles in a requirement set Y , by satisfying the operator input/output criteria set forth in each Test Oracle…

CLAIM

Supports

A101

ARGUMENT

Is evidence for

E67
No Evidence/Evidence: Rack/Document: Tool/ Manual: Test Vectors and Report with Oracle Coverage metrics

EVIDENCE

C105
Test harness correctly executes test cases on target software Executable Object/Source Code of Component X of component Y and determines its result

CLAIM

Supports

A105

ARGUMENT

Is evidence for

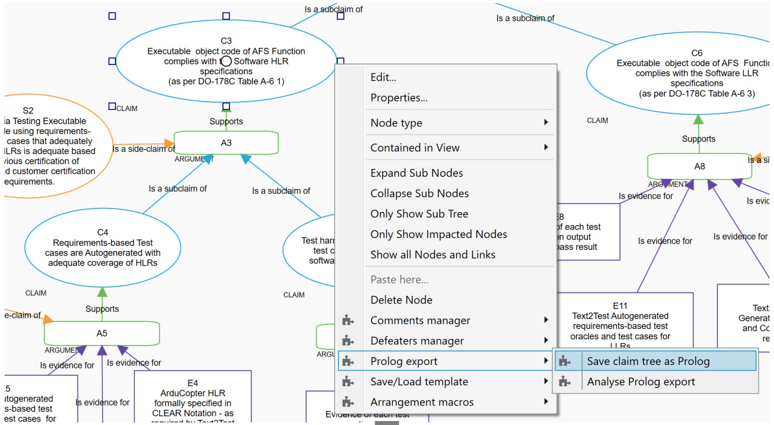
E70
No Evidence/Evidence: Rack/Document: Tool/ Manual: Evidence of each test execution output showing pass result

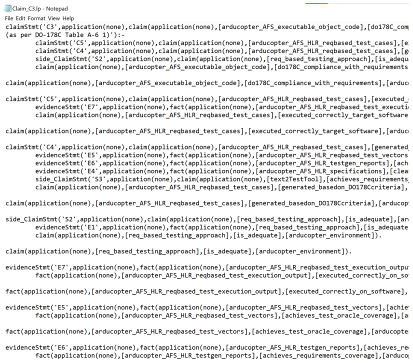
EVIDENCE

ASCE AUTOMATIC PROLOG EXPORT FOR S(CASP) ENGINE

- Idea is to convert the ASCE network to a logical representation that allows semantic analysis and reasoning about the validity of the case
- Claims are formalized using node properties:
  - ➢ Object O satisfies property P in environment E
- The claim structure is exported as a series of Prolog predicates

- It is then possible to evaluate the top-level claim as a Prolog *query*. When s(CASP) determines that a claim does not hold, we can determine the reason it does not hold by running the *negated query* and looking at the justification tree to see why the counter-claim holds
- Automated Analysis for:
  - ➢ Semantic-based analysis of CAE
  - ➢ Automatically Identifying Defeaters
  - ➢ Assurance Case Synthesis





Claim_C3.lp - Notepad

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        claimStmt('C4',application(none),claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[g
        side_ClaimStmt('S2',application(none),claim(application(none),[req_based_testing_approach],[is_adequ
        claim(application(none),[arducopter_AFS_executable_object_code],[do178C_compliance_with_requirements

claim(application(none),[arducopter_AFS_executable_object_code],[do178C_compliance_with_requirements],[arduc

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        claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[executed_correctly_target_software

claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[executed_correctly_target_software],[arduc

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        evidenceStmt('E5',application(none),fact(application(none),[arducopter_AFS_HLR_reqbased_test_vectors
        evidenceStmt('E6',application(none),fact(application(none),[arducopter_AFS_HLR_testgen_reports],[ach
        evidenceStmt('E4',application(none),fact(application(none),[arducopter_AFS_HLR_specifications],[clea
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claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[generated_basedon_DO178Ccriteria],[arducop

side_ClaimStmt('S2',application(none),claim(application(none),[req_based_testing_approach],[is_adequate],[ar
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fact(application(none),[arducopter_AFS_HLR_reqbased_test_execution_output],[executed_correctly_on_software],

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fact(application(none),[arducopter_AFS_HLR_reqbased_test_vectors],[achieves_test_oracle_coverage],[arducopte

evidenceStmt('E6',application(none),fact(application(none),[arducopter_AFS_HLR_testgen_reports],[achieves_re
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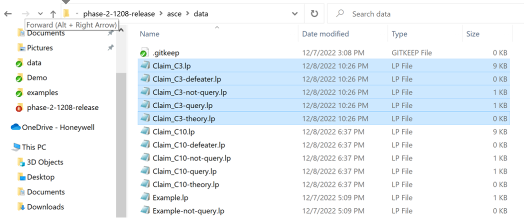

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Claim_C3-defeater.lp	12/8/2022 10:26 PM	LP File	0 KB
Claim_C3-not-query.lp	12/8/2022 10:26 PM	LP File	1 KB
Claim_C3-query.lp	12/8/2022 10:26 PM	LP File	1 KB
Claim_C3-theory.lp	12/8/2022 10:26 PM	LP File	0 KB
Claim_C10.lp	12/8/2022 6:37 PM	LP File	9 KB
Claim_C10-defeater.lp	12/8/2022 6:37 PM	LP File	0 KB
Claim_C10-not-query.lp	12/8/2022 6:37 PM	LP File	1 KB
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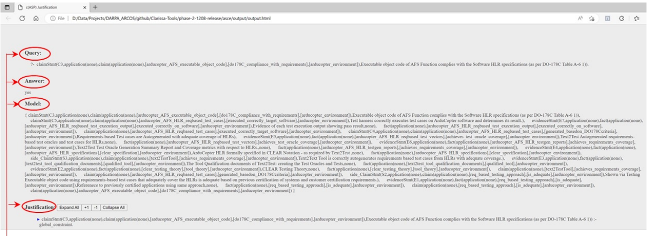

s(ASP) Justification
File | D:/Data/Projects/DARPA_ARCOS/github/Clarissa-Tools/phase-2-1208-release/asce/output/output.html

Query:

?- claimStmt(C3,application(none),claim(application(none),[arducopter_AFS_executable_object_code],[do178C_compliance_with_requirements],[arducopter_environment]),Executable object code of AFS Function complies with the Software HLR specifications (as per DO-178C Table A-6 1)).

Answer:

yes

Model:

{ claimStmt(C3,application(none),claim(application(none),[arducopter_AFS_executable_object_code],[do178C_compliance_with_requirements],[arducopter_environment]),Executable object code of AFS Function complies with the Software HLR specifications (as per DO-178C Table A-6 1)), claimStmt(C5,application(none),claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[executed_correctly_target_software],[arducopter_environment]),Test harness correctly executes test cases on ArduCopter software and determines its result.), evidenceStmt(E7,application(none),fact(application(none),[arducopter_AFS_HLR_reqbased_test_execution_output],[executed_correctly_on_software],[arducopter_environment]),Evidence of each test execution output showing pass result,none), fact(application(none),[arducopter_AFS_HLR_reqbased_test_execution_output],[executed_correctly_on_software],[arducopter_environment]), claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[executed_correctly_target_software],[arducopter_environment]), claimStmt(C4,application(none),claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[generated_basedon_DO178Ccriteria],[arducopter_environment]),Requirements-based Test cases are Autogenerated with adequate coverage of HLRs), evidenceStmt(E5,application(none),fact(application(none),[arducopter_AFS_HLR_reqbased_test_vectors],[achieves_test_oracle_coverage],[arducopter_environment]),Text2Test Autogenerated requirements-based test oracles and test cases for HLRs,none), fact(application(none),[arducopter_AFS_HLR_reqbased_test_vectors],[achieves_test_oracle_coverage],[arducopter_environment]), evidenceStmt(E6,application(none),fact(application(none),[arducopter_AFS_HLR_testgen_reports],[achieves_requirements_coverage],[arducopter_environment]),Text2Test Test Oracle Generation Summary Report and Coverage metrics with respect to HLRs.,none), fact(application(none),[arducopter_AFS_HLR_testgen_reports],[achieves_requirements_coverage],[arducopter_environment]), evidenceStmt(E4,application(none),fact(application(none),[arducopter_AFS_HLR_specifications],[clear_specification],[arducopter_environment]),ArduCopter HLR formally specified in CLEAR Notation - as required by Text2Test ,none), fact(application(none),[arducopter_AFS_HLR_specifications],[clear_specification],[arducopter_environment]), side_ClaimStmt(S3,application(none),claim(application(none),[text2TestTool],[achieves_requirements_coverage],[arducopter_environment]),Text2Text Tool is correctly autogenerates requirements based test cases from HLRs with adequate coverage.), evidenceStmt(E3,application(none),fact(application(none),[text2test_tool_qualification_documents],[qualified_tool],[arducopter_environment]),The Tool Qualification documents of Text2Test: creating the Test Oracles and Tests,none), fact(application(none),[text2test_tool_qualification_documents],[qualified_tool],[arducopter_environment]), evidenceStmt(E2,application(none),fact(application(none),[clear_testing_theory],[tool_theory],[arducopter_environment]),CLEAR Testing Theory,none), fact(application(none),[clear_testing_theory],[tool_theory],[arducopter_environment]), claim(application(none),[text2TestTool],[achieves_requirements_coverage],[arducopter_environment]), claim(application(none),[arducopter_AFS_HLR_reqbased_test_cases],[generated_basedon_DO178Ccriteria],[arducopter_environment]), side_ClaimStmt(S2,application(none),claim(application(none),[req_based_testing_approach],[is_adequate],[arducopter_environment]),Shown via Testing Executable object code using requirements-based test cases that adequately cover the HLRs is adequate based on previous certification of systems and customer certification requirements.), evidenceStmt(E1,application(none),fact(application(none),[req_based_testing_approach],[is_adequate],[arducopter_environment]),Refereence to previously certified applications using same approach,none), fact(application(none),[req_based_testing_approach],[is_adequate],[arducopter_environment]), claim(application(none),[req_based_testing_approach],[is_adequate],[arducopter_environment]), claim(application(none),[arducopter_AFS_executable_object_code],[do178C_compliance_with_requirements],[arducopter_environment]) }

Justification:

▸ claimStmt(C3,application(none),claim(application(none),[arducopter_AFS_executable_object_code],[do178C_compliance_with_requirements],[arducopter_environment]),Executable object code of AFS Function complies with the Software HLR specifications (as per DO-178C Table A-6 1)) :- global_constraint.

Answer to whether Claim Holds, Resultant Model and Justification

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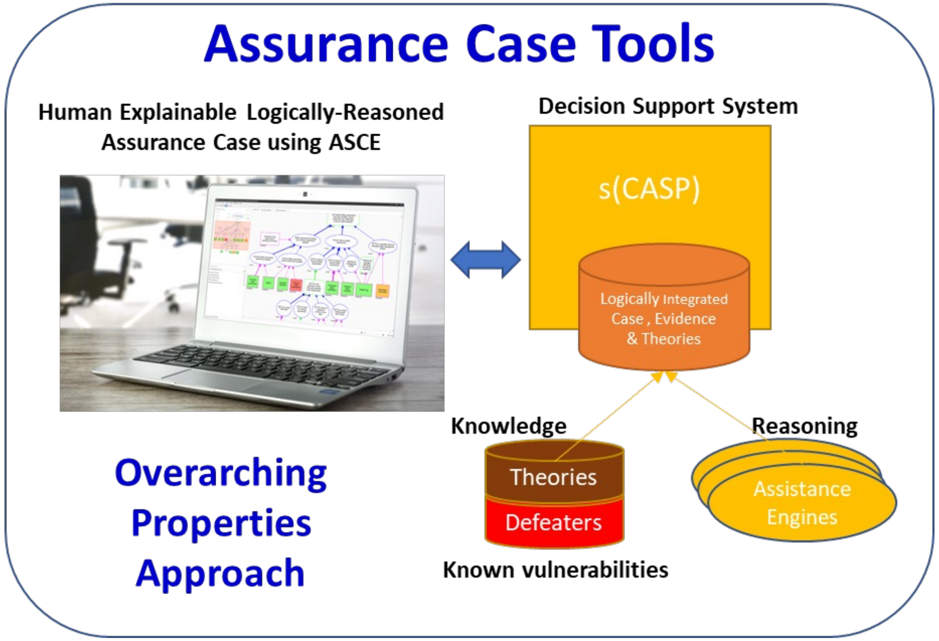
CLARISSA RESEARCH CONTRIBUTIONS

Novelties in Assurance Case Foundations and Realization in Tools

- ❑ Assurance 2.0 methodology ensures focus on positive claims while simultaneously searching for negative defeaters that invalidate the claim
- ❑ Requirements that the completed assurance case should be indefeasible whereby no credible new information would change the judgment i.e., no unresolved doubts
- ❑ Developed "Theory" as reusable assurance case templates with semantics
- ❑ Integrated Assurance for Safety cases and Security cases
- ❑ Automatically translating assurance case as an equivalent logic program that is amenable to common-sense reasoning
- ❑ Automated checks for consistency and completeness
- ❑ Expert user guided synthesis of assurance case with their defeaters


Assurance Case Tools
Human Explainable Logically-Reasoned Assurance Case using ASCE
Decision Support System
s(CASP)
Logically Integrated Case , Evidence & Theories
Knowledge
Reasoning
Theories
Defeaters
Assistance Engines
Known vulnerabilities
Overarching Properties Approach

CLARISSA: Foundations, Tools and Automation Support for Assurance Cases, to appear in DASC 2023 https://2023.dasconline.org/

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