Using a Perfect Argument in an Imperfect World

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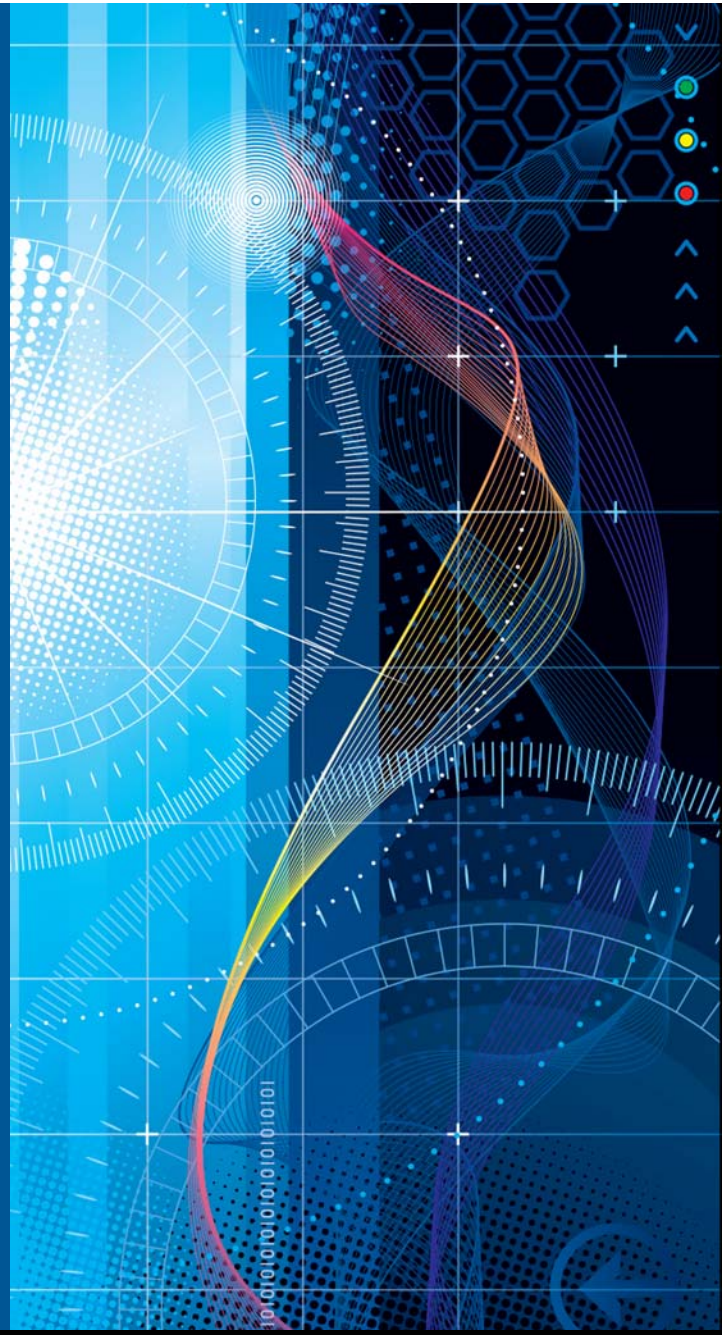

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Overview

The role of proof in an assurance case

- Use *eliminative argumentation*
  - Doubts about validity of claims
  - Doubts about validity of evidence
  - Doubts about validity of inferences
- As doubts are eliminated, confidence increases
  - Schema for use of proof
  - Trivial example
  - More realistic example

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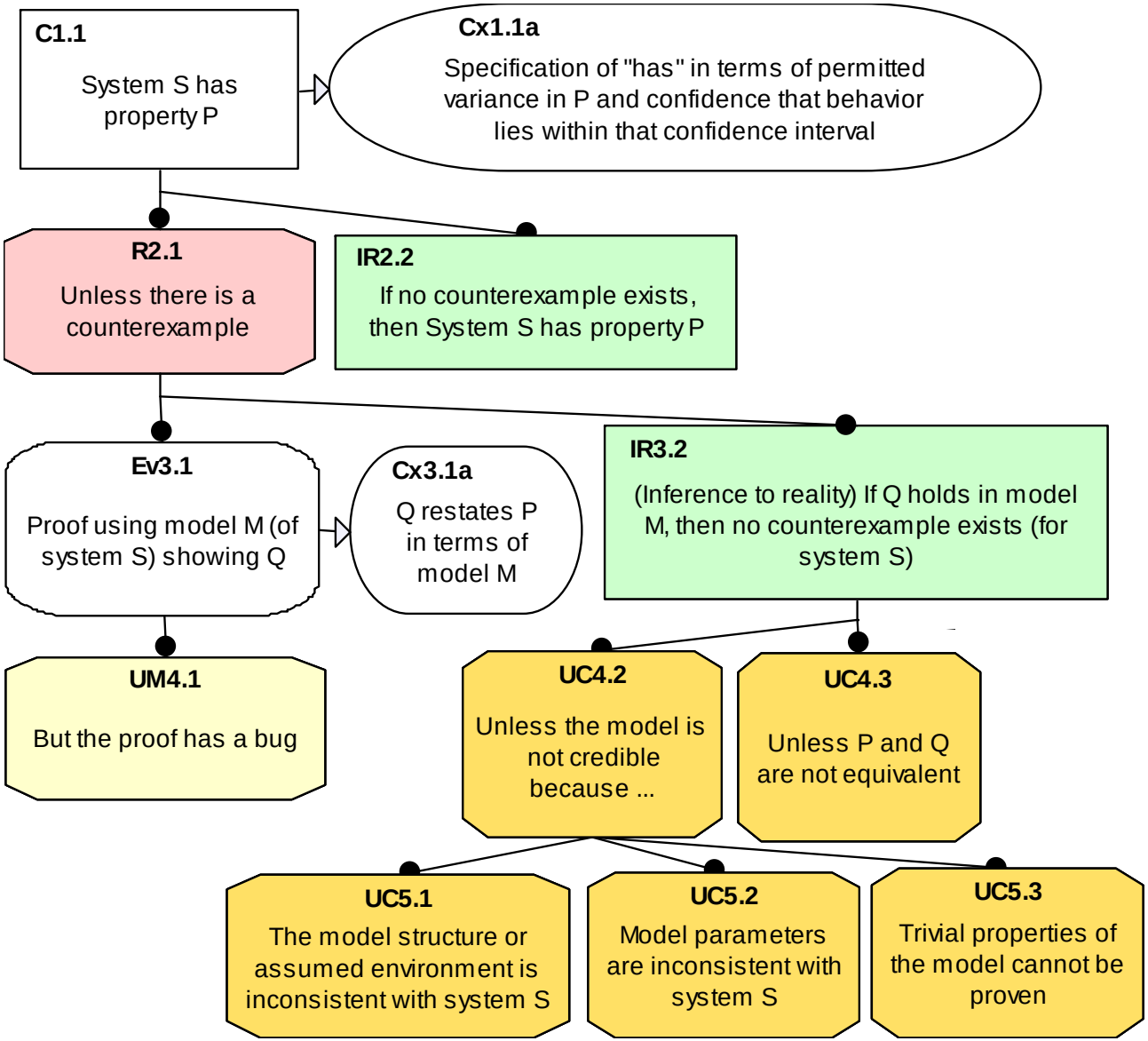
Schema for Use of Proof in a Case



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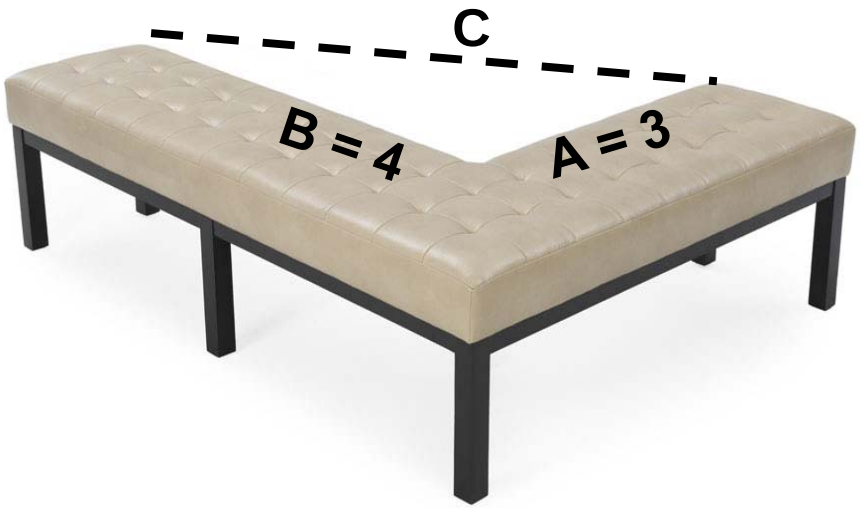
Triangle Example



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Triangle Example

C1.1

In physical triangle ABC (system S), C = 5

Cx1.1a

C = 5 means C lies within 0.02 of 5 with 99% confidence

R2.1

Unless when A = 3 and B = 4, C is not to equal to 5

IR2.2

If there is no possibility that C /= 5, then C = 5

Cx3.1a

B' = 4

C'

A' = 3

Ev3.1

Proof using model M showing C' = sqrt(A'*A' + B'*B'), and so C' must equal 5

IR3.2

(Inference to reality) If C' = 5 in the model then C must equal 5 in system S

UC4.1

Unless the model is not credible because ...

UC4.2

Unless C'=5 is not equivalent to saying C=5

UC5.1

The physical triangle does not lie in a plane

UC5.2

The actual values of A, B, and angle AB are too different from those in model M

UC5.3

Angles A'C' and B'C' do not sum to 90 degrees

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Calculating Confidence

$A = 3 \pm 0.02$ (with 99% confidence)

$B = 4 \pm 0.02$ (with 99% confidence)

$\alpha = 90° \pm 1.0°$ (with 99% confidence)

$C = sqrt\ (A^2 + B^2 - 2AB\cos(\alpha))$

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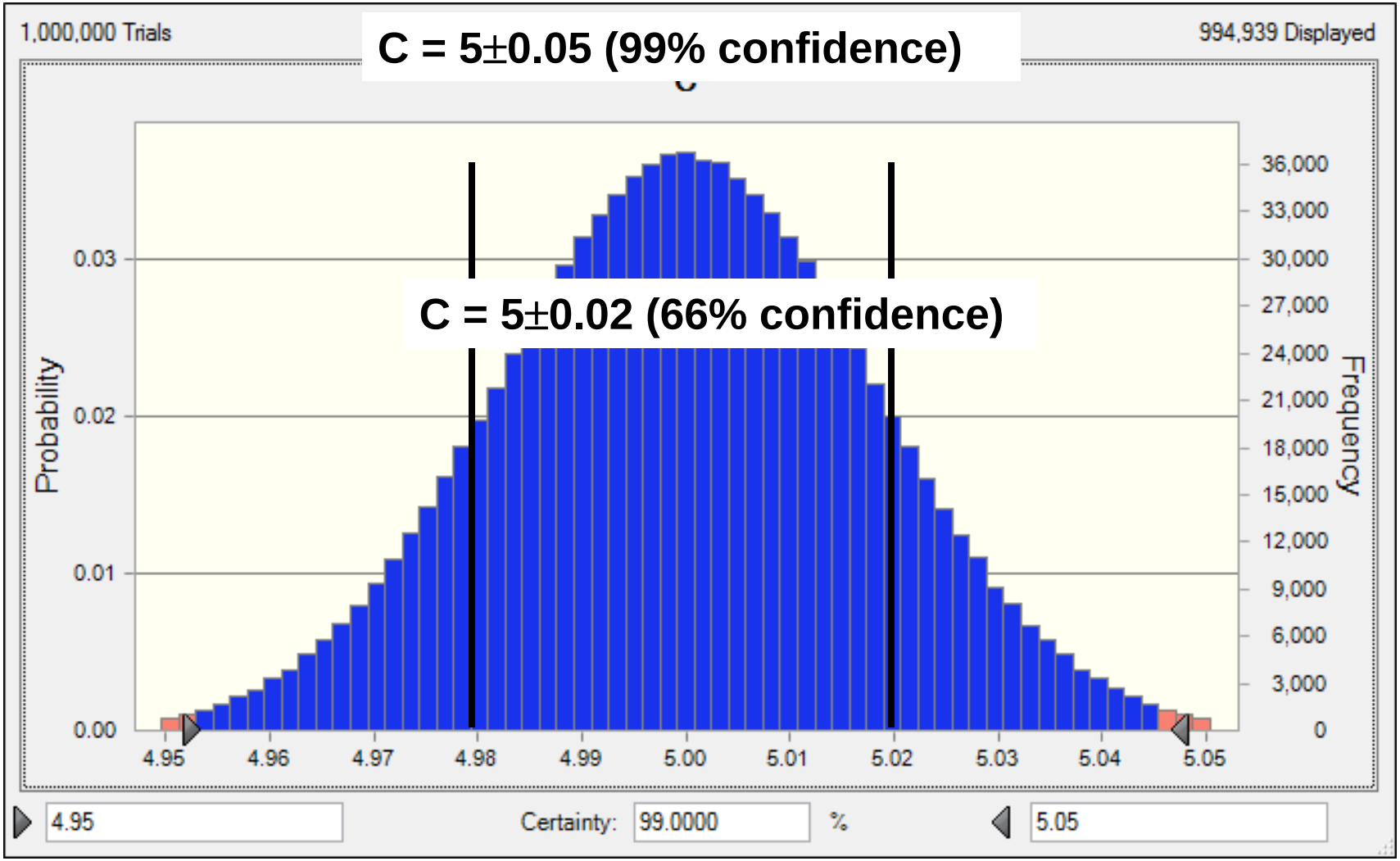
Calculating Confidence



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Calculating Confidence

Were fortunate to have a way of calculating how inaccuracies in the model would affect confidence in the conclusion

- Probabilistic variations in the model
- Affect confidence gained from the proof
- The analysis suggests where to strengthen the case

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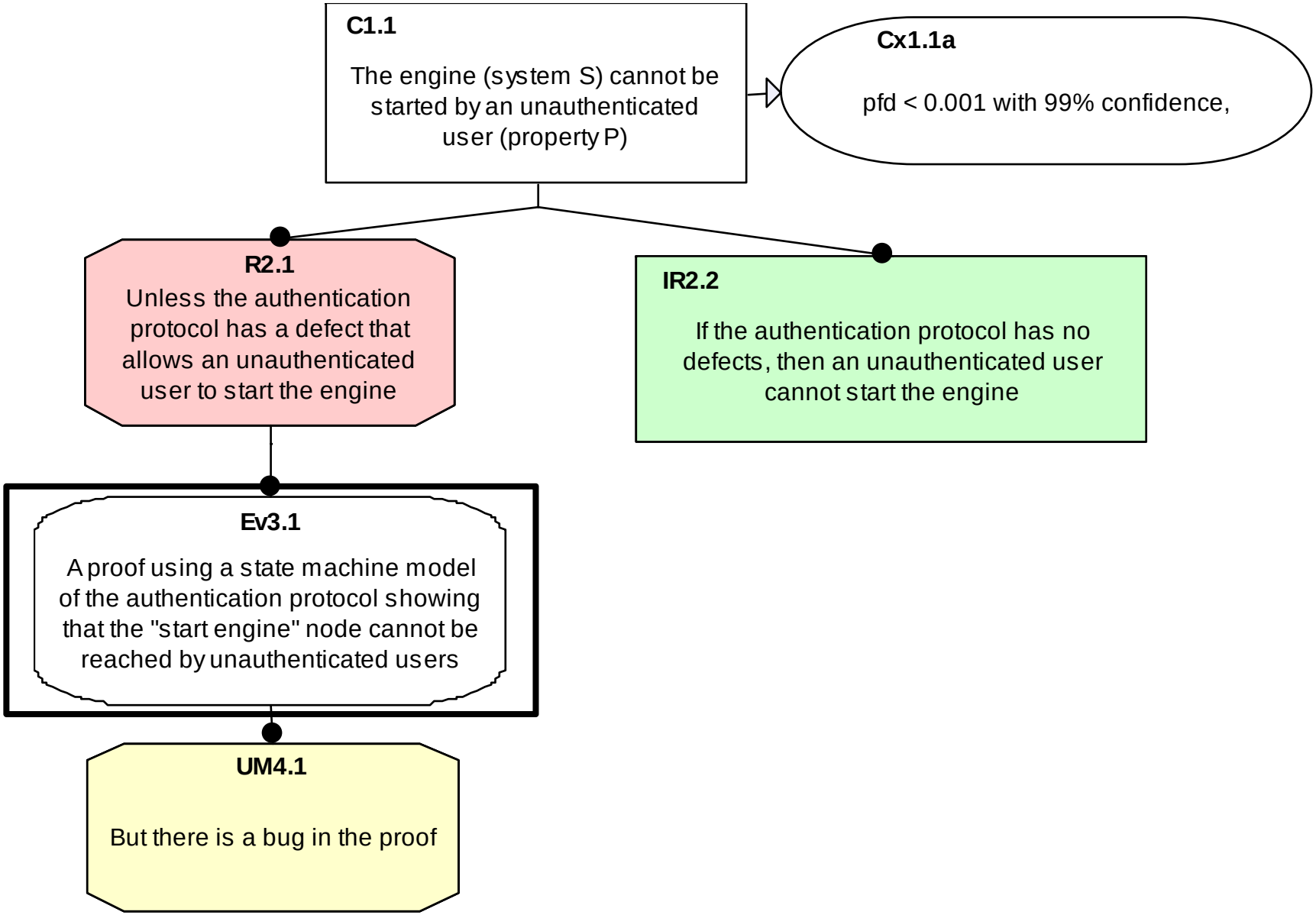
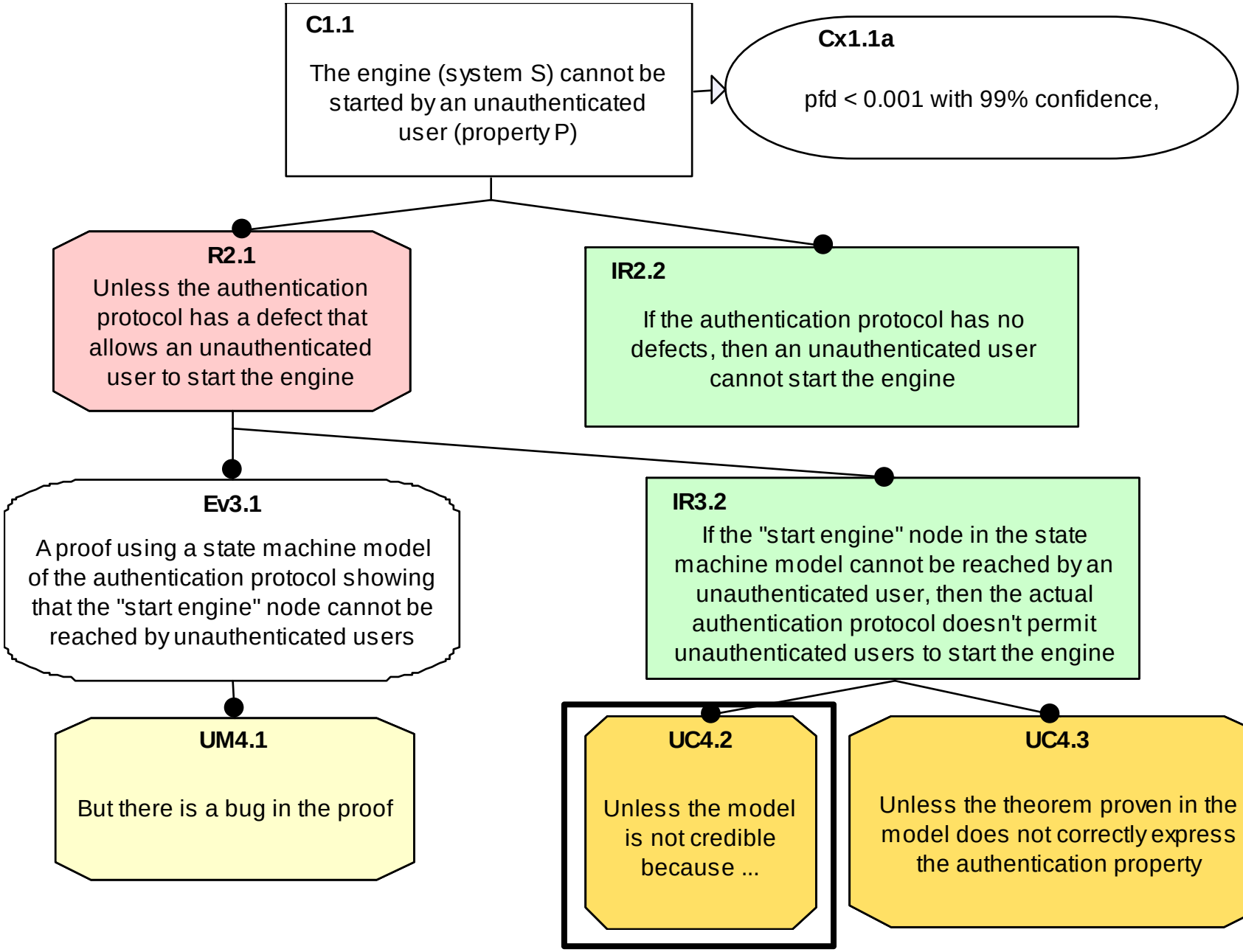

C1.1
The engine (system S) cannot be started by an unauthenticated user (property P)
Cx1.1a
pfd < 0.001 with 99% confidence,
R2.1
Unless the authentication protocol has a defect that allows an unauthenticated user to start the engine
IR2.2
If the authentication protocol has no defects, then an unauthenticated user cannot start the engine
Ev3.1
A proof using a state machine model of the authentication protocol showing that the "start engine" node cannot be reached by unauthenticated users
UM4.1
But there is a bug in the proof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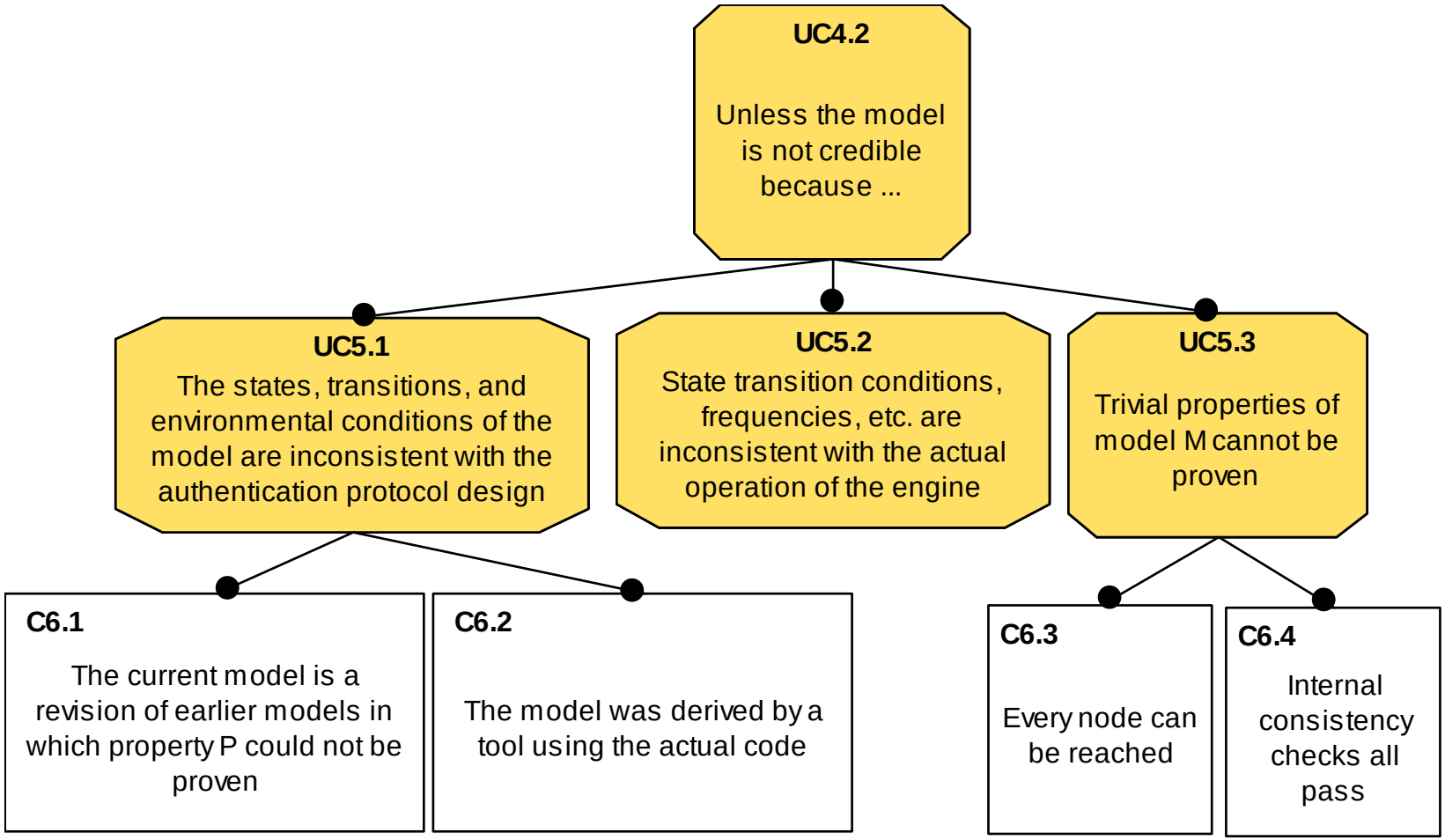
IR2.2
If the authentication protocol has no defects, then an unauthenticated user cannot start the engine
Ev3.1
A proof using a state machine model of the authentication protocol showing that the "start engine" node cannot be reached by unauthenticated users
IR3.2
If the "start engine" node in the state machine model cannot be reached by an unauthenticated user, then the actual authentication protocol doesn't permit unauthenticated users to start the engine
UM4.1
But there is a bug in the proof
UC4.2
Unless the model is not credible because ...
UC4.3
Unless the theorem proven in the model does not correctly express the authentication property

Model Credibility Evidence



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Summary

Used Eliminative Argumentation to explore role of proofs in an AC

Considered how to use the proof as a guide for estimating the extent to which one can have confidence in the application of the proof result to the real world

- Modeling inaccuracies

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