Understanding Evidence: Lessons from the GPCA Case Study

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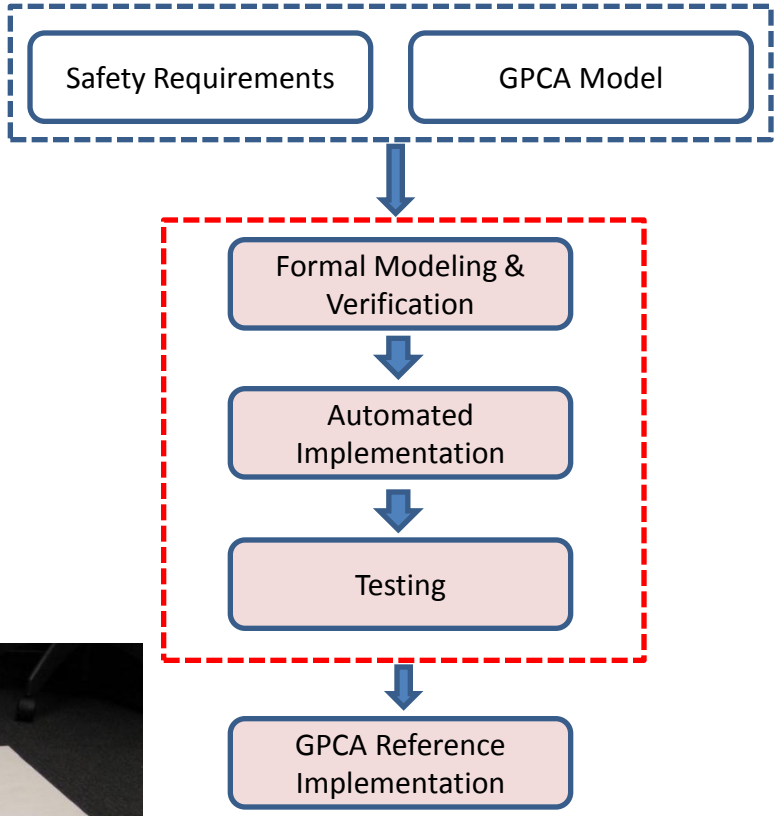
Outline

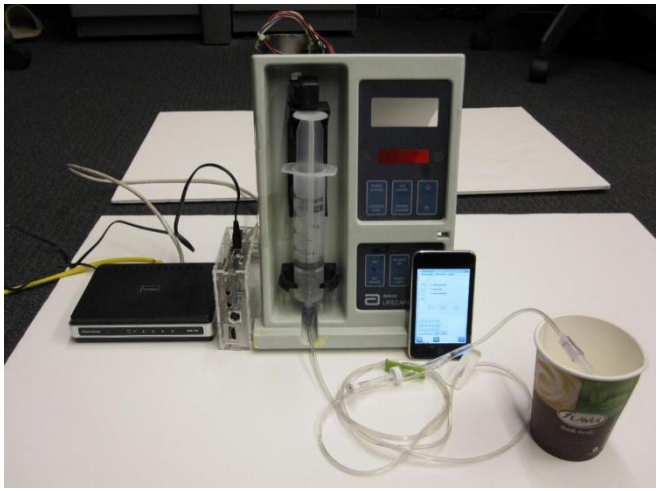
- GPCA Case Study
  - Prototype implementation
  - Development approach
  - Safety argument
- Lessons
  - Evidence for the safety argument
    - Confidence in the evidence
  - Evidence from formalization

GPCA Case Study

Goals:

- Study generative techniques in assurance-based development
- Reason about the achieved level of assurance

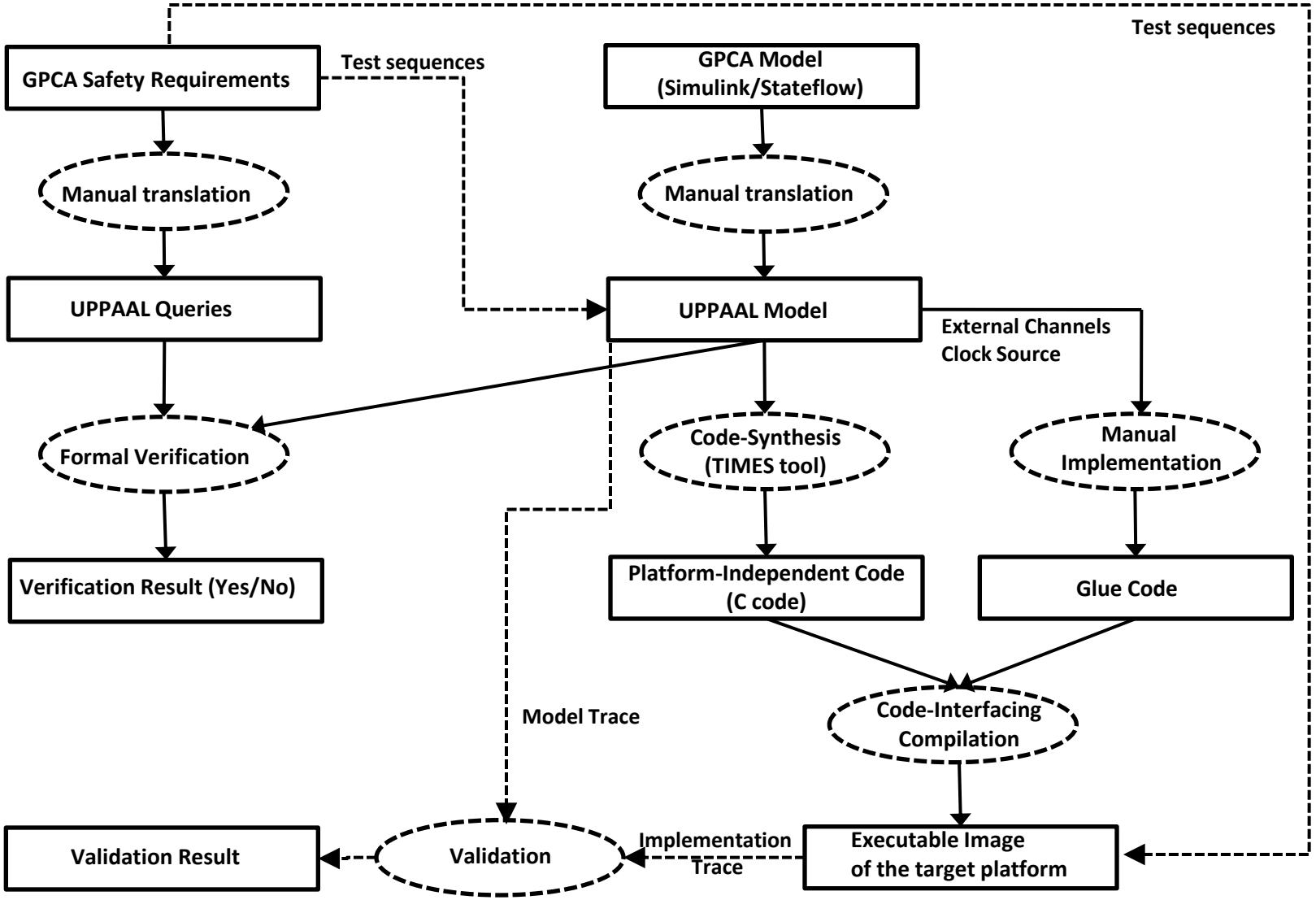




Starting Points

- Hazard analysis
  - Basis for safety requirements derivation
- Safety requirements
  - Determines properties in formal verification
- Design specification
  - Input to the code generation process
    - Via a separate formalization step

Model-based GPCA Implementation



Outcomes of the GPCA Case Study

- Set of artifacts
  - Prototype implementation
  - Formal models and formalized properties
- Development process
  - Still under construction
    - Dealing with platform-dependent code
- Safety argument
  - Generalized to a pattern for model-based development

Evaluation of Starting Points

- How good are the safety requirements?
  - Derived from hazard analysis (mitigation strategies)
    - Are there other sources?
  - Completeness and adequacy
    - Evidence of completeness is traceability
    - What is the evidence of adequate mitigation?
  - Level of abstraction
- In progress
  - In collaboration with Mats Heimdahl

Categorization of Properties

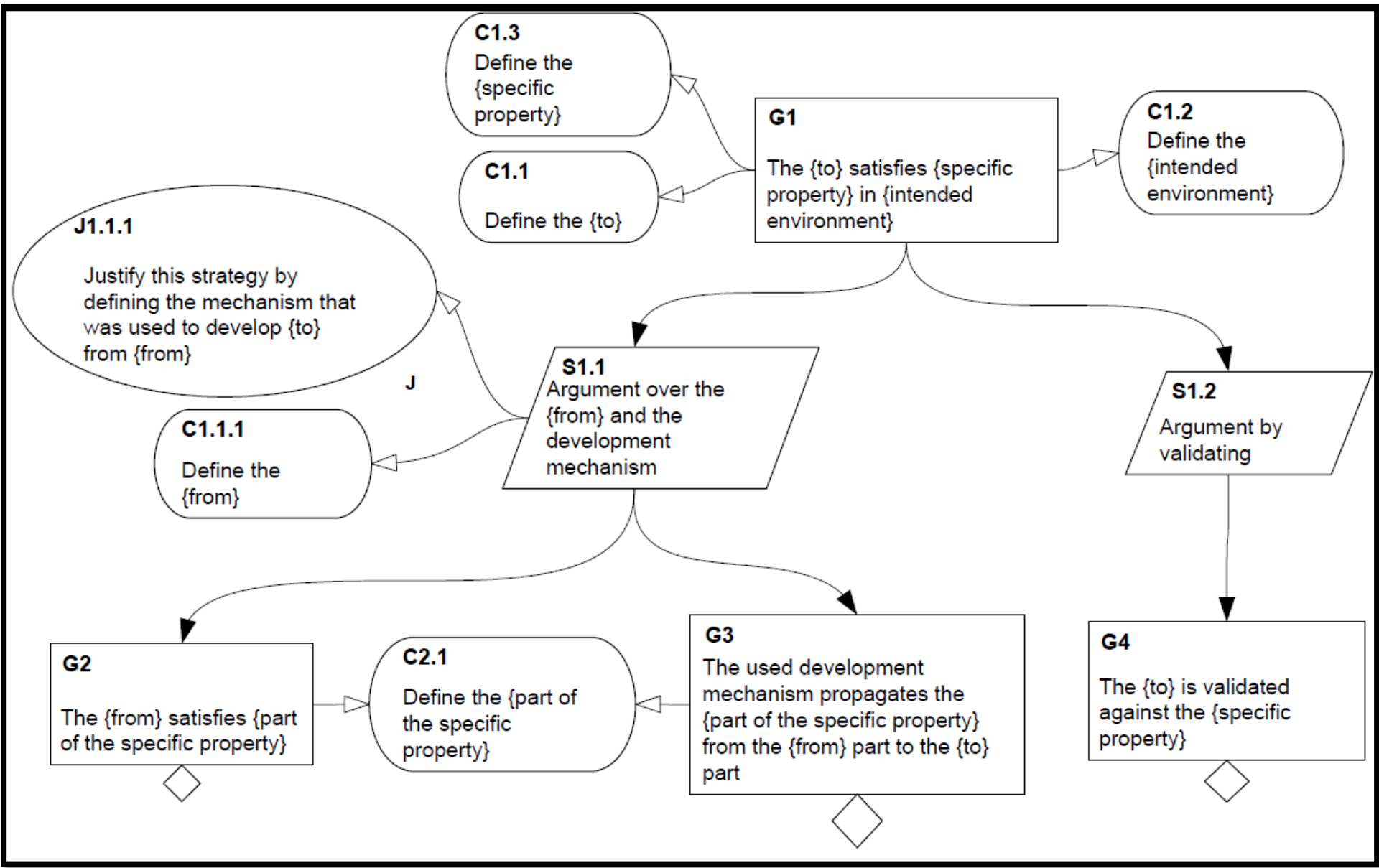
- Category 1: Properties that can be formalized and verified
- Category 2: Properties that are at a different level of abstraction than the model
  - Amount remaining shall be recalculated…
- Category 3: Properties that cannot be formalized but can be informally validated
  - Flow rate shall be programmable
- Category 4: Properties that need clarification
  - A clear indication shall be displayed…

From-To Pattern

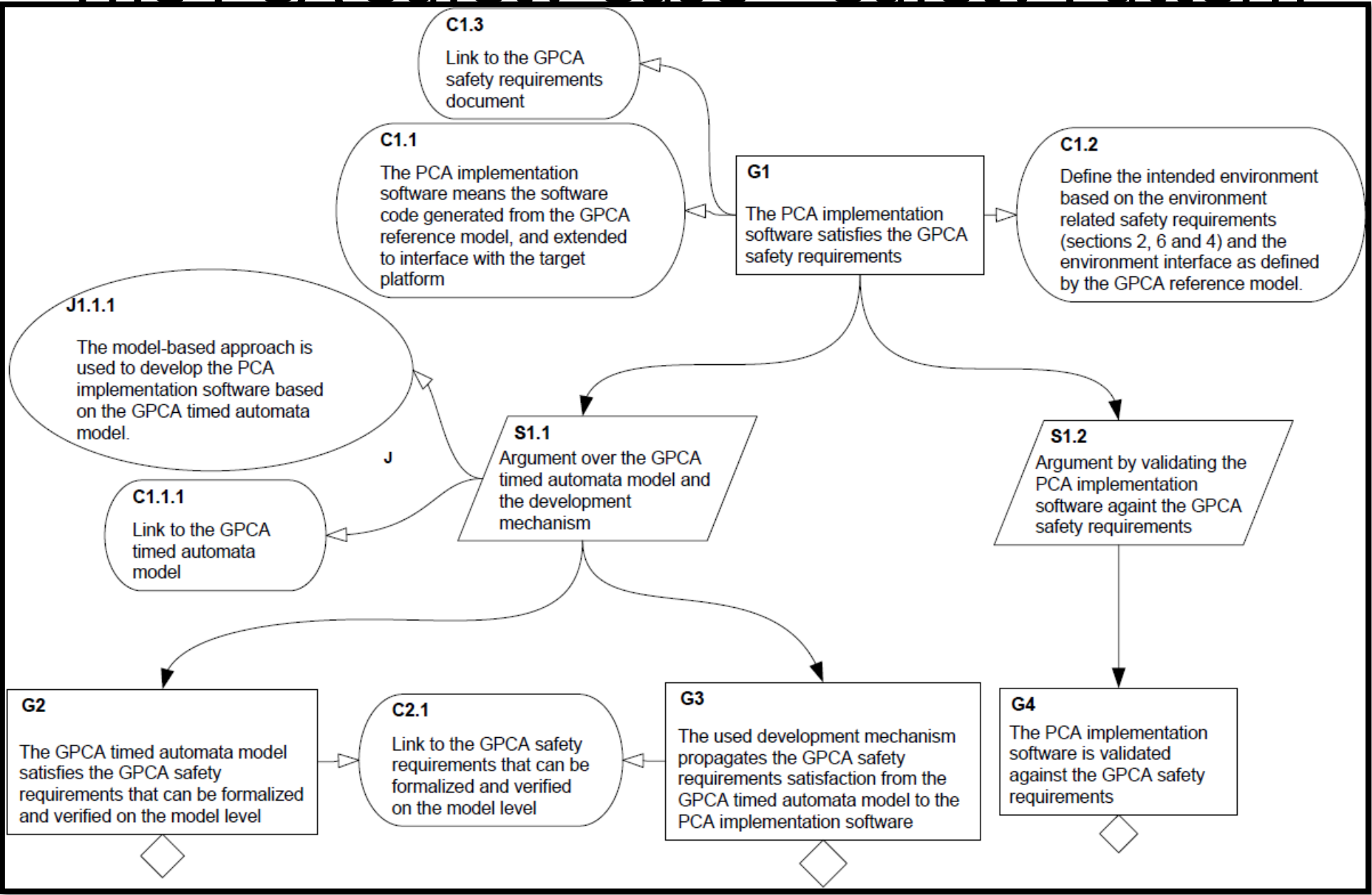
- Similarities in model-based development processes lead to similarities in safety arguments
  - From-To pattern captures these similarities

- Assurance through
  - Verification of properties in models
  - Preservation of properties through transformation

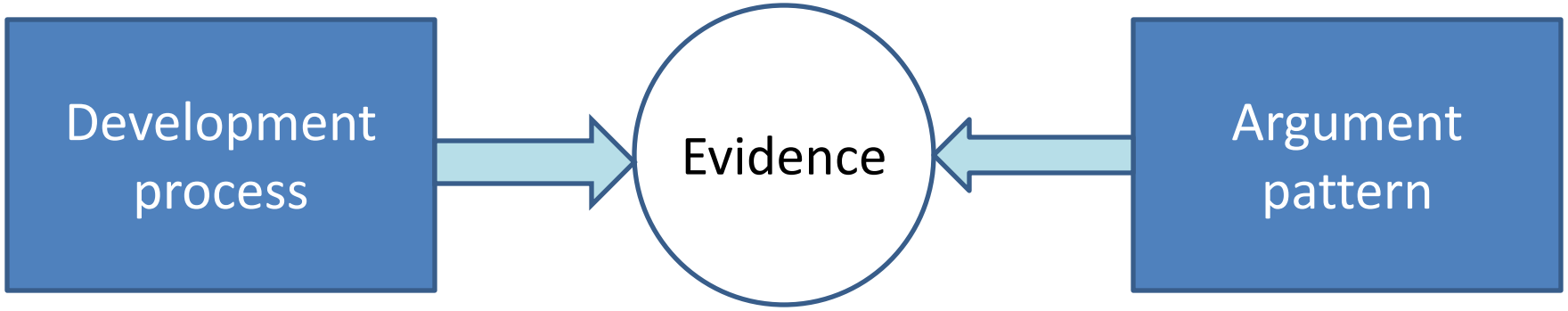
The PCA Safety Case – Safety Pattern



The PCA Safety Case – Safety Pattern



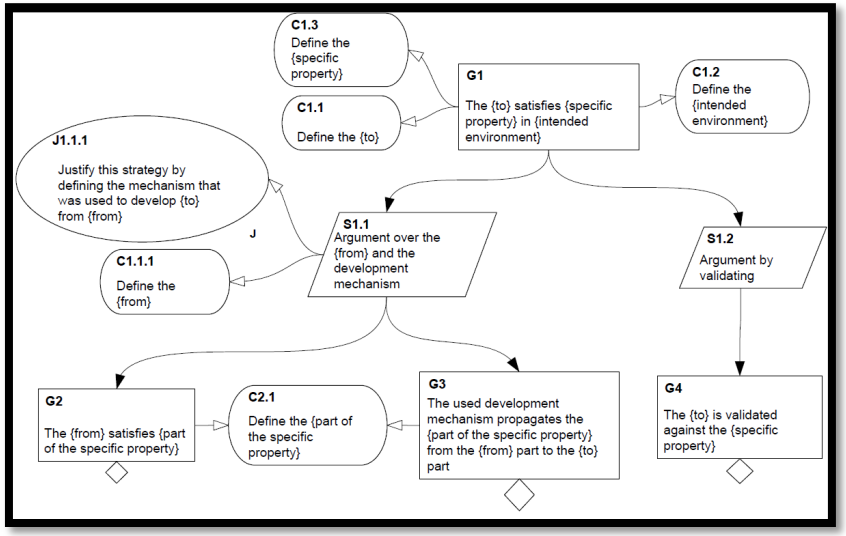
Lesson 1: What Evidence Is Needed?



- Structure of the safety argument determines kinds of evidence needed for assessing safety
  - An argument pattern implies the kinds of evidence needed in argument following this pattern
- Development process determines kinds of evidence that can be obtained

Evidence for From-To Pattern

- Model analysis results
  - Verification
  - Simulation
- Property preservation by the transformation
  - Correctness proofs
  - Tool qualification
- Validation
  - Evaluation of the outcome
  - Reasoning about modeling assumptions



Confidence in Evidence

- Required kind of evidence may be supplied by different evidence items
  - Different evidence items may vary in conclusiveness
  - E.g., test suites with different code coverage offer the same kind of evidence, but different confidence in the outcome
- Separation of safety argument from confidence argument

Lesson 2: Evidence Via Formalization

- Our approach relies on formal modeling and verification
  - Formalization of requirements is part of the process
- Formalization results may be (negative) evidence
  - Category 2: different levels of abstraction
    - Evidence of problems with the process or choice of formalism
  - Category 4: requirements too vague to formalize
    - Evidence of problems with requirements elicitation