
Capgemini
HISC
HIGH INTEGRITY SOFTWARE
CONFERENCE
OCT 17, 2023
EXPERT TESTING WITHOUT THE EXPERTS
Thomas Wilson
HISC 2023
THE FUTURE OF YOUR industry IS intelligent

AGENDA

01 ABOUT ME

02 EARLY MOTIVATIONS

03 OUR APPROACH

04 RELATED WORK

05 CASE STUDIES

06 CONCLUSIONS

THOMAS WILSON

High-Integrity Software Engineer

With Capgemini engineering

formerly, ALTRAN

for 16 years

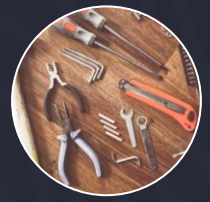
- 10 years client project engineering
- 6 years software engineering process improvement research

PhD in Applied Formal Methods

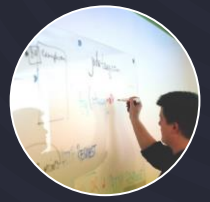
Senior Architect for Test for High-Integrity Expertise Centre of Capgemini Engineering in Bath

IMPROVEMENT ENGINE

Research & Technology

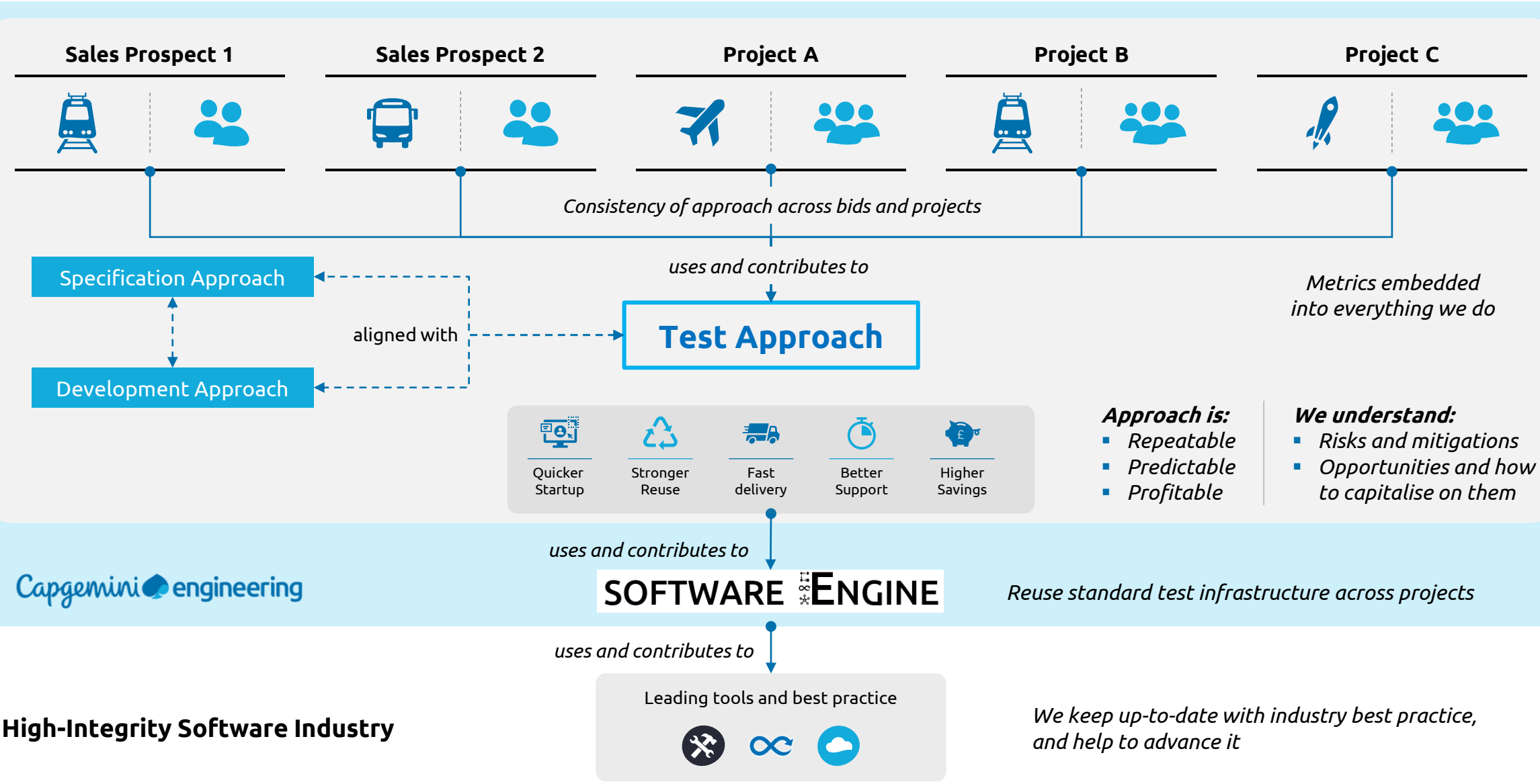


Production Environment



Special Interest Groups

IMPROVING MODEL-BASED TESTING



EARLY MOTIVATIONS

SOFTWARE FOR SMALL BUSINESSES

"BUSINESS MADE SIMPLE"

16 YEAR OLD PROGRAMMER

CAREER-SHAPING EVENTS

BUSINESS

contact management database

accountancy software

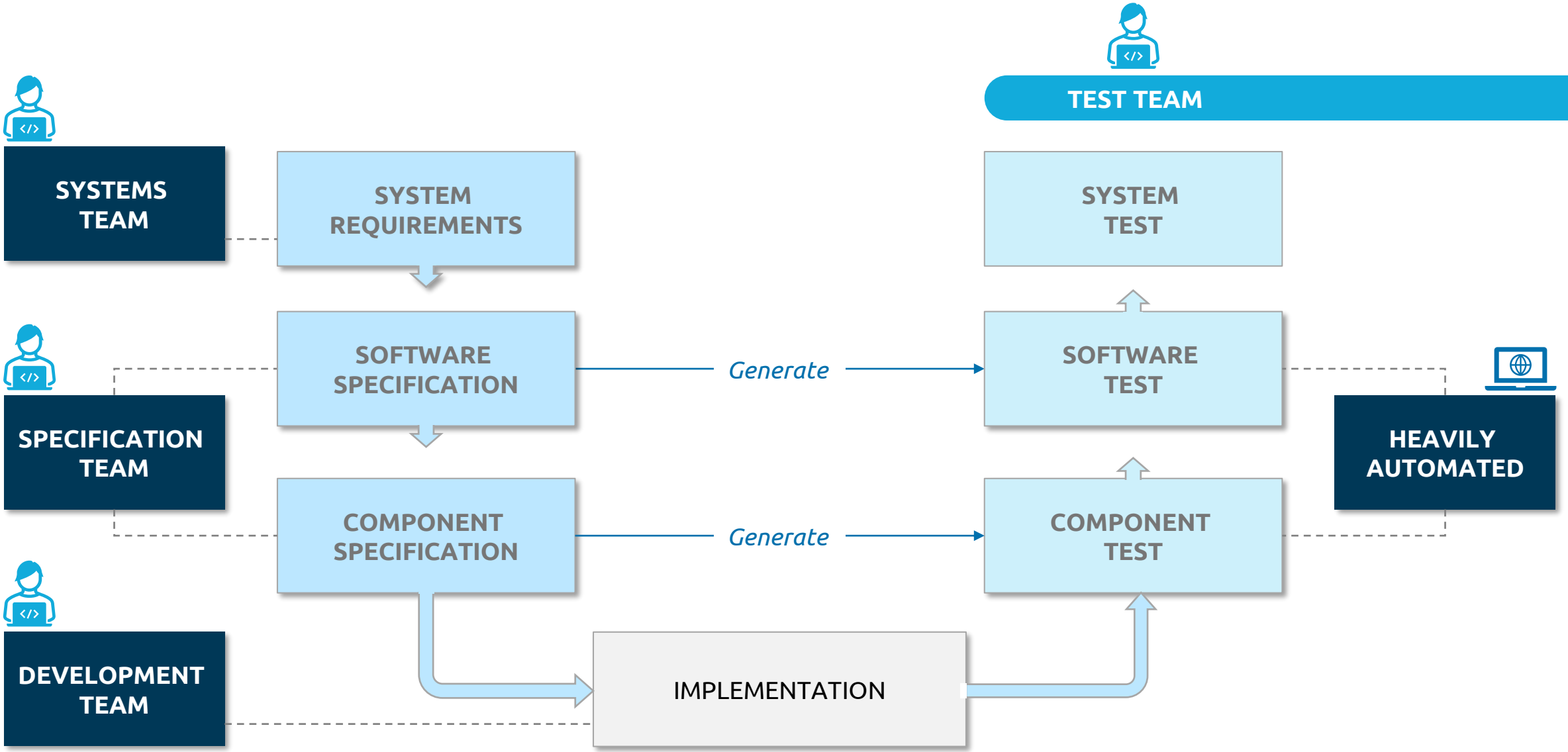
MATHS

Can we use maths more?

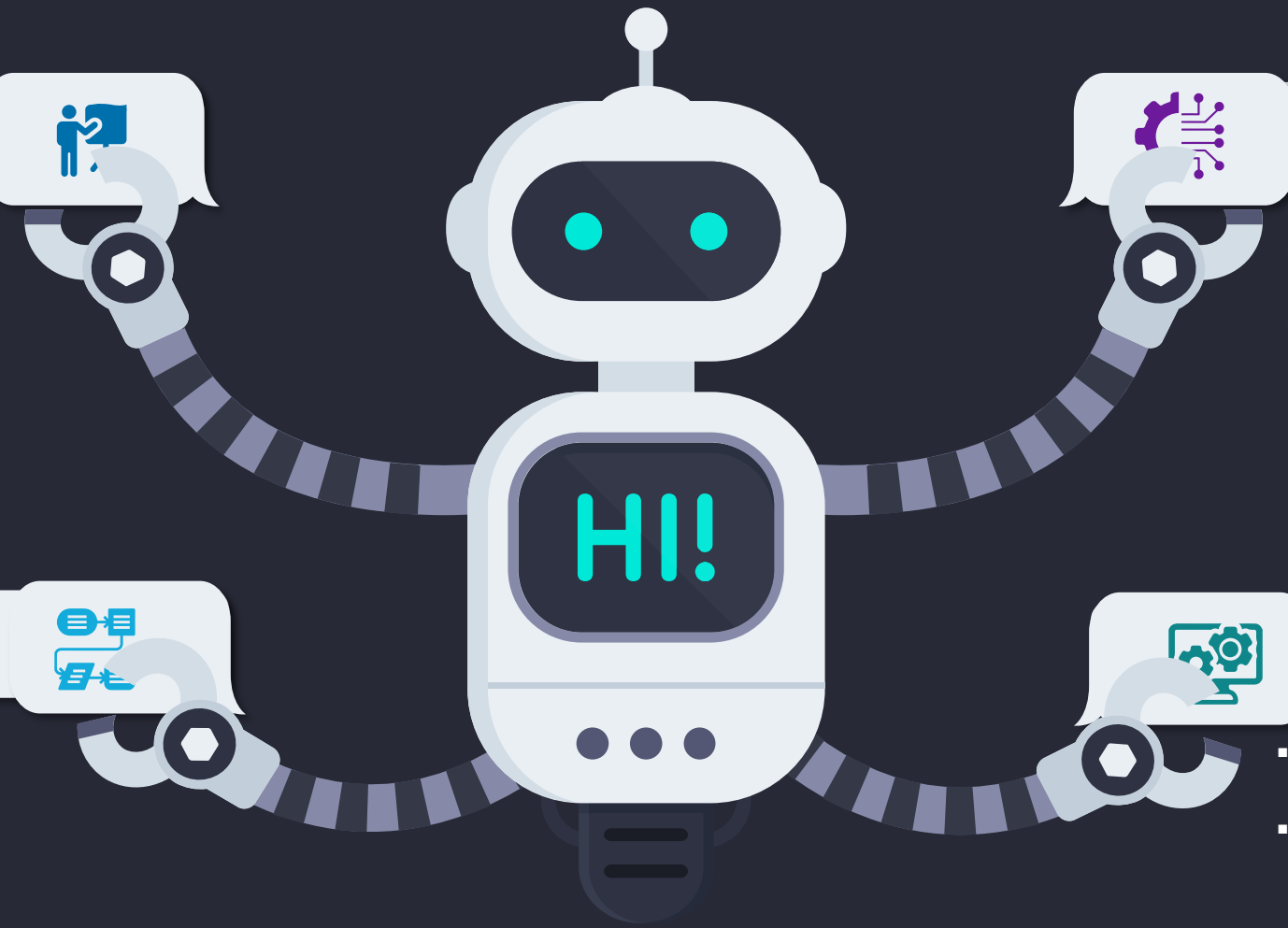
Programming is mathematical

Can we exploit that more?

OUR APPROACH



MODEL-BASED SPECIFICATION



DEFINE CONTEXT AND EXTERNAL INTERFACE(S)

- Model of the world needed to describe the machine's interface
- Define interface(s) to operations of the machine, with their inputs and outputs

SPECIFY DETAILED BEHAVIOUR

- Specify persistent state required for system/packages
- Specify detailed behaviour for (partial) operations

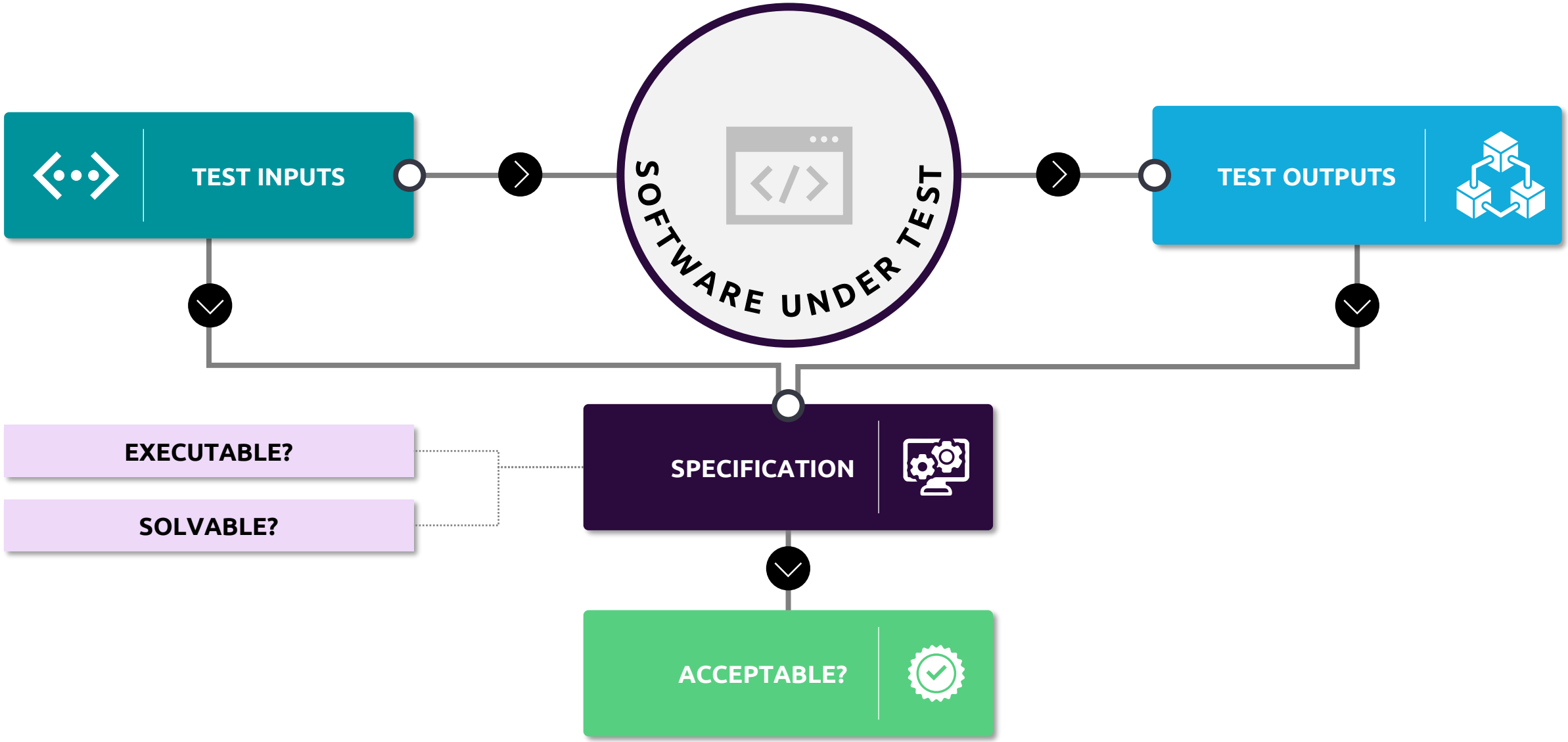
DECOMPOSE AS REQUIRED

- Where required, identify suitable packages to divide specification into and decompose operations into partial operations that update the separate packages

CHECK CORRECTNESS AND USEFULNESS

- Check unambiguous, consistent, complete
- Check feasible, refutable, traceable, usable

DETERMINING WHAT THE TESTS SHOULD CHECK FOR



COVERAGE CRITERIA FOR RULE-BASED TESTING

When processing a file containing:

```
pred p1 [ a, b : Bool] {
   a or b
}
```

If we had an expression:

p1[a1, b1] **or** c1

Then we'd generate conditions:

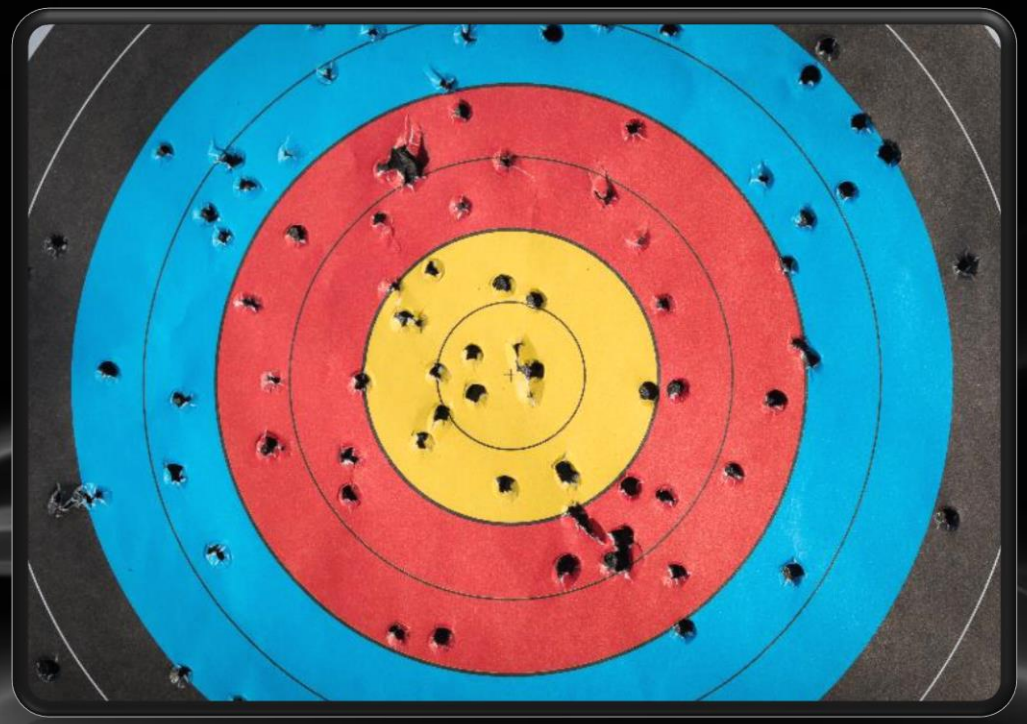
a **or** b

	1 (T)	2 (T)	3 (F)
a	●	○	○
b	○	●	○

- 1 (T)
  - p1[a1, b1]
    - **let** a = a1, b = b1 |
      - a
      - **not** b
  - **not** c1
- 2 (T)
  - p1[a1, b1]
    - **let** a = a1, b = b1 |
      - **not** a
      - b
  - **not** c1
- 3 (T)
  - **not** p1[a1, b1]
    - **let** a = a1, b = b1 |
      - **not** a
      - **not** b
  - c1
- ...

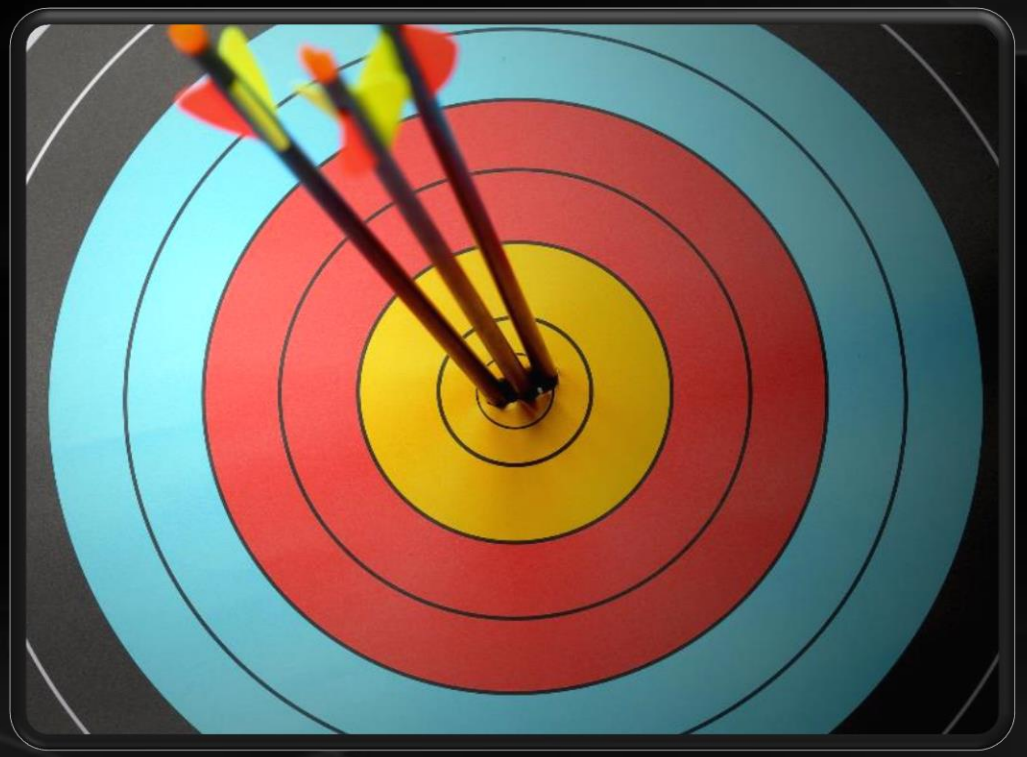
GETTING COVERAGE FOR RULE-BASED TESTING

BLACK BOX



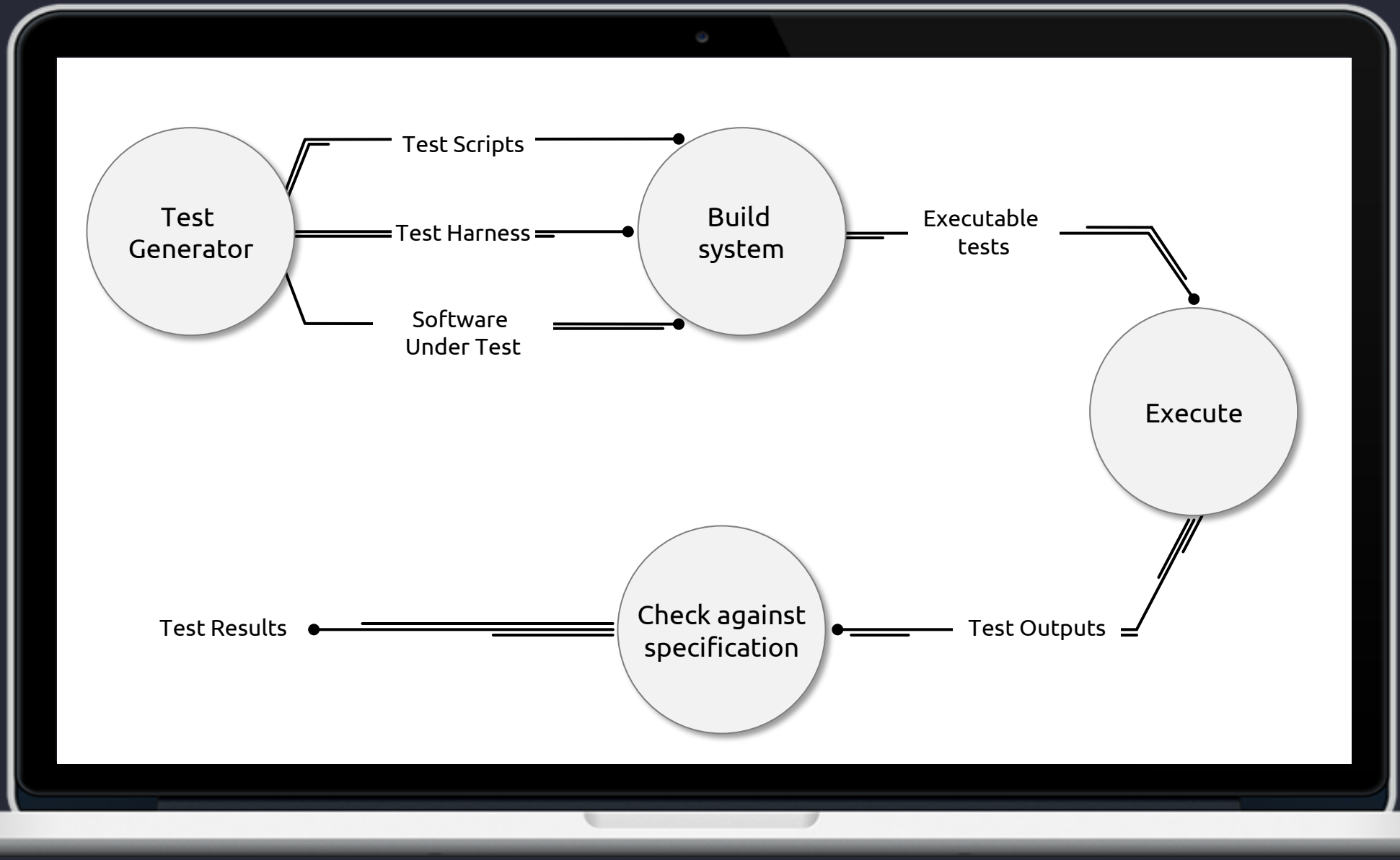
CONSTRAINED RANDOM
ML-BASED
SOLVER-BASED ON CODE

GREY BOX

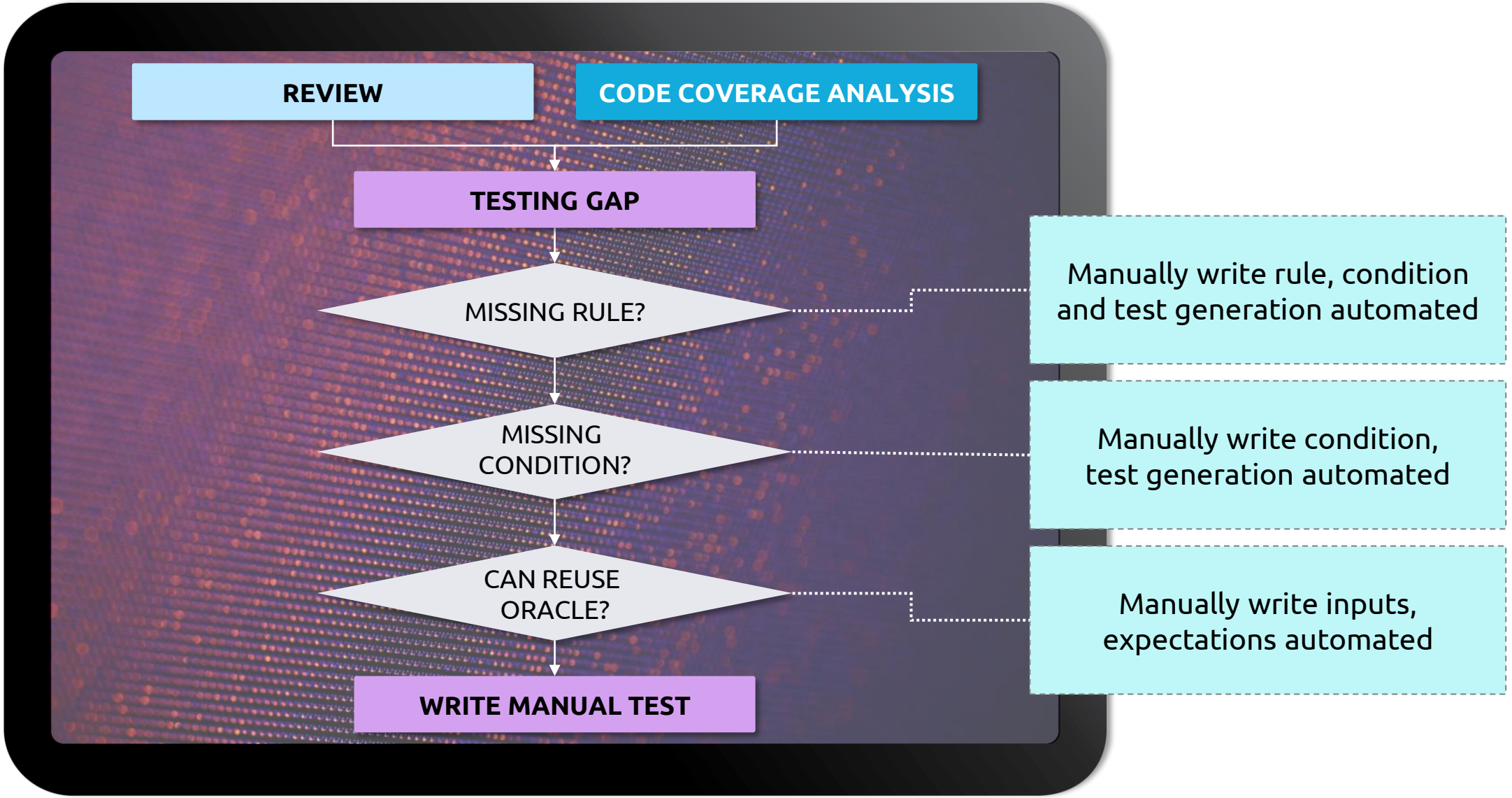


SOLVER-BASED ON SPECIFICATION

RUNNING TESTS AGAINST AN IMPLEMENTATION

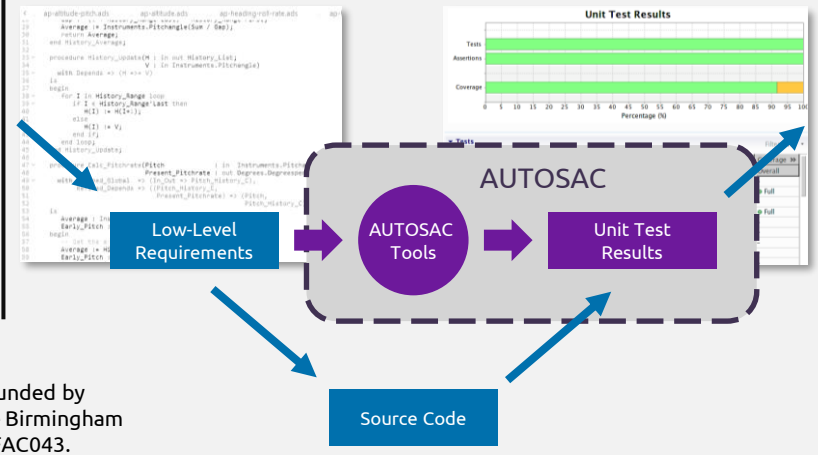


CREATIVE TESTING



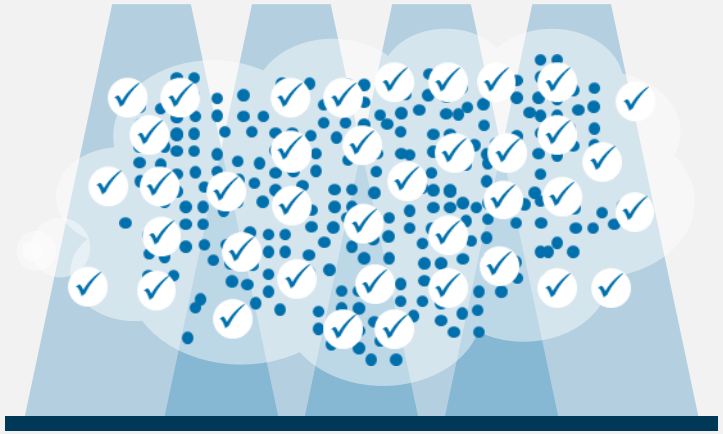
RELATED WORK

AUTOSAC

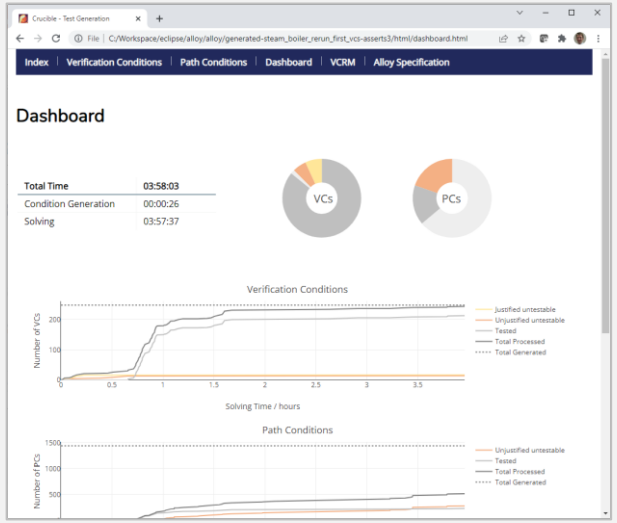


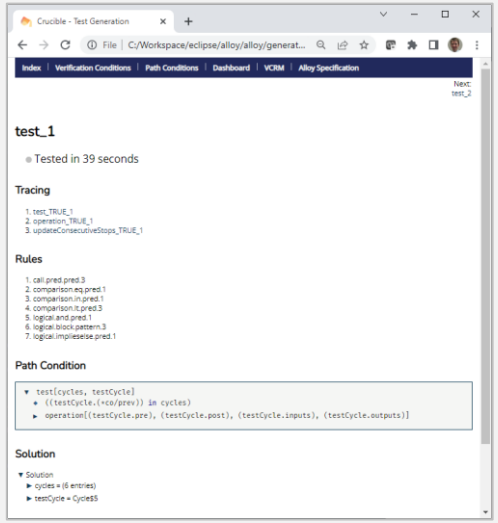
AUTOSAC was a NATEP project funded by Birmingham City Council/Finance Birmingham and the FAC, as project number FAC043.

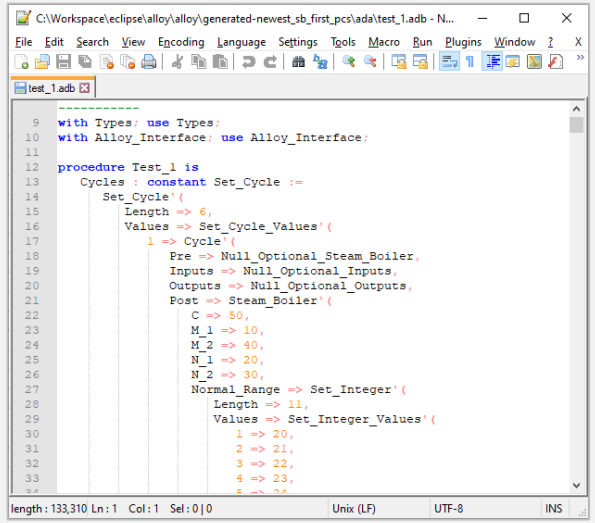
ConTestor



CRUCIBLE



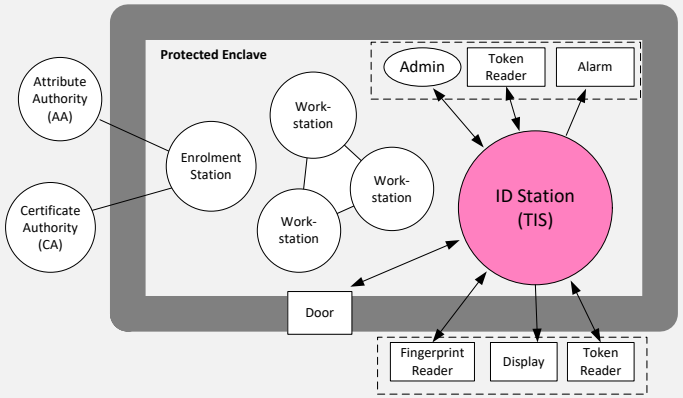




The development of Crucible was supported by the HICLASS project, funded by the Aerospace Technology Institute and Innovate UK, as project number 113213.

CASE STUDIES

TOKENEER

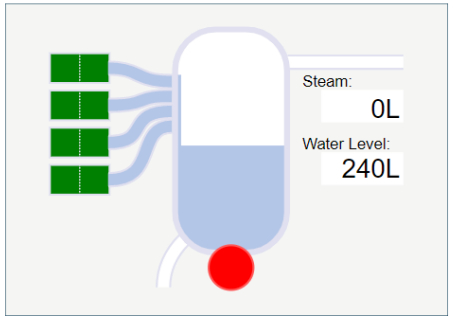


- Alloy specification from original Z specification
- Generate unit tests against original SPARK
- Animation to validate

STEAM BOILER

Input	Value
stop	F
sbw	T
pur	T
ps	[T,T,T,T]
pcs	[T,T,T,T]
level	240L
steam	0L
pr	[F,F,F,F]
pcr	[F,F,F,F]
lr	F
sr	F
pfa	[F,F,F,F]
pcfa	[F,F,F,F]
lfa	F
sfa	F

Cycle4 State: Normal Mode



Output	Value
mode	Normal
pr	F
vo	F
po	[T,T,T,F]
pfd	[F,F,F,F]
pcfd	[F,F,F,F]
lfd	F
sfd	F
pra	[F,F,F,F]
pcra	[F,F,F,F]
lra	F
sra	F

- Alloy specification from original requirements
- Generate test sequences against SPARK implementation
- Manual testing via animator

PROJECT X

Retrospectively applied to past client project

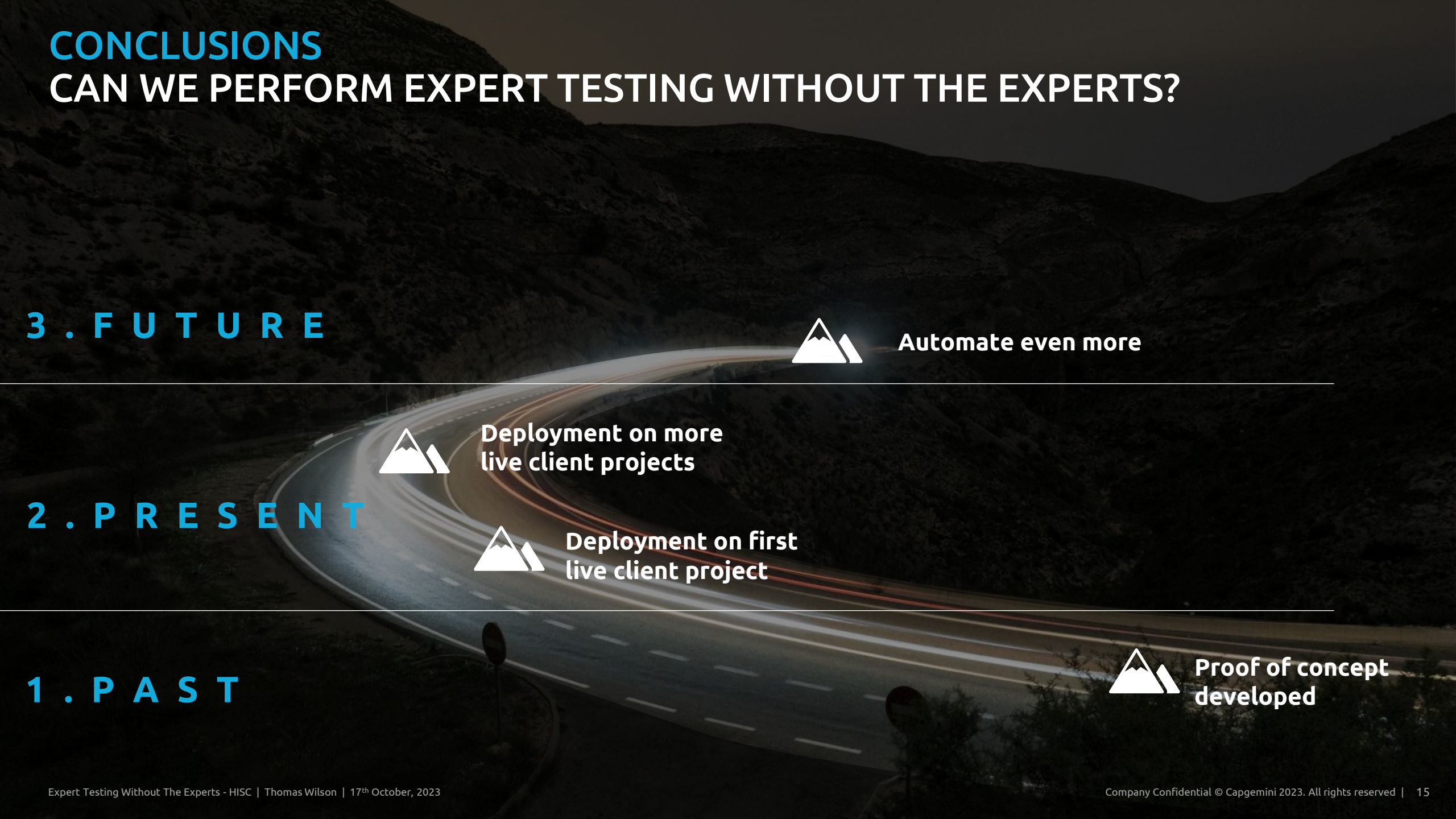
- Alloy specification from original requirements
- Generate unit tests against original SPARK
- Use of CVC4 as external solver

PROJECT Y

Being applied to live client project

- Alloy specification from software requirements
- Generate component tests against SPARK implementation
- Animation to validate

CONCLUSIONS
CAN WE PERFORM EXPERT TESTING WITHOUT THE EXPERTS?

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