

# 10th UCAAT

User Conference on  
Advanced Automated Testing

## Digital Twins for Test Automation of IoT-based Healthcare Applications at Scale

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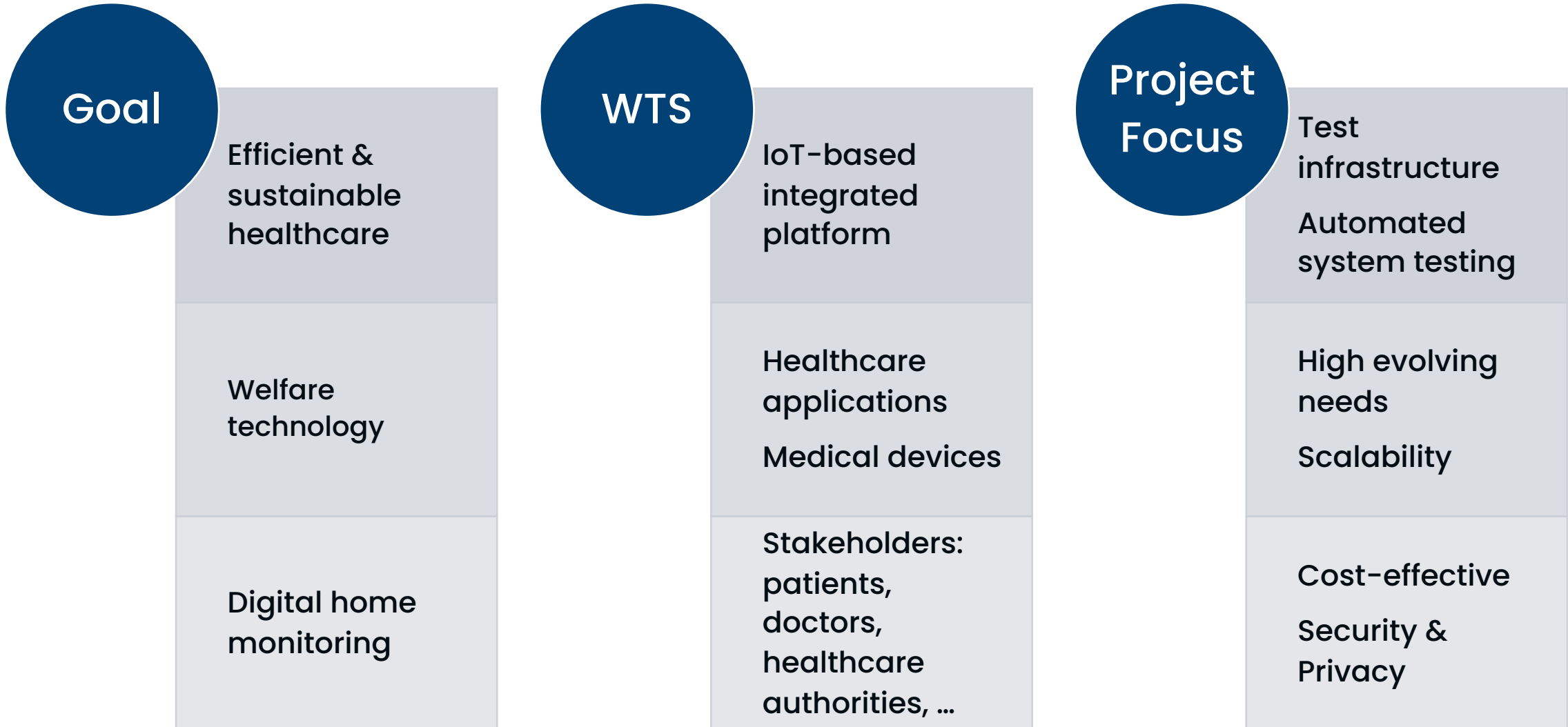
Simula Research Laboratory, Oslo, Norway

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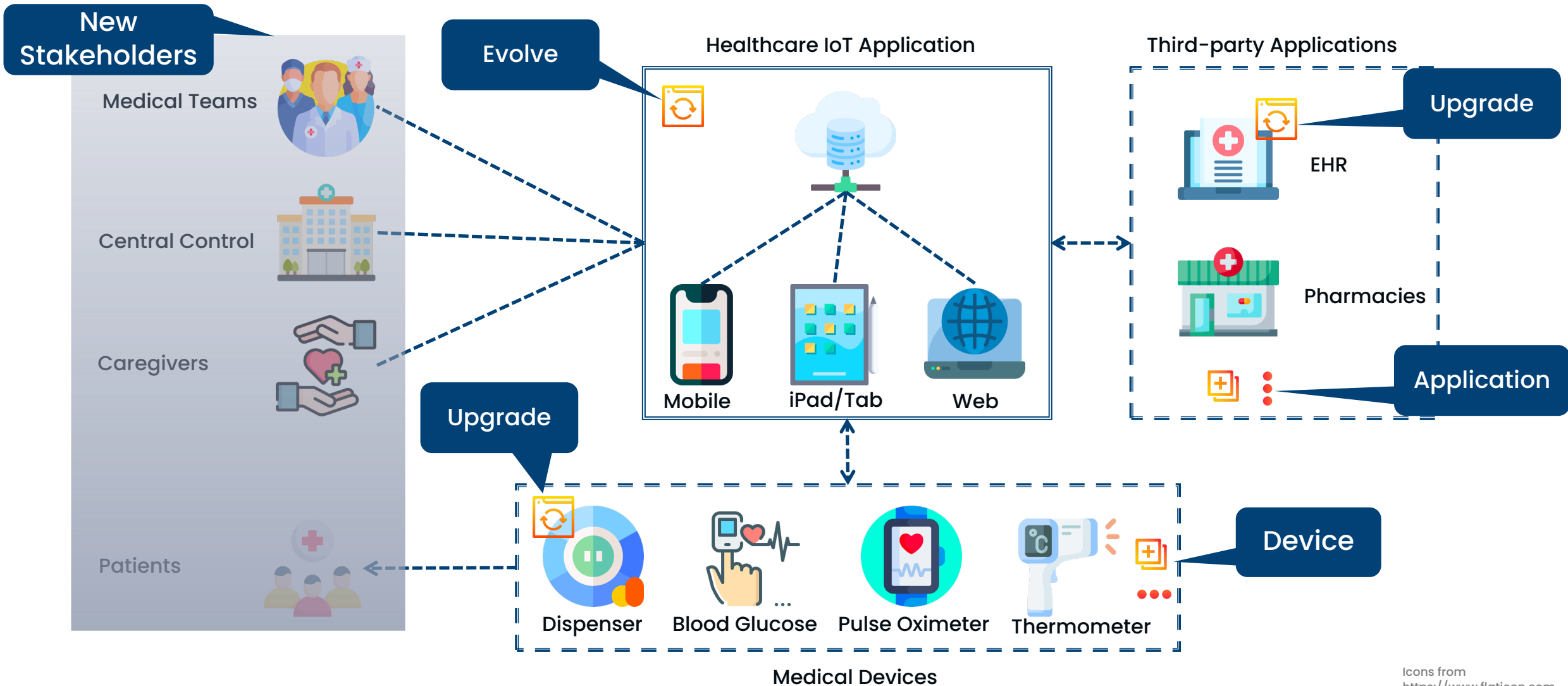
14/11/2023



# WTT4Oslo – Innovation Project



# Industrial Context: Healthcare IoT Application



Icons from <https://www.flaticon.com>

# Automated Testing Challenges

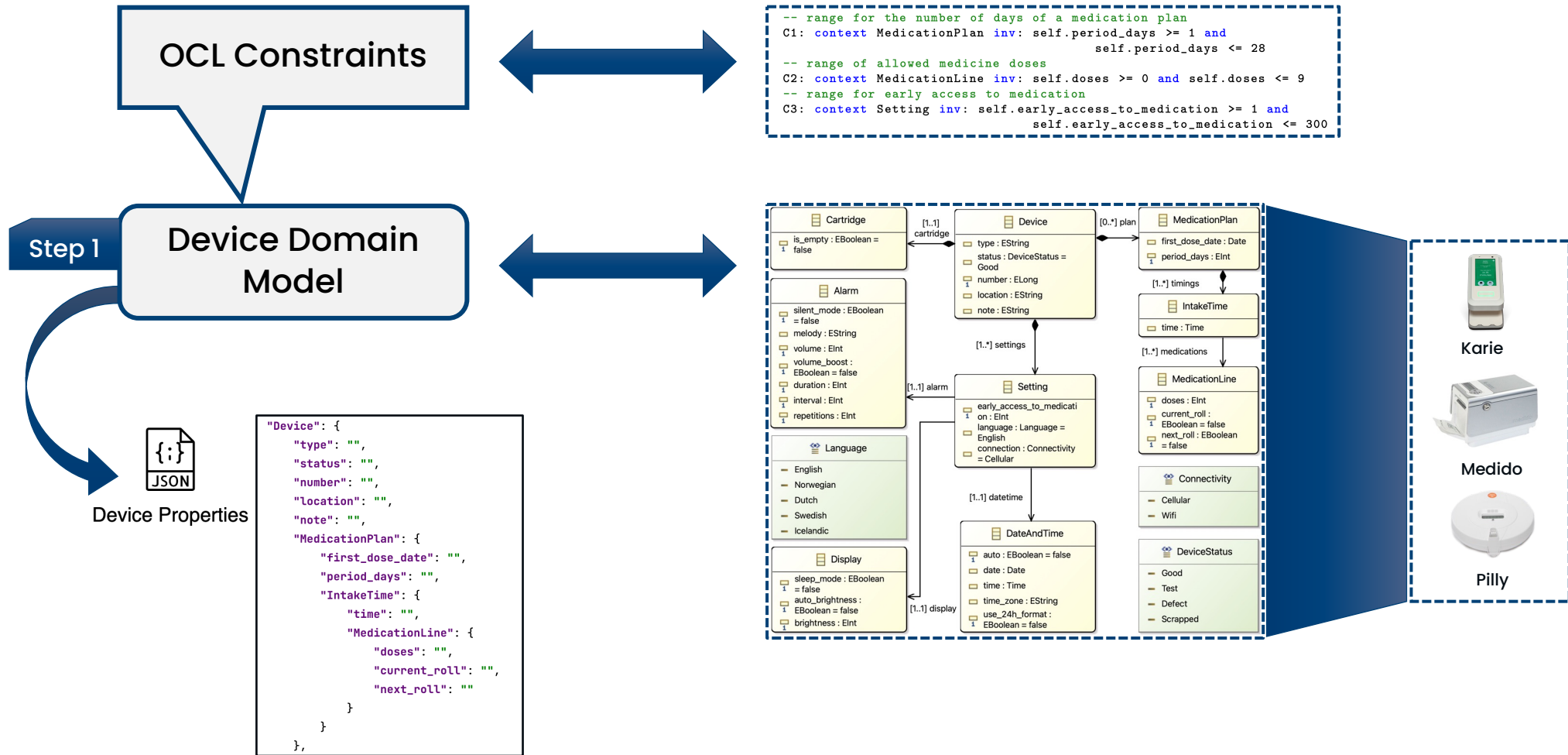
## Testing healthcare IoT applications at scale

- Integrating thousands of medical devices
  - Time-consuming, costly, and impractical
- Using medical devices assigned to patients for testing
  - Unsafe
  - Privacy concerns
- Service blocking by medical device service providers
- Damaging of medical devices during testing

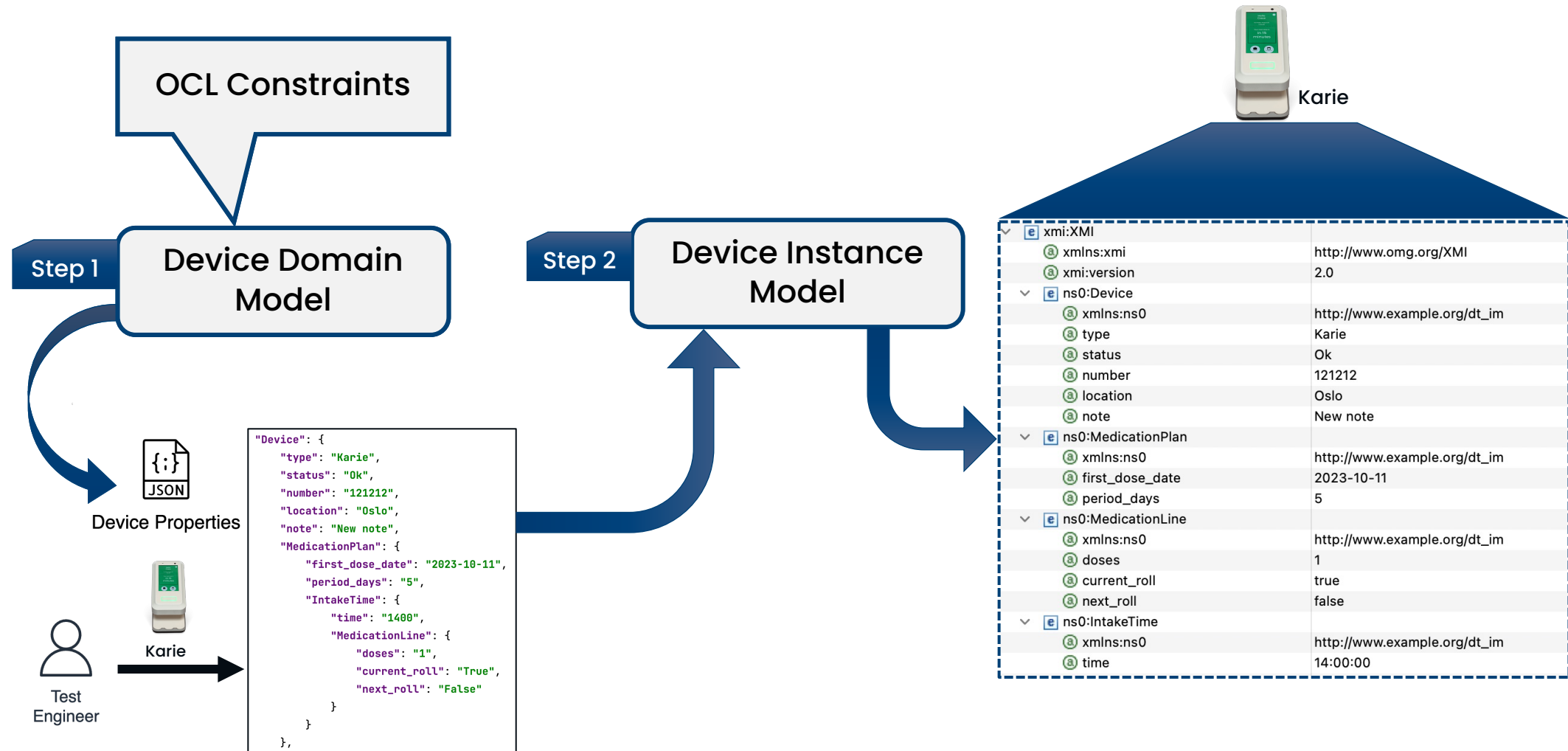
## Support automated testing of healthcare IoT applications

- Create digital twins of medical devices
- Model-driven engineering approach

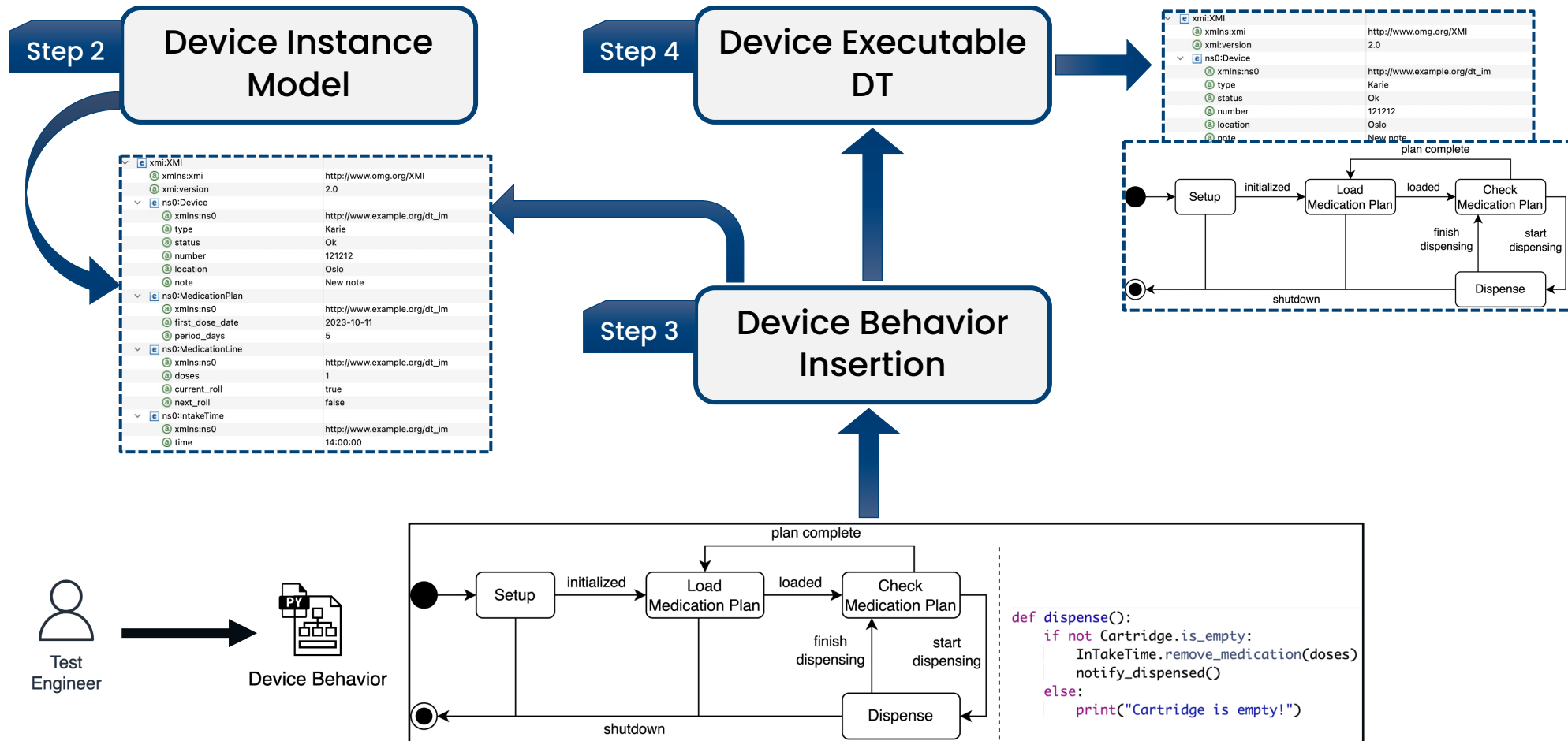
# Approach: Model-based Digital Twins



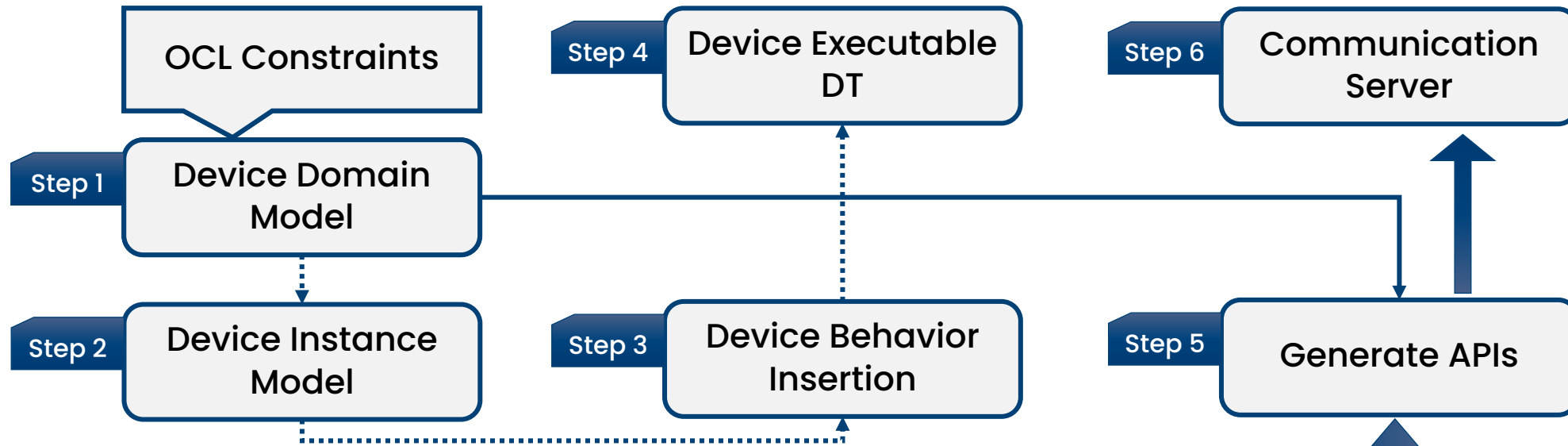
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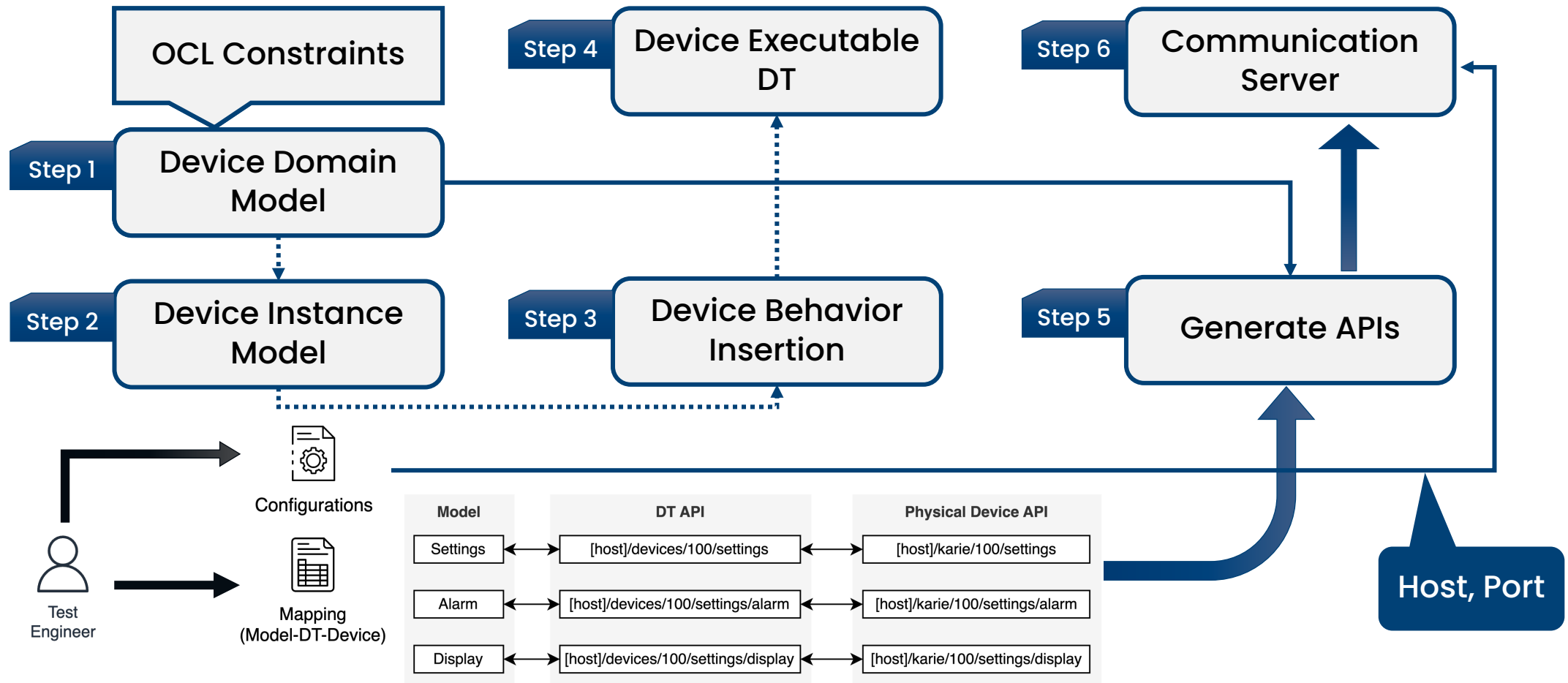
Test Engineer



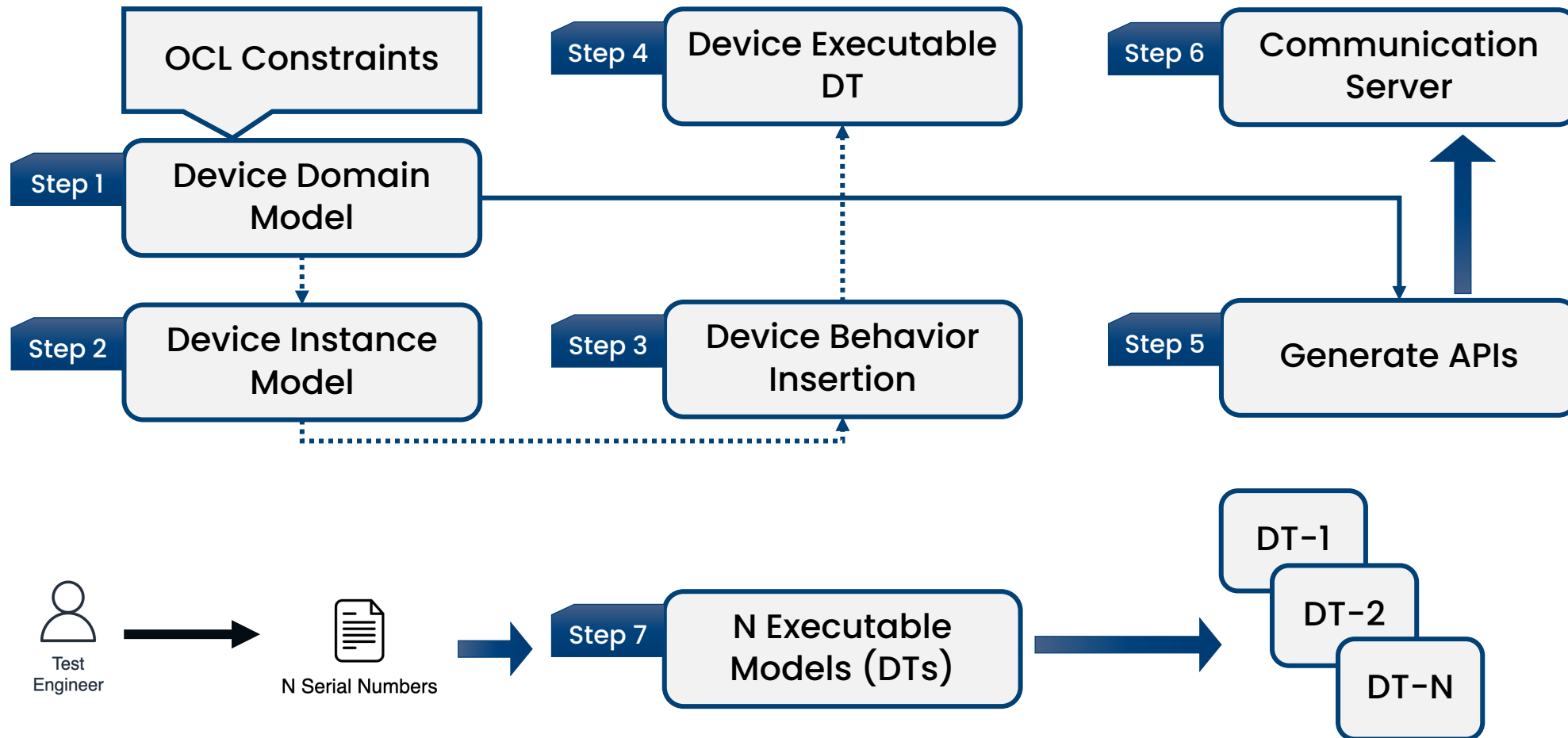
Model	DT API	Physical Device API
Settings	[host]/devices/100/settings	[host]/karie/100/settings
Alarm	[host]/devices/100/settings/alarm	[host]/karie/100/settings/alarm
Display	[host]/devices/100/settings/display	[host]/karie/100/settings/display



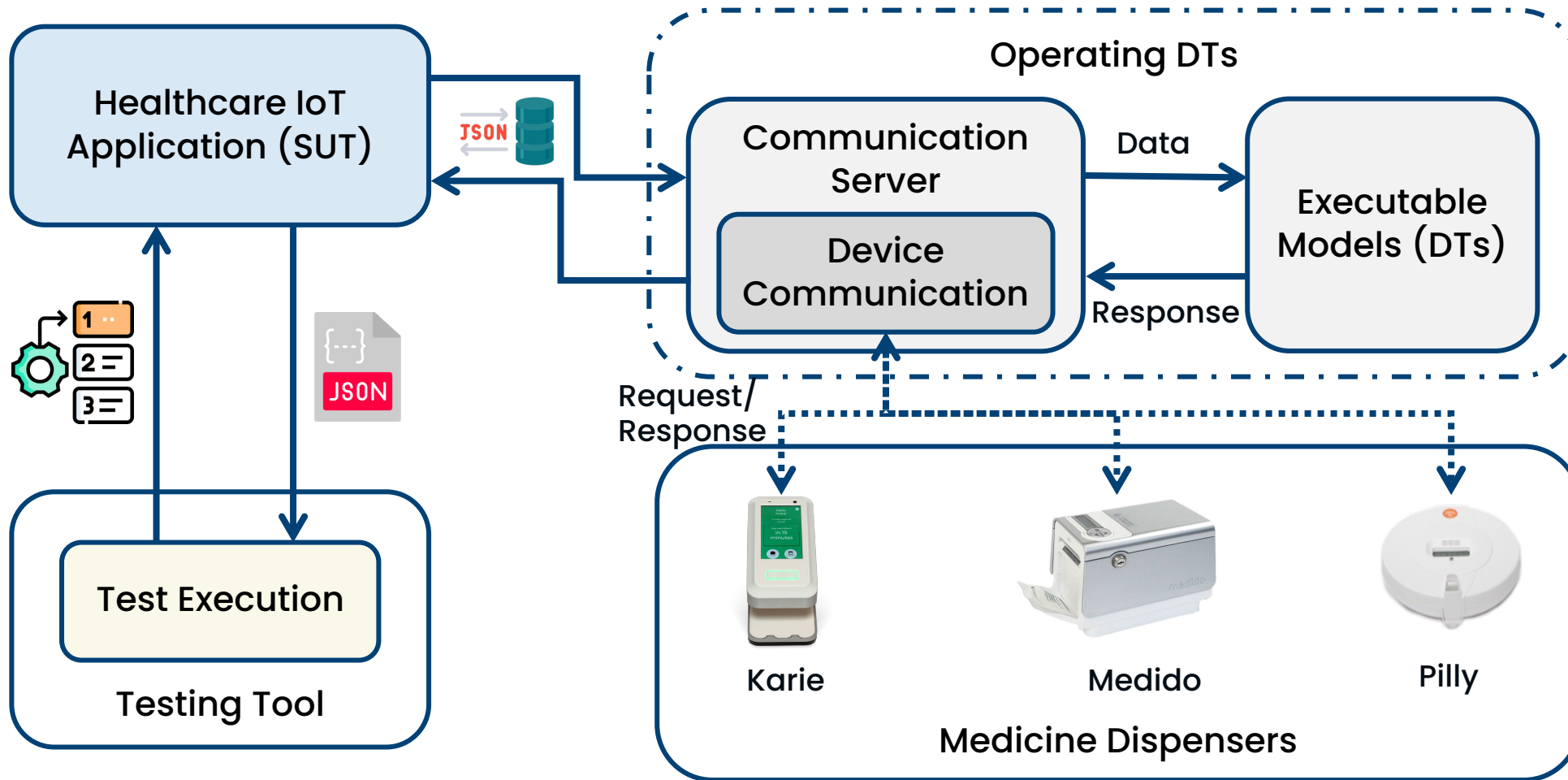
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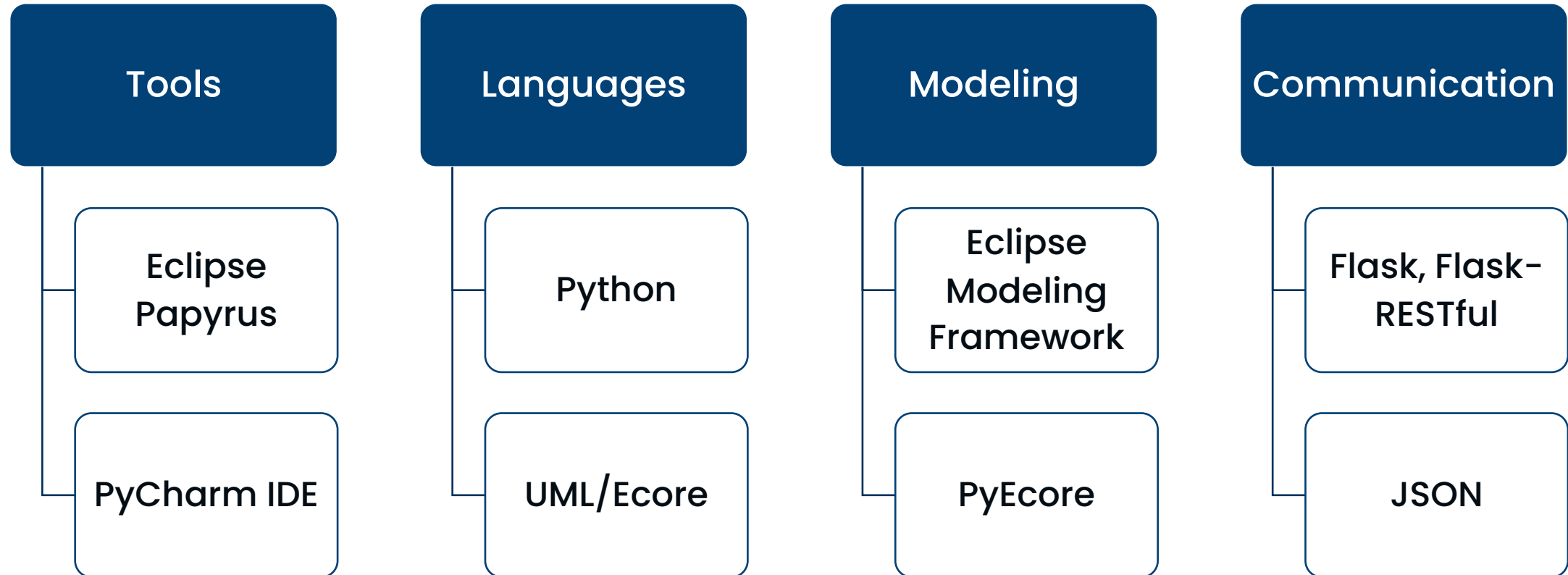


# Approach: Model-based Digital Twins



Icons from <https://www.flaticon.com>

# Technologies, tools, and practices



# Industrial Evaluation

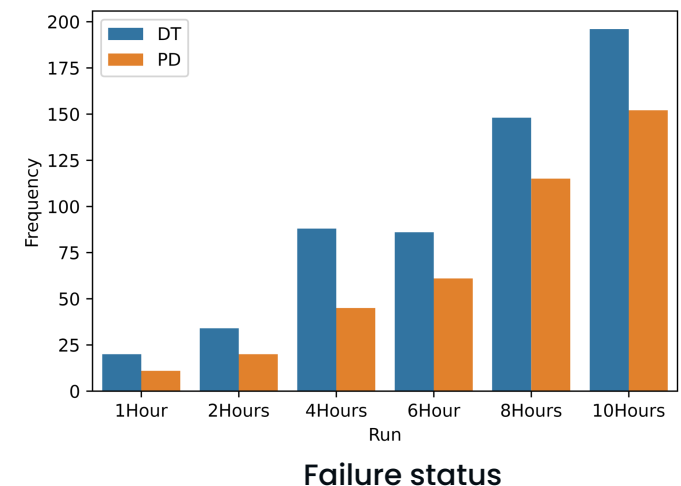
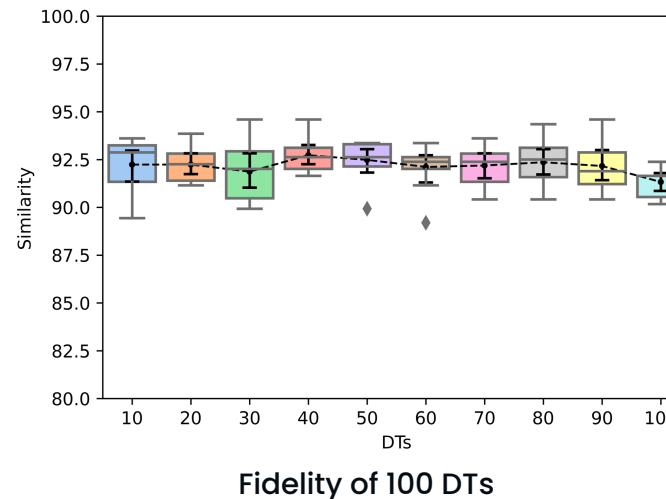
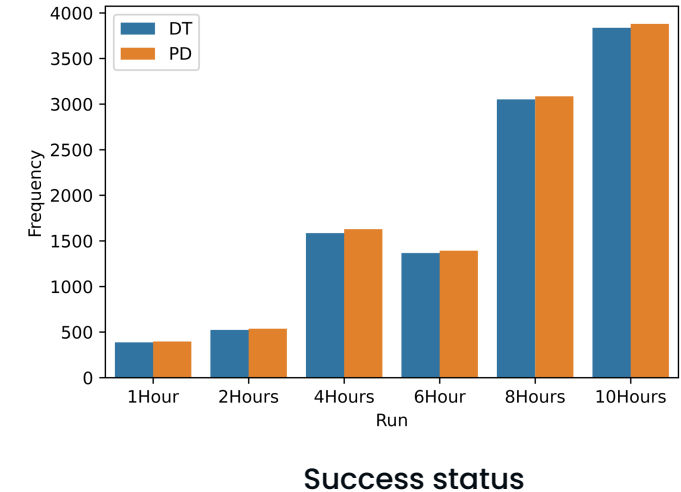
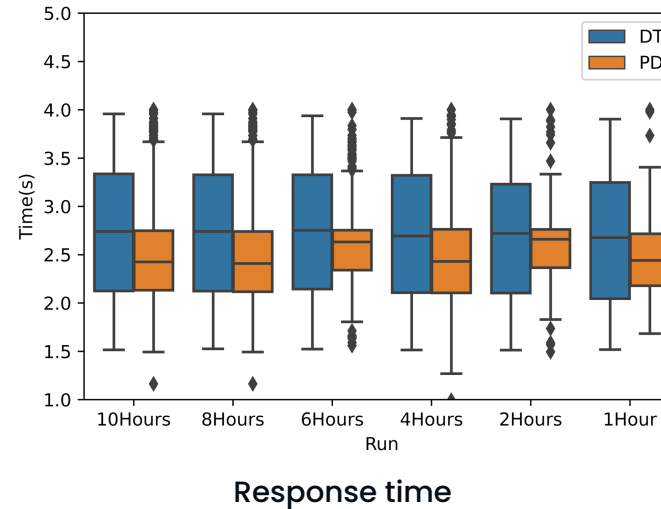
## Karie medicine dispenser

DT and PD operate >92% similarly

- Response time
- Status codes (Success & Failure)

## 100 DTs similarity with PD

- >92%
- Response time
- Status codes (Success & Failure)



# Experiences and Lessons Learned

01

**Empowering healthcare IoT application test infrastructure with DTs**

02

**One-time modeling effort and can be easily reused for building other DTs**

03

**DTs' fidelity in terms of their internal behaviors**

04

**The need for domain-specific testing strategies and test optimization**



## Context

- Healthcare IoT Application
- Testing automation



## Approach

Model-based digital twins of medicine dispensers



## Evaluation

- High fidelity DTs
- Support testing at scale



## Experiences

- DTs role in testing automation
- Domain-specific testing strategies

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