

10th UCAAT

User Conference on
Advanced Automated Testing

Testing of IoT Systems Exemplified by a Fire Protection System

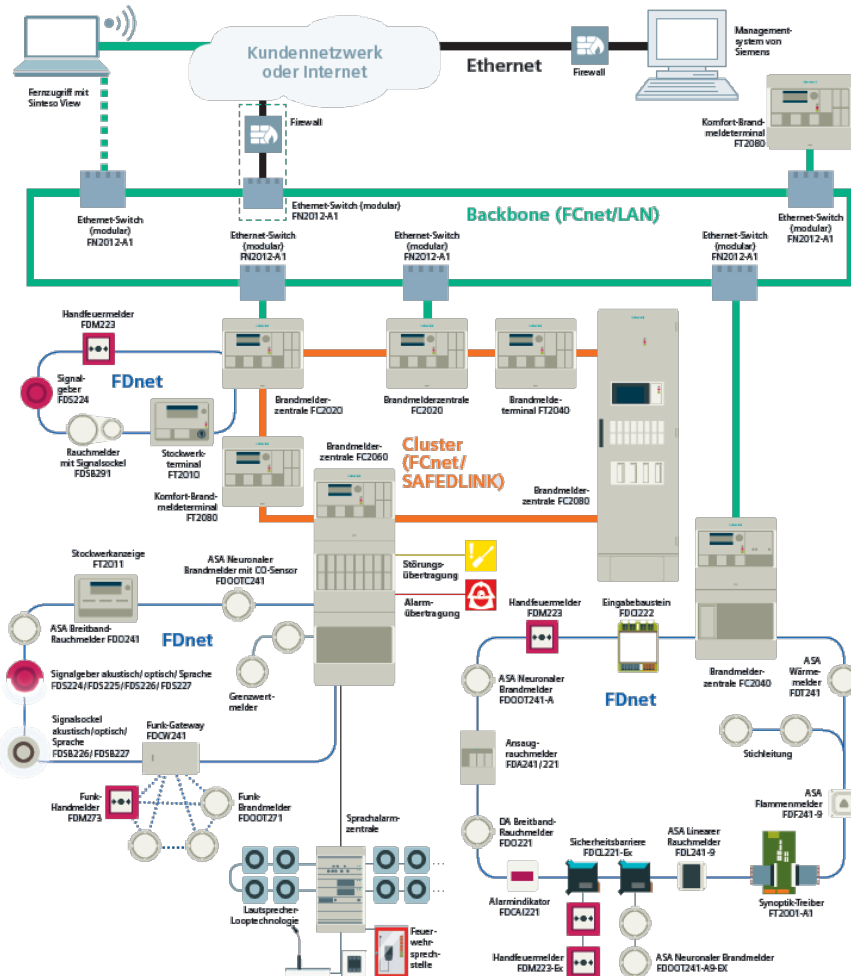
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Overview – The System

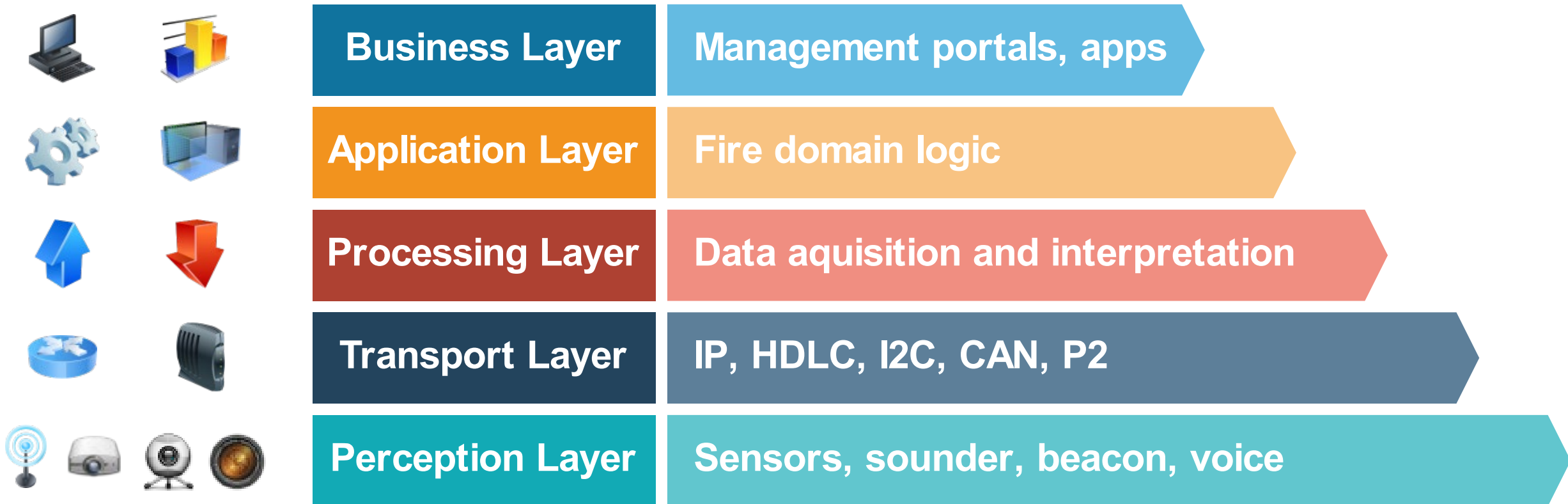


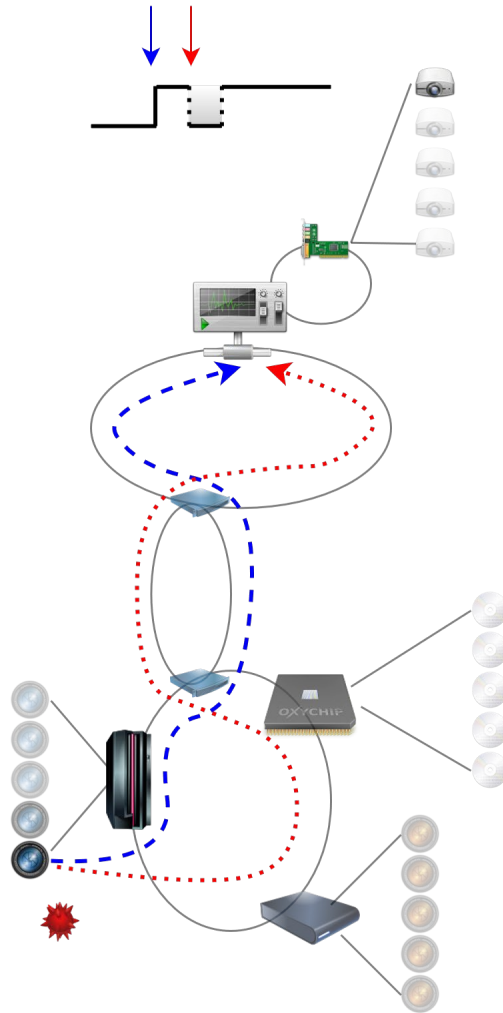
Fire Protection System is

- Safety relevant
- Undergoes strict approval process
- Distributed geographically
- Redundant on different levels
- Heterogeneous technology
- Heterogeneous development environments
- Highly configurable
- Highly scalable
- Backwards compatible for decades
- Lifespan of decades

Fire Protection System has IoT characteristics

IoT Architecture of Fire Protection System ^{10th}UCAAT





System is prone to signal concurrency

- Redundant and asynchronous architecture
 - Many parallel processors and processes
- Detector signals can travel on different routes
 - Resulting in signal racing
- Out of order arrival of events
 - Signals toggle, repeatedly set to same status
- System must be tested for concurrent events
 - Test automation framework must support it

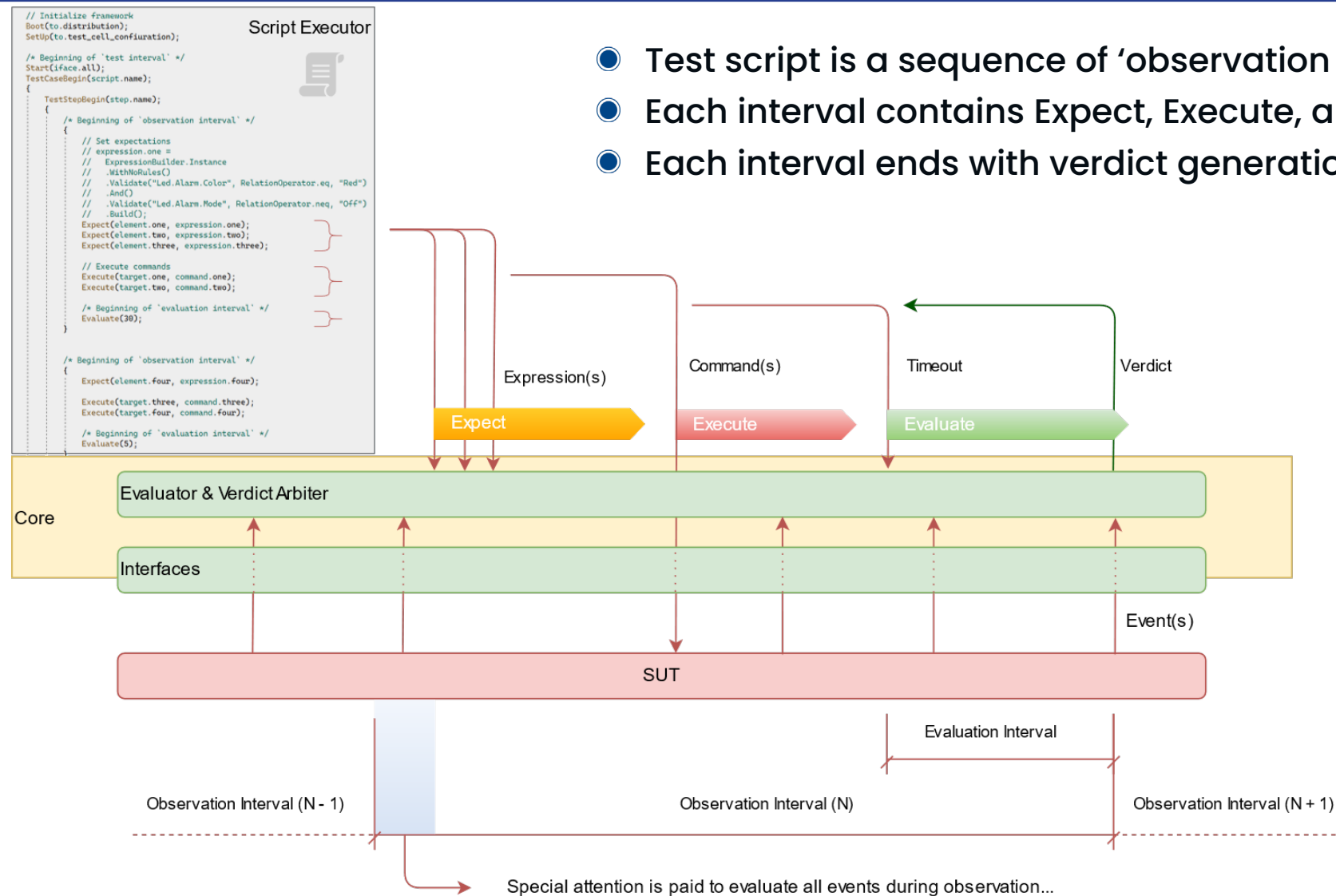
Fire Protection System testing faces tough challenges

- Undetected bug in critical functionality is dangerous, not simply annoying
 - People's lives are at stake
- Early defect detection, rigorous testing on integration and system level
 - Field installed systems are most of the time idle, giving no feedback for analysis
- Careful risk analysis is a must
 - Separate critical from non-critical functionality to place resource on the right task
- Testing in virtual environment not always possible or even allowed
 - Approval body requires system demonstration and results from real system test
- Performance testing of a large-scale distributed system
 - Highly scalable test automation to support complex setups
- Strict regulation
 - Keeping record of test executions and test environments is required for decades

Test automation requires flexibility, extensibility, scalability, maintenance

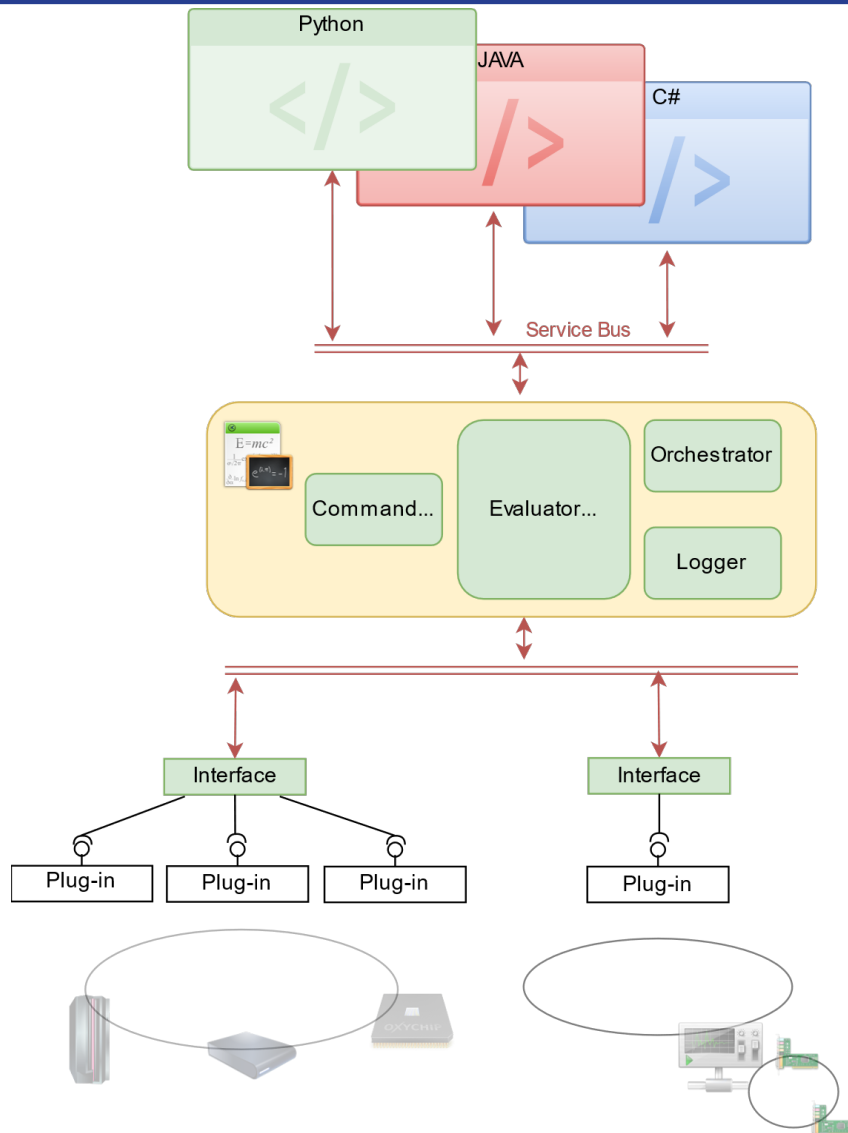
- Safety first
 - Implicit monitoring of many signals
- Many physically distributed SUT interfaces
 - Test setup follow SUT
- Heterogeneity of SUT interfaces
 - Flexible architecture for integrating HW and SW components
- State-based SUT behavior
 - Signal reconstruction from events for evaluation of transient characteristics
- SUT actions are not instantaneous
 - Events might occur before action is completed
- Heterogeneous development environments
 - Different user groups have different tools and workflows

Test Framework – General Work Flow



- Test script is a sequence of 'observation intervals'
- Each interval contains Expect, Execute, and Evaluate sections
- Each interval ends with verdict generation

Test Framework Architecture



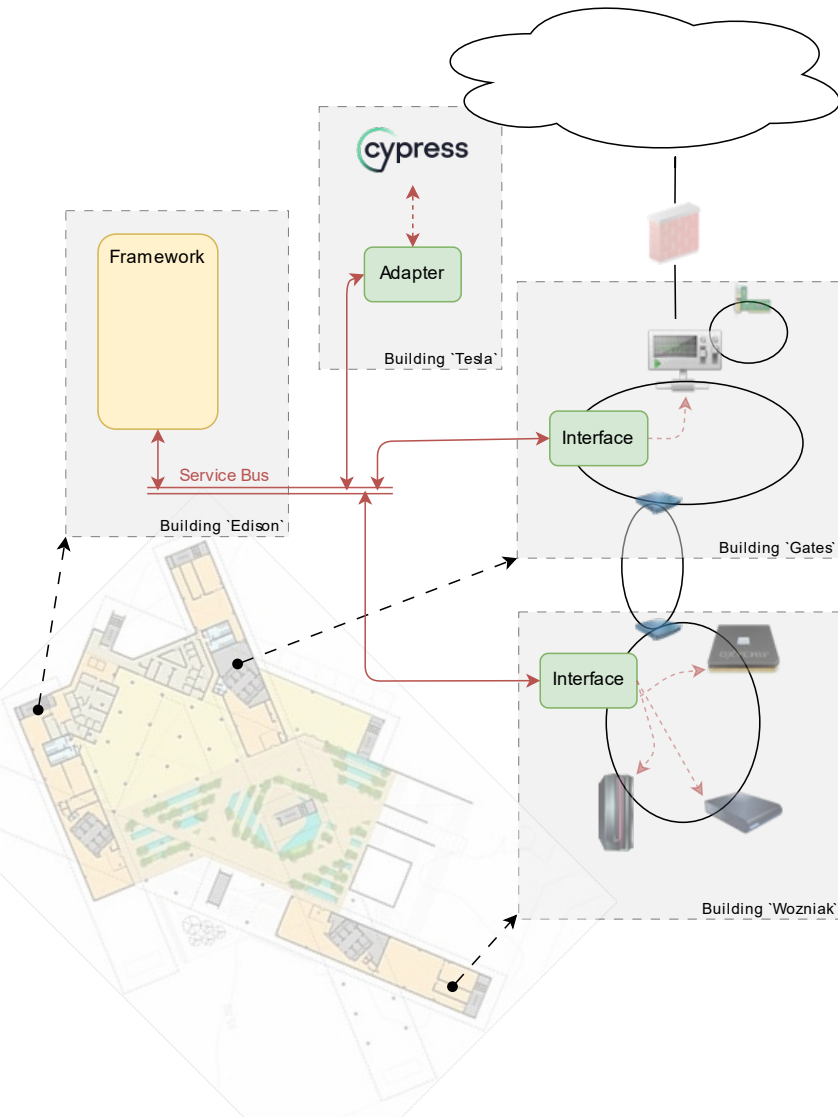
Scalable framework to test Fire Protection System

- Opensource component for distribution and module supervision (Service Bus)
- gRPC for inter-module communication
- Loosely coupled test interfaces for SUT data and commands
- Loosely coupled executors for script commands and expectations
- Core modules for configuration, SUT data evaluation, and verdict generation
- Core modules can be distributed if needed

Geographical Deployment

Example

- Test installation in campus with 2 buildings
- Cloud management in third building
- Interfaces deployed in system segments
- Framework communication in VPN



Testing a Fire Protection System shares many similarities with other IoT systems

- Working with spatially distributed and heterogeneous SUT interfaces
 - Mixture of HW and SW
- Testing of highly concurrent system interactions
 - Events and actions
- Test setup for each system is unique
 - Impossible to predict or define a “standard” system
- Long regression test to ensure compatibility of components and SW
 - Updating or adding new devices must not break the system
- Test tools must support a broad technology mixture
 - From small programmable logic to mainframe

Any further questions?

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