Complex systems and vertical applications

Upper tester implementation

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Introduction

- ETSI CDM Testing Platform implementation
- Allows (IUT) providers to connect their candidate IUTs
- Validate stakeholders against conformance and interoperability reqs
- GOAL: enable candidate nodes and adaptors that pass the tests to enter the CISE Testing Network

Infrastructure design

Private cloud using a multi-tenant infrastructure
IAAS

- Server Farm: 2 mirrored/synchronized servers vs potential downtimes
- VMs deployment and management
- SDN with VLANs, custom firewall rules
- Fiber-optic communication $\leq$ 100 Mbit/s download/upload
- Hardware Resources: dual Xeon Gold 5317 CPUs (12 cores), 4.8 TB HDD, 1.9 TB SSD, Ethernet 25 Gb/s SFP+ adapters.

Infrastructure design

PAAS

- Hypervisor services: VMware ESXi
- Container management: Docker, Kubernetes
- Network Monitoring: Zabbix, Nagios tools for various protocols (e.g., FTP, HTTP, HTTPS).
- VPN Services: OpenVPN
- DBMS
- PKI: local PKI digital certificates, supports signing/verifying of CISE messeges

Infrastructure design

SAAS
suite of software accessible by any user tenant

- CISE Adaptor: sends CISE messages to ensure conformance testing w.r.t candidate nodes
- CISE Service Registry: services discovery provided by Adaptors and nodes
- CISE Simulator: send/rec CISE messages to/from CISE Nodes, adaptors, or other simulators

Underlying protocols

TCP/IP RFC 9293 - ISO/OSI

- Application Layer (ISO/OSI Layer 7)
  CISE services operate here, utilizing HTTP/HTTPS for web communication, SOAP or REST.
- Transport Layer (ISO/OSI Layer 4): TCP ensures reliable data transmission between CISE nodes and adaptors
- Network Layer (ISO/OSI Layer 3): IP for addressing and routing data packets within the CISE network

Data and service model

Entities

CISE Node:

- manages the information exchange protocol between partners
- security, access rights and reliability aspects
- common for all the partners

CISE Adaptor:

- translates the data model and communication protocol between CISE and the Legacy System
- specific for each Legacy System

CISE Adaptor

Communication between legacy systems and CISE nodes

- Node to node: communication between CISE nodes
- Adaptor to node: (bridge) communication between legacy systems and CISE nodes

Functions

- Data query and reception
- Feedback and acknowledgement handling
- Service discovery

Message patterns

- Pull and push (specific or multicast)
- Publish/Subscribe
- Acknowledgement

Data model

Logical representation of the information shared within the network
Information Categories

- Different service Types supported
- The registration process for Producer and Consumer services requires specifying the supported Service Type
- Vessels: static information, tracks, vessels of interest
- Persons: crew and passengers
- Reporting formalities: notifications related to service operations
- Alerts and Risks
- Assets: real-time positions of surveillance and intervention assets

Communication patterns

Multiple communication patterns for each scenario

- Pull Request: a consumer requests information from a provider
- Push: a provider sends information to a consumer
- Publish/Subscribe: a consumer subscribes to update infos
- Ackn: confirms receipt and processing of messages
- Feedback: updates or errors related to information exchange

Message flow paramameters

- Message description: type, sender, recipient, and payload
- Service description: Id the service, its type, features
- Participant description: details about involved entities (i.e endpoints and contact information)
- Message Type: nature of the message (i.e. PullRequest, Push)
- Sender
- Recipient
- Payload: core data exchanged, adhering to the CISE data model
- Signature: ensures message authenticity (XMLSignature standard)

Testing platform

Constraints and requirements

- Compatibility with ETSI validation handbook: adhering to ETSI EG 201 015 reqs
- Platform independence: decoupled from specific test system platforms
- Tool independence: separation of tool-specific interfaces from core functionalities
- Configurable and customizable: flexibility in test setup
- Test automation: tools and interfaces for SUT
- Extensibility: to support future CDM protocols
- Reusability: generic components usable in other test platforms

Motivations

Nodes and Adaptors

- Standardized qualification process for implementing the ETSI standard
- Developed by industries independently
- Error fixing in standards

Test

Conformance tests

- Ensure IUTs conform to the CISE Data and Service models
- Network configuration
- Communication Node to Adaptors / Node to Node
- TTCN tests notation

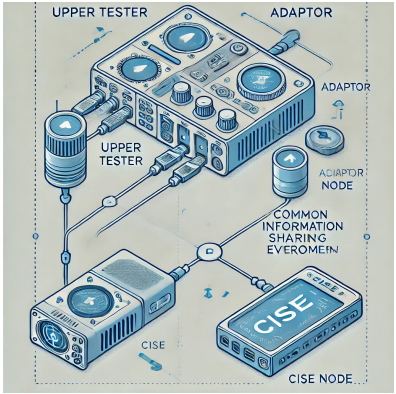
Interoperability tests

- Testing different independent implementations

Test system implementation

- Language: python
- FastAPI endpoint exposure: endpoints that interact with the SUT
  `http://10.50.1.181:8000/api/v1/message/send`
- Message handling: forwards Pull Requests, manages subscriptions, unsubscriptions, and discovery operations to the adaptor
- Adaptor interaction: adaptor processes these requests and sends responses back to the SUT, ensuring seamless communication and testing
- REST protocol, methods allowed: POST
- Input: HTTP headers (Accept: application/json, Content-Type: application/json) and HTTP Body (Message class data structure)
- Output: Acknowledgement class
- Each message received stored (data analysis, logging, bug fixing...)

Communication



Possible improvements

- Upper tester containerization with Docker
- Logging more detailed informations: time elapsed for exchanging data, # requests per sender, responses stored
- Store informations in hashed No-sql DB (or blockchain or DHT), now just in a json file
- Non-repudiation feature
- Add more workers to avoid DOS (actually already possible) and improve scalability
  - `uvicorn app:app --host 10.50.1.181 --port 8000 --workers NNN --log-level debug`

Applications in maritime industry and vertical sectors

Applications in the Maritime Industry

Key role in enhancing maritime operations
Framework for sharing information securely and efficiently

- Maritime surveillance: vessel movements, potential threats, maritime security
- Port management: streamlining port operations, managing vessel arrivals and departures, ensuring compliance with regulations
- Search and rescue operations: coordinating efforts between various maritime agencies to respond to emergencies.
- Environmental monitoring: tracking environmental data and monitoring pollution levels
- Search and rescue (SAR) operations: response to maritime emergencies
- Law enforcement: anti-smuggling operations, illegal phishing operations, border security

Applications in vertical Sectors

Beyond the maritime industry, adapt CISE network to other sectors

- Aviation surveillance: air traffic management and security
- Airport management: cargo/civil airport operations, aircraft arrivals/departures
- Energy sector: offshore energy infrastructure monitoring, (wind farms, oil rigs)
- Anti-piracy operations: protecting trade operations
- Joint military exercises/operations: multi national cooperation

Conclusions

- ETSI CDM Testing Platform, with its IaaS, PaaS, and SaaS layers, provides a **robust** and **flexible environment** for **validating candidate** IUTs **against** CISE conformance and interoperability **standards**
- It facilitates **rigorous testing** and ensures compliance with the CISE **data** and **service** models
- This platform is crucial for **enhancing maritime surveillance** capabilities across EU member states
- By **extending** the CISE network to these **vertical sectors**, it can provide significant **benefits** in terms of enhanced coordination, improved situational awareness, and effective responses to various challenges

It is not trivial implementing solutions compliant with standards