6th UCAAT User Conference on Advanced Automated Testing

ETSI

F-INTEROP

Online & remote interoperability testing for IoT

Presented by Federico SISMONDI and César VIHO

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Agenda

- Why the F-Interop project?
- Online remote interoperability testing requirements
- F-Interop platform architecture and components
- Current status of F-Interop platform
- Remote interoperability testing in practice with F-Interop
- F-Interop achievements and next steps

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F-Interop: the context, the needs from SDOs and SMEs

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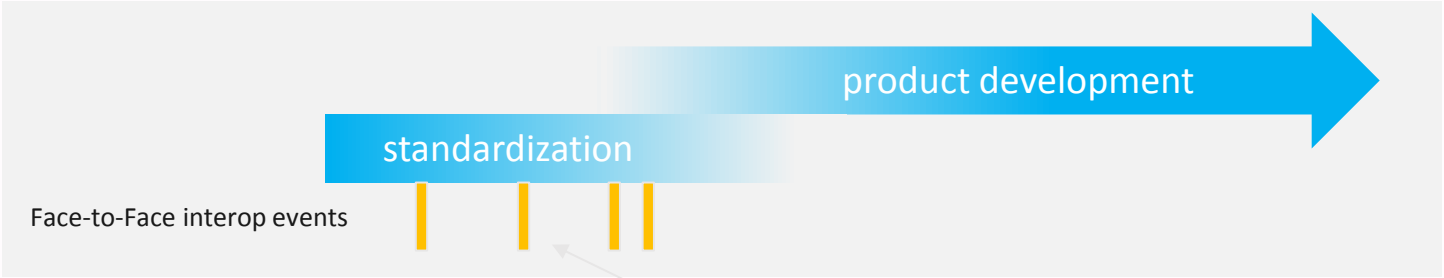
Interoperability testing

"The purpose of interoperability testing is to prove that end-to-end functionality between (at least) two communicating systems is as required by the standard(s) on which those systems are based."

https://portal.etsi.org/Services/CentreforTestingInteroperability/ETSIApproach/InteroperabilityTesting.aspx

State of the Art: Face-to-Face Events

Similar requirements from all SDOs: ETSI, IPv6 READY, IETF, ITU, oneM2M, W3C, ...

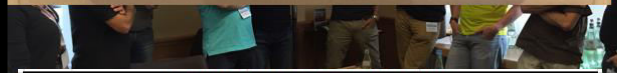


Goals of these events:

- Make better standards
- Reduced time-to-market
- Increase adoption

Example: ETSI plugtests

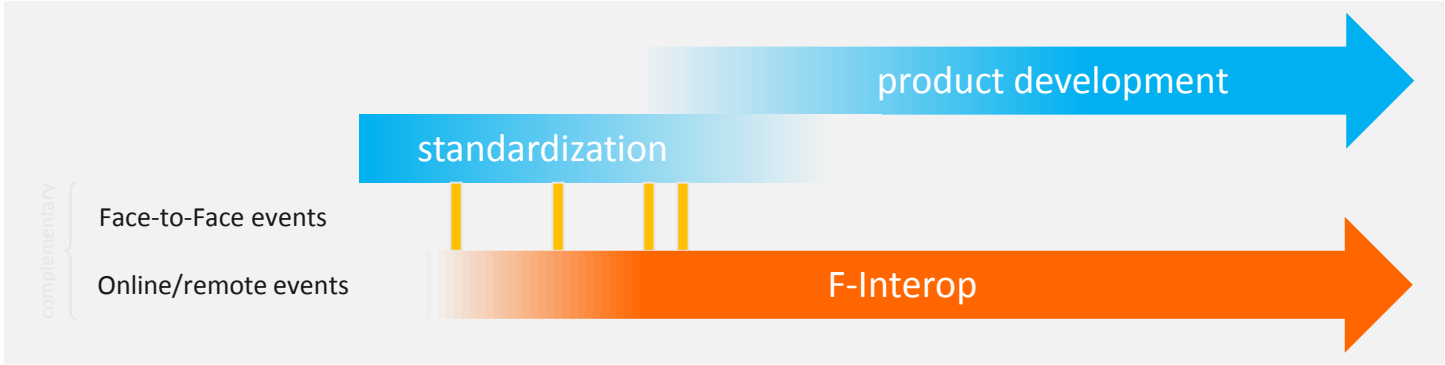
- 6TiSCH: Jul'15, Feb'16, Jul'16
- oneM2M: Sep'15, May'16, Nov'16
- CoAP: Mar'12, Nov'12, Nov'13, Mar'14



Joint 6TiSCH/6lo Agenda (JULY 2016)			
Time	Friday 15	Saturday 16	Sunday 17
08:30		Room Opening	Room Opening
09:00 11:00		TEST SESSION #3	TEST SESSION #7
11:00 13:00	SET-UP	TEST SESSION #4	TEST SESSION #8
13:00 14:00	LUNCH 12:30 to 13:30 WELCOME 13:30 to 14:00	LUNCH	LUNCH
14:00 16:00	TEST SESSION #1	TEST SESSION #5	TEAR-DOWN 14:00 to 15:00
16:00 18:00	TEST SESSION #2	TEST SESSION #6	
18:00 19:00	WRAP UP	WRAP UP	

Few and far apart	Short	Face-to-face
• *Once or twice a year*	• *2-5 days typical*	• *Cost of traveling*

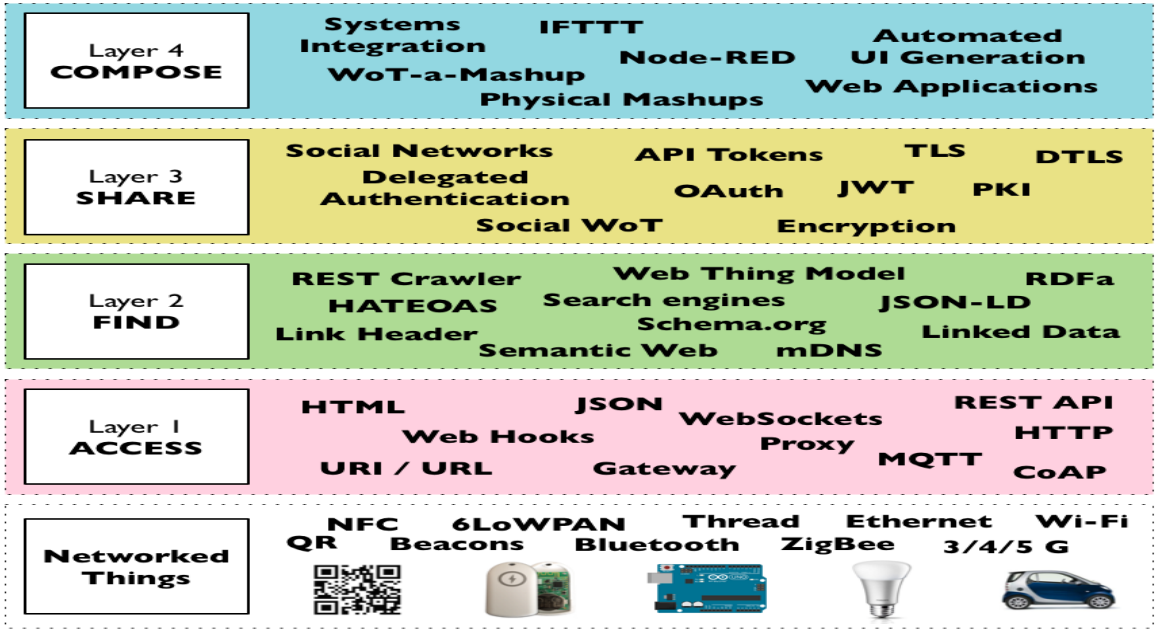
In practice, attended by large companies working on standardization ☹



Online	Remote

Inclusive of SMEs, more standards-based products on the market, faster ☺

IoT standards and technologies evolve fast

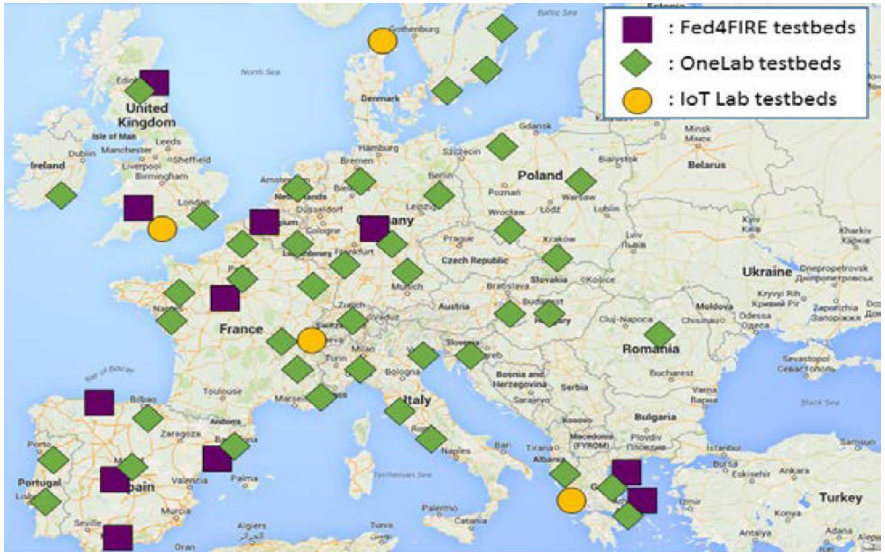


Source: Building the Web of Things: book.webofthings.io
Creative Commons Attribution 4.0

Leveraging from European testbeds

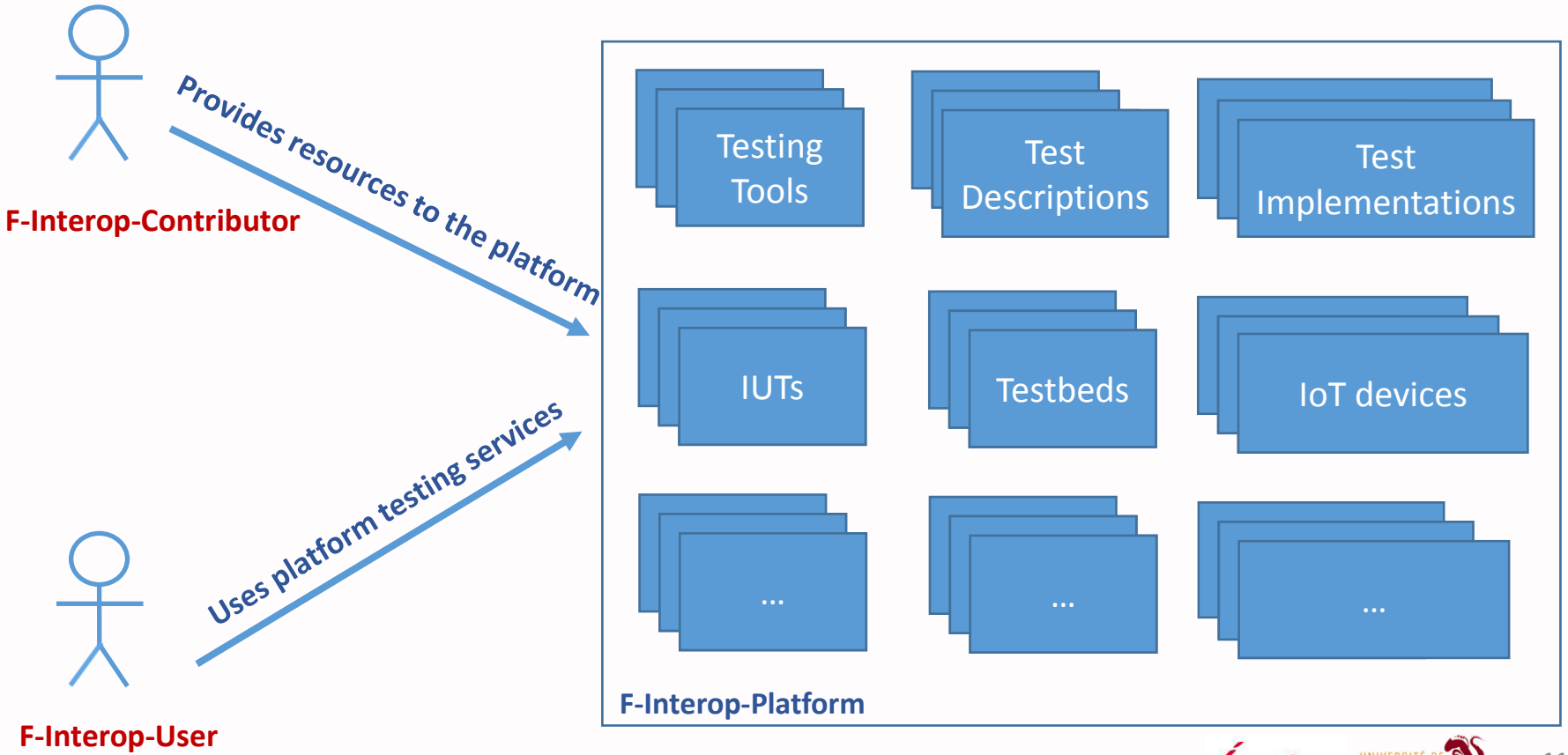
32 testbeds, 4755 nodes

- Fed4FIRE (www.fed4fire.eu/testbeds)
  - 24 testbeds
  - ~1000 nodes
- OneLab (onelab.eu)
  - Includes 6 IoT-lab deployments (including 2728 IoT nodes)
- IoT lab (www.iotlab.eu)

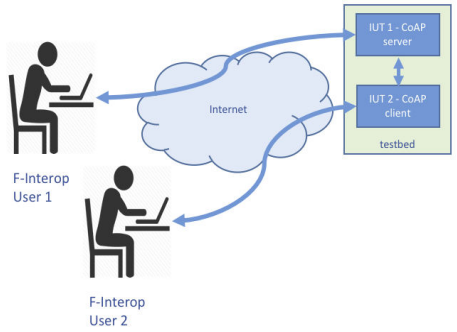


F-Interop: remote interop testing requirements

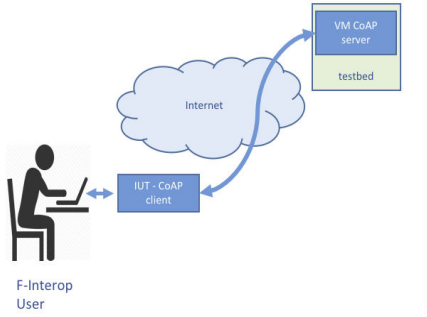
F-Interop actors and components



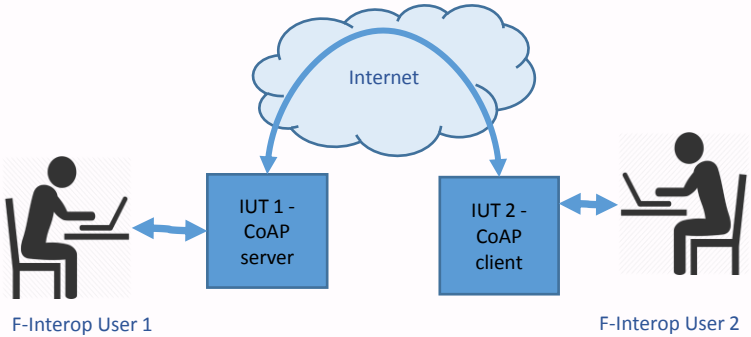
Gathering requirements



a) Testbed interoperability session.



b) "Remote IUT vs testbed IUT" interoperability session.



b) Remote interop over the internet.

ETSI
Plugtests
tests
specification

Interoperability
tests
best practices
documents

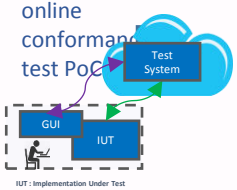
Testing tools
used
during
plugtests

Methodology for deriving F-Interop-Platform requirements

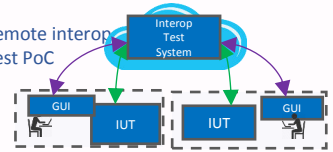
1st stage

CoAP/OneM2M interop/conformance testing

online conformance test PoC



remote interop test PoC



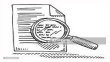
IUT : Implementation Under Test

CoAP plugtests tests specification

CoAP testing tools used for plugtests

6TiSCH interop/conformance testing

6TiSCHplugtests tests specification



6TiSCHtesting tools used for plugtests.

Performance & Scalability testing

Passive Analyzer

Network emulation

Active Protocol Emulator

Energy efficiency testing

Consumption Estimator

COLLECTING

2nd stage

F-Interop User/Contributor needs by test types

- FI-User and FI-Contributor needs for CoAP/OneM2M tests
- FI-User and FI-Contributor needs for 6TiSCH remote tests
- FI-User and FI-Contributor needs for perf & scalability testing
- FI-User and FI-Contributor needs for energy efficiency testing

DERIVING

3rd stage

F-Interop Platform Requirements

- F-Interop Platform Requirement
- Priority
- References to FI-UN and FI-CN
- Scope
- Description

ORDERING, CONSISTENCY CHECK

4th stage

Final F-Interop Platform Requirements

Platform requirements

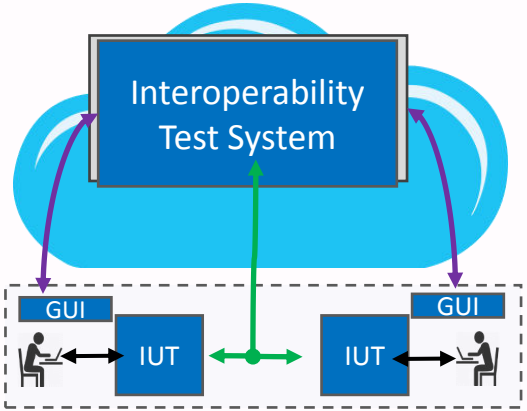
F-Interop-Platform requirements				
Req. Id	Field/Step	Requirement Scope	Requirement description	Reference FI-UN/FI-CN
FI-PR.05	FI-Session.1	Test suites discovery and selection.	FI-Platform MAY provide networking compatibility and reachability tests adapted to the protocol testing solution and the location model chosen. FI-Platform MAY provide tools for overcoming most common compatibility and reachability problems –e.g. port forwarding via ssh tunneling for UDP-based test suites must be provided if FI-User is running his/her IUT behind a firewall that is filtering UDP traffic-	FI-UN.18, FI-UN.19
FI-PR.06	FI-Session.1	Test suit discovery and selection	FI-Platform SHOULD allow active and passive traffic analysis i.e. the use of Agents and probes installed in the IUT(s).	
FI-PR.07	FI-Session.1	Test suit discovery and selection	FI-Platform SHOULD support different tools to gather network traffic and statistics in real-time.	
FI-PR.08	FI-Session.1	Test suites discovery and selection	FI-Platform MUST provide the user with timeline control to allow the user to set scalability parameters for points in time relative to the beginning of test when using active protocol emulators for scalability tests.	FI-UN.22, FI-UN.23, FI-UN.24

For complete list see https://www.f-interop.eu/index.php/documents/public-deliverables

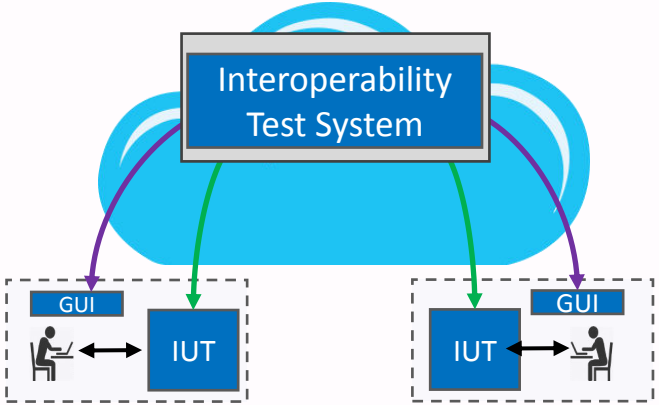
F-Interop: Location Models and Architecture

Location models

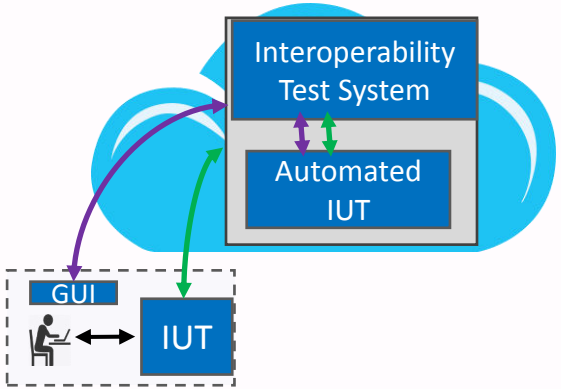
Both IUT and users in same location



Remote user-to-user

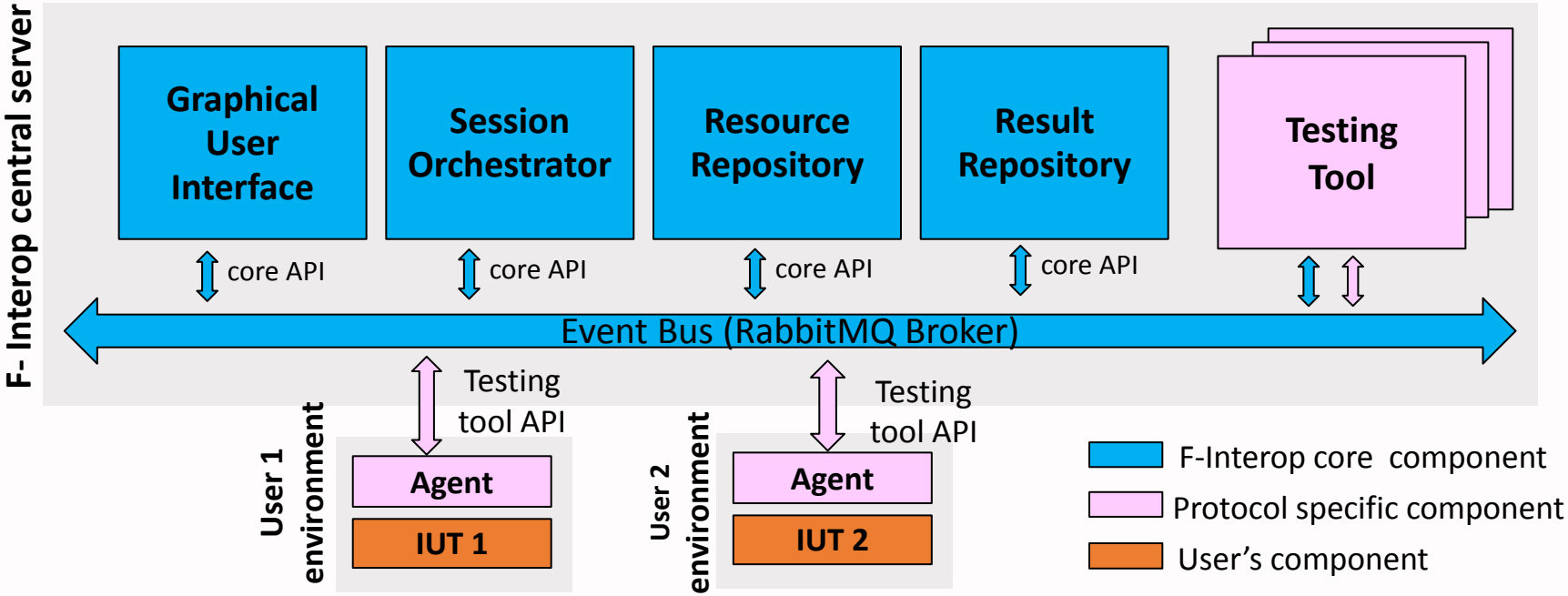


Remote single-user testing against automated IUT (hosted by F-Interop)

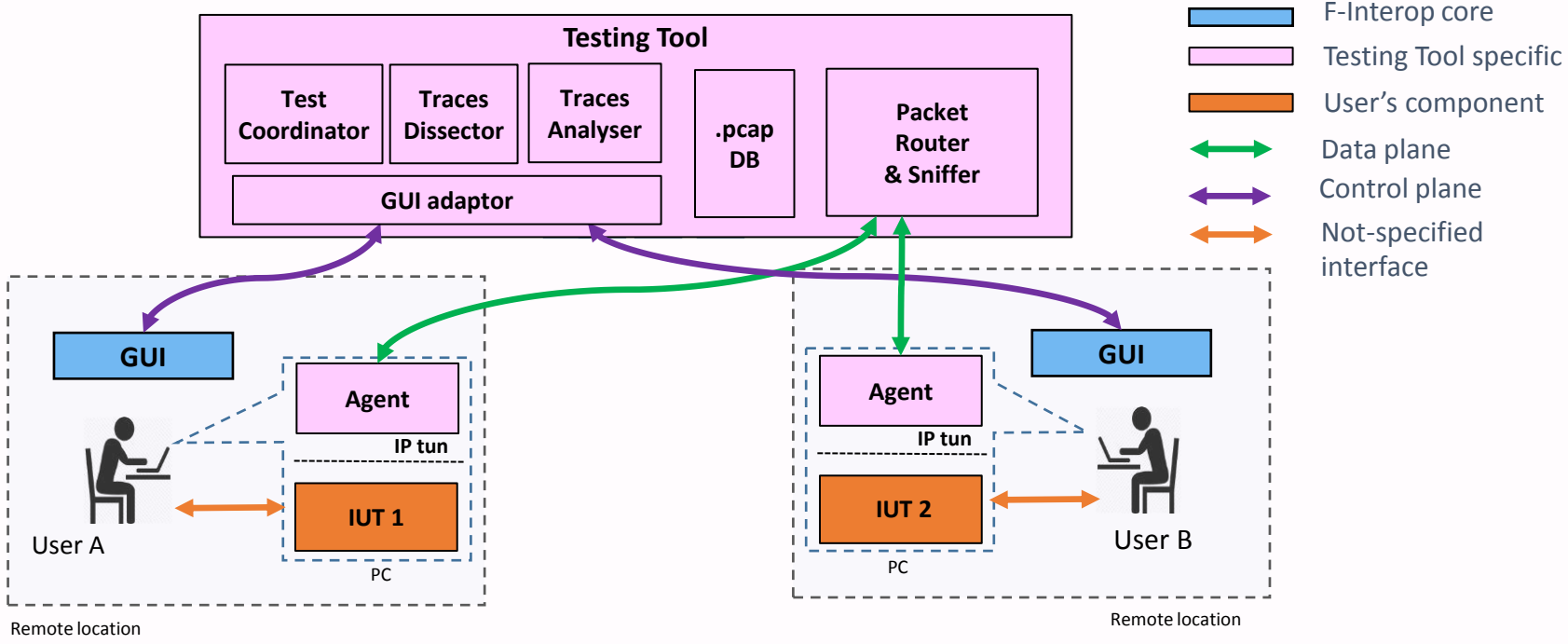


Data plane
Control plane
Unspecified interface

Platform architecture overview



Testing Tool architecture overview



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A F-Interop session

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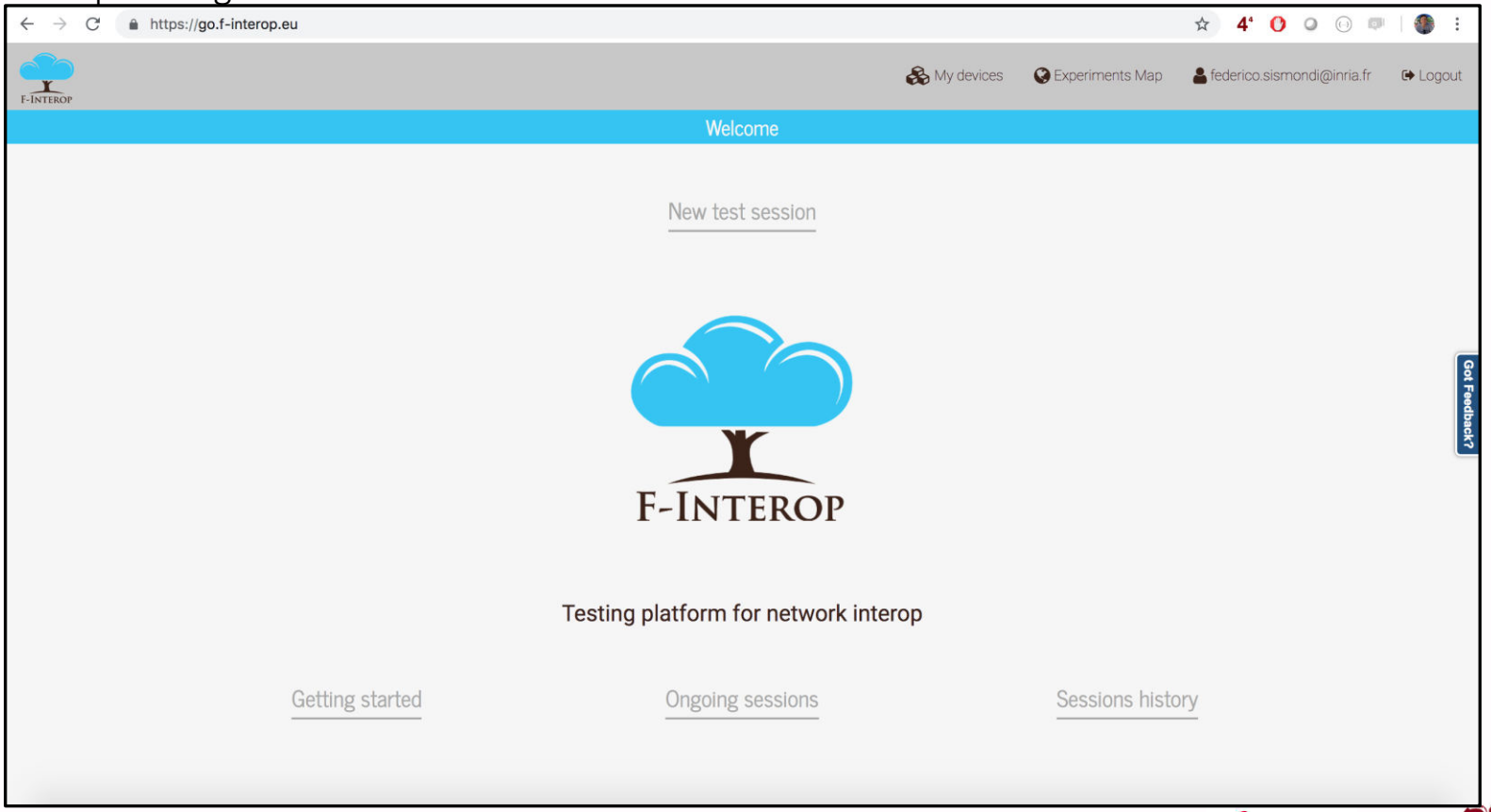
F-Interop session: Only 8 steps to get your IoT device tested

step 0	User registration, authentication and authorization & IUT registration / identification
step1	Test suites discovery and selection
step2	Session resources description
step3	Resource reservation
step4	Resource provisioning, configuration and session setup
step5	Test execution
step6	Results analysis and reporting
step7	Results and session configuration storage

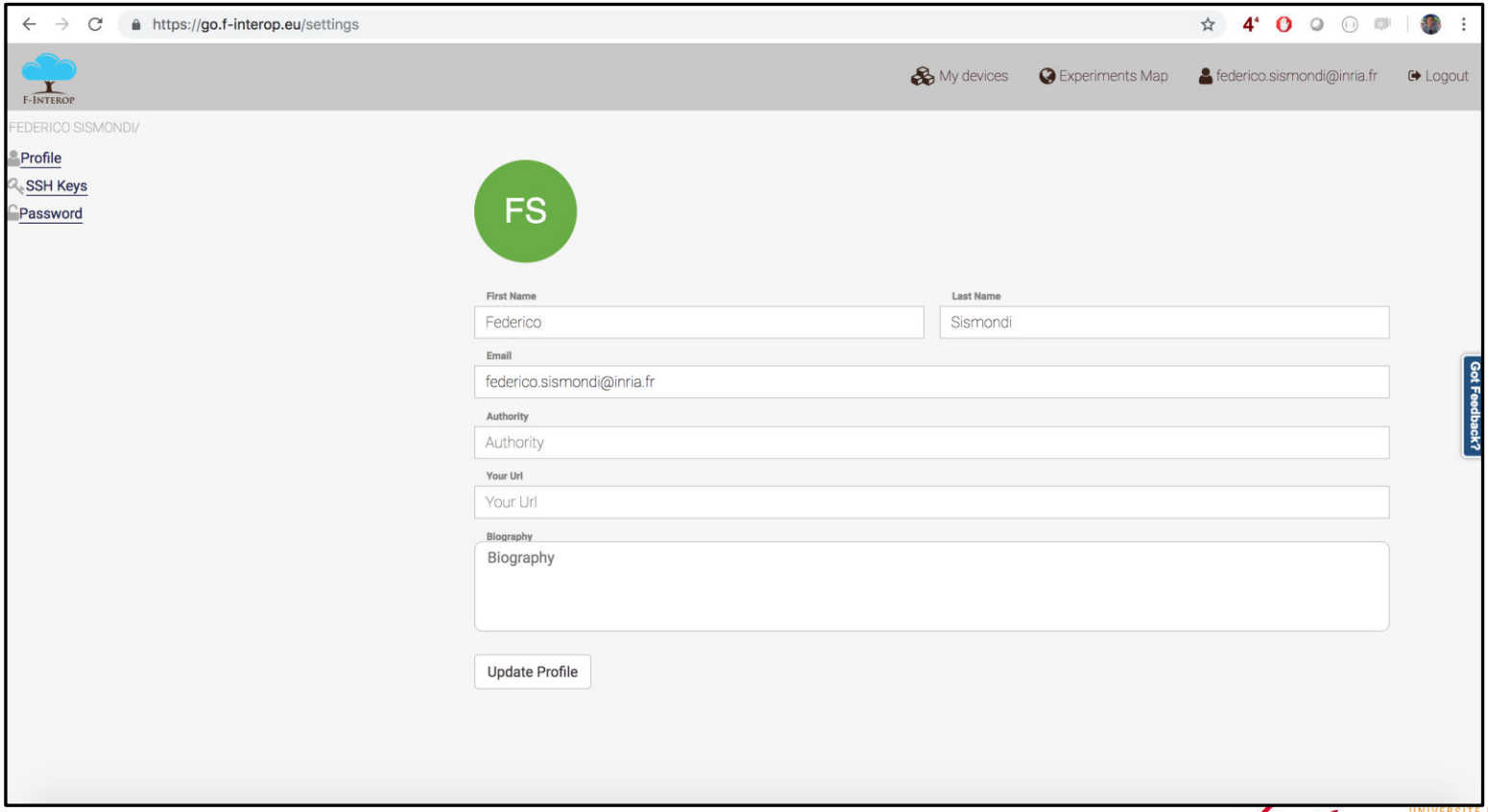
The F-Interop platform

go.f-interop.eu – go! check it out!



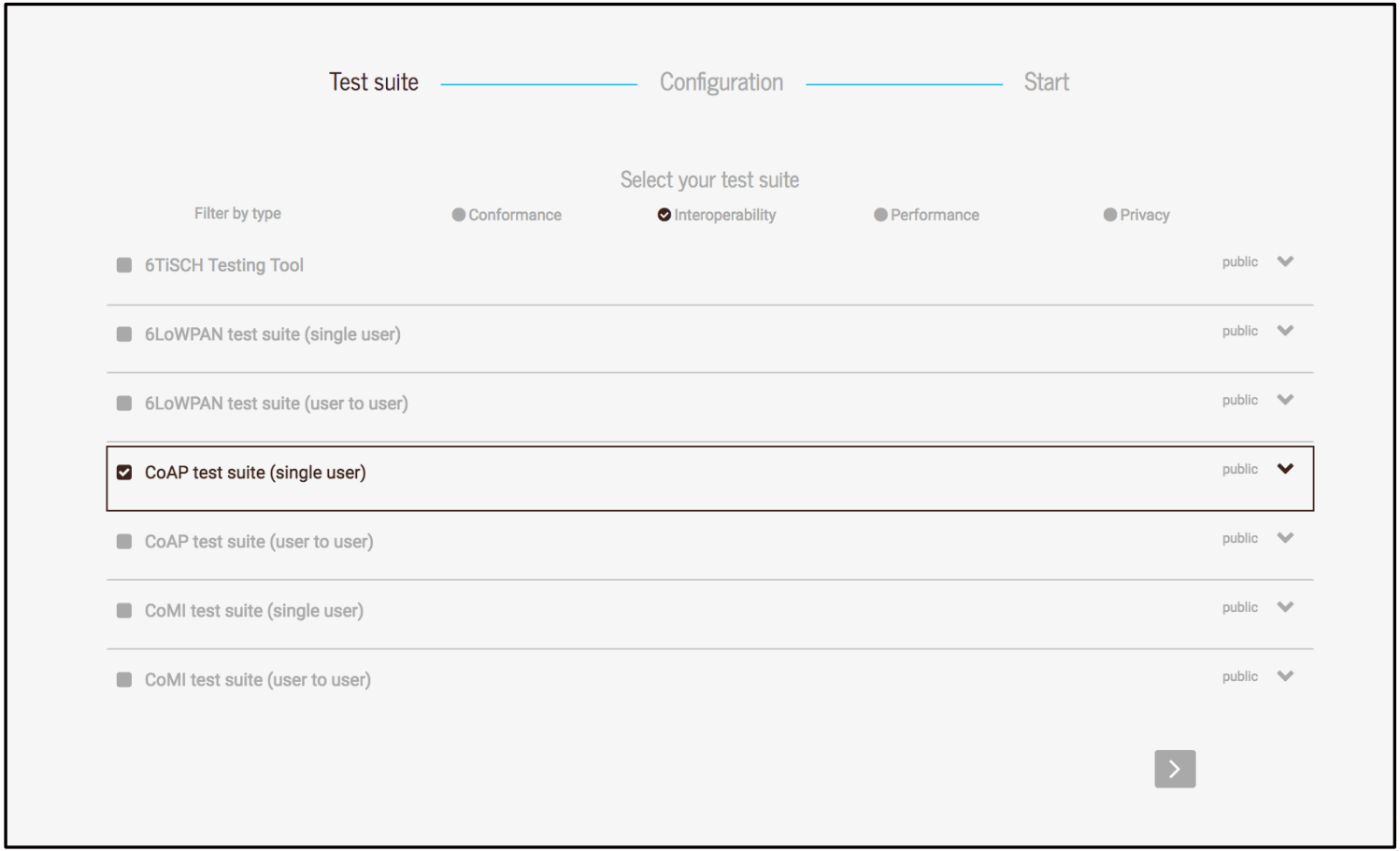
The F-Interop session – step 0

User registration, authentication and authorization



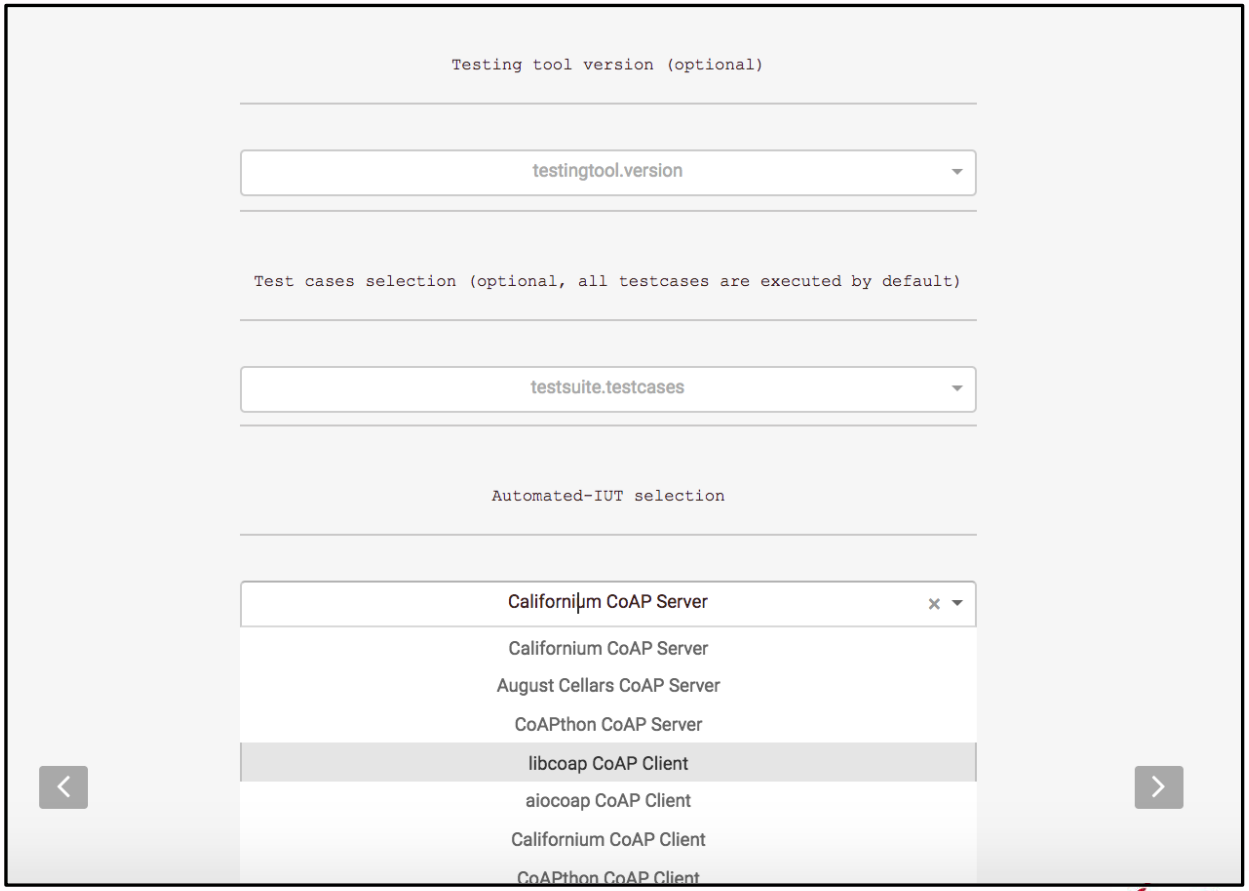
The F-Interop session – step 1

Test suites discovery and selection



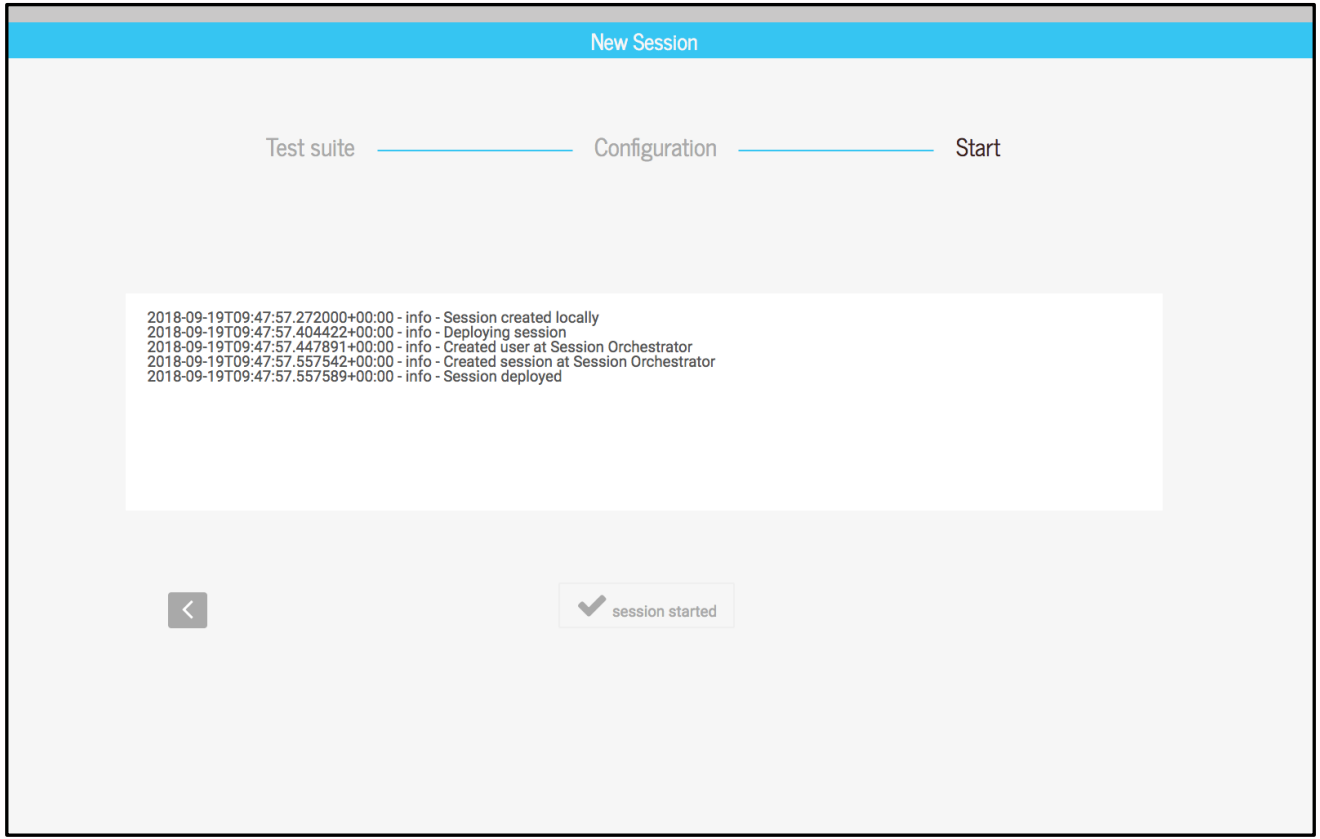
The F-Interop session – step 2

Test Suite Setup



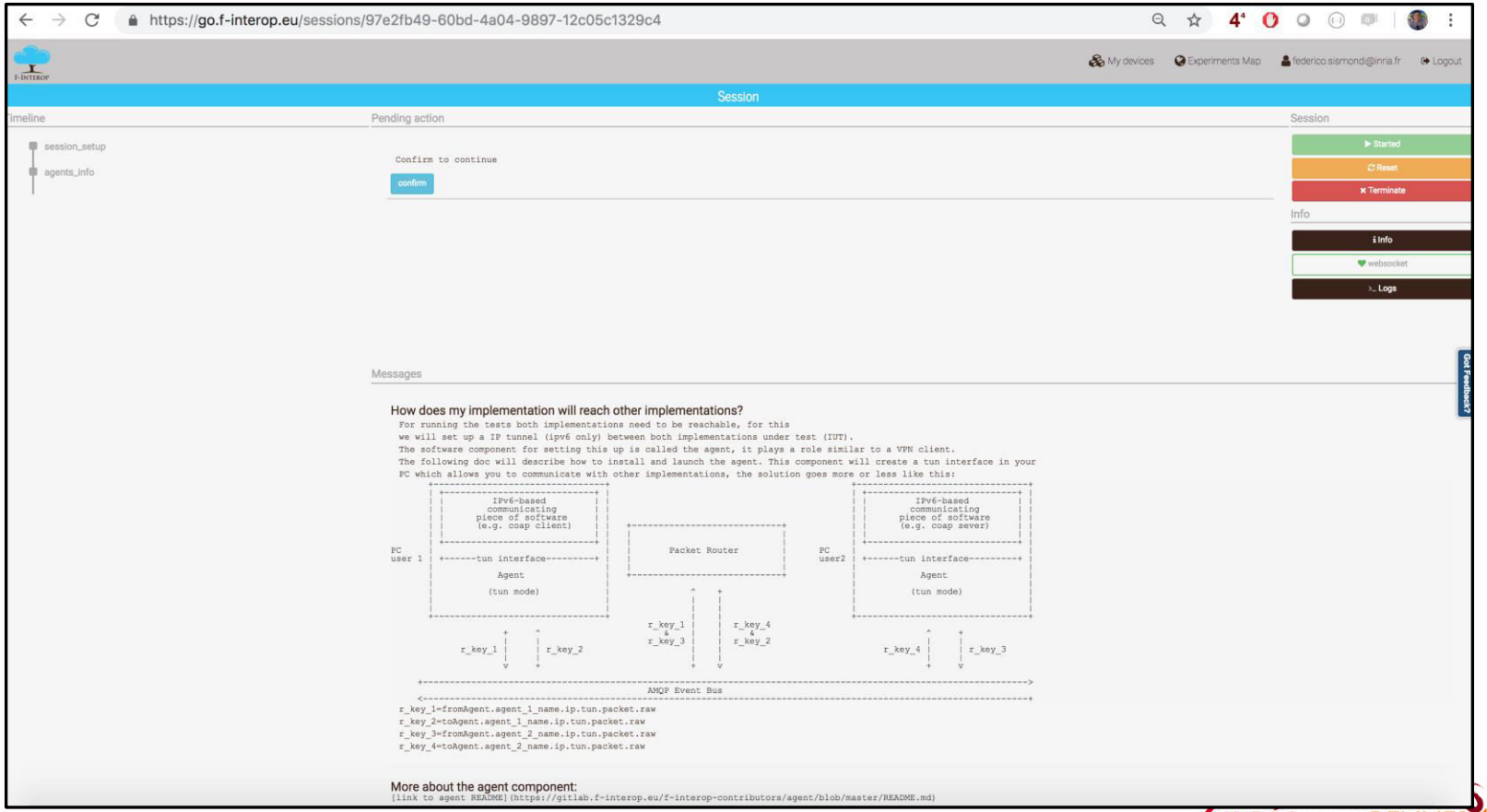
The F-Interop session – step 3 and step4

Resource reservation and resource provisioning



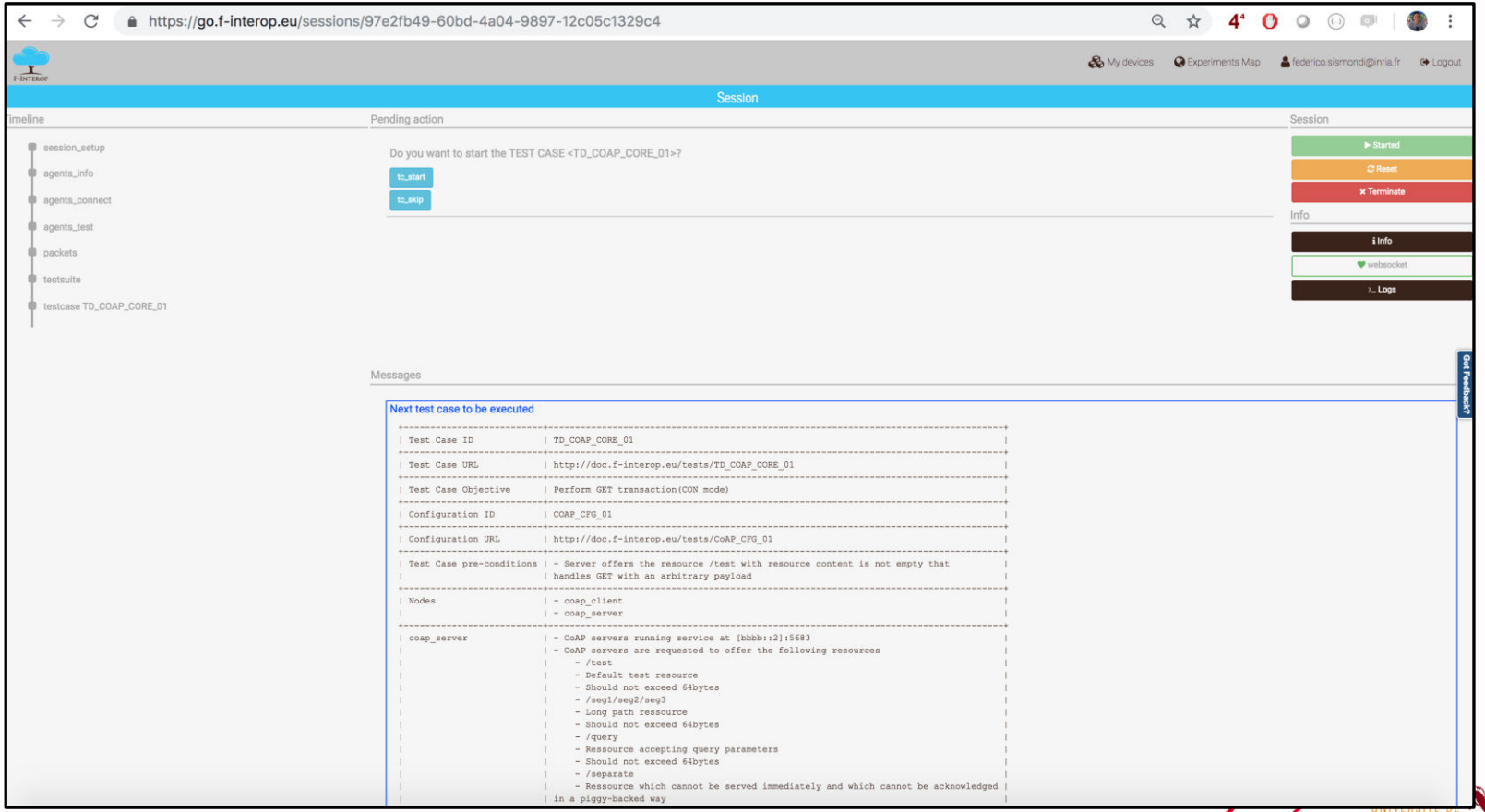
F-Interop session - Step 5

Test execution (1/3)



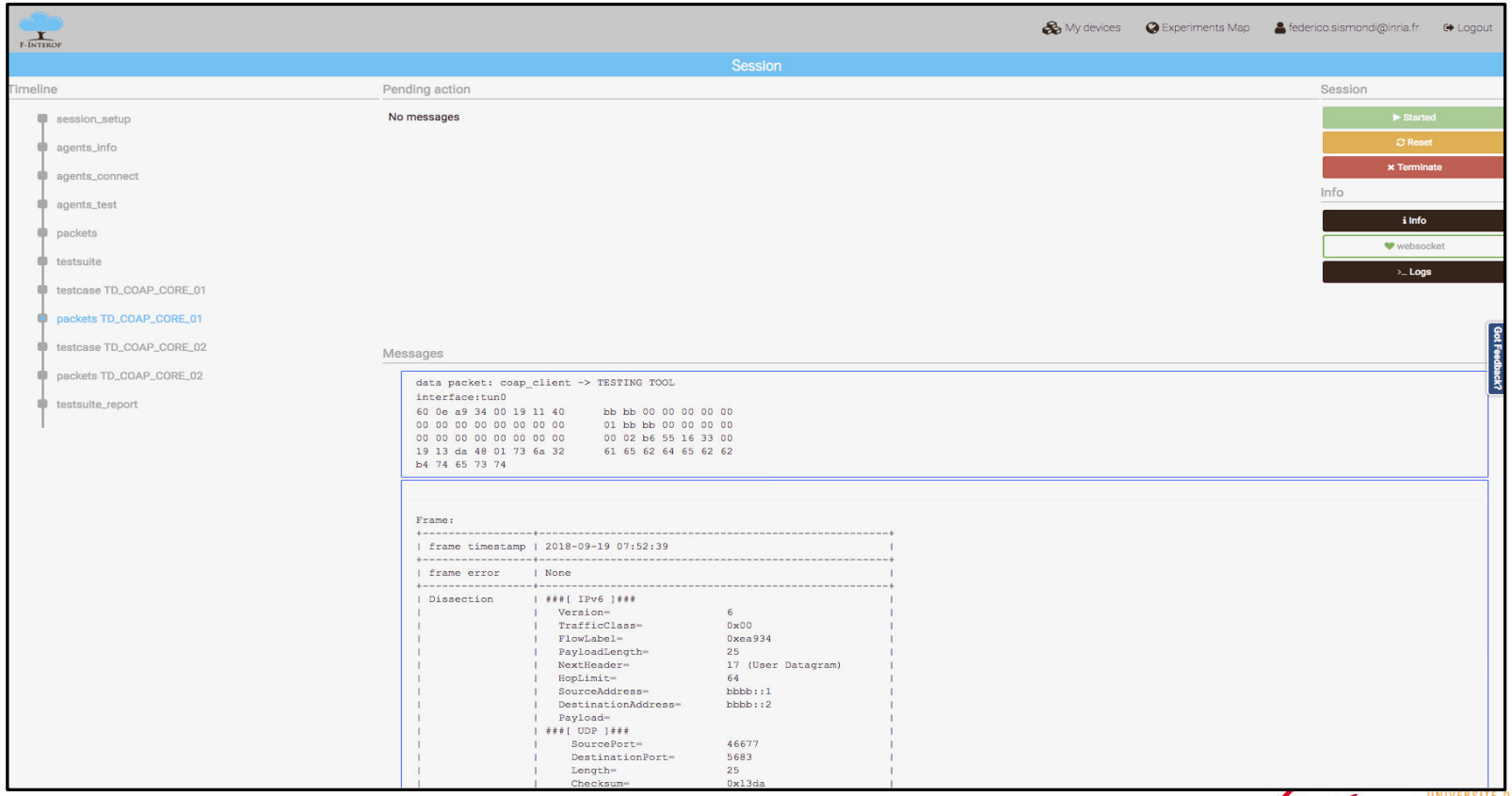
F-Interop session - Step 5

Test execution (2/3)



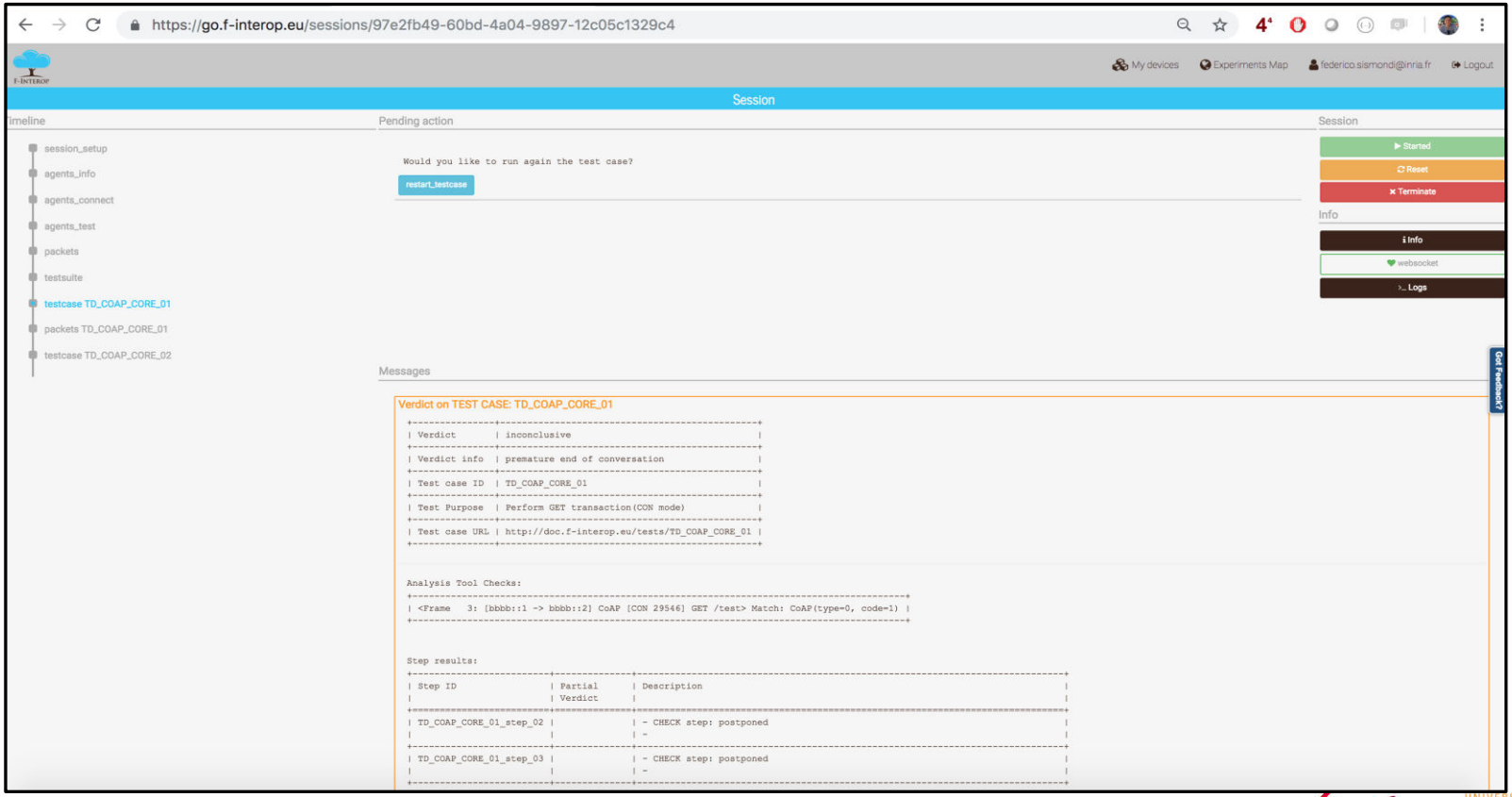
F-Interop session - Step 5

Test execution (3/3)



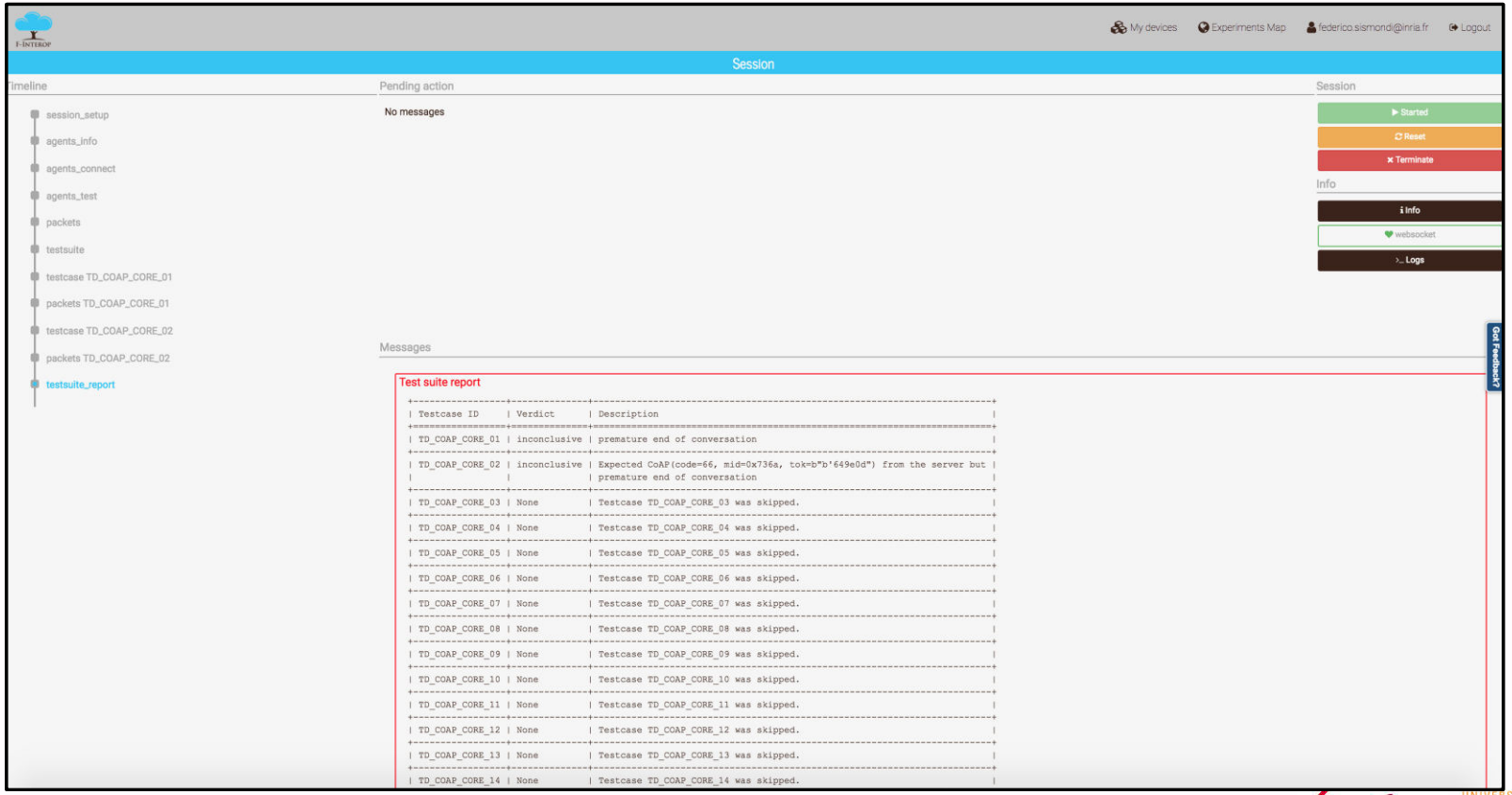
F-Interop session - Step 6

Analysis of traces, verdicts and reporting (1/2)



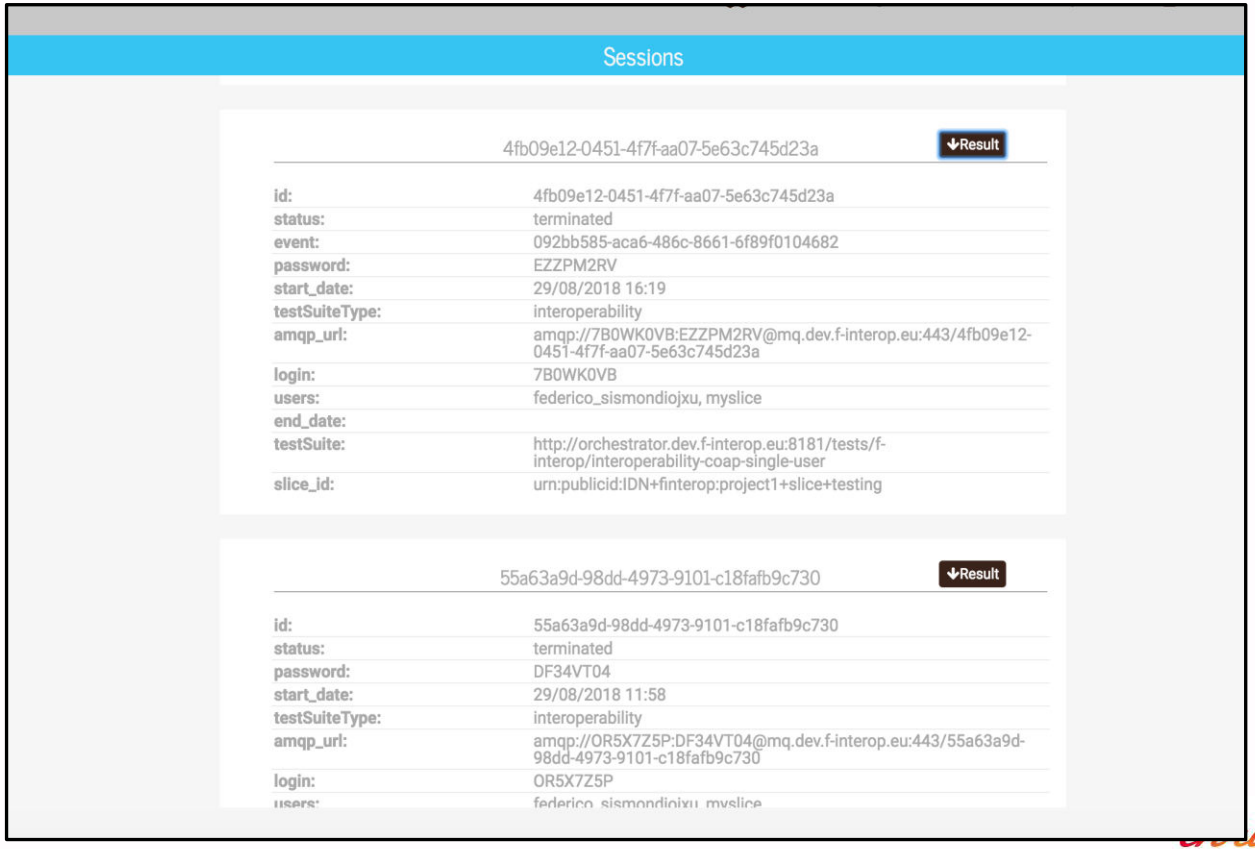
F-Interop session - Step 6

Analysis of traces, verdicts and reporting (2/2)



F-Interop session - Step 7

Session results and configuration storage



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F-Interop: interoperability testing in practice

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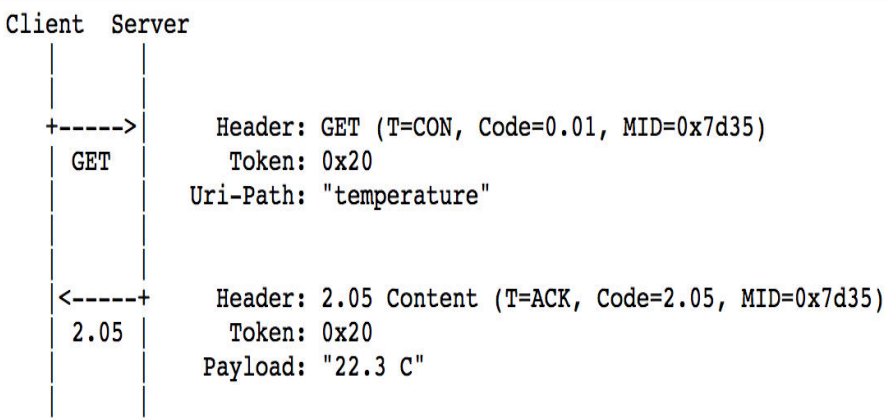
CoAP protocol use case

- What's CoAP?
  - IETF standard for the IoT, with a web approach
  - client-server communications
  - ~ HTTP for IoT but enabling asynchronous transactions
- Testing CoAP interoperability, what do we need?
  - Two implementations, a client and a server
  - Test specification
  - Test Setup
  - Demo using F-Interop (video)

CoAP defines request-response exchange pattern



Sources:
https://tools.ietf.org/html/rfc7252#page-104
https://tools.ietf.org/html/rfc7641#page-24

Also enables SUSBCRIPTION to states

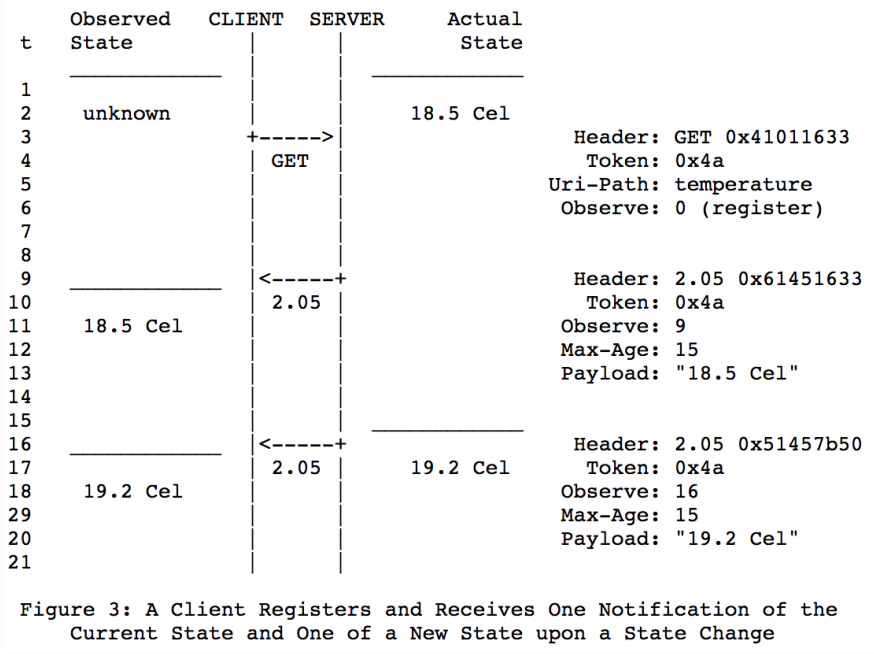
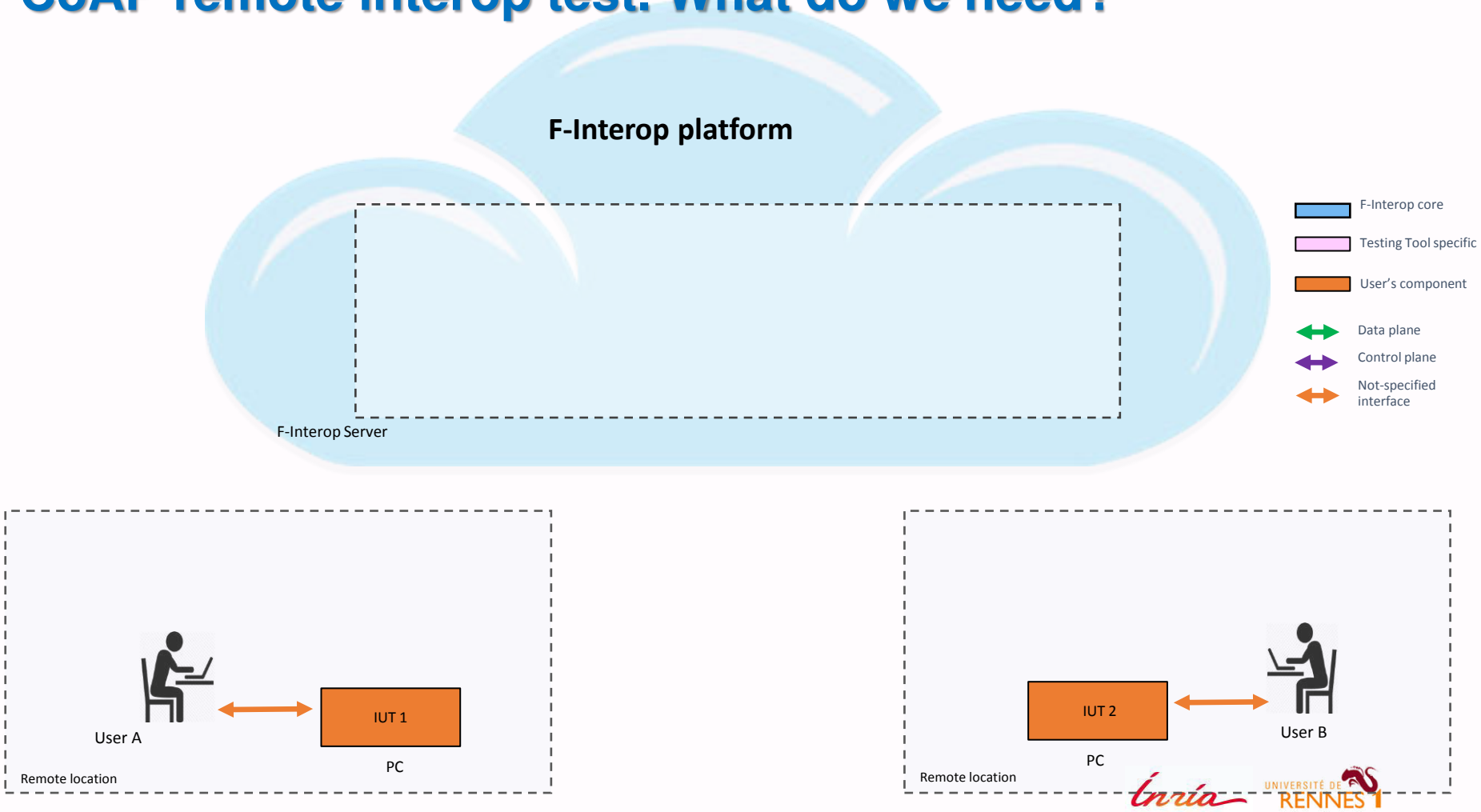


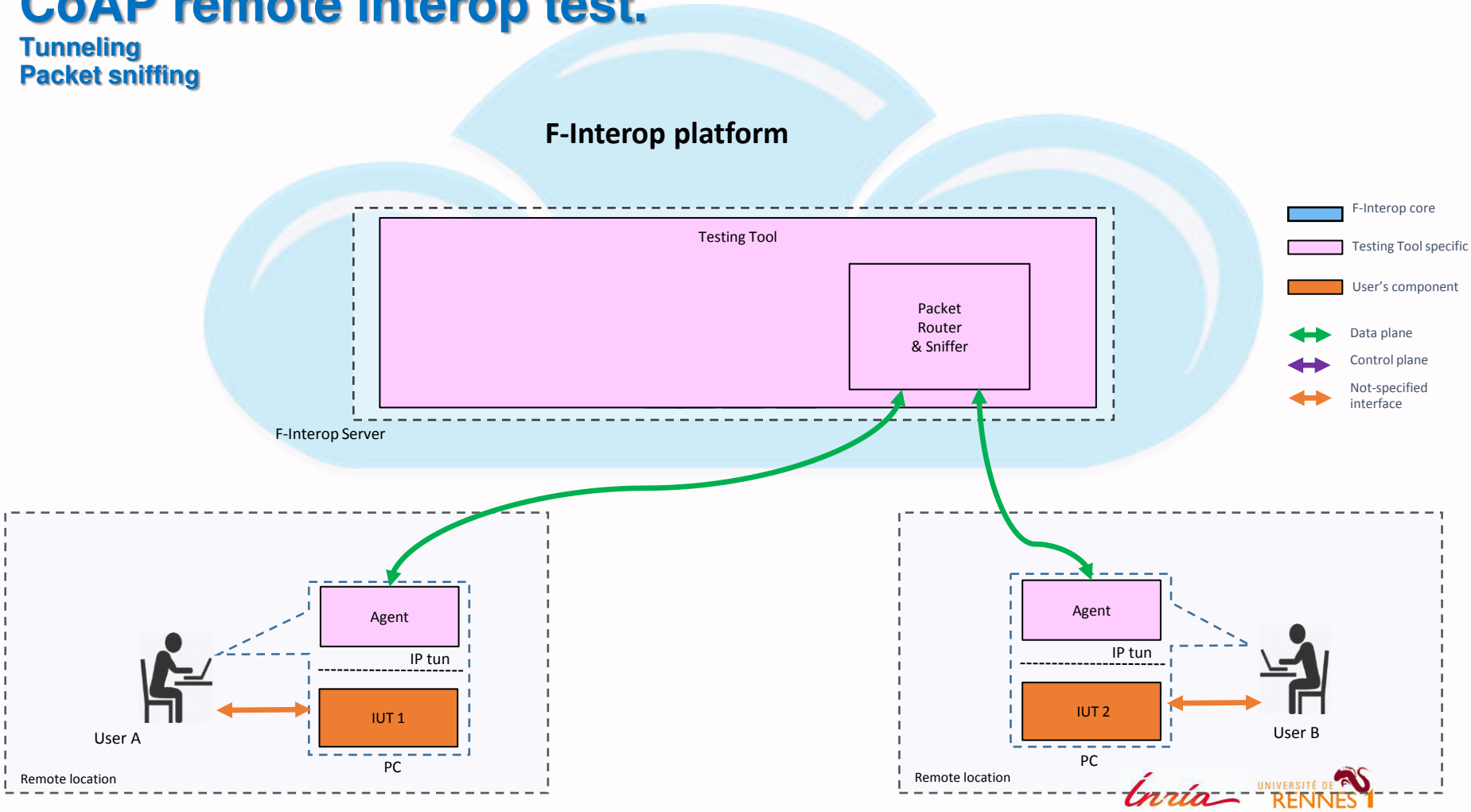
Figure 3: A Client Registers and Receives One Notification of the Current State and One of a New State upon a State Change

CoAP remote interop test. What do we need?



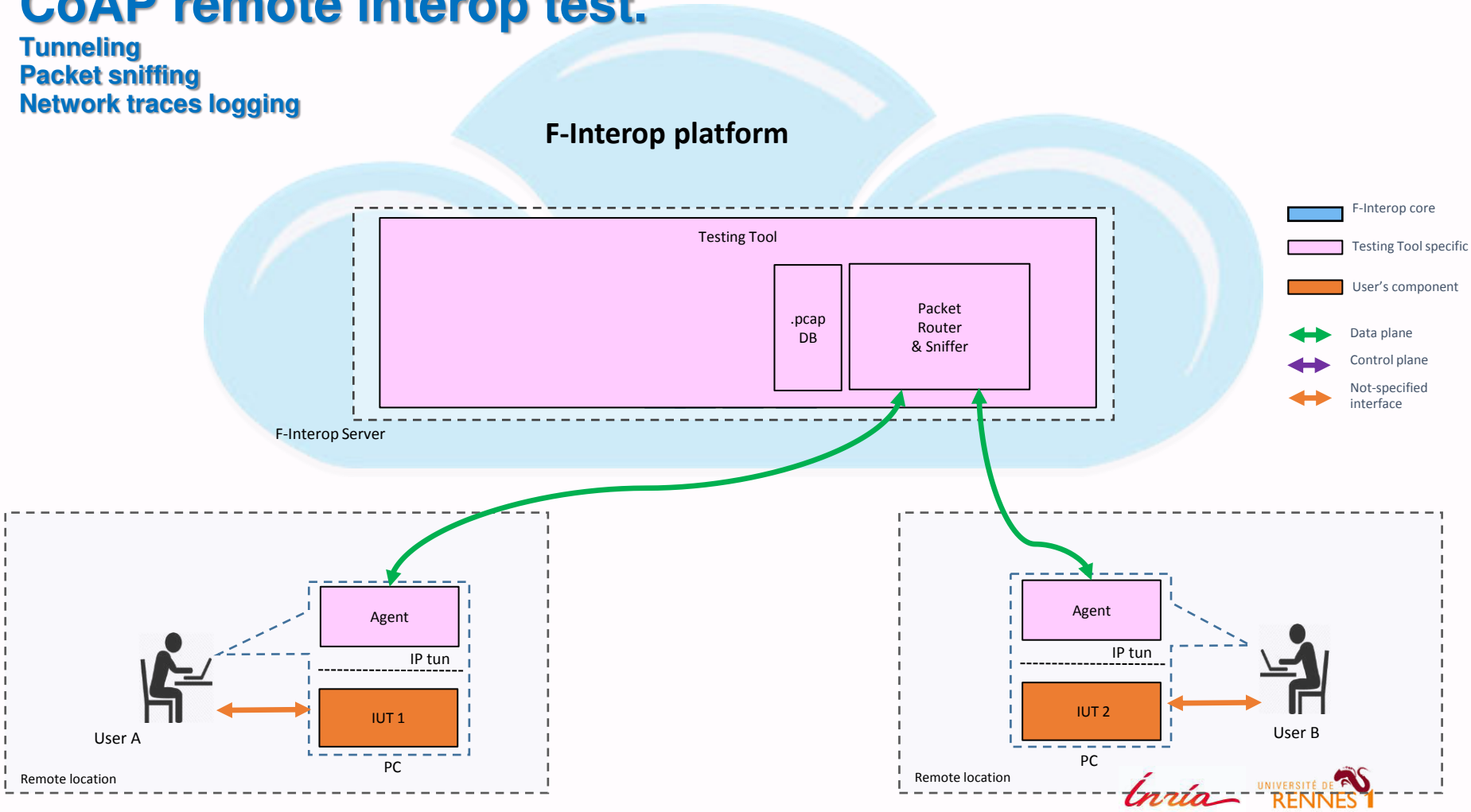
CoAP remote interop test.

Tunneling
Packet sniffing



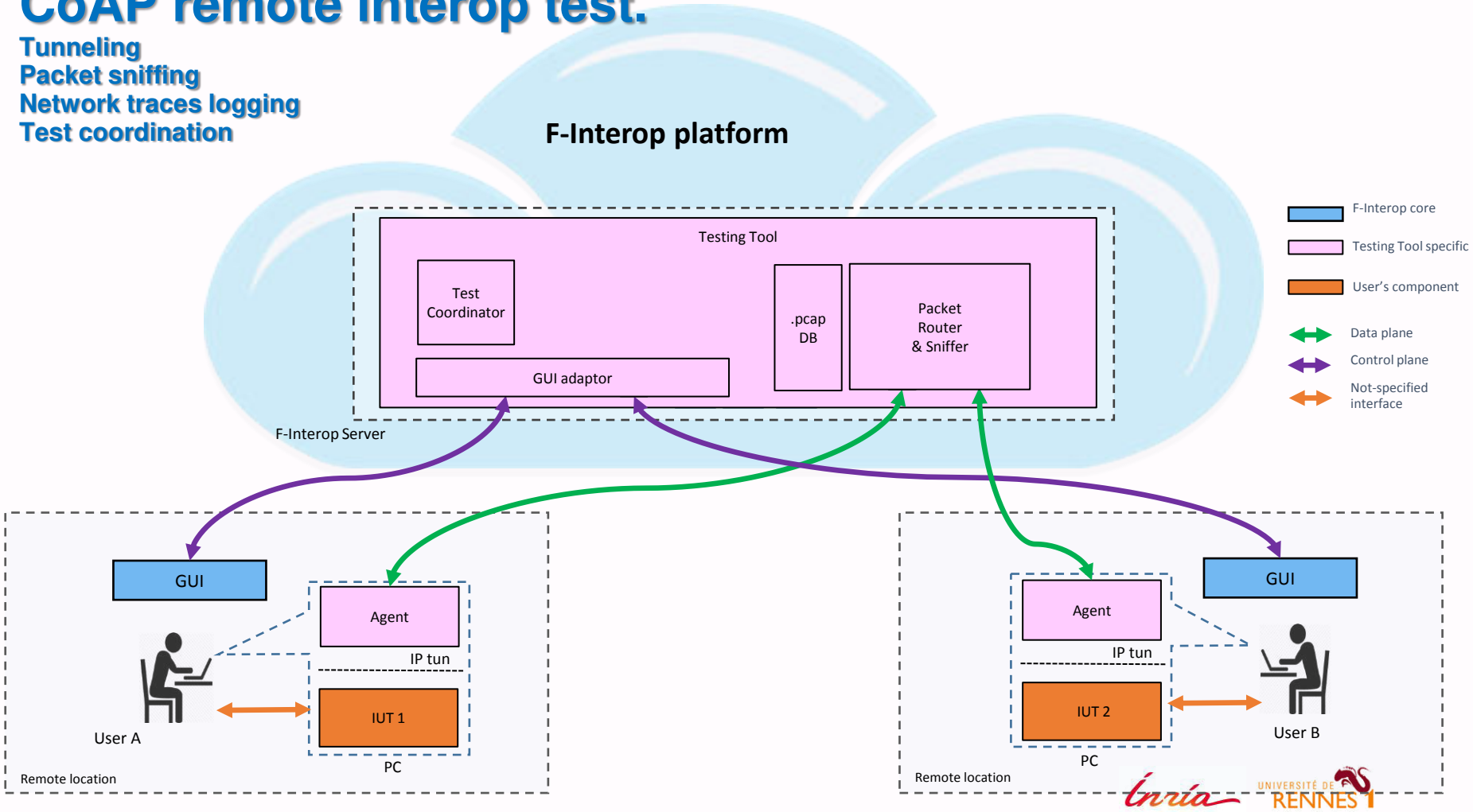
CoAP remote interop test.

Tunneling
Packet sniffing
Network traces logging



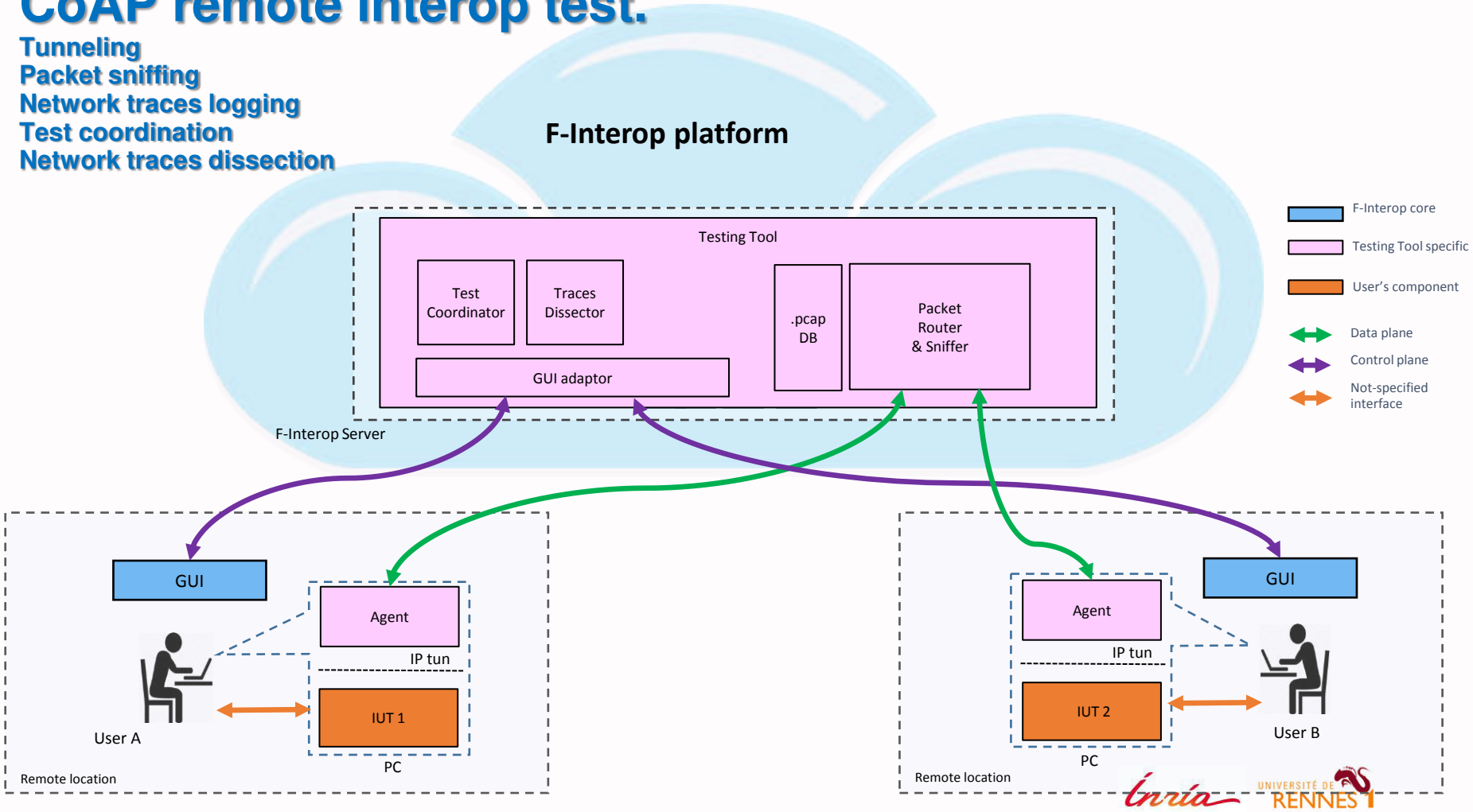
CoAP remote interop test.

- Tunneling
- Packet sniffing
- Network traces logging
- Test coordination



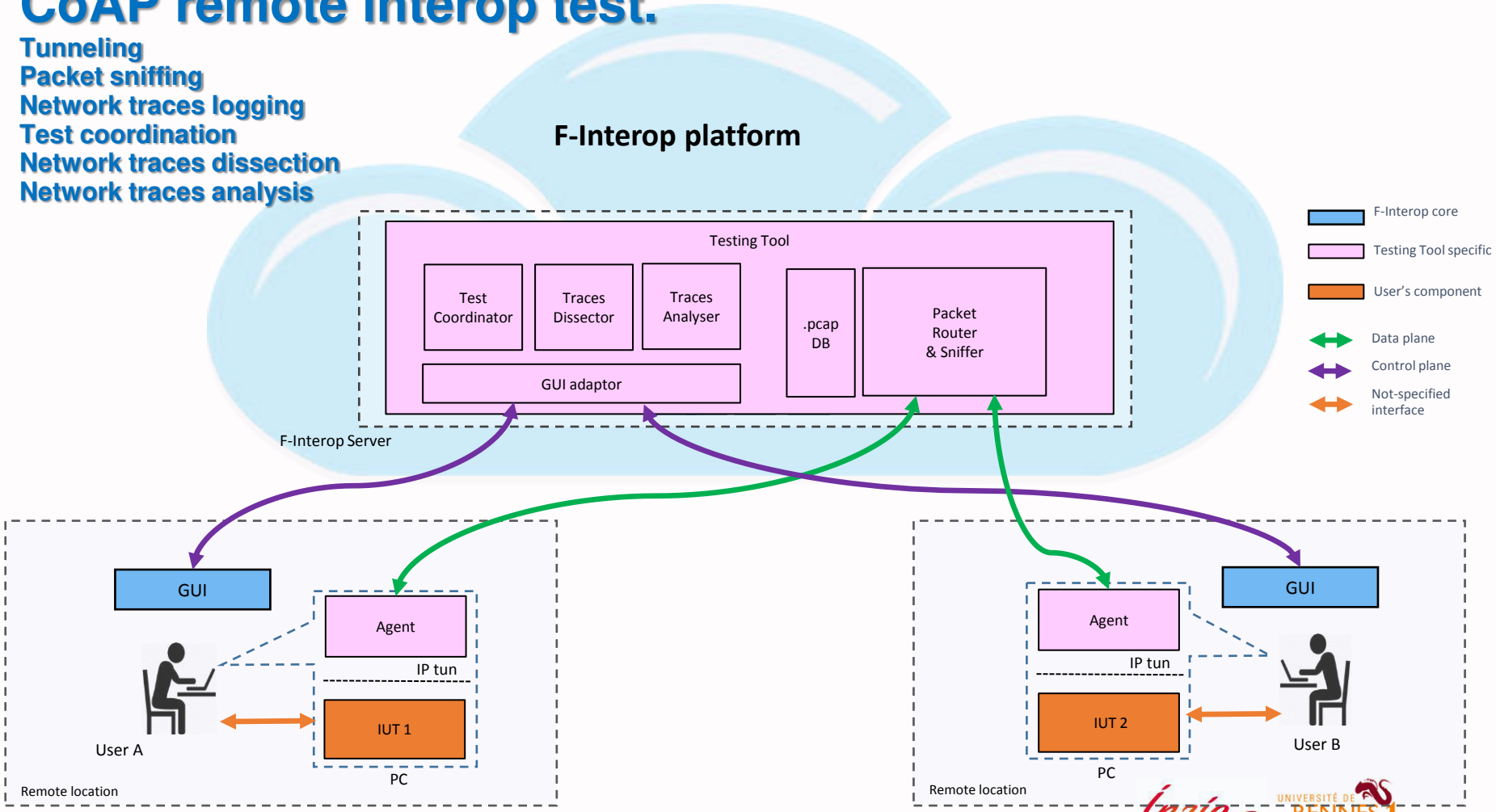
CoAP remote interop test.

- Tunneling
- Packet sniffing
- Network traces logging
- Test coordination
- Network traces dissection

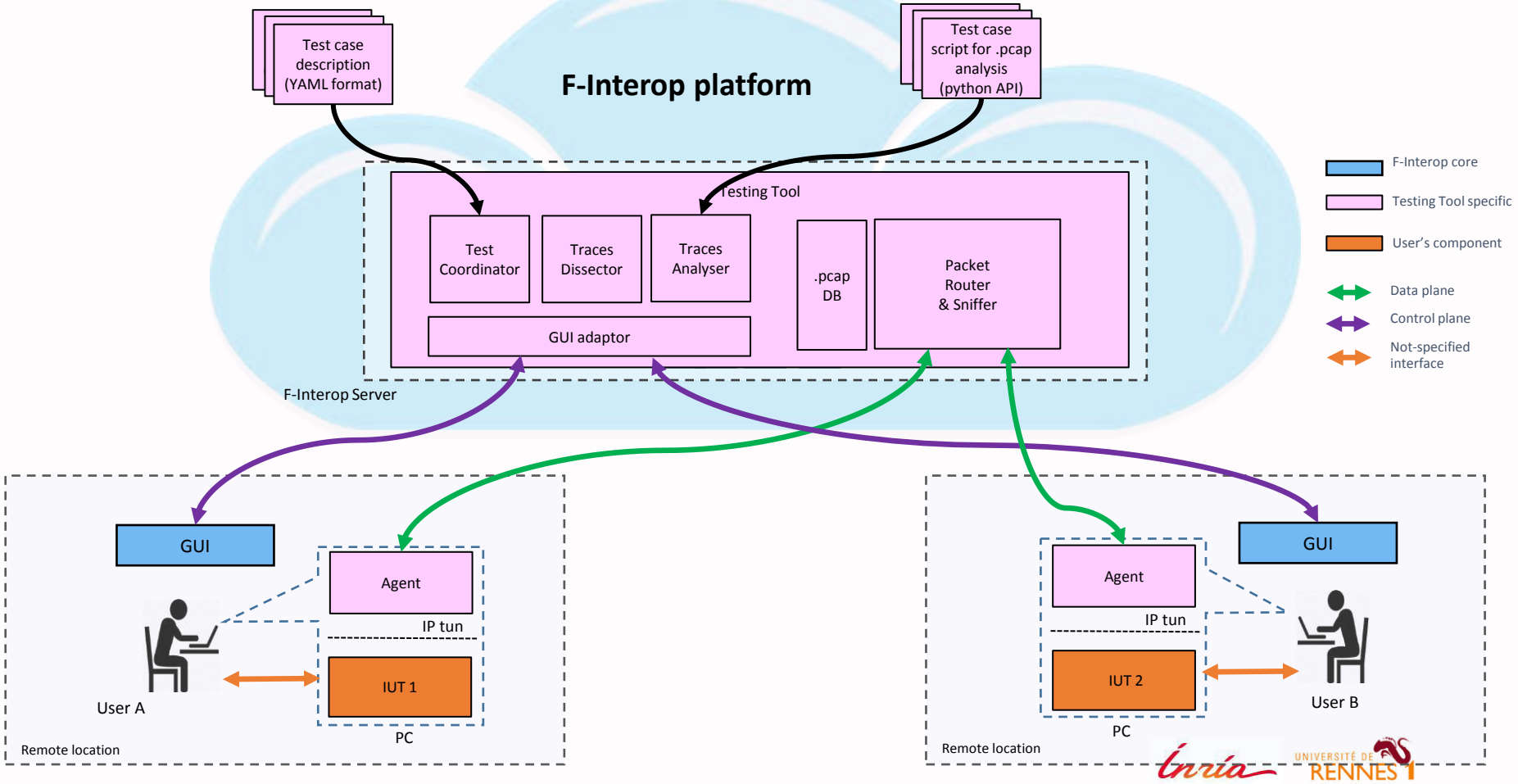


CoAP remote interop test.

- Tunneling
- Packet sniffing
- Network traces logging
- Test coordination
- Network traces dissection
- Network traces analysis



How do we add new tests?



Under the Hood: What's a test?

1. Test description in human and machine language

```
--- !testcase
testcase_id: TD_COAP_CORE_01_v01
uri : http://f-interop.paris.inria.fr/tests/TD_COAP_CORE_01_v01
configuration: CoAP_configuration_BASIC
objective: Perform GET transaction(CON mode)
pre_conditions: Server offers the resource /test with resource content is not empty that handles GET with an arbitrary payload
references: '[COAP] 5.8.1, 1.2, 2.1, 2.2, 3.1'
sequence:
  - step_id: 'TD_COAP_CORE_01_v01_step_01'
    type: stimuli
    iut : coap_client
    description:
      - Client is requested to send a GET request with
      - Type = 0(CON)
      - Code = 1(GET)

  - step_id: TD_COAP_CORE_01_v01_step_02
    type: check
    description:
      - The request sent by the client contains
      - Type=0 and Code=1
      - Client-generated Message ID(\u2794 CMID)
      - Client-generated Token(\u2794 CTOK)
      - Uri-Path option "test"

  - step_id: TD_COAP_CORE_01_v01_step_03
    type: check
    description:
        - Server sends response containing
        - Code = 2.05(Content)
        - Message ID = CMID, Token = CTOK
        - Content-format option
        - Non-empty Payload

  - step_id: TD_COAP_CORE_01_v01_step_04
    type: verify
    iut: coap_client
    description:
        - Client displays the received information
```

STIMULI either executed manually by USER
Or by a automated IUT

CHECK executed automatically by Analyzer on the exchanged traces
(automatically issue verdicts!)

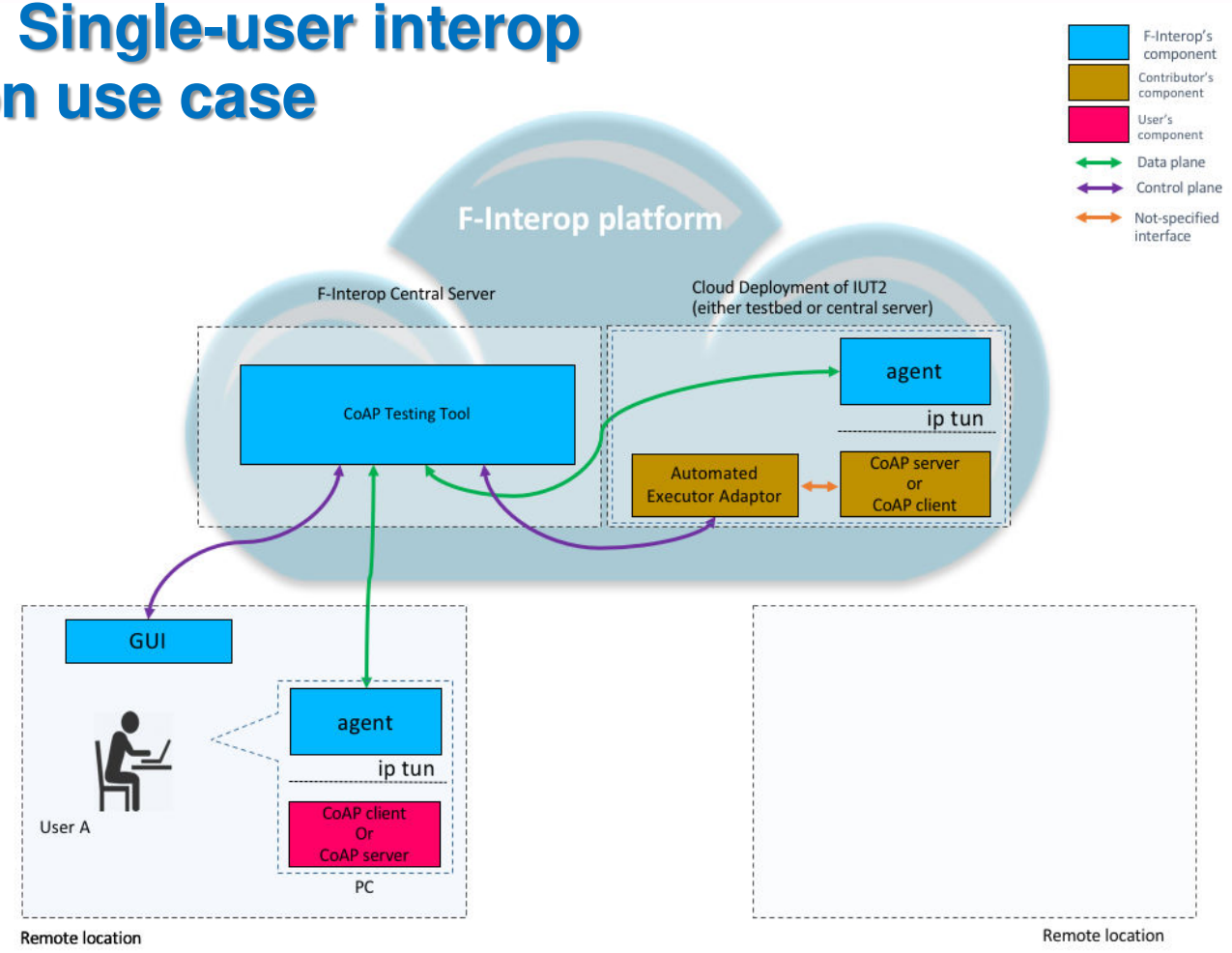
VERIFY executed manually by user! (User sends verify response using GUI)

Under the Hood: What's a test?

2. Test analysis scripts for CHECK for conformance and interoperability errors

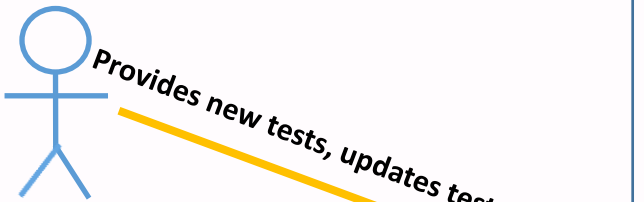
```
#!/usr/bin/env python3

from ttproto.ts_coap.common import CoAPTestcase
from ttproto.ts_coap.templates import *

class TD_COAP_CORE_01 (CoAPTestcase):

    def run (self):

        # match stimuli
        self.match_coap ("client", CoAP (type="con", code="get",
                         opt = self.uri ("/test")))
        CMID = self.frame.coap["mid"]
        CTOK = self.frame.coap["tok"]

        # match step 2
        self.next()
        if self.match_coap ("server", CoAP (
                         code = 2.05,
                         mid = CMID,
                         tok =CTOK,
                         pl = Not(b""),
                    )):

            # match step 3
            self.match_coap ("server", CoAP (
                         opt = Opt (CoAPOptionContentFormat()),
                    ), "fail")
```

Demo: Single-user interop session use case

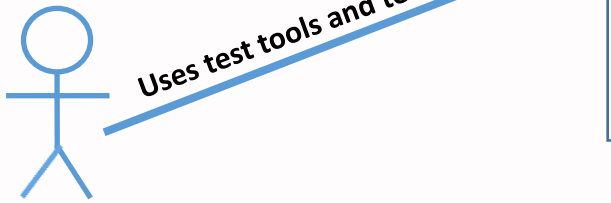


(10 mins approx.)

F-Interop: current status



F-Interop-Contributor



F-Interop-User

CoAP interop testing tool	oneM2M interop testing tool	OMA Lightweight M2M interop testing tool	6LoWPAN interop testing tool
CoAP server performance testing tool	6TiSCH conformance testing tool	OSCORE conformance testing tool	CoMI interop testing tool
WoT interop testing tool	Privacy testing tool	LoRaWAN conformance testing tool	Semantic data validator testing tool

F-Interop-Platform

Developed by F-Interop

Developed by F-Interop contributor

F-Interop's face-to-face and remote interoperability test events:

- 14-15 July 2017: ETSI #1 F-Interop 6TiSCH Interoperability Event, Prague (CZ), Inria-UR1
- 26-27 June 2018: ETSI #2 F-Interop 6TiSCH Interoperability Event, Paris : Inria –UR1
- October 2018: F-Interop CoAP Interoperability Event, Full remote, To be organized by Kereval & Inria-UR1

6th UCAAT User Conference on Advanced Automated Testing

ETSI

F-Interop: Achievements and next steps

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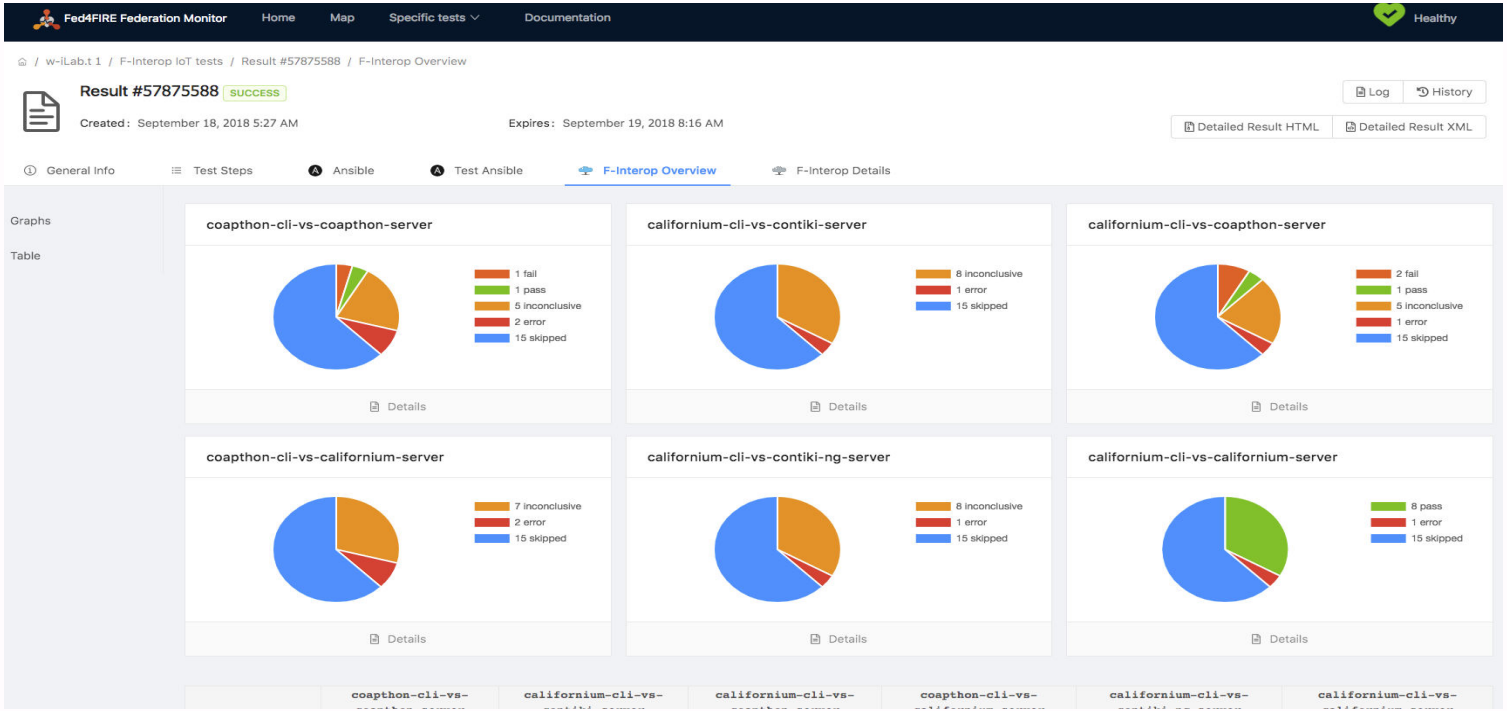
Achievements and next step

- F-Interop project is officially ending in November 2018
- **F-Interop platform answers to the predefined needs**
  - Platform enables full remote & online interop test execution
  - Tests IoT implementations from companies' premises
  - Feedbacks to standardization process
  - Shortens time-to-market for IoT implementations
- **Future of the F-Interop platform**
  - Remote online ETSI's plugtests events?
  - labelling/certification for IoT protocols?
  - Continuous interoperability testing! Already in the pipes!

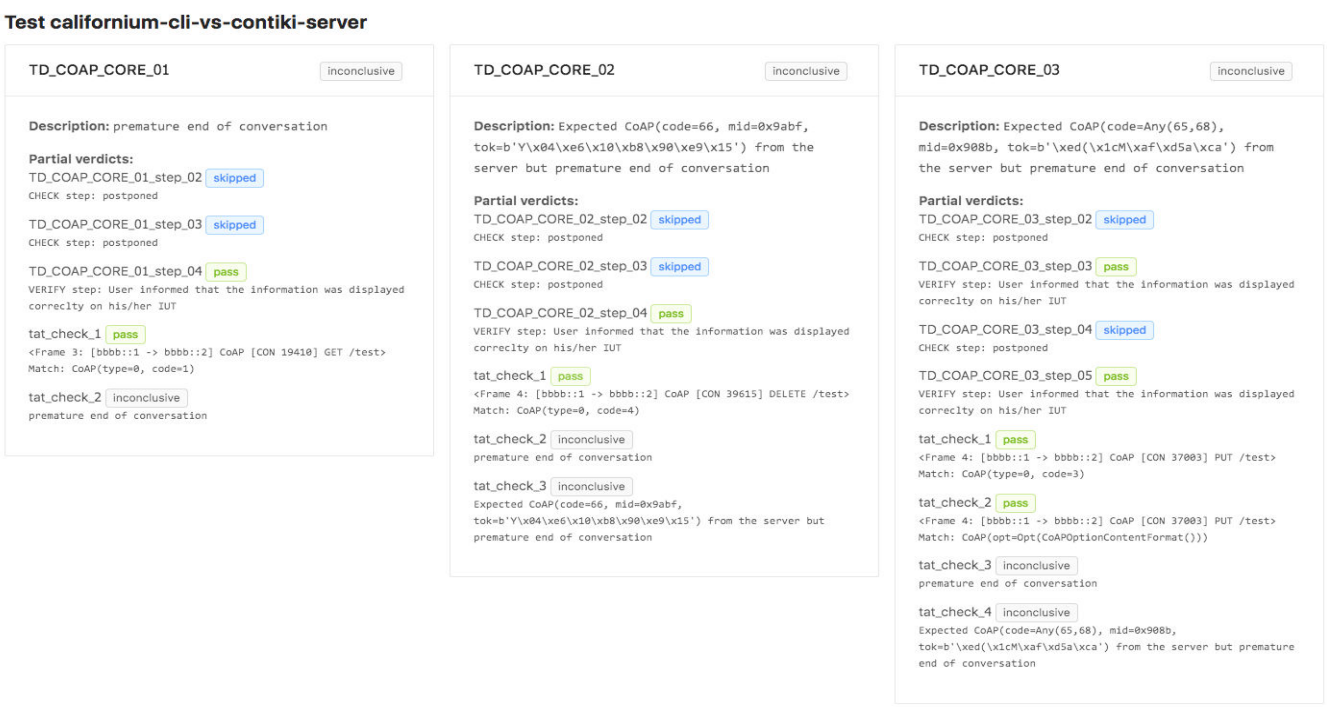
Continuous interoperability testing

- Not a just idea, we have running code!!
- Check out https://fedmon.fed4fire.eu/ -> F-Interop IoT tests

Continuous interoperability testing



Continuous interoperability testing



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ETSI The Standards People

Thank you

Contacts:
federico.sismondi@irisa.fr ; cesar.viho@irisa.fr

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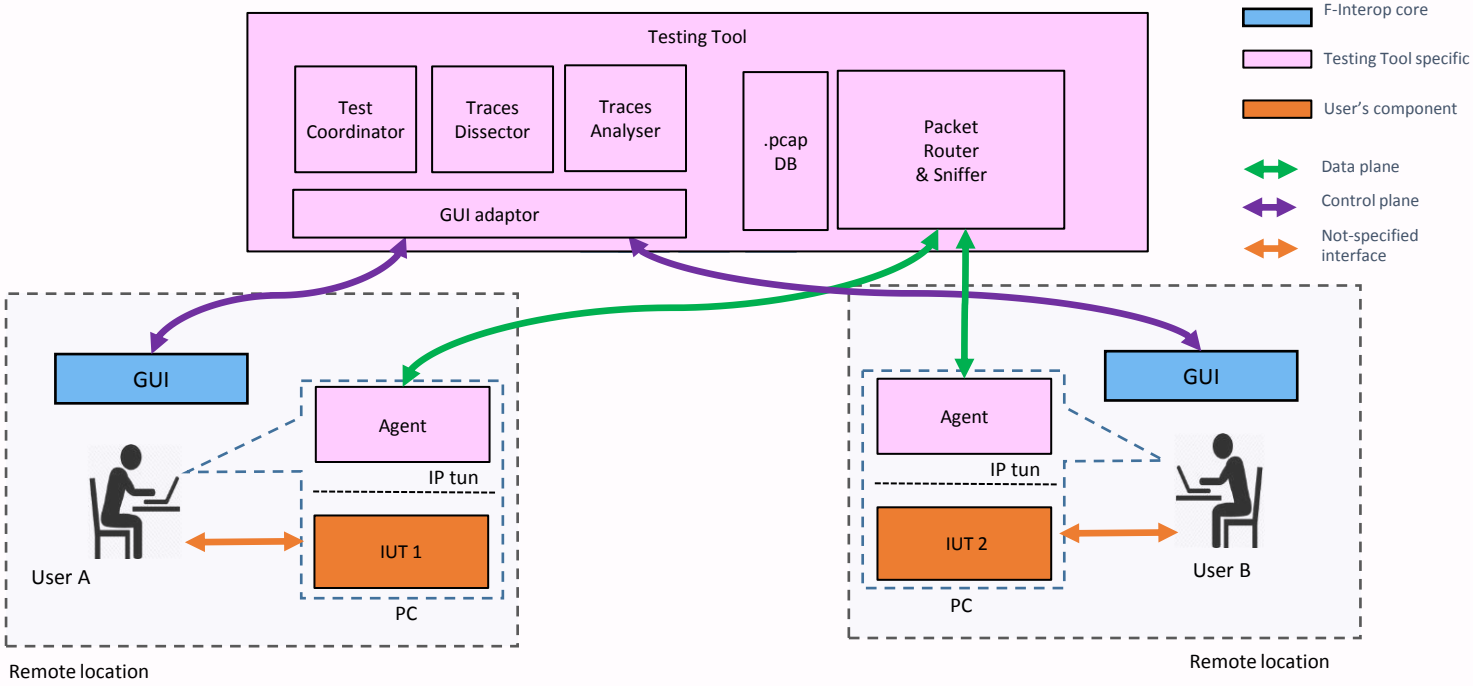
F-Interop's interoperability testing tools

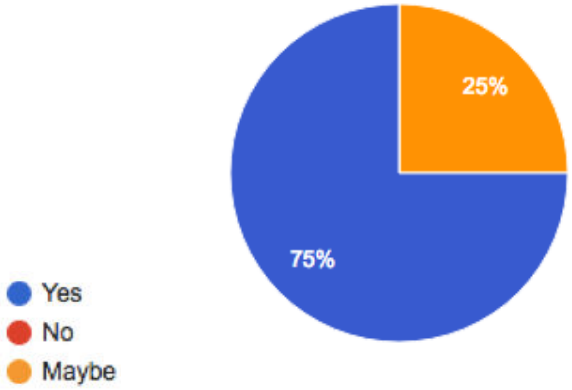
- "The purpose of interoperability testing is to prove that end-to-end functionality between (at least) two communicating systems is as required by the standard(s) on which those systems are based." (ETSI)
- testing tools create an environment which will help the user(s) executing **online and remote standard-based interoperability tests**
- communication "tunneling" between IUTs (a VPN-like setup)
  - controlled environment
  - bypass UDP-blocking firewalls and other middle boxes
- coordinating the interop test
  - dispatches commands to users (through GUI) based on test descriptions
  - e.g. 'user1: CoAP Client is requested to send a GET request with...'
- sniffing the traffic
  - generate PCAP files records
  - Users can download PCAP files at the end of test session.
- dissecting the messages
  - include wireshark-like view of the exchanges between implementations
  - help users find problems in the messages exchanged by the implementations
- analyzing the traffic exchanged
  - automatically issue PASS/FAIL/INCONCLUSIVE verdicts based on the test description

Testing Tool architecture overview:



DEMAND: Survey Results – Remote vs. Face-2-face

Do you think your organization will participate more in testing services when provided remotely?



REMOTE / ONLINE TESTING	
+	-
Cost effective	Privacy & Confidentiality
Flexibility on location/ no need to travel	Reliability & Quality of testing
Flexibility on time, availability	Security
Faster, repeatability	No meeting with community, no exchange of knowledge
Faster standards development	Complexity: remote interconnection
Easier organization	Instructions
	No clear verdict from platform?