A Service Based Architecture for Multidisciplinary IoT Experiments with Crowdsourced Resources

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- Testbeds
- Testbed as a Service (TBaaS)
- Related work
  - GENI
  - OneLab
  - Fed4FIRE
  - GEANT
  - EpiCollect, PhoneLab

Our Contribution

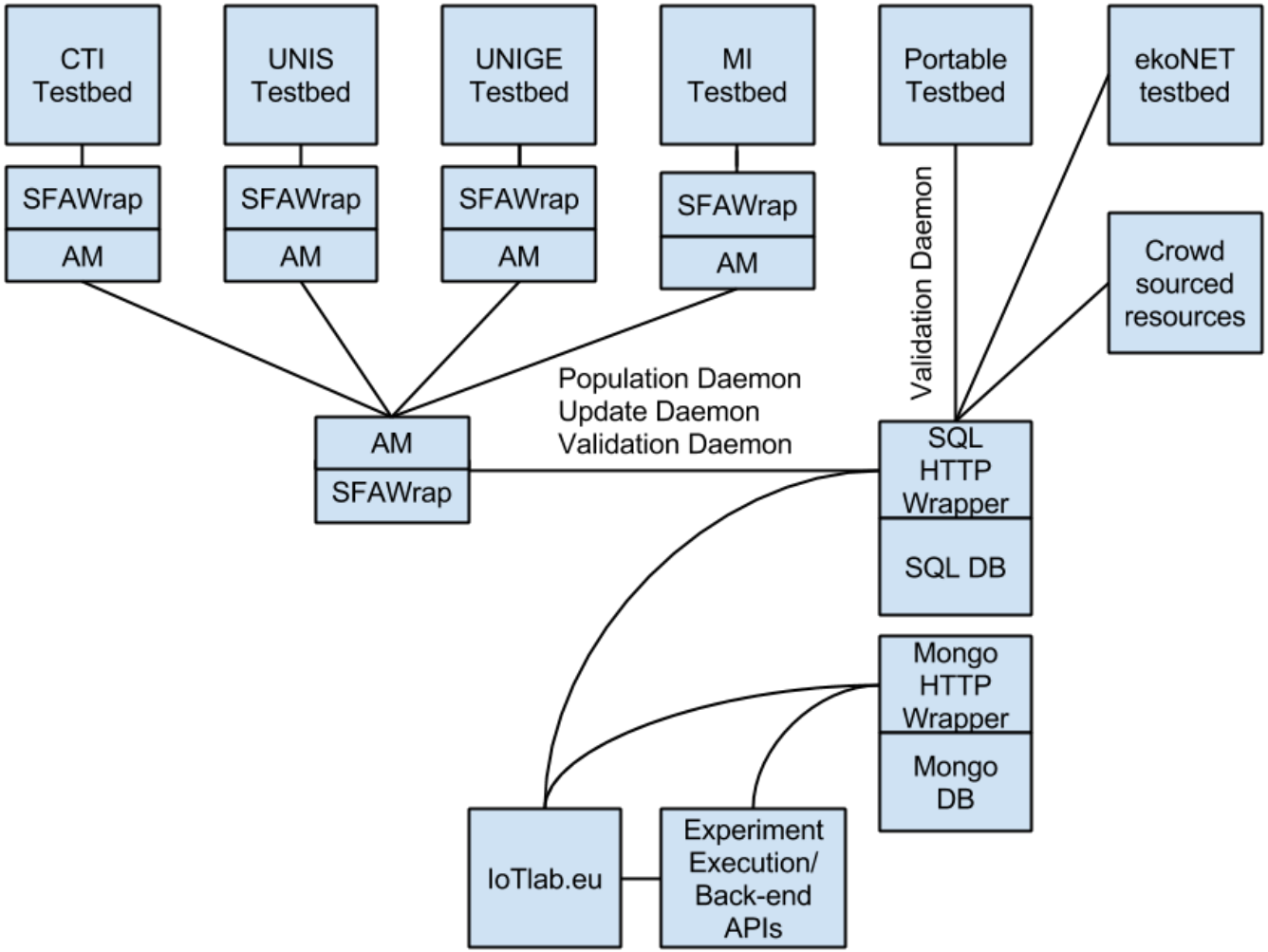
- Federated a wide range of devices
  - Static
  - Virtual
  - Crowdsourced
- Novel, generic yet specified experimentation mechanism
- User incentivization

We adopted and adapted the RSpec schema for the resource description

```
<node component_manager_id="urn:publicid:IDN+iotlab:ctitestbed+authority+cm"
exclusive="false" component_name="node_8.cti" ip="2001:620:607:5f00::8"
protocol="coap" port="5683">
  <interface component_id="urn:publicid:IDN+iotlab:ctitestbed:ctitestbed+
  node+node_8.cti"></interface>
  <location longitude="21.7333" latitude="38.25"/>
  <resource name="Transformers" path="/gpio" type="actuator" unit="None">
    <gpio>
      <dout data_type="" interface_def="a" name="Transformers"
      path="/transformers" resource_type="ipso.gpio.dout" resource_id="593"/>
    </gpio>
  </resource>
  <resource name="Energy Meter" path="/gpio" type="sensor" unit="KWh">
    <gpio>
      <din data_type="KWh" interface_def="a" name="Energy Meter"
      path="/energy" resource_type="ipso.gpio.din" resource_id="594"/>
    </gpio>
  </resource>
</node>
```

We have federated the following resources:

- Static IoT resources
- Mobile/portable IoT resources
- Virtual/modelled resources
- Web services
- Crowdsourced Resources - Opportunistic/Participatory sensing


CTI Testbed
UNIS Testbed
UNIGE Testbed
MI Testbed
Portable Testbed
ekoNET testbed
SFAWrap
AM
SFAWrap
AM
SFAWrap
AM
SFAWrap
AM
Validation Daemon
Crowd sourced resources
Population Daemon
Update Daemon
Validation Daemon
AM
SFAWrap
SQL HTTP Wrapper
SQL DB
Mongo HTTP Wrapper
Mongo DB
IoTlab.eu
Experiment Execution/ Back-end APIs

Efficient description of diverse experiments in a generic yet specific way through IFTTT scenaria and Questionnaires.

A diverse way of discovering, provisioning and reserving resources

- Survey Queries
- Survey Lists
- Geofencing
- Project Code

IFTTT scenario

- Get a value from specified resources
- Define an action
  - Set a condition
  - Set an outcome

Experiment Description

```
<?xml version='1.0' encoding='utf-8'?>
<experiment>
  <measurements><ip>129.194.70.52</ip><port>9000</port></measurements>
  <identifier>IemNuXCQTGasLMo5mMjkqxPYKewJYhkh</identifier>
  <reading>
    <frequency unit='minutes'>1</frequency>
    <start>2015-06-19 14:54</start>
    <end>2015-06-19 14:54</end>
    <resources>
      <id component=urn:publicid:IDN+iotlab:mitestbed:mitestbed+node+
      node7.mitestbed' resource_id='undefined' port='61616'
      ip='2001:620:607:5800:0:0:0:1c' protocol='coap'
      type='sensor' path='/co2' unit='ppm'></id>
    </resources>
  </reading>
  <action>
    <conditions>
      <average logic='and'>
        <id component='urn:publicid:IDN+iotlab:unigetestbed:unigetestbed+node+
        C3S7A1-LightLevel' resource_id='undefined' port='8111' ip='129.194.70.52'
        protocol='http' type='sensor' path='/lum' unit='lx'></id>
        <threshold type='less' value='100'></threshold>
      </average>
    </conditions>
    <outcome logic='and'>
      <id component='urn:publicid:IDN+iotlab:ctitestbed:ctitestbed+node+
      node_light_control' port='568' unit='none' resource_id='undefined'
      ip='2001:620:607:5f00::15' protocol='coap' type='actuator' path='PUT-dev0-1'></id>
    </outcome>
  </action>
</experiment>
```

Naive approach through Threads. more robust solution Queues.

- Queues
  - Persistent
  - Monitoring
  - Control
  - Scalable

An Incentive mechanism Necessary for effective user engagement in the experiments Persuade users to complete task segments

- Incentives framework
  - Sponsor
  - Charity
- Reputation mechanisms
  - Platform
  - Researcher
  - User

- Network Scalability
  - Scenaria
    - High-end
    - Average
    - Low-end
  - Packages
    - Sensing package 400 bytes
    - Sourcing package 100 Kbs

Table 1. Mobile Side - Bandwidth requirements, number of connections with server.

Mobile Side	BW (3G/LTE Kbps)	BW (Wi-Fi)	Capacity 100%	Capacity 50%
High-end scenario	0,271	5,417	369.231	184.615
Average scenario	0,017	0,347	5.760.000	2.880.000
Low-end scenario	0,002	0,045	44.883.117	22.441.558

Table 2. Testbed Side - Bandwidth requirements, number of connections with server

Testbed Side	Bandwidth (Kbps)	Capacity at 100%	Capacity at 50%
High-end scenario	0,013	8.000.000	4.000.000
Average scenario	0,002	48.000.000	24.000.000
Low-end scenario	0,0004	240.000.000	120.000.000

- Architecture Scalability
  - Cache
  - Load balancer
  - Queues

Upatras use-case

- Crowd
  - Passive light readings
  - Participatory localization through QR code scanning
  - Questionnaires to adjust parameters
- Static
  - Automation
  - Meters

Ekonet use-case

- Mobile sensors
- Crowd
  - Questionnaire

- Experiments
  - Dynamic Experiments
  - Change Experiments Parameters
- Deployment in Industrial Setting
- Explore more options for crowd interaction
- Data visualization

Thank you for your attention, any questions?