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**CUniCredit**-

Giovanni Merlino - smartme.IO

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## **IoTronic** FaaS for the IoT in the Fog

### Roles

- MDSLab research group @UniME (<u>mdslab.unime.it</u>) PostDoc member
- ICT staff @UniME (<u>unime.it/it/dipartimenti/ingegneria</u>) member
- CINI Smart City Lab @UniME (consorzio-cini.it/index.php/en/laboratori-nazio nali/smart-cities) member
- **#SmartME crowdfunding initiative** (<u>smartme.unime.it</u>) **co-organizer**
- smartme.IO (smartme.io) co-founder













## Academic (UniMe) spin-off company, focusing on Smart City solutions, «on a *shoestring* budget»

Small but *dedicated* team



## **Technology transfer**







- A growing list of active partnerships and customer companies (B2B)
  - Environmental monitoring (for Smart Cities)
  - Monitoring **building statics** and dynamics
  - Fleet management for electric cars and dump trucks
  - Modular home automation kit
- borne out of **#SmartME crowdfunding** initiative
- o innovative startup (D.L. 24 Gennaio 2015 n. 3) on 24/03/2017
- academic spin-off company
  - approved on 11/04/2017 by the University of Messina



### The **#SmartME** project



- collaboration of *MDSLab* team with key actors
  *Arduino* Labs, municipality, university branches
  - successful crowdfunding initiative
  - a platform for experimental testbeds

http://messina.smartme.io/smartme

http://smartme-data.unime.it











Too(I)smart is a reuse project and an evolution of the #SmartMe best practice, currently involving

### TURIN, PADUA, LECCE, SYRACUSE next to MESSINA

Main goal in the #SmartMe project, firstly developed at the University of Messina, lies in **transforming urban systems** in a **network of things** able to take on an **active role**, interacting among each other, with citizens and with the public administration thanks to the *Internet of Things* and *Cloud Computing* paradigms

Too(I)smart: not only a technological solution, but also a set of enabling actions to activate pervasive city-level monitoring processes and open innovation labs for companies and research Too(I)smart: not only a research project, but also a cooperative development initiative launched by public administrations sharing common goals, starting from solutions driven by non-proprietary rationales, and geared toward developing skills within institutions and locally on the urban fabric

All tools are going to be published in the official AGID "reuse kits" repo:

https://developers.italia.it/it/software

according to the "reuse and open source" guidelines:

https://www.agid.gov.it/it/design-servizi/riuso-open-source



### Example of (early) #SmartME node







### Architecture of the Too(I)Smart framework







### Some more details on the dataplane



Please refer to our previous presentation (video included) at the **OpenStack Summit 2017** in **Boston**:

 <u>https://www.openstack.org/summit/boston-2017/summit-schedule/events/17951/a-monitoring-case-study-fo</u> <u>r-monasca-smart-city-infrastructure</u>



## **Motivation**



• How to manage in a scalable and powerful way the proliferation of (increasingly smarter) mobile and IoT devices?



### **IoT ecosystem:**

- Mobiles
- Cyber Physical Systems
- Smart appliances
- Sensors/Actuators
- Wearables
- Vehicles
- ...



## **IoT devices**



- Microcontroller boards or single board computers with sensors/actuators attached to (analog/digital) gpio pins or serial bus
- a wide range of interfaces





- Smart objects providing interactions with physical world
- wi-fi/bluetooth connectivity

- Smartphones with sensors on-board
- wi-fi/bluetooth/3-4G connectivity







Data-oriented approach



- IoT devices send data to the Cloud
- The application is built on top of **standard cloud facilities** (VMs, storage, network)
- The application makes use of stored (non-real time) IoT data
- Indirect, IoT device-initiated only, retrieval of actuation commands



Application-specific (vertical) approach



- The application uses ad-hoc mechanisms to interact with IoT devices
- No explicit interactions between Cloud components and IoT infrastructure
- Static infrastructure deployment





### Full IoT cloudification (the *I/Ocloud*)





- We consider the IoT infrastructure as a **natural extension** of a datacenter
- Well-defined Cloud API as a resource management interface
- Separation of concerns between infrastructure and application (when needed)
- From Cloud to Fog/Edge computing
- Device computation offloading



I/Ocloud edge/virtIO duality: capabilities (IaaS)



# I/O resources correspond to IoT resources

- $\circ~$  locally available to certain IoT nodes
- exposed by the I/Ocloud



## **I/Ocloud reference implementation**

Stack4Things: underlying technologies



http://stack4things.unime.it





### **Current hardware/platform support**











- Two application messaging patterns in one unified protocol
  - Publish & Subscribe
  - RPC



 WAMP (<u>http://wamp-proto.org</u>) is an open standard WebSocket subprotocol







## **OpenStack-based implementation: IoTronic**



- IoT resource management service for OpenStack clouds
- (unofficial) OpenStack project

<u>https://launchpad.net/iotronic</u> <u>https://opendev.org/x/iotronic</u> <u>https://opendev.org/x/iotronic-lightning-rod</u> <u>https://opendev.org/x/iotronic-ui</u> <u>https://opendev.org/x/python-iotronicclient</u>





## **OpenStack: an Edge operating system?**



### https://wiki.openstack.org/wiki/Edge\_Computing\_Group#Related\_OSF\_Projects

#### **Related OSF Projects**

#### OpenStack

#### openstack.org

- IRC channels on Freenode https://wiki.openstack.org/wiki/IRC 📾
- IRC meetings on Freenode http://eavesdrop.openstack.org
- Mailing lists http://lists.openstack.org/cgi-bin/mailman/listinfo delta

#### Cyborg

https://wiki.openstack.org/wiki/Cyborg a

#### Glance

- https://docs.openstack.org/glance/latest/ 6
- https://wiki.openstack.org/wiki/Glance

#### Keystone

- https://docs.openstack.org/keystone/queens/ 6
- https://wiki.openstack.org/wiki/Keystone a

#### IoTronic - unofficial

- IoT resource management service for OpenStack clouds
- https://www.openstack.org/assets/presentation-media/vancouver.pdf
- subproject of Stack4Things: http://stack4things.unime.it d
- https://github.com/openstack/iotronic a (OpenStack-compliant service for IoT / far-edge nodes IaaS enablement)
- https://github.com/openstack/iotronic-lightning-rod @ (node-side agent for the IoTronic service)
- https://github.com/openstack/python-iotronicclient i (client for the IoTronic service)
- https://github.com/openstack/iotronic-ui a (Horizon plugin for the IoTronic service)
- https://bugs.launchpad.net/iotronic/+bugs 6

#### Airship

- http://www.airshipit.org @
- https://www.openstack.org/videos/vancouver-2018/airship-making-lifecycle-management-for-open-infrastructure-repeatable-and-predictable
- https://github.com/openstack/airship-in-a-bottle
- IRC on Freenode #airshipit

#### StarlingX

Linicon: Grog Waines





https://iot.mozilla.org

**Things Gateway** 





## **IoTronic:** features

object virtualization - interaction with IoT devices as entities in the Cloud through a uniform interface
 overlay networks of things - creation and management of Cloud-mediated virtual networks among remote objects
 remote control and customization - full customization of devices from low-level firmware/operating system configuration up to business logic
 fleet management and delegation - IoT objects can be organized in fleets and controlled hassle-free, coupled with a complex delegation model for a multi-tenant Cloud of objects
 fog orchestration - objects orchestrated by aggregating them in IoT ensembles, allowing to build and deploy new Fog-like applications





### **Neutron integration: Cloud-side architecture**





### **Neutron integration: node-side architecture**







### Some more details on the control plane



Please refer to our previous presentation (video included) at the **OpenStack Summit 2018** in **Vancouver**:

 <u>https://www.openstack.org/summit/vancouver-2018/summit-schedule/events/21201/an-edge-computing-ca</u> <u>se-study-for-monasca-smart-city-ai-powered-surveillance-and-monitoring</u>



### **Delegated authorizations: architecture**







### **Delegated authorizations: entity-relationship diagram**







## **Delegated authorizations: smart contracts**







### PaaS



### **Plugin-based development:**

- plugins as minimal, high-level, self-contained code units (design-time advantage)
- plugins as isolated (sandboxed) processes (run-time advantage)

Enabling mechanisms:

- plugin wrappers for runtime execution
- plugin registration on the Cloud
- plugin injection (deployment)
- RPC exposed Cloud-side for starting/calling

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### Does it *somehow* remind anybody of.. serverless?





## "Classic" OpenStack FaaS







## **Zun-powered FaaS**







## IoTronic-powered (deviceless) FaaS







## **Deviceless runtime creation (sequence)**







## **Deviceless function execution (sequence)**





### **Demo time**







## Thanks? Q&A



**Giovanni Merlino** 

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Company / Project(s) links: <u>http://smartme.io</u> <u>https://opendev.org/x/iotronic</u> <u>http://stack4things.unime.it</u>

A shout to our interns and thesis students, for having worked on the FaaS implementation and made the demo possible:

### Francesco Aragona Domenico Doddis

