‘The BLORIN project: ICT services for next generation energy grids’

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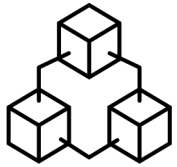
University of Palermo

DLT Workshop
Florence, November 8, 2022

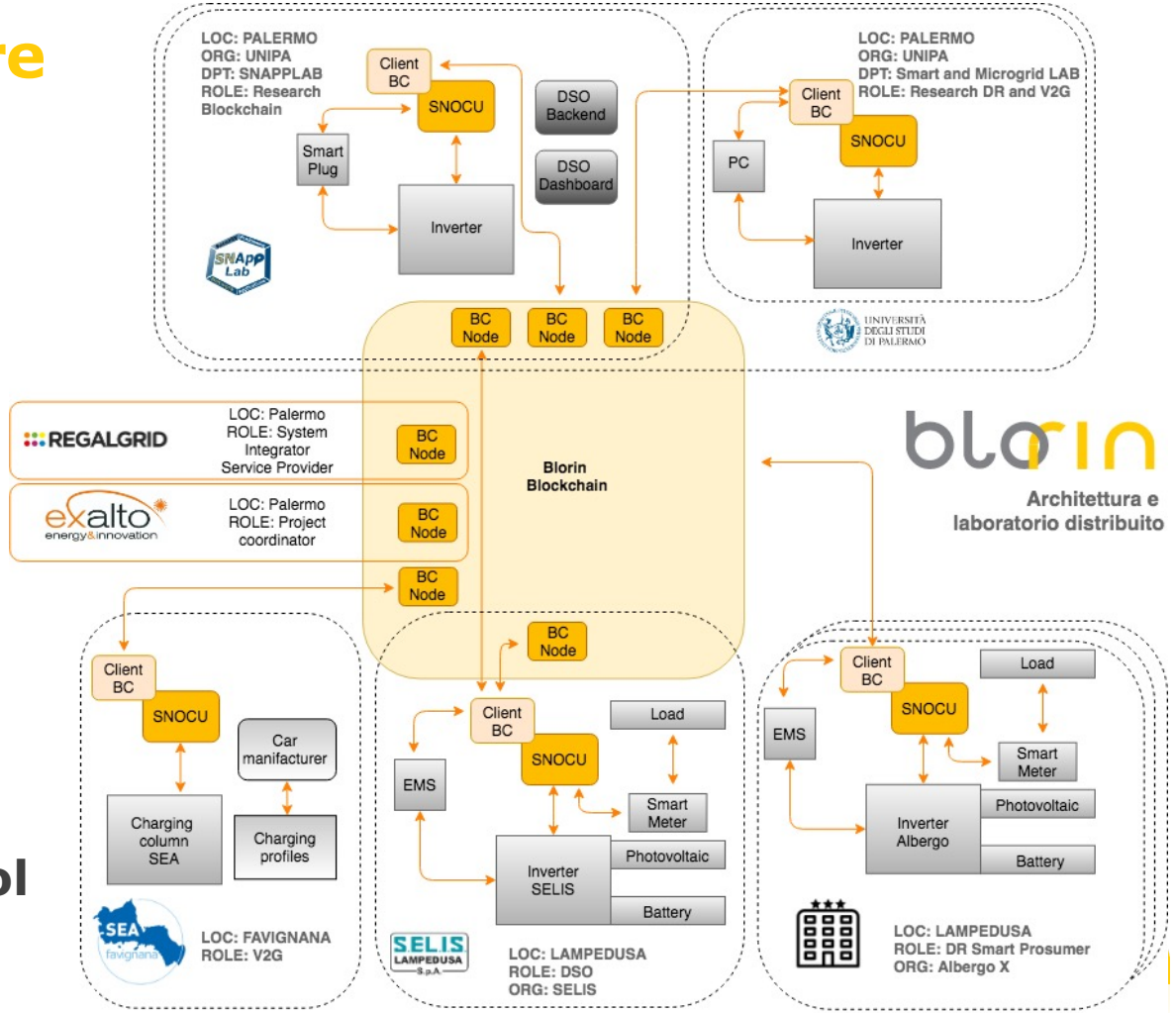
BLORIN motivation: why use blockchain



- create and coordinate **aggregation of prosumers for DR events**
- create **energy communities** with a bottom-up approach, the opportunistic way
- add **transparency** in attributing losses, charging profiles, DR, V2G programs, battery management
- Use smart contract, channels and secure multiparty computation enable a **perfect tradeoff between transparency, accountability and privacy**
- introduce **new business models** (tokenization)

BLORIN architecture

- Blockchain peers
- MSP
- Channels
- Orderer
- Blockchain clients (SNOCU, EMS, BMS, …)
- BLORIN API
- Involved actors
- **Monitoring and control functionalities**

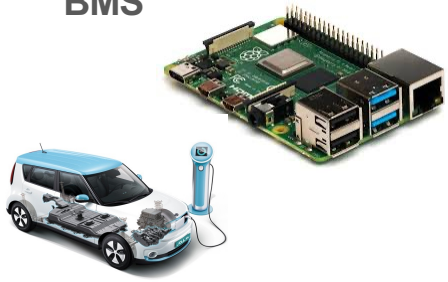


BLORIN Sensing, metering, labs

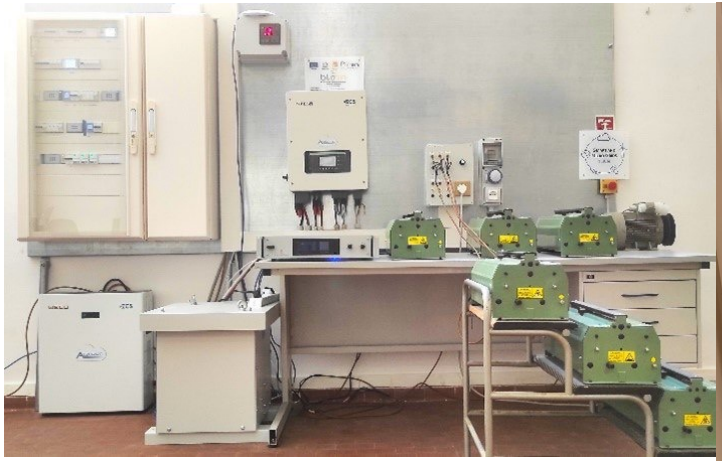
SNOCU

Blorin blockchain-ready EMS

Blorin blockchain-ready BMS

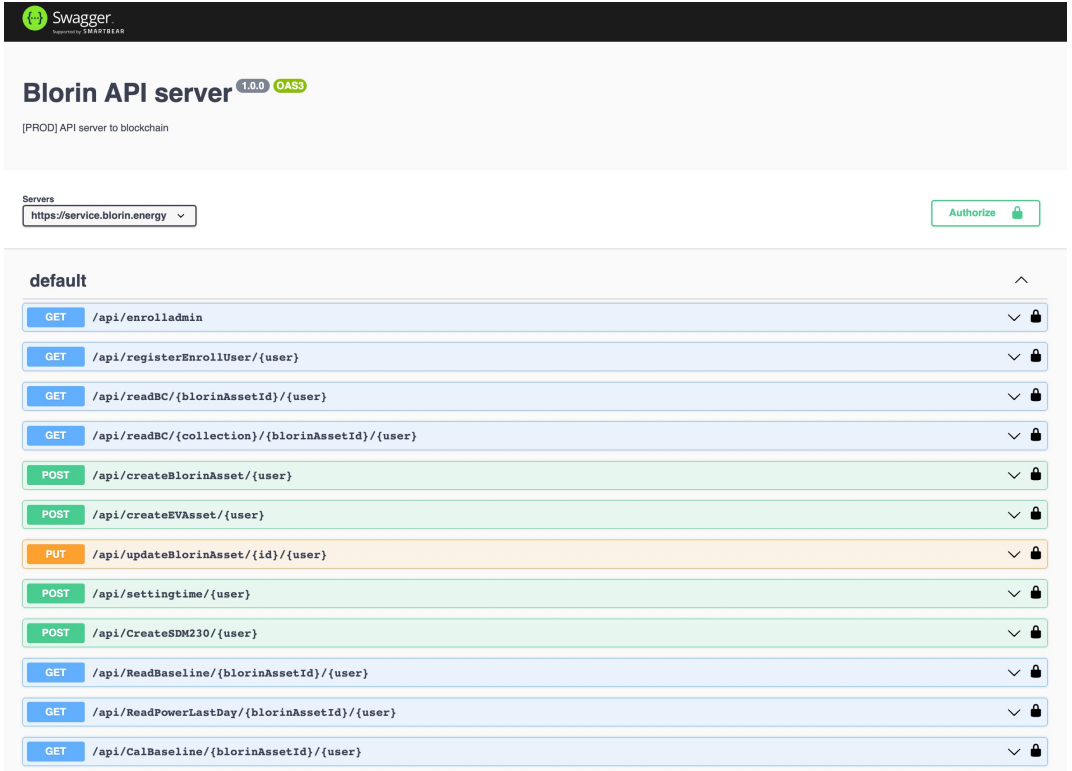


Blorin prototype at SMG lab



Blorin prototype at SNAPP lab

BLORIN API for the data gateway



- Guarantees openness
- OpenAPI 3.0 – OAS3
- Blockchain-ready client
- Eventually one for each trust environment (one for each actor)

Sensor/ actuator

MQTT

IoT broker

Lightweight client

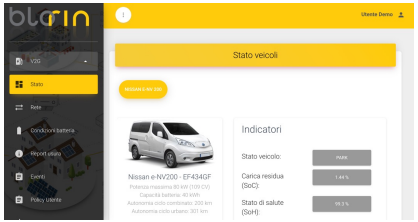
OpenAPI

Data GW

Blockchain node

blorin

BLORIN logic: local and distributed algorithms



- Multiple control loops
- Fast and slow actions
- Sharing policies through blockchain (traceability of applied policies)

Slow
Control loop
e.g. setting V2G policies for primary regulation
(sec, min)

Fast
Control loop
e.g. primary regulation
(us, ms)

BLORIN ICT technologies, protocols, devices

Blockchain, virtualization and operation

- ansible
- docker
- kubernetes
- kubectl
- helm
- istio
- flannel
- jq
- yq
- krew
- Hyperledg
- hlf operator

V2G

- Google home assistant
- OBD II
- OCPP
- Steve
- SMET II

Smart meters / clients

- Blorin EMS
- Blorin BMS
- SNOCU
- SONOFF (smart plug)

Sensing and communication

- Wireguard
- MQTT
- SCADA
- IoT
- OpenAPI
- Swagger

Programming Languages and DB

- NodeJS
- Javascript
- Python
- React
- Mongo
- CouchDB (fabric)

BLORIN distributed experimental ecosystem

exalto energy&innovation

REGALGRID sharing your power

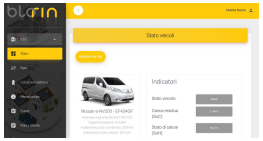
UNIVERSITÀ DEGLI STUDI DI PALERMO

SEA favignana

S.E.L.I.S. LAMPEDUSA S.p.A.

Partners

Citizens



Blockchain

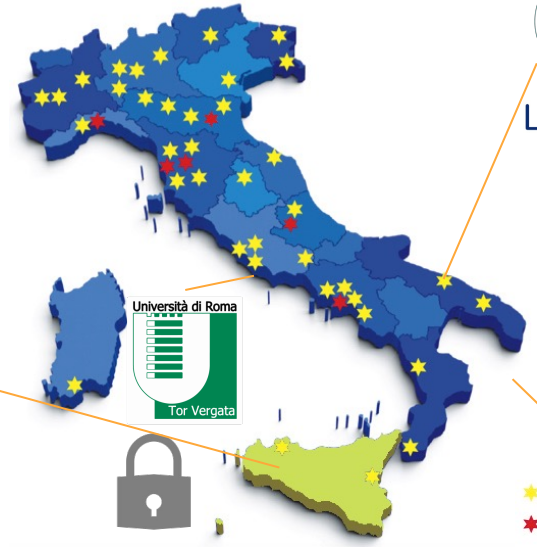
Cloud services

IPSec tunnel

VPN

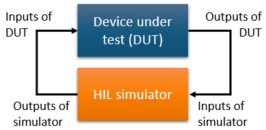
Demand Response

Vehicle To Grid



Cryptography
Privacy

LabZERO HIL



cnit

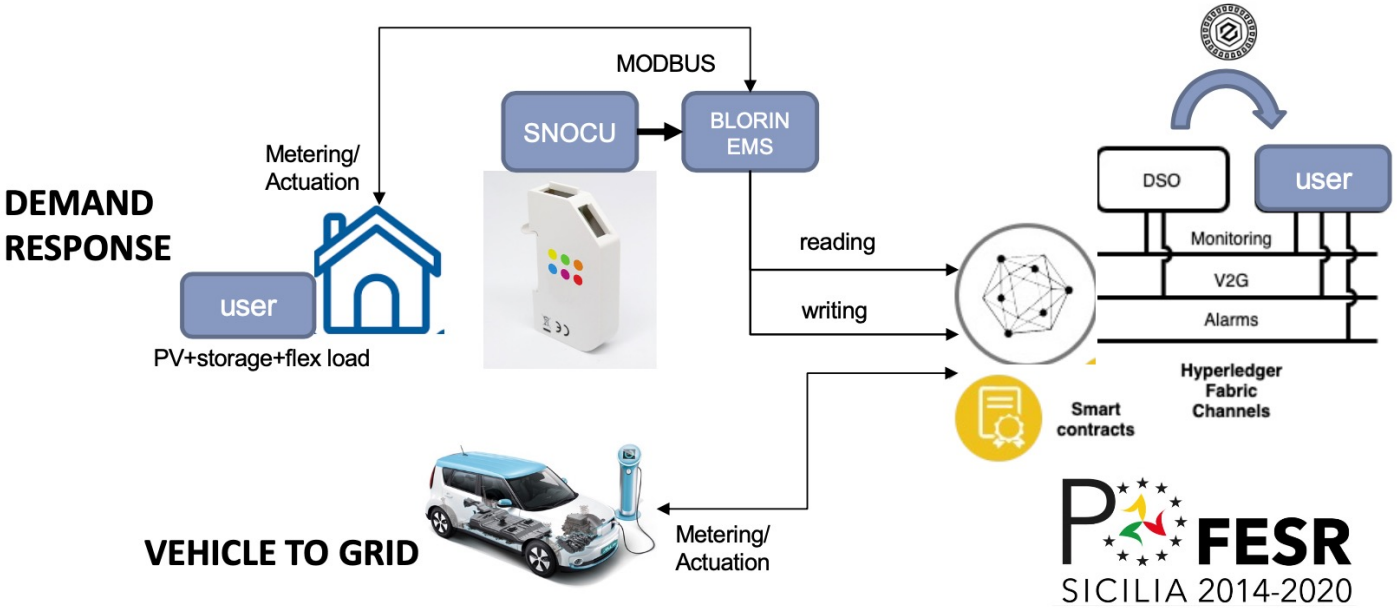
Università consorziate
Laboratori nazionali

IoT Security

Consultants

blorin

Blorin: DR and V2G



Baseline computation

La **Load Baseline** di un cliente *c* consiste di un vettore di consumi tipici di potenza in 24 h:

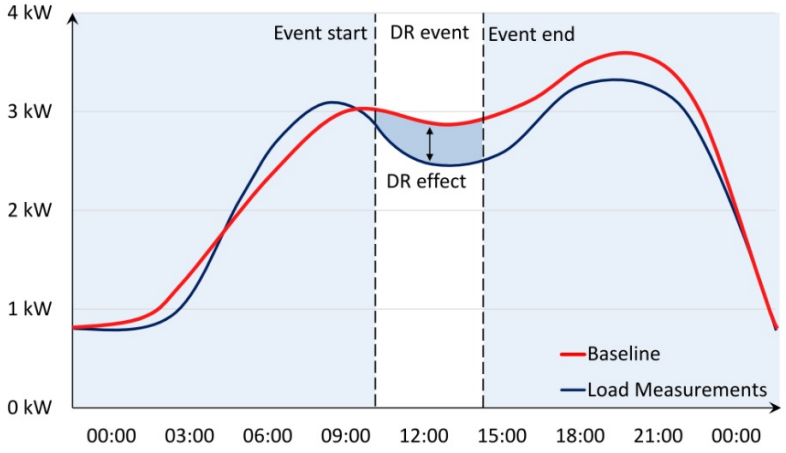
$$\mathbf{B}^{(c)} = \left[\bar{P}_{B,1}^{(c)}, \bar{P}_{B,2}^{(c)}, \ldots, \bar{P}_{B,h}^{(c)}, \ldots, \bar{P}_{B,24}^{(c)}\right]$$

- Weekdays Baseline: *High X of Y Method*

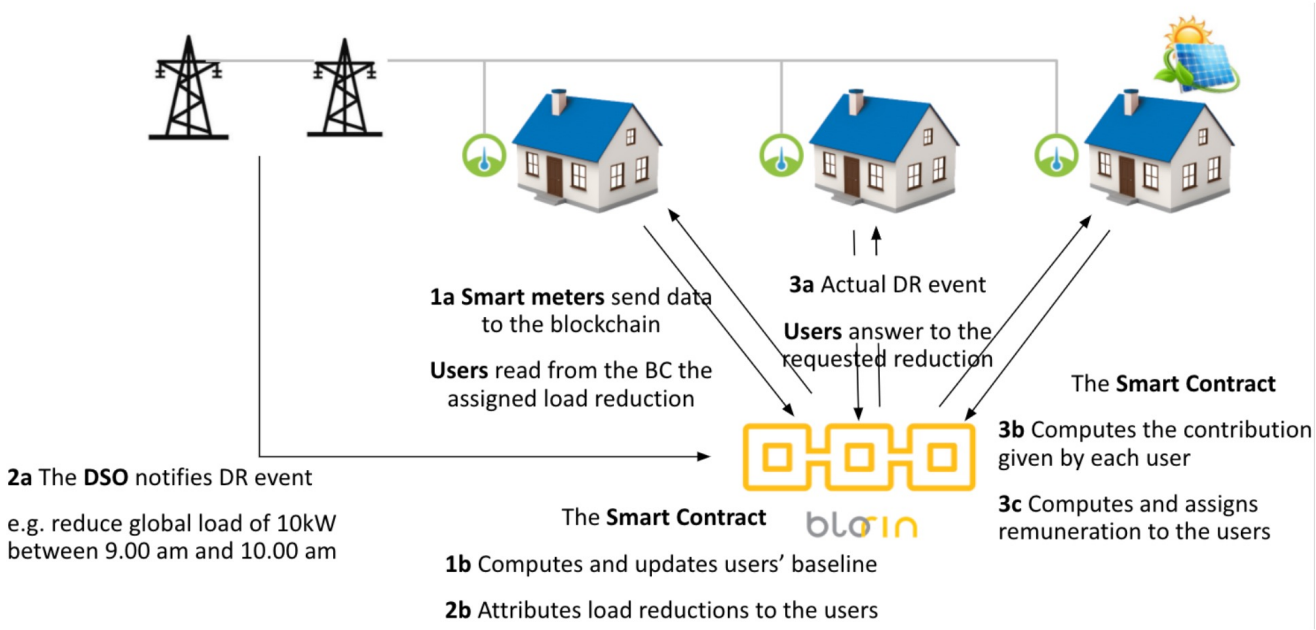
$$\bar{P}_{B,h}^{(c)} = \frac{1}{X} \sum_{j \in \mathrm{High}(X,Y,d)} P_{B,h,j}^{(c)} \quad \forall\, h \in \{1, 2\ldots, 24\}$$

- Weekend Baseline: *Low X of Y Method*

$$\bar{P}_{B,h}^{(c)} = \frac{1}{X} \sum_{j \in \mathrm{Low}(X,Y,d)} P_{B,h,j}^{(c)} \quad \forall\, h \in \{1, 2\ldots, 24\}$$



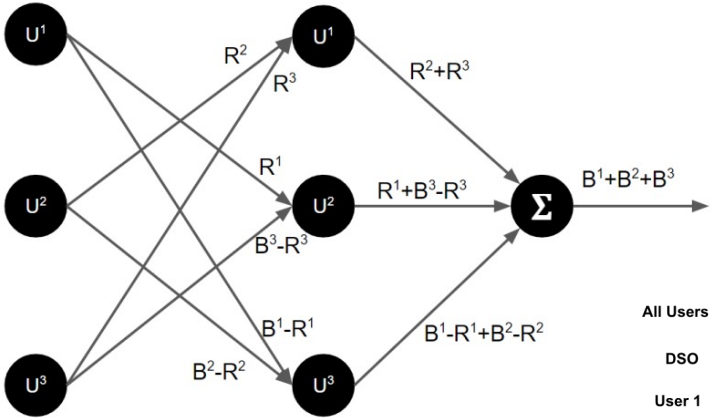
Blorin DR: actors and interactions

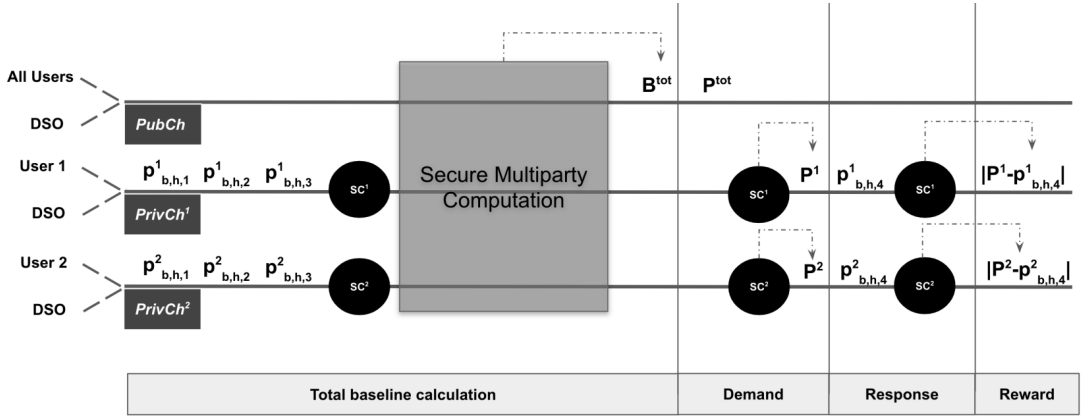


$$\mathbf{B}^i = [\bar{p}^i_{B,1}, \bar{p}^i_{B,2}, ..., \bar{p}^i_{B,h}, ..., \bar{p}^i_{B,96}]$$

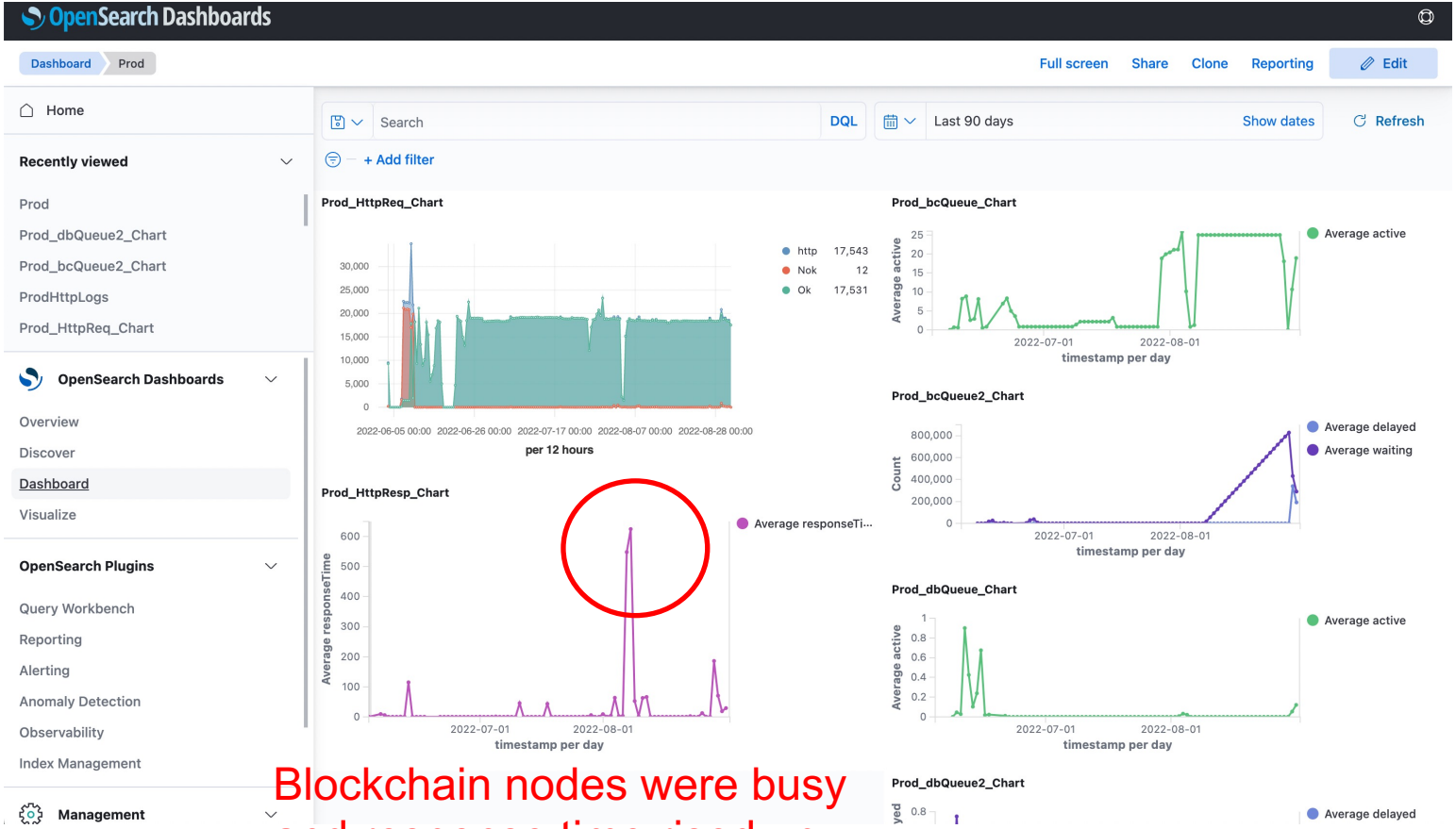
$$\bar{p}^i_{B,h} = \frac{1}{X} \sum_{j \in High(X,Y)} p^i_{B,h,j} \quad \forall h \in \{1, ..., 96\}$$

Blockchain and SMC for transparency, accountability and privacy





BLORIN reporting dashboard



Blockchain nodes were busy and response time rised up

Thanks for your attention

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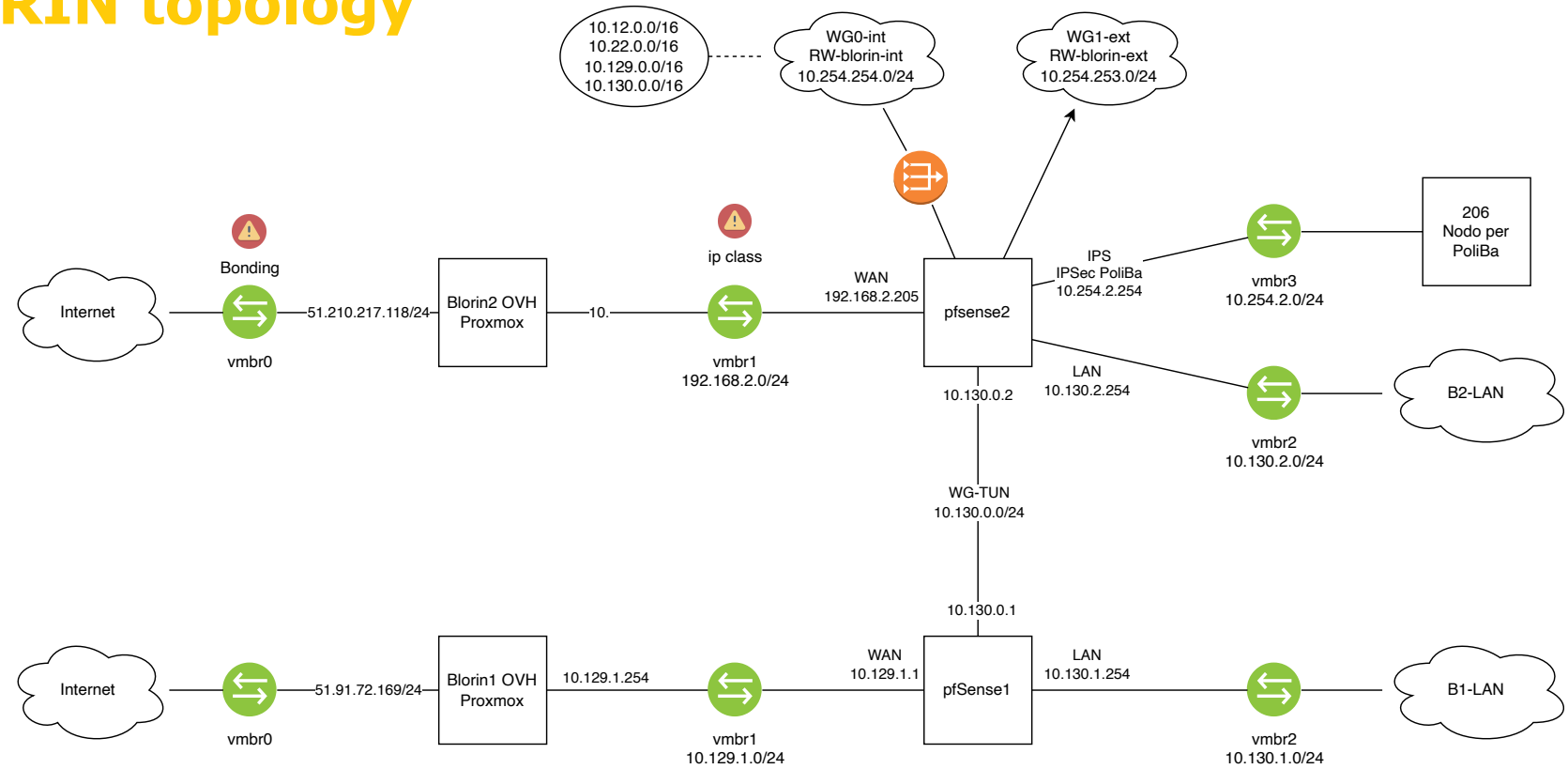
BLORIN topology



Research contracts
CNIT and the University of Tor Vergata

CNIT activities are still ongoing; mainly focused on SCADA, IoT and their security in the Blorin context. These activities are cornerstone elements for data acquisition within the Blorin trust model.

Activies about **applied cryptography, security and privacy assigned to the University of Tor Vergata have already finished**. They worked on:

- threat and privacy models in Blorin scenarios
- validation methods applied to encrypted data without exposing data in clear
- Definition of trust models in realistic scenarios;
- Definition of privacy-preserving mechanisms of data processing inscribed within smart contracts.

Joint scientific results will be reported later

BLORIN lesson learnt

- **Blockchain platforms are slower and heavier than databases, but …**
- **Distributed systems have pros and cons**
- During the experimental phase many blockchain nodes went down, but …
  - availability and partition tolerance are cornerstone (distributed systems)
  - **We were able to recover all data**
  - **Different (and more articulate) trust model**
- **Running distributed logic with smart contracts (chain codes) is a different matter than just writing code**
- **Blockchain and Secure Multiparty Computation are big blobs and extremely useful tools to handle with care**
- **Blockchain is not fast enough to face quick events (e.g. primary regulation).**

BLORIN challenges and future directions

- **Involvement of public actors (ARERA, GSE, RSE, …):** once blockchain is implemented significant stakeholder consensus is required for a unified direction.
- **Technology acceptance among population**: definition of the ‘killer application’ and incentives for people
- **Integration with existing technologies**: new-generation, dual channel Italian smart meters, bidirectional charging stations were not that stable
- **Charging station issues:** hardware issues of the power supply and chip shortage

- ICT supporting technical and societal perspectives

BLORIN possible follow up

- **Involvement of public actors (ARERA, GSE, RSE, …):** once blockchain is implemented significant stakeholder consensus is required for a unified direction.
- **Consolidation and simplification of the webapp** for massive involvement of population
- **Study of Blorin's impact on energy communities**
- **Extensive data acquisition**
- **Larger testing areas**
- **More blockchain-ready smart meters, more openness and interoperability**