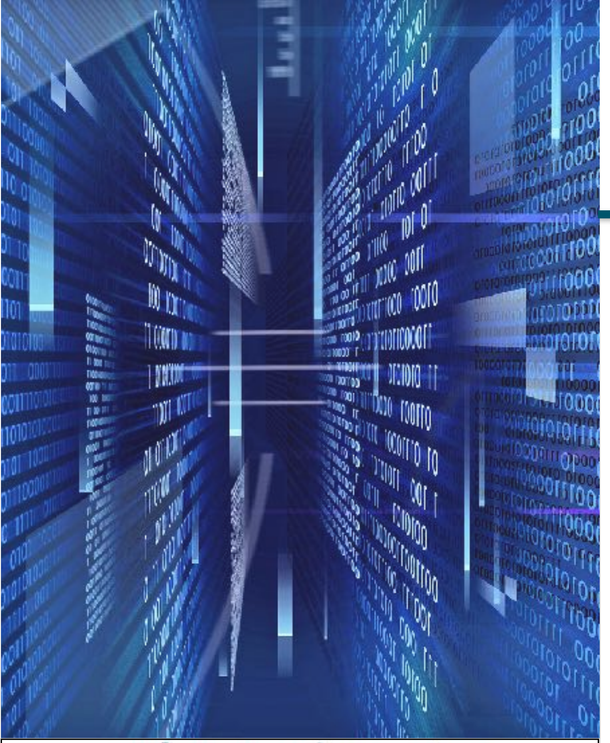


cybersecurity centre
GCHQ Academic Centre of Excellence EPSRC

UNIVERSITY OF Southampton

Federation-as-a-Service: the SUNFISH experience

Vladimiro Sassone

Scientific Leader
SUNFISH

Cyber Security Centre
University of Southampton

Cybersecurity Southampton

CyberSecuritySoton.org [w]

@CybSecSoton [fb & tw]

the SUNFISH project

UNIVERSITY OF Southampton

SecUre iNFormatIon SHaring in federated heterogeneous private clouds

Ultimate Goal:

providing a secure by-design federation of individual clouds that enables the regulated and monitored sharing of cloud services

Horizon 2020 project consisting of:

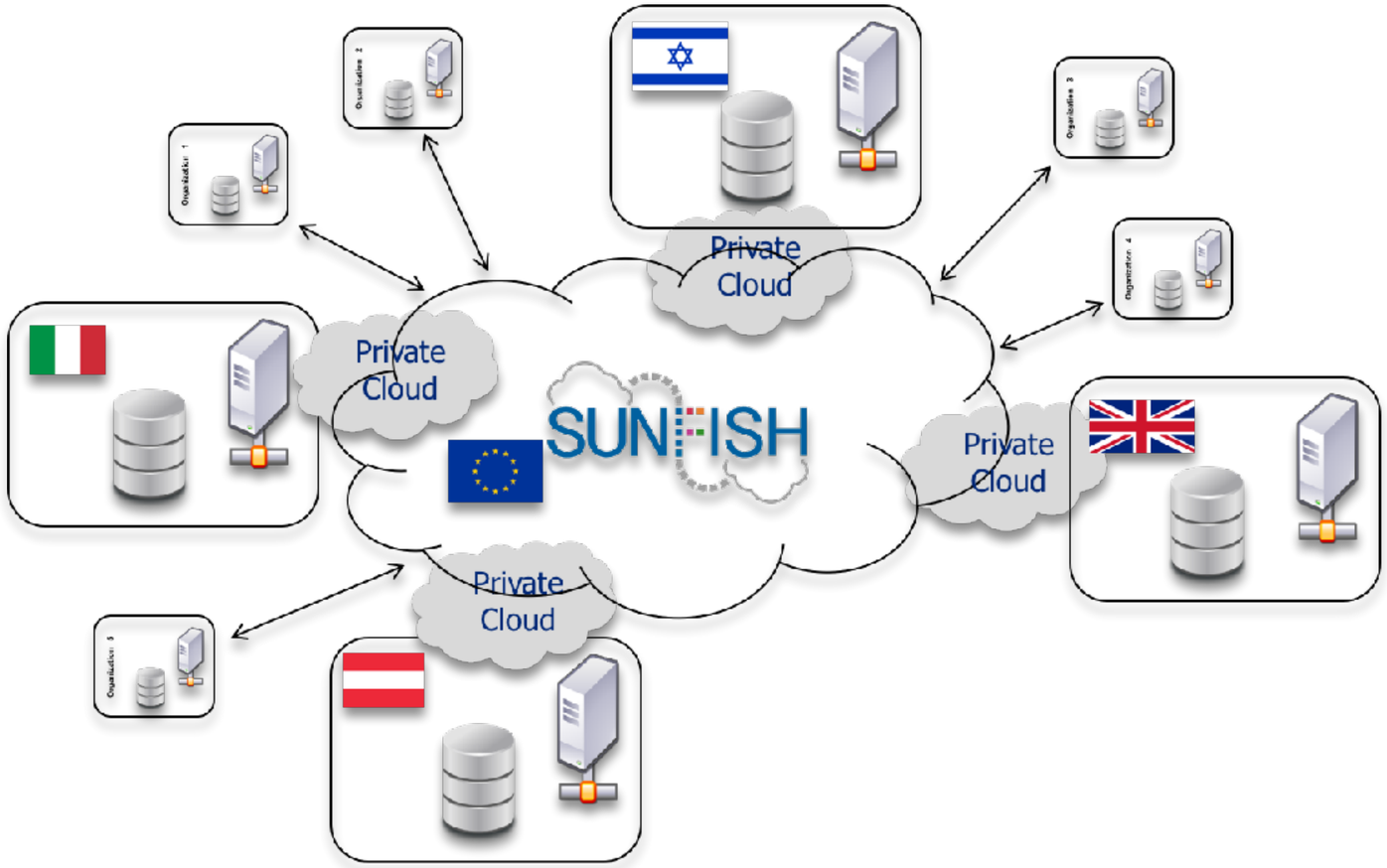
4 Public Bodies
- Ministry of Economy and Finance (Italy)
- Ministry of Finance (Malta)
- Malta Information Technology Agency (Malta)
- South East Regional Organised Crime Unit (UK)

3 Academic Partners
- University of Roma La Sapienza (Italy)
- Technische Universität Graz (Austria)
- University of Southampton (UK)

2 Industrial Partners
- IBM Israel – Science & Technology Ltd (Israel)
- PricewaterhouseCoopers Advisory SpA (Italy)

1 public-funded non-profit association - A-Sit (Austria)

1 SME - Cybernetica (Estonia)



Different cloud systems homogeneous aggregation of goal-oriented cloud systems

Multiple underlying motivations leading to a cloud federation:

- sharing of computing resources
- controlled usage of federated services or data
- collaboration among entities belonging to different administrative domains

Each federation aims at achieving a business need that the single clouds would not have achieved by themselves.

the need for a new cloud federation solution

Cloud federation is still a quite new concept that, despite the recent large research efforts, lacks of solid proposals.

The following needs must be ensured

- Enabling the federation and *sharing of any cloud service* (from IaaS to SaaS)
- Provisioning services according to *Access Control* and *SLA* policies
- Calculating o*ptimal workload plans* of federated resources
- *Monitoring* and *auditing* service provisioning
- Offering by design *privacy-preserving services*

The SUNFISH project aims at achieving these objectives by proposing a new and innovative cloud federation platform that private and public companies can adopt.

FaaS: Federation-as-a-Service

FaaS is a new and innovative cloud federation solution that enables the secure creation and management of cloud federations

Some FaaS functionalities:

- Dynamic federation of clouds and their services
- Advanced, innovative privacy-preserving services
- Innovative cloud federation governance

A cloud federation solution that could be widely adopted among companies, *especially in the public sector,* must rely on a **governance** that is

- **distributed**: no single point (-of-failure) of the federation manages and stores the governance data
- **democratic**: all federation members have the same authorities and duties

This ensures that any governance action, e.g. the enforcement of access control policies, is carried out with the *consensus of all the federation members.*

why FaaS

FaaS permits Cloud systems to be more flexible and to better *adapt to new emergent needs*. More generally, it increases the *operational efficiency* of clouds. (e.g., optimised usage of resources and usage of advanced security service not usually widely available)

FaaS permits *reducing the burden* needed for sharing services among individual clouds. It strengthens each federated cloud to achieve its business goals.

Concerning the *public sector*, FaaS supports its digital transformation by offering a principled *consolidation* solution to reduce replicated IT investments and to prompt better *harmonisation* among systems.

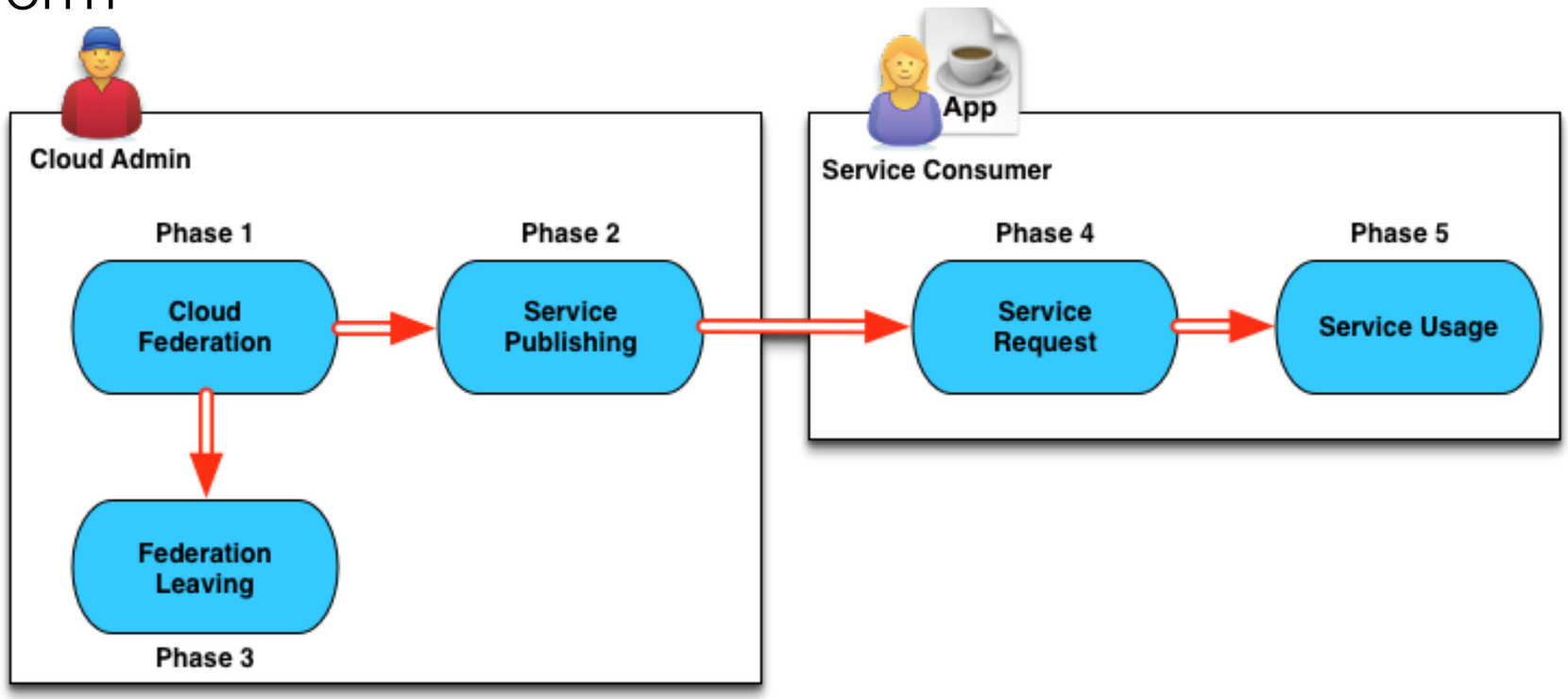
FaaS at work

FaaS offers well-defined high-level operating phases supporting *cloud administrators* to

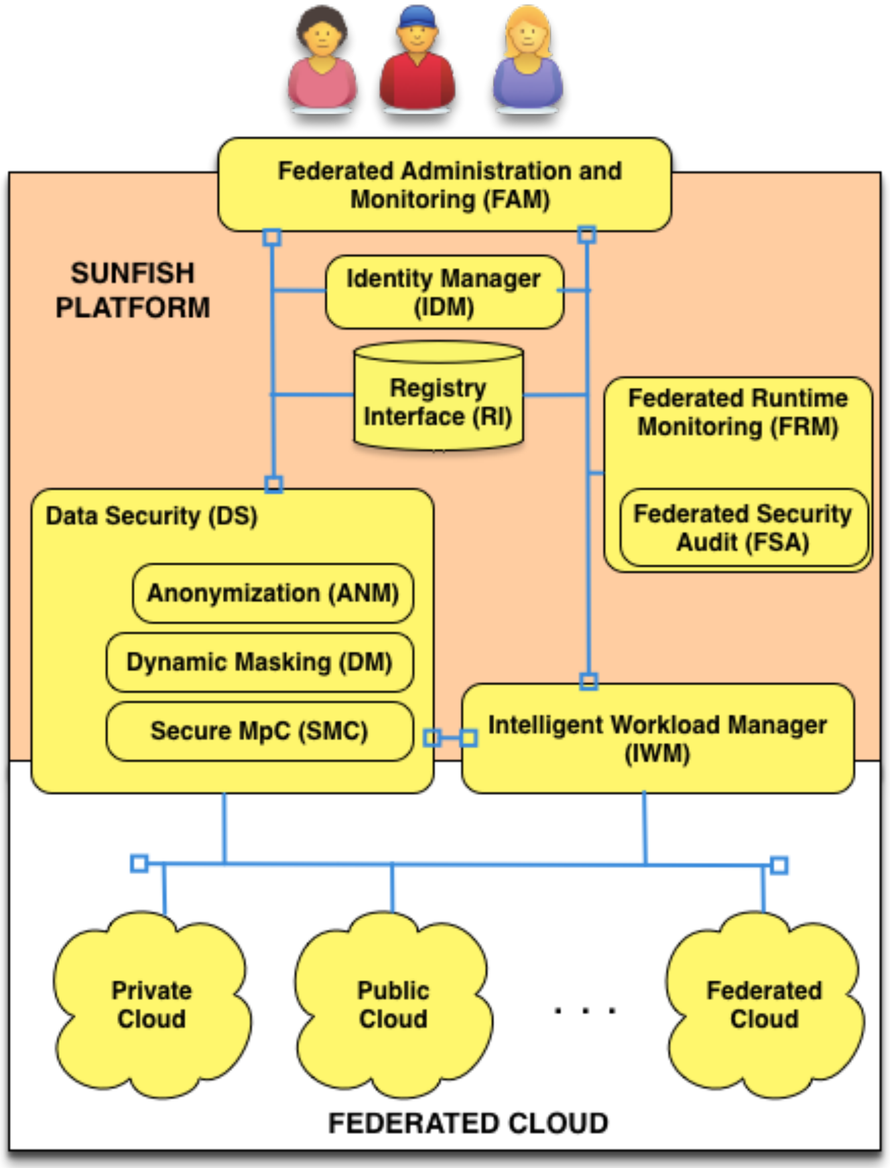
- federate cloud systems
- publish service on the platform
- leave the federation

and *cloud end-users* to

- request federated services
- use requested services



implementing FaaS: the SUNFISH platform



FaaS is supported by a software platform designed and implemented by the SUNFISH project

The SUNFISH platform features various well-structured components whose interactions enable and support all the FaaS functionalities.

For examples, we have

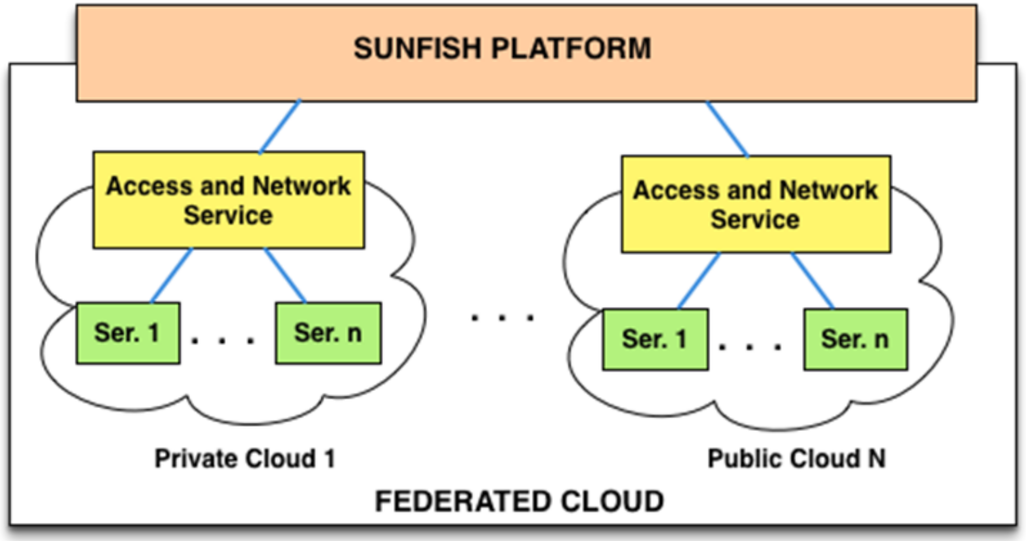
- Dynamic Masking
- Data Security
- Secure Multi-Party Computation
- Runtime Monitoring

distributing the SUNFISH platform on clouds

The deployment of the SUNFISH platform on the clouds must be completely distributed, to avoid centralisation or control of one cloud over another, i.e. ensuring a full democratic federation.

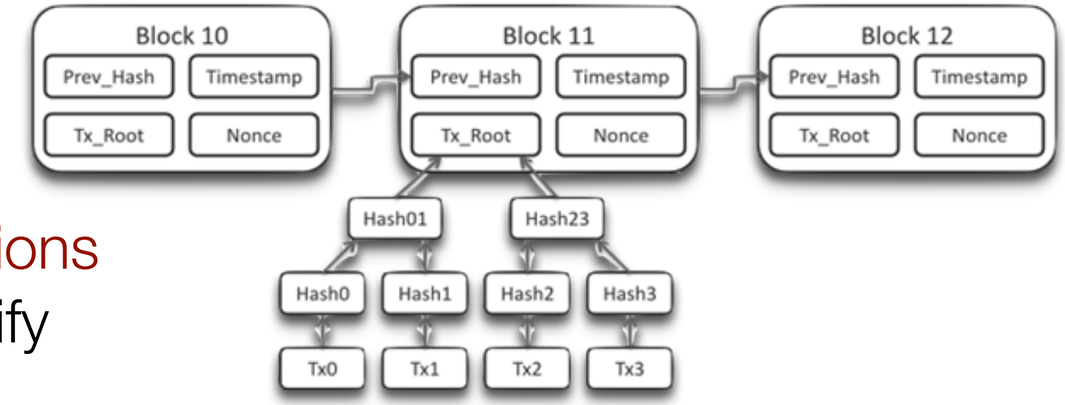
To this aim, we deal with these main issues

- coherent storage and update of federation state
- monitoring of distributed components
- ensuring integrity of governance data
  (e.g., SLA and Access Control policies)
- distributed support for data masking



SUNFISH fosters a principled first time exploitation of blockchain technology

From Blockchain to a Blockchain-based Registry



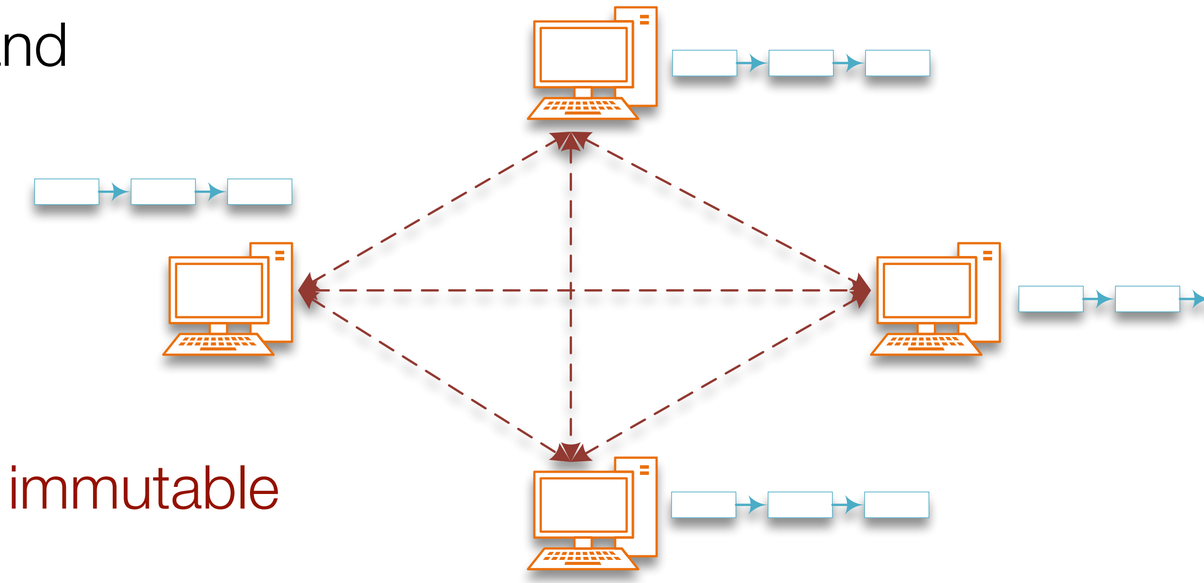
The blockchain is a distributed public record of transactions

Available to everyone/allowed entities to view and verify

A chain of blocks, where each block:

Consists of a header, hash of the previous block and transactions

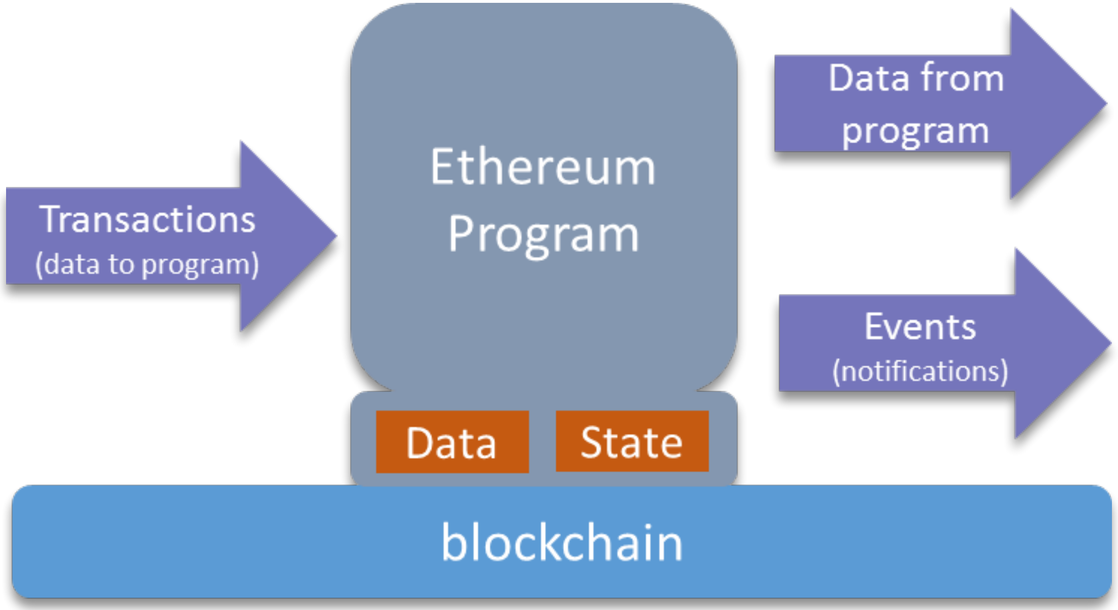
Generated at pre-defined intervals



Once a block is part of the chain:

Transactions become (practically) irreversible and immutable

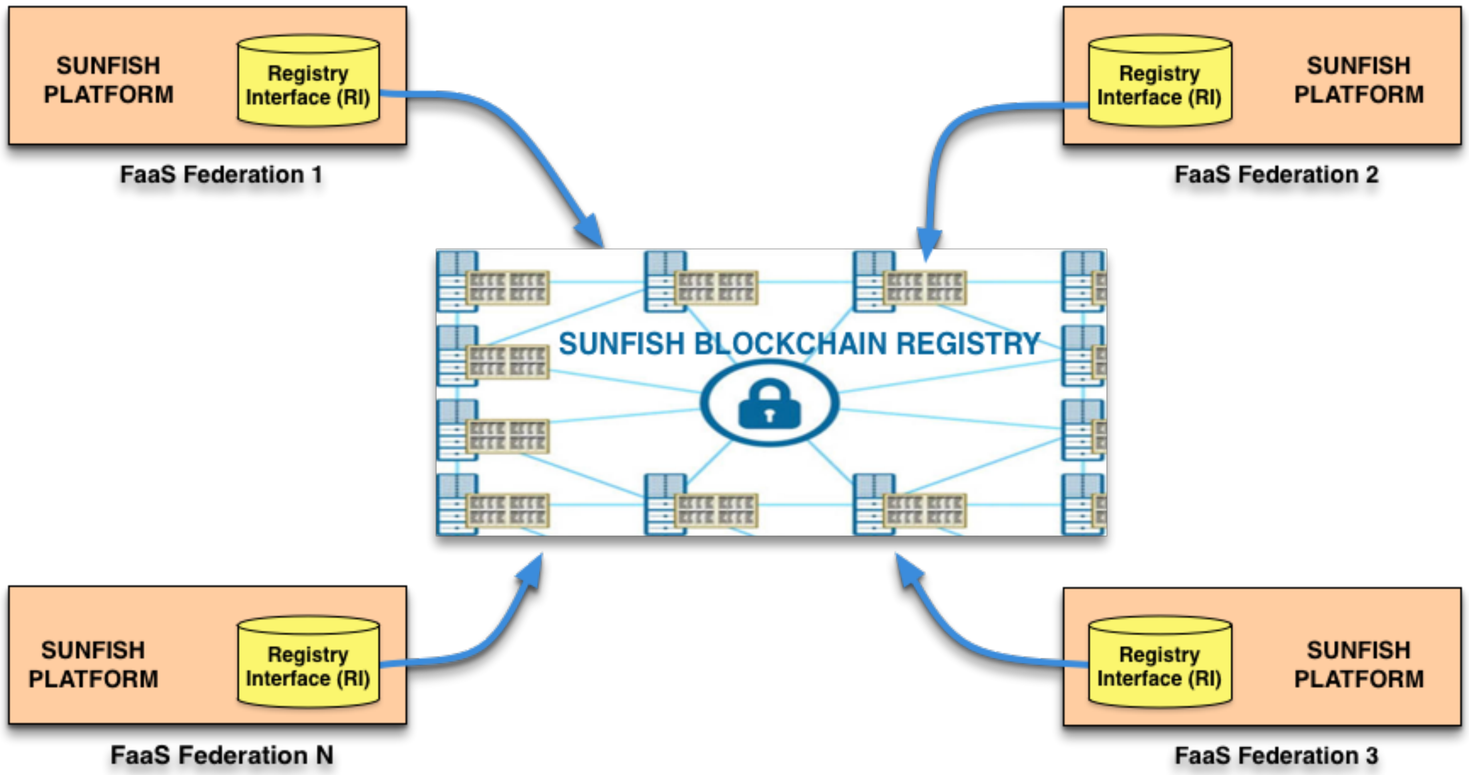
An Ethereum program (called smart-contract) is like any computer program, but it is stored and executed on a blockchain



Once a smart-contract receives input/command via transactions, it processes the input according to its logic, its own data and the global state of the chain.

Blockchain-based cloud federations

A blockchain-based registry as a reliable, distributed mean to support multiple deployment of the SUNFISH platform



Regulated interactions with blockchain permit improving the assurance on each platform component

(e.g., the access control system relies on no tampered policies)

Distributed ledger for a cloud federation

Non-repudiable manner (i.e. via smart contracts) of carrying out federation governance

blockchain-based functionalities

Federation contract

avoiding the use of a “trusted third-party” to store the federation agreement contract

Federated services

saving the current state of the federation

Access Control and SLA policies

storing the policies of the member clouds

Federation Monitoring

storing the logs of the Access Control system

Data Masking

supporting storage and retrieval of tokenisation table

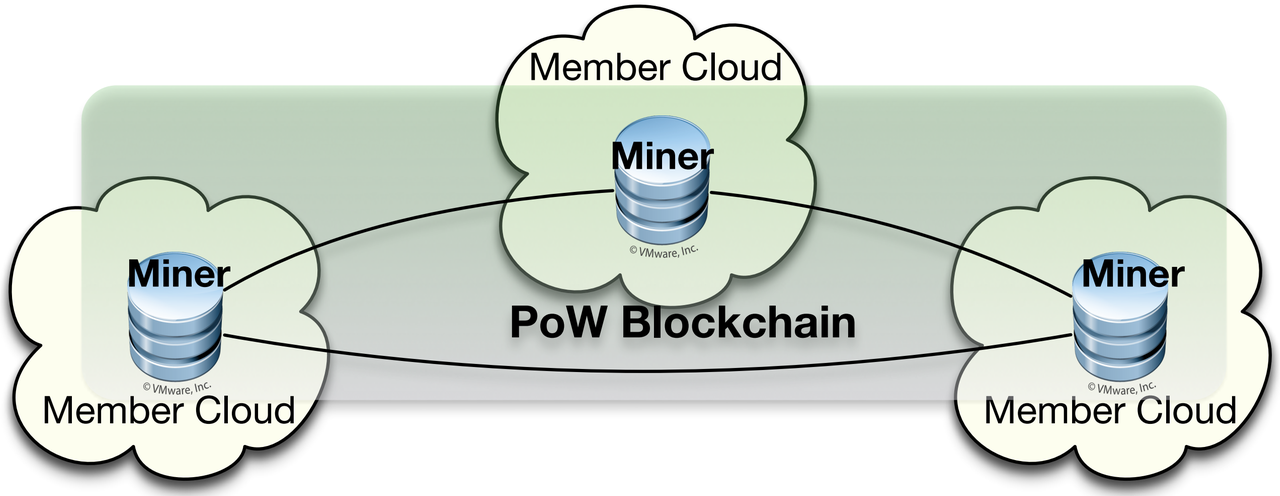
Data Anonymisation

storing an history-record of released anonymised data

how about efficiency?

UNIVERSITY OF Southampton

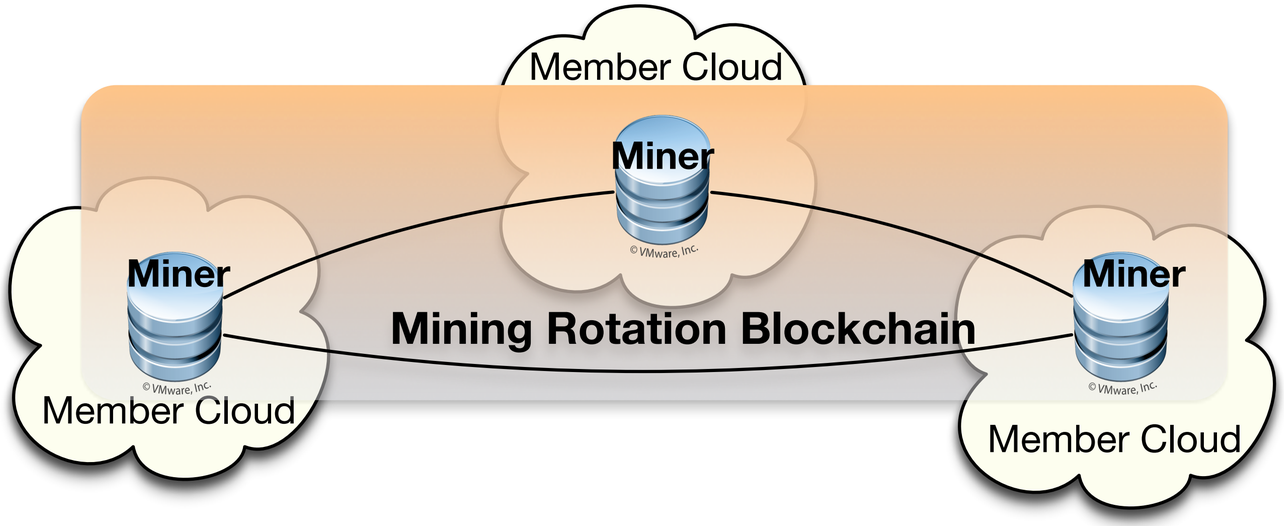
Balancing integrity guarantees (PoW) and better performance (Mining Rotation)



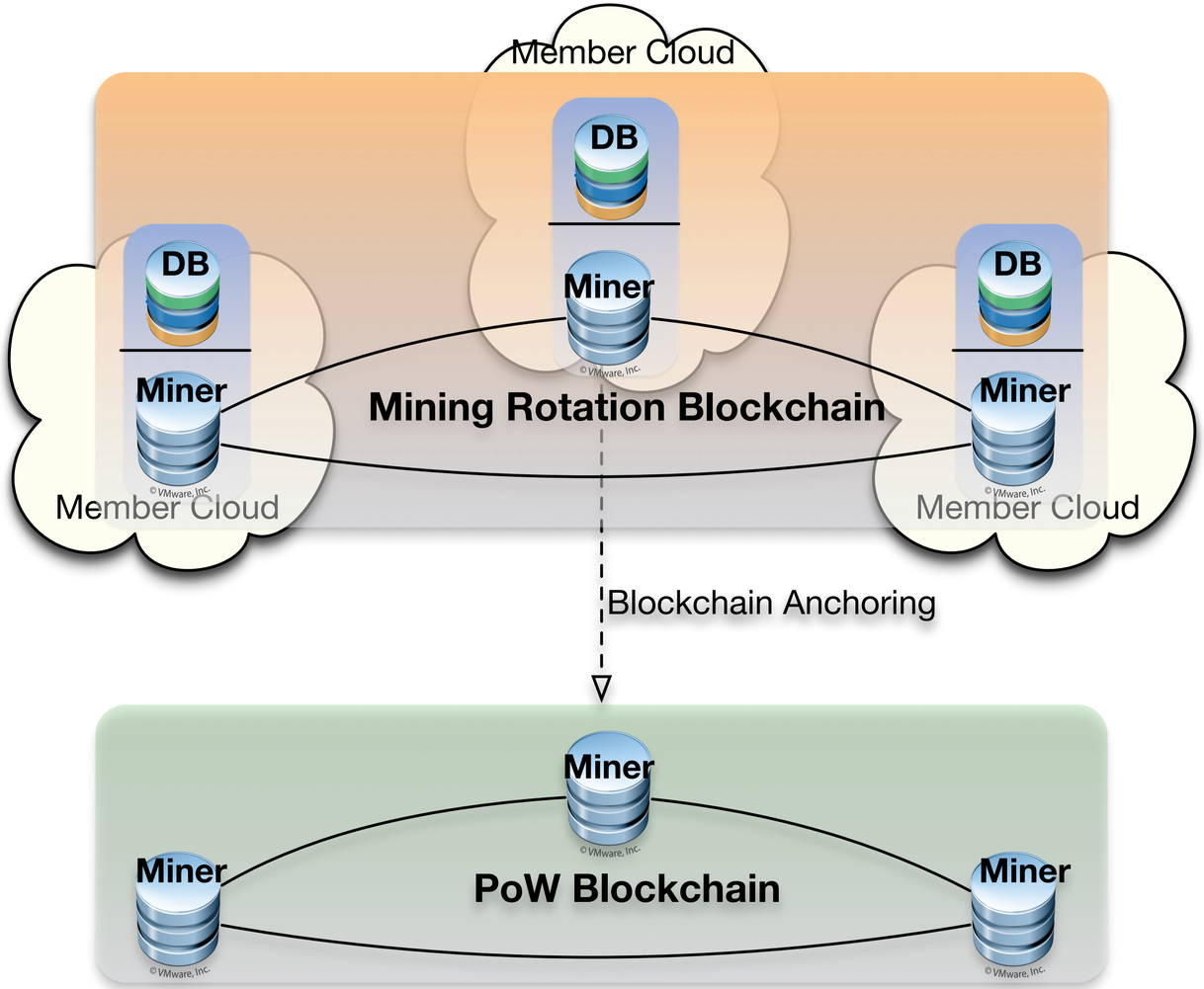
how about efficiency?

UNIVERSITY OF Southampton

Balancing integrity guarantees (PoW) and better performance (Mining Rotation)



Balancing integrity guarantees (PoW) and better performance (Mining Rotation)



Beyond FaaS

IoT: a new era for computing systems

The advent of IoT is changing modern computing systems paving always new challenges.

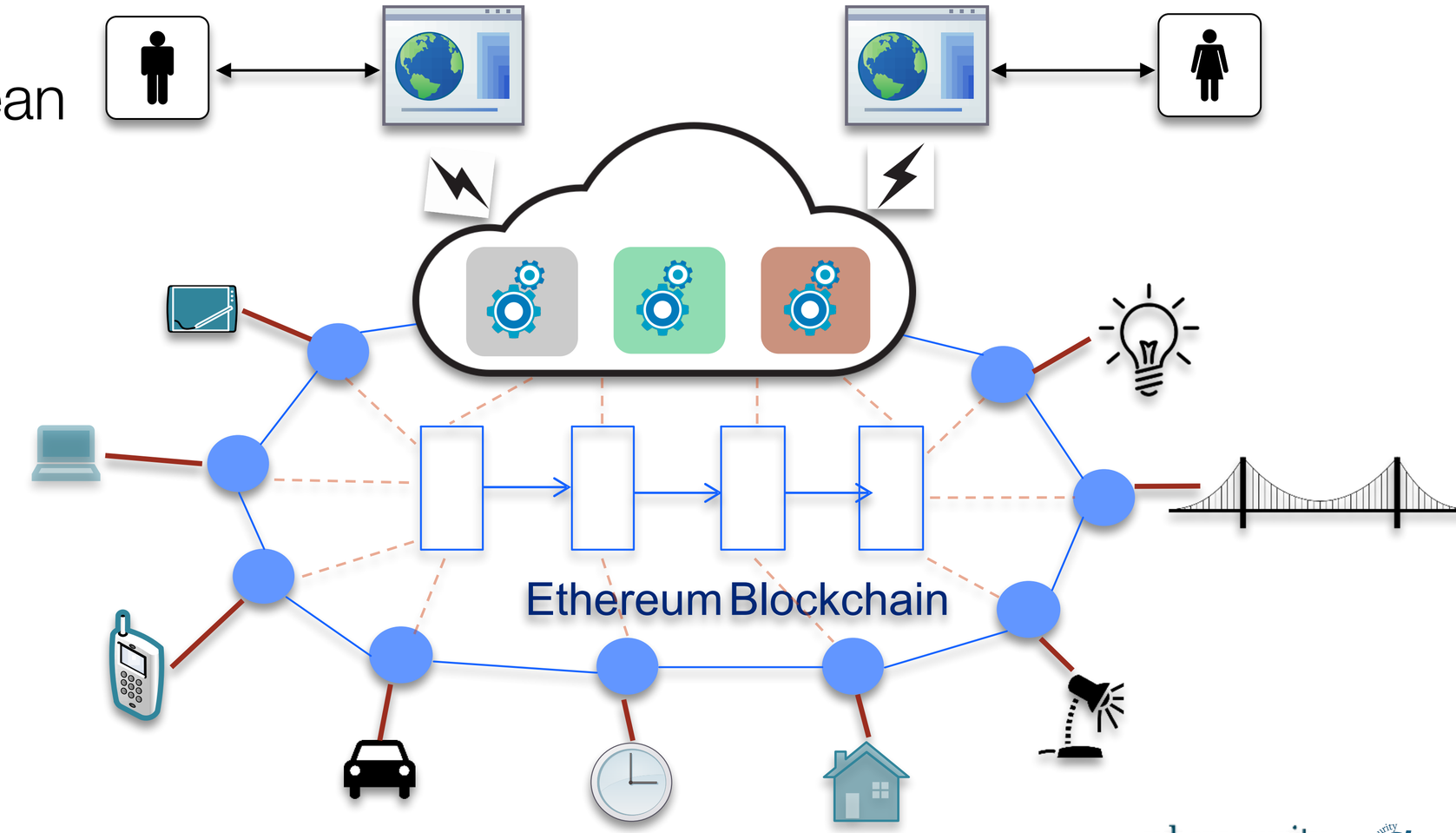
Nowadays, IoT devices can sense any information, from temperature to electricity consumption, and be involved in any system and process, from smart-house to industrial supply chains.

Current computing systems for IoT suffer, e.g., from

- reliable means to check provenance of sensed data
- integrity-preserving data storage
- interoperable communication infrastructure
- interconnection with cloud systems
  to do data computation
- trusted data facilities to share data among devices

Our vision: a smart contract-based blockchain as

- reliable communication mean
- data integrity guarantor
- data provenance evidence
- interconnection with federated cloud systems
- infrastructure for data sharing among devices

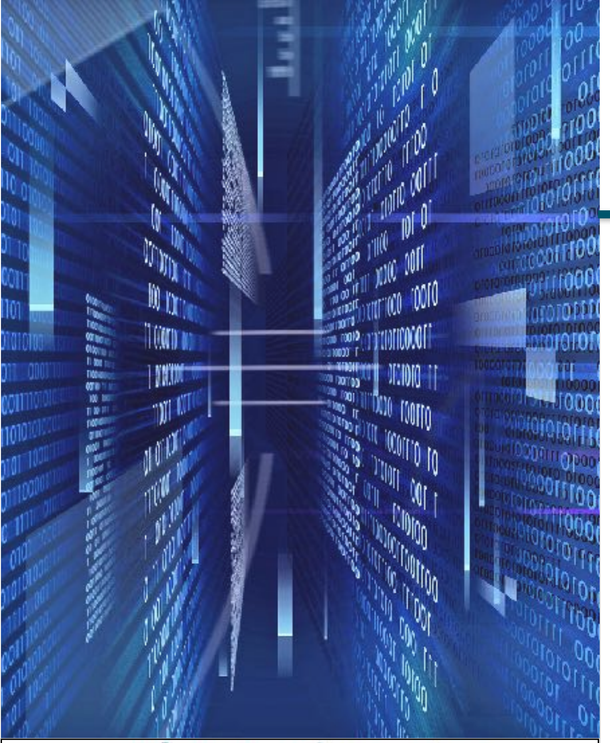


On the basis of the achievement of the *SUNFISH platform*, we will have to face many more difficulties…..

- IoT devices may not be able to *interact* directly to a *blockchain:* innovative communication mechanisms will be needed

- the amount of produced data may be too large to be computed on a Cloud: an approach *à la* Edge Computing will be used

….but we like them!



cybersecurity centre
GCHQ Academic Centre of Excellence EPSRC

Cybersecurity Southampton

CyberSecuritySoton.org [w]

@CybSecSoton [fb & tw]

UNIVERSITY OF Southampton

Thank you for your attention

SUNFISH

http://www.sunfishproject.eu/