CLOUD COMPUTING 2020

PANEL

Cloud Technologies: Connected and Unconnected, yet Processing

CHAIR

Aspen Olmsted

Panel

Chair

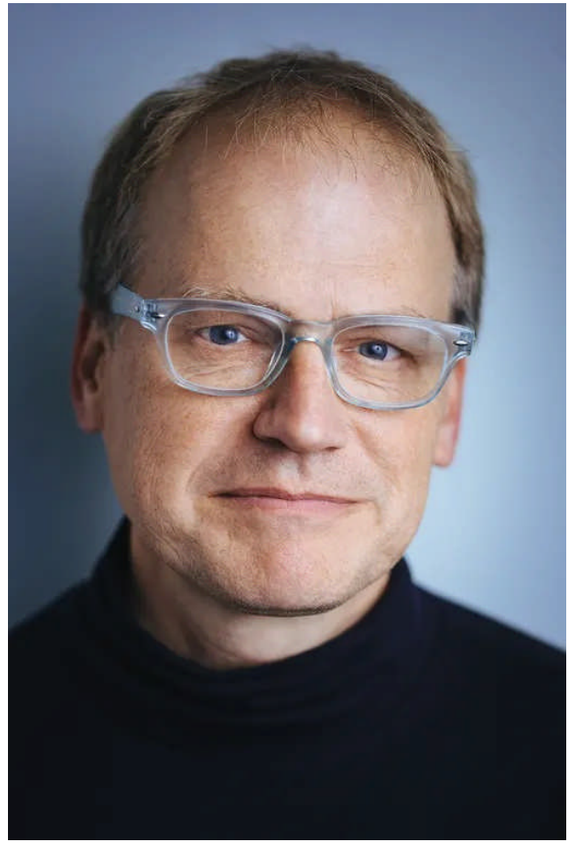
- Aspen Olmsted, New York University, USA

Panelists

- Jiye Yu, Hitachi, Ltd., Japan
- Sebastian Fischer, Fraunhofer AISEC, Germany
- Bob Duncan, University of Aberdeen, United Kingdom
- Magnus Westerlund, Arcada University of Applied Sciences, Finland

Panel Chair

- 25 years in Industry Developing N-Tier Business Solutions
- Program Director and Professor at Fisher College in Boston
- Acting Program Director for New York University Cyber Fellows Program
- Research is in N-Tier and Cloud Application Correctness



Issues

- Synchronization of data and configuration between
  - Cloud and clients
  - Cloud VMs
- Stability of Connections
  - Latency
  - Reliability
- Privacy of Data over Connections

More Issues

- Processing
  - In Cloud
  - At Client
- Integrity when Systems are reconnected
  - Which version wins
  - Versioning levels

Panellist Position

Cloud Improves Availability but does it also allow us to improve Integrity and Confidentiality

Aspen Olmsted, Fisher College & New York University, USA aolmsted@fisher.edu

- During COVID, K-12 and Higher Education Moved to Cloud and Remote
- News Media Focuses on challenges and Failures
- NYU has created an Online Cybersecurity MS degree with connections that cannot be offered in brick and mortar
- edX MicroBachelors offers undergraduate credits for high-quality low-cost education in the cloud
- This is a model for how many businesses can improve the integrity and confidentiality in other domains

→ COVID and Cloud will change how we do business

→ Integrity and confidentiality will be higher utilizing cloud and remote

→ Old models were inefficient

Panellist Position

System Operator: Managing Kubernetes Operators for Your System

Jiye Yu, Hitachi, Ltd., Japan, jiye.yu.kb@hitachi.com

- Kubernetes and Operator
- System Operator to mange the whole Kubernetes system
- Deployment, upgrade, monitoring and backup
- Make policy on system level by monitoring data

→ Extend the ability of Kubernetes Operators

→ System Operator for Kubernetes

Panellist Position

Cloud Technologies provide a huge diversity of services, but they lack IT-Security. Especially, with the growing amount of IoT devices, the security (and privacy) challenges are getting more and more...

Sebastian Fischer, Fraunhofer AISEC, Germany, sebastian.fischer@aisec.fraunhofer.de

- Baseline IT-Security
- Internet of Things (IoT) Security
- IoT Services

Panellist Position

The Complexities of Modern Cloud and the Impact on Compliance

Bob Duncan, University of Aberdeen, **bobduncan@abdn.ac.uk**

- Cloud security
- Corporate compliance
- Blockchain and the forensic trail
- Accountability

→ IoT security is hard to balance due to complexity and untrained users

→ Removing a need for centralized control of security is an opportunity for distributed systems

→ Autonomous Systems require Autonomous Security

Panellist Position

Distributed security for distributed architectures

Magnus Westerlund, Arcada University of Applied Sciences, Helsinki, Finland

- Blockchain enforced security model
- Autonomous IoT devices
- Fleet monitoring
- Towards distributed security

→ IoT security is hard to balance btw complexity and untrained users

→ Removing a need for centralized control of security is an opportunity for distributed systems

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FISHER COLLEGE

Cloud Computing 2020

Cloud Technologies: Connected and Unconnected, yet Processing

(cloud technological impact, service reliability, challenges for data and processes, trusted and secured environments, etc.)

Aspen Olmsted, Ph.D.

Fisher College

Panelist

- 25 years in Industry Developing N-Tier Business Solutions
- Program Director and Professor at Fisher College in Boston
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During COVID, K-12 and Higher Education Moved to Cloud and Remote

- Society and news media have focused on challenges and failure
- I have experience with NYU and edX that show the opposite
- The quality of education including integrity and confidentiality have increased in these programs
- These are a model of the new economy that utilizes the cloud

NYU Cyber Fellows

- MS in Cyber Security
- 600 Students in First Two Years
- 100% Online
- Much Higher Quality than Brick and Mortar
- 75% Scholarship (75% Cheaper)
- Free Certificates to ensure students master prerequisites before first class
- Industry Partner Badges to master applied tooling
- NSA Cyber Operations and Cyber Defense
- CTF and Red/Blue Team Events with Industry

Certificates

Adult students may not have undergraduate classes, or they took them decades before. The certificates allow the students to master prerequisite content.

- Python
- C++
- Data Structures
- Discrete Math

edX MicroBachelors

- Online classes with labs and proctored exams offered by big name colleges.
- Credits Aggregated at one university (Thomas Edison)
- 1/3 cost of cheapest university
- NYU MicroBachelors Courses

Conclusions

- COVID and Cloud will change how we do business
- Integrity and confidentiality will be higher utilizing cloud and remote
- Old models were inefficient

HITACHI
Inspire the Next

System Operator: Managing Kubernetes Operators for Your System

Jiye Yu
Hitachi, Ltd. R&D Group
jiye.yu.kb@hitachi.com

Kubernetes Operators

HITACHI
Inspire the Next

Issue: It is infeasible for Kubernetes to manage thousands of applications with various working styles

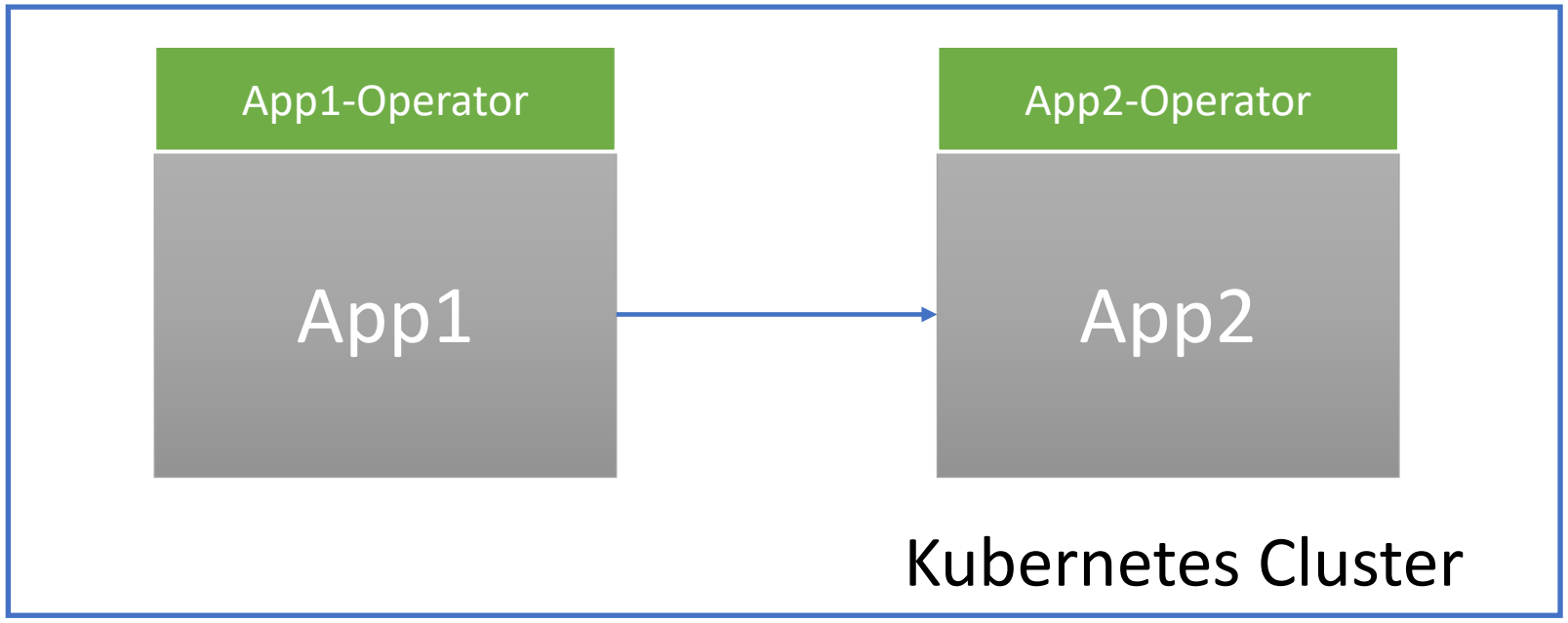
- Kubernetes Operator is a solution
  - ✓ Concept Operator raised by CoreOS
  - ✓ Operator is designed for packaging, deploying and managing a Kubernetes application automatically
- How Kubernetes Operator works
  - ✓ Human operators who have deep knowledge on specific applications ‘teach’ Operators to repeat their work patterns on those applications.
- Benefits of Kubernetes Operator
  - ✓ Operators increase Kubernetes functionality
  - ✓ Make migration easier among various Kubernetes clusters
  - ✓ Ecosystem is growing – OperatorHub shares existing Operators to users

Consider a system consisting of two applications...

HITACHI
Inspire the Next

There is a system which is made of App1 and App2. The Operators are reconciling their own app respectively.

Qustion: As this is a system. Can we coordinate these two Operators as a whole?



Proposal of System Operator

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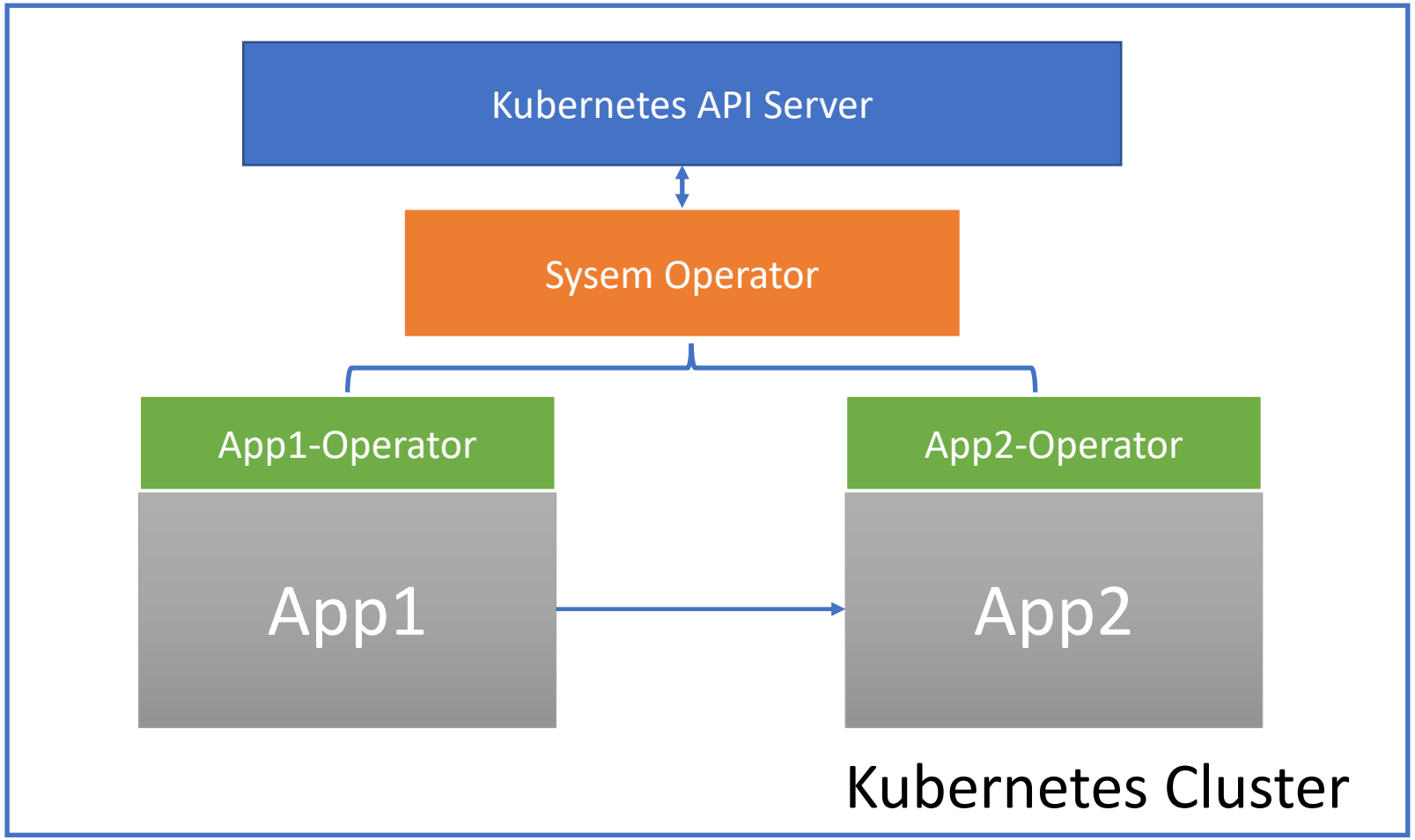
Then, we tried to propose a concept of System Operator.

- It will be an Operator of the Operators.



What should System Operator do

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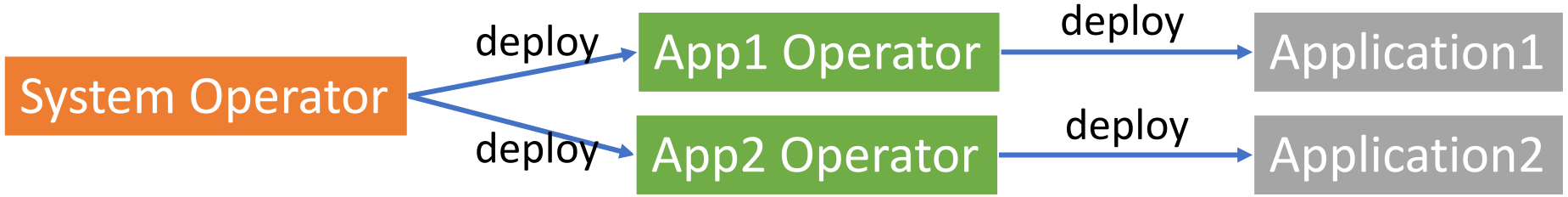
- We designed System Operator's features in three levels:
- Level1
  - ✓ System construction, it looks like:



  - ✓ Operator's update
- Level2
  - ✓ System Monitoring
  - ✓ Disaster recovery and regular backup
- Level3
  - ✓ Auto-scaling to applications

How to achieve System Monitoring

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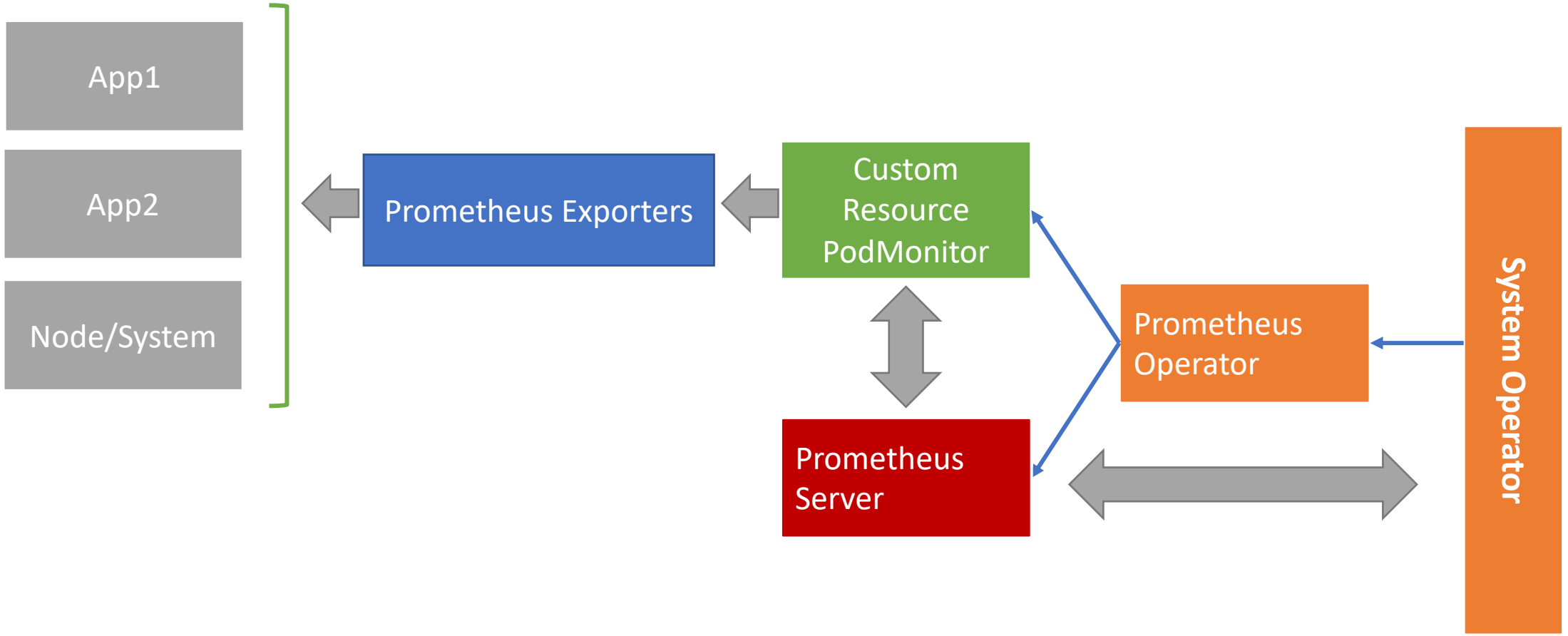
Prometheus Operator will be a good bridge.
Monitoring data is important for System Operator to do following system adjustment.



Summary and Future Work

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System Operator allows users to

- Deploy system in Kubernetes by Operators
- Make global policy according to monitoring data
- Share your system by sharing the config of System Operator

System Operator is still under research

- We are considering more usecases for System Operator
- More features will be introduced into System Operator

Thank you!

Fraunhofer
AISEC

“Cloud Technologies provide a huge diversity of services, but they lack IT-Security. Especially, with the growing amount of IoT devices, the security (and privacy) challenges are getting more and more...”

Sebastian Fischer (Fraunhofer AISEC, Germany)

Challenges

- Increasing services and amount of devices
- All-time accessible (cloud technologies)
- Cheap devices (especially IoT devices)
- -> security risks
- -> attack on a large scale
- -> impact on privacy

Some Solutions

- Baseline requirements (security standards)
- Security awareness of the user
- Offline services
- Service free devices / Optional services
- What else???

Fraunhofer AISEC

IoT Security Standards

- Germany: DIN SPEC 27072 (Consumer IoT)
- Europe: ETSI EN 303 645 (Consumer IoT)
- US: NISTIR 8259 (Consumer IoT)
- IEC 62443 (Industrial IoT)
- …

Open Questions

- Current state of security
- The future of (cloud) services
- The future of IT-Security
- …

Panellist Position

The Complexities of Modern Cloud and the Impact on Compliance

Bob Duncan, University of Aberdeen, **bobduncan@abdn.ac.uk**

- Cloud security
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- Accountability

→ IoT security is hard to balance due to complexity and untrained users

→ Removing a need for centralized control of security is an opportunity for distributed systems

→ Autonomous Systems require Autonomous Security

Outline

- Cloud Technologies
- Connected and Unconnected, yet Processing
- Cloud technological impact
- Service reliability
- Challenges
- Data and processes
- Trusted and secured environments
- Compliance with legislation and regulation

Cloud Technologies

- Cloud started as a simple suite of outsourced tools
- IaaS, PaaS or SaaS
- Service reliability was reasonable, security and privacy less so
- Now we have more things as a Service than can possibly fit on this page
- We can even have a cloud of clouds as a Service
- What started as three simple either/or options is now a mixture of combinations
- With included and excluded components, this equals more comlpexity

Connected and Unconnected, yet Processing

- Cloud can be permanently connected, and processing
- Cloud can be occasionally connected, and processing
- Cloud can incorporate remote processing of data
- Cloud can incorporate intermittent connections for data processing
- Cloud can do in-cloud processing
- Cloud can store in-cloud, or can use external storage
- Cloud can do connection by-request
- Cloud can do any permutation of these

Cloud technological impact

- Cloud offers rapid spooling up of new technology
- Cloud offers major reductions in capital investment requirements
- Cloud can offer major reductions in the need for large premises
- Cloud can offer high flexibility in change for new markets
- Cloud offers fast expanding startups the ability to complete with global corporates

Service reliability

- Service reliability was the initial major selling point for cloud
- That is still high, where one service provider is delivering the service
- When multiple service companies are involved, this can be compromised
- This can lead to slackness in some service providers “It wasn’t my fault, it was these other companies who did not …”
- On the plus side, those offering poor service tend not to be in business for long
- On the other hand, if you are relying on their service and get poor reliability….

Challenges

- Dealing with the complexities on offer can be challenging
- Coping with multiple service providers can lead to issues
- Ensuring proper security and privacy can still be a challenge
- Proper accountability where multiple service providers are involved
- Keeping track of data collected can be a problem
- The more complex your setup is, the more challenges you have

Data and processes

- Data is at the core of compliance with legislation and regulation
- Once multiple service providers are involved, this needs proper control
- With non-permanent connections, keeping proper track of the data is hard
- Keeping track of processes that are both in-cloud and external is also hard
- The more complexity that is possible = the more challenging it all becomes

Trusted and secured environments

- Large service providers are usually very ‘switched on’ on as far as trust and security are concerned, typically less so for smaller service providers
- Usually very well documented in the service level agreement
- They must be accountable for their actions, without ‘get-out’ clauses in the service level agreements
- Again, this is fundamental to the ability for the cloud user to achieve compliance with the relevant legislation and regulation

Compliance with legislation and regulation

- Cloud users are accountable to the legislative and regulatory authorities for ensuring they can demonstrate compliance
- Cloud users cannot ‘pass the buck’ to service providers as an excuse for any failures or shortcomings
- Using a complex cloud service structure could make compliance far less transparent, which can lead to issues with the regulators
- Cloud users who get it wrong are likely to face punitive action by the regulators, especially if they are negligent

ARCADA

Distributed security for distributed architectures:

Towards a blockchain enforced security model ◆

Presentation is loosely based on the following paper:
https://arxiv.org/abs/2007.02652

Magnus Westerlund, DSc.

Principal Lecturer

magnus (dot) westerlund (at) arcada (dot) fi

Arcada University of Applied Sciences, Helsinki, Finland

Agenda

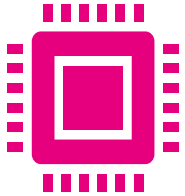
- Introduction of Blockchain
- What is blockchain useful for
- Use Case: Security in IoT systems
- Towards operationally autonomous security

What is Blockchain?

- A peer-to-peer distributed ledger that is cryptographically secure, append-only, immutable, and updated by consensus among peer nodes.
- This provides useful technology for:
  - Finance, legal, logistics, e-currency/value tokens, security, and any business that is dependent on transactions between parties.
- Blockchain also introduces challenges for legal systems, companies preferring data silos, and traditional monetary/power systems.

Example use cases (beyond finance)

Media, e.g. IPR, advertisement and subscriptions



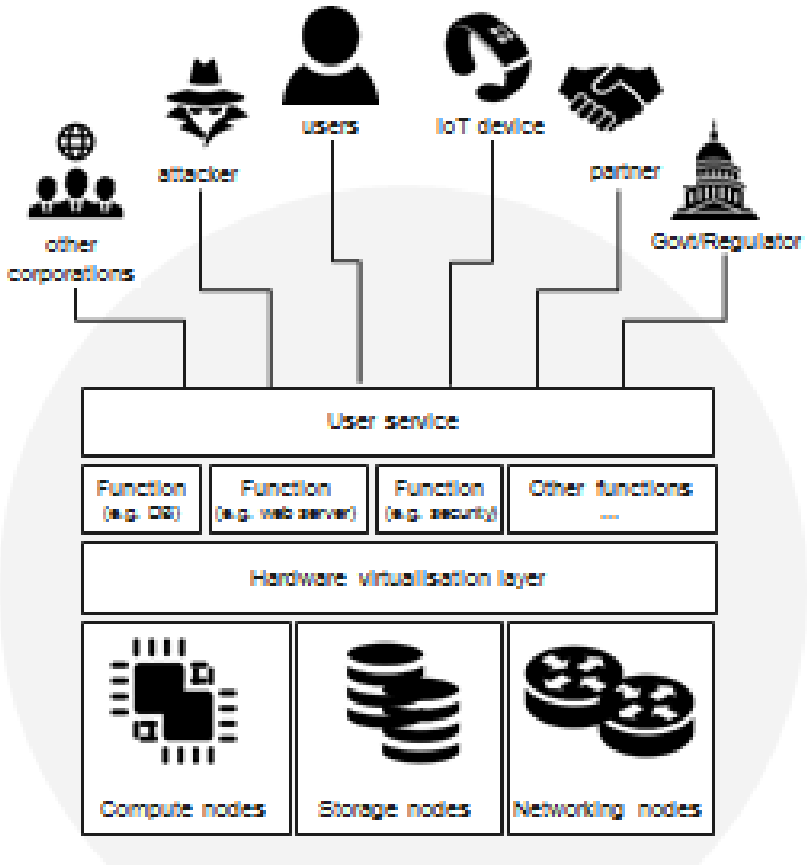
Computer/IoT security, the Internet was not constructed with security in mind, now a redo?

Supply chain, globalization has led to increasingly complex supply chains, a decentralized platform can be an intermediary.

Most use cases focus on how to create a value-based economy for specific cases.

- The difference to the GOFA platforms is that now we do not need a trusted intermediary.
- The ledger provides global near instant transaction verification and a conceptually decentralized platform.

What is so different with blockchain solutions?



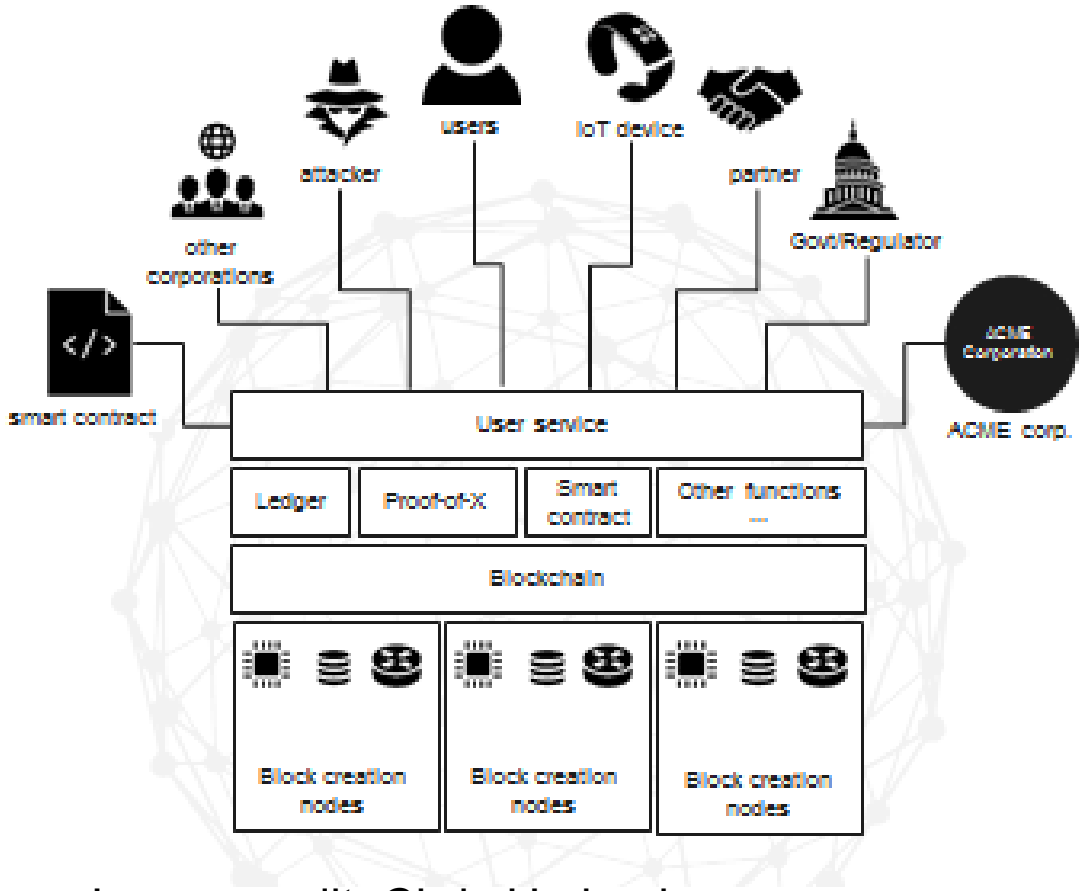


Image credit: Chris Umbach

Blockchain and DLT

- Distributed Ledger Technology (DLT)
  - DLT can include other technical implementations than block-based
  - Blockchain refers to early chains such as Bitcoin and Ethereum, that bundle transactions into blocks shared by peers (Fig 1).
  - DLTs include **distributed acyclic graphs**, for linking transactions and allows much faster thoroughput(Fig 3).

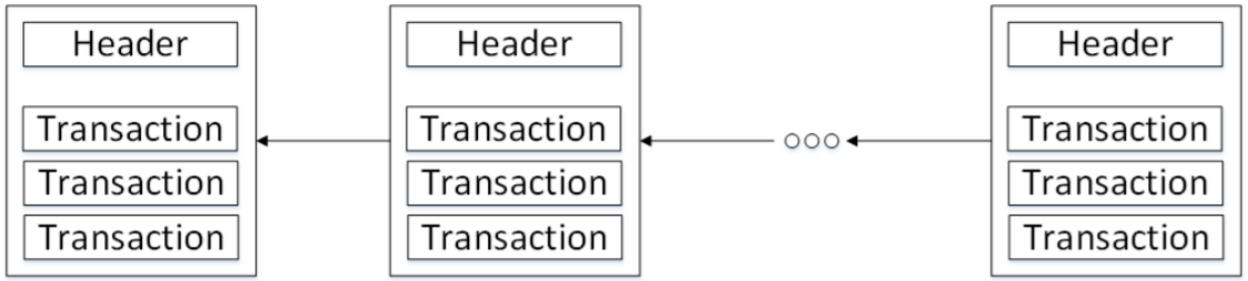


Fig. 1. Blockchain as a data structure.

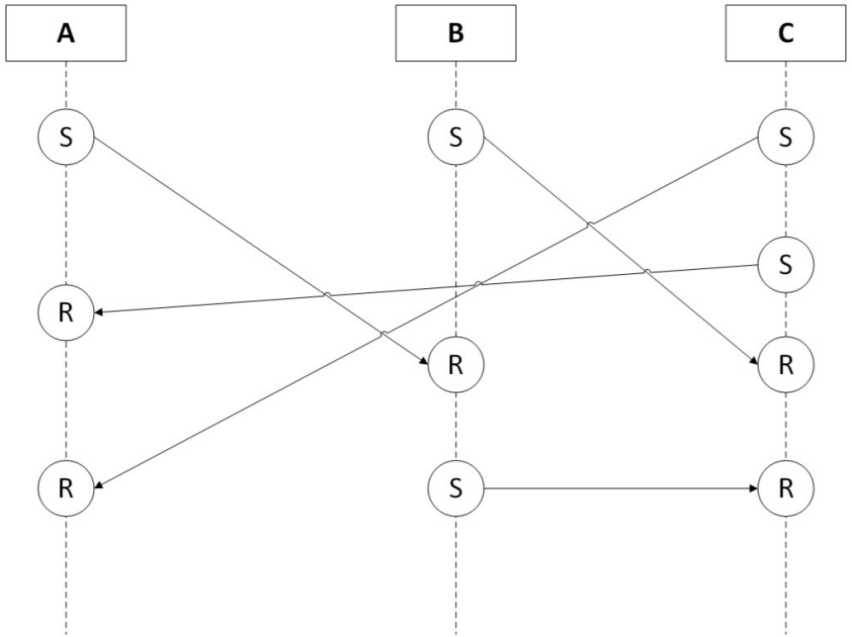


Fig. 3. Transaction handling in the block lattice. *S* represents a *send* transaction, *R* represents a *receive* transaction.

Image credit: Bencic and Zarko arXiv:1804.10013v1

Blockchain evolution

Generation	Innovation	Examples
1	Distributed Ledger	Enforce a global “truth”, Bitcoin
2	Smart Contracts	Arbitrary transactions verified on-chain, Ethereum
3	De-facto standards for improved utility	Interledger transfers, reduction of transaction costs, and increased throughput, e.g. IOTA and Polkadot

What is an IoT system, today and in the future

- **Today**, reading data from sensors and acting through actuators
- **Tomorrow**, autonomous intelligent systems
- What we mean with an autonomous system is still unclear
  - One perspective is that they should be operationally autonomous
  - What is operationally autonomous security, should security not be under centralized control?
  - But how do we maintain a cryptographic setup for an autonomous system that is based on a distributed architecture?
  - Who maintains the keys?
  - How do we ensure devices are not breached?
  - How to ensure provenance and enable forensic investigations?

Security in IoT systems

- IoT security is a current large-scale problem that we must address
  - Current security is often based on trust for a centralized authority
- It is hard and costly to maintain IoT systems using traditional approaches, due to the nature of IoT systems:
  - distributed,
  - heterogeneous,
  - energy conserving,
  - plug and play,
  - limited computational power and storage
- Given the challenges, can we distribute the control of security?

An autonomous system should be self-contained

- Hardening the device in order to remove the ability to directly interact with it remotely, thereby reducing attack vectors
- The hypothesis is that all systems are breakable, but that we can make it “very hard” for anyone to get in.
  - Remove user log-in on the device, retain a system (OS) user.
  - Deny any externally initiated incoming connections to the device
  - Encrypt hard drive with system user credentials
  - Maintain a cryptographic protocol on the device that generates new keys for new data reporting tasks

Push-pull communication method

- Going towards autonomous systems means they should maintain themselves and deal with security by themselves.
  - Let us rely on the blockchain for a ground truth of how a well-maintained system should look like
  - Let us maintain any licenses needed on the blockchain
  - Devices should only perform externally initiated operations based on a push-pull method
  - Thus, commands are not sent directly to devices, but rather through the blockchain that the device fetches.

Photo by Ashley Jurius on Unsplash

Smart Contracts defines the security protocol

- Through smart contracts we can implement arbitrary transactions
- Here we define User and Device and their respective properties
- Initially the user links themselves and the device to the blockchain by creating a unique Ethereum address.
- Then the user links both to the respective smart contracts

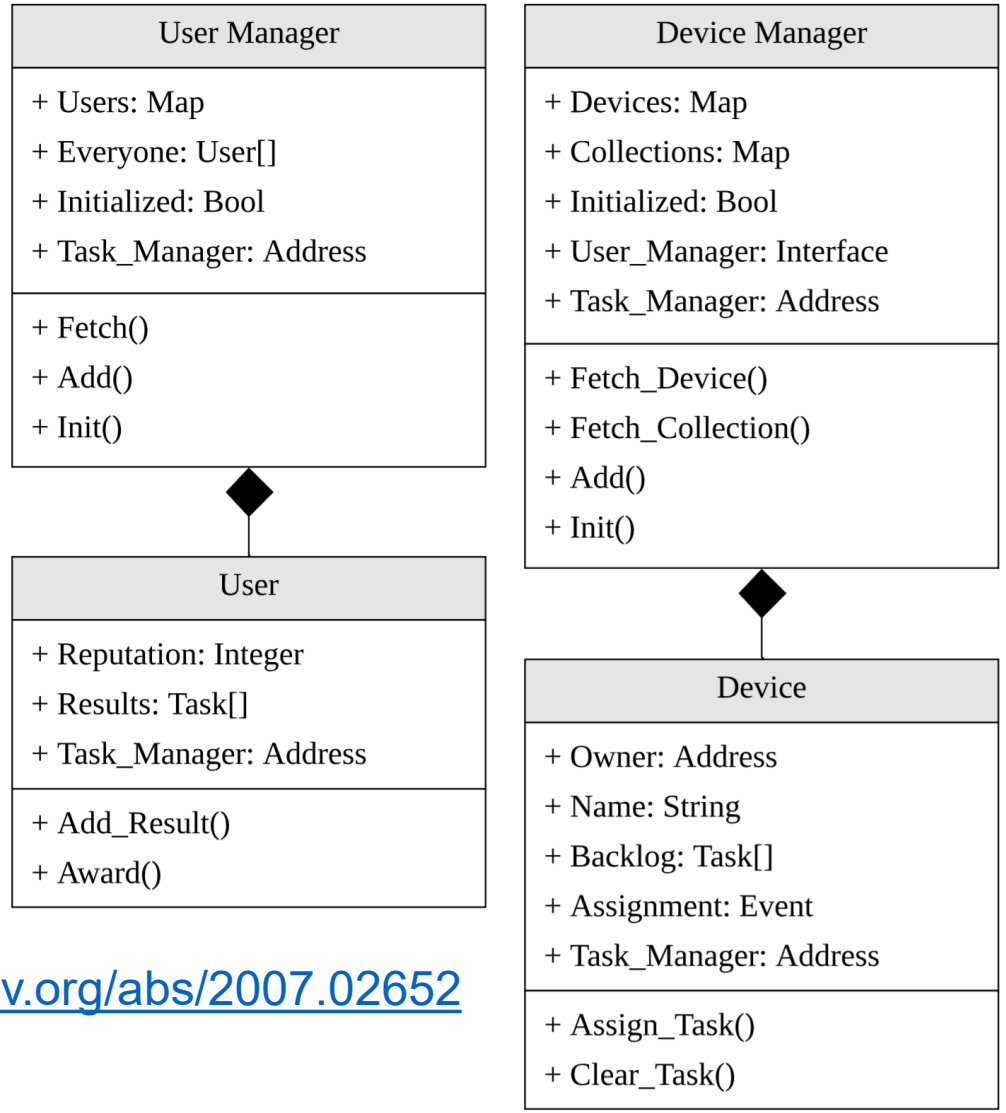
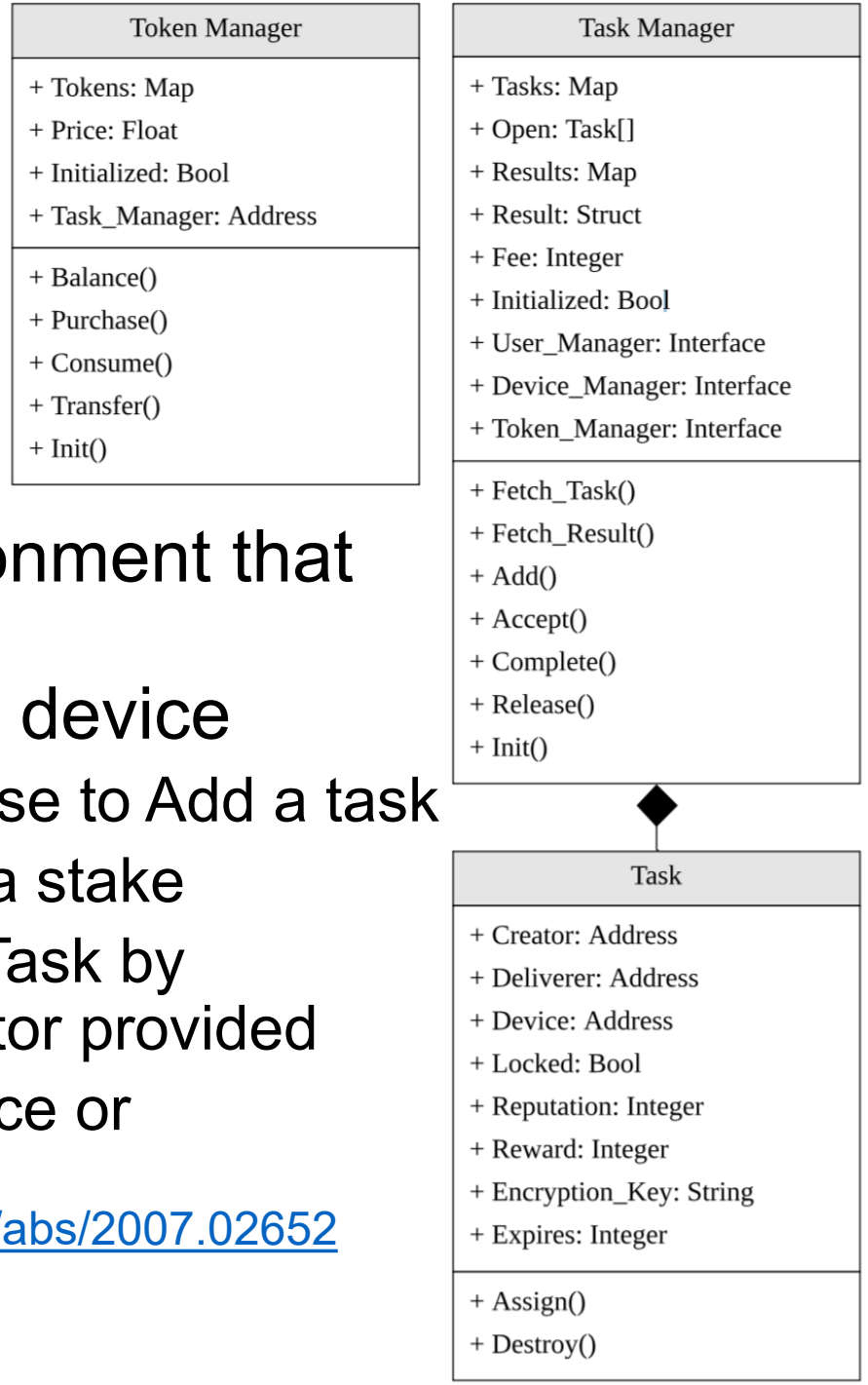


Image from: https://arxiv.org/abs/2007.02652

Executing a task on the device



- Let us consider a trivial task were a user wants to measure the temperature of the environment that the device reside in without directly controlling the device or a centralized API that controls the device
  - Then User (Creator) purchase tokens, and uses these to Add a task
  - A Device receives the Task, accepts it by providing a stake
  - Device takes the measurement and completes the Task by returning the measurement to an endpoint the Creator provided
  - The stake and the token Fee is returned to the Device or device Owner contract

Image from: https://arxiv.org/abs/2007.02652

Summary

- The proposed protocol can be used for creating operationally autonomous IoT devices, i.e. self-contained.
- The device can still perform advanced and arbitrary tasks
  - We are currently working on implementing a service layer
- The hardening will make it very hard for an intruder to attack
- We can create an economy around IoT services and security that have previously not been possible
  - E.g. very easy to provide a per instance payment for a security patch
- Easy to also implement for your own chain if needed
  - Less reliable than using Ethereum, but lower overhead cost per transaction

ARCADA

Thank you!

Magnus Westerlund, DSc.

magnus.westerlund@arcada.fi