

# CCI – Complex Cyber Infrastructure

**Cees de Laat**

Systems and Networking Laboratory  
Complex Cyber Infrastructure group  
University of Amsterdam

<https://cci-research.nl>



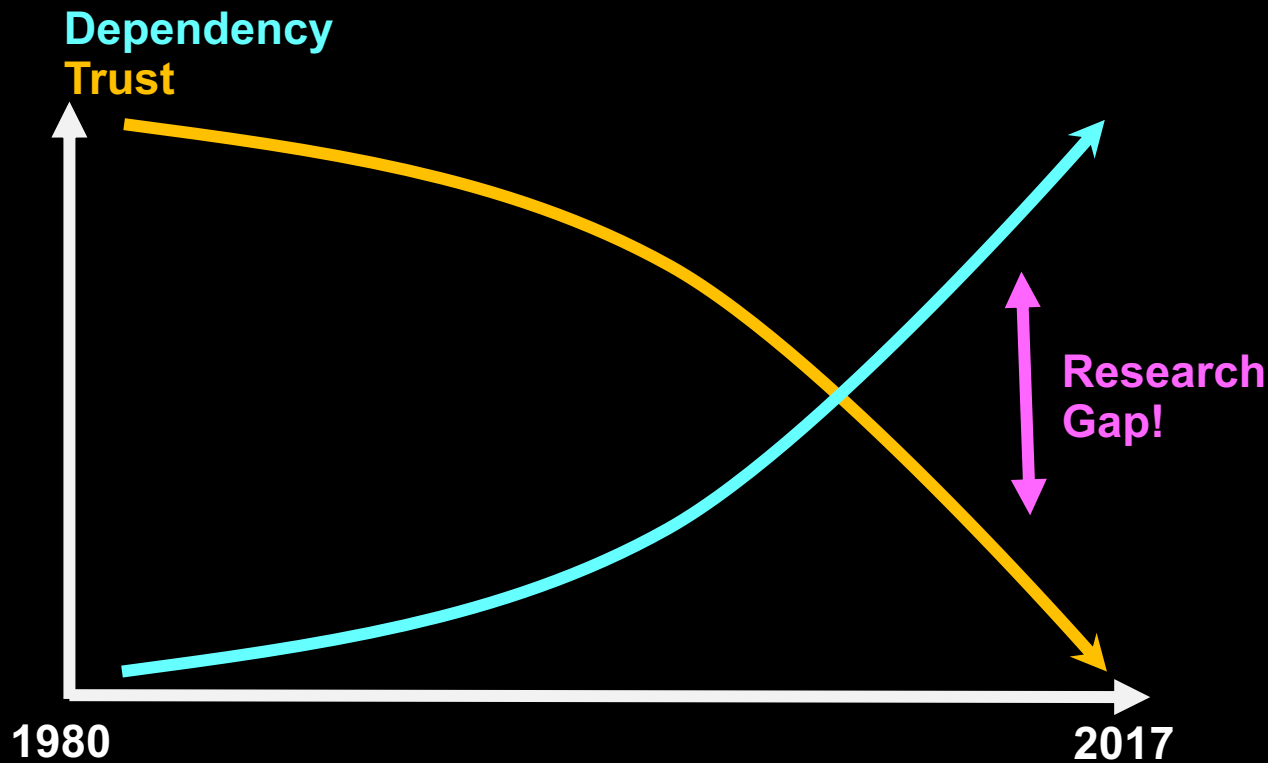
# Mission

- CCI focuses on the complexity of man-made systems on all scales.
- Cyber Infrastructure is rapidly evolving from relatively simple fixed components to programmable and virtualized objects with many degrees of freedom, owned, operated and governed by different entities in multiple administrative domains interacting on the Internet.
- Harnessing this complexity in a transparent, trust-able way for safe and secure data processing is a major research topic that defines the focus of CCI research.
- The challenges are addressed by combining methods and results from research into distributed data processing, programmable networks, policy reasoning and normative control, hardware and cryptographic security, and software language engineering.

# Mission

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# Fading Trust in Internet



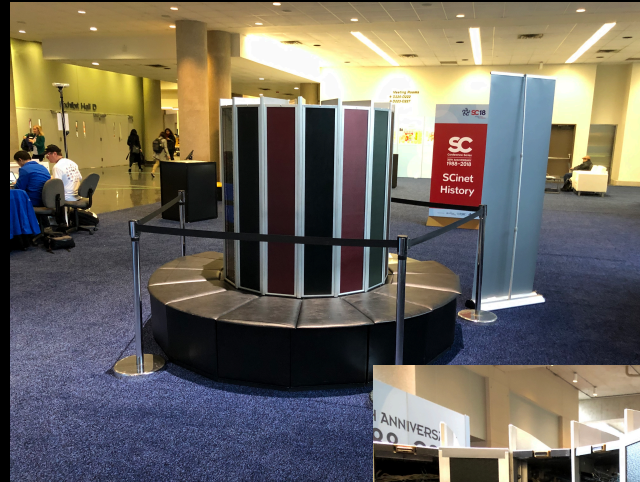
# Some progress



2018

= ~7x

? 540 MHz  
? MFlops  
1000 MByte memory  
16000 MByte ssd  
0,0012 kWh – 18 h

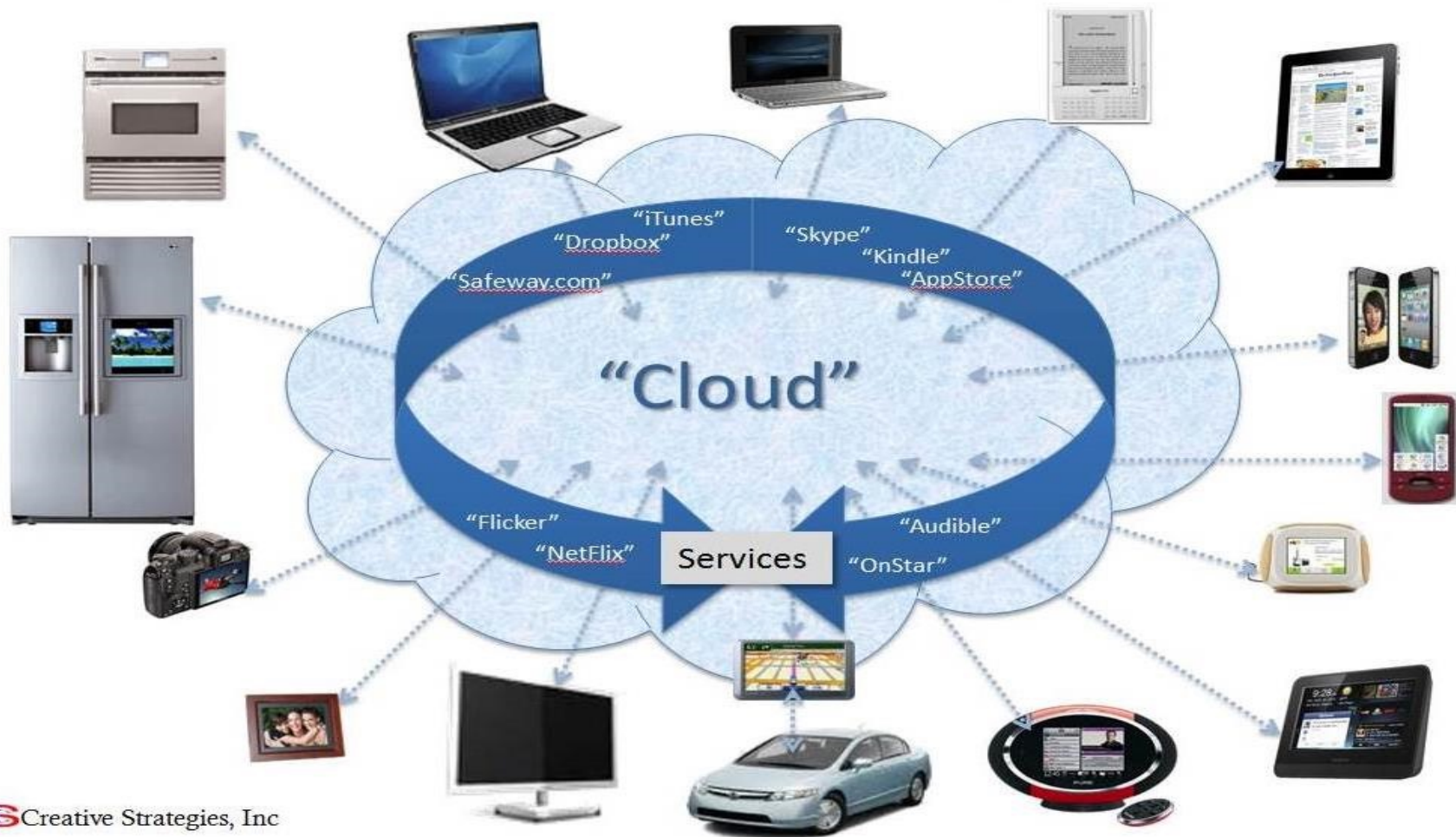


1976

80 MHz  
160 MFlops  
8 MByte memory  
300 MByte disks  
120 kW



# Internet of Things



# Now, how do we get and use data?

## 2019 *This Is What Happens In An Internet Minute*



- Move towards streaming
  - Netflix
  - youtube
- Same in science world
  - SKA / LOFAR
  - Light Source
  - Environmental (Marine, Meteorology, ...)
- Data is not always huge
  - Sometimes it is very complex
  - Some example:
    - biodiversity

# Change in computing

- Early days a few big Supercomputers
  - Mostly science domain
- Via grid to commercial cloud
  - AWS, Azure, Google Cloud, IBM, Salesforce
  - The big five: Apple, Alphabet, Microsoft, Facebook and Amazon
  - Computing has transformed into an utility
- Data => Information is the key





# Harvard Business Review



Harvard Business Review


ECONOMY

## Managing Our Hub Economy


by **Marco Iansiti** and **Karim R. Lakhani**

FROM THE SEPTEMBER–OCTOBER 2017 ISSUE

WHAT TO READ NEXT

The IT Transformation Health Care Needs

SUMMARY SAVE SHARE COMMENT H H TEXT SIZE PRINT \$8.95 BUY COPIES



THOMAS M. SCHEER/EYEM/GETTY IMAGES

### I. The Problem

The global economy is coalescing around a few digital superpowers. We see unmistakable evidence that a winner-take-all world is emerging in which a small number of “hub firms”—including Alibaba, Alphabet/Google, Amazon, Apple, Baidu, Facebook, Microsoft, and Tencent—occupy central positions. While creating real value for users, these companies are also capturing a disproportionate and expanding share of the value, and that’s shaping our collective economic future. The very same technologies that promised to democratize business are now threatening to make it more monopolistic.

Data value creation  
monopolies



Create an equal  
playing field



Sound Market  
principles

<https://hbr.org/2017/09/managing-our-hub-economy>

# SARNET: Security Autonomous Response with programmable NETWORKS

Marc Lyonnais, Leon Gommans, Rodney Wilson, Lydia Meijer, Frank Fransen Tom van Engers, Paola Grosso, Gauravdeep Shami, Cees de Laat, Ameneh Deljoo, Ralph Koning, Ben de Graaff, Gleb Polevoy, Stojan Travanovski.



## Big Data: real time ICT for logistics Data Logistics 4 Logistics Data (dl4ld)

Lydia Meijer (PI), Cees de Laat (Co-PI), Leon Gommans, Tom van Engers, Paola Grosso, Kees Nieuwenhuis.



## EPI: Enabling Personalized Interventions

Cees de Laat(PI), Sander Klous (PL), Leon Gommans, Tom van Engers, Paola Grosso, Henri Bal, Anwar Osseyran, Aki Harma, Douwe Biesma, Peter Grünwald, Floortje Scheepers, Gertjan Kaspers.



# Data Sharing: Main problem statement

- Organizations that normally compete have to bring data together to achieve a common goal!
- The shared data may be used for that goal but not for any other!
- Data or Algorithms may have to be processed in foreign data centers.
  - How to organize alliances?
  - How to translate from strategic via tactical to operational level?
  - How to enforce policy using modern Cyber Infrastructure?
  - What are the different fundamental data infrastructure models to consider?

# Big Data Sharing use cases placed in airline context



Global Scale



Aircraft Component Health  
Monitoring (Big) Data  
NWO **CIMPLO** project  
4.5 FTE

National Scale



Cargo Logistics Data  
(C1) DaL4LoD  
(C2) Secure scalable  
policy-enforced  
distributed data  
Processing  
(using blockchain)



Cybersecurity Big Data  
NWO **COMMIT/**  
**SARNET** project  
3.5 FTE

Campus /  
Enterprise Scale

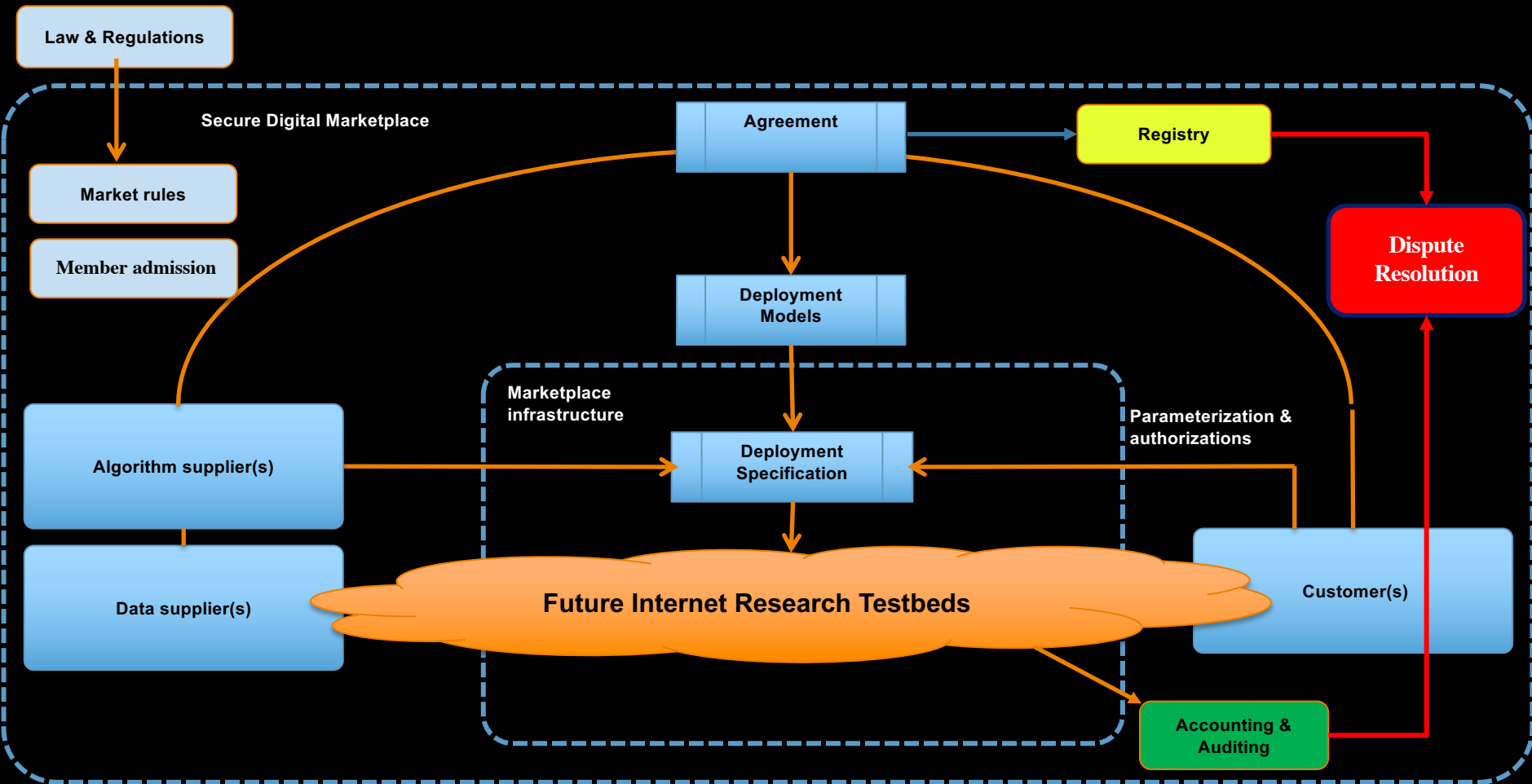
NLIP **iShare** project

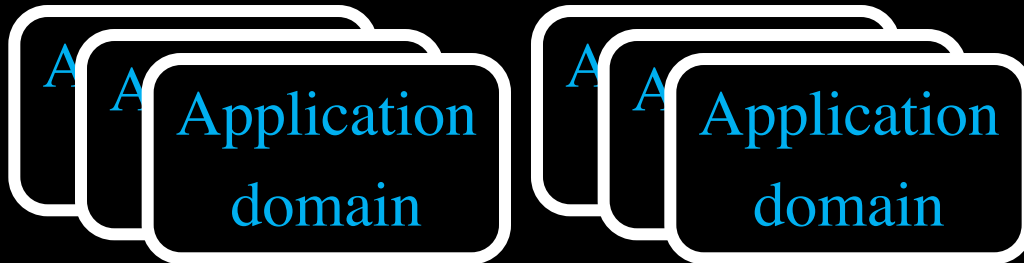


**iSHARE**  
powered by NLIP



# Secure Digital Market Place Research





AmDex

Data objects & methods  
Data & Algorithms service

FAIR / USE

AmsIX

Routers - Internet – ISP's - Cloud  
IP packet service

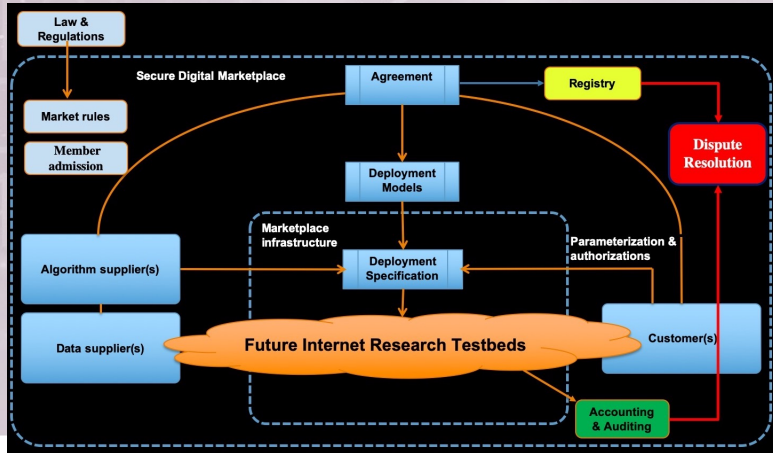
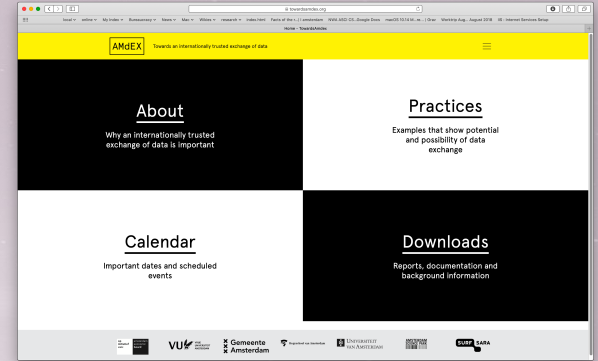
IP / BGP

Layer 2 exchange service  
Ethernet frames

ETH / ST

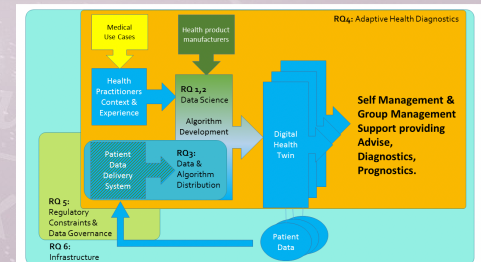
## AMdEX.eu

- Competing organisations, share data for common benefit
- Trust, Risk, data ownership & control
  - Industry: AF-KLM, Health, etc
  - Science: European Open Science Cloud
  - Society: Amsterdam Economic Board

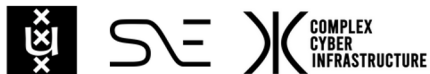


Aircraft Maintenance AF-KLM

Health:  
Enabling  
Personal  
Interventions



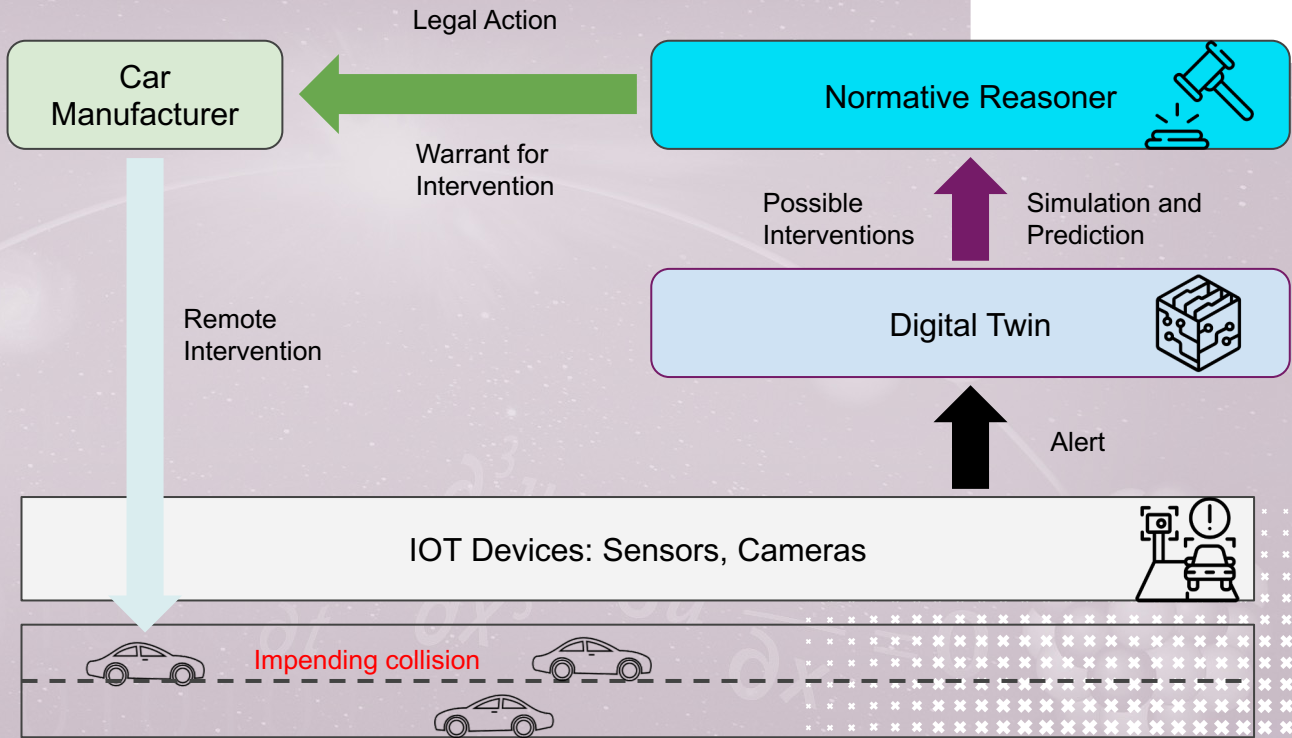
# Legal Interventions for Connected and Cooperative Automated Mobility



Providing Safety for AVs by External Monitoring and Intervention



Ensuring legality of Monitoring and Interventions



Smart Road,  
Autonomous Vehicles



Study and develop design tools and building blocks to secure IoT devices and beyond.

- Secure Processors and Architectures
  - ▶ Security Extension for RISC-V
  - ▶ eFPGAs for crypto-agility
- Energy Efficient Design of Cryptographic Primitives
- Design Automation for Embedded Security
  - ▶ Automatic Application of Physical Attacks Countermeasures
  - ▶ Automatic Verification of Physical Attacks Countermeasures
- Security Implications of Novel Computing Paradigms
  - ▶ Security Approximate Computing
  - ▶ Efficient Implementation of Post-quantum Cryptography

# Research lines

## Security

Securing embedded and cyber-physical systems with a particular focus on **side-channel attacks** and efficient implementation of **security primitives**. Secure implementations of hardware, software and hardware/software co-designed systems. Design tools to automate the construction and the **verification** of secure systems and architectures.

## Normative Systems

Building **trust** in IT solutions and infrastructures by constructing embedded compliance monitoring and enforcement technologies that meet **normative requirements** following from legal, social and ethical norms. Our research includes formal representation of and automated reasoning with and about norms from **policies, contracts** and **regulations** and simulation of such policies regulating complex infrastructures.

## Data Exchange and Infrastructure

Enabling inter-organizational data exchange and processing in **multi-party distributed systems** in a **secure** and **reliable** way with **full control** over the data by the data owners.

## Fundamentals of Software Services

Automatic **decomposition** of monoliths into fine-grained equivalents, like decomposing services into microservices. Automatic **(re)-composition** of microservices. Identifying invariants of services, to eventually build **controllable** complex **software services**.

## Programming Languages

Researching methods to ease the construction of programming **languages** and programming **tools**. Applying these methods to construct new languages and tools that aid the tackling of **complex systems**.

# Meet the CCI group

## Group Chair



Cees de Laat



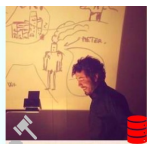
## Websites



Ivi



CCI



Giovanni Sileno



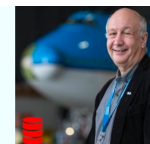
L. Thomas van Binsbergen



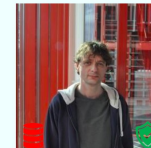
Ana Oprescu



Wouter Los



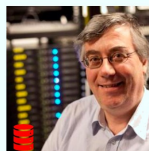
Leon Gommans



Guido van 't Noordende



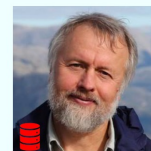
Tom van Engers



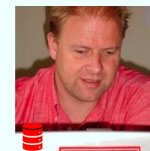
Karst Koymans



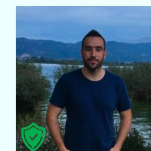
Kishor Joshi



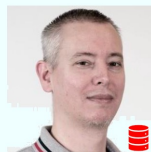
Yuri Demchenko



Jaap van Ginkel



Kostas Papagiannopoulos



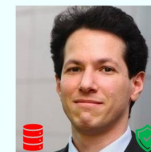
Merrick Oost-Rosengren



Arno Bakker



Sander Klous

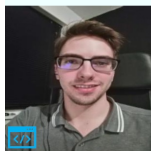


Zoltan Mann

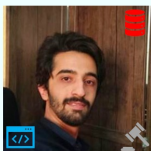


Francesco Regazzoni

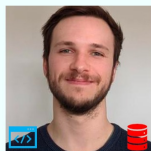
## PhD Candidates



Damian Frolich



Mostafa Mohajeri Parizi



Christopher Esterhuyse



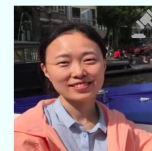
Lu-Chi Liu



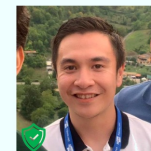
Milen Girma Kebede



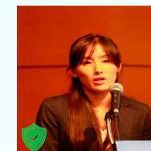
Peter Fratric



Xin Zhou



Marco Brohet



Aya Fukami

# Education

The **CCI** group is closely working together with:

- the Security and Network Engineering (**SNE**) Master
  - [www.os3.nl](http://www.os3.nl) ,
- the Software Engineering Master (**SE**)
  - <https://www.uva.nl/en/programmes/masters/software-engineering/software-engineering.html> and
- the Computer Science Master (**CS**)
  - <https://www.uva.nl/en/programmes/masters/computer-science/computer-science.html>

programs to disseminate knowledge through education.

Best IT Master in  
Keuzegids 2021  
(Dutch)



**KEUZEGIDS**  
2021  
masters

# Conclusions, Info, Acknowledgements, Q&A

- Data hindered by risk of unexpected use, lack of trust
- Using market principles, enforcement and determining incentives and value in the data life cycle to make data flow
- More information:
  - <https://cci-research.nl/>
  - <https://dl4ld.nl/>
  - <https://towardsamdex.org>
  - <https://www.esciencecenter.nl/project/seconnet>
  - <https://delaat.net/>
  - <http://epi-project.nl/>

