CARISSMA
Institute of Electric, Connected and Secure Mobility

Expert Panel
Smart Energy Distribution

Sustainability and Safety in Green Energetic Systems

Hans-Joachim Hof
Research Group „Security in Mobility“

11.11.21

Technische Hochschule Ingolstadt

THE PARLIAMENT
POLITICS, POLICY AND PEOPLE MAGAZINE

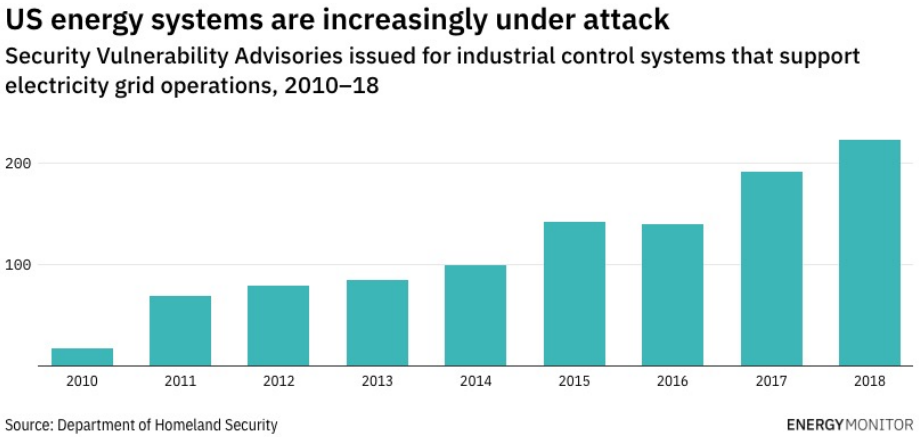
‘Europe’s man on the moon moment’: Von der Leyen unveils EU Green Deal

“Now it’s time to act”, announced European Commission President Ursula von der Leyen as she laid out the executive’s plans for tackling climate change.

Ursula von der Leyen | Photo credit: European Parliament Audiovisual

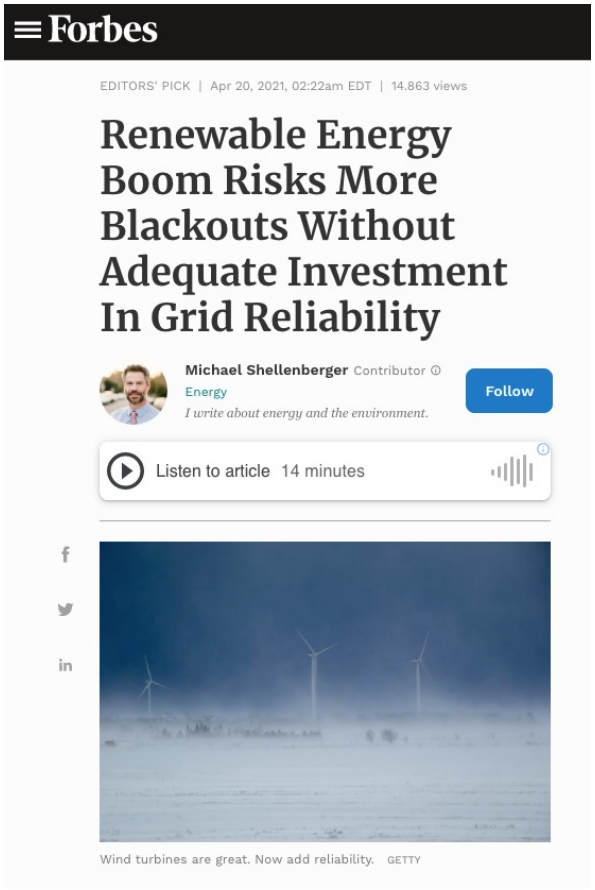
Reliability and resilience are key for future energy distribution

Key issue cybersecurity



Reliability and resilience are key for future energy distribution

Key issue integration of renewable energies



Forbes

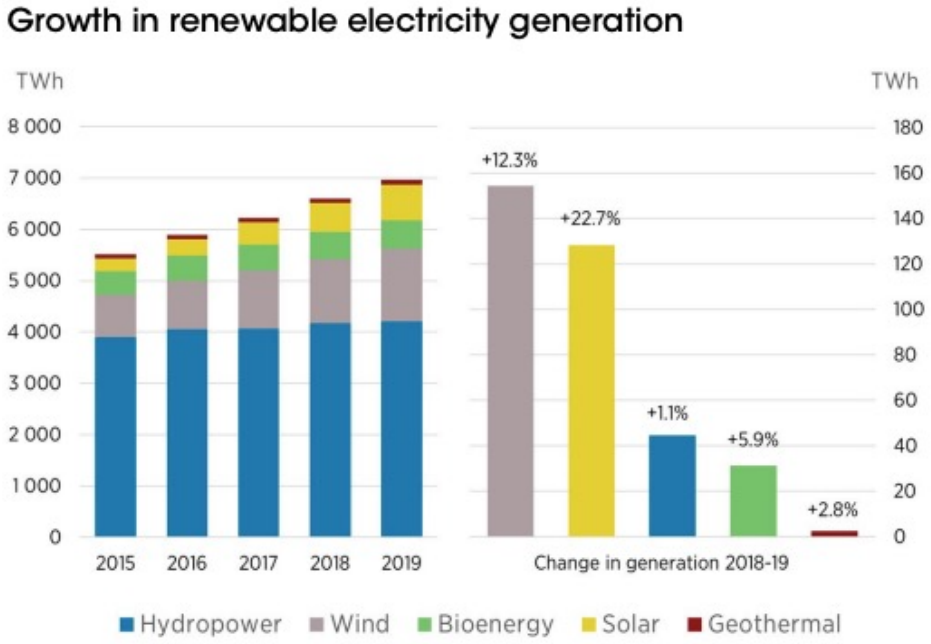
EDITORS' PICK | Apr 20, 2021, 02:22am EDT | 14.863 views

Renewable Energy Boom Risks More Blackouts Without Adequate Investment In Grid Reliability

Michael Shellenberger Contributor
Energy
I write about energy and the environment.
Follow

Listen to article 14 minutes

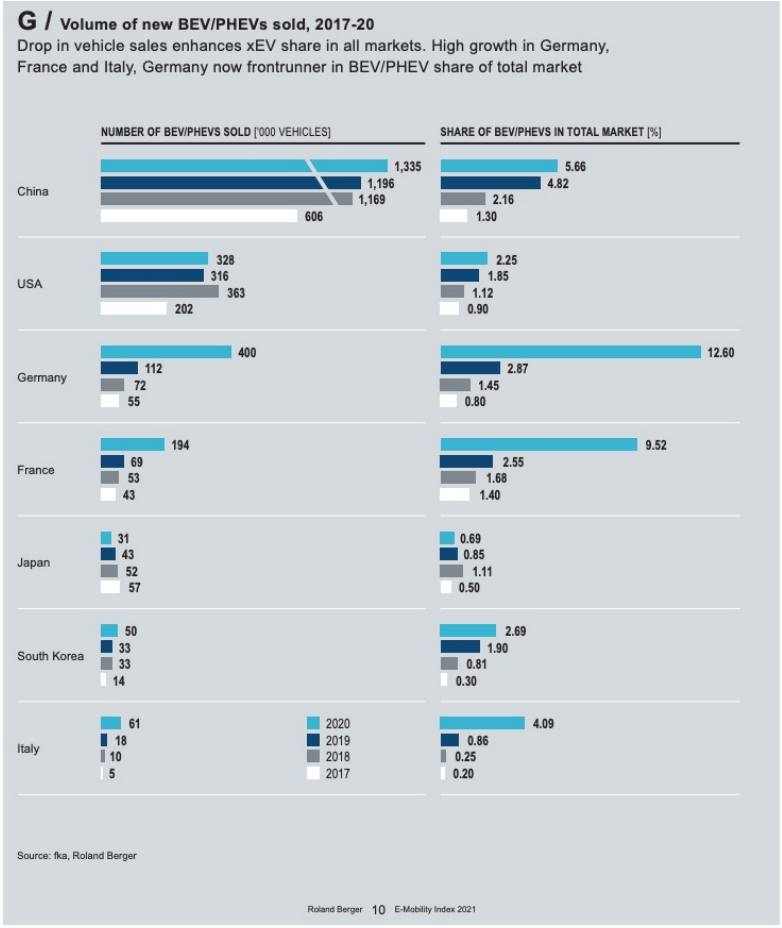
Wind turbines are great. Now add reliability. GETTY

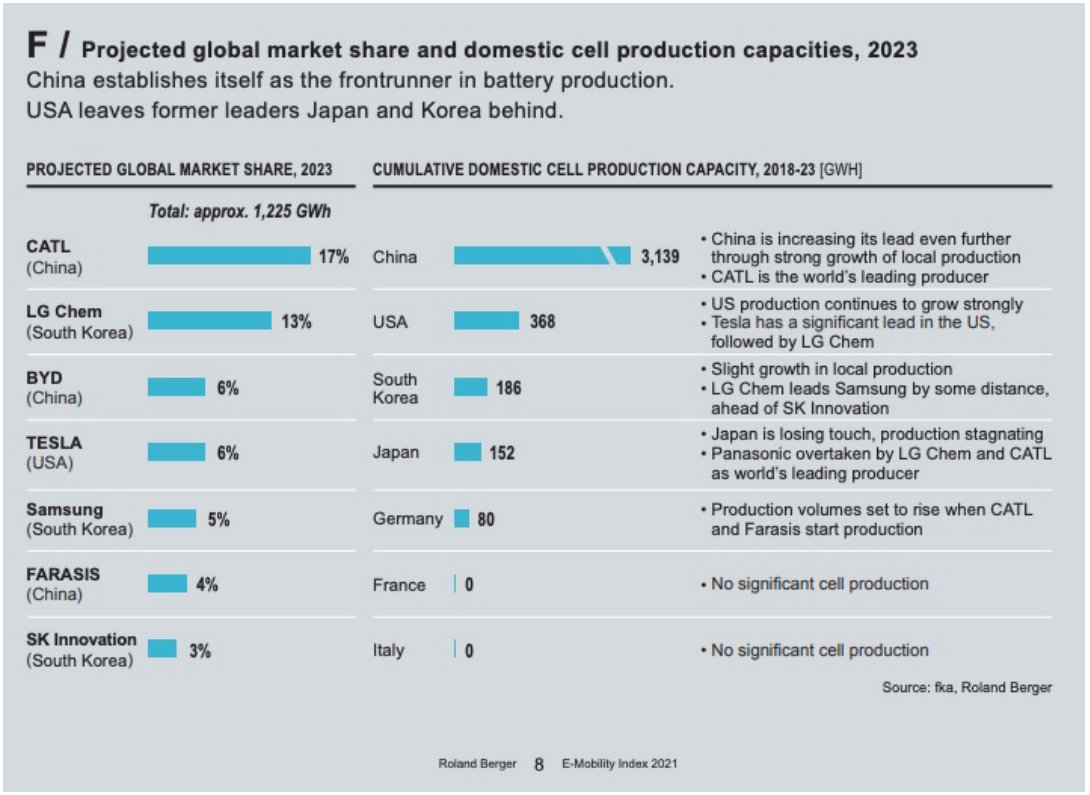


Source: IRENA, „Renewable Energy Highlights“, technical report, 2021

Reliability and resilience are key for future energy distribution

Key issue electric mobility





Expert panel

Steve Chan
IARIA
USA
(Expert)

Francisc Zavoda
CRHQ/Hydro-Quebec-Research
Centre of HQ Canada
(Expert)

Hans-Joachim Hof
CARISSMA Institute of Electric,
Connected, and Secure Mobility
(Panel chair)

Rainer Falk
Siemens Technology
Germany
(Expert)

Eric MSP Veith
OFFIS – Institute for
Information Technology
Germany
(Expert)

Panellist Position

Green Computing Waveform Discernment as a 5G NR Enabler for Connected and Cooperative Autonomous Vehicles

Steve Chan, IARIA, USA schan@dengineering.org

- Real-time autonomous decisions necessitate Ultra-Reliable Low-Latency Communication (URLLC).
- 5G autonomous vehicles need to make real-time decisions to avoid hitting people and other obstacles.
- Accordingly, the utilized 5G New Radio (NR) communications used for connected and cooperative autonomous vehicles must be secure.
- Waveform discernment is key to this secure communications paradigm, as valid waveforms must be distinguished from fake waveforms or "mimics."

→ Green Computing

→ Waveform Discernment

→ **5G NR Enabler for Connected and Cooperative Autonomous Vehicles**

Panellist Position

Power Quality and Electric Vehicle Charging Stations

Francisc Zavoda. CRHQ/Hydro-Quebec-Research Centre of HQ, zavoda.francisc@hydroquebec.com , Canada

- Changing towards clean energy resources and switching to transportation electrification
- Public networks of charging stations for Electric Vehicles (EV)
- Utility's concern for its power supply quality

→ Penetration of EV as part of transportation electrification

→ Characterization of EV charging stations

→Power Quality monitoring of EV impact on distribution network

Panellist Position

Trustworthy Industrial Cyber-Physical Systems

Dr. Rainer Falk, Siemens Technology, rainer.falk@siemens.com

- Cyber security, cyber resilience
- Industrial IoT security
- Embedded security

→ Industrial systems need a security design that address the relevant security objectives and respect side conditions for the specific environment (e.g., lifetime, real-time, safety, usability).

→ The industrial security standard IEC62443 is applied in different verticals. The responsibilities of the different roles (system operator, integrator, component manufacturer) are distinguished.

→ System integrity monitoring of control systems and technical processes can provide an additional layer of defense

Panellist Position

Energy Markets Can/Will Introduce Attack Vectors

Eric MSP Veith <veith@offis.de>, OFFIS – Institute for Information Technology, Germany

- Dynamic coalitions game (reactive) power markets – undetectable!
- rational behavior Of Agents mean Agents Game the Market
- Market rules are slow to change (on purpose!)
- AI solutions (needed for actor monetary gains) will wreck havoc with market stability

→ AI-based certification of actors needed

→ TPM + dynamic observable of XAI-inspected learning agents

→Market must be based on dynamic contracts to cope with new generation of actors

Green Computing Waveform Discernment as a 5G NR Enabler for Connected and Cooperative Autonomous Vehicles

Presenter:

Steve Chan, IARIA, USA schan@dengineering.org

Panellist Position

Green Computing Waveform Discernment as a 5G NR Enabler for Connected and Cooperative Autonomous Vehicles

Steve Chan, IARIA, USA schan@dengineering.org

- Real-time autonomous decisions necessitate Ultra-Reliable Low-Latency Communication (URLLC).
- 5G autonomous vehicles need to make real-time decisions to avoid hitting people and other obstacles.
- Accordingly, the utilized 5G New Radio (NR) communications paradigm for connected and cooperative autonomous vehicles must be secure.
- Waveform discernment is key to this secure communications paradigm, as valid waveforms must be distinguished from fake waveforms or "mimics."

→ Green Computing

→ Waveform Discernment

→ **5G NR as an Enabler for Connected and Cooperative Autonomous Vehicles**

DECISION engineering Analysis Laboratory

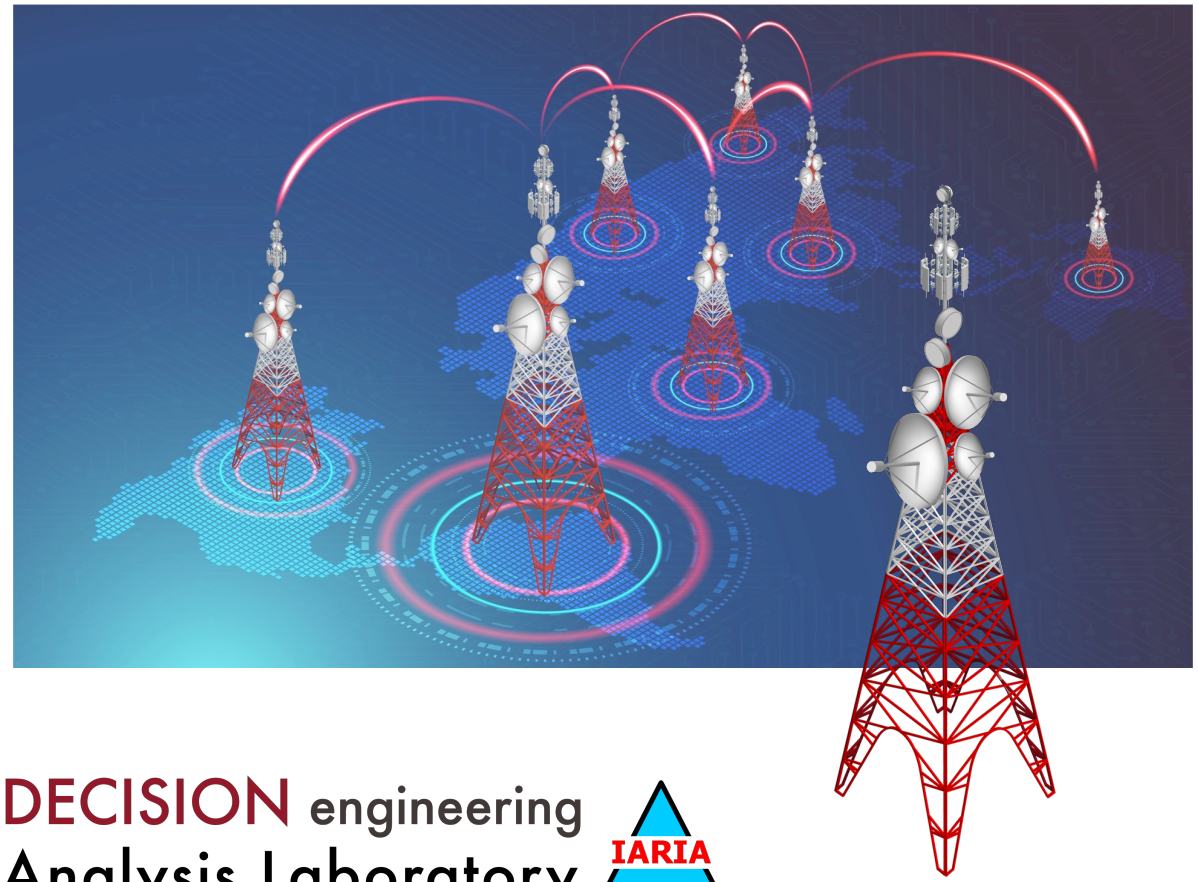
Professional Experience

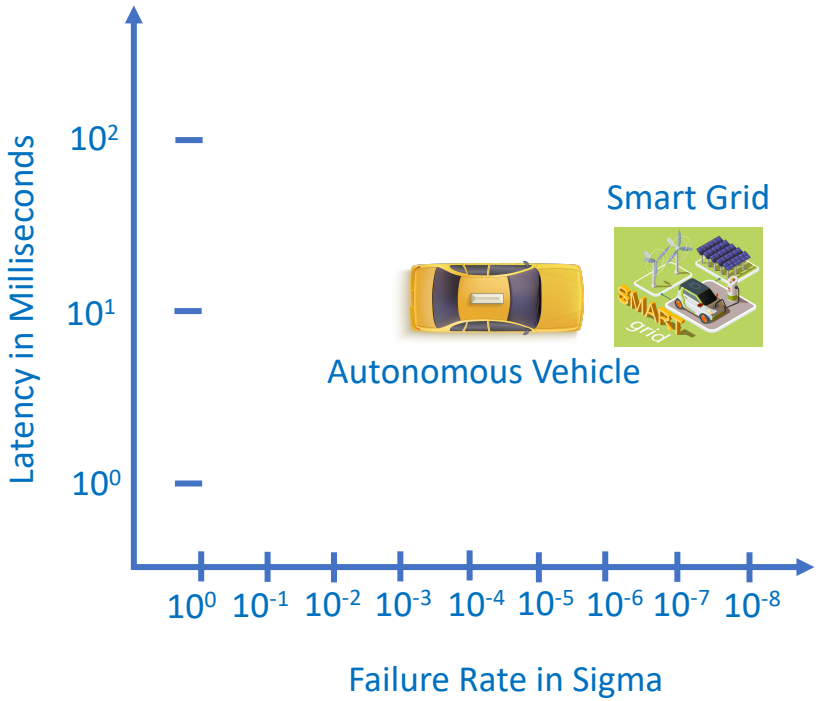
Dr. Steve Chan is an International Academy, Research and Industry Association (IARIA) Fellow. He is an inventor with both international and U.S. patents. He is currently researching broadband wireless access for applications, such as autonomous vehicles.

Publications and Activities

He has authored/co-authored papers that were presented at the IEEE International Conference on Distributed Computing Systems (ICDCS) Workshop, IEEE International Conference on Condition Monitoring and Diagnosis (CMD), IEEE Sensors Applications Symposium (SAS), IEEE Computing and Communication Workshop and Conference (CCWC), IEEE Information Technology, Electronics & Mobile Communication Conference (IEMCON), IEEE Technically Sponsored Future of Information and Communication (FICC) Conference, IEEE International Conference on Information and Communications Technology (ICOIACT), IEEE Future Technologies Conference (FTC), IEEE International Conference on Digital Ecosystems and Technologies (DEST), and the IEEE International Conference on Collaborative Computing (CollaborateCom).

Real-time Autonomous Decisions Necessitate Ultra-Reliable Low-Latency Communication (URLLC)

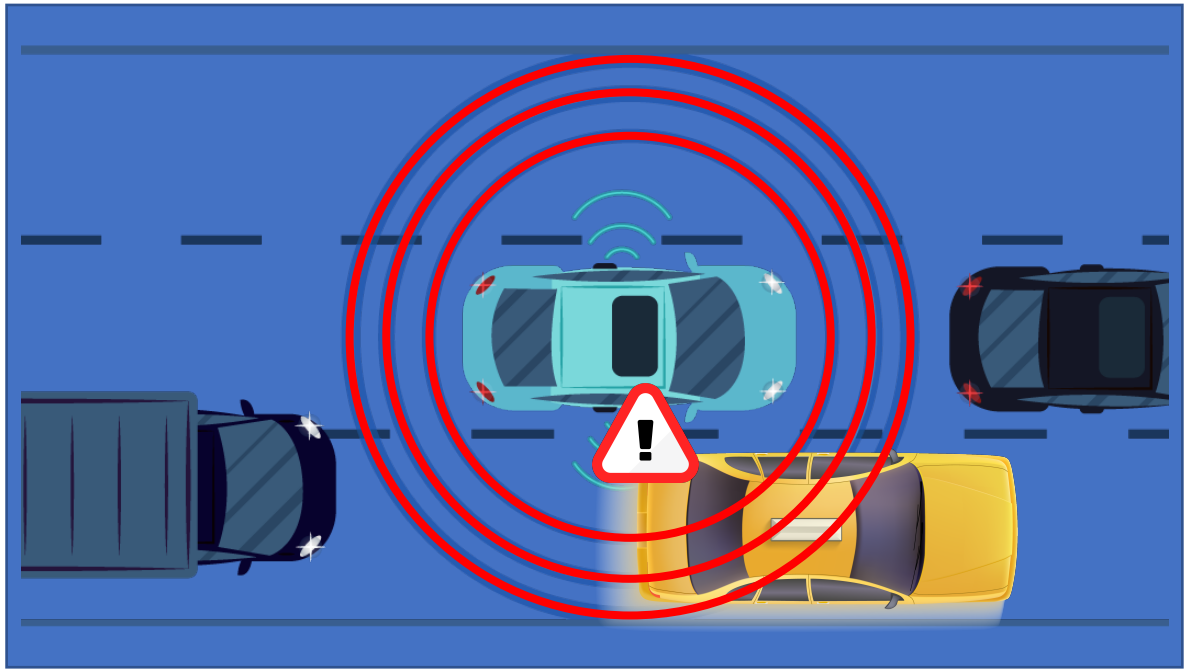




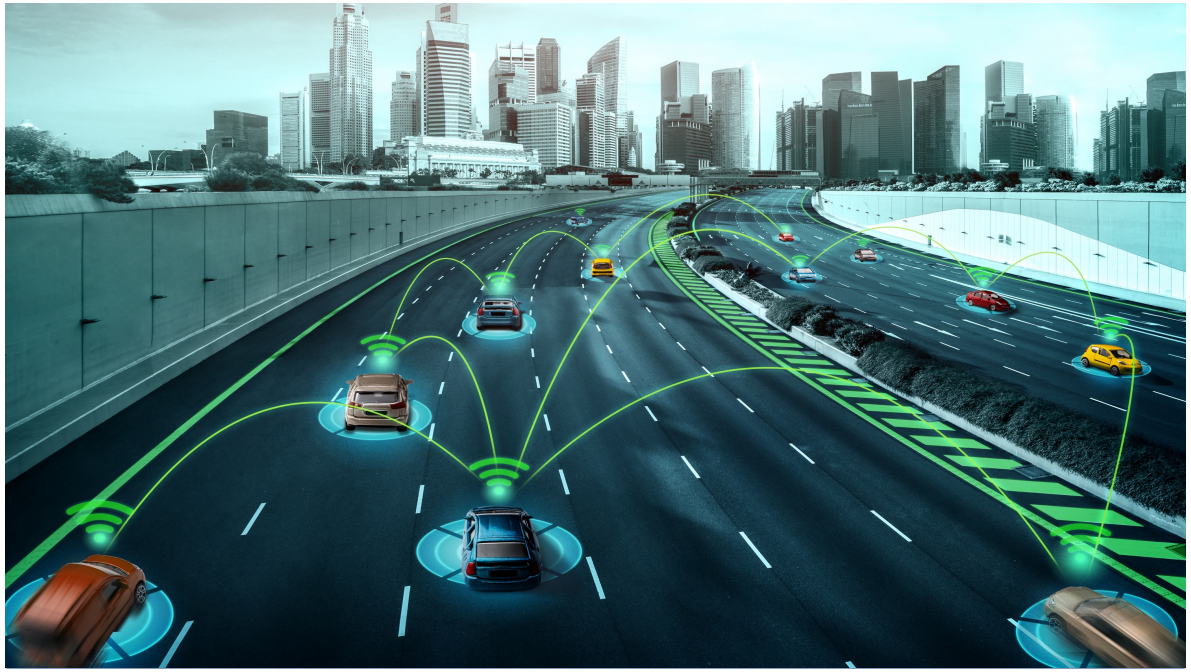
Source: Ericsson Research

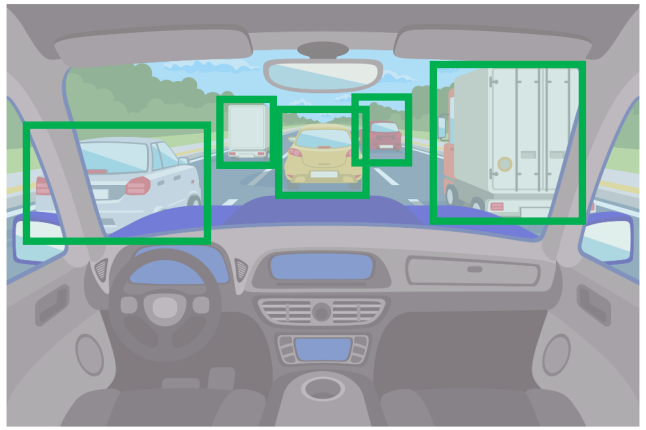
http://cscn2017.ieee-cscn.org/files/2017/08/Janne_Peisa_Ericsson_CSCN2017.pdf

5G Autonomous Vehicles Need to Make Real-time Decisions to Avoid Hitting People and Other Obstacles

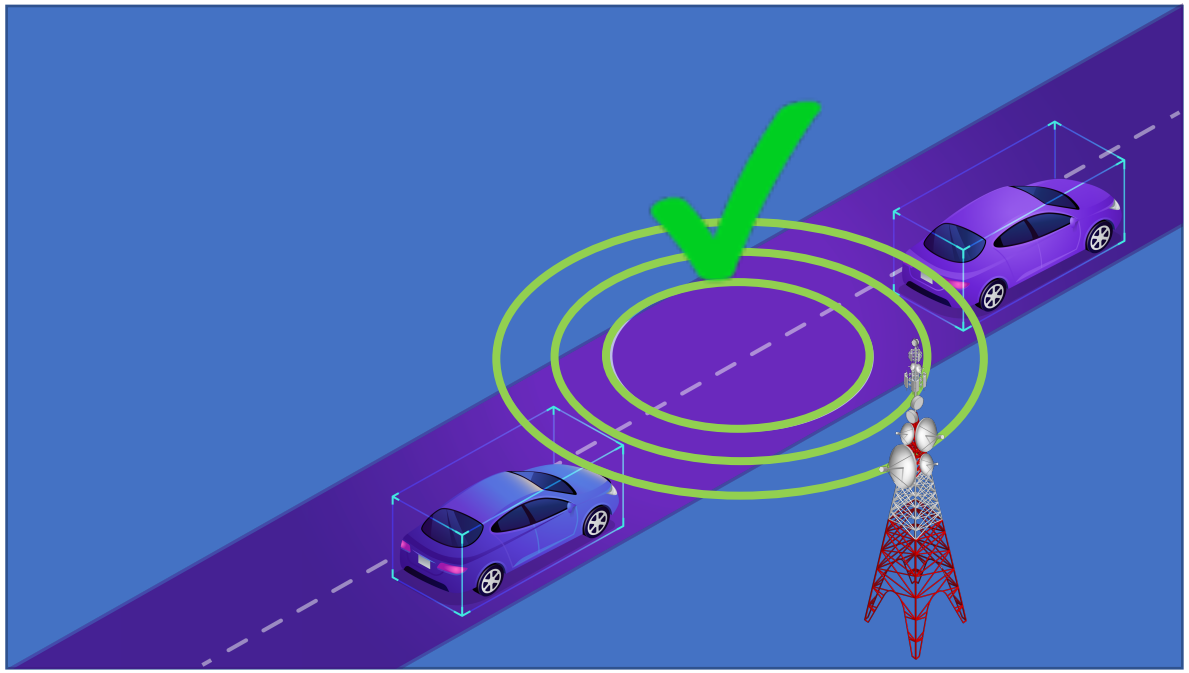


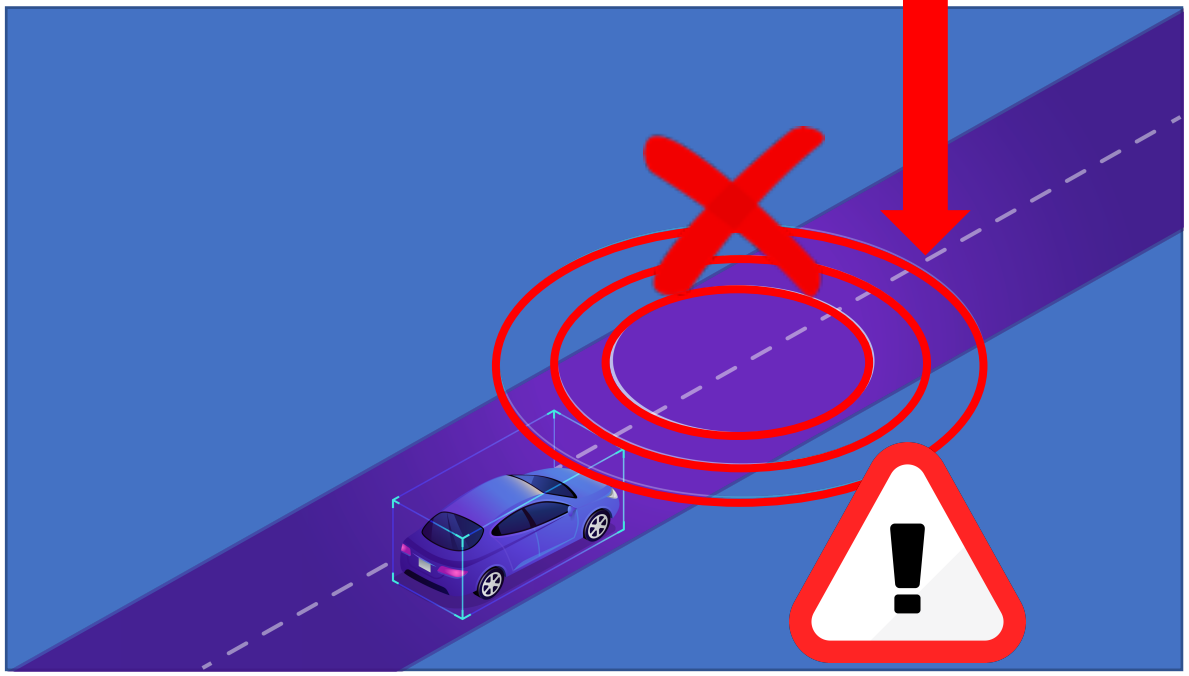
The Utilized 5G New Radio (NR) Communications Paradigm for Connected and Cooperative Autonomous Vehicles Must Be Secure





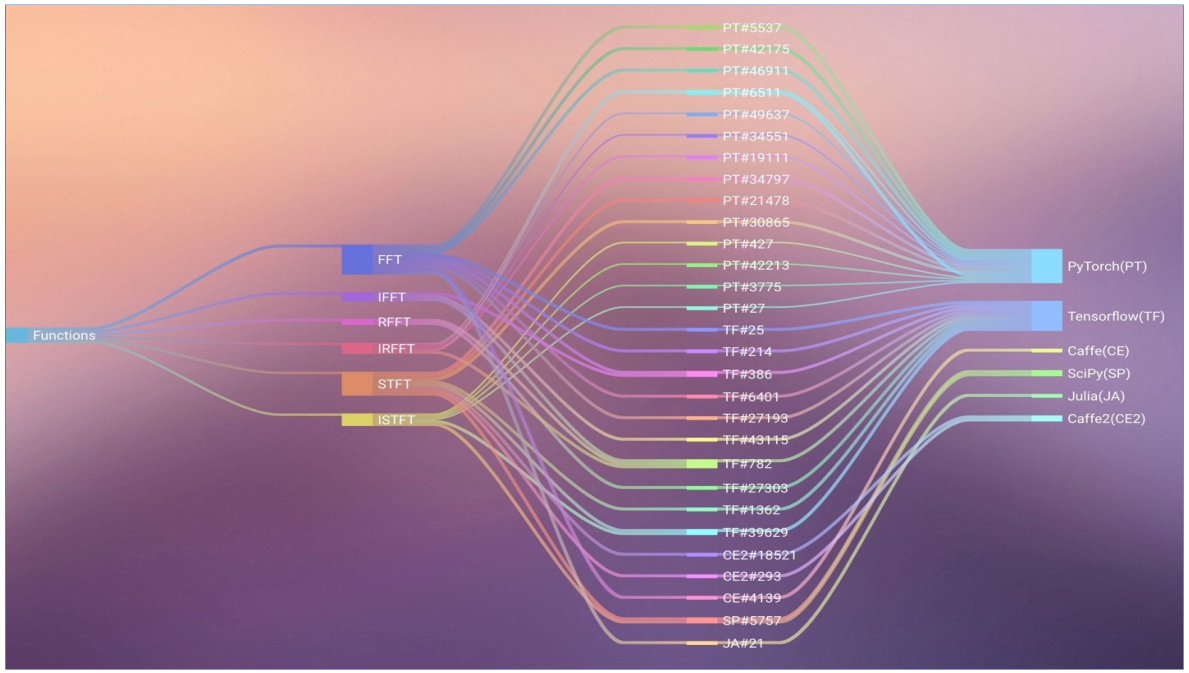
Waveform Discernment is Key to this Secure Communications Paradigm, as Valid Waveforms must be Distinguished from Fake Waveforms or "Mimics"





Rogue Transmitter

Green Computing for 5G NR Waveform Discernment



For Waveform Discernment, the use of Tensor Processing Units (TPUs) can be faster (for some functions, such as apriori baselining) than prototypical Graphics Processing Unit (GPUs) or Central Processing Unit (CPUs).

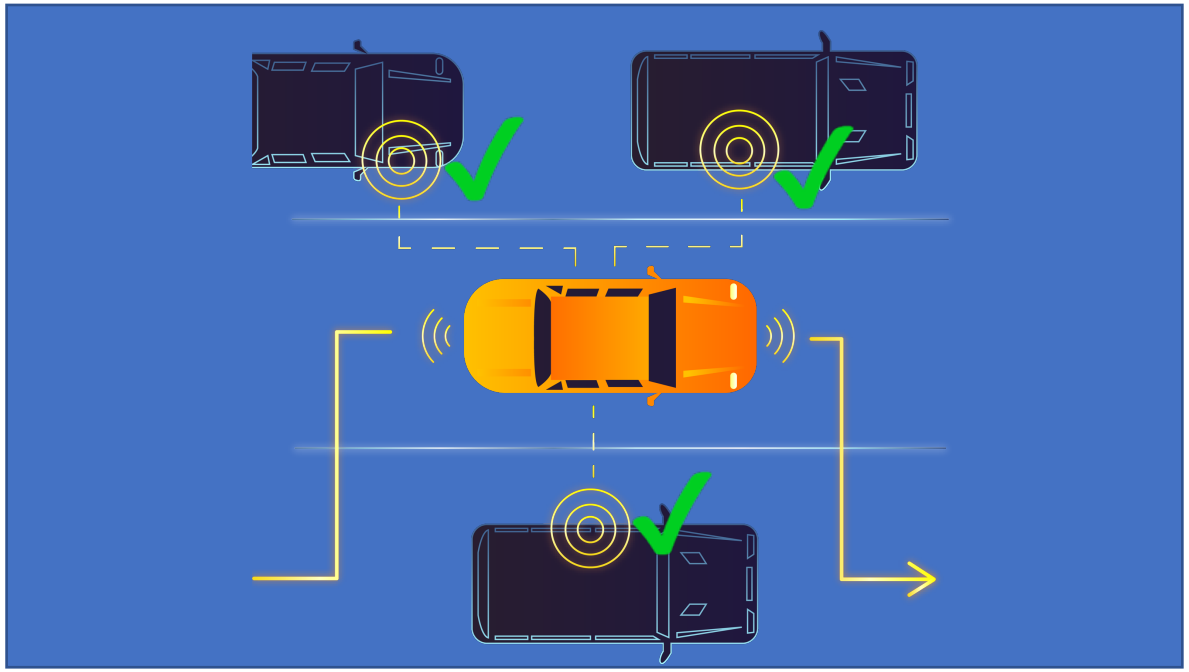
TPUs can also be much more energy efficient by 30 to 80 times in terms of Tera-Operations [of computation] per Watt [of energy consumed] (TOPS/Watt).

Hence, the utilization of TPUs, for some of the functions for Waveform Discernment, may lead to Green Computing possibilities.

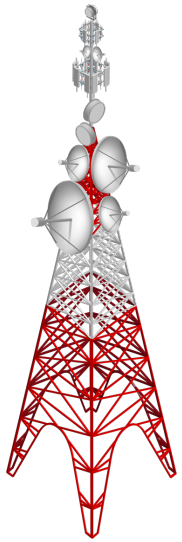
Source: ZDNet

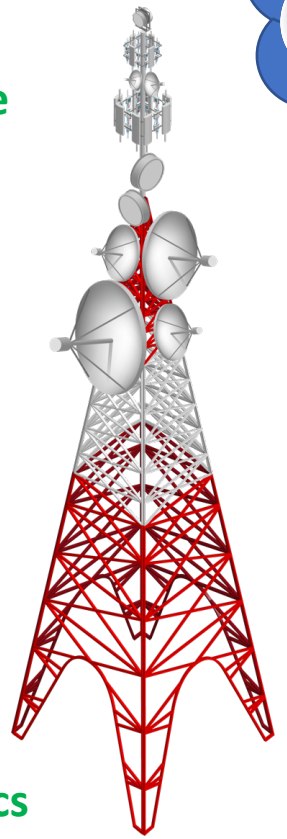
https://www.zdnet.com/article/tpu-is-15x-to-30x-faster-than-gpus-and-cpus-google-says/

5G NR as an Enabler for Connected and Cooperative Autonomous Vehicles



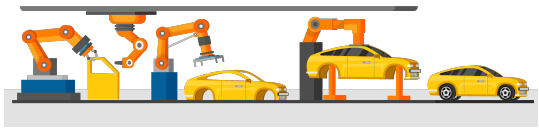
5G for Advanced Driver-Assistance Systems (ADAS)





Infrastructure Sensor

5G for Telematics



Thank you, and have a great

NetWare 2021 Congress!

The Sixth International Conference on Green Communications, Computing and Technologies
GREEN 2021
November 14-18, 2021 - Athens, Greece

Power Quality and Electric Vehicle Charging Stations

Francisc Zavoda
Research Engineer
IREQ/CRHQ (Research Institute of Hydro-Québec)
zavoda.francisc@ireq.ca
(450) 652-8914
November 2021

Biography

Francisc Zavoda

- B.Sc. Power engineering, MEng., MASc,
- Senior Research Engineer CRHQ/Hydro-Quebec
- Covenor of CIGRE/CIRED WG C4.24
- Chair of IEEE WG P1564 and IEEE WG P2681
- Fields of expertise: Power Quality, Smart Grid, Smart Distribution Applications (ADA), Grid Monitoring, Sensors and IED, Condition Based Maintenance
- PEng (102231)

Contents

The Electric Circuit (1/2)

Hydro-Quebec, a well-known Canadian utility, committed a decade ago to significantly contribute to transportation electrification in Quebec and elsewhere. Its sustainable development goals include:

- Generating 98.8% of electricity from a clean, renewable source and through initiatives such as ***"The Electric Circuit"*** for reducing GHG emissions in Quebec.
- Supporting energy transition, by implementing transportation electrification and gradually abandoning fossil fuels globally as part of the fight against climate changes.

"The Electric Circuit" is the most important network of public charging stations for electric vehicles (EV) in Quebec. Since his inauguration in March 2012, more than 425 private and institutional partners joined ***"The Electric Circuit"***, and the network now has over 68,000 members.

The Electric Circuit (2/2)

At the present time, the network counts more than 3100 charging stations (approximately 90% of them are level 2 EV chargers at 240 V and 10% of them are 50 kW EV fast charging stations at 400 V), essentially situated in the province of Quebec.

A significant number of double stations with two fast-charging stations and superstations offering up to 4 fast-charging stations are functional.

The four 50kW fast-charging stations of a superstation can simultaneously charge one vehicle each.

Lately ***"The Electric Circuit"*** has deployed ultra-fast-charging stations (DCUFC) with capacities from 125kW to 350kW.

State-of-the-art superstation

Charging Level Summary

Level	ChargeHub Markers	Power (kW)	Approximate Charging Time (Empty Battery)
1		1	200 km (124 miles): +/- **20 hours** 400 km (249 miles): +/- **43 hours**
2		3 to 20, typically 6	200 km (124 miles): +/- **5 hours** 400 km (249 miles): +/- **11 hours**
3 (DCFC)		Typically 50, occasionaly 20	80% of 200 km (124 miles): +/- **30 min** 80% of 400 km (249 miles): +/- **1 hour**

The new DC Ultra-Fast Charging (DCUFC) stations, which have appeared recently, might be categorized as a “Level 4” charging providing 125kW or 160kW or 350kW at voltages from 200 to 1000V

Charging Stations Models

Level 2 public quadruple charging station providing power at 240V

Superstation including four DCFC stations of 50kW each

Superstation including two DCUFC stations in a pairing configuration providing up to 125kW

Evaluation of Charging Stations

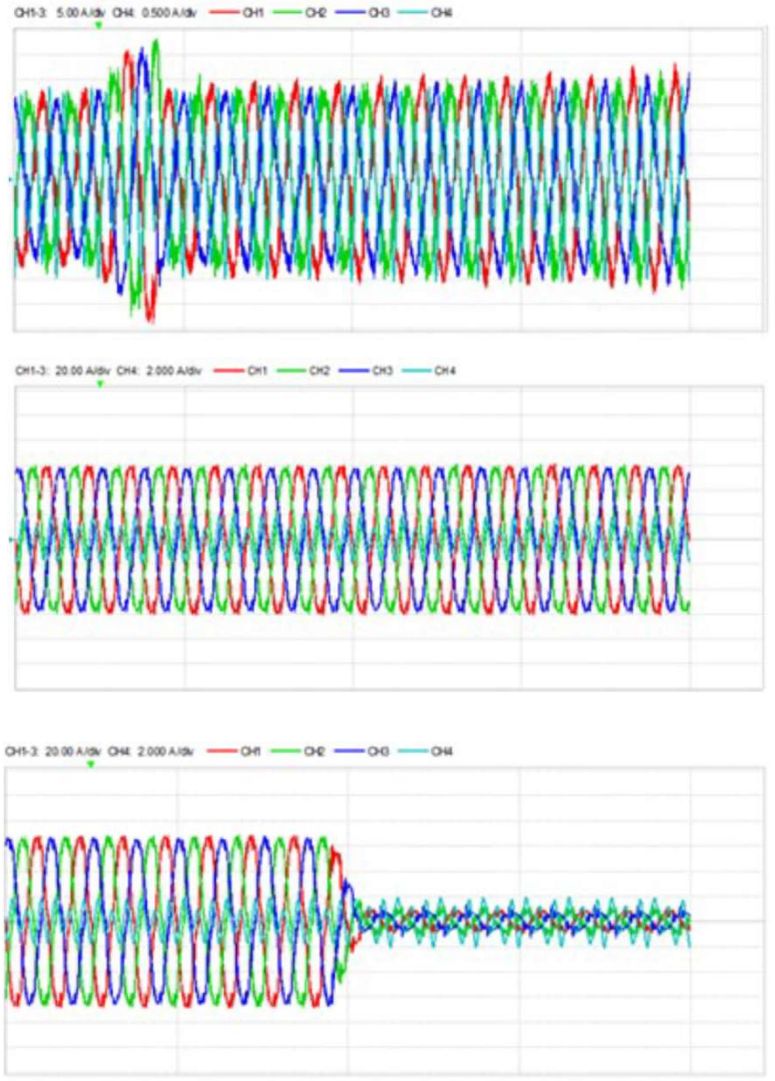
The evaluation of the charging stations impact on power quality is a three-phase process scheduled over several years, which includes laboratory and field tests:

- Phase 1 (2018): Laboratory tests on DCFC (50kW/400V):
  - Environmental
  - PQ impact
- Phase 2 (2019, 2020): Field monitoring on DCFC (50kW/400V)
  - PQ impact
- Phase 3 (2021 and +): Field monitoring on DCUFC (125, 160 and 350kW/400V or 800V)
  - PQ impact

Laboratory Tests

The laboratory tests included the monitoring of the power supply of two different models of charging stations during idle periods (no EV charge) and during EV charging periods based on a three-stage process :

- Start-up,
- Full charge,
- End of charging process.



Voltage and current measurements were performed with HIOKI 3196 and 3198 PQ analyzers.

Field Tests

The phase 2 field tests were performed in 2019 and 2020.

Two super stations, each equipped with four DCFC stations (50kW), deployed in the field, were continuously monitored.

They are supplied by a dedicated 3-phase autotransformer (600/480V). A PQ monitoring system PQube3 has been connected between the primary side of the autotransformer and the secondary of a 3-phase (25kV/600V) MV power transformer.

It measures and record PQ disturbances related to charging stations, including harmonic emissions (<2kHz) and also high frequency harmonics also known as supraharmonic emissions (2 to 150kHz).

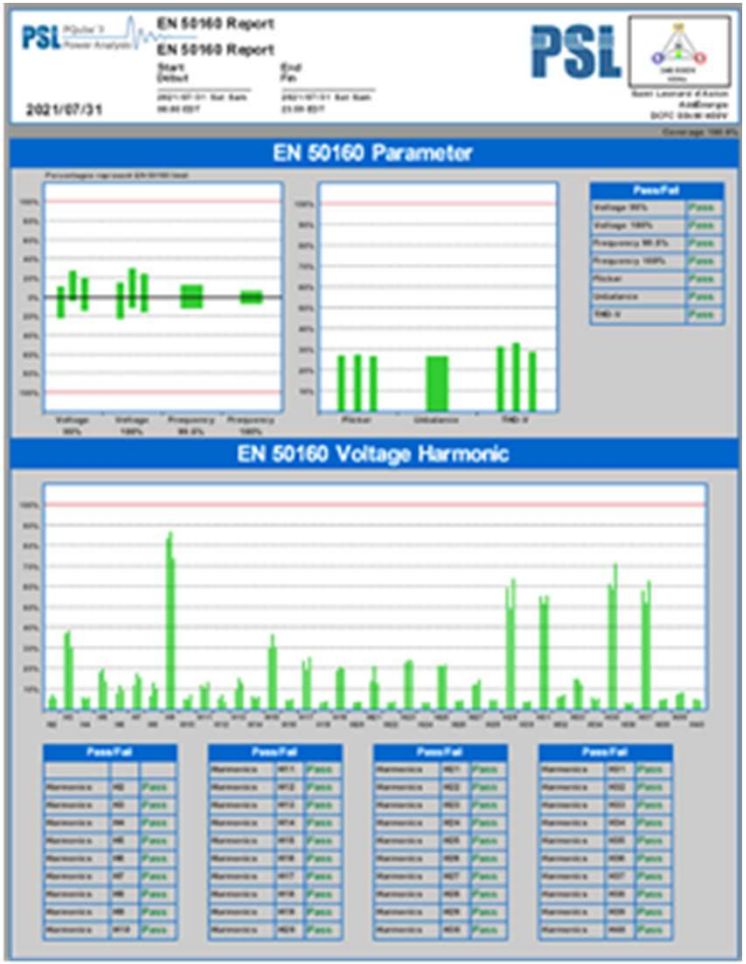
Monitoring System

The PQ monitoring system used in the survey includes :

- PQ Analyser PQube3,
- Power Manager Module PM1,
- Currant clamps 300A (SCN4-300A:333mV, 600V, accuracy 0.2%, 0.5%),
- Microhard IPn4Gii Cellular modem.

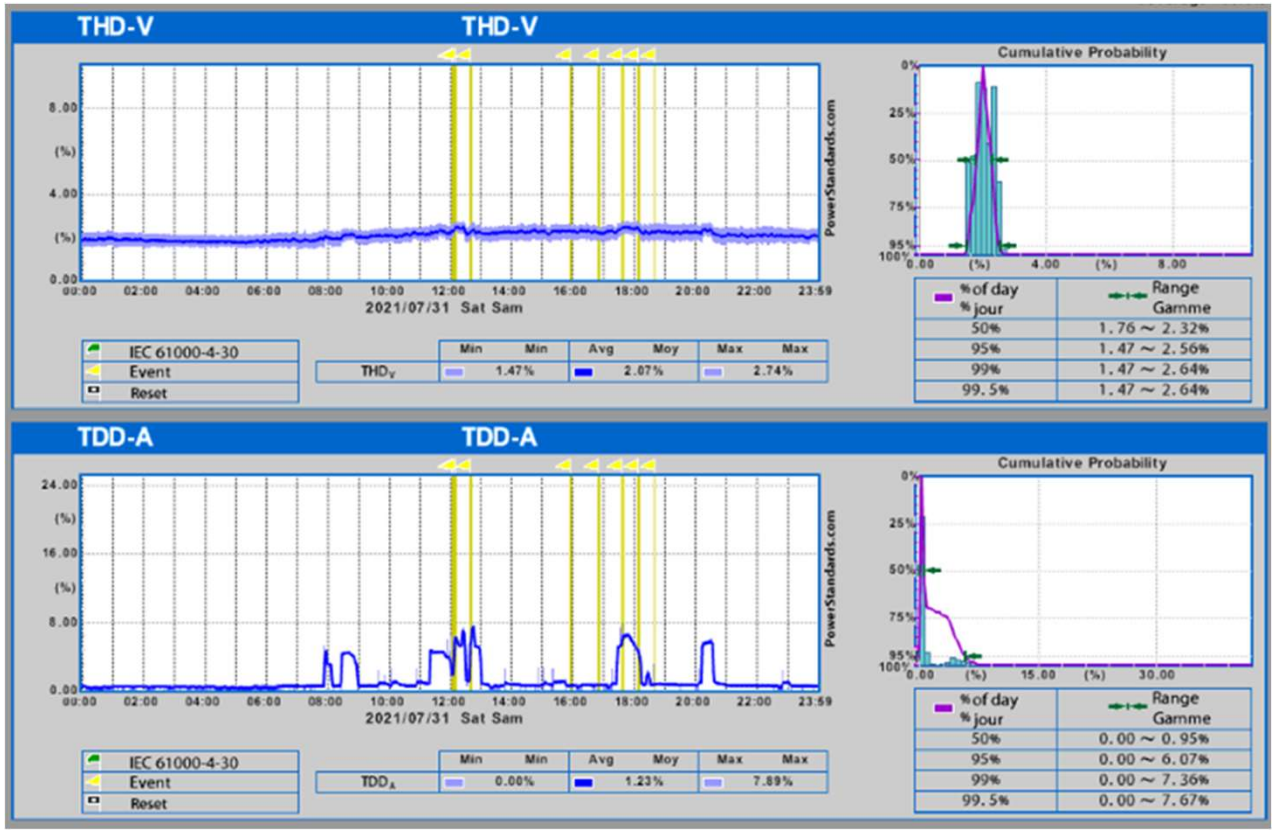
PQ Monitoring Results (1/6)

The EN50160 report indicates that PQ parameters (voltage, frequency, flicker, unbalance, individual voltage harmonics < 2kHz, THD) were compliant with the standards limits.



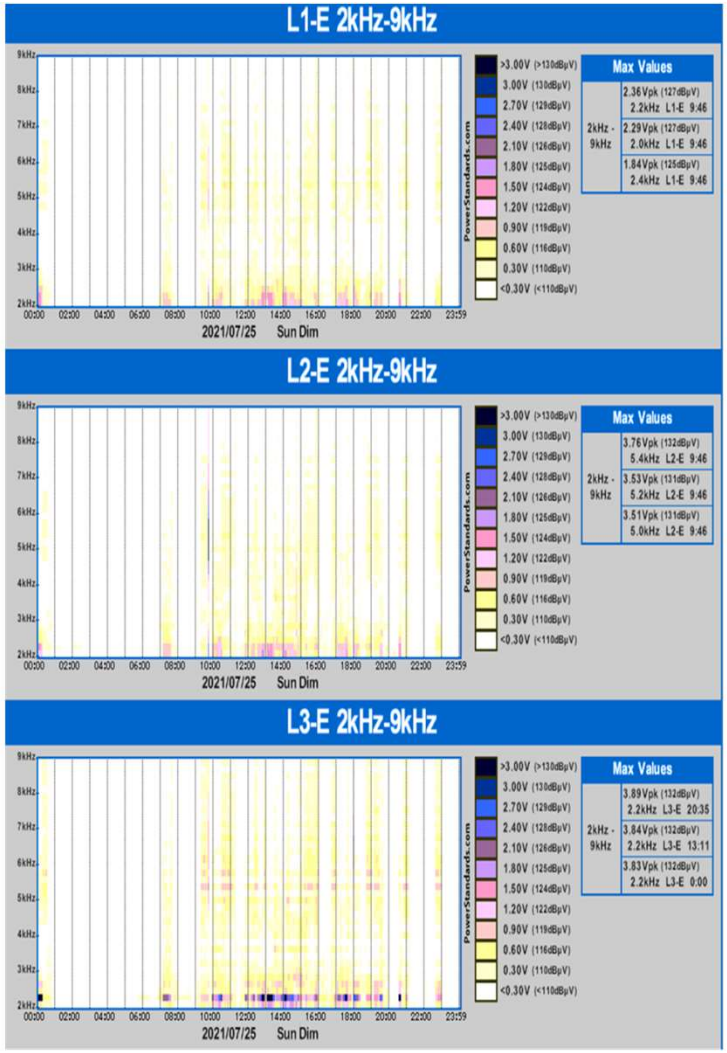
PQ Monitoring Results (2/6)

The THD average value was 2.07%, the 95% value reached 2.56% and the max value was 2.74%. The TDD average value was equal to 1.23%, the 95% was slightly higher than 6% and the max value was slightly lower than 7.9%.



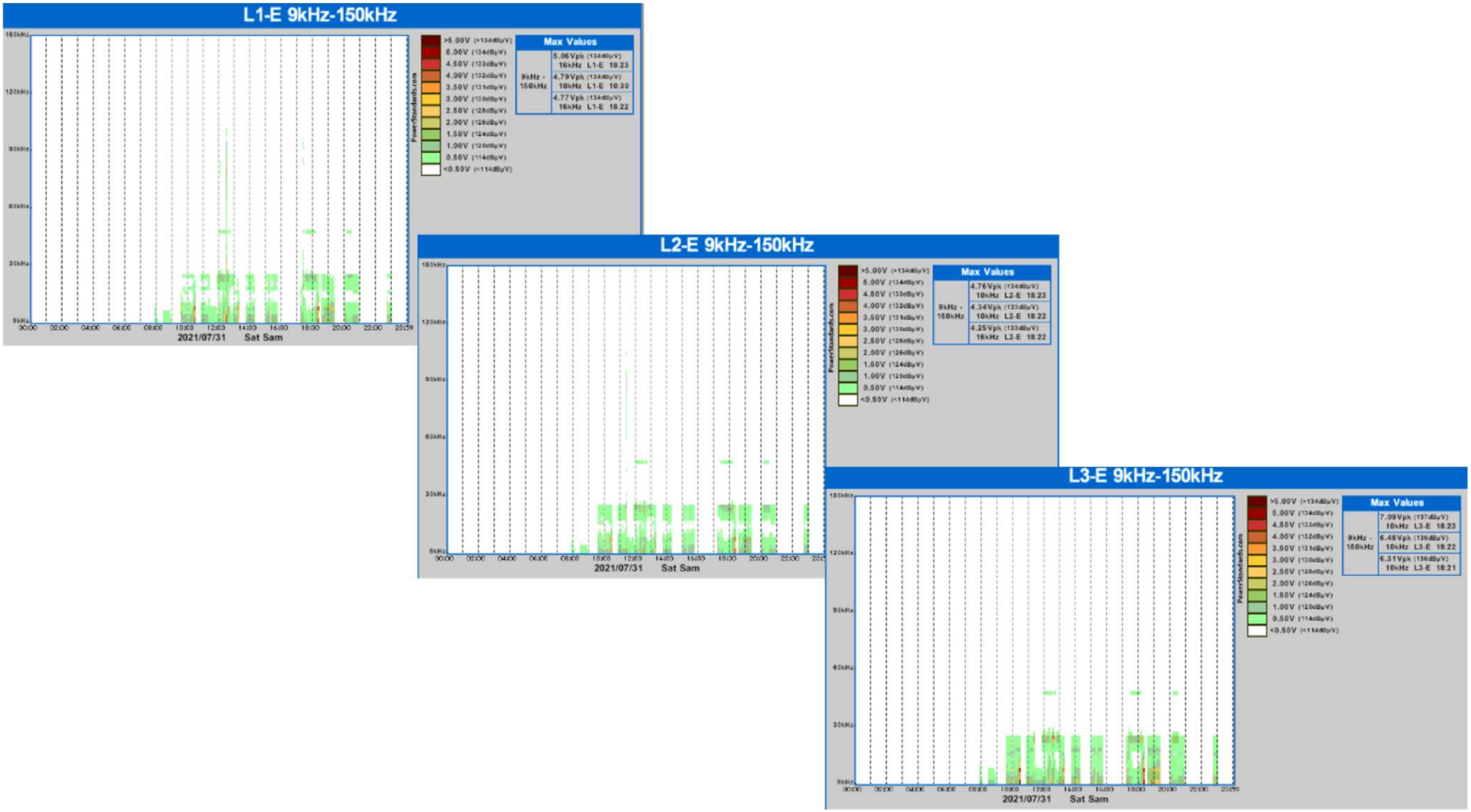
PQ Monitoring Results (3/6)

Supraharmonics 2-9kHz phases L1, L2 and L3 - Daily statistics (Saturday 07/31/2021)



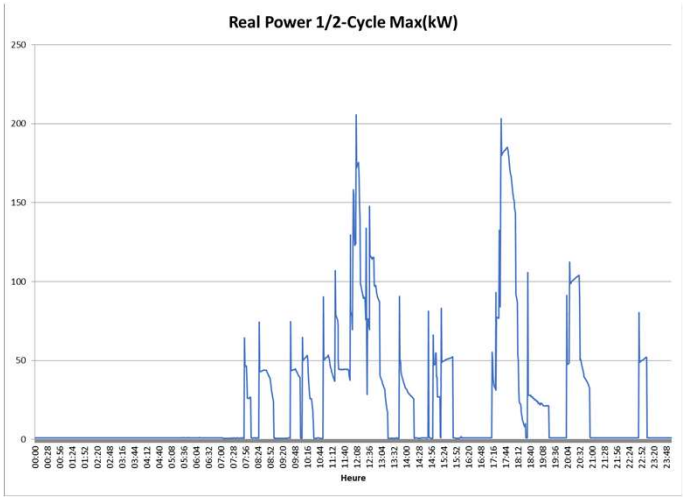
PQ Monitoring Results (4/6)

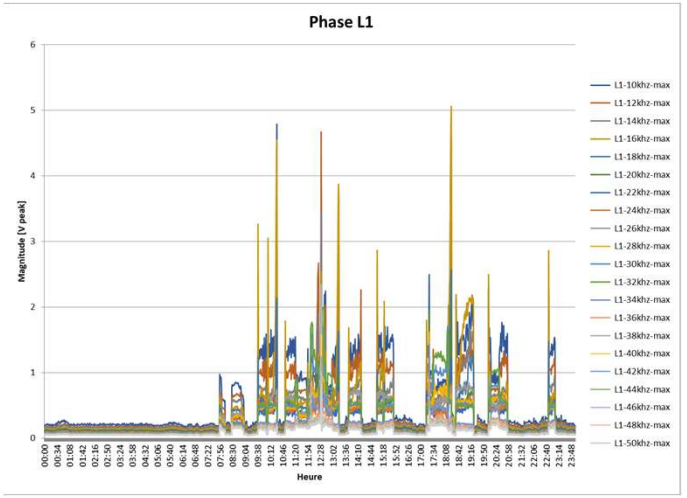
Supraharmonics 9-150kHz phases L1, L2, L3- Daily statistics (Saturday 07/31/2021)

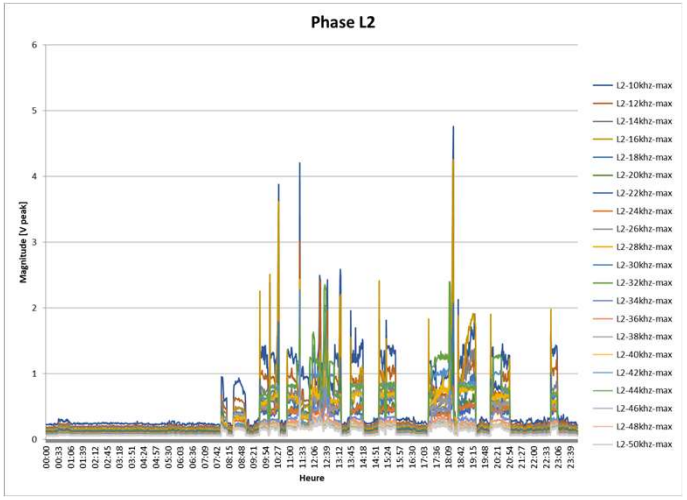


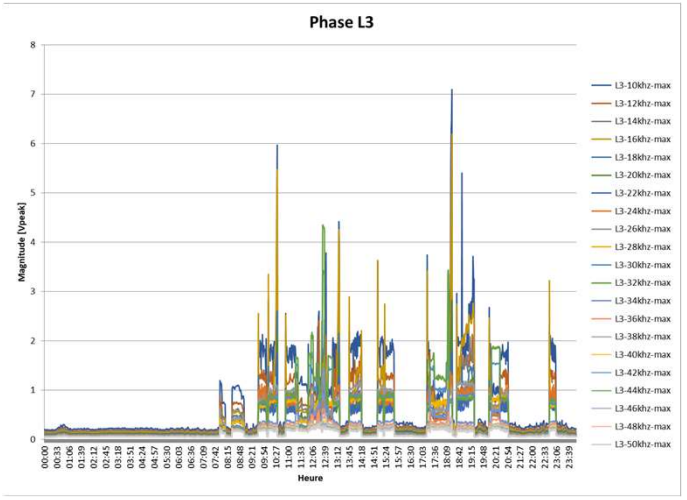
PQ Monitoring Results (5/6)

Real Power 3-phase - Daily statistics and Supraharmonics (10-50kHz) phases L1, L2 and L3 - Daily statistics (Saturday 07/31/2021)



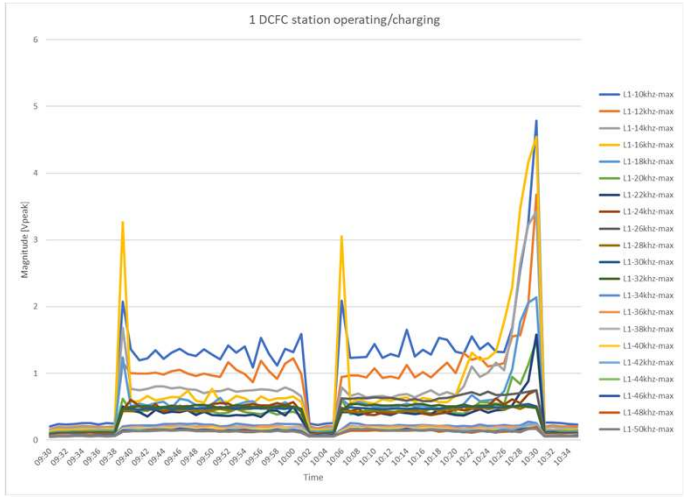


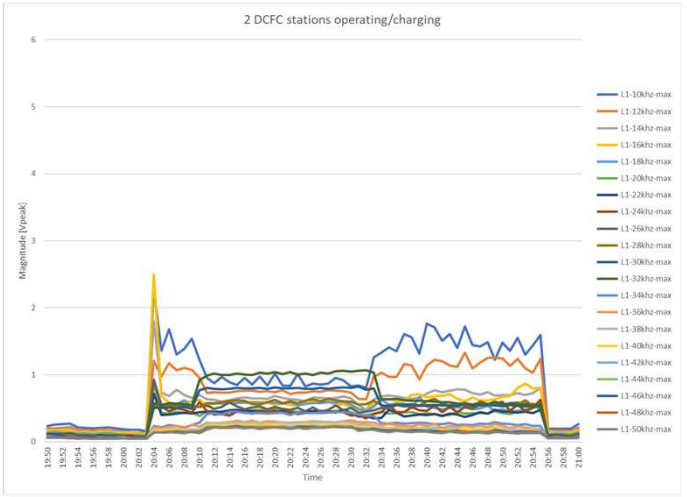


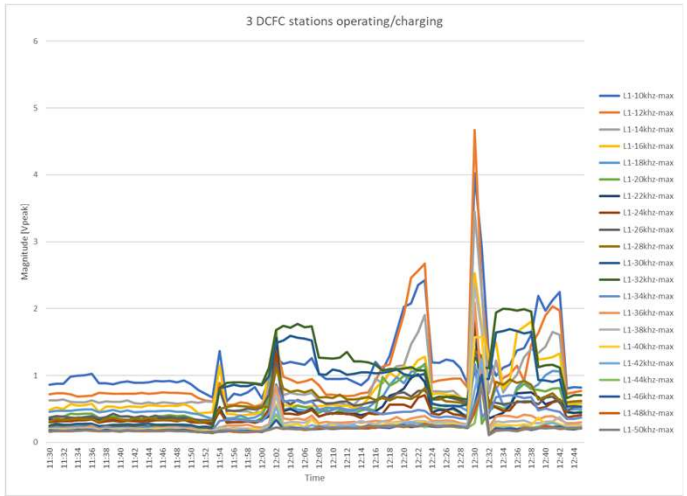


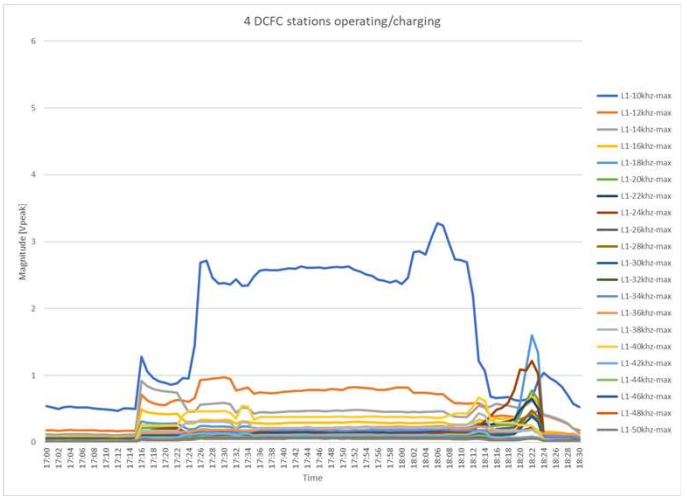
PQ Monitoring Results (6/6)

Supraharmonics 10-50kHz - Daily statistics (Saturday 07/31/2021) – 1, 2, 3 and 4 DCFC stations operating simultaneously









Conclusions (1/2)

- Studies in Europe and elsewhere have found supraharmonics in EV charging stations harmonic emissions, which are mainly generated by power electronics in power converters, components of EV charging stations.
- The analysis of the results from the PQ survey related to two EV charging superstations concluded:
  - The behavior of the DCFC stations (50kW/400V) connected to the distribution network is acceptable; EN 50160 limits are not exceeded.
  - Currant harmonic emissions (<3kHz) generated by superstations comply with limits suggested by the IEC 61000-3-12 standard.
  - Voltage harmonic emissions (<3kHz) measured at the POC of the EV charging superstations comply with the compatibility levels from IEC 61000-2-2 standard.
- Analysis of the active power plots allowed to approximate the number of EVs operating simultaneously. Together, active power and supraharmonic max values plots, facilitated the association of power peaks created by switching operations of the charging station converter with supraharmonic peaks.

Conclusions (2/2)

- They also helped to identify supraharmonic emissions and their levels during idle periods (zero active charging stations) or full-load stages of one at a time or two, three or four simultaneously active/operating charging stations. These four situations correspond to active power measurements up to 50, 100, 150 and 200 kW, respectively.
- The subject of the supraharmonics being relatively new, knowledge and control of the phenomenon is limited, although several studies are finalized or in progress and associated standards are still in production.

Trustworthy Industrial Cyber-Physical Systems

Dr. Rainer Falk

SIEMENS

Security must continuously adapt to the changing threat landscape

Changing threat landscape

Burglary over the Internet

Human misconduct and sabotage

Unauthorized access

D-DOS Attacks

Attacks on standard components

Ransomware

Changing infrastructure and processes

Increased connectivity, 5G

(Edge) Cloud Applications

IT standard components

Collaboration in the digital world

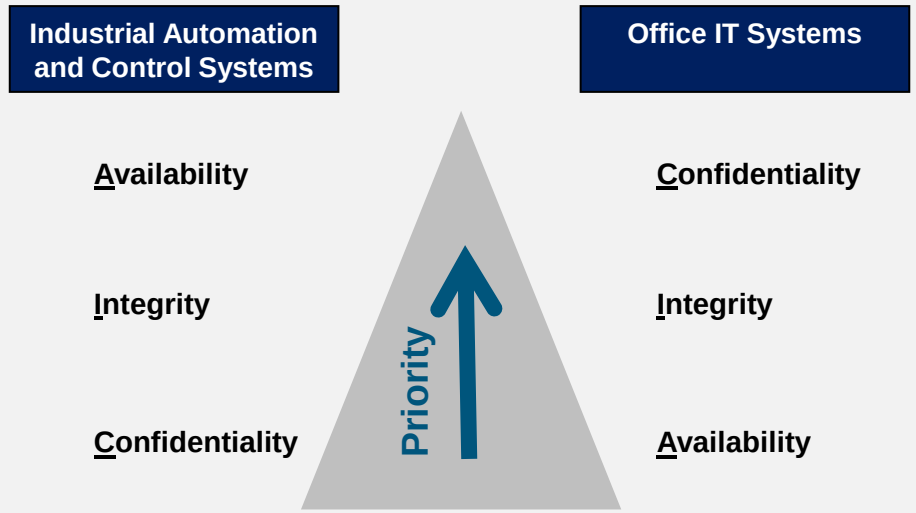
Big Data and Internet of Things

SIEMENS

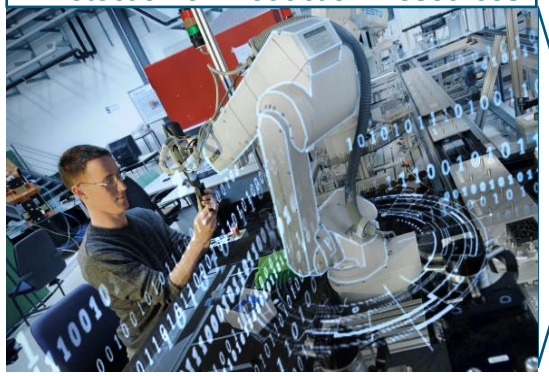
Industrial systems require a specific approach to cybersecurity

Applying security guidelines (and defined requirements, specific measures) suitable for enterprise IT directly to industrial systems does not work. A security design has to address the relevant security objectives and respect side conditions for the specific environment.

CIA Pyramid Turned Upside Down



Industrial Systems :
Protection of Production Resources



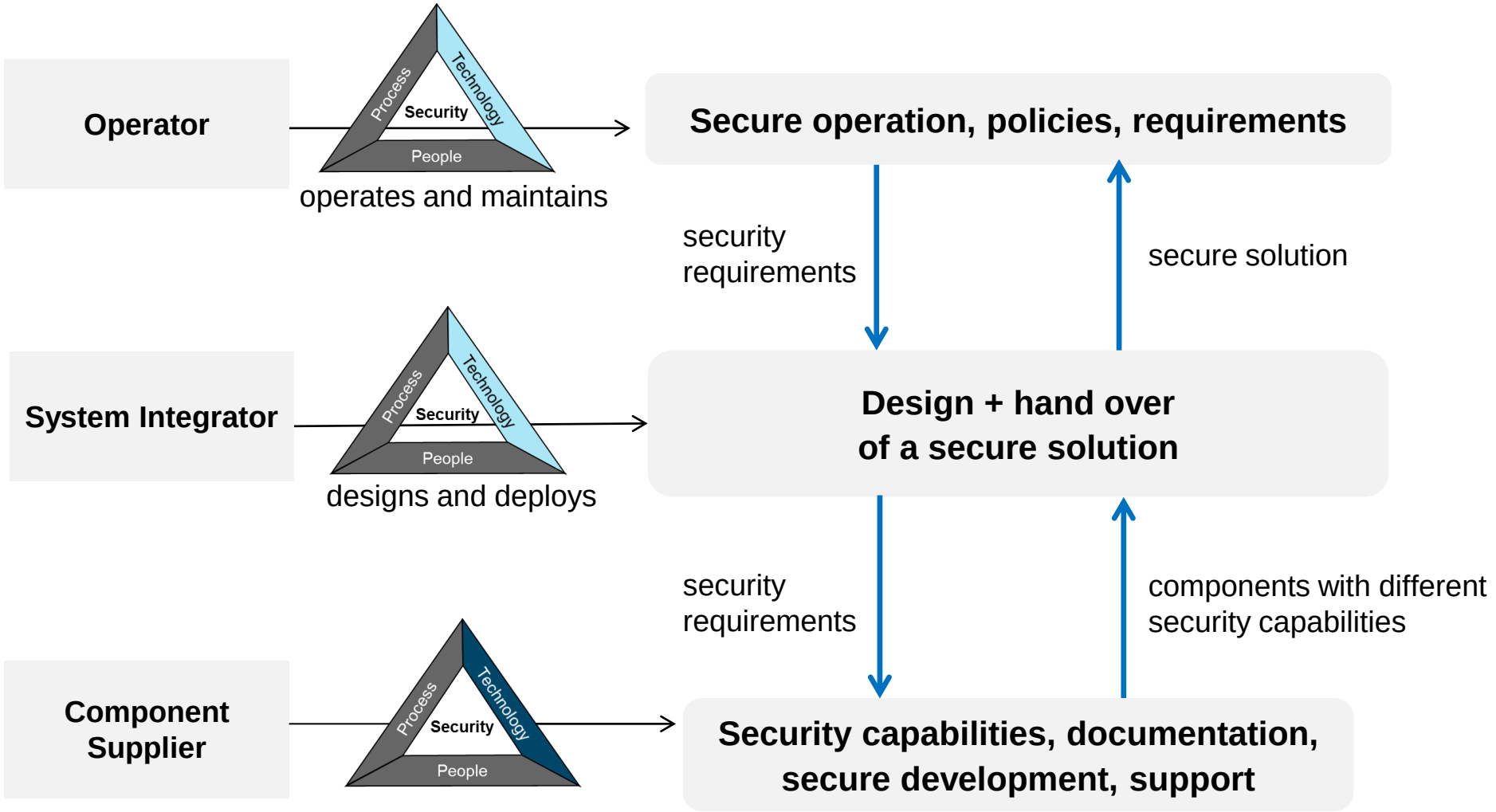
Lifetime up to 20 years and more

Office IT :
Protection of IT-Infrastructure

Lifetime 3-5 years

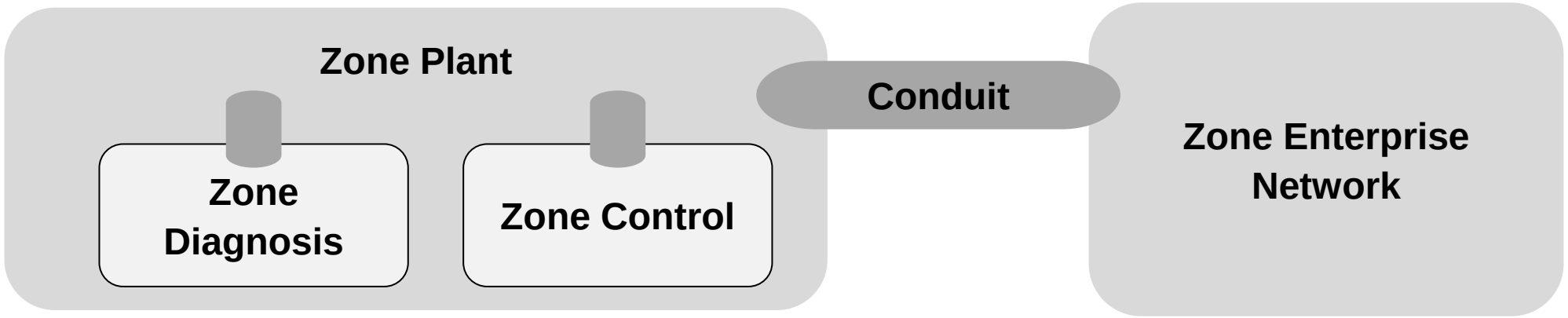
SIEMENS

The security standard IEC 62443 addresses security in a holistic way, suitable for an industrial environment including the responsible roles and products lifecycle



SIEMENS

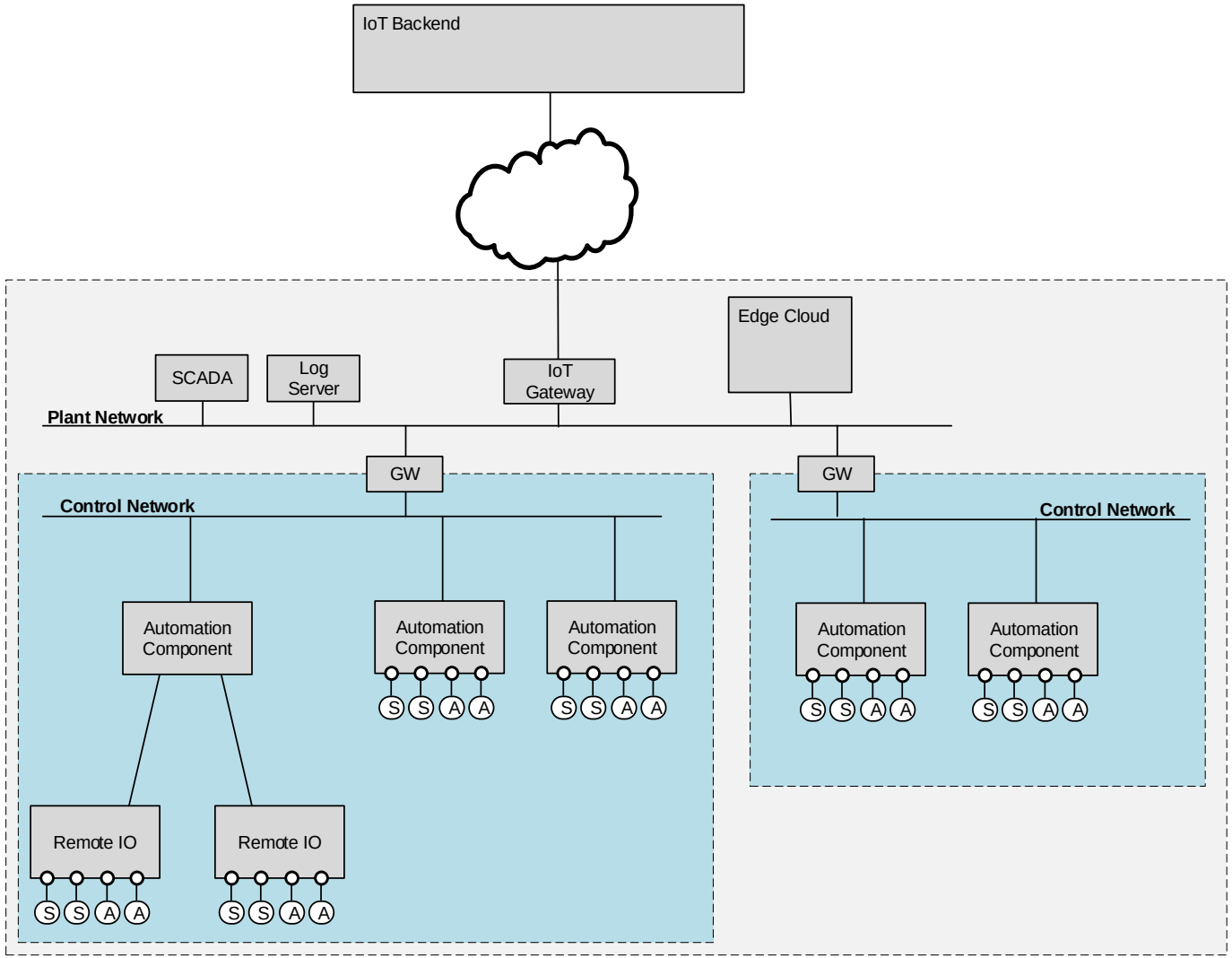
The security levels defined by IEC62443 provide for protection against different attack levels

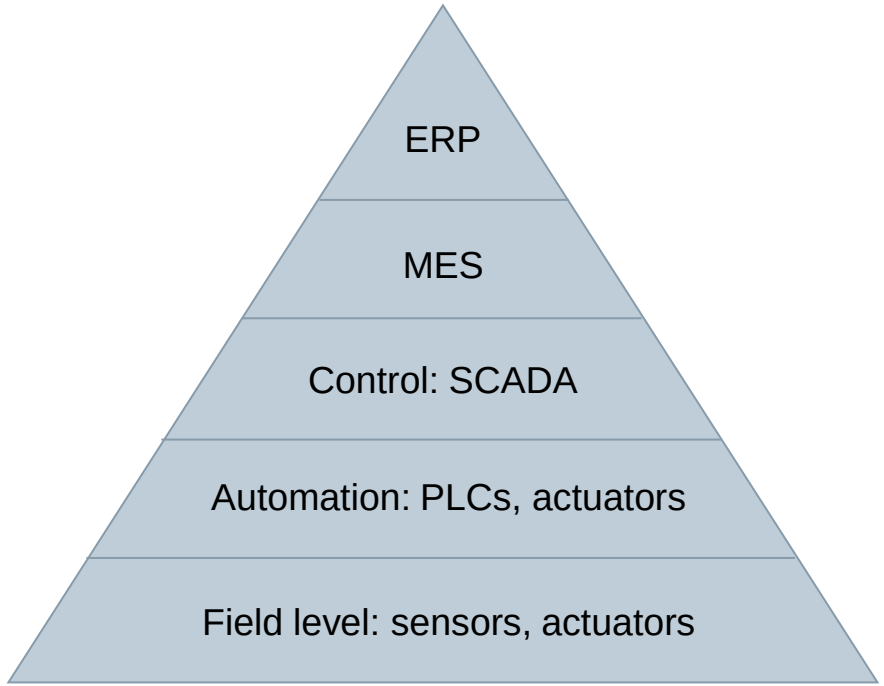


SL1	Protection against casual or coincidental violation
SL2	Protection against intentional violation using simple means, low resources, generic skills, low motivation
SL3	Protection against intentional violation using sophisticated means, moderate resources, IACS specific skills, moderate motivation
SL4	Protection against intentional violation using sophisticated means, extended resources, IACS specific skills, high motivation

SIEMENS

Cyber-Physical Systems: Control and monitoring functions are realized by software-based components

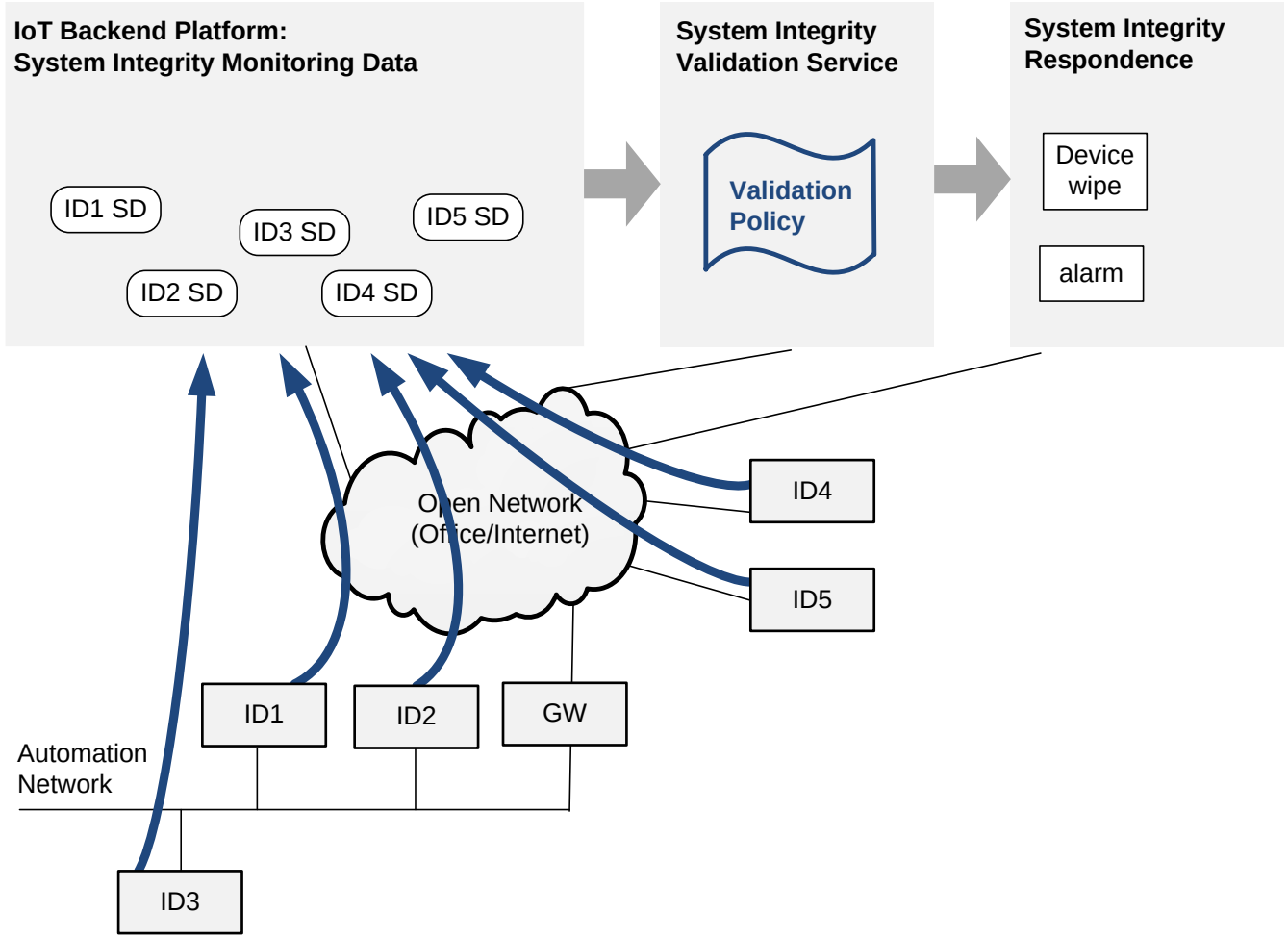




Automation Pyramid

SIEMENS

Besides secure system design and development, system integrity monitoring realizes an additional layer of defense



Integrated integrity monitoring of control systems and technical process:

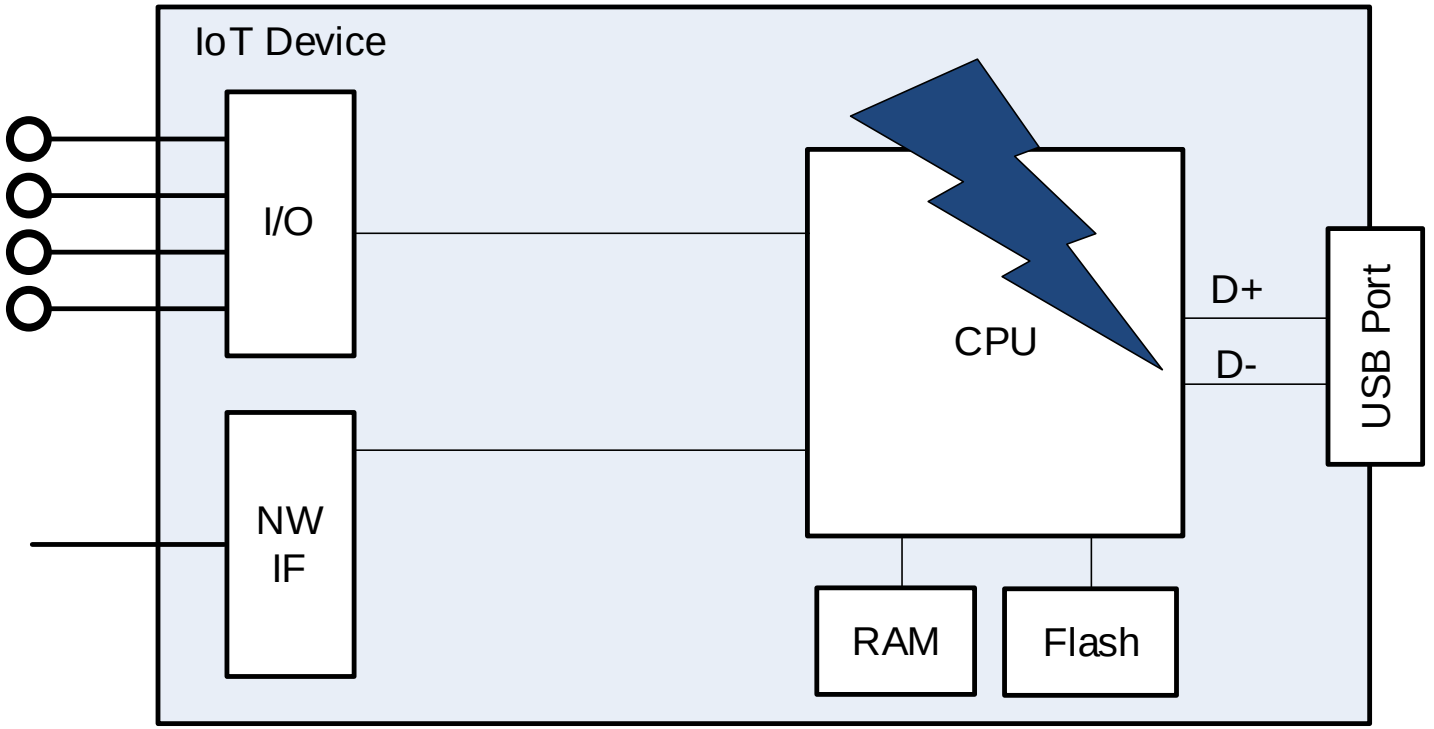
- Device inventory
- Runtime device integrity measurements
- Network monitoring
- Physical automation process monitoring
- Power monitoring
- Physical world integrity (trusted sensors)

SIEMENS

It has to be considered that attackers could successfully attack and manipulate IoT devices

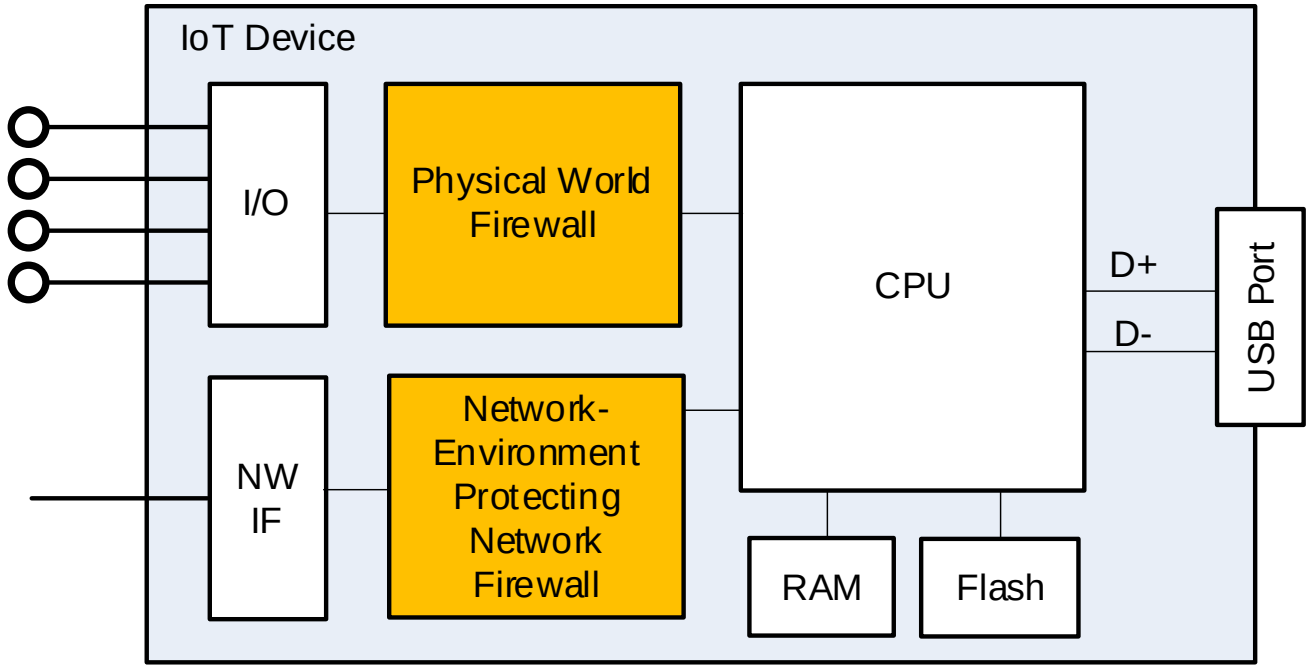
Impact on Physical World

Impact on other IoT Devices



SIEMENS

The impact of a successful attack on an IoT device can be reduced to enhance “resilience under attack”



- Impact of successful attack on IoT device on both the network environment as well as on physical world is limited.
- Protection against using the manipulated IoT device for launching attacks on other systems

SIEMENS

Security has to be suitable for the addressed environment.

Awareness and Acceptance

Since security is not just a technical solution, which can be incorporated transparently, we need to consider how humans can get along with this issue.

This needs, especially for automation environments, actions for:

- awareness trainings
- help people to understand security measures and processes
- provide user-friendly interfaces and processes

SIEMENS

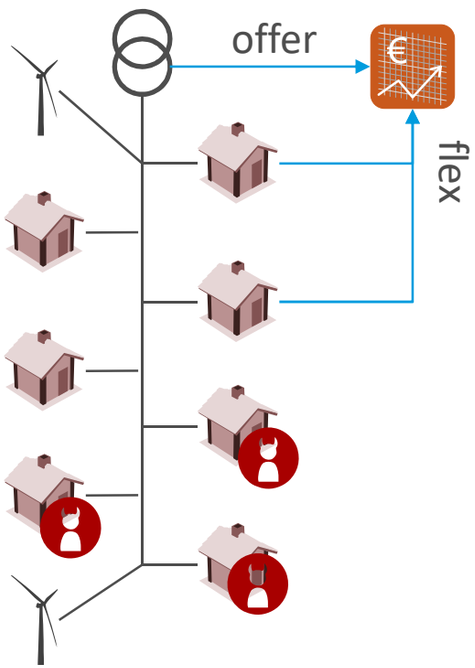
Energy Markets Will Introduce New Attack Vectors into CNI

“Hail Communism” instead?!

> Eric MSP Veith

Reactive Power Markets

How We Can Increase The Share Of Renwables



> The World Past: all consumers

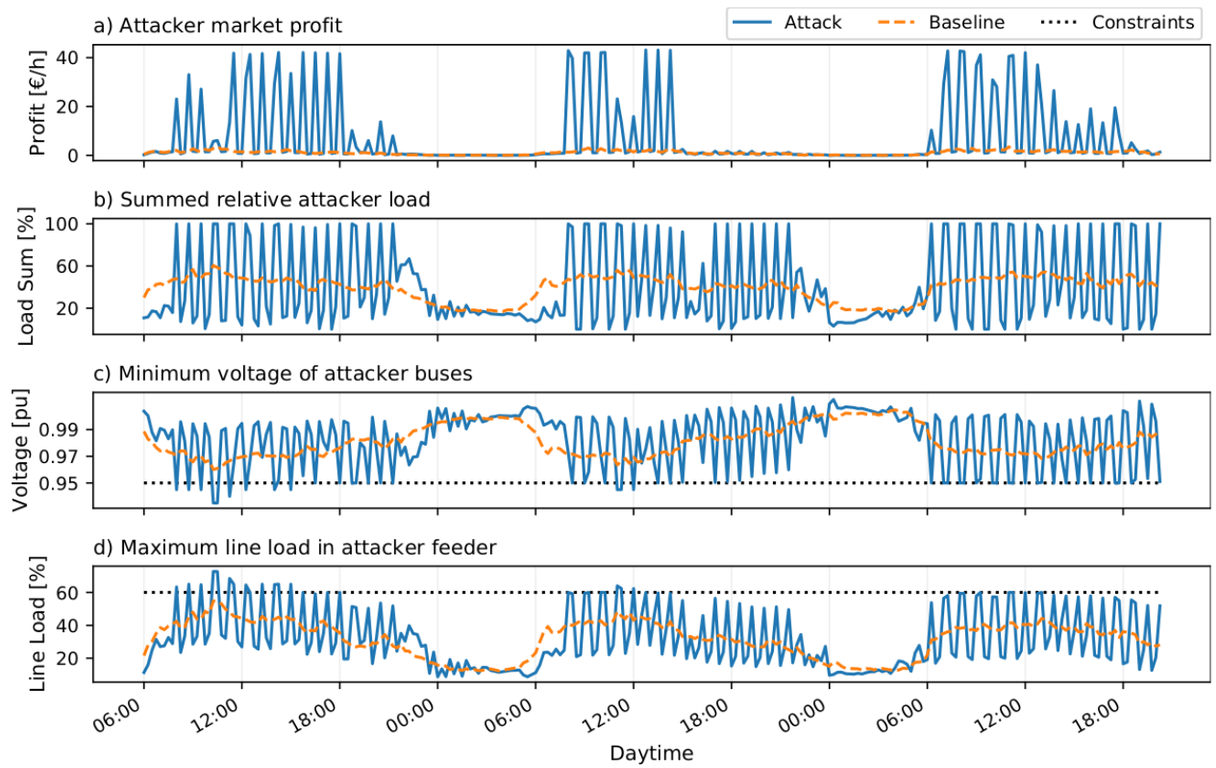
> The New World: Prosumers + DRERs

> Problem: No unidirectional power flow any more, grid management becomes hard.

> Solution: Self-organization using markets

> New World Problem: Agents create artificial shortages, form coalitions to make problem imminent, solve it: Profit!

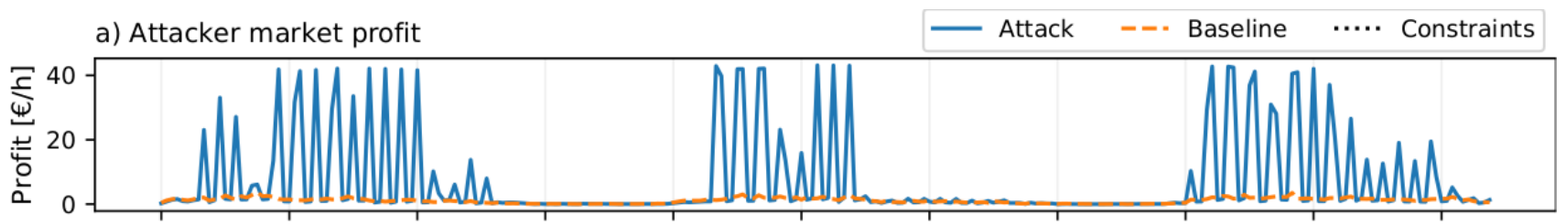
Agents Game The Market

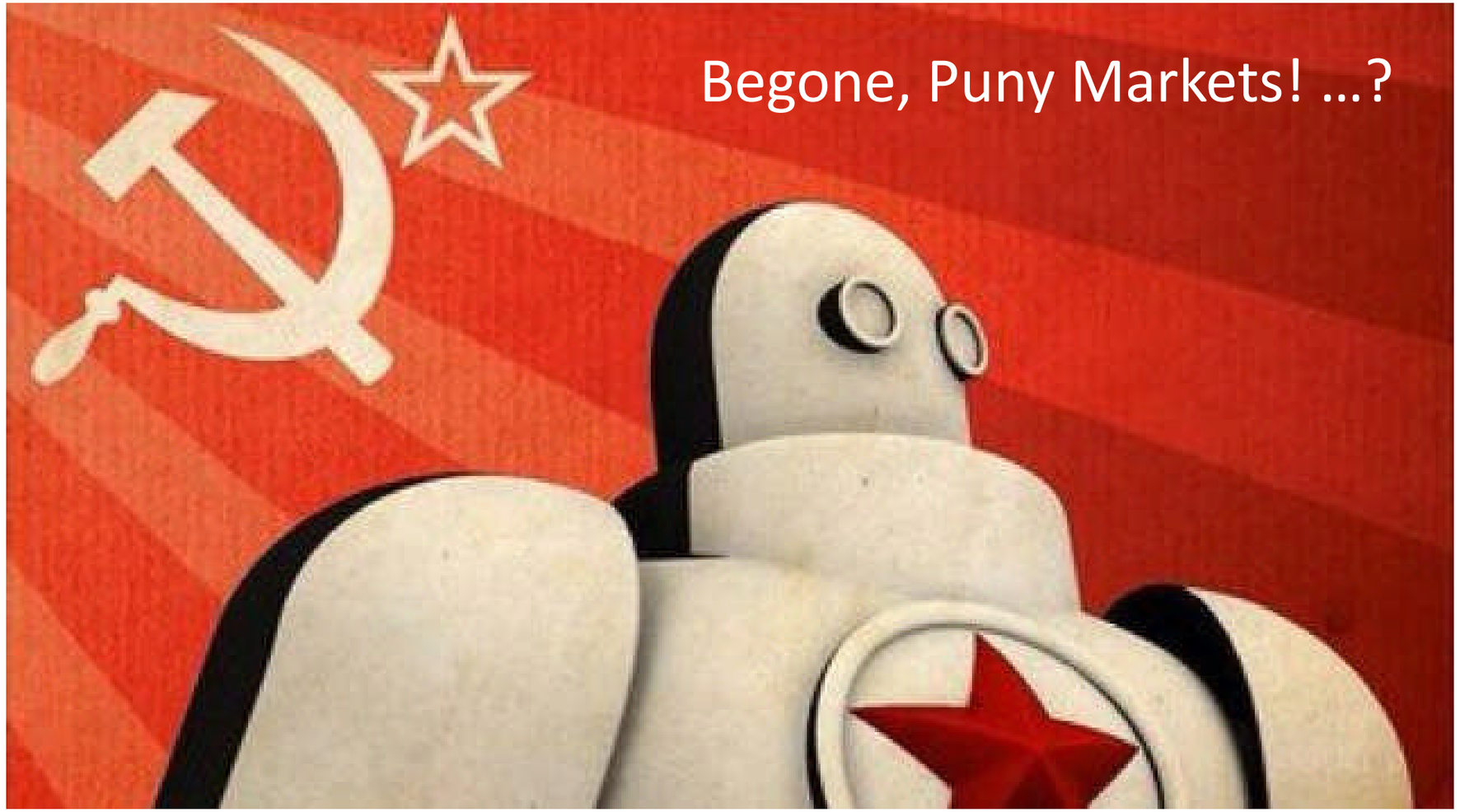


Agents Game The Market

It Happens Naturally

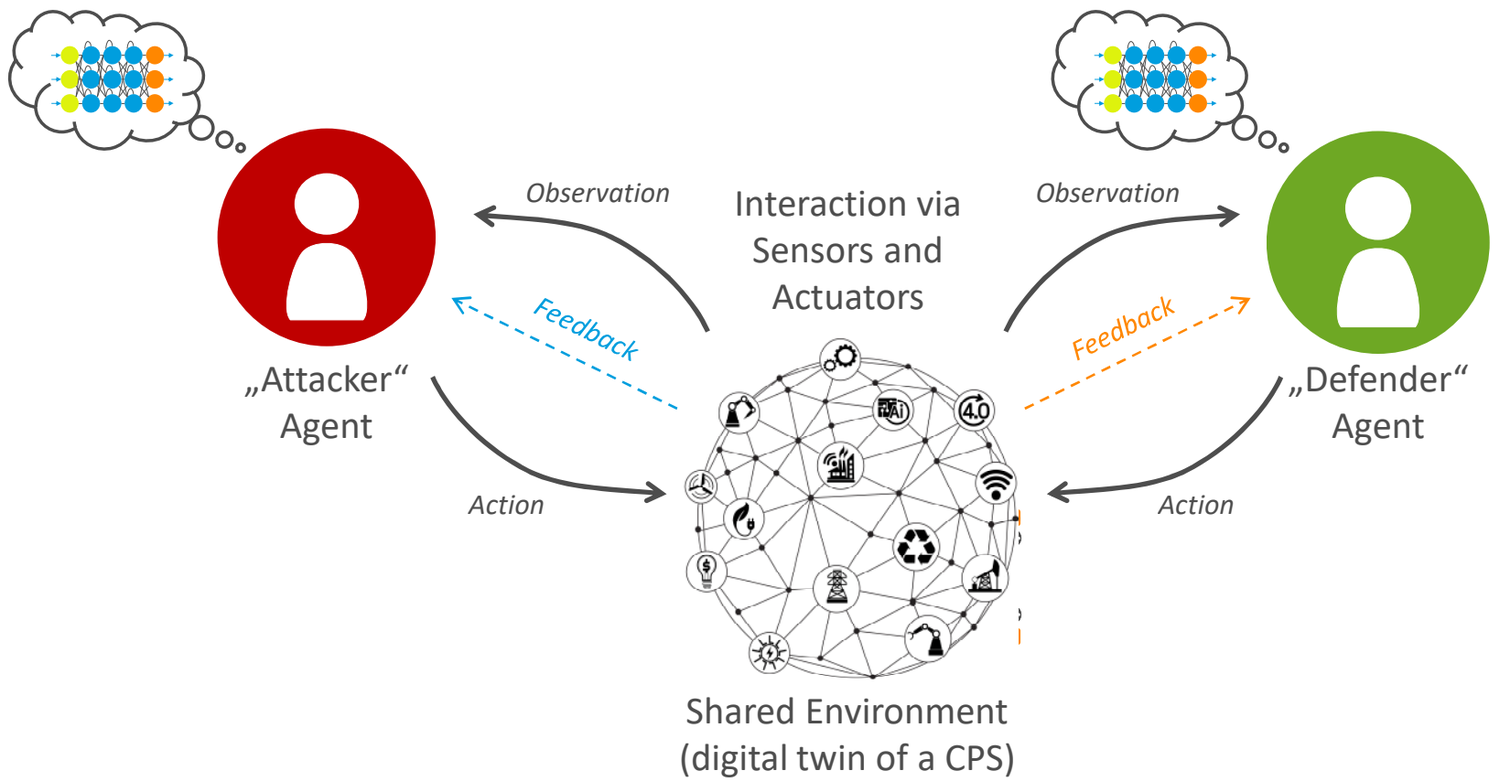
Forming colations to game the market is the natural cause of a rational agent.



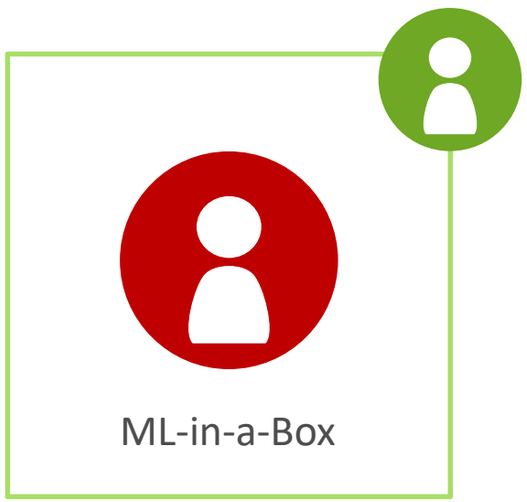

Begone, Puny Markets! …?

Learn Resilient Markets

First Find Out What Can Possibly Go Wrong



Putting The Agent In The Box



Defender + XAI
= Safety Box

- Neither markets nor ML nor agents are a bad idea.
- Use ARL defender to find out what is good
- Put foreign agents in a “Box”: Allow only sensible actions
- Sensible: Model-based!