

# Climate Change Is A World-Wide Catastrophe.

Damages worldwide until 2060:

- 20 trillion USD iff  $\leq 1.5^{\circ}\text{C}$
- 44 trillion USD iff  $\leq 2.6^{\circ}\text{C}$
- 72 trillion USD iff  $\leq 4.5^{\circ}\text{C}$



# GREEN 2021 Conference

## AI vs Climate Change

How AI Creates  
Resilient and Efficient Planning & Design  
for Green Renovation Projects

> Lasse Hammer – OFFIS e.V.

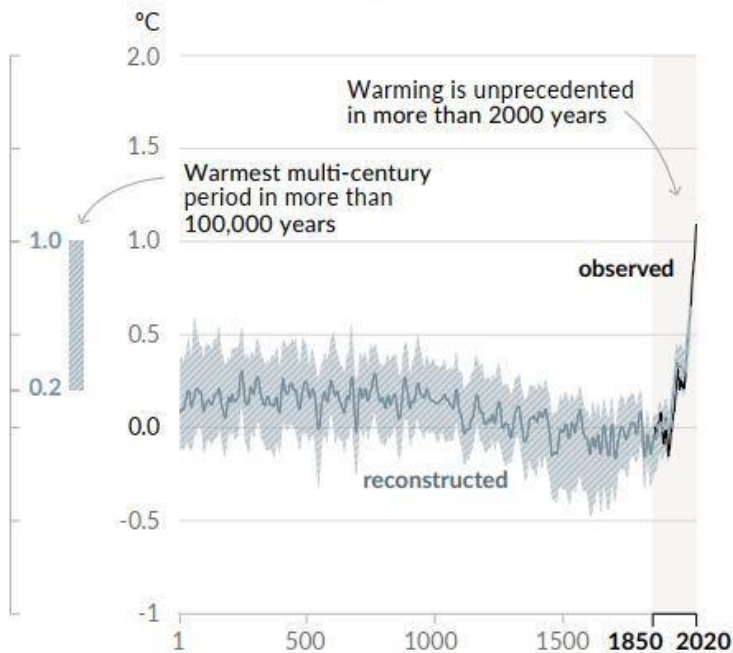
**Status Quo**

**RenovAlte Project**

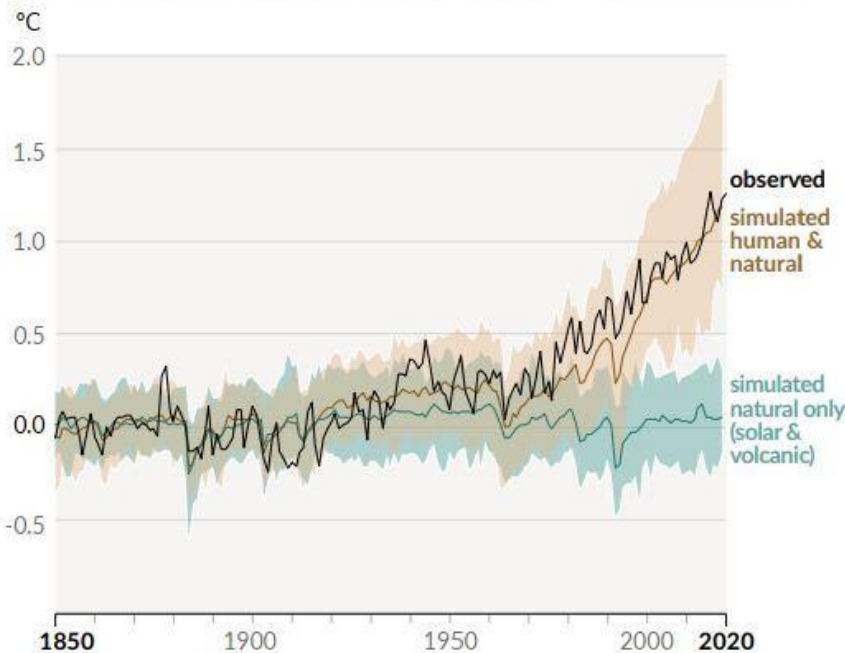
**Adversarial Resilience Learning**

### Changes in global surface temperature relative to 1850-1900

a) Change in global surface temperature (decadal average) as **reconstructed** (1-2000) and **observed** (1850-2020)



b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)



IPCC Report 2021, Fig. SPM.1





# The Climate Catastrophe Has Long Since Reached All Countries.

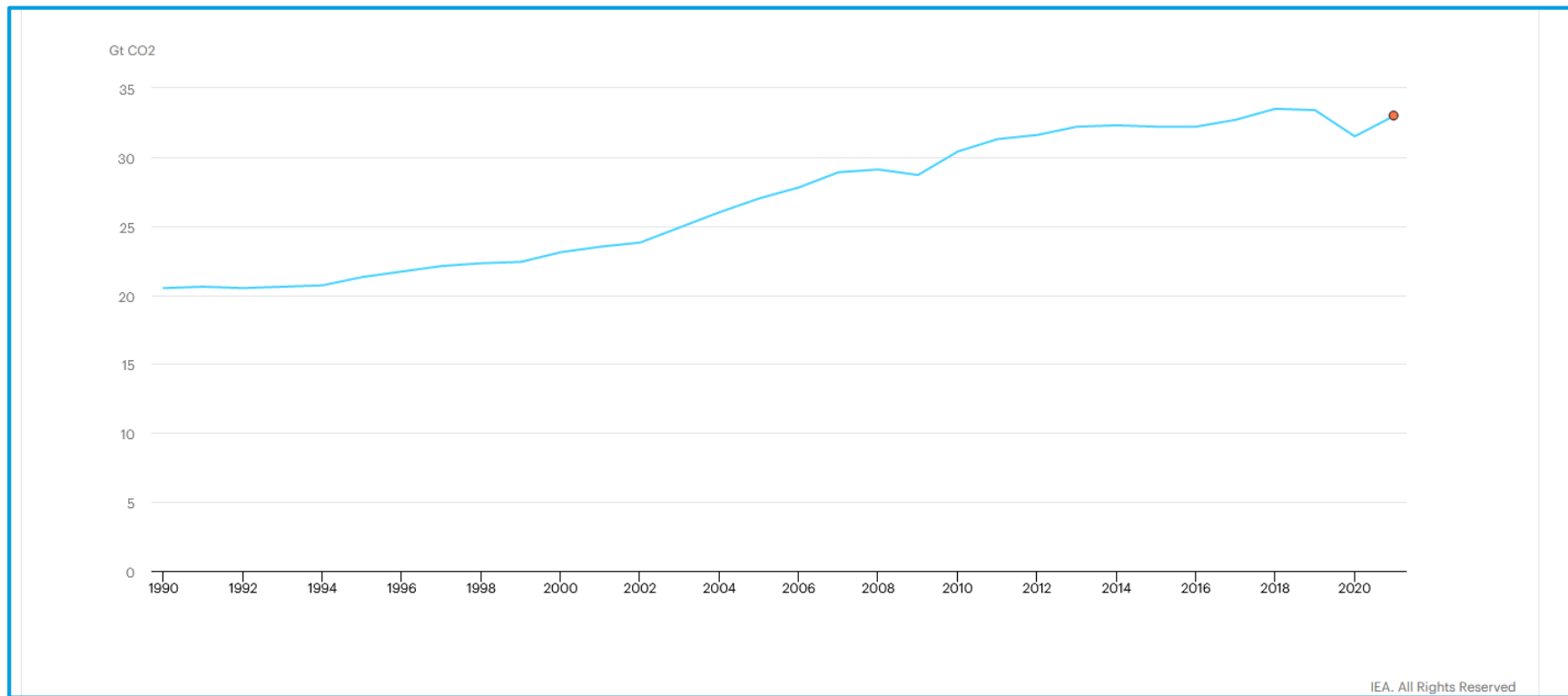
Germany: 2021 fourth year in a row with substantially lower crop yields (-2.8% winter corn).



An aerial photograph showing a residential area in Germany that has been severely flooded. The floodwater is a murky, brownish-yellow color and has inundated the yards and streets between several houses. The houses have dark roofs, and some have solar panels. To the left of the flooded area, a multi-lane highway runs parallel to the flood. Several vehicles, including a red truck and a white car, are visible on the highway. The floodwater appears to be quite deep, reaching up to the roofs of some smaller structures. The surrounding area includes some green trees and a road with parked cars on the far left.

# 2021 Flood in Germany (Ahr)

# Global CO<sub>2</sub> emissions are still rising





Buildings are responsible for 38% of global CO<sub>2</sub> emission.





Germany plans reduction by  
67% until 2030.



# Renovation and insulation of existing buildings





Impact of changing  
environment?





## Surfside Champlain Towers South Condo Collapse & the Science of Concrete [Video]

TOPICS: American Chemical Society Concrete  
By AMERICAN CHEMICAL SOCIETY OCTOBER 22, 2021



## Shortages of materials and skills are holding builders back

Construction output is falling as a result of material price increases and skills shortages; restricting smaller builders' ability to recover from the pandemic.

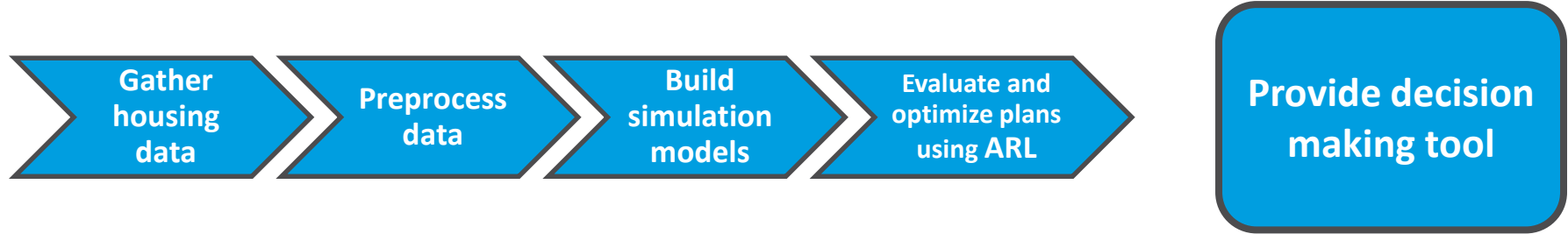
**Optimize renovation plans to be robust in a changing environment!**

# The RenovAlte Project







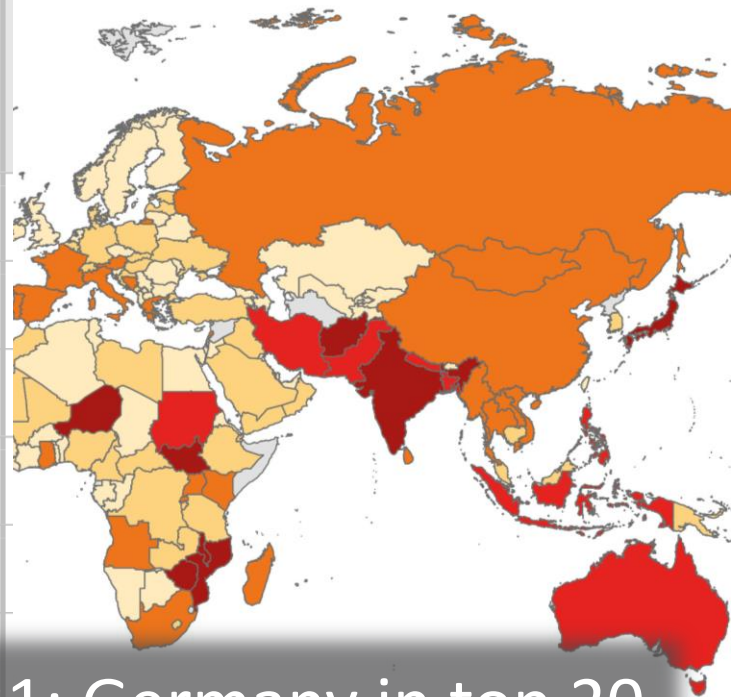


# Climate Catastrophe Changes The Game Rapidly

Not Just The “Usual Suspects”




Ranking 2012 (2011)	Country	CRI score	Death toll	Deaths per 100,000 inhabitants	Absolute losses (in million US\$ PPP)	Losses per unit GDP in %
1 (37)	Haiti	6.83	128	1.23	1220.66	9.53
2 (4)	Philippines	10.33	1408	1.47	1205.48	0.29
3 (3)	Pakistan	12.67	662	0.37	6087.82	1.11
4 (22)	Madagascar	15.67	113	0.50	356.98	1.69
5 (131)	Fiji	17.00	17	1.89	135.55	3.18
6 (36 <sup>9</sup> )	Serbia	17.67	28	0.39	1325.06	1.70
7 (131)	Samoa	18.33	6	3.28	220.91	19.57



Climate Risk Index 2012

... 2021: Germany in top 20



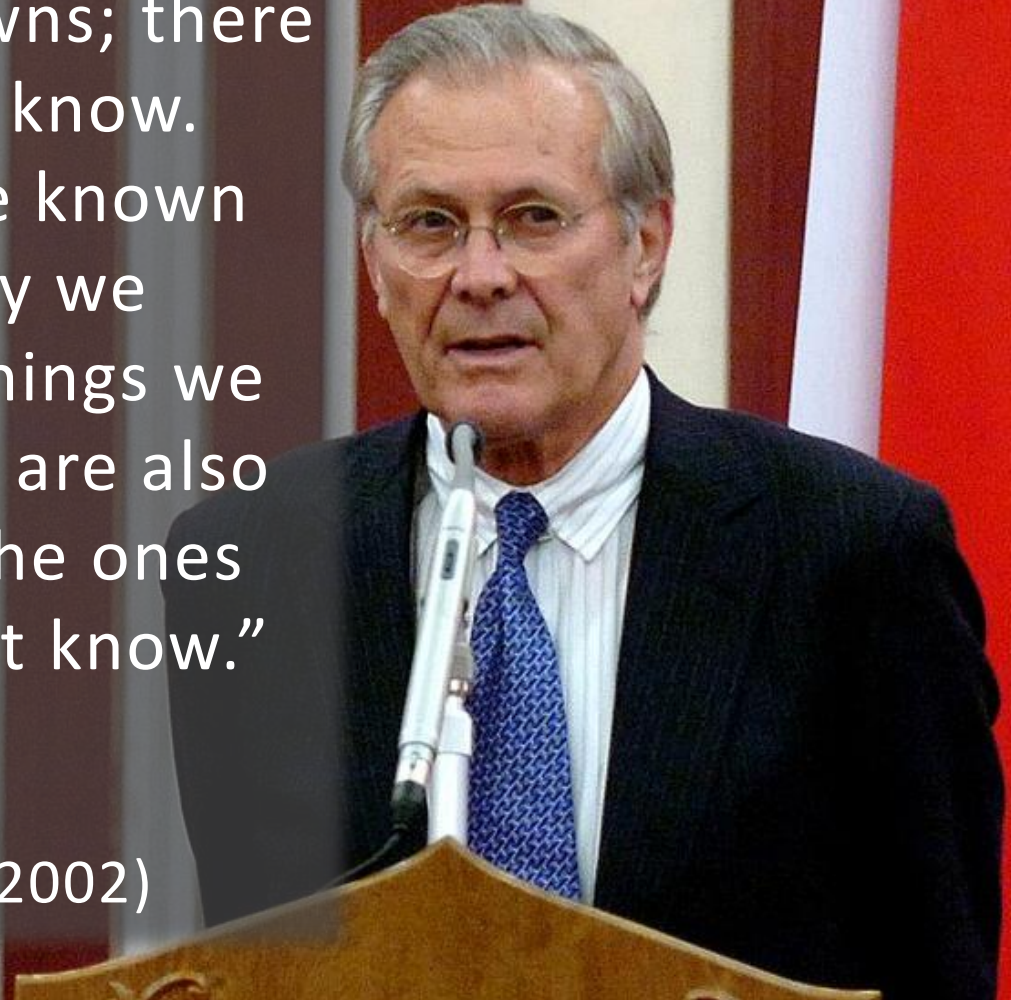


Can You “Optimize” Against Climate Change?



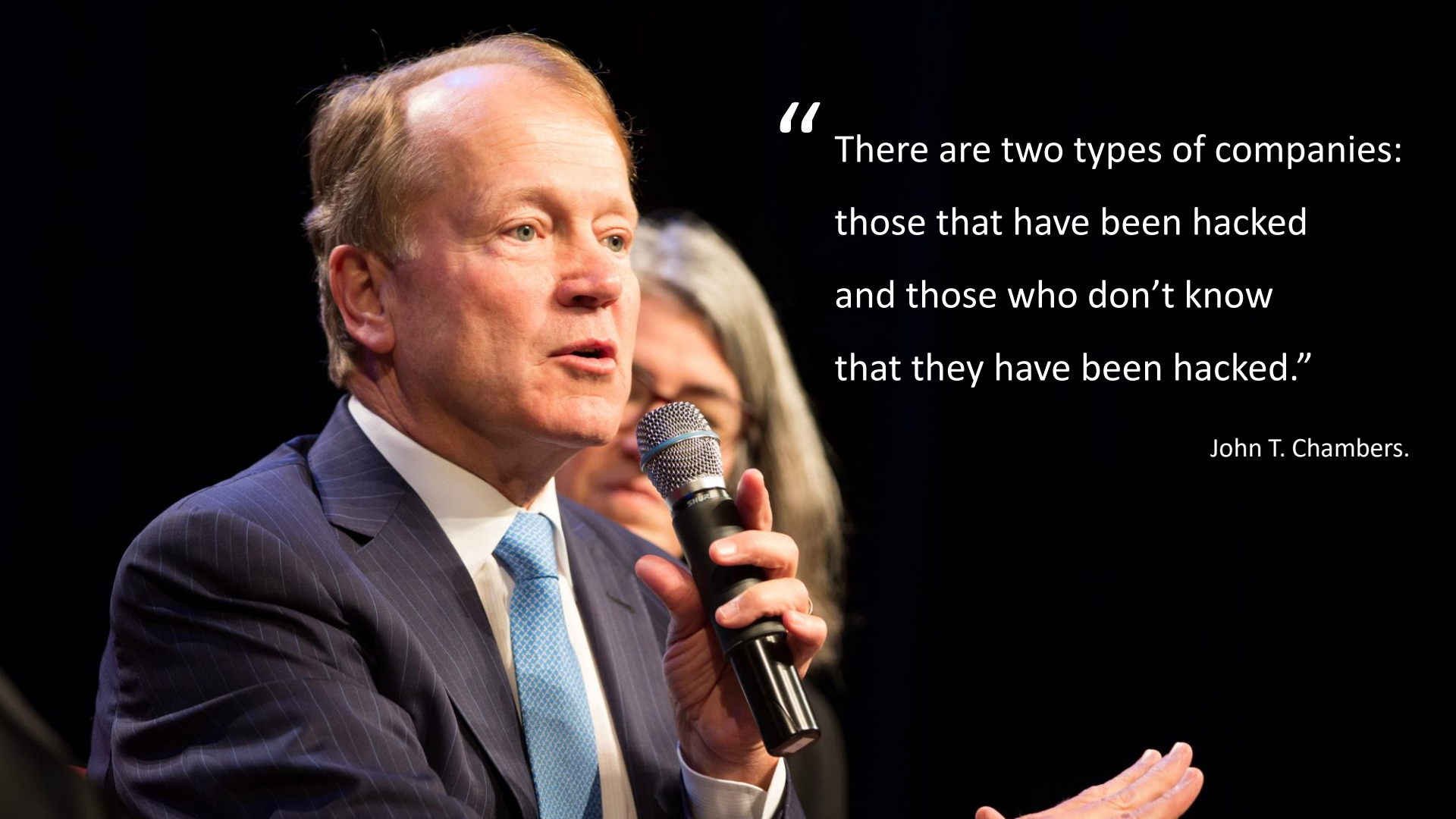
“There are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns - the ones we don't know we don't know.”

– Donald Rumsfeld  
(Press Conference Feb 12, 2002)



# Cyber Security for Critical National Infrastructures Has Many Unknown Unknowns.



A photograph of John T. Chambers, a middle-aged man with light brown hair, wearing a dark blue pinstripe suit, a white shirt, and a blue patterned tie. He is holding a black microphone in his right hand and gesturing with his left hand. The background is dark, and another person with long grey hair is partially visible behind him.

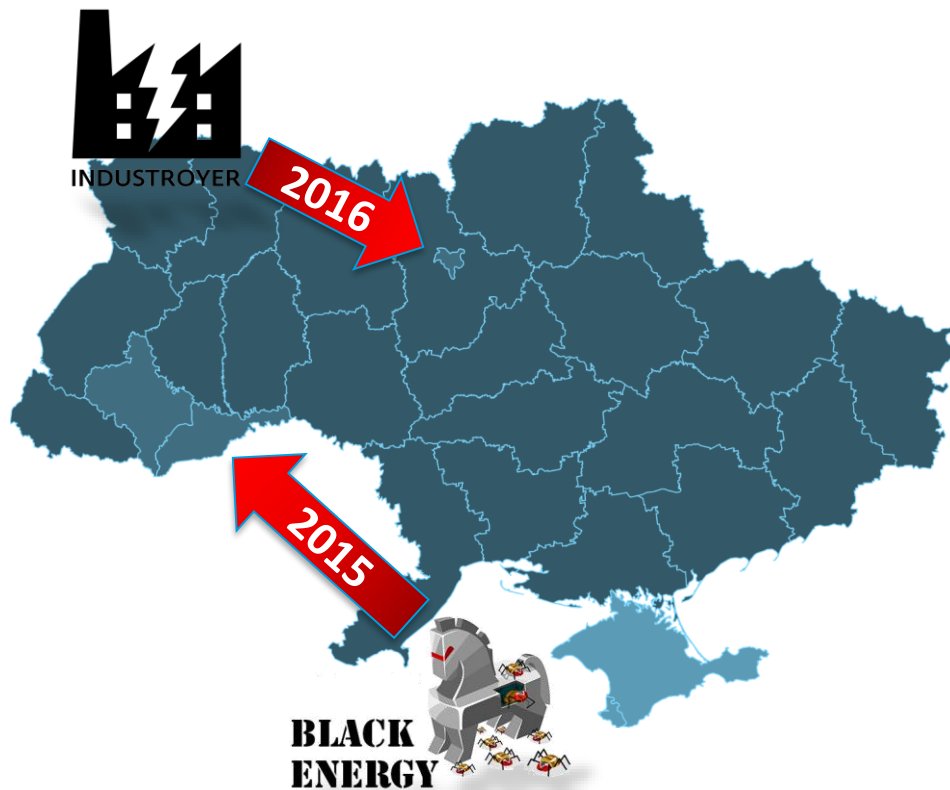
“ There are two types of companies:  
those that have been hacked  
and those who don’t know  
that they have been hacked.”

John T. Chambers.



# Applies to Critical Infrastructures, too

Attack against the Ukrainian Power Grid



**Dec 23<sup>rd</sup>, 2015**

- > Cyber Attack leads to **Blackout**
- > **3 Grid Operators** targeted
- > Operative **Intrusion into Control Systems**
- > Disconnect of **several Transformers**
- > Several Months in Preparation

**2016**

- > **Highly automated** Variant

**Our infrastructures are valuable targets.**



TLP: White

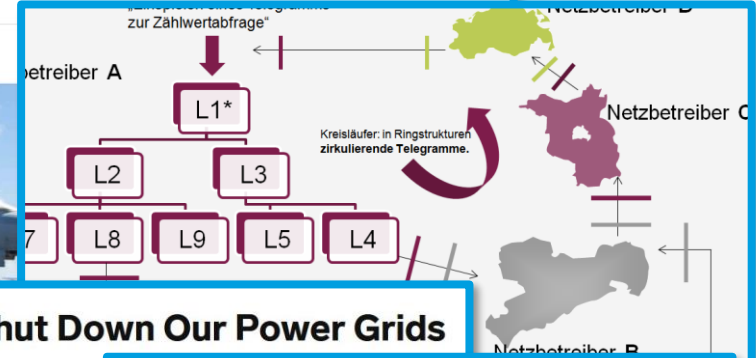
## Analysis of the Cyber Attack on the Ukrainian Power

Defense Use Case

March 18, 2016

## Covert Military Information Operations and the New NDAA: The Law of the Gray Zone Evolves

Walter Chesney Tuesday, December 10, 2019, 5:03 PM



## NSA Director: Yes, China Can Shut Down Our Power Grids

AP KEN DILANIAN, Associated Press Nov 20, 2014, 6:28 PM

China and "one or two" other



ANDY GREENBERG SECURITY 07.06.2017 11:36 PM

## Hack Brief: Hackers Targeted a US Nuclear Plant (But Don't Panic Yet)

Hackers have reportedly targeted US energy utilities, and may be laying the groundwork for blackouts. But they may yet be a long way from that goal.

## Russian hackers hit Ireland's power grid in another cyberattack on UK's critical infrastructure

Although there is no evidence to suggest that Irish energy networks were disrupted, security experts reportedly believe hackers have stolen data.



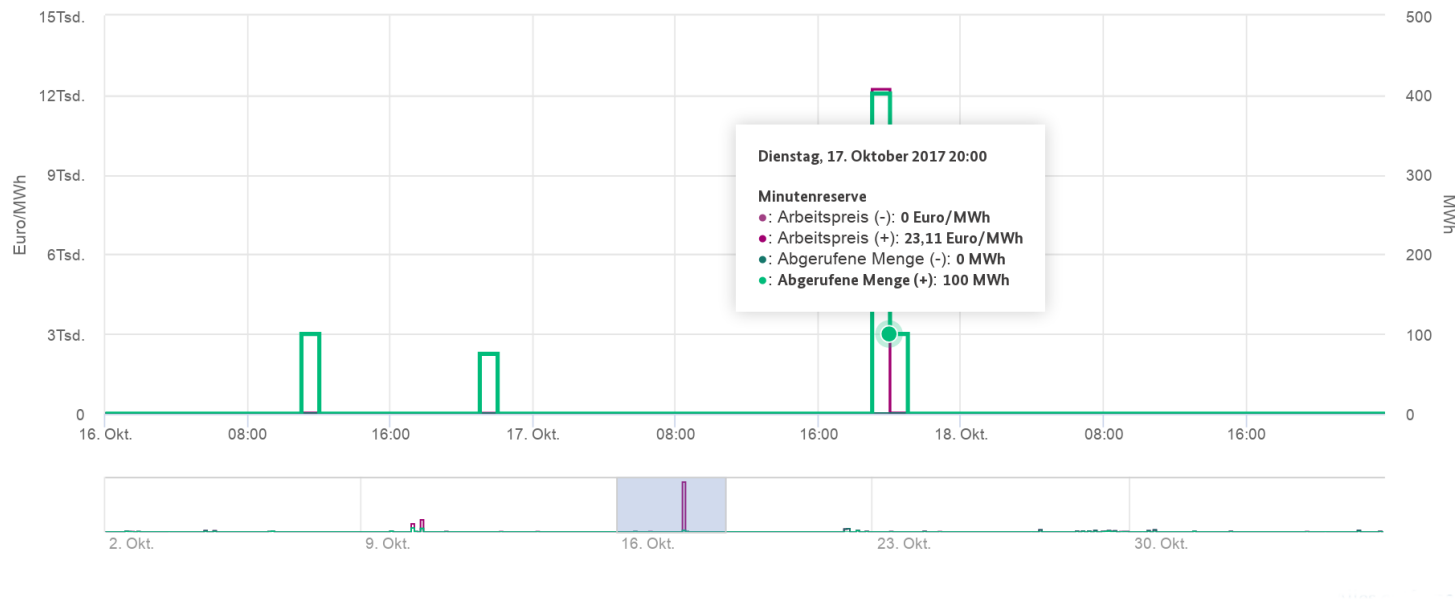
By India Ashok

July 17, 2017 09:56 BST



# Market can also be the Culprit

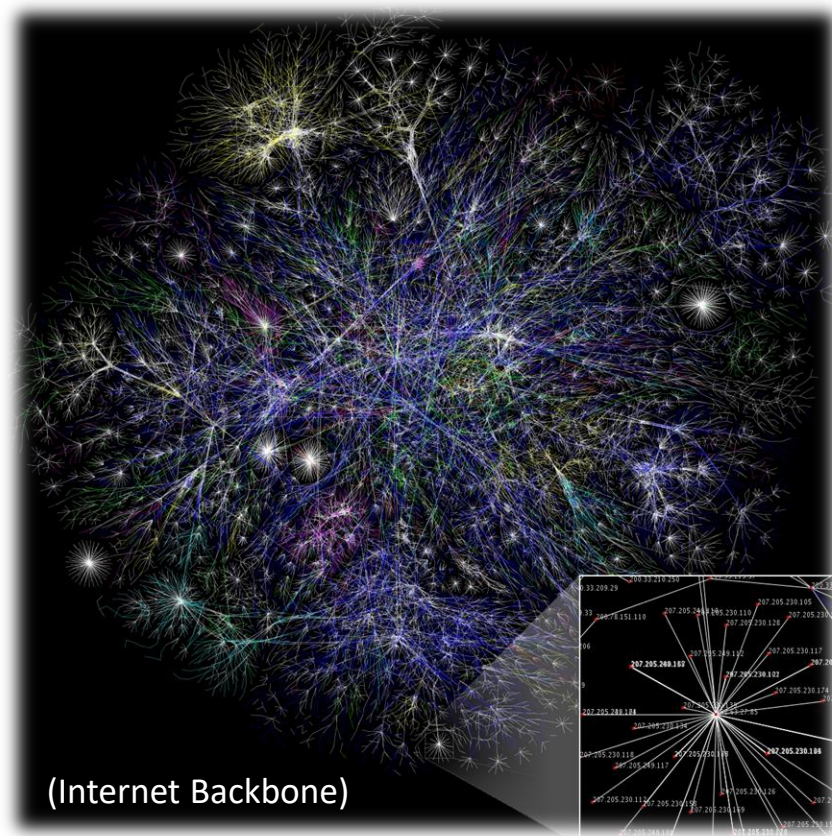
## Gaming a Critical Infrastructure?







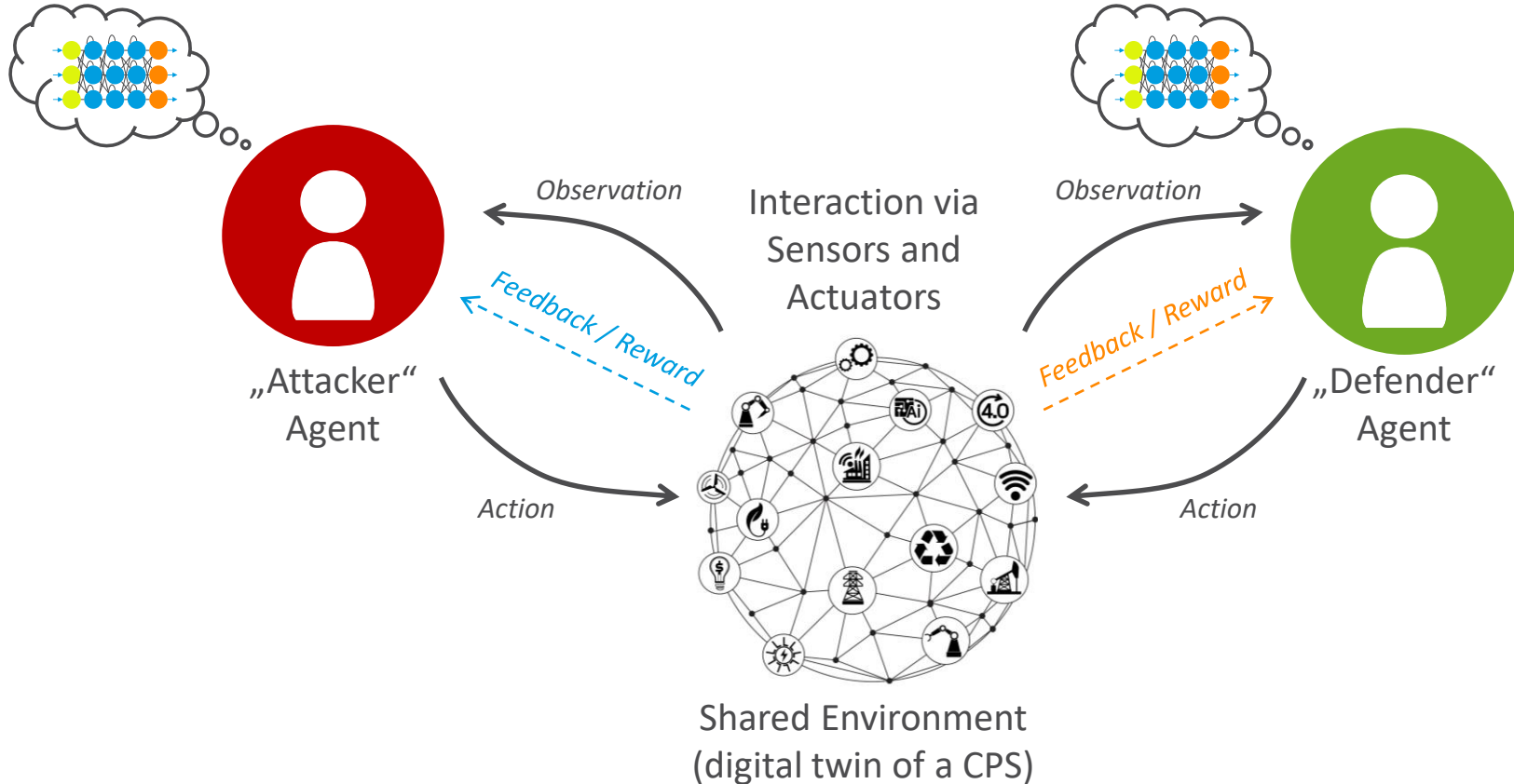
- > Interconnected CPS have always attack surface **due to their inherent complexity**
  - > Low latency of ICT and OT
  - > High interdependence
  - > Complexity in breadth and depth
  - > Critical Services as SPOF (DNS, BGP, SCADA, SDL)
- > Learning Strategies for **automatic issue mangement**



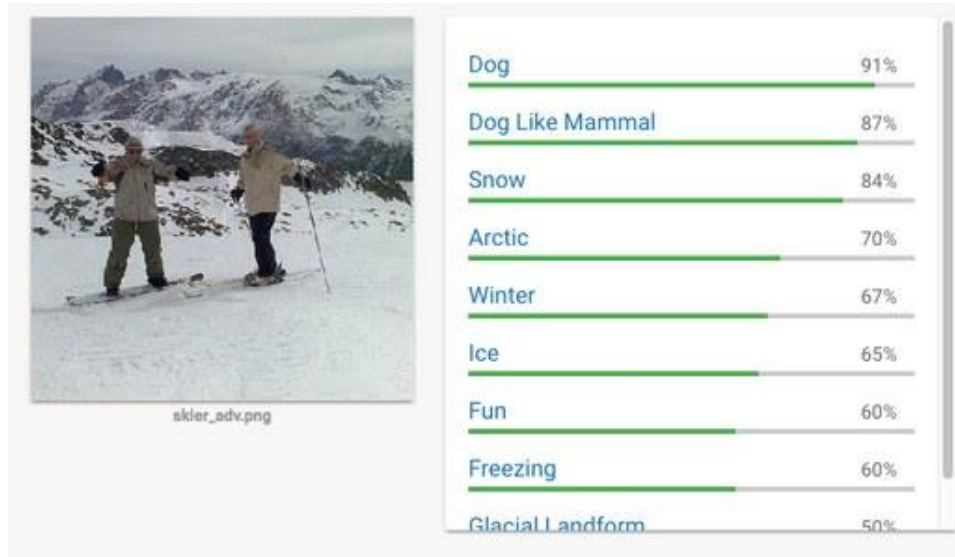
(Internet Backbone)

# Adversarial Resilience Learning Concept

Competing Agents Learn in a Shared Environment



- > Attempt to modify input data slightly in order to yield extremely different output from ANN
- > Modification of data not or only slightly visible to humans
- > Ex: RGB noise on a picture, small textual changes in spam messages
- > AL: Finding mechanisms against these attacks





# Generative Adversarial Networks

ARL != GAN



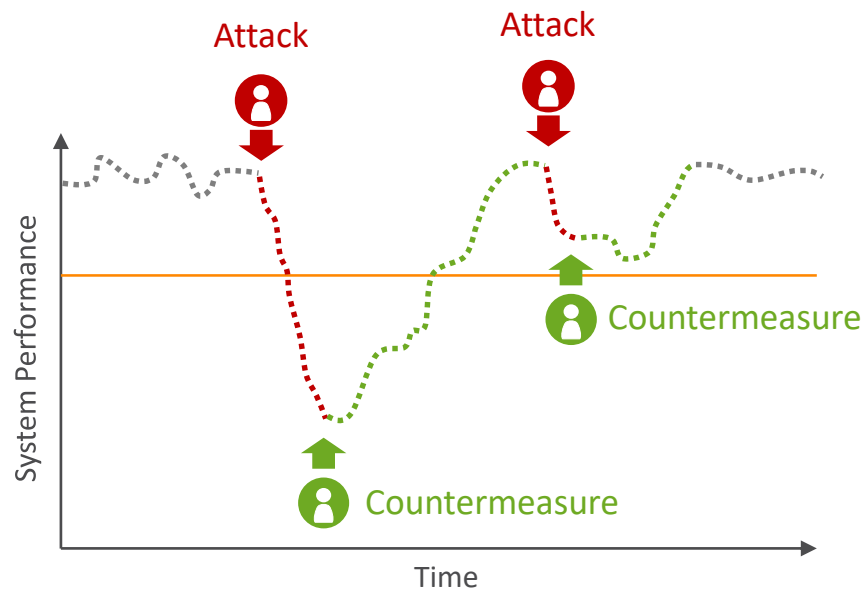
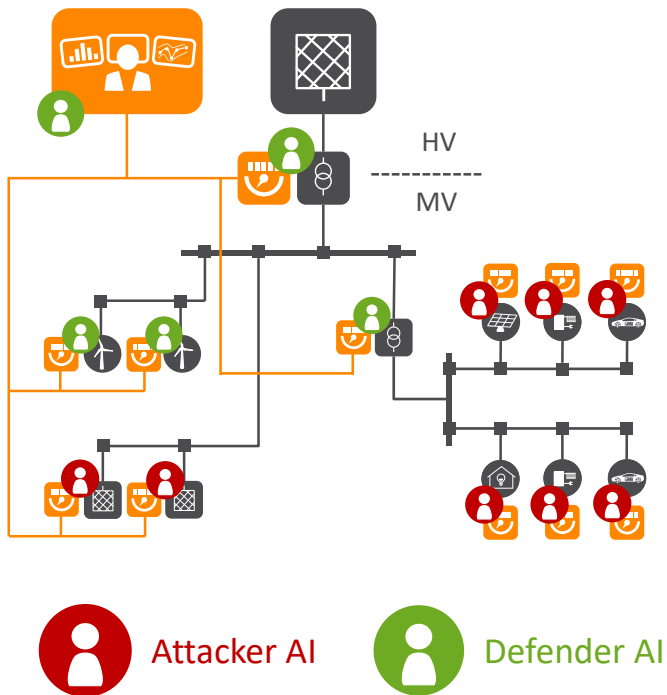
- > Two ANNs with **different roles**:  
Generator and Discriminator
- > Zero-sum game
- > Generator maps vector of latent variables to feature space;  
Discriminator evaluates the result
- > Error measure: Ability of the  
Discriminator to differentiate  
between real and generated data's  
distribution





# Demo: Attack on a Power System

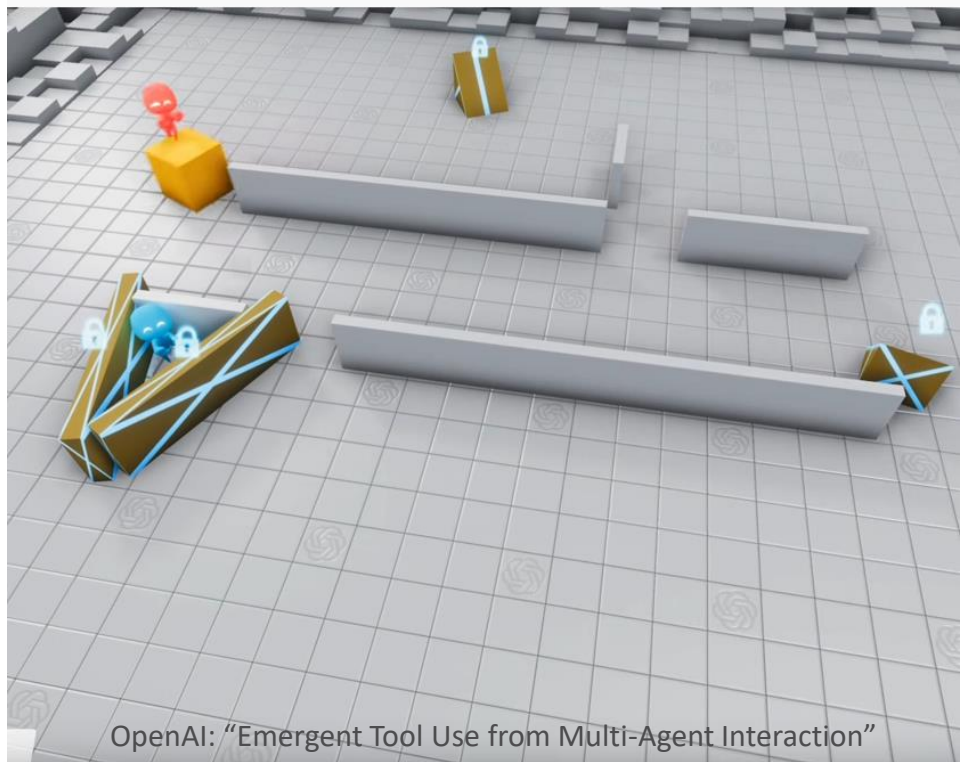
Prevention of (sub-)system takeover as a secondary problem

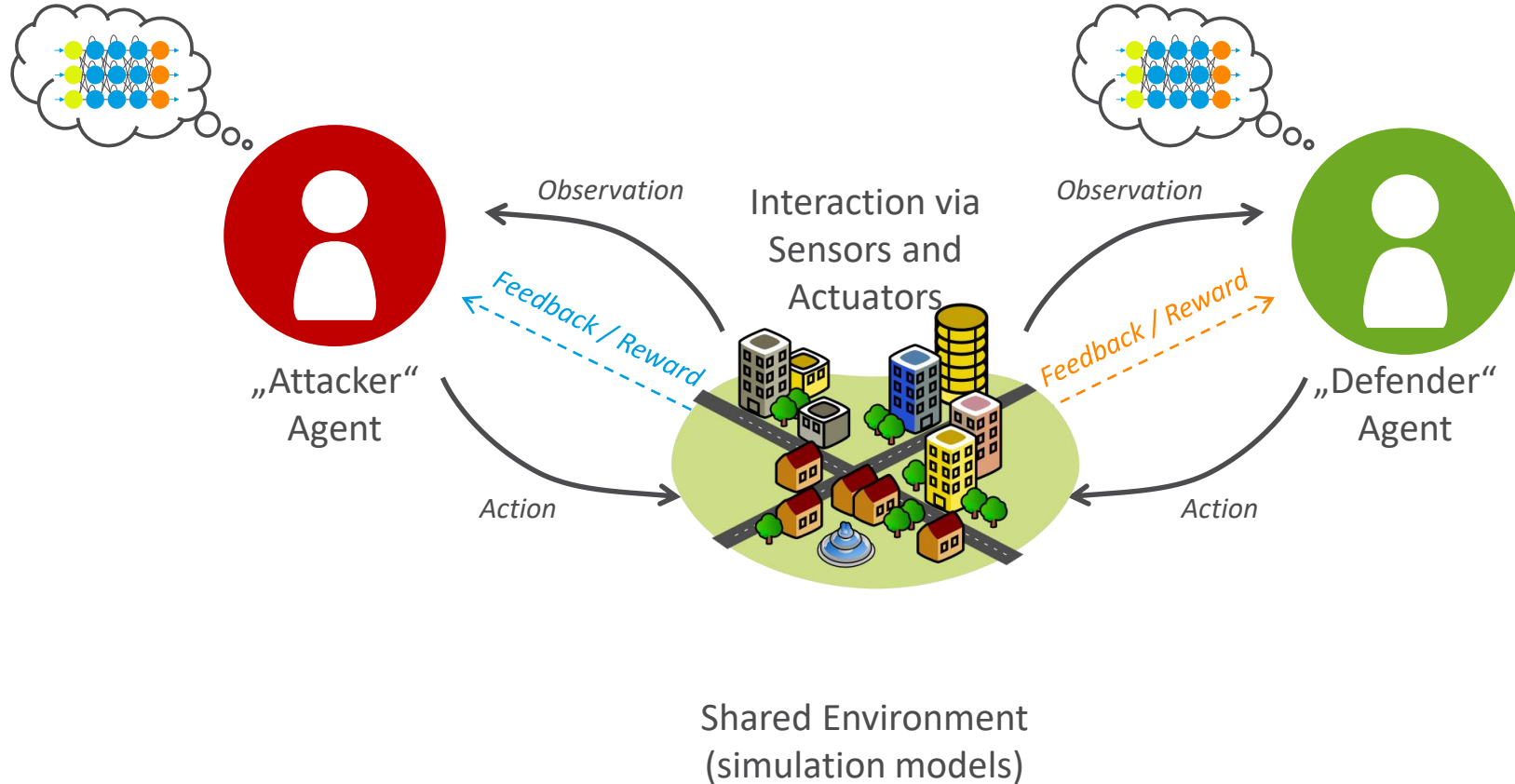


# Why does it work?

RL Agents discover bugs in the engine

- > Setup: Two groups of agents play *hide and seek*
- > No domain information; agents learn strategies and tool use independently
- > Result: Agents learn to exploit bugs in the underlying game engine
  - > Holes in walls
  - > Sliding boxes
  - > Edge/corner jumps





## Learns to model realistic threats:

- > Climate change
- > Natural disasters
- > Shortage of workforce
- > Material shortages
- > Etc.





## Creates resilient renovation strategies:

- > Choice of measures
- > Choice of material
- > Creation of work schedules



**Is changed continuously:**

- > Defender changes renovation plan to simulate
- > Attacker changes simulation properties dynamically



Shared Environment  
(simulation models)

## Goals:

- > Improve long term resilience of renovations
- > Provide decision making tool for optimized housing renovation
- > Automated monitoring and predictive maintenance for road renovation

**Reduce impact of changing environments on renovation planning and execution**



## Contact us!

Lasse Hammer  
OFFIS e.V. - Workgroup PSI

> [lasse.hammer@offis.de](mailto:lasse.hammer@offis.de)





- > <https://www.ipcc.ch/report/ar6/wg1/>
- > IEA, Global energy-related CO2 emissions, 1990-2021, IEA, Paris  
<https://www.iea.org/data-and-statistics/charts/global-energy-related-co2-emissions-1990-2021>
- > UNO - Summary of the 2020 global status report for buildings and construction
- > <https://scitechdaily.com/surfside-champlain-towers-south-condo-collapse-the-science-of-concrete-video/>
- > <https://www.fmb.org.uk/resource/shortages-of-materials-and-skills-are-holding-builders-back.html>