Detect and Protect.

AOC Europe Online Summit

Supporting EMSOs through Edge AI and Cloud Native Computing

Marco Kullmann
Spectrum Dominance and Airborne Solutions Division
Head of Processing and Software Solutions
May 18th 2021

Driving Factors for AI based EW Sensors

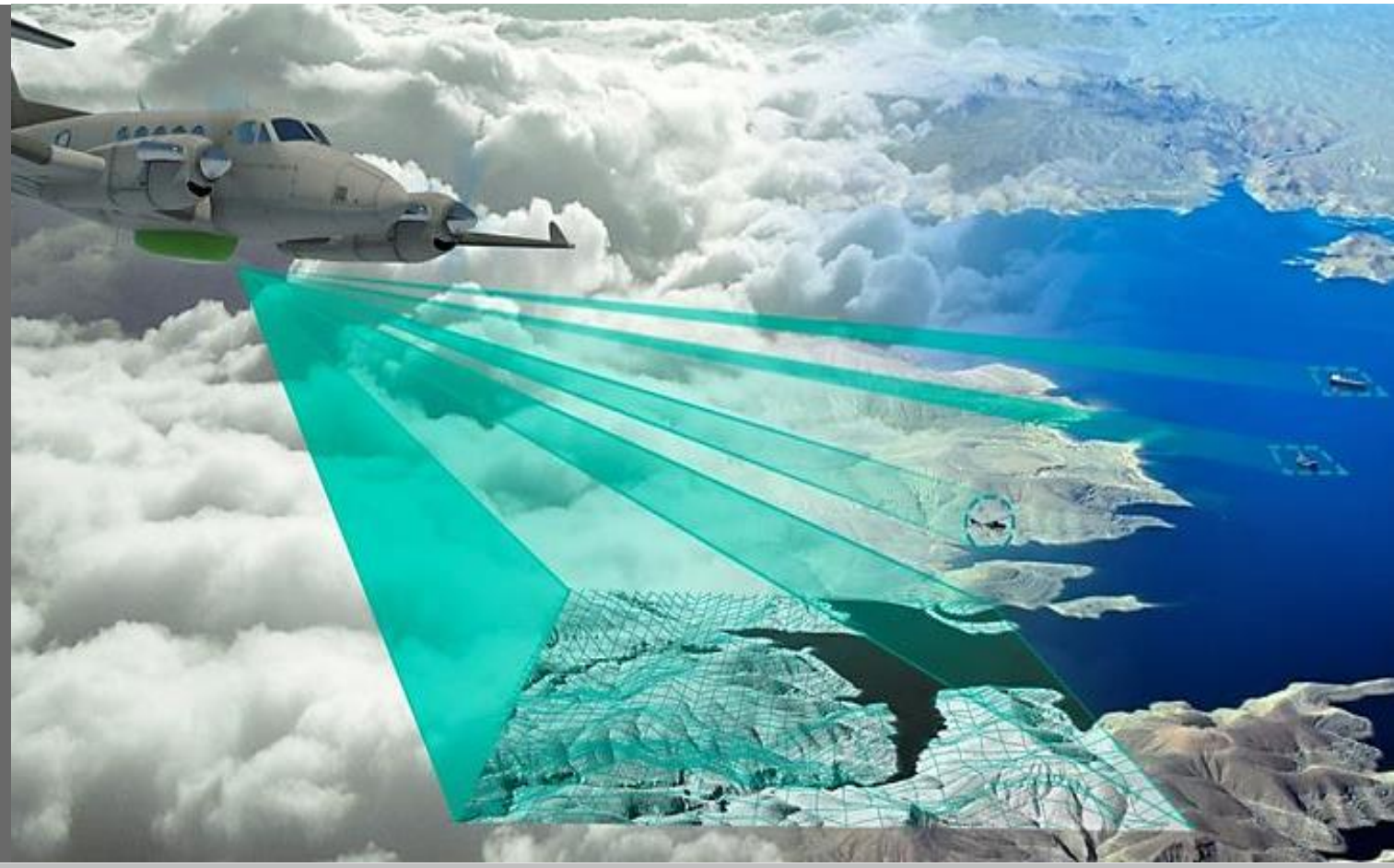
Challenges of Modern Signal Scenarios

- EW systems need to operate in congested RF environments
- modern software define radars have very high dynamic signal parameters
- need to identify and jam agile emitter (e.g. cognitive radars)
- short reaction times required

→ need to adapt sensors to new threats quickly without changing the sensors code base

→ update of threats libraries (hours instead of weeks or months)

→ new concepts for pattern recognition required



Artificial Intelligence for EW Applications

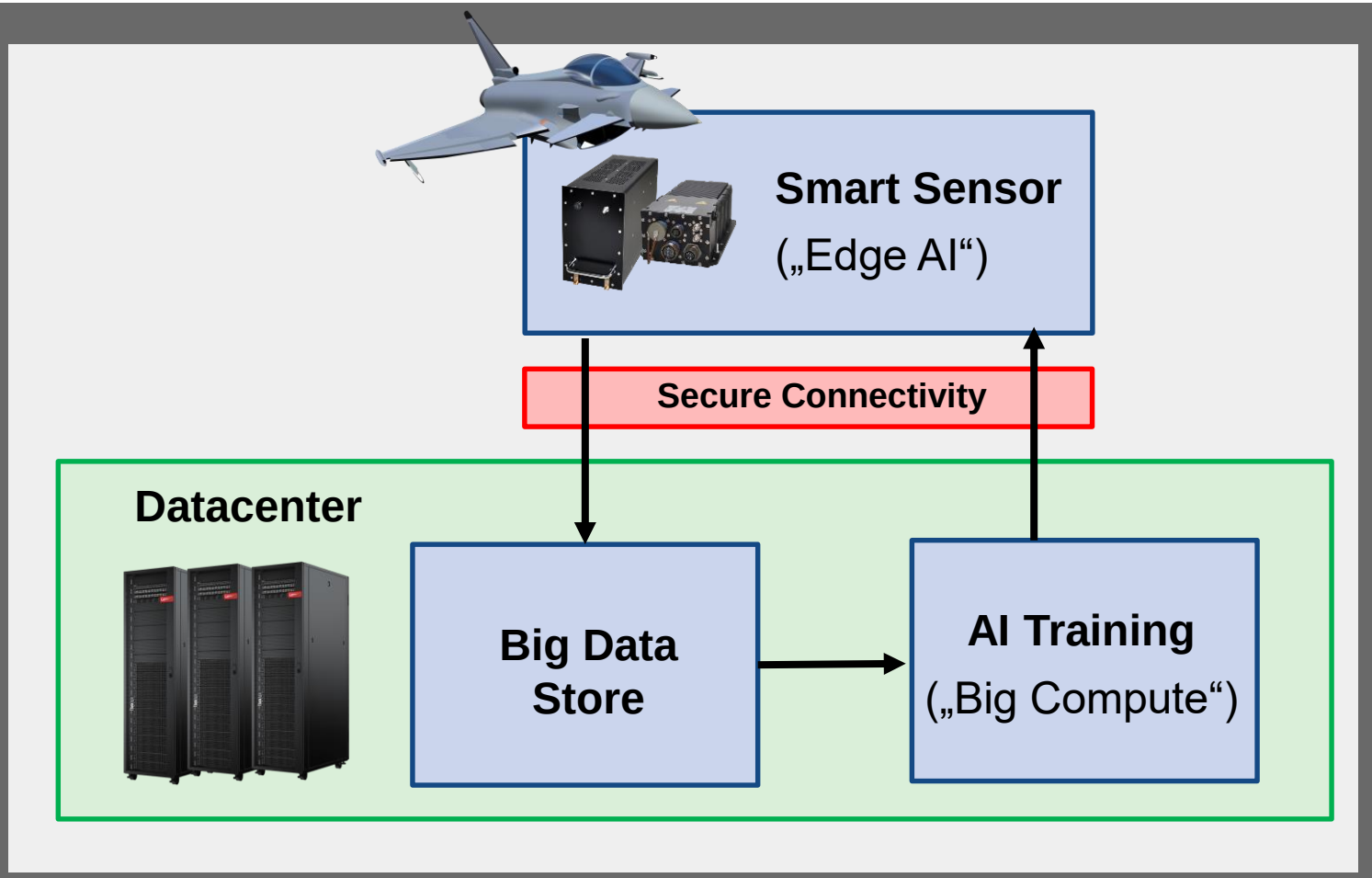
Simplified System Modell for Bringing AI into Operation

Smart Sensor (“Edge AI”)

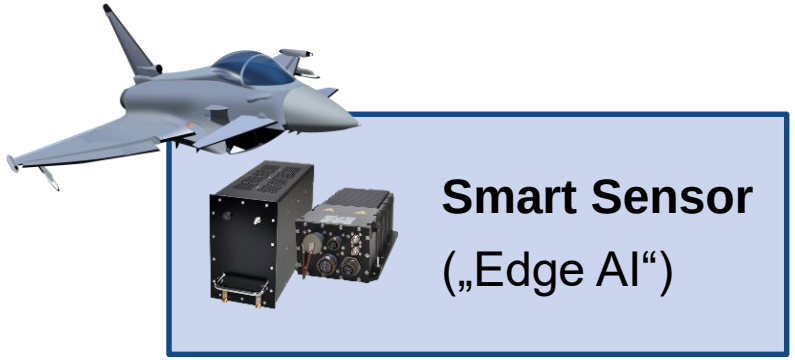
- AI algorithms (DL, CNN, RNN, reinforcement learning, …)
- efficient compute HW for inference

Datacenter

- storing of sensor data (“Big Data”)
- sensor data fusion & pre-processing
- data annotation (manual & semi-automatic)
- data augmentation
- ML training (supervised & un-supervised)



Smart Sensors

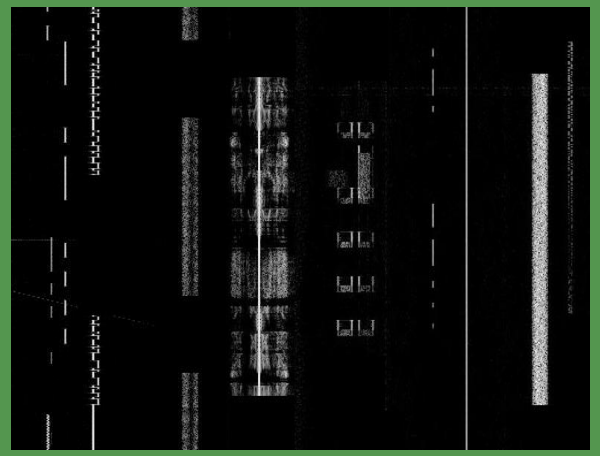


Examples of AI algorithms

Deep Learning Applications for EW Application

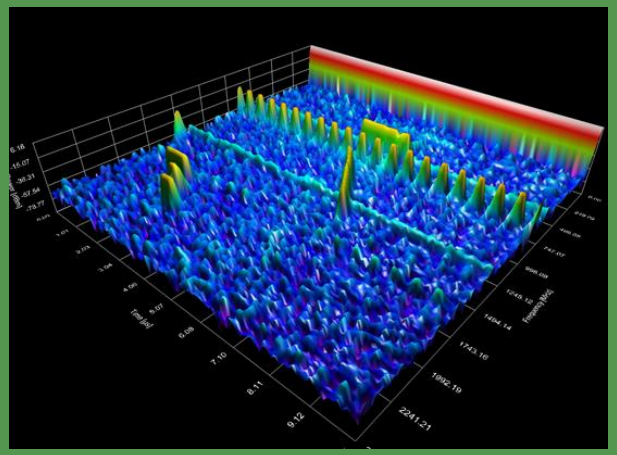
Examples of Senor Data Processing (Edge AI)

Spectrogram based Signal Detection and Classification



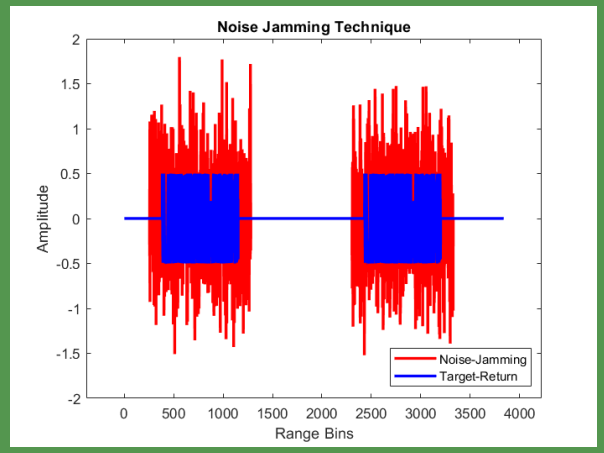
SIGINT application

Radar ESM Processing („De-Interleaving“)



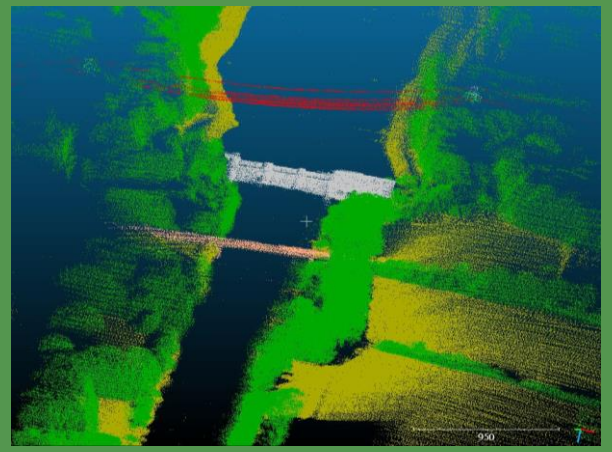
Radar Warner

Intelligent Cognitive Core



EA / Radar ECM

Airborne 3D LiDAR Semantic Segmentation

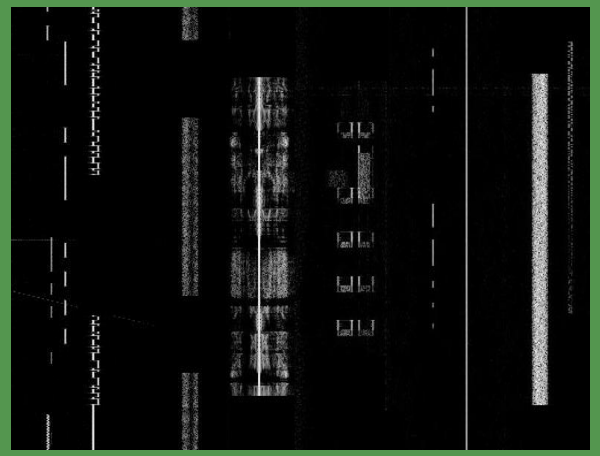


Obstacle Warning / Situational Awareness

Deep Learning Applications for EW Application

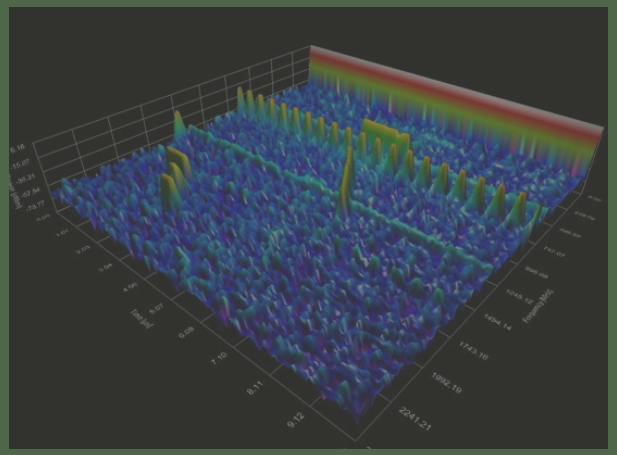
Examples of Senor Data Processing (Edge AI)

Spectrogram based Signal Detection and Classification



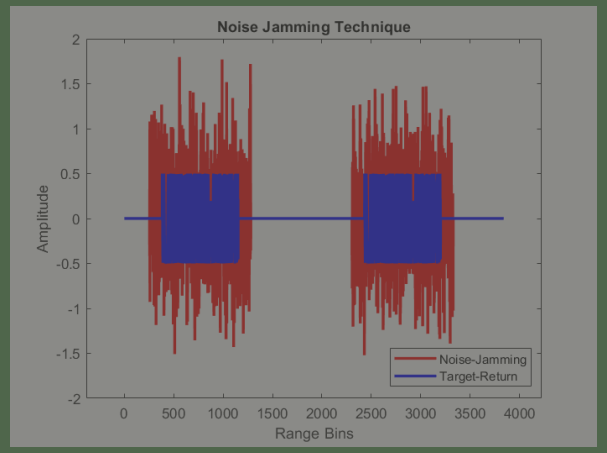
SIGINT application

Radar ESM Processing („De-Interleaving“)



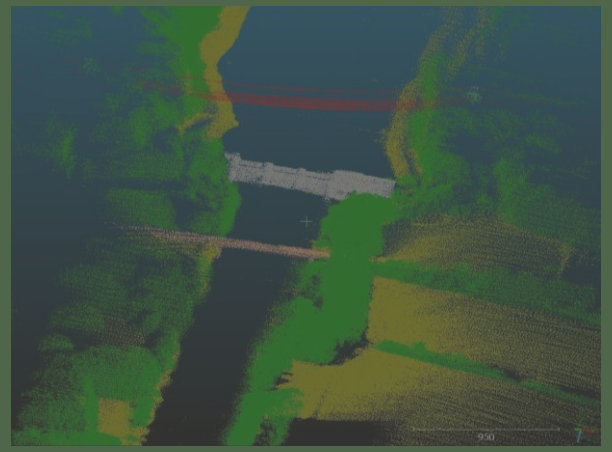
Radar Warner

Intelligent Cognitive Core



EA / Radar ECM

Airborne 3D LiDAR Semantic Segmentation

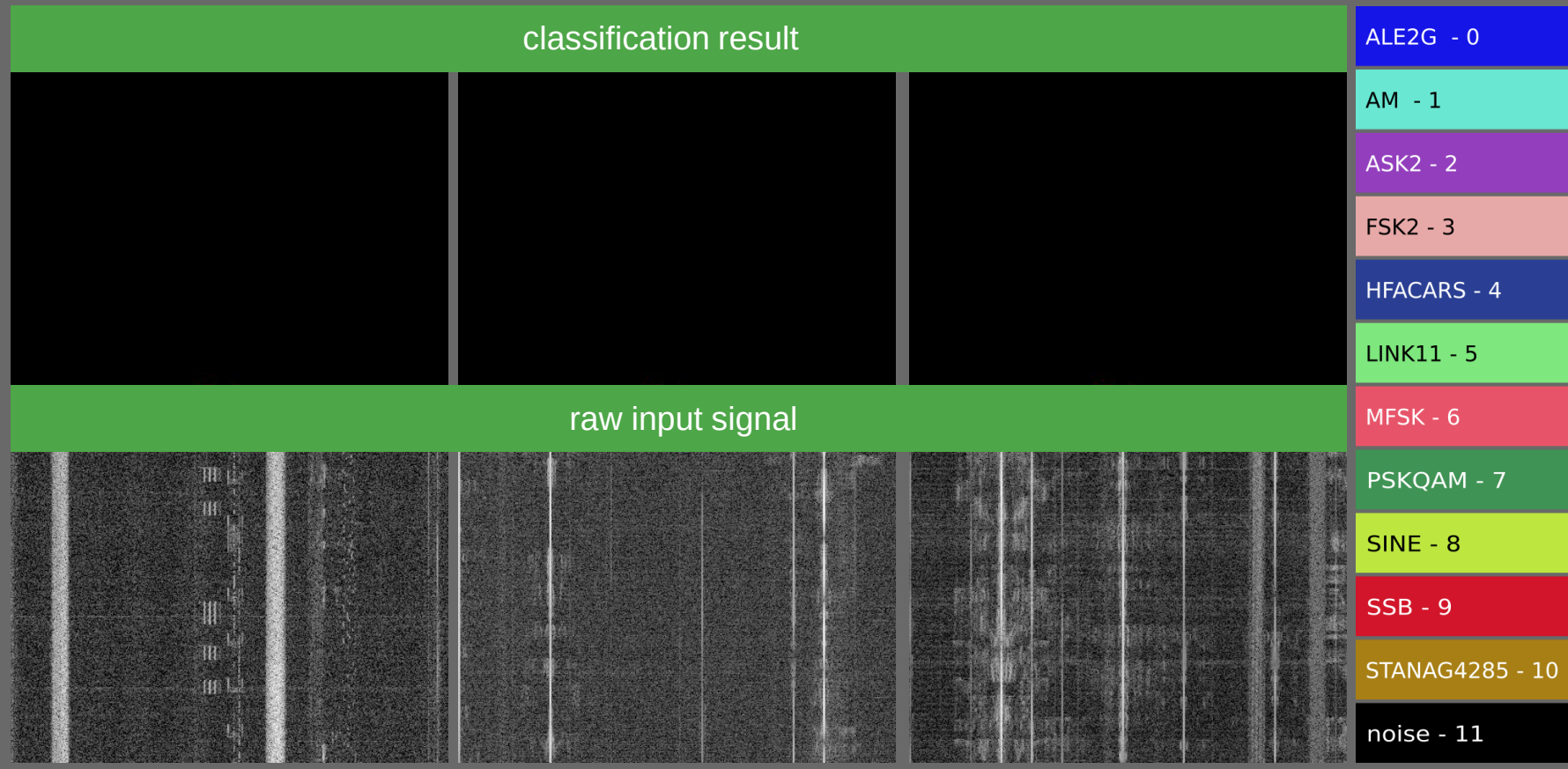


Obstacle Warning / Situational Awareness

SIGINT – Signal Detection and Classification based on Spectrograms

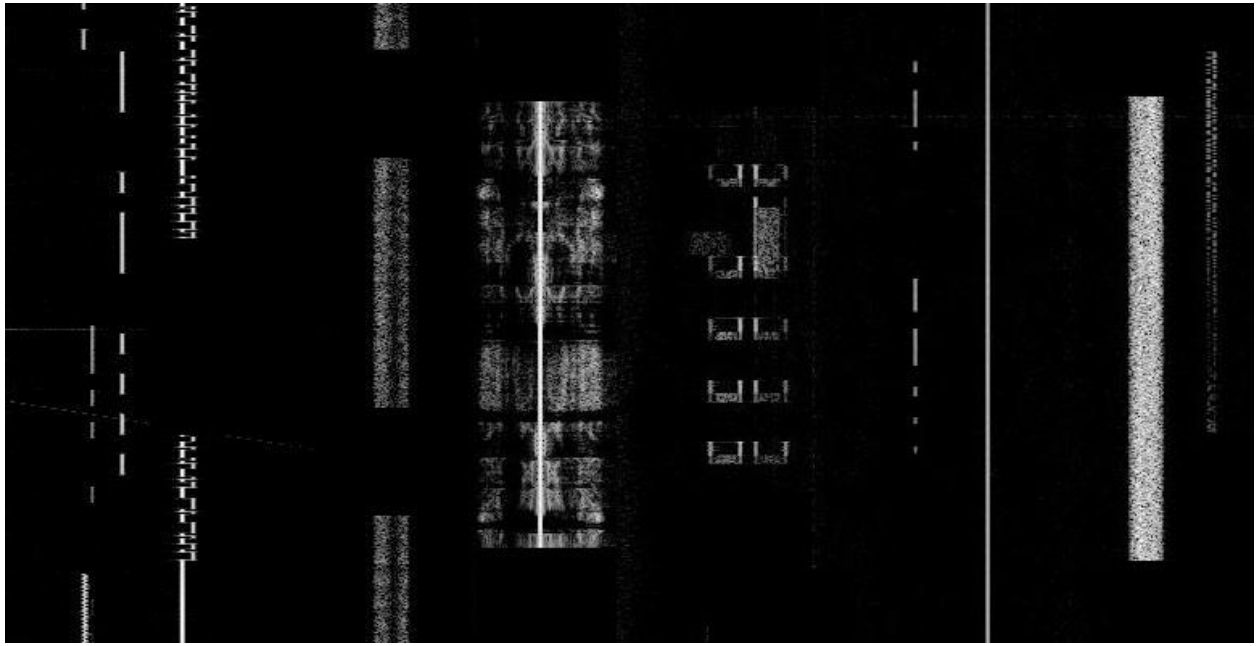
Semantic Segmentation using Deep Learning Networks

- better and more robust detection and classification results
- add new classes with Deep Learning with little effort without altering code base.
- simplified system architecture, detection based on raw data classifier training „end-to-end“.



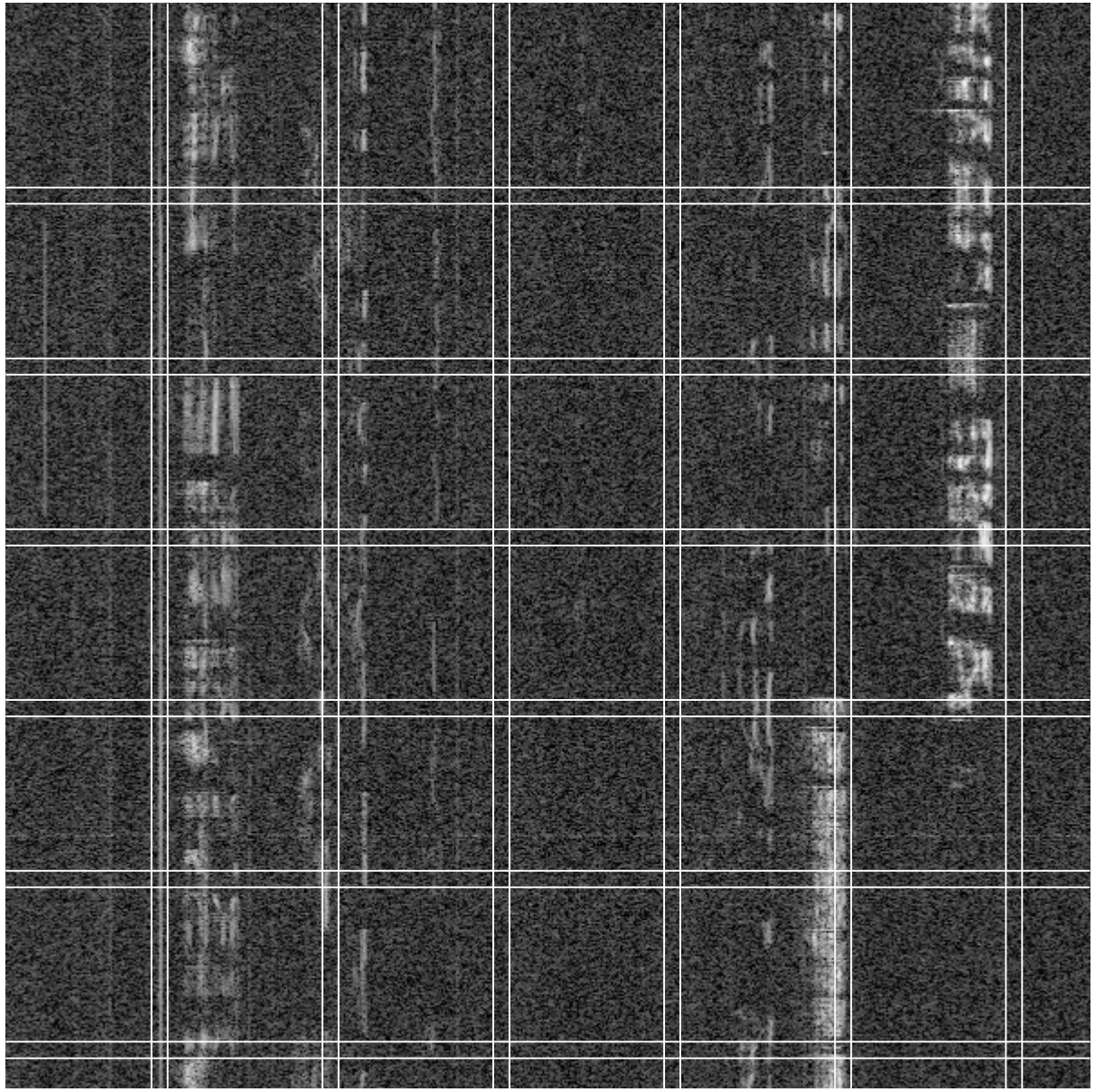
RF Spectrogram Object Detection

Localization & Classification based on small tiles

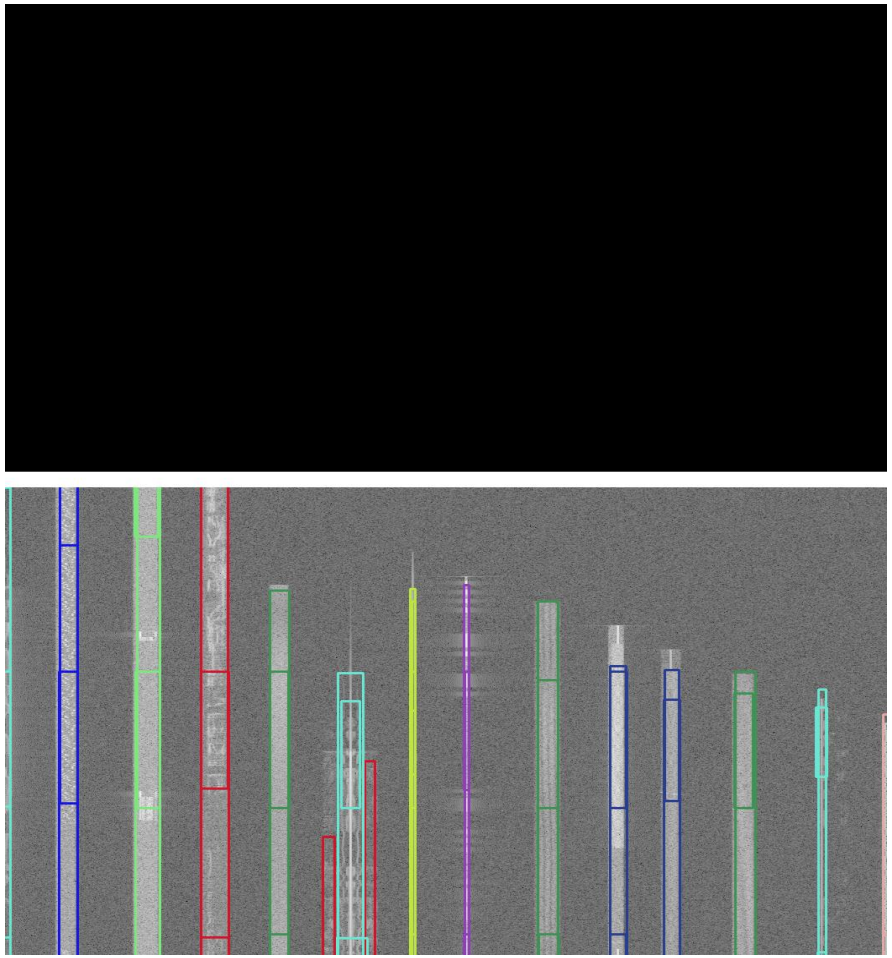


picture dimension e.g.: 15360x7500
(nFFT x timesteps / 125Hz@8ms / 2MHzx60sec)

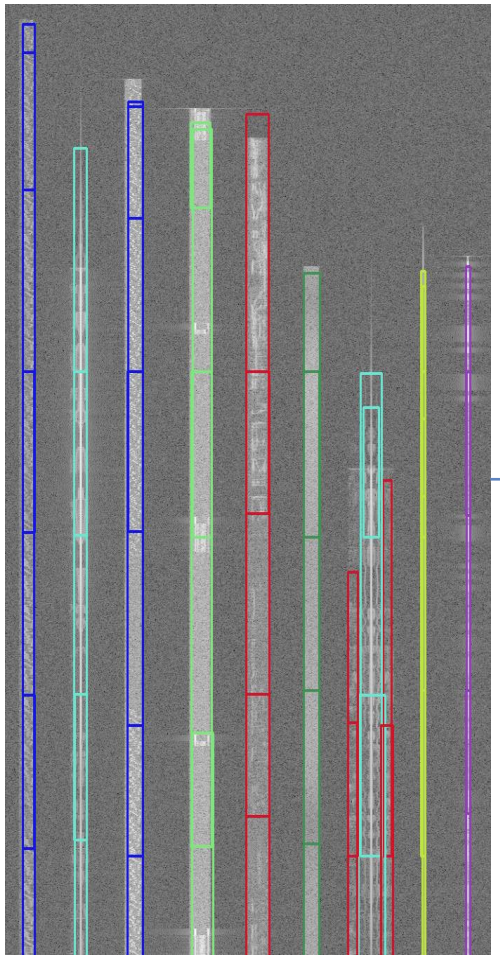
43x22=946 Patches à 512x512pcs@30% overlap



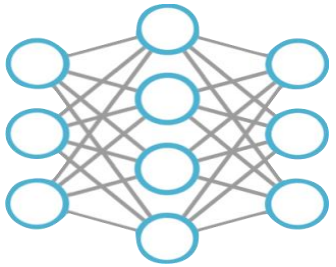
Learned Instance Merger to generate signals



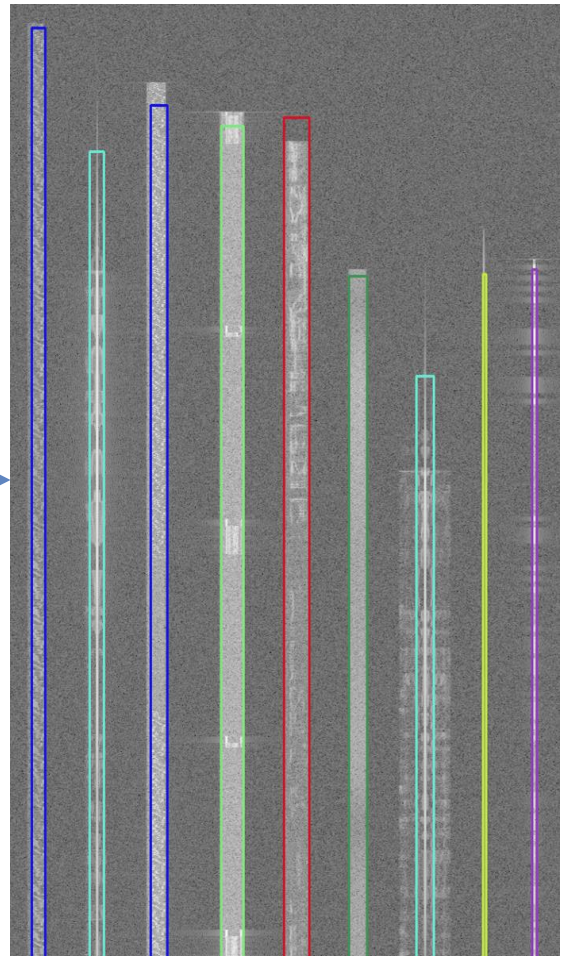
Merging



Raw Detection Output



ML Model

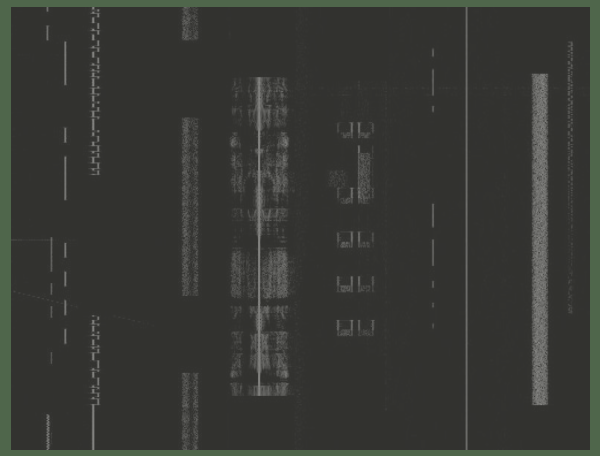


Merged Instances

Deep Learning Applications for EW Application

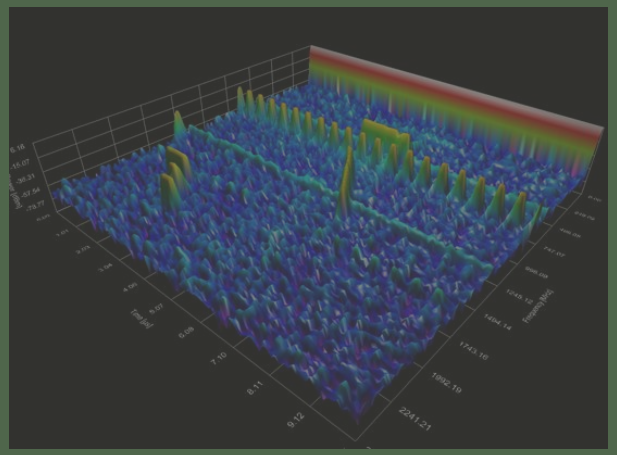
Examples of Senor Data Processing (Edge AI)

Spectrogram based Signal Detection and Classification



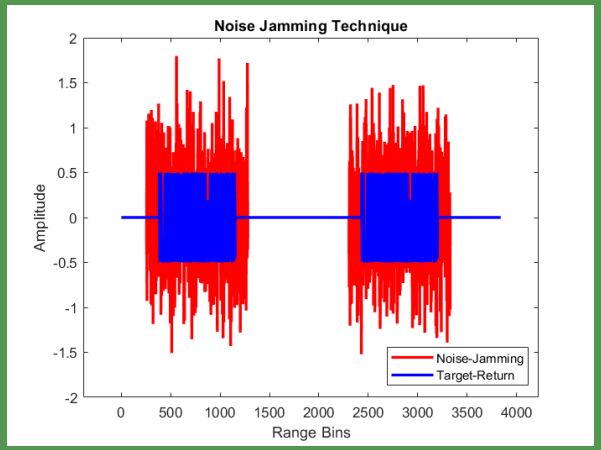
SIGINT application

Radar ESM Processing („De-Interleaving“)



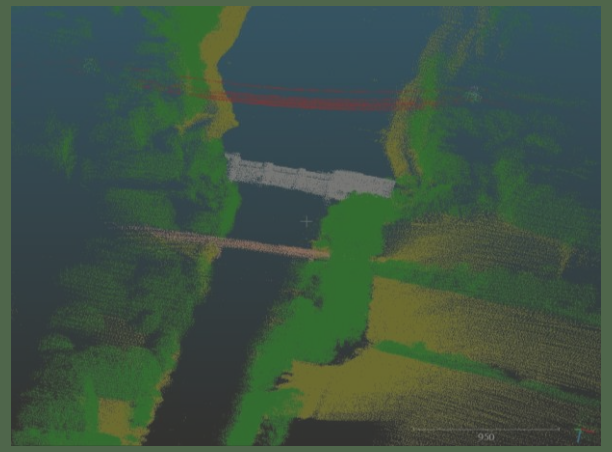
Radar Warner

Intelligent Cognitive Core



EA / Radar ECM

Airborne 3D LiDAR Semantic Segmentation

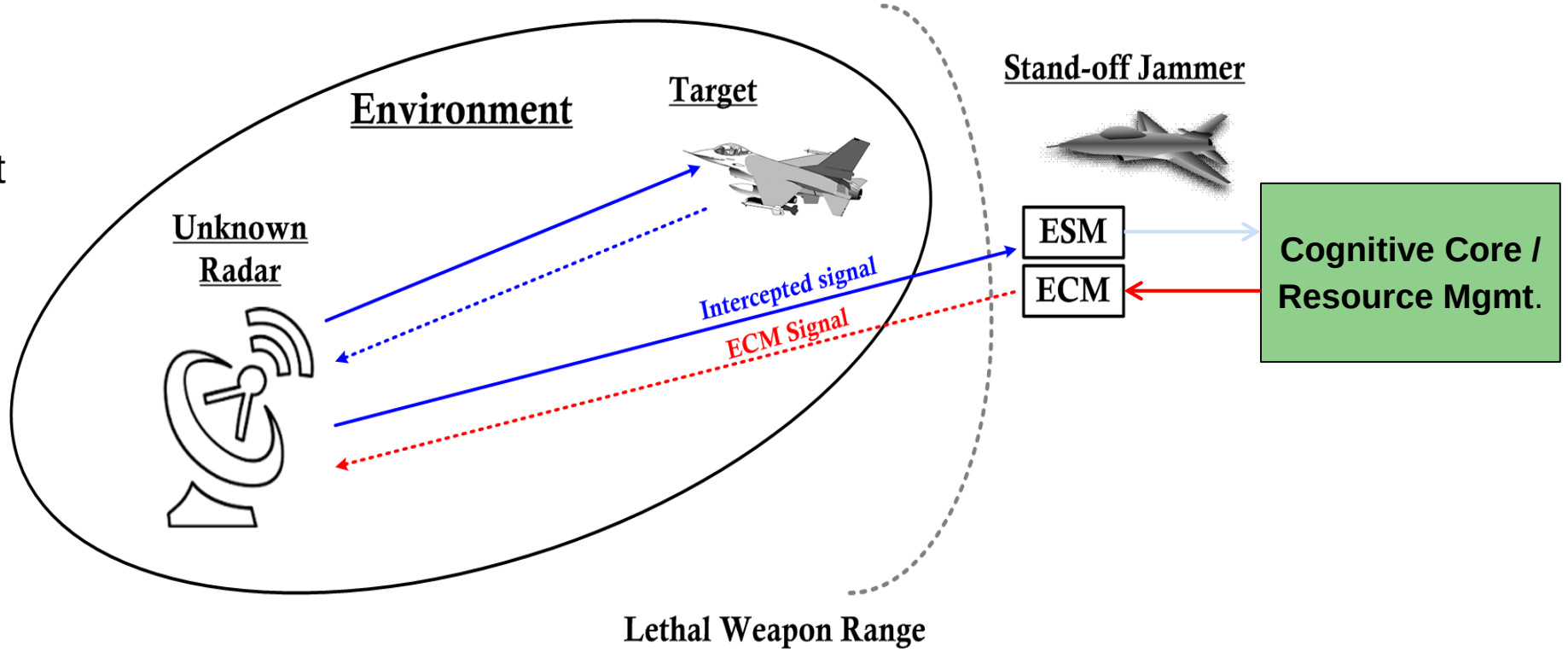


Obstacle Warning / Situational Awareness

Intelligent Cognitive Core for EA System

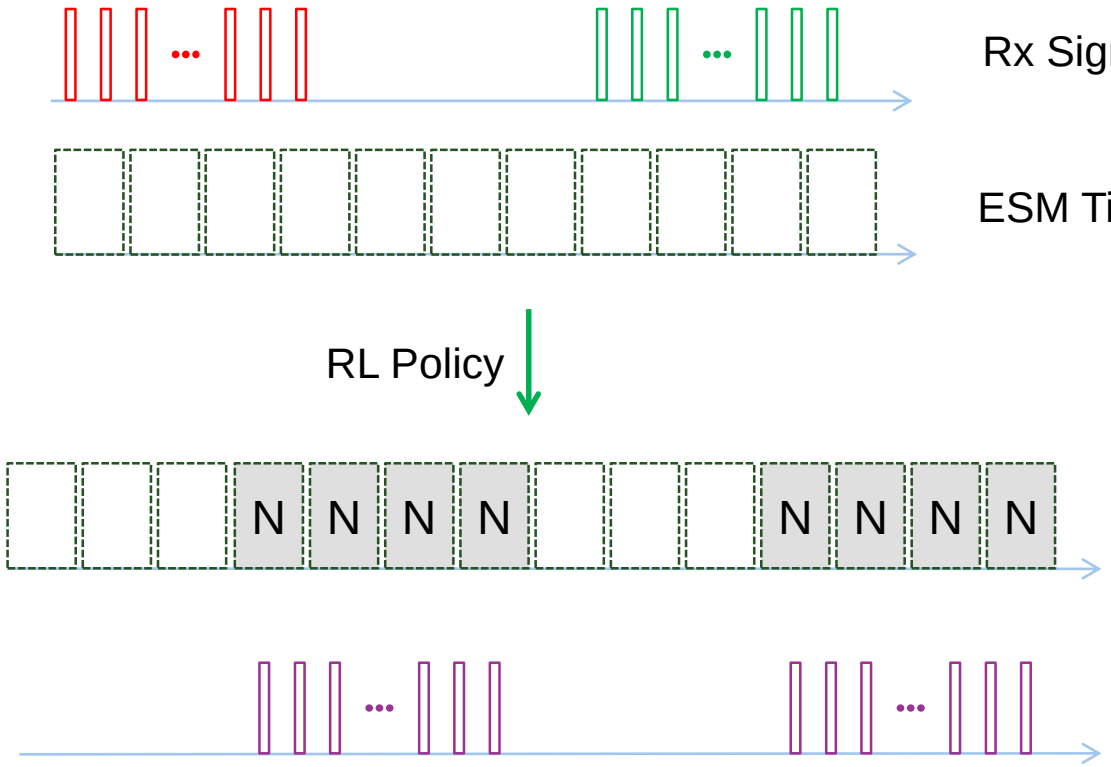
Simplified System Model

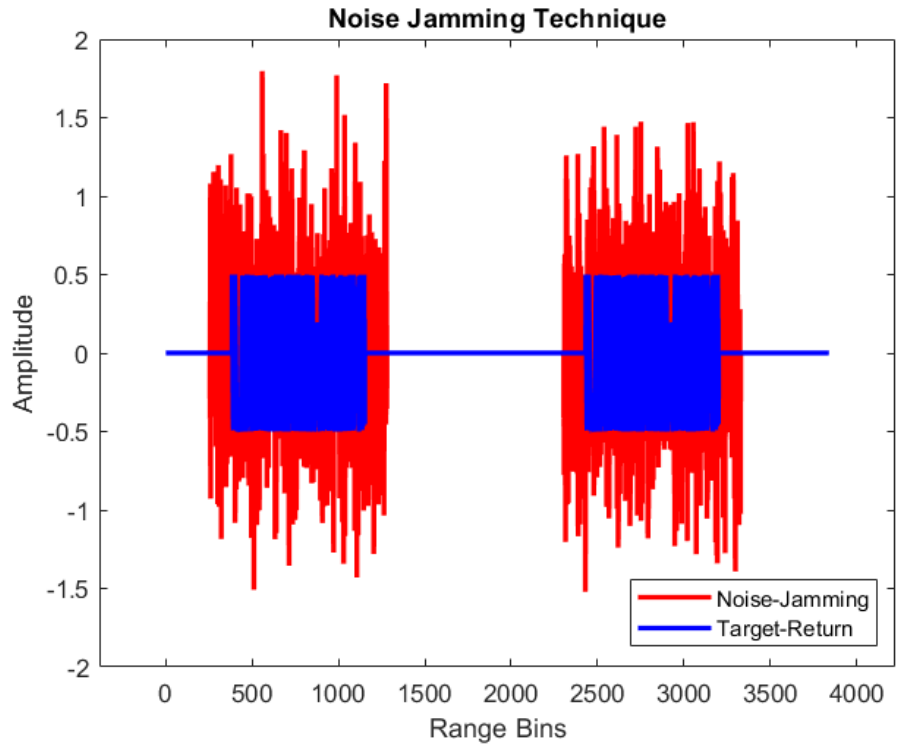
Reinforcement learning for selection and configuration of best jamming strategy against unknown emitters.



Intelligent Cognitive Core for EA System

Reinforcement Learning for ECM – Measured Results



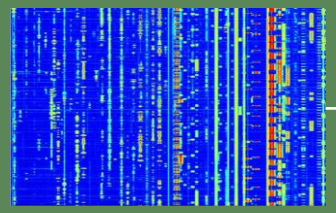


Pulsed Noise (Narrowband)

Deep Learning Networks

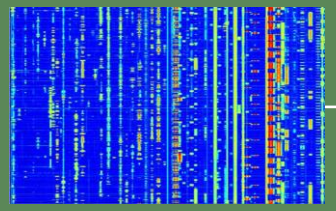
Comparison with Traditional Pattern Recognition Systems

Traditional Pattern Recognition (feature extraction: “hand-crafted” based on mathematical models)



low-level feature extraction → trainable classifier

Deep Learning (feature extraction end-to-end based on training data only



low-level feature extraction → mid-level feature extraction → high-level feature extraction → trainable classifier

huge amount of real world training data required for training of deep learning networks

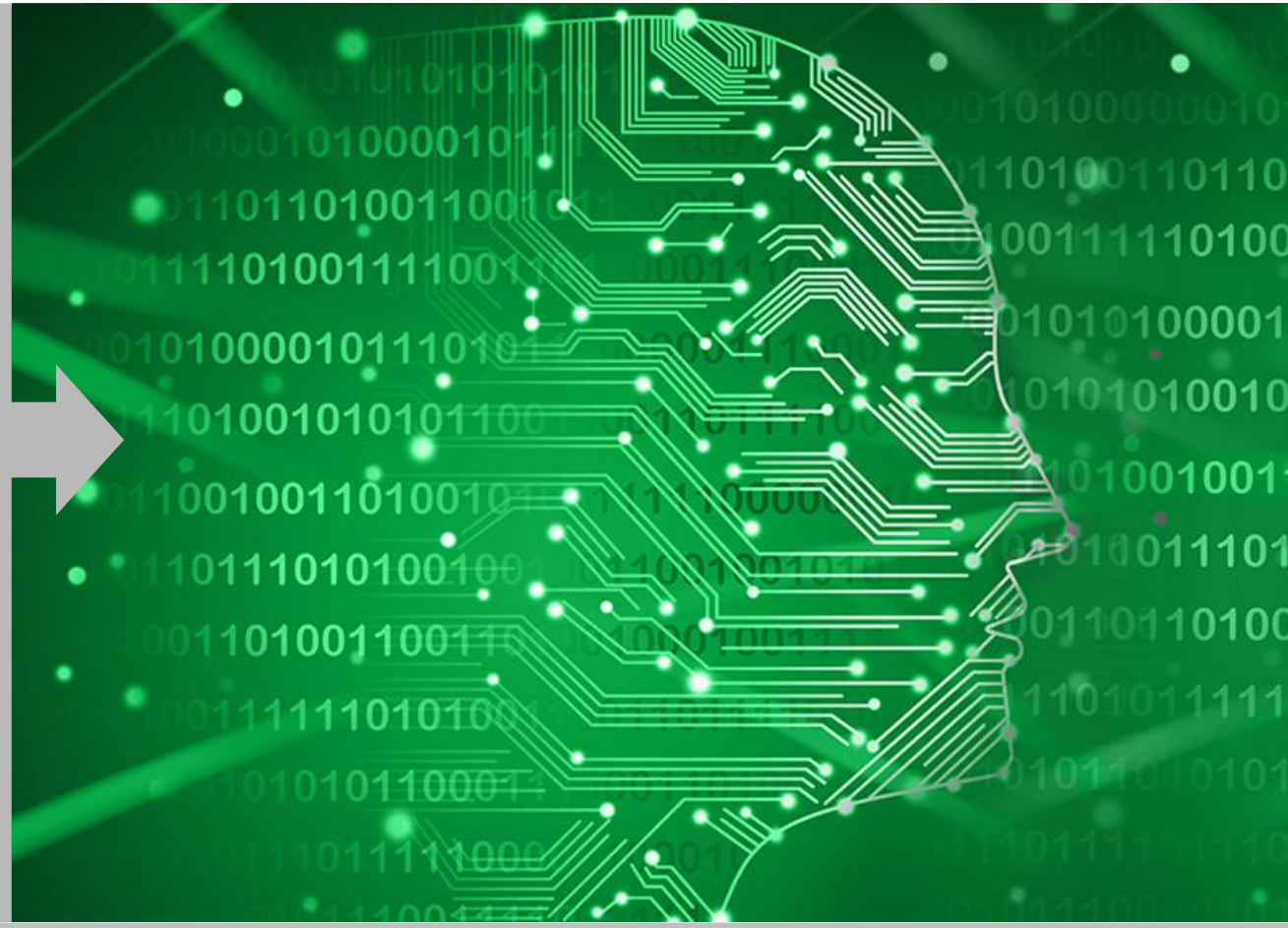
AI / Deep Learning
Paradigm Shift in Pattern Recognition

- shift from mathematical system model to a data centric machine learning approach (data science)
- performance driver: data, data, data (availability of large amount of representative labeled sensor data)

New solutions required for:

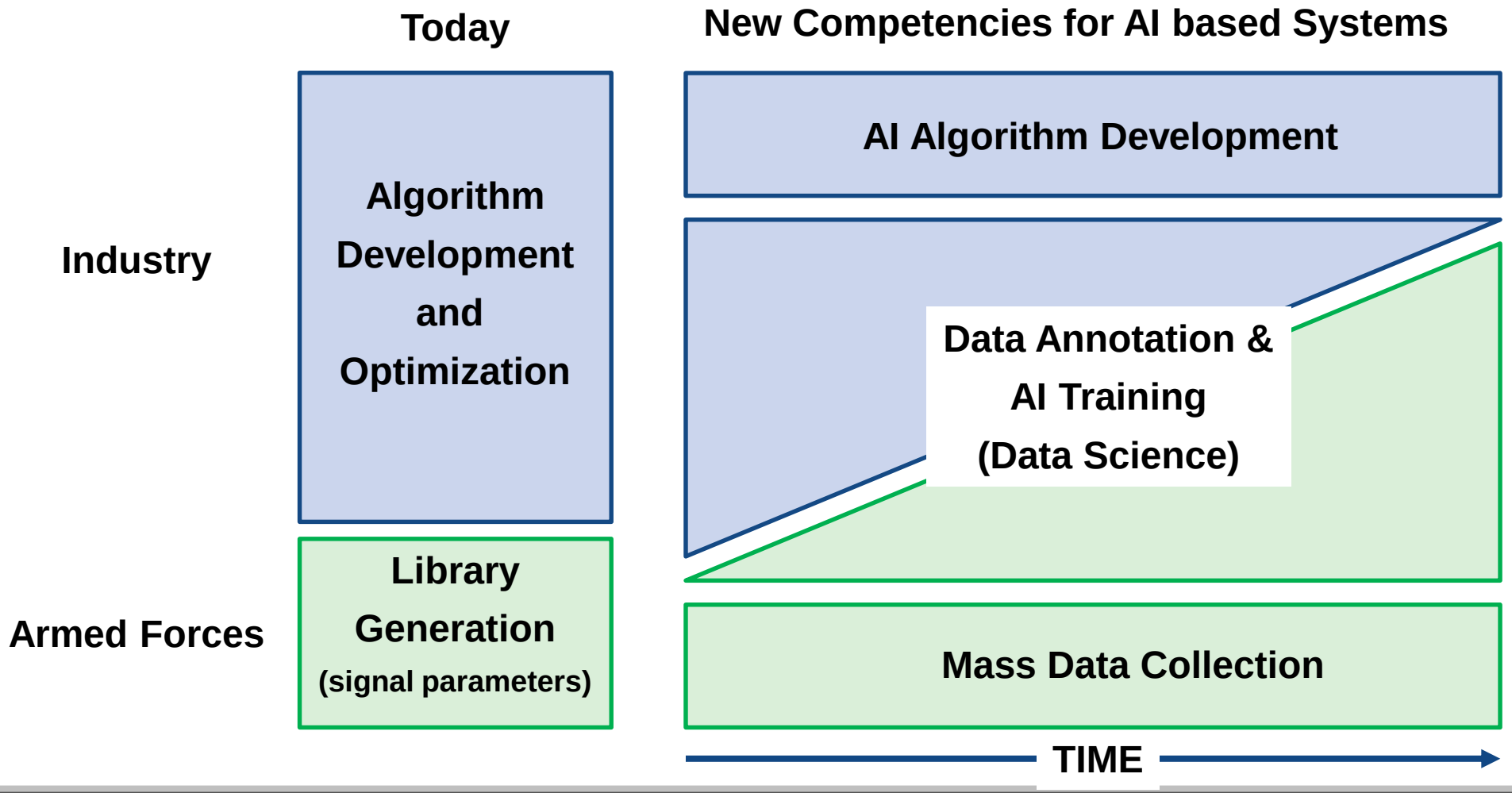
- data acquisition/recording,
- data storage
- data management

Math. Modell



New Collaboration Models between Armed Forces and Industry

Example: EW Centre / EW Support



Datacenter

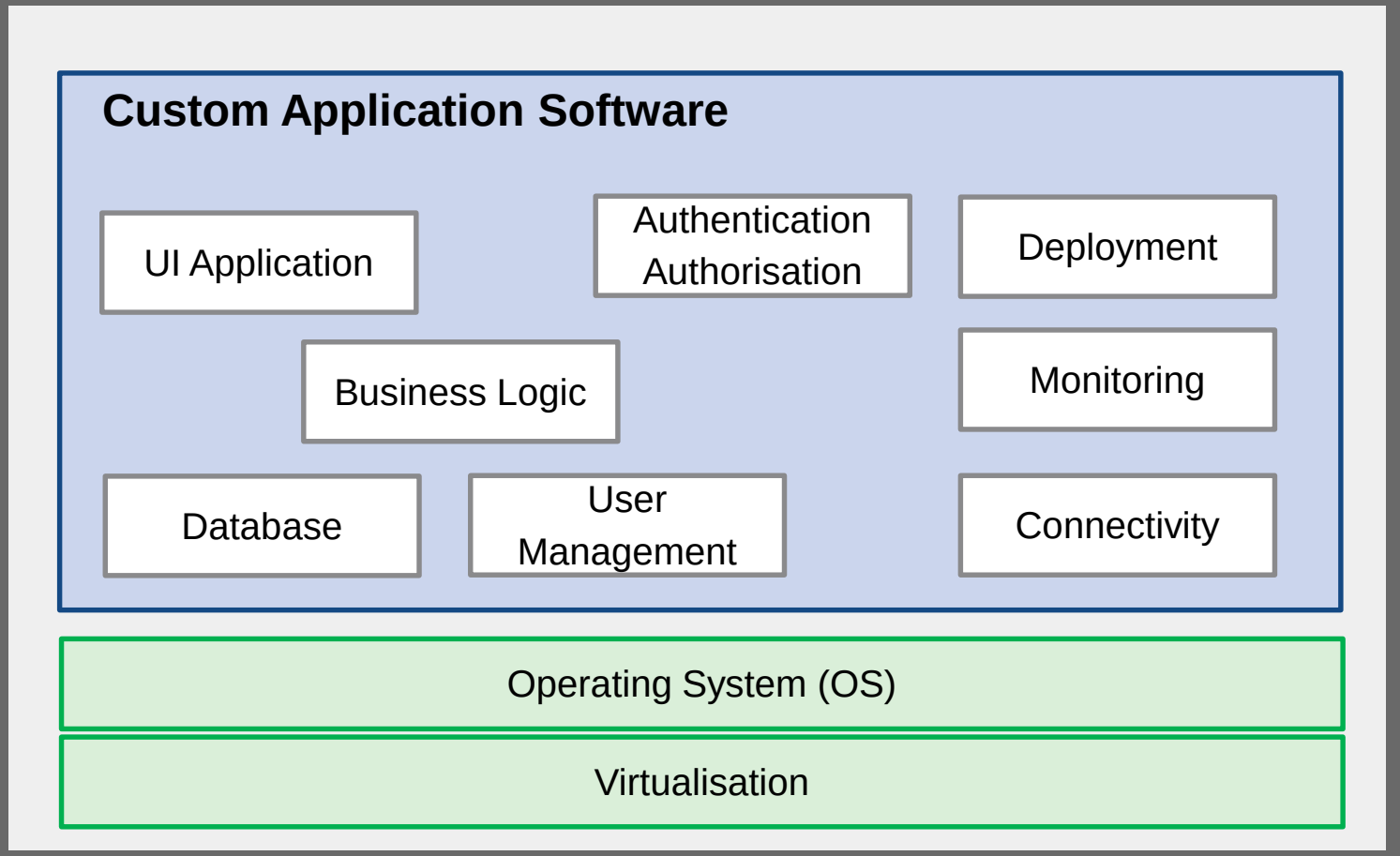
New technology stack for future AI based applications

Datacenter in Detail

Custom Application Software vs. Cloud Software Stack (Simplified Example)

Traditional custom application software:

- requires lots of coding (development cost)
- little support for AI, big data
- no standardization and interoperability
- limited support for IT-platform consolidation
- high training and maintenance costs

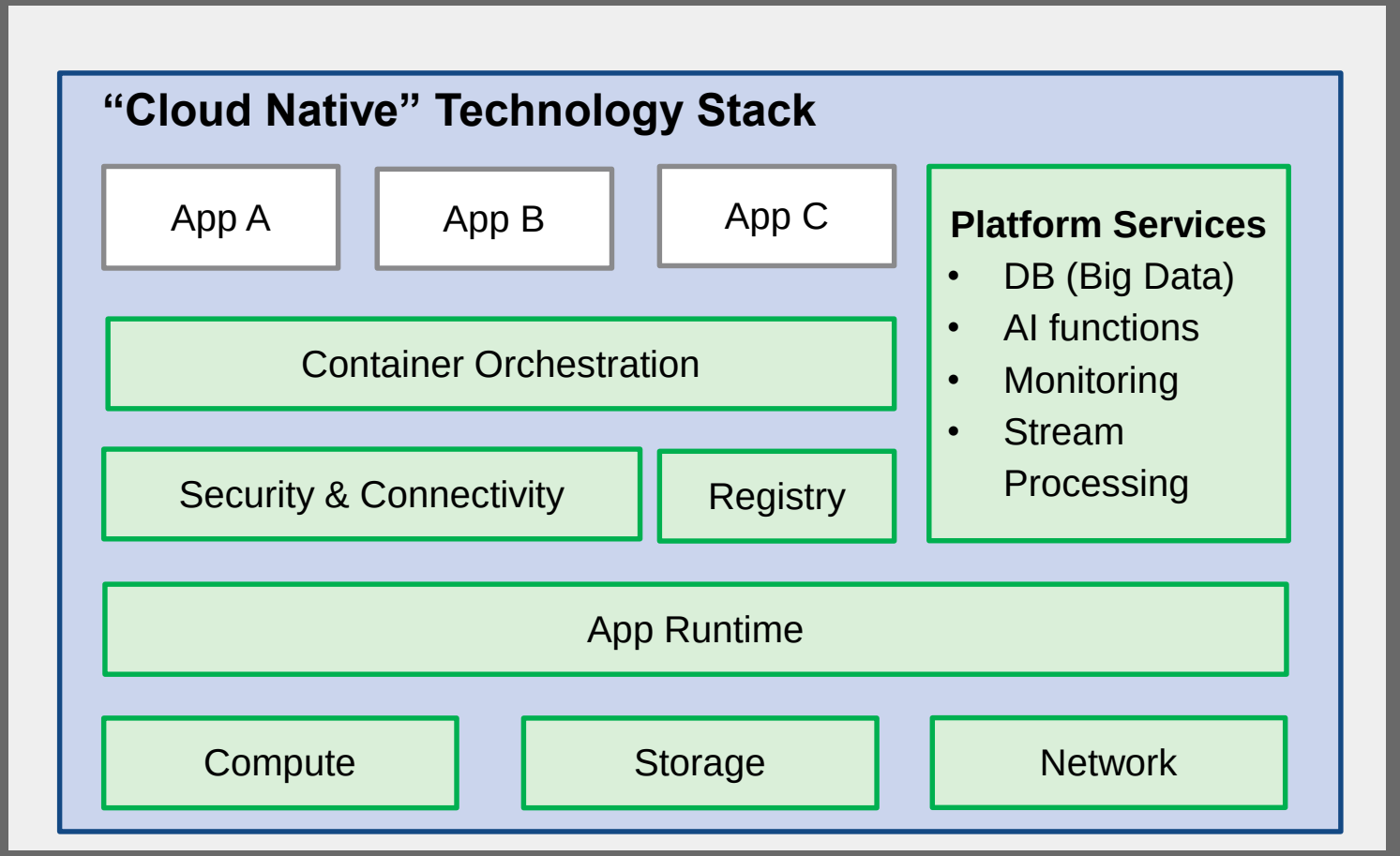


Datacenter in Detail

Cloud Software Stack (Simplified Example)

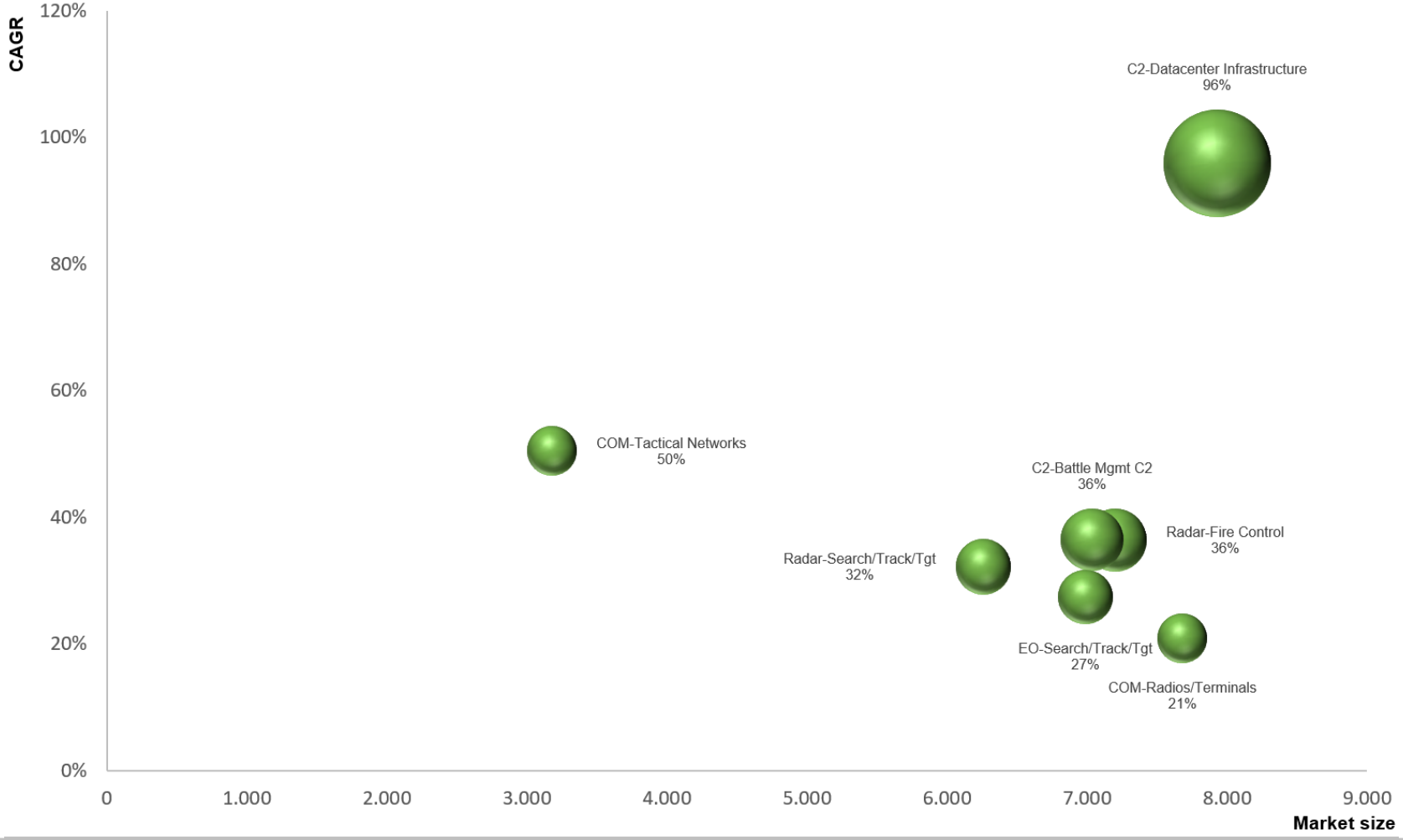
Cloud Native Technology Stack:

- platform build around “apps”
- many system functions are build into the platform (less development effort)
- platform designed for Big Data and AI
- build-in IT security and secure connectivity
- automated SW deployment
- standardized interfaces
- harmonized system and SW maintenance
- simplifies IT system consolidation



Global C4ISR Market TOP7 Ranking 2021

Overview Top7 by CAGR & Size from 2021 until 2025



Source: independent IHS Jane's Market Database, recording stated opportunities, tenders and contracts

Bubbles-Point = Market Size (per Janes Segment) & Growth '21 in%
Bubble-Size = Size CAGR
* Market Size = Average+5years (2021-2025)

Summary

Summary

- **AI will be key element of future intelligent sensors**
  - increased performance and robustness
  - quick adaption to new threats
  - allowing better situational awareness and faster discission making
- **AI requires end-to-end view of full EW lifecycle**
  - new generation of AI enabled sensors
  - data acquisition (recording of sensor raw data from real world scenarios)
  - new generation of datacenters for big data, analytics and AI training required
- **Challenges**
  - success stories of civil applications still need to be transferred to the military domain and tested in operational scenarios.
  - datacenter consolidation requires open standards for cloud software stacks
  - classified data requires cloud solutions to be operated on-premise
  - high quality data recorded from real world scenarios is essential
- **New Cooperation Models between Industry and Armed Forces Required**
  - New ways of sharing data and joint continuous optimization

HENSOLDT Sensors GmbH
Marco Kullmann
Wörthstrasse 85
89077 Ulm, Germany
email: marco.kullmann@hensoldt.net

HENSOLDT Sensors GmbH
Willy-Messerschmitt-Straße 3
82024 Taufkirchen, Germany