

REFLECTING ON COMMUNICATION PARADIGMS

DEPENDABILITY DEMAND AS A CHANCE

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OBSERVATIONS AND PARADIGMS

- ≡ Humans communicate wirelessly
- ≡ Humans constantly sense partner actions & reactions and environment
- ≡ Humans are sensing and detecting disturbances
- ≡ Humans always check dependability



Paradigms in question

Wireless is not dependable

No active control over dynamic channel quality

The environmental changes are not sensed

Security is ensured after successful reception

Dependability must be time invariant



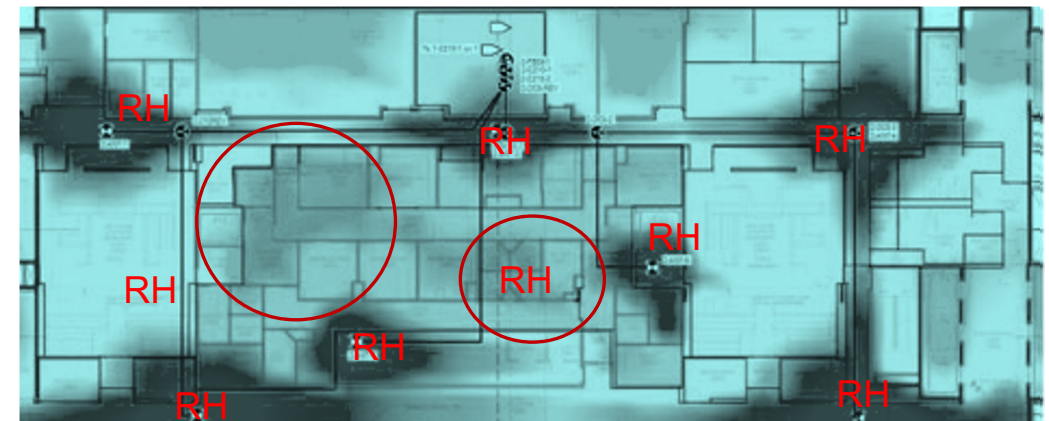


LEARN THE ENVIRONMENT

- ≡ Base stations are fixed and can adapt to their scenario
- ≡ Base stations can have outages
- ≡ UE can act as sensors in static or mobile scenarios
- ≡ Communicating parameters learned from other mobile devices used for this area
- ≡ Landscape of communication Dependability

COVERAGE MAP

- ≡ Radio heads (RH)
 - ≡ Dynamic
 - ≡ Blocked
 - ≡ Fail
 - ≡ Jammed
- ≡ UE sense
 - ≡ Position
 - ≡ Signal strength
 - ≡ Variability
 - ≡ Density
- ≡ Dynamic Map
 - ≡ Updated in core
 - ≡ Provide to device
 - ≡ Resource planning
- ≡ Predict
 - ≡ Dependability
 - ≡ Latency
 - ≡ Coverage
 - ≡ Localization



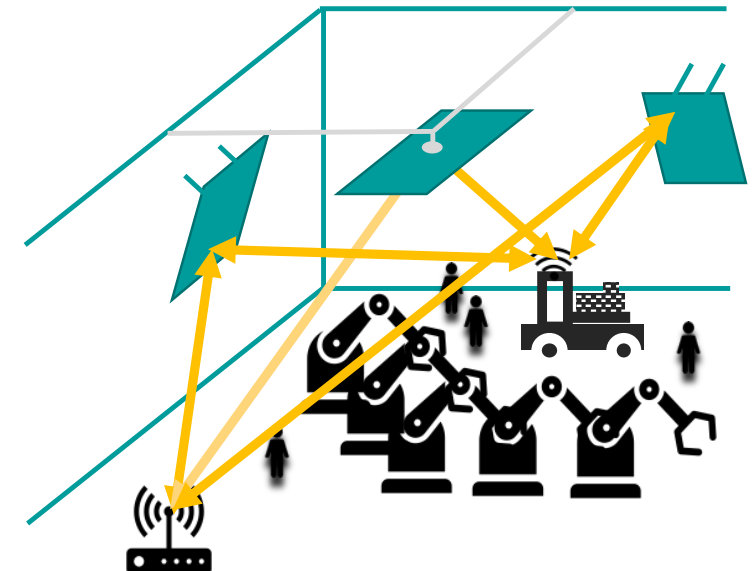
Dynamic
environment

Missing
radio head

MULTIPATH SUPPORTS DEPENDABLE COMMUNICATION

WITH STEERABLE BEAMS & RECONFIGURABLE INTELLIGENT SURFACES

- ≡ Single reflection
 - ≡ Achieve line of sight condition
 - ≡ Alternative path if temporarily unavailable
- ≡ Multiple reflections to one node
 - ≡ Multiple received packets from different directions
 - ≡ Single anchor localization
 - ≡ Localization based on TDOA
 - ≡ Direction and movement detection





LEARN THE TIMING

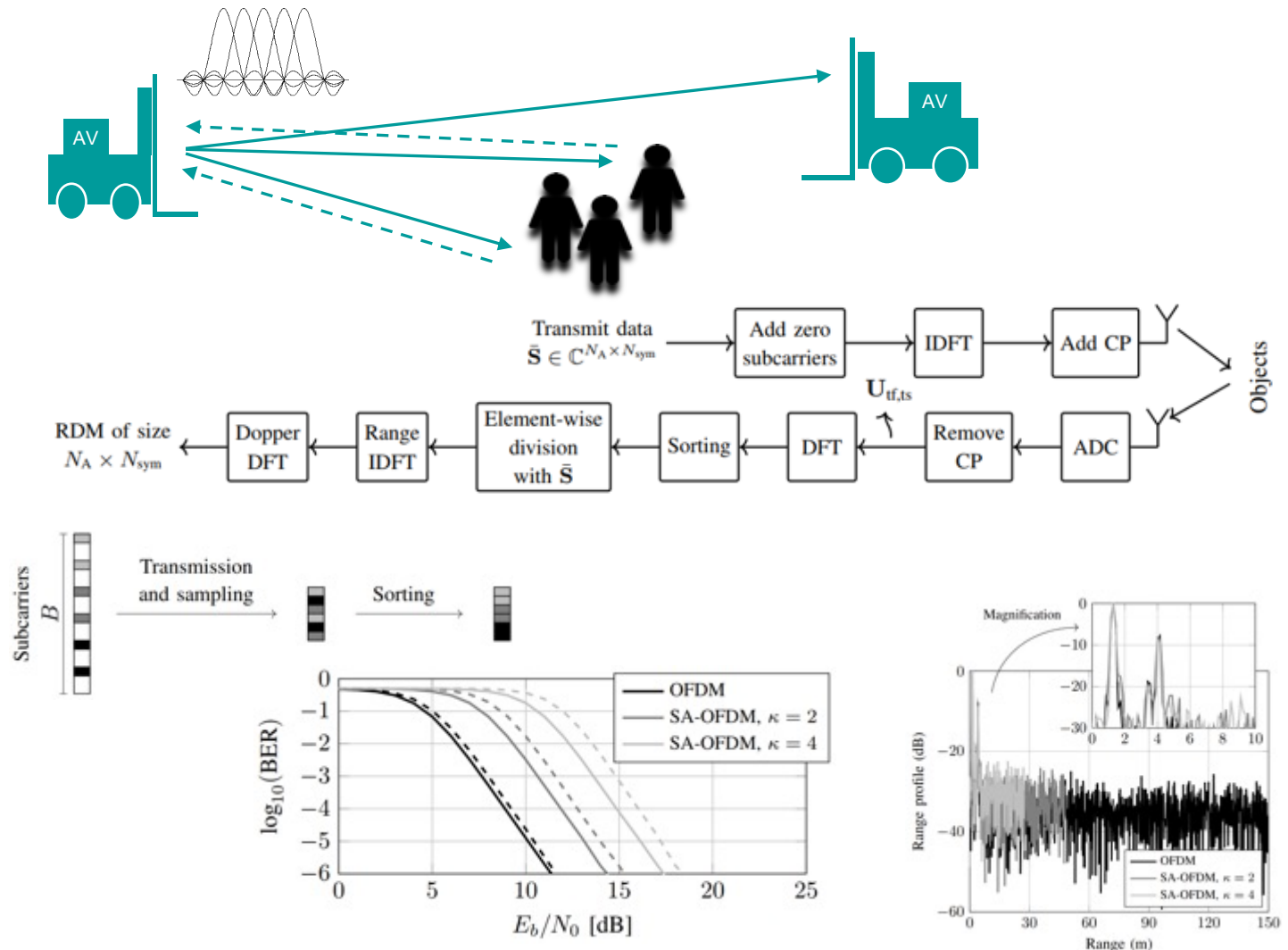
- ≡ Moving obstacles can be considered
- ≡ Dynamic parameters can be learned
- ≡ Blocking scenarios become deterministic
- ≡ Time and position variant prediction of the communication landscape
- ≡ Embedded intelligence to reduce prediction latency

JOINT COMMUNICATION & SENSING

≡ OFDM joint communication and radar

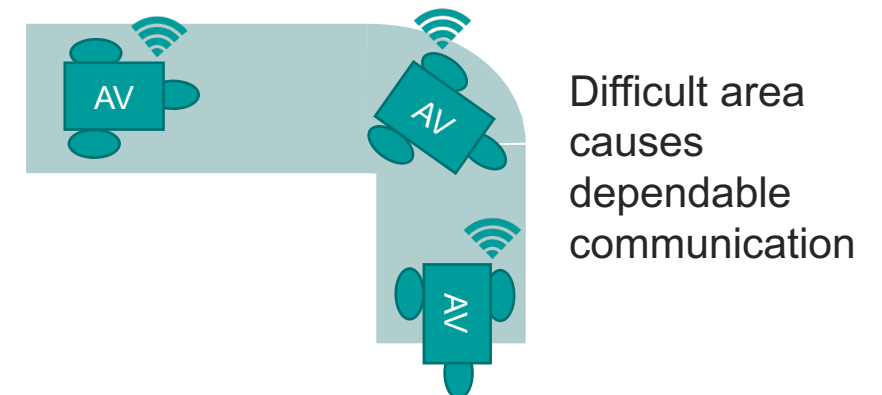
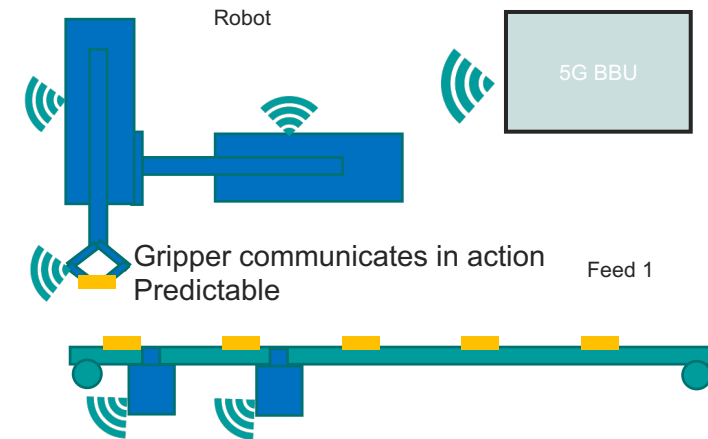
≡ Waveform design and receiver concepts

≡ Analytical investigations, simulations, and measurements



DEPENDABILITY PREDICTION

- ≡ Dependability is needed
 - ≡ Trigger by messages
 - ≡ Trigger by position of devices
 - ≡ Trigger by communicated values
- ≡ Switching to short latency / high redundancy if needed
 - ≡ Planning ahead
 - ≡ Analyzing on-line
- ≡ Demand can be learned from message analyzing
 - ≡ Supported by unsupervised learning
 - ≡ Supported by labeled learning



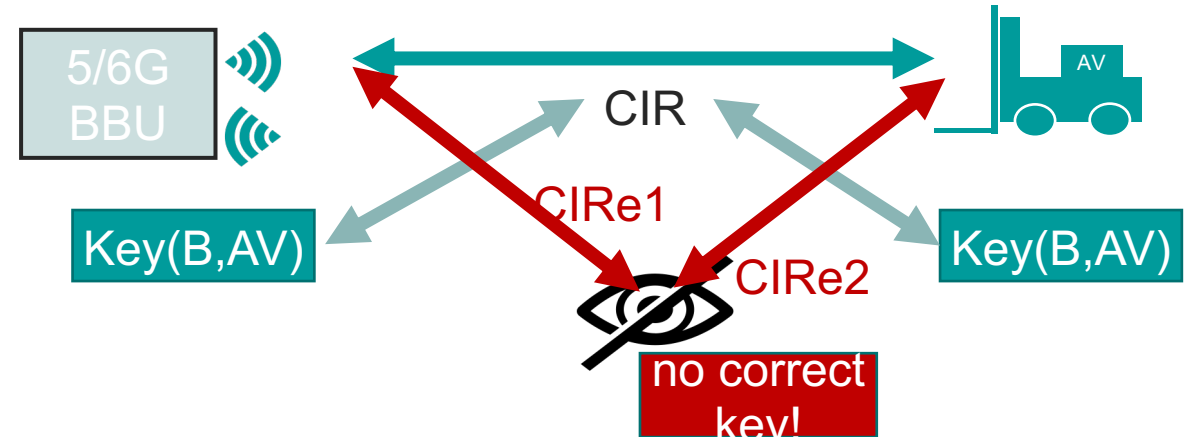


APPLY THE SECURITY

- PHY layer security
- Point to point privacy
- Point to many privacy
- Location based security
- Jamming detection
- Jamming mitigation
- Integrating network information

PHY LAYER SECURITY

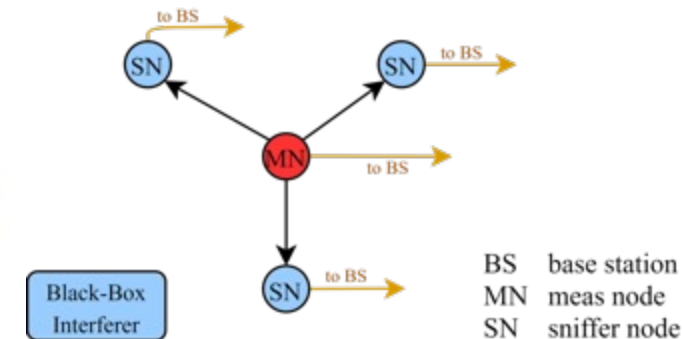
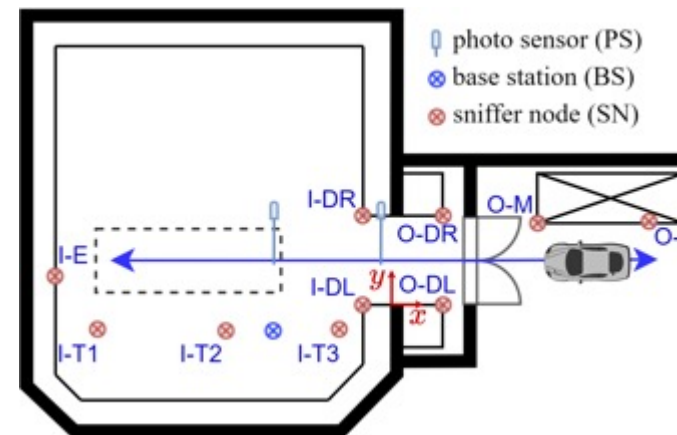
- ≡ How to avoid Eve's dropping
 - ≡ Shared random vector
 - ≡ Generate Key
 - ≡ Symmetric encoding



- ≡ Proximity validation
 - ≡ Time of arrival methods
 - ≡ Relay alert
 - ≡ Localization

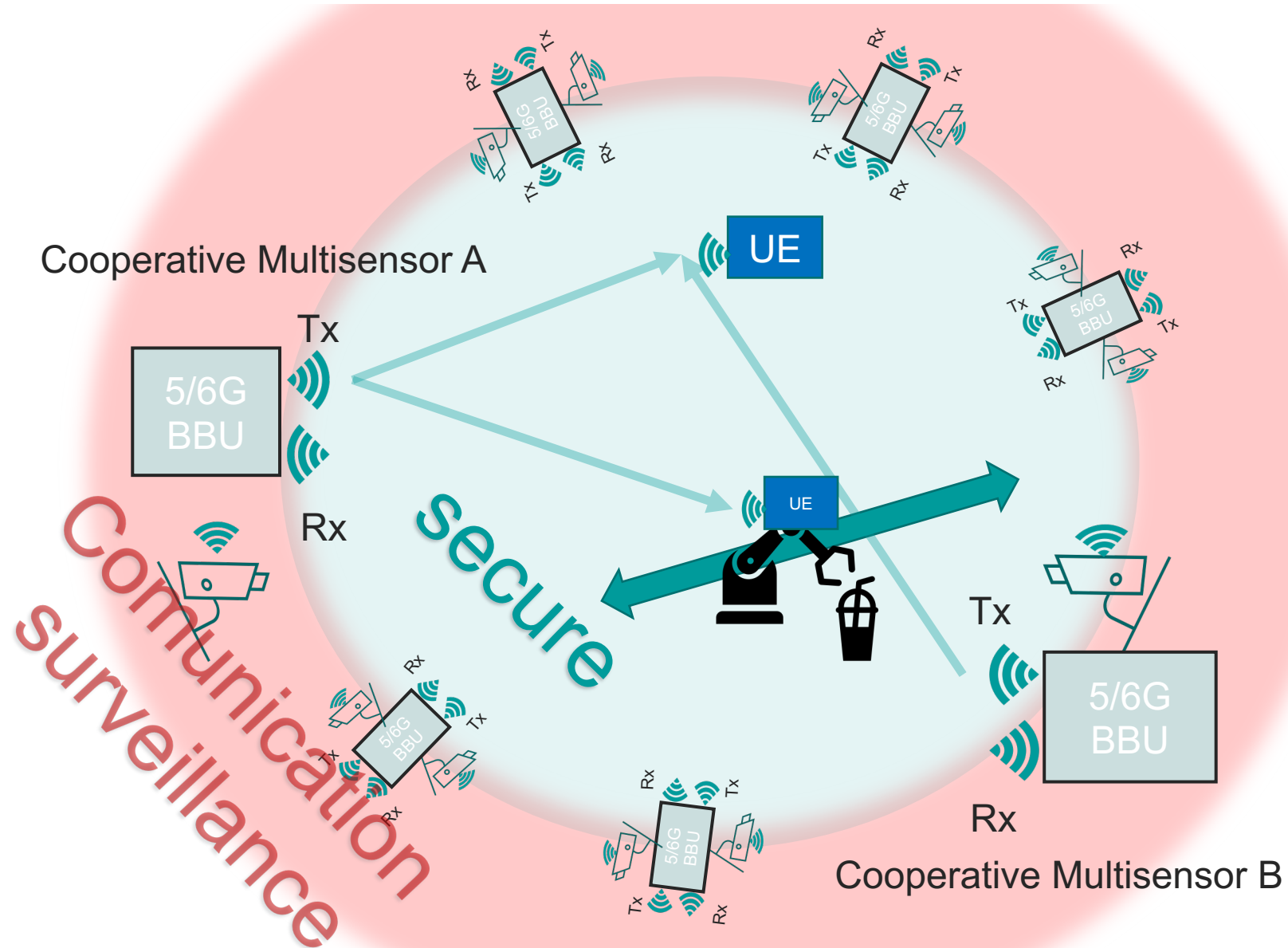
J. Karoliny, T. Blazek, F. Ademaj, H. -P. Bernhard and A. Springer, "RSSI-Based Machine Learning with Pre-and Post-Processing for Cell-Localization in IWSNs," *2021 IEEE 7th World Forum on Internet of Things (WF-IoT)*, 2021, pp. 604-609, doi: 10.1109/WF-IoT51360.2021.9595760.

A. Chorti *et al.*, "Context-Aware Security for 6G Wireless: The Role of Physical Layer Security," in *IEEE Communications Standards Magazine*, vol. 6, no. 1, pp. 102-108, March 2022, doi: 10.1109/MCOMSTD.0001.2000082.



COOPERATIVE SENSING FOR SECURITY

- ≡ Goal: Security and safety similar quality as wired connection
- ≡ Insulation of the wireless channel
- ≡ Use all available sensing data for an insulated area
- ≡ Identify objects / intruders / interferers





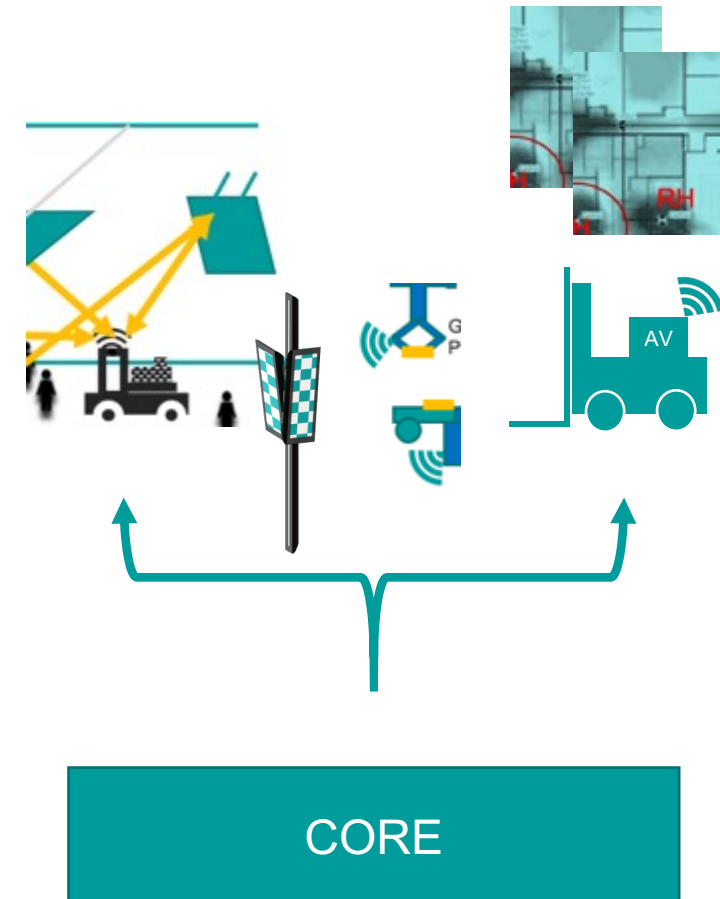
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COMBINE FOR DEPENDABILITY

- ≡ Learning
 - ≡ Environment
 - ≡ Time behavior
 - ≡ Security
- ≡ Combine it to safety functions
- ≡ Provide in the 5G/6G core

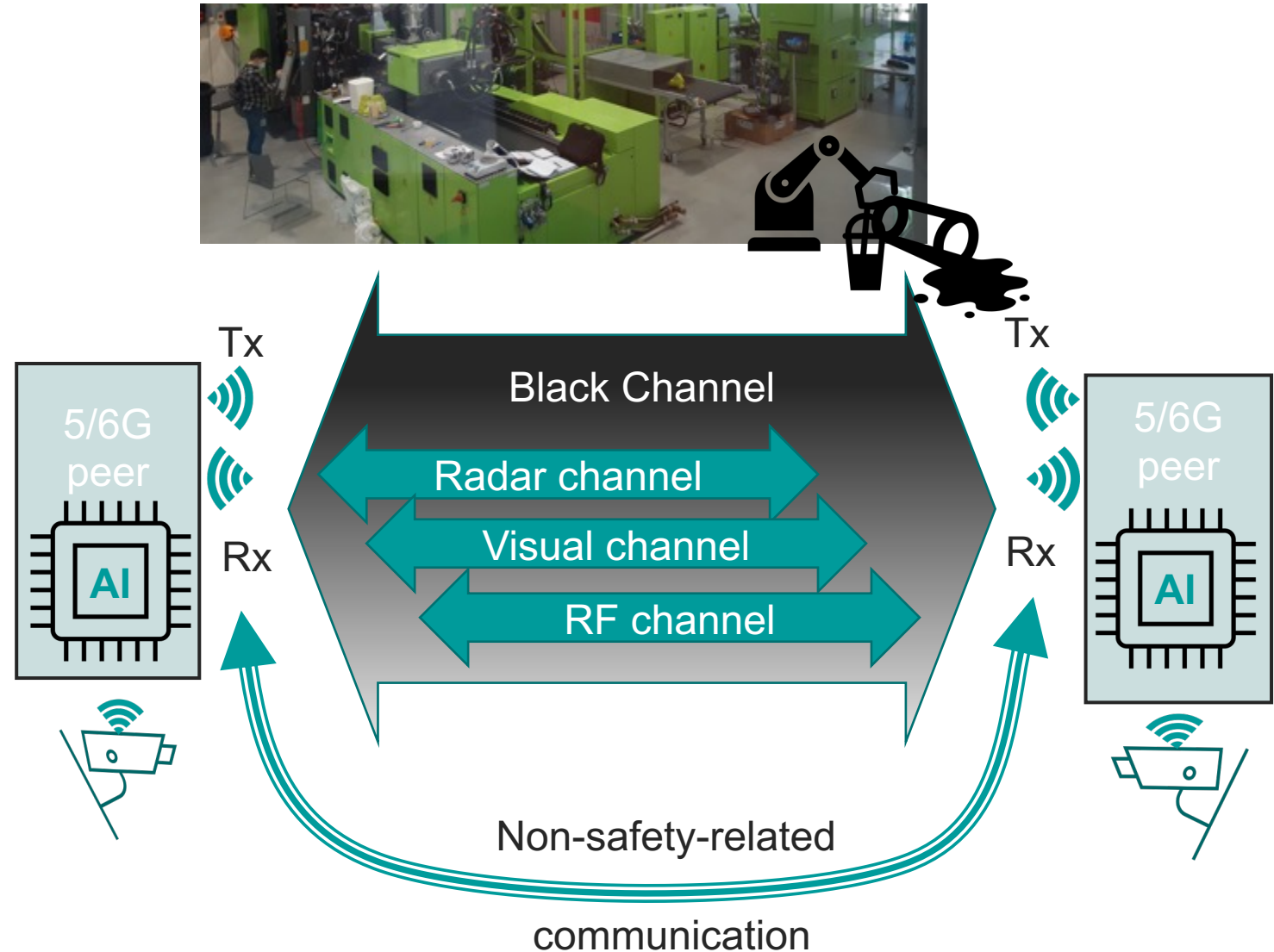
FEDERATED COMMUNICATION & SENSING (FC&S)

- ≡ Federation
 - ≡ More than Joint Communication & Sensing JC&S
 - ≡ Includes JC&S
 - ≡ Pull all collected data together
 - ≡ Combine and interpret
 - ≡ Store and manage
 - ≡ Learn
 - ≡ Distribute

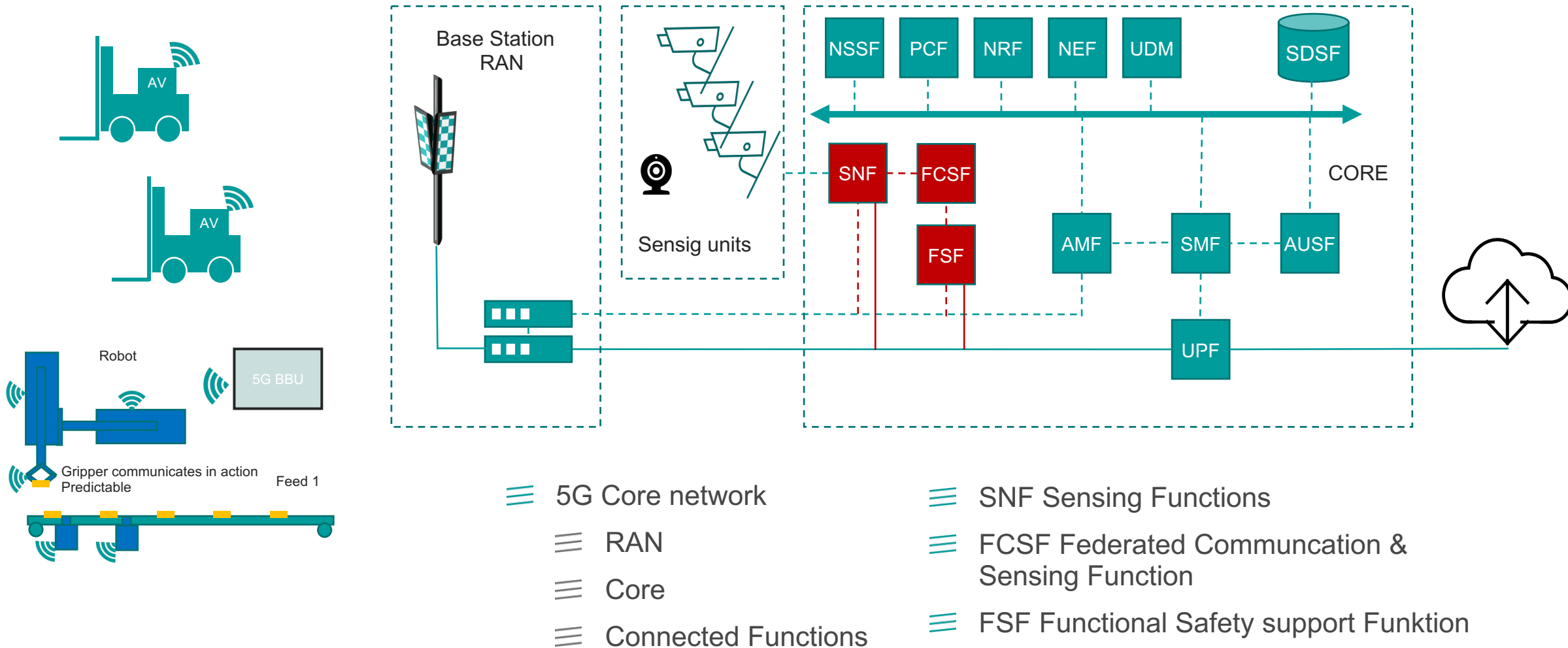


FEDERATED SENSING 4 DEPENDABILITY

- ≡ Safety protocols
 - ≡ Dynamic safety relevance qualification of data
 - ≡ Relevance found by sensor data and AI/ML
- ≡ Black channel unloading
 - ≡ Not safety critical bypass
 - ≡ Split the communication channels by QoS and protocol in safety critical and non-safety-critical
- ≡ Re-define communication protocols
 - ≡ Safe protocols
 - ≡ Unsafe protocols



NETWORK STANDARD PERSPECTIVE



PARADIGMS RENEWED

- ≡ Learn the environment
- ≡ Learn the timing
- ≡ Apply security
- ≡ Combine for dependability





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DISCUSSION?

THANKS!

LET'S START NOW OR LATER!