

SFERA-III

Solar Facilities for the European Research Area



"5G and IoT Platform for CSP"

Inga Miadowicz, DLR, Solar Research

NETWORKING

Summer School: "Smart CSP: How Smart Tools, Devices, and Software can help improve the Design and Operation of Concentrating Solar Power Technologies" - WP1 Capacity building and training activities - Cologne, Germany, September 14th-15th 2023

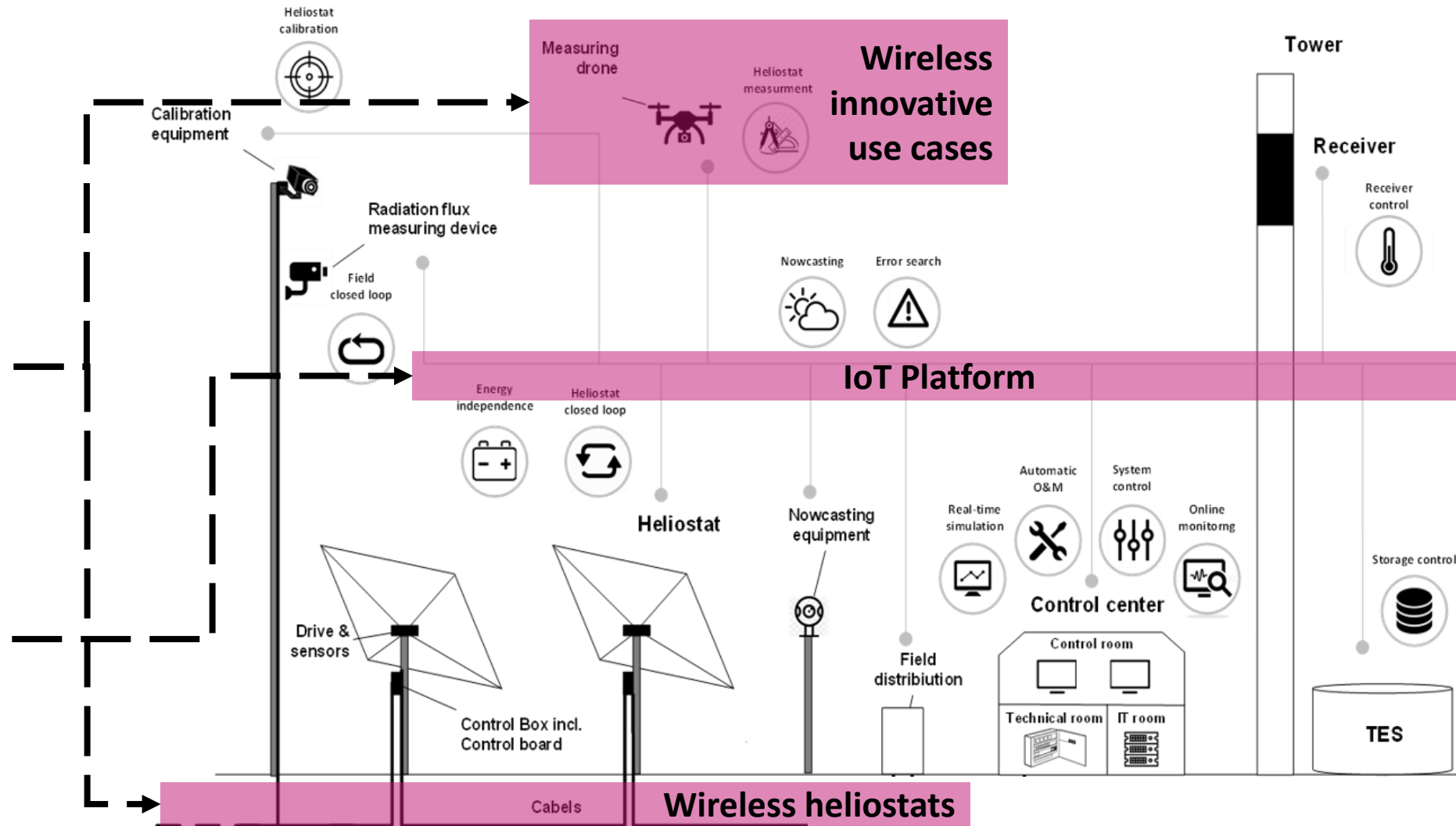


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Content

Smart CSP Infrastructure

- 1 **5G Campus Network**
Private 5G network for wireless use cases and heliostats
- 2 **IoT Platform**
System infrastructure for data management and interconnection of subsystems



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Part 1: 5hine - 5G Solutions for efficient solar-thermal power plants *Inga Miadowicz, DLR, Solar Research*



5G and IoT Platform for CSP

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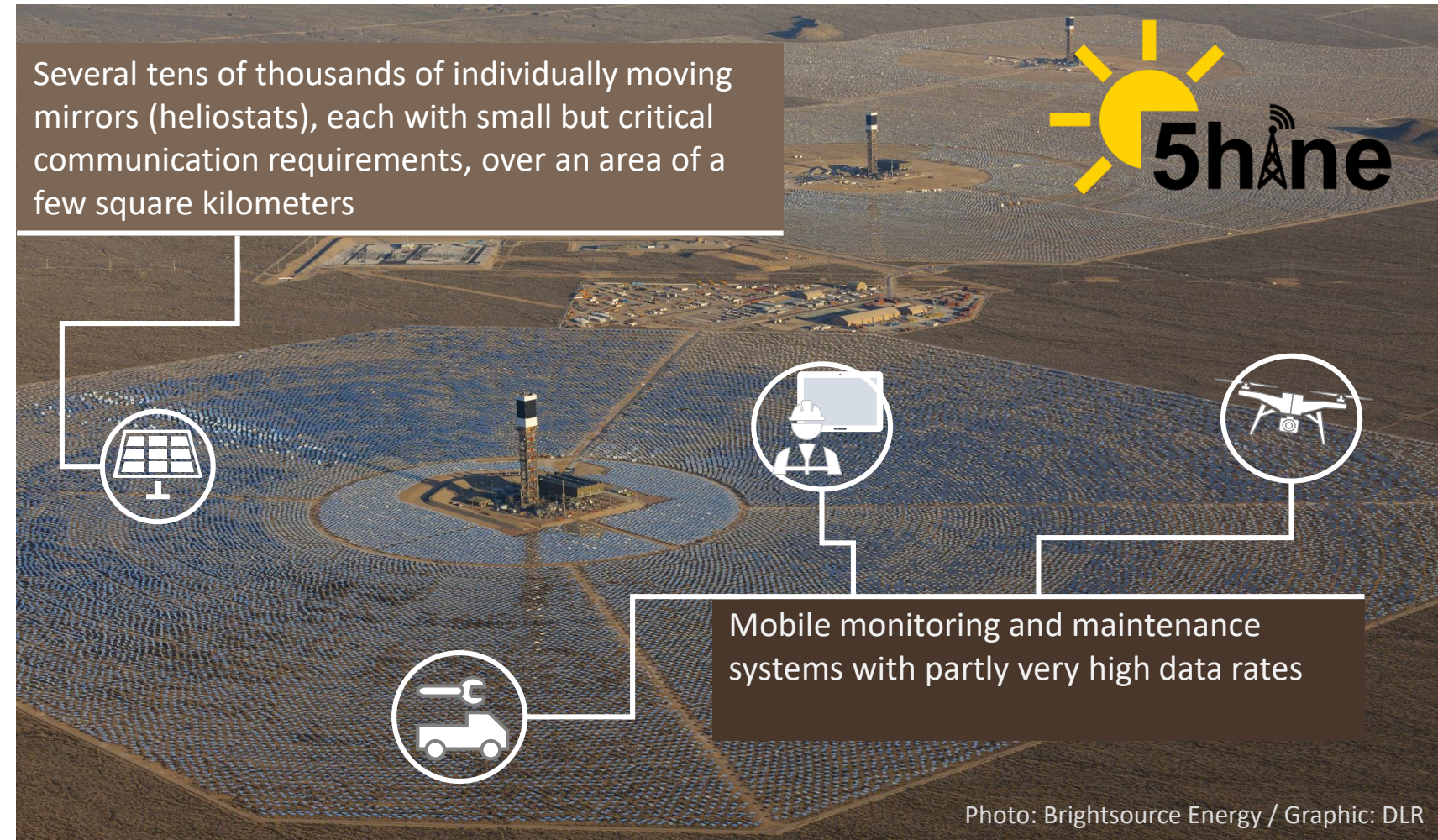


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Motivation

- Issue 1:
Wiring of Heliostat field is expensive and elaborate
→ ~ 7% of total investment costs [6]
- Issue 2:
Monitoring & Maintenance needs flexible wireless solutions
→ eg. Drones
- Issue 3:
High communication requirements in designated areas

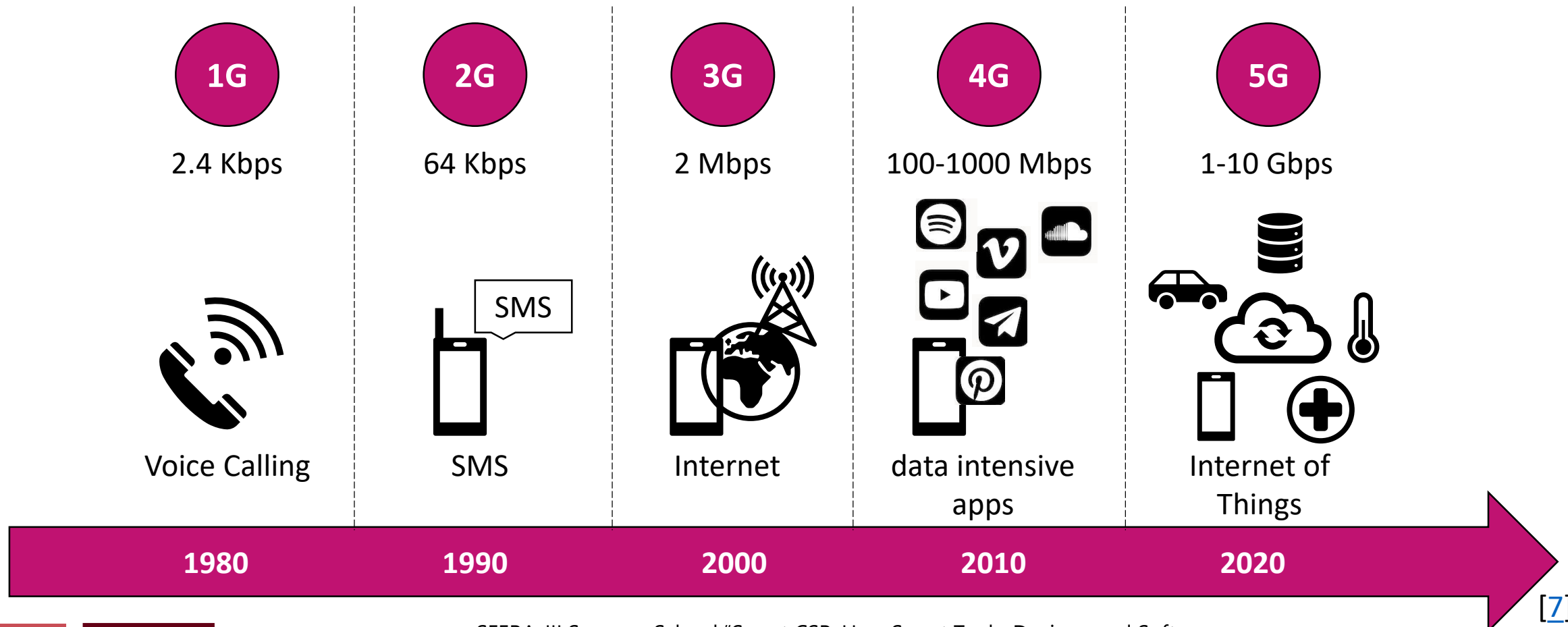
Several tens of thousands of individually moving mirrors (heliostats), each with small but critical communication requirements, over an area of a few square kilometers



Mobile monitoring and maintenance systems with partly very high data rates

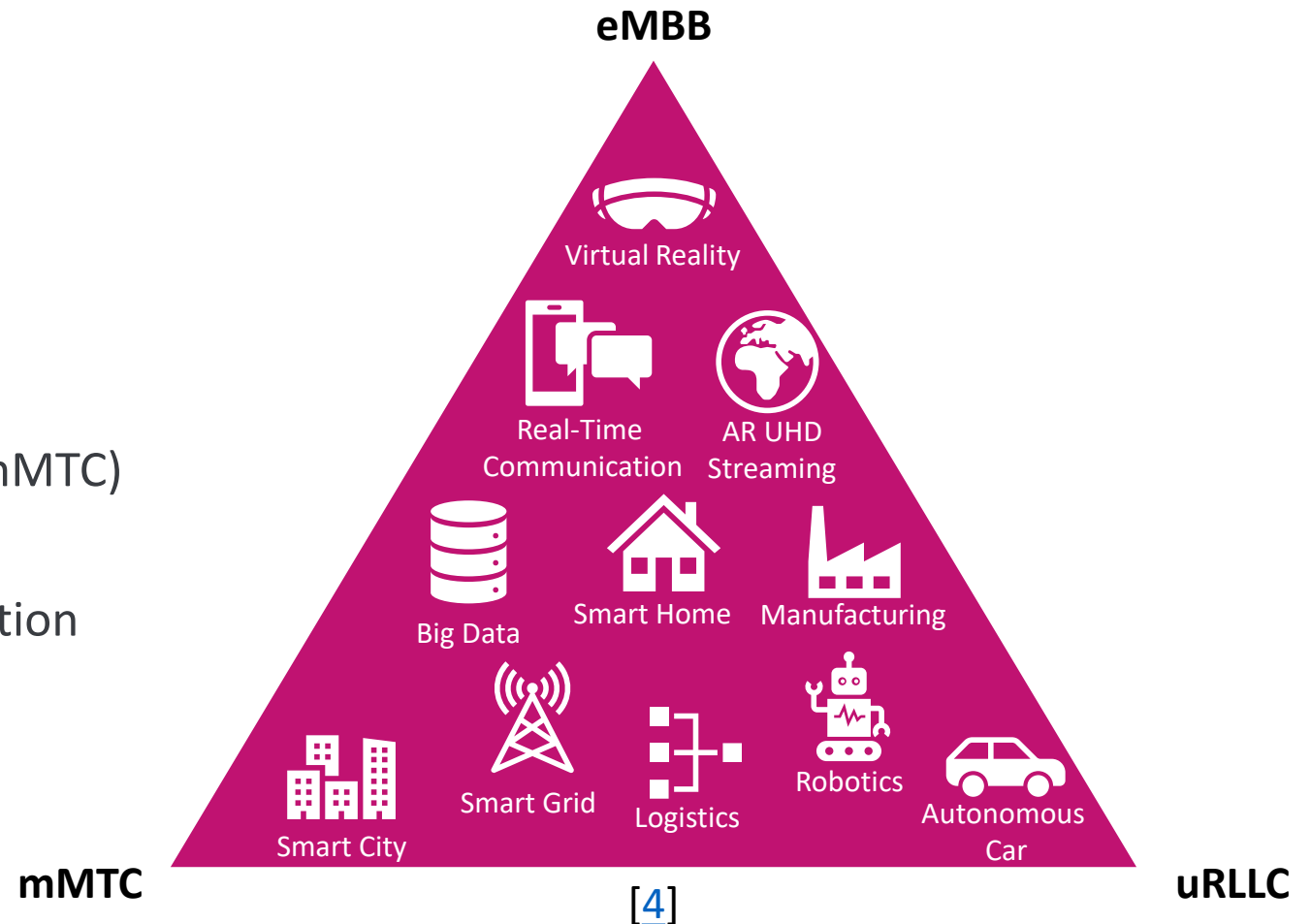
Photo: Brightsource Energy / Graphic: DLR

Background



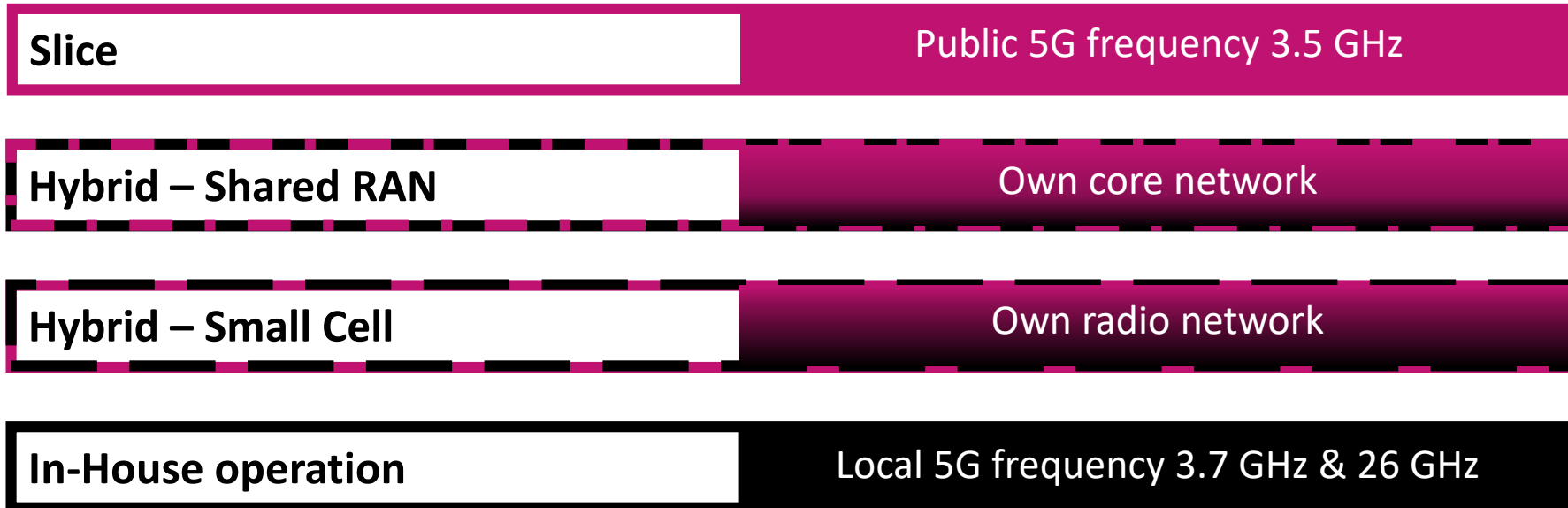
Background

- 5G Requirements profiles
 - Enhanced Mobile Broadband (eMBB)
 - Massive Machine Type Communication (mMTC)
 - Ultra-reliable and low latency communication (uRLLC)
 - Mixed requirement profiles



Background

- 5G campus network and new network operation models
 - Geo-localized networks adapted for special requirements of the domain
 - Can be completely isolated or based on public infrastructure

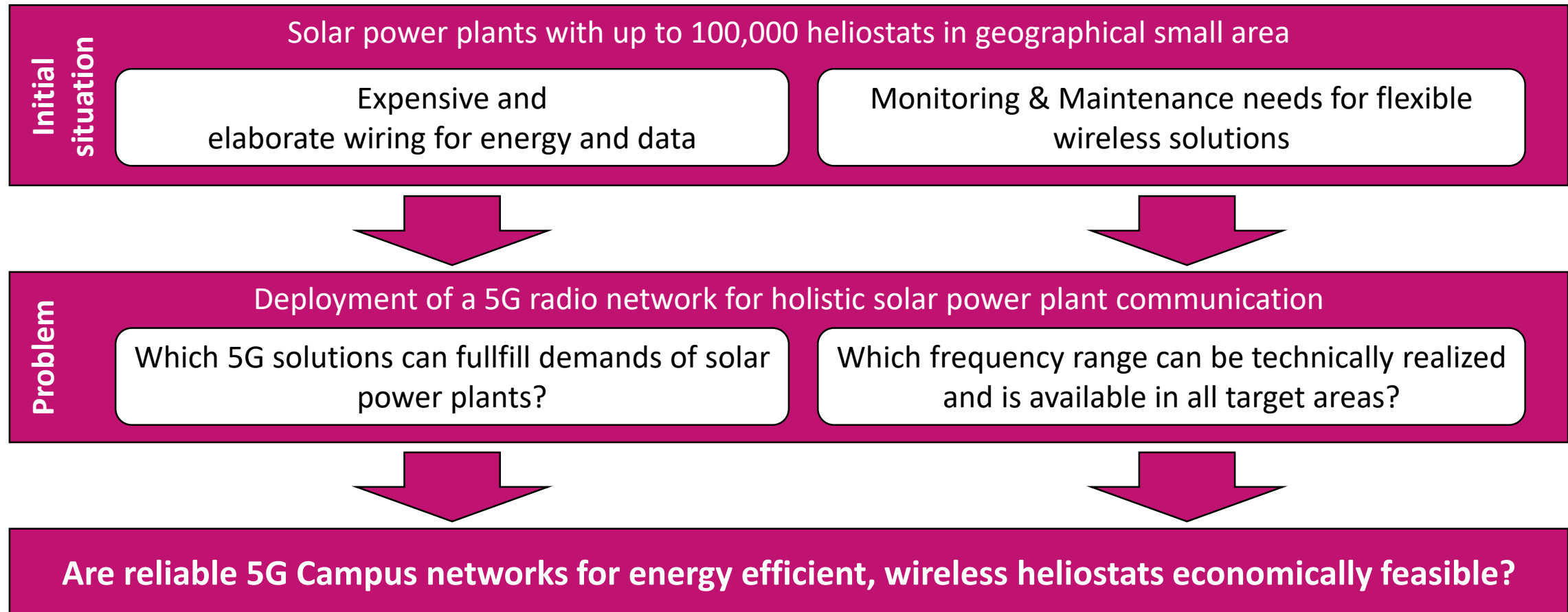


gNB (public)



gNB (private) [5]

Project goals

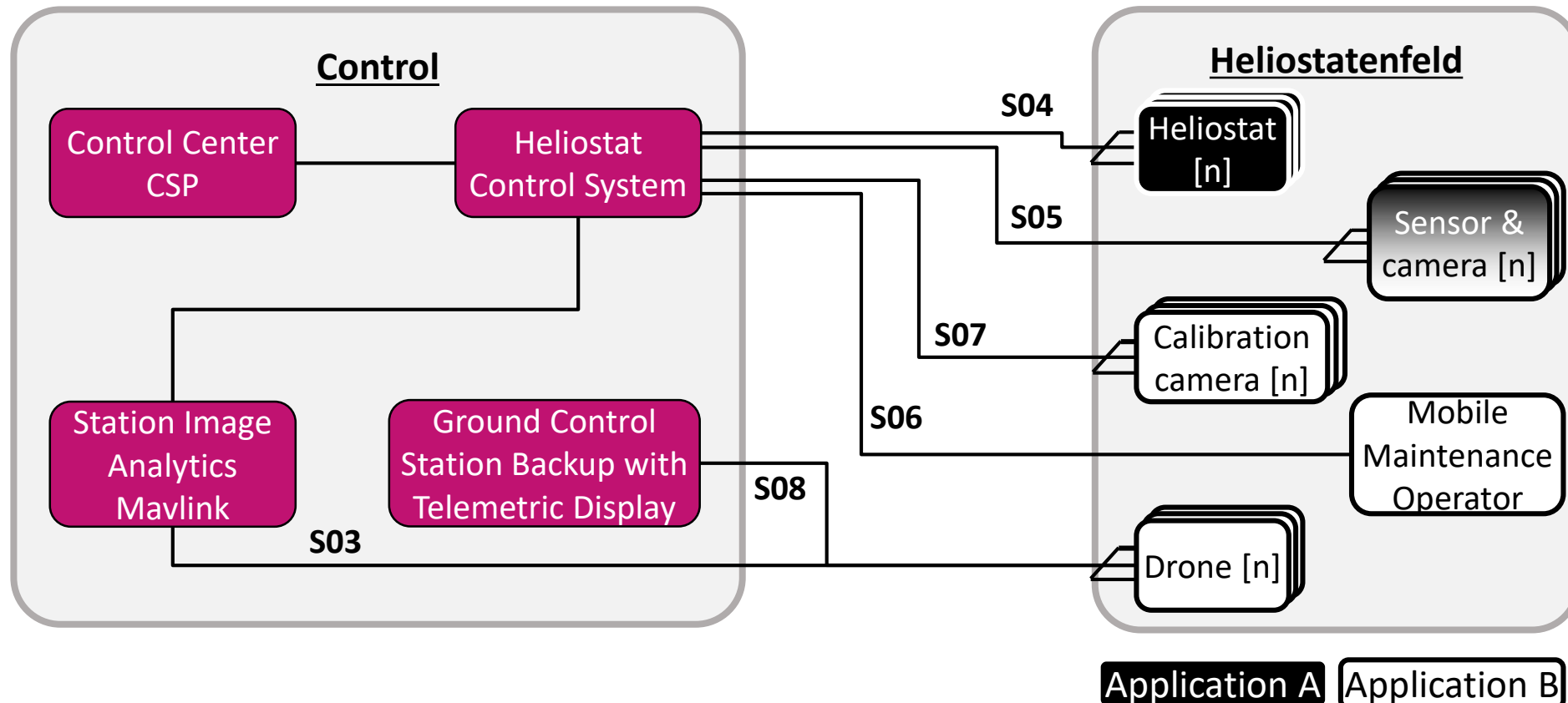


Requirements

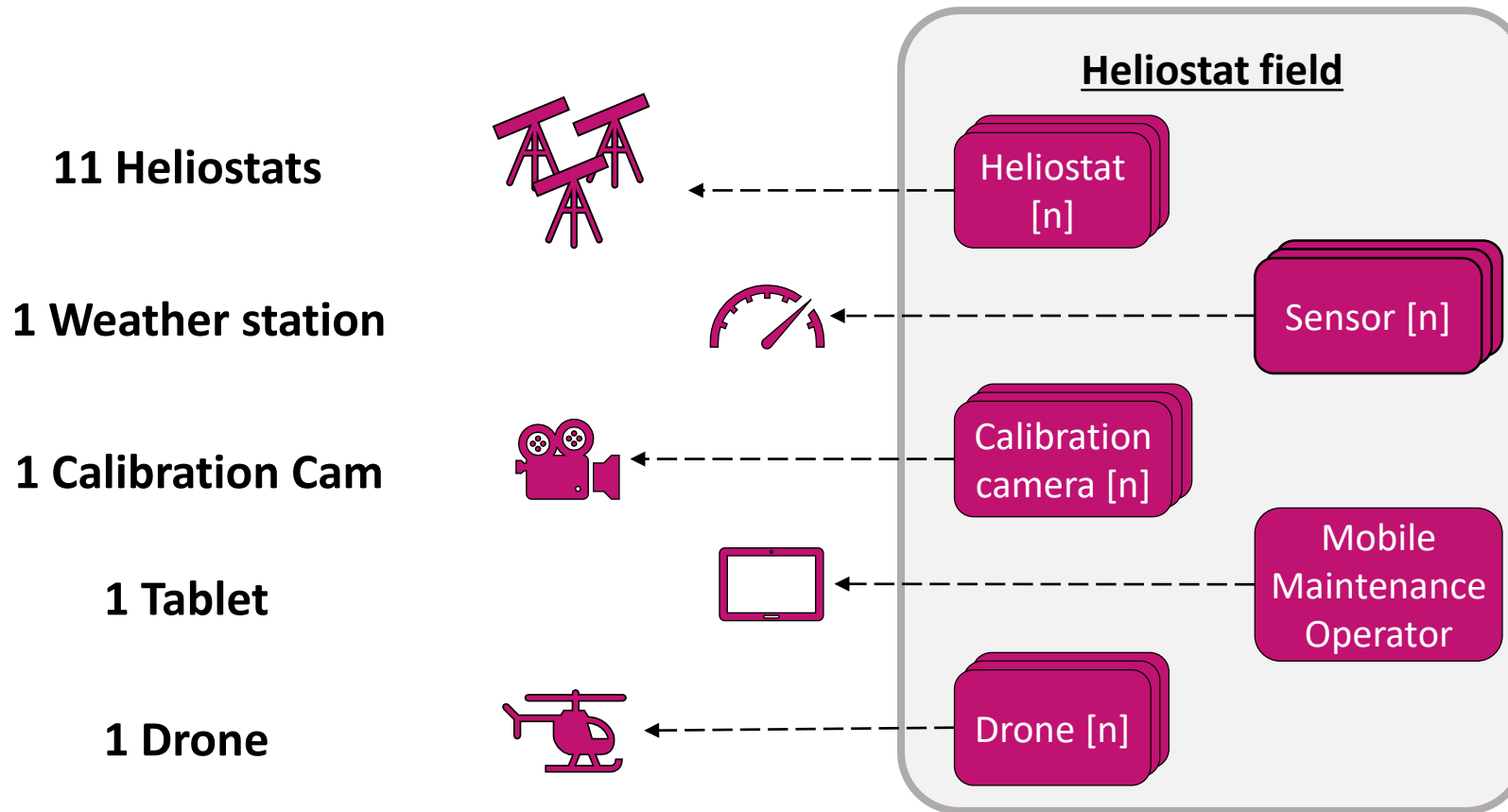
Application A: Highly scaled number of participants with transmission of small amounts of data, cost effective, low power (heliostats, sensor)
 → mMTC

Application B: Small number of participants with high data volumes, low latency & reliability (e.g. drone)


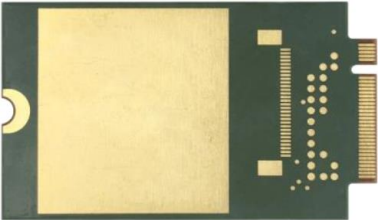

→ eMBB, uRLLC



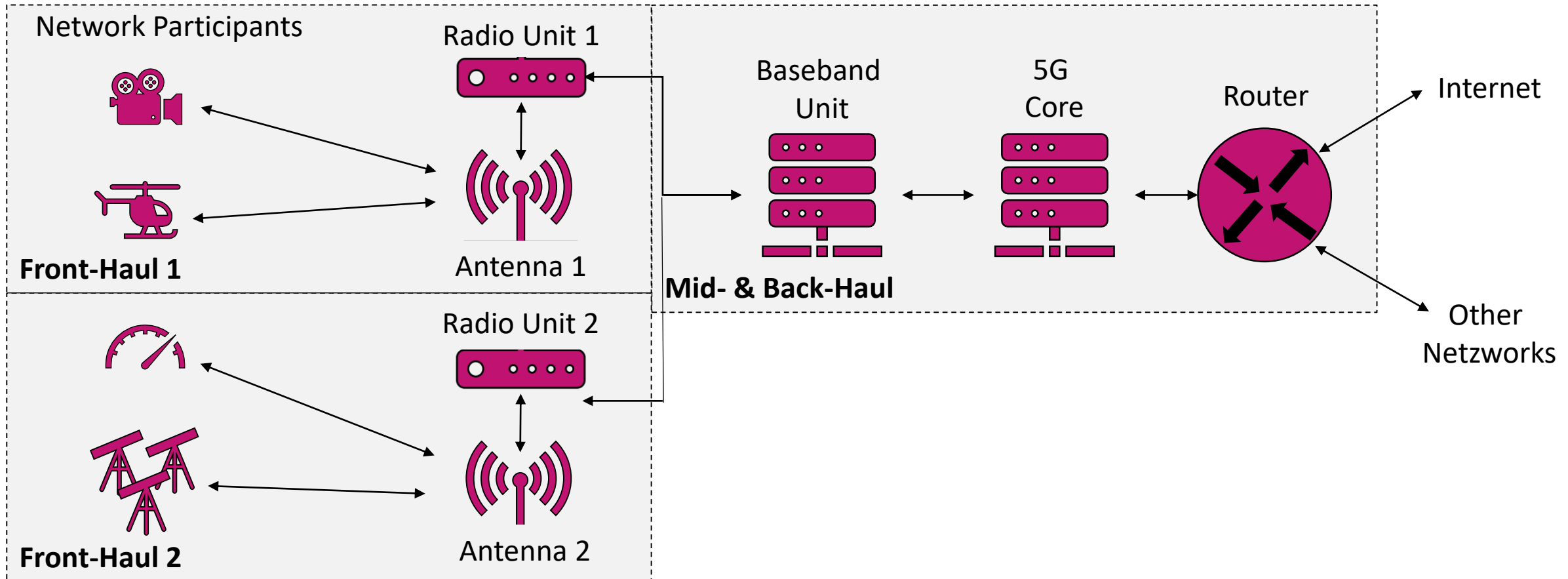
Concept



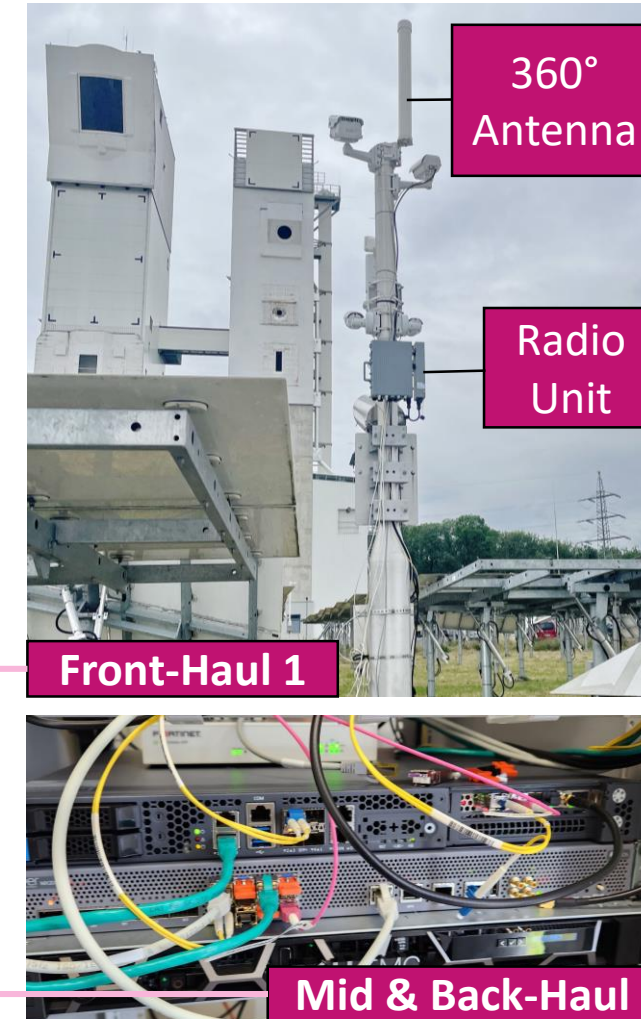
Concept

Device that directly supports 5G & campus network	5G Modem that can be integrated on board	5G Router that can be plugged into device in exchange for ethernet
<p>Tablet</p> 	<p>Drone</p> <p>Heliostat (onboard)</p> 	<p>Heliostat (plug-in)</p> <p>Calibration Cam</p> <p>Weather Station</p> 
<p><i>Support of campus networks currently limited!</i></p>	<p><i>Most effort because of hardware re-design</i></p>	<p><i>Higher Hardware-Costs & Protection with outdoor case necessary</i></p>

Concept



Realization



Summary

- **Wireless heliostats** allow to **save costs and effort for cabling & allow more flexibility** for innovative use cases like drones
- 5G technology has a **higher data rate**, can support **different requirement profiles** and allows the use of **campus networks**
- Solar power plants are **typically location in designated areas** have a **heterogeneous requirement profile for data communication**
- A 5G campus network is currently **demonstrated & evaluated at solar tower Jülich** → technical and economical evaluation is still ongoing

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Part 2: An IoT Platform as the basis for monitoring and automation in the solar thermal power plant

Inga Miadowicz, DLR, Solar Research

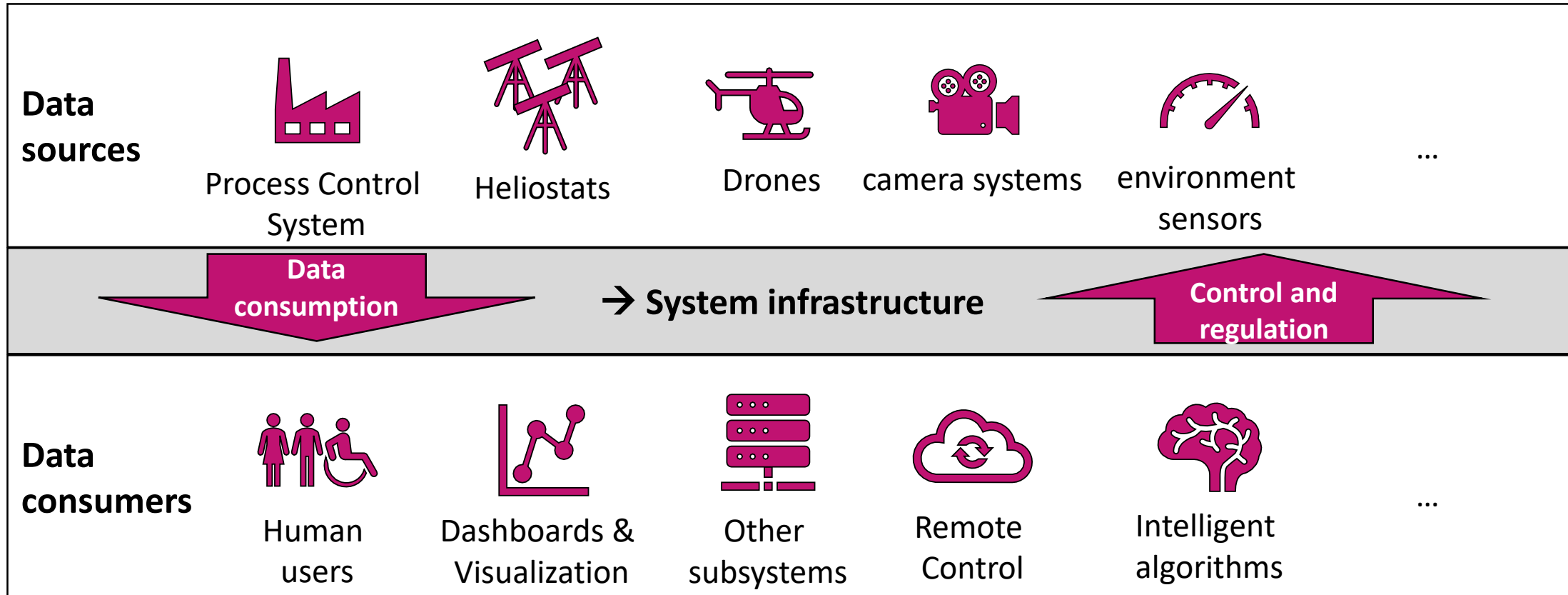
5G and IoT Platform for CSP

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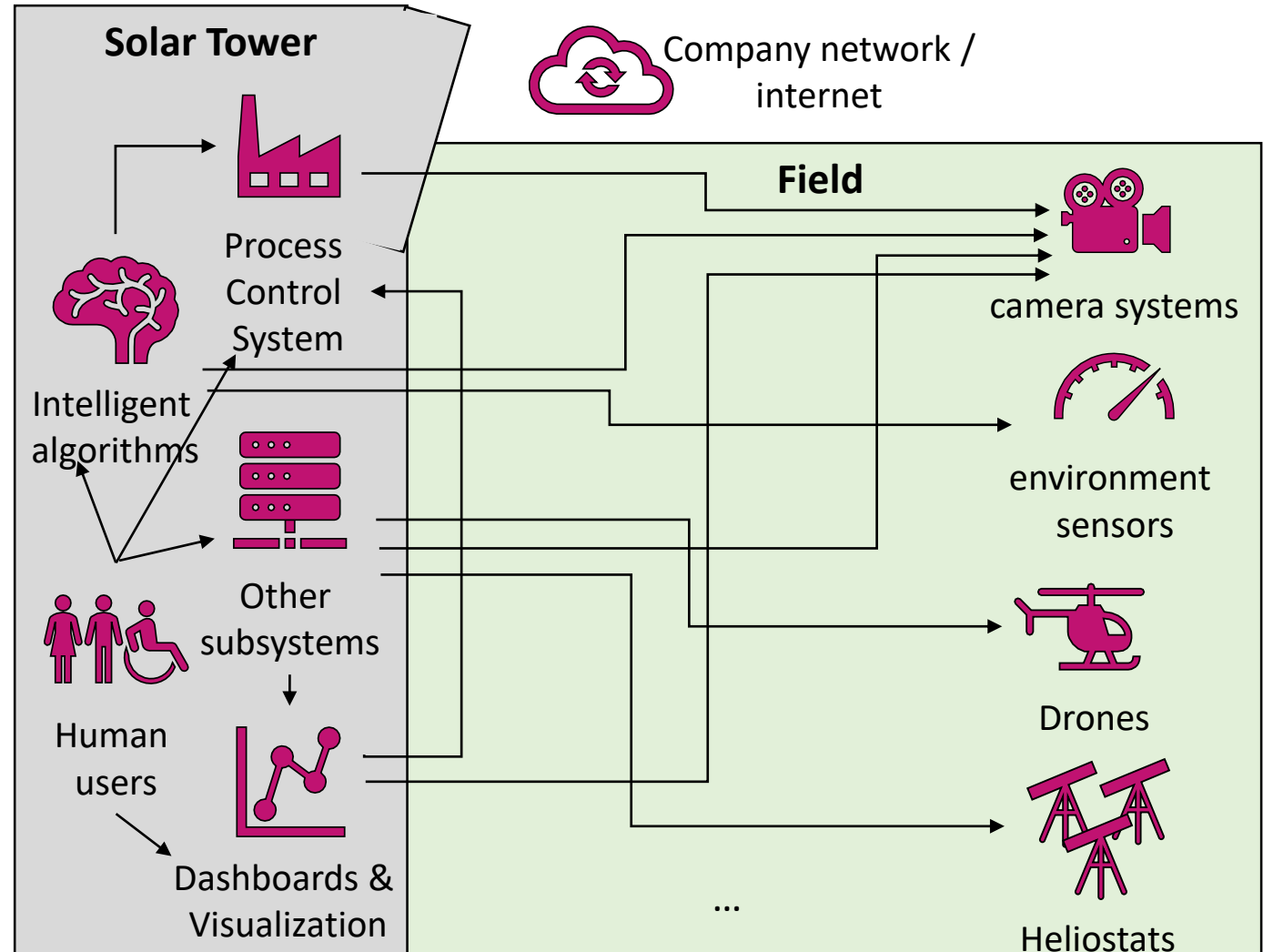
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Motivation



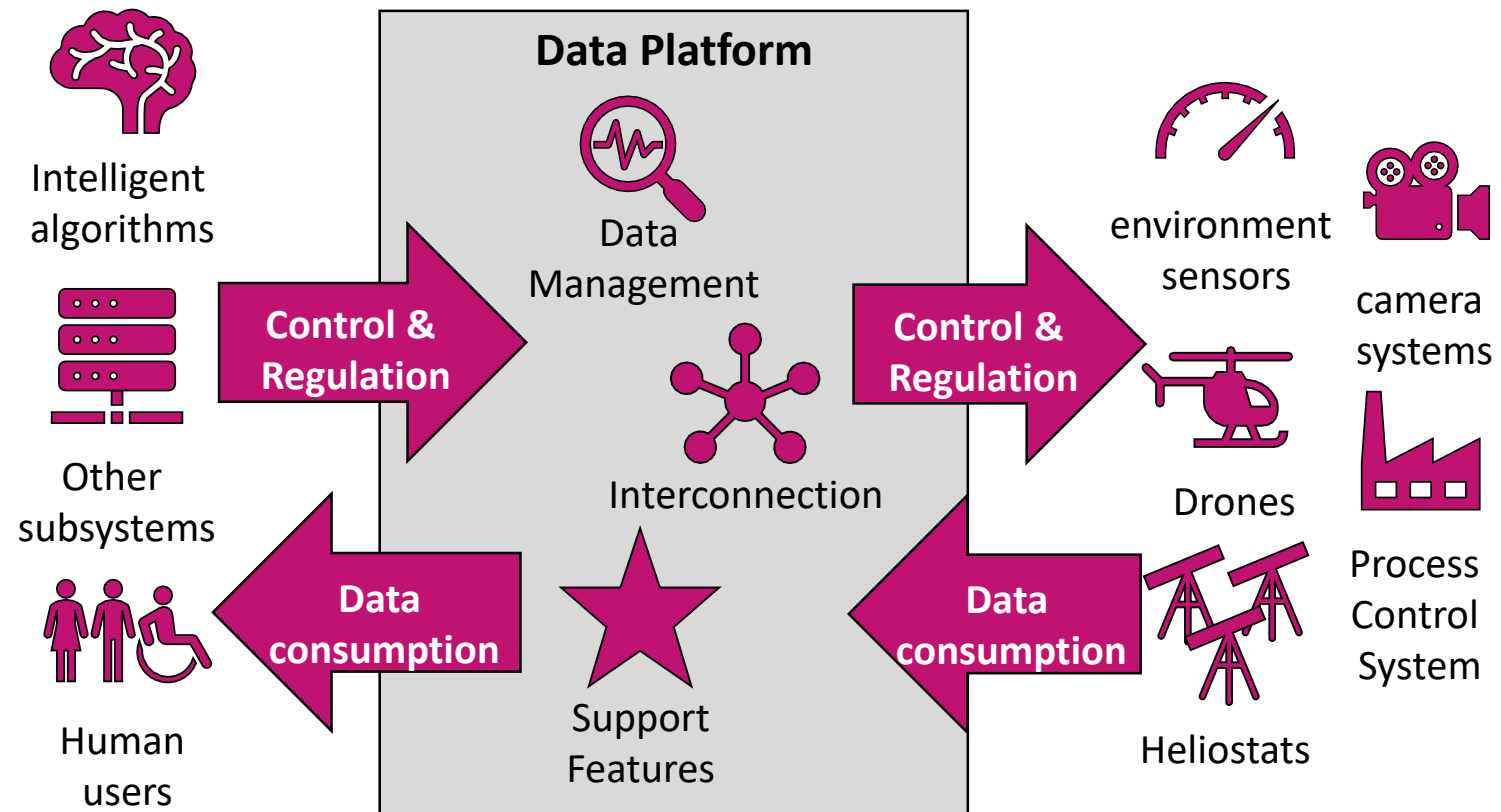
Motivation

- Actual situation
 - Series of distributed subsystems
 - Partly connected data silos
 - Airgapped high-security environment
- Challenges
 - Heterogeneous systems and interfaces
 - Performance, stability and security
 - Huge amount of data
 - ~ 5.5 TB to process per day
 - ~ 10 TB to store per year
 - Complexity of the overall system
 - ...

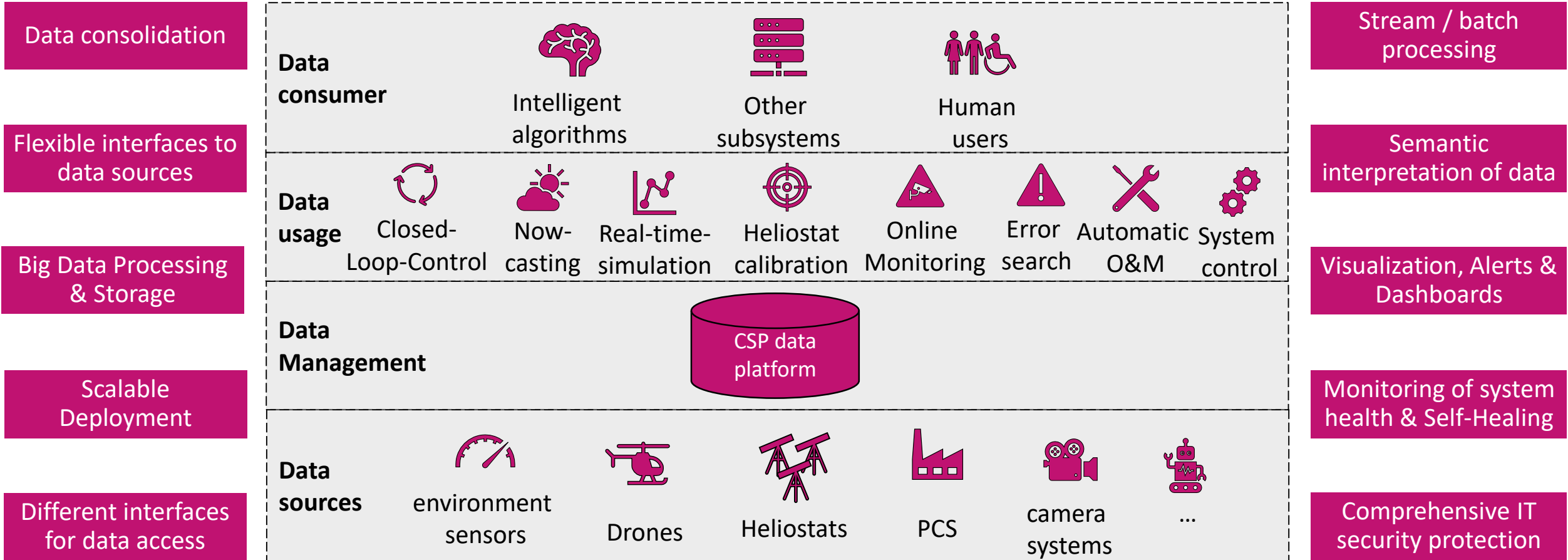


Project Goal

- Data Platform as a centralized infrastructure for interconnection & data management
 - Collect & provide data from all sources and allow their control and regulation of system components
 - Break data silos and provide features for data-based applications and human users
 - Provide robust, secure, performant, flexible and scalable system infrastructure

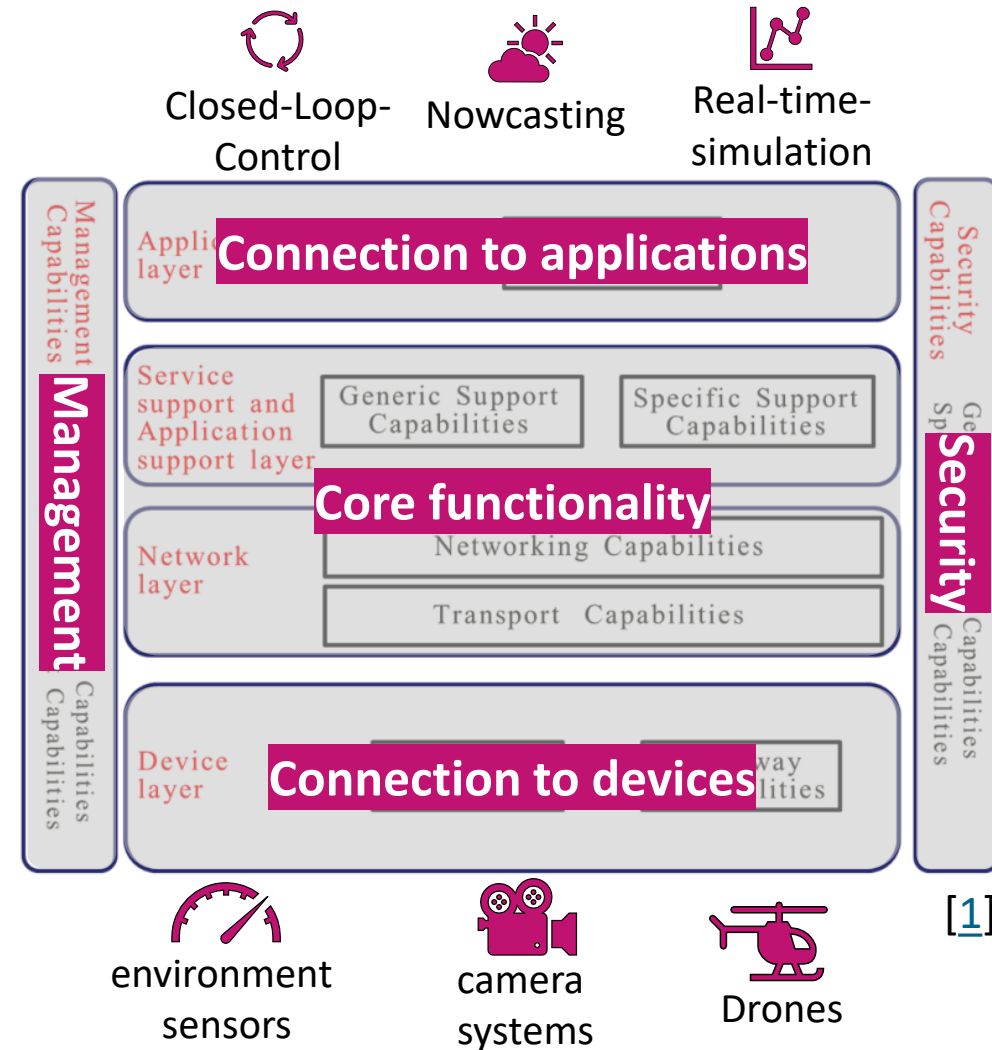


Requirements

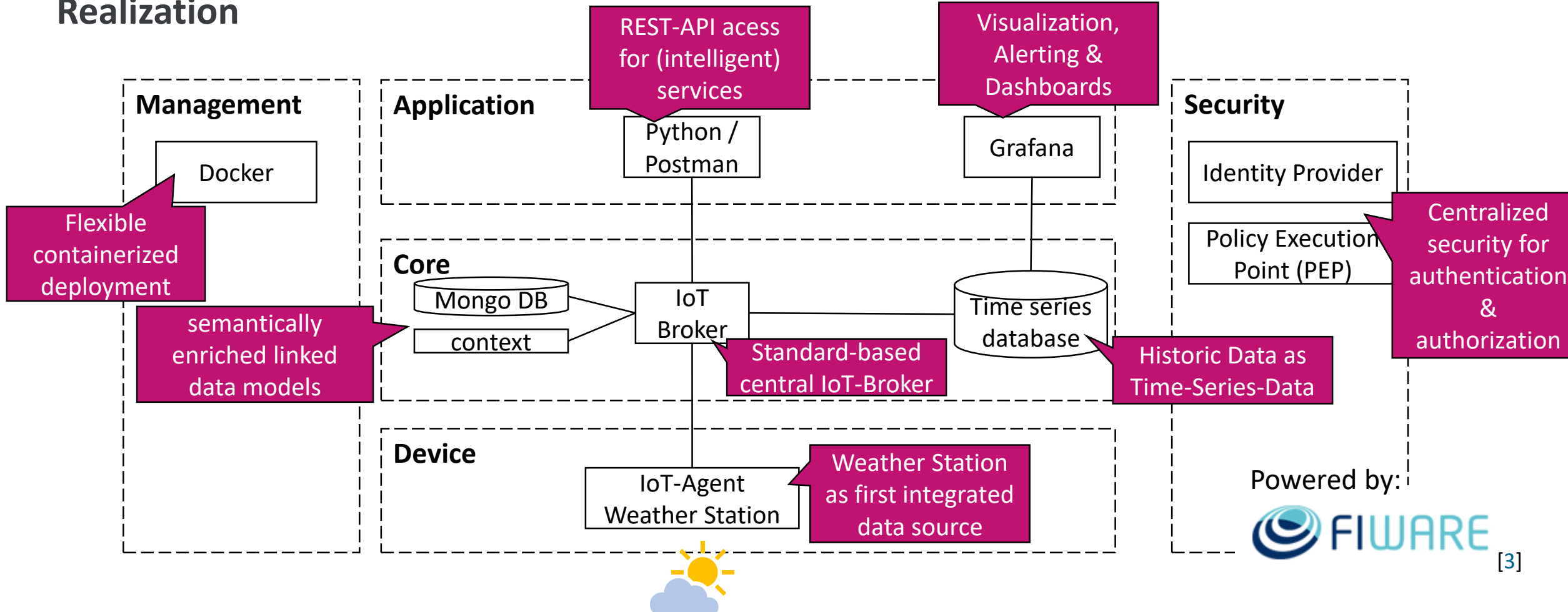


Concept

- Reference Architectures for (I)IoT-Platforms
 - Consumes data at device layers and provides it to application layer
 - Core functionality for data management
 - Management and security services that provide functions for all layers



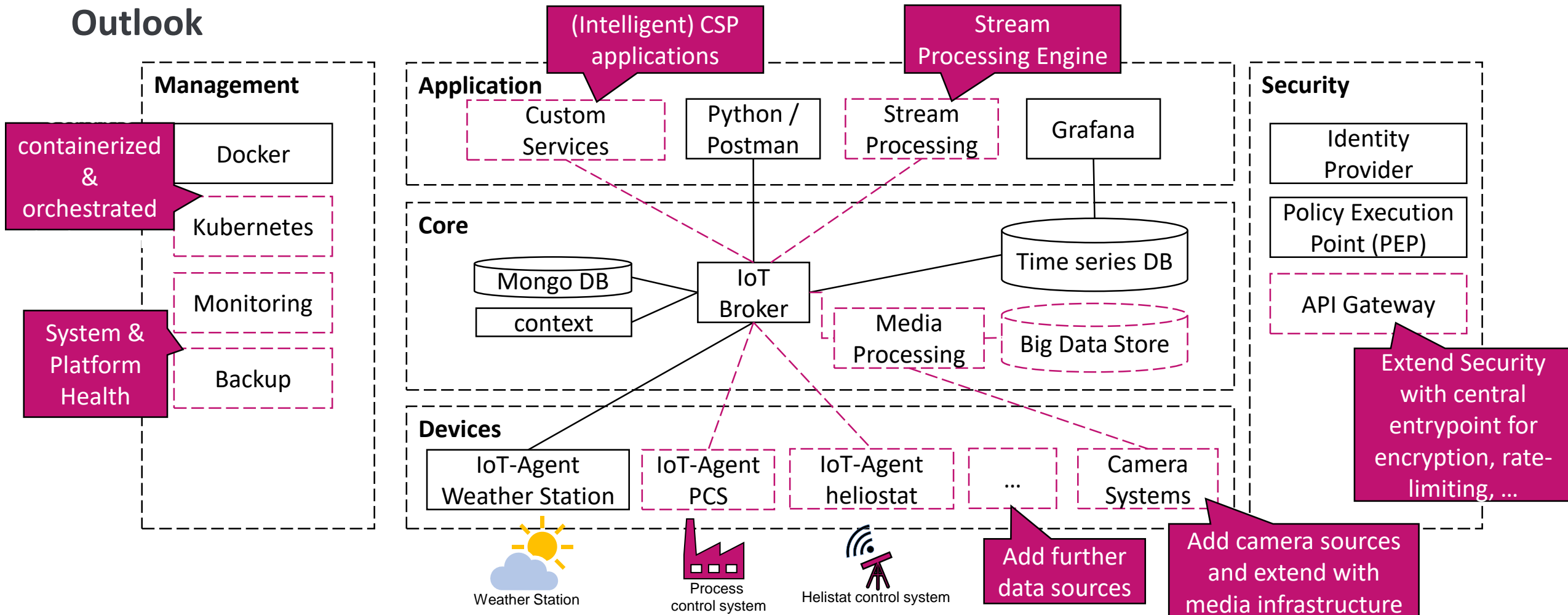
Realization



Realization



Outlook



Summary

- The **amount of data** and the **need for processing methods** is growing
- **Solar power plants have high requirements on technical infrastructure** like huge amount of subsystems and data, high degree of heterogeneity, sensitive control processes, low latency requirements...
- **A qualitative system infrastructure for data management and interconnection** of system components is important as a **basis for condition monitoring and automatization**
- A **data platform** can be used as a **middleware for interconnection and data management** of the system and its components

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Thank you.

Inga Miadowicz, DLR, Solar Research

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Literature

- [1] International Electrotechnical Commission (IEC): *“IoT 2020: Smart and secure IoT platform”*, 2016, Geneva, Schweiz, <https://www.iec.ch/basecamp/iot-2020-smart-and-secure-iot-platform> (visited at 18.10.2022)
- [2] M. Ullah and A. Narayanan and A. Wolff and P. H. J. Nardelli: *„Unified Framework to Select an IoT Platform for Industrial Energy Management Systems“*, MIPRO 2021, Opatija, Kroatien
- [3] FIWARE Foundation e.V.: *„FIWARE, the Open Source Platform for Our Smart Digital Future“*, 2022, Online: <https://www.fiware.org/> (visited at 02.05.2023)
- [4] International Telecommunication Union: *“ICT infrastructure business planning toolkit – 5G networks”*, 2023, Online: https://www.itu.int/hub/publication/d-pref-ef-ict_struct_kit-2023/ (visited at 08.09.2023)
- [5] Bundesministerium für Wirtschaft und Energie (BMWi): *“Leitfaden 5G-Campusnetze – Orientierungshilfe für kleine und mittelständische Unternehmen”*, 2020, Berlin
- [6] SANDIA Report: *Power Tower Technology Roadmap and Cost Reduction Plan* (2011), SAND2011-2419
- [7] Rana, M. M., et al. (2016). *Microgrid State Estimation Using the IoT with 5G Technology*. Internet of Things (IoT) in 5G Mobile Technologies. C. X. Mavromoustakis, G. Mastorakis and J. M. Batalla. Cham, Springer International Publishing: 175-195.

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- Author: Inga Miadowicz
- Institute: Institute of Solar Research
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