

IOT FOR CRISIS & DISASTER MANAGEMENT: HOT TOPICS AND FUTURE IMPACT

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OUTLINE

- Status Quo in the Internet of Things (IoT)
- Status Quo in Command & Control (C&C) Systems
 - Do IoT and C&C Systems go together?
- Future of IoT for Crisis & Disaster Management
- Conclusions and Call for Action

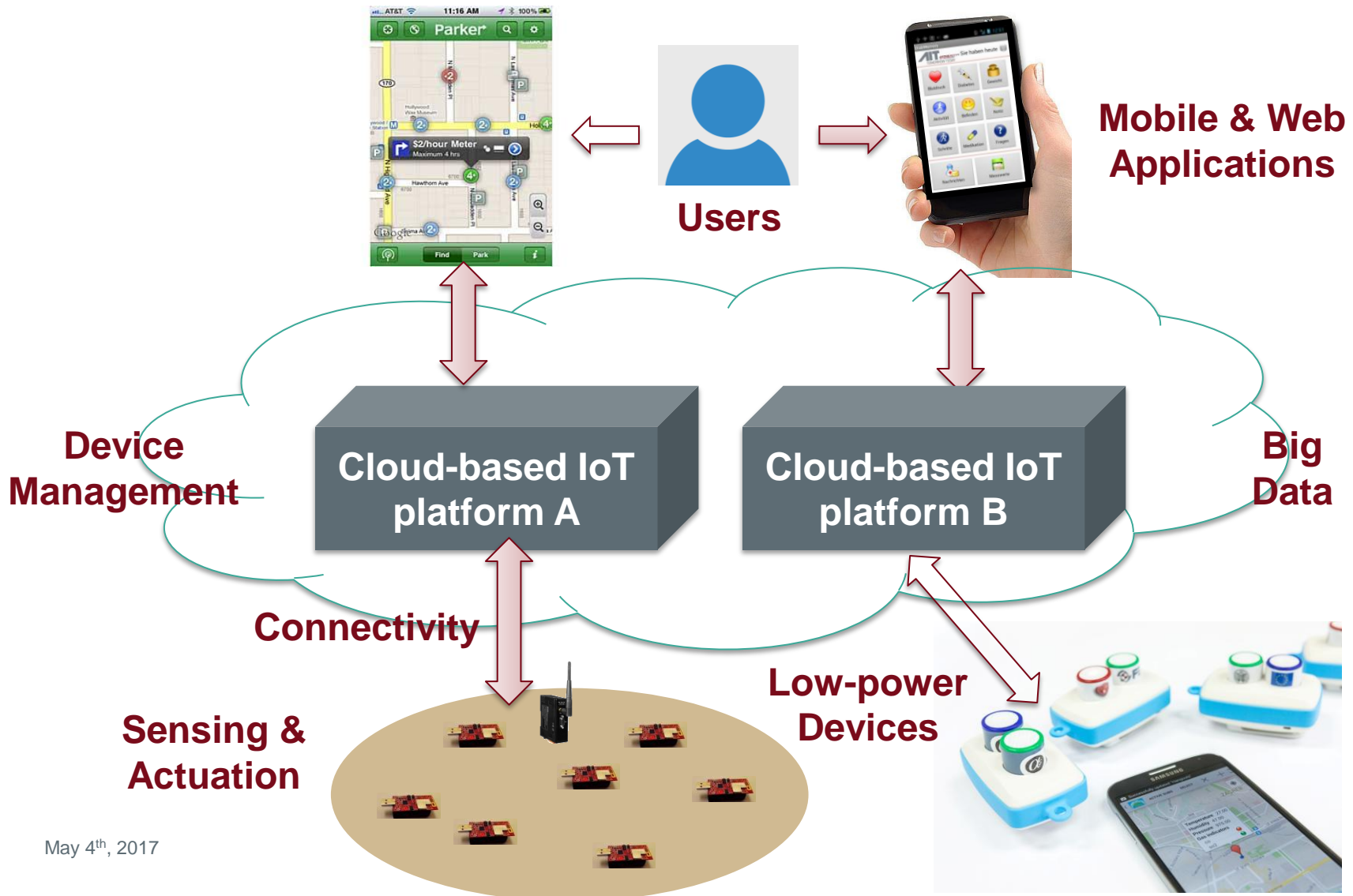
STATUS QUO IN THE INTERNET OF THINGS (IOT)



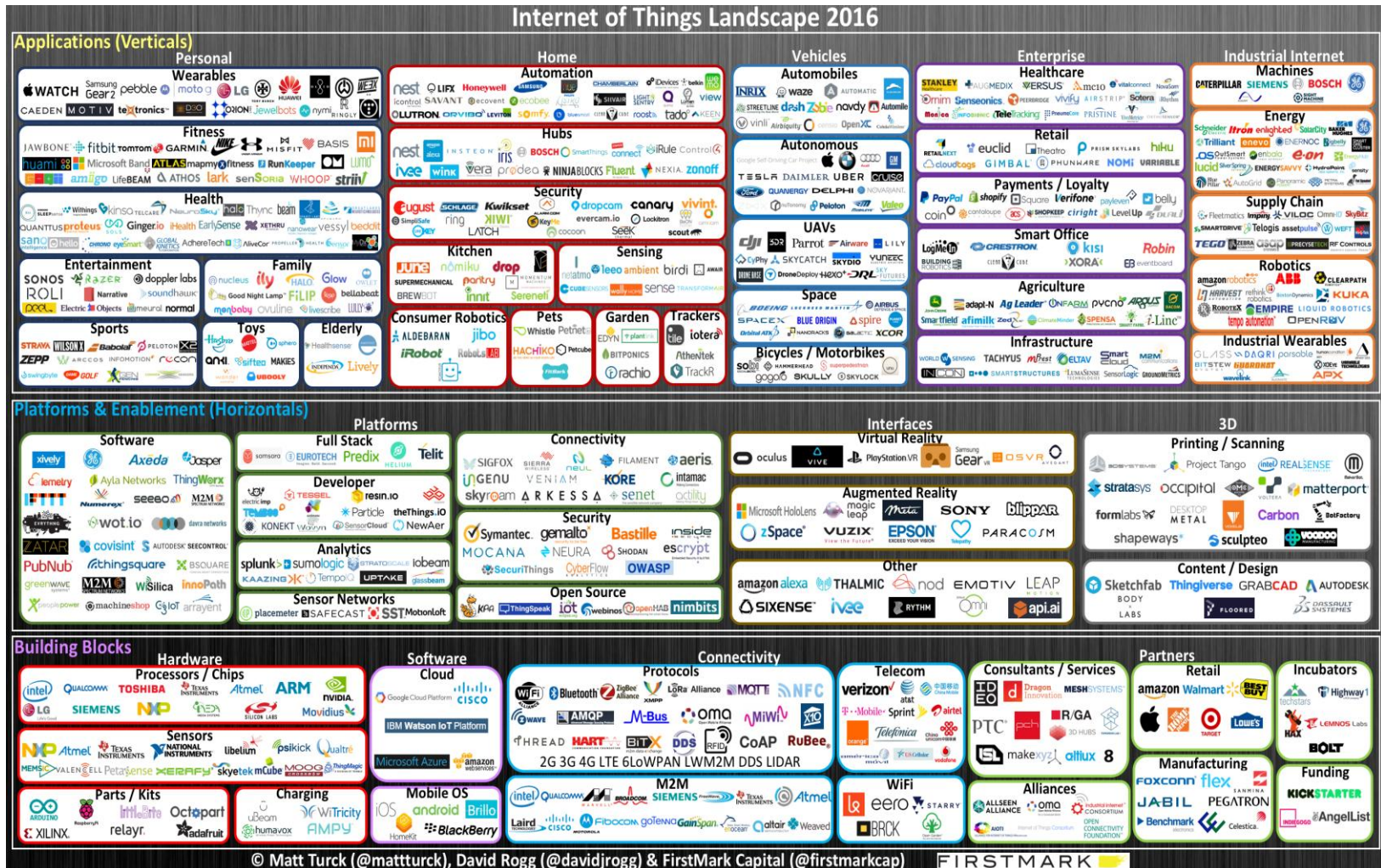
TOWARDS IOT UBIQUITY

- The Internet of Things (IoT) has gained traction in science and industry over the last years
- Tremendous growth is to be experienced in the coming years:
 - Gartner estimates that 6.4 billion connected things were in use worldwide in 2016, up 30% from 2015, and will reach 20.8 billion by 2020
 - Ericsson predicts there will be a total of approximately 28 billion connected wireless devices worldwide by 2021, with nearly 16 billion related to IoT
 - IoT sensors and devices are expected to exceed mobile phones as the largest category of connected devices in 2018, growing at a 23% compound annual growth rate (CAGR) from 2015 to 2021

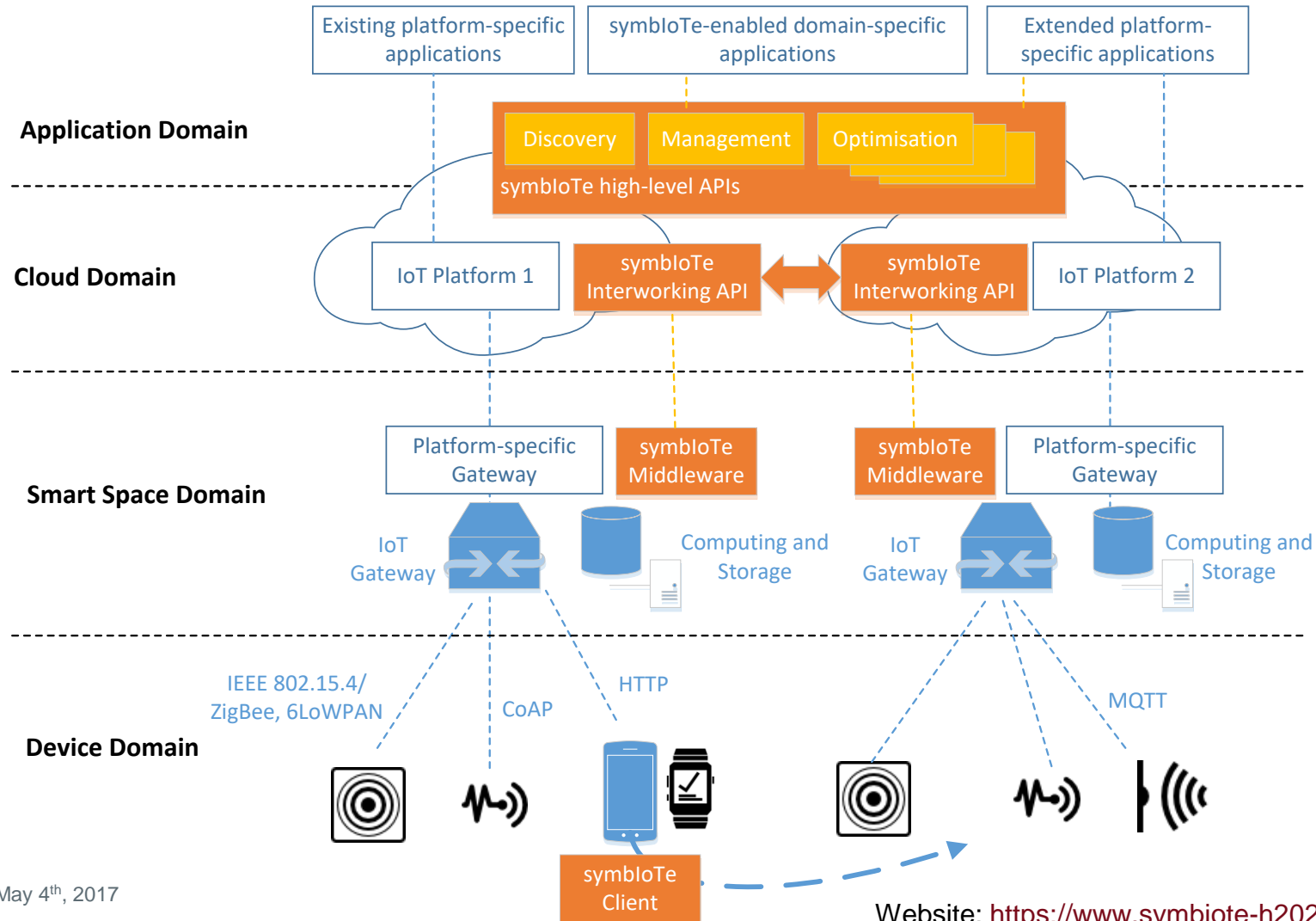
IOT: WHAT IS IT ACTUALLY ALL ABOUT?



IOT LANDSCAPE FRAGMENTATION: LACK OF SYSTEM INTEROPERABILITY



ENABLING IOT INTEROPERABILITY: THE H2020 SYMBIOTE PROJECT

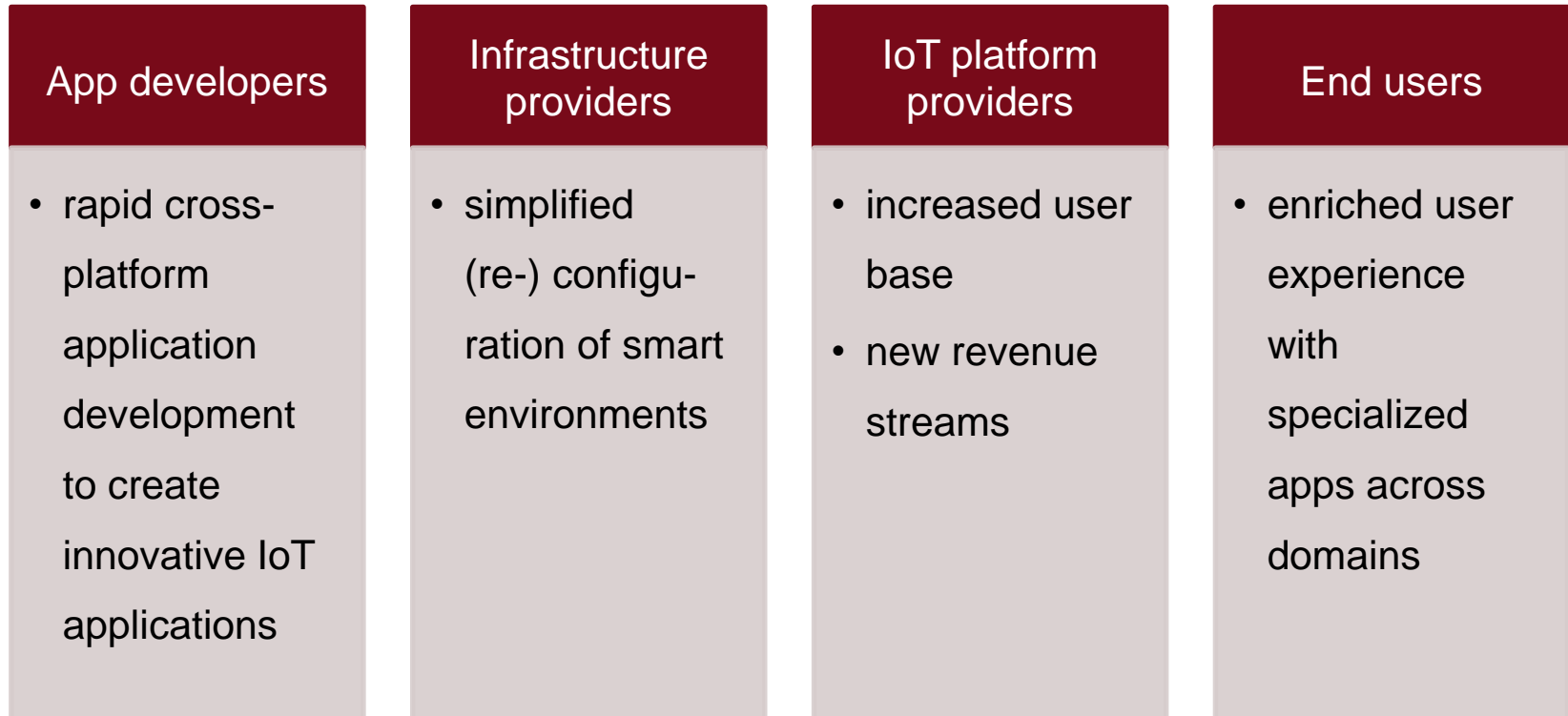


QoS, Security, Privacy, Trading/Bartering of resources

H2020 SYMBIOTE: BENEFITS AND OPPORTUNITIES

Open source software for flexible IoT ecosystems that will allow the co-creation of added value IoT services

→ **Lower market entry costs for SMEs and industries**



CENTRALIZED VS. DECENTRALIZED IOT SOLUTIONS

- There is an ongoing discussion regarding the **degree of centralization in IoT**
 - Centralized approaches → **benefits for application developers**
 - Decentralized approaches → more in line with the **original idea of the Internet** as a distributed system of communicating hosts which facilitates **local user empowerment**
- Currently, both approaches are being pursued, however, there are few attempts aiming at bringing the two together
 - Recent submission of an **H2020 proposal by AIT and partners** advocating the design of a **hybrid platform-based / decentralized IoT architecture**
- General trend: **interoperability** and **system decentralization** are getting into the focus of R&D in IoT

STATUS QUO IN COMMAND & CONTROL (C&C) SYSTEMS



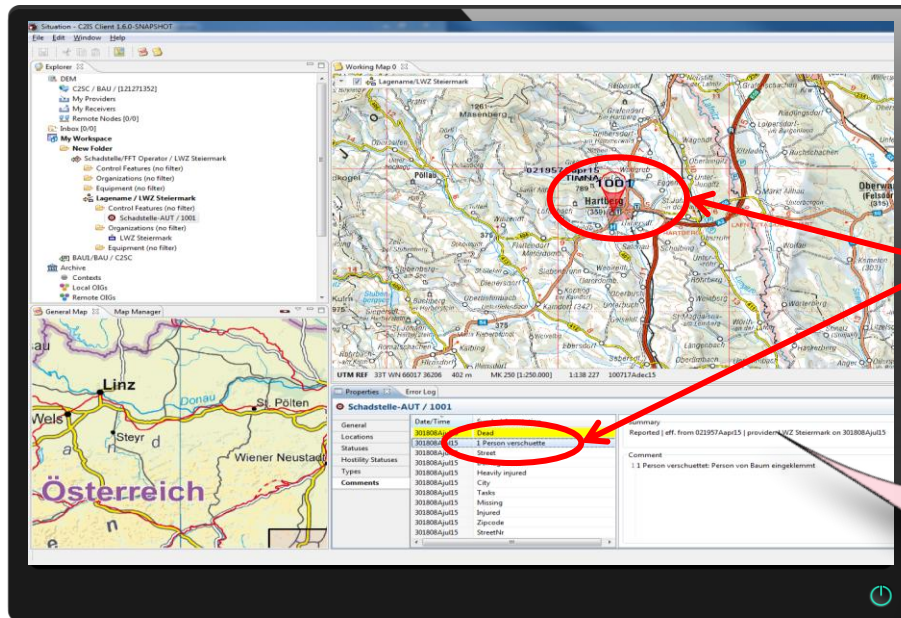
COMMAND & CONTROL SYSTEMS TODAY

- In the **civil space**, command & control (C&C) systems are offered by many different suppliers:
 - **Mostly low interoperability** → the available systems display **some intra-organizational flexibility** regarding their use (e.g., distributed operation based on a central server instance), however, **few implement information exchange standards** like CAP, EMSI/TSO, or EDXL that would enable true inter-organizational interoperability
- In the **military space**, products based on the **Multilateral Interoperability Program (MIP) standard** prevail that enable **truly decentralized operation** even under **intermittent communications**, however, they mostly do not support interoperability with civil C&C systems
- Therefore, **joint civil-military operations** represent an **enormous challenge** with respect to **interoperability** and the **spatial distribution of actors**

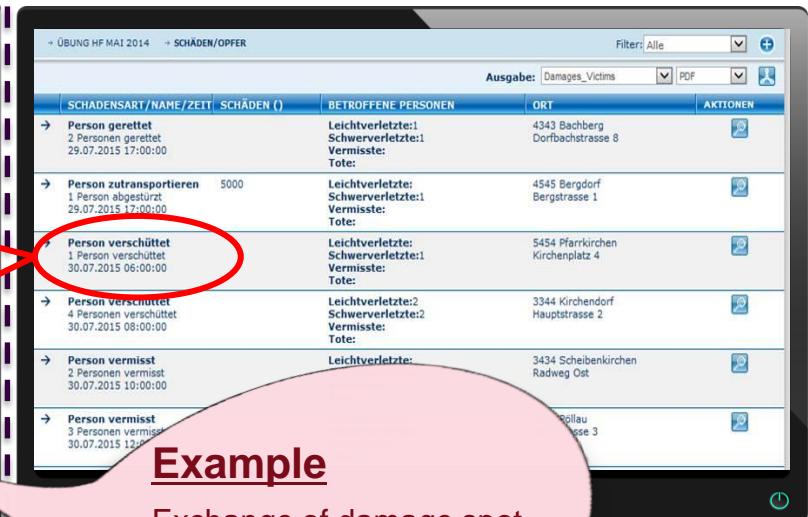
CIVIL-MILITARY INTEROPERABILITY FOR CRISIS & DISASTER MANAGEMENT: THE INKA & INTERPRETER APPROACH

- Austrian national research projects by AIT and partners since October 2014
- Objective: Optimization of civil-military C&C system interoperability for the management of crises and disasters

C&C System Phönix (AAF)



C&C System of the National Warning Center in Styria

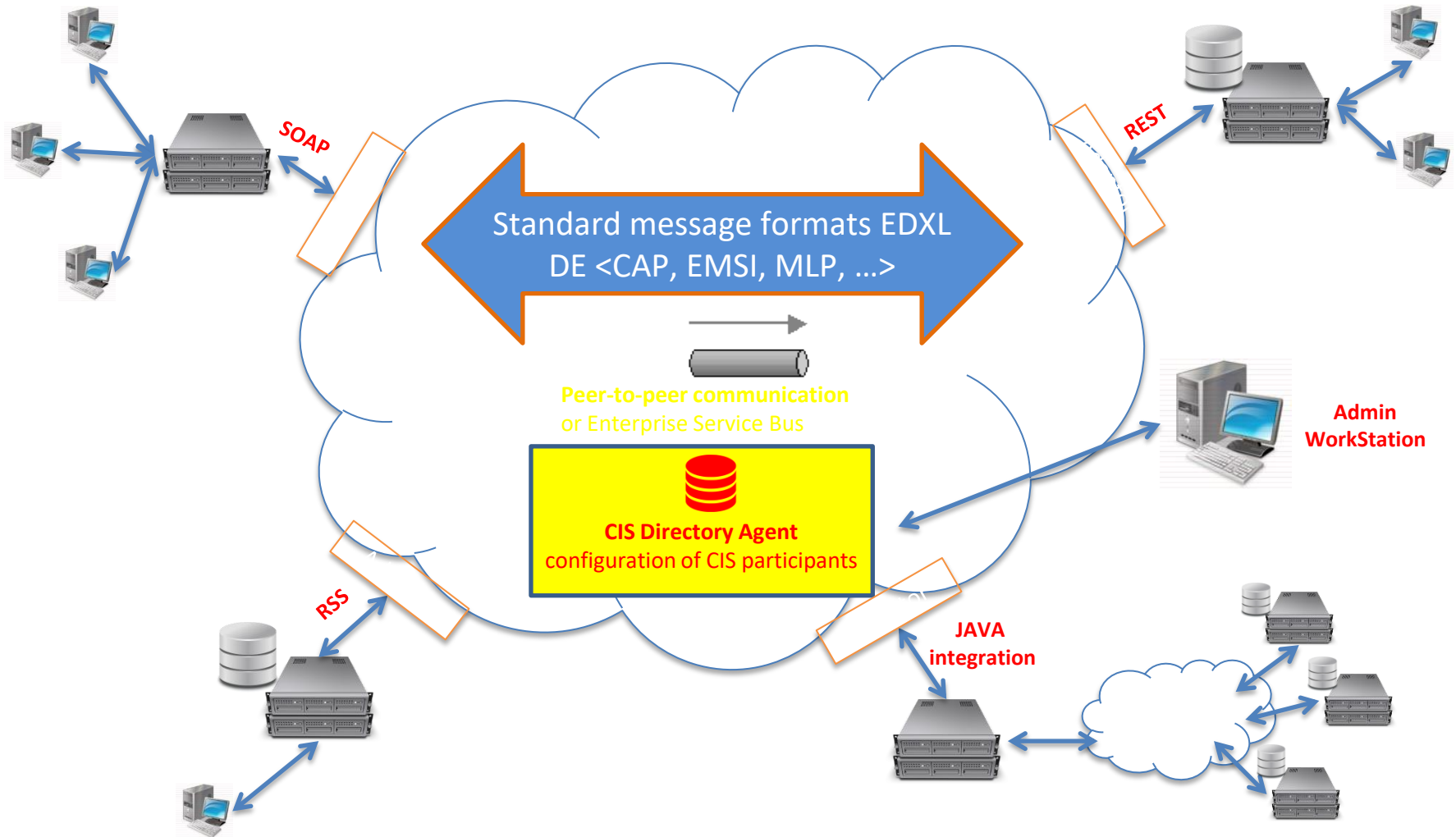


Example

Exchange of damage spot information:

- Geolocation
- Detailed Information

C&C SYSTEM INTEROPERABILITY: THE H2020 EPISECC COMMON INFORMATION SPACE (CIS)



DO IOT AND COMMAND & CONTROL SYSTEMS GO TOGETHER?



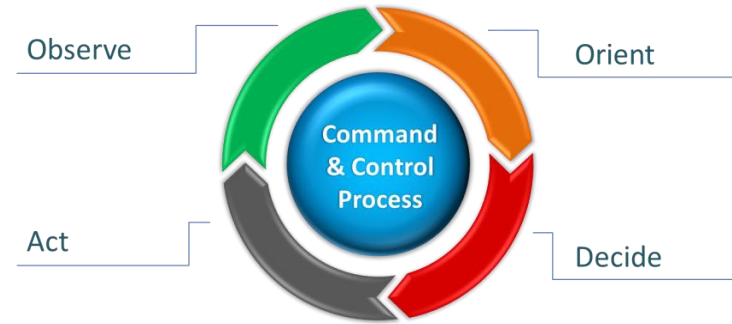
DO IOT AND COMMAND & CONTROL SYSTEMS GO TOGETHER?

- Interestingly, we find the **same challenges** in the worlds of IoT and command & control systems:
 - Concepts for ensuring **interoperability**
 - Choice of the degree **(de-)centralization**
- Naturally, the **existence of common problems** across domains **does not necessarily imply that the domains should be considered jointly**
- However, provided that there is a **common application field**, it may make sense to **consider the problems/solutions concurrently and holistically**
- Question: **Is there a common application field for IoT and for C&C systems?**
 - **OODA evolution provides the answer →**



COMMAND & CONTROL PROCESSES IN CRISIS & DISASTER MANAGEMENT PRACTICE (1/3)

- The **evolution of OODA** points us to the **future importance of IoT** in the context of C&C systems
- We differentiate between the following **three phases**:



- **Phase 1:** C&C systems represent the main information system for successful disaster response operations. The **information is communicated out-of-band** (e.g., via liaison officers using PPDR radio) and being maintained within the C&C system
- **Phase 2: Some information** is being automatically collected in the field and **conveyed to the headquarters via machine-to-machine (M2M) communications**, e.g., GPS coordinates of personnel and vehicles or measurements from various sensor networks
 - In-band transmission of **instrumental Observations**
 - First element of IoT/M2M in C&C systems

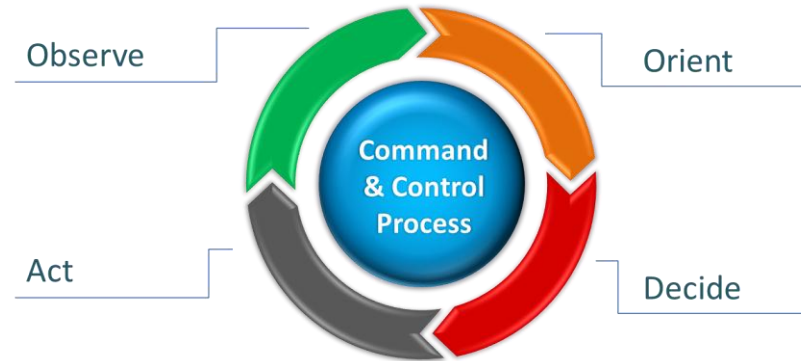
COMMAND & CONTROL PROCESSES IN CRISIS & DISASTER MANAGEMENT PRACTICE (2/3)

- **Actuation** will play an ever increasing role in C&C processes due to the **advent of autonomous robotics** for crisis & disaster management operations



- The inclusion of autonomous robotics in the 3rd phase will introduce the full spectrum of IoT capabilities/properties to future C&C processes:
 - **Phase 3:** In addition to observations that are continuously being collected in the field, increasingly **high-level commands** will be **issued in the headquarters and communicated** to the mixed human-robotic teams in the field
 - **In-band transmission of commands**
 - **Autonomous Actuation of commands** by robotic (UAV, UGV, etc.) systems

COMMAND & CONTROL PROCESSES IN CRISIS & DISASTER MANAGEMENT PRACTICE (3/3)



- The **challenges of enabling interoperability and ensuring a meaningful distribution of functions remain the same.**

We approach the problems as follows:

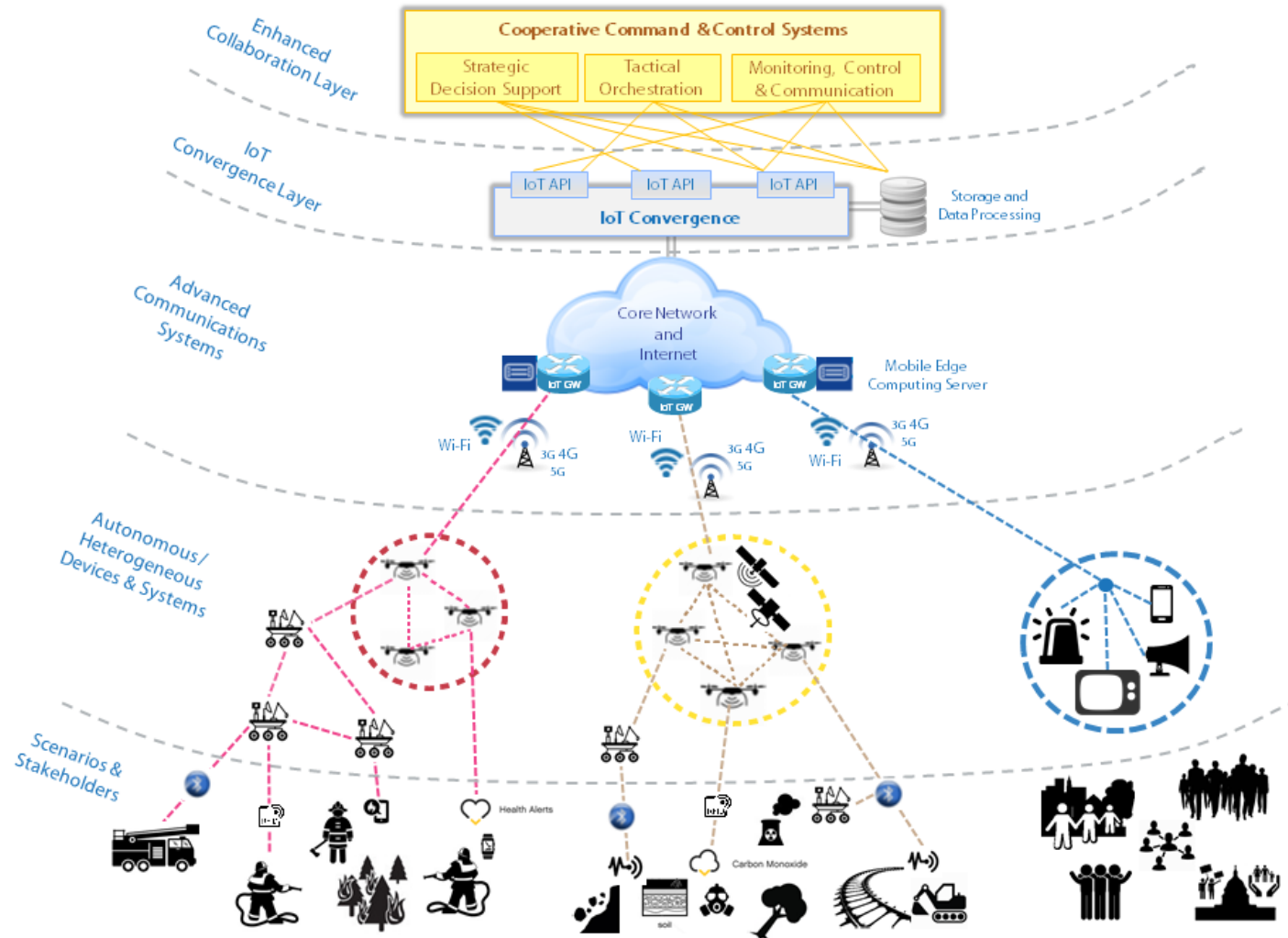
- **Interoperability:** Implementation and use of the existing standards, definition of joint operational practices
- **System distribution:** Definition of the degrees of decision autonomy that will be delegated to joint teams of humans and machines, or solely machines, in the field

→ **Autonomous Actuation capabilities are a key enabler for decentralization** and high-level C&C operations in the headquarters

FUTURE OF IOT FOR CRISIS & DISASTER MANAGEMENT



OUR VISION FOR THE FUTURE OF IOT-ENABLED COMMAND & CONTROL SYSTEMS



RESEARCH ROADMAP: IOT-ENABLED C&C USE CASES

- In our research roadmap, we foresee a number of IoT-enabled C&C use cases that are to be implemented as show cases, e.g.:
 - UAV-based supervision of forest fires end embers
 - UAV-based support of traffic incident response
- Showcase innovation: the **robotic systems** not only act autonomously for the duration of a single mission, but are rather **capable of continuous engagement**, based on intelligent system scheduling
- Recent submission of an **H2020 proposal by AIT, University of Zagreb, Frequentis and other partners** defining a corresponding advanced C&C system for the inclusion of autonomous robotics in public safety use cases

CONCLUSIONS AND CALL FOR ACTION

- Enabling interoperability and ensuring a purposeful degree of centralization represent central issues both in IoT and C&C systems R&D
- In the world of **IoT**, a **trend toward decentralized systems** can be observed
 - We believe in **hybrid approaches** which will combine the advantages of both systems
- In the C&C systems realm, **robotics will represent a fundamental game changer** in the years and the decades to come:
 - The C&C systems will need to evolve accordingly, i.e., close integration with IoT systems will be required
 - **Trend towards “IoT-enabled Command & Control”**
- R&D in IoT and C&C systems are far from coming to an end
 - **AIT welcomes collaborations** both in the framework of collaborative research projects and the joint engineering of next generation products and services

THANK YOU FOR YOUR ATTENTION!

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