Project cluster FAST- fast actuators sensors and transceivers
- Technological breakthrough by real-time capability

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This abstract gives an overview of the German research and development initiative FAST, a project cluster aiming at a technological and economic breakthrough by means of real-time capabilities. The FAST project cluster consists of around 80 partners from industry and academia, with a strong participation of small innovative companies. FAST comprises around 20 projects and is scheduled from 2014 to 2020.

Sensor and actuator systems are of central importance for the progress in almost all areas of our life. Experts estimate that in 2017 every human being will use approximately 1,000 sensors daily (source: WWRF) and the market volume in the field of sensors will account for 76.7 milliard US$ (source: Global Industry Analysts). In the future the amount of sensors and actuators per system is expected to increase significantly, e.g. to more than 200 in cars.

For many applications in the area of security, traffic, medical, sports, consumer electronics and communications, real-time capabilities enable new application functionality and markets. For instance by processing in a smart cloud infrastructure, sensor and actuator data can be optimally distributed and overall costs are reduced since very simple sensors and actuators can be used. The entire process including sensing, data transfer, processing and actuation must have a negligible delay. This is in particular a huge challenge for systems that connect a high amount of sensors and actuators comprehensively via mobile networks.

FAST enhances sensor and actuator systems to get as close as possible to the ultimate physical limitation given by the speed of light – which is almost 300 000 km/s. In ideal case, a signal needs only 0.1 ms for 30 km. A comparison between the state of the art and key goals of FAST is shown in Table I.

Table I: State of the art and key goals

	State of the art	**Key goals of FAST**
Mobile networks	> 30 ms (4G)	< 1 ms (5G)
WLAN	> 5 ms	< 0.5 ms
LAN	> 50 µs	Synchronisation in ns range

In FAST, e.g. the following approaches are tackled to solve the challenges:

- enhanced data protocols for communication with flexible and very short data frames well below 1 ms,

- highly parallel processing,
- extremely fast and energy efficient semiconductor technologies,
- very high operation frequencies and bandwidth,
- adaptive error correction,
- distributed co-existence and interferer management,
- adaptive resource management,
- self-organized sensor networks,
- avoidance of latency generating data compression and the use of cartographic methods combing symmetrical for communication, and
- asymmetrical approaches for key exchange to maximize the security.

Examples for specific application of the real-time technologies are:

- 5G communications,
- automated driving,
- road traffic management,
- 10 Gb/s real-time Ethernet in vehicles,
- airbag functions depending on posture,
- high-resolution MIMO (multiple in multiple out) based real-time imaging radar for airplanes,
- sensor networks,
- real-time automated industry,
- real-time control,
- testing and synchronization of machines, motors and work pieces,
- movement analysis and optimization of athletes and in the care sector,
- interactive exo-skeletons e.g. as walking aid (as an alternative to the inflexible wheel chair),
- tele-surgery,
- remote treatment of patients,
- virtual reality apps,
- real-time connection of musicians via internet, and
- real-time cloud services.

The FAST consortium consist of 44 small and medium sized enterprises, 19 large companies, 8 universities, 6 research institutes and one association. The FAST partners encompass the whole competency and value chain from materials, semiconductors, components and software to complex systems and communication networks.

FAST addresses business potentials in the milliard-€-range. One example: In 2020, 250 Mio. Ethernet links, which cost in the order of 15 € each, are estimated for the car market segment.

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