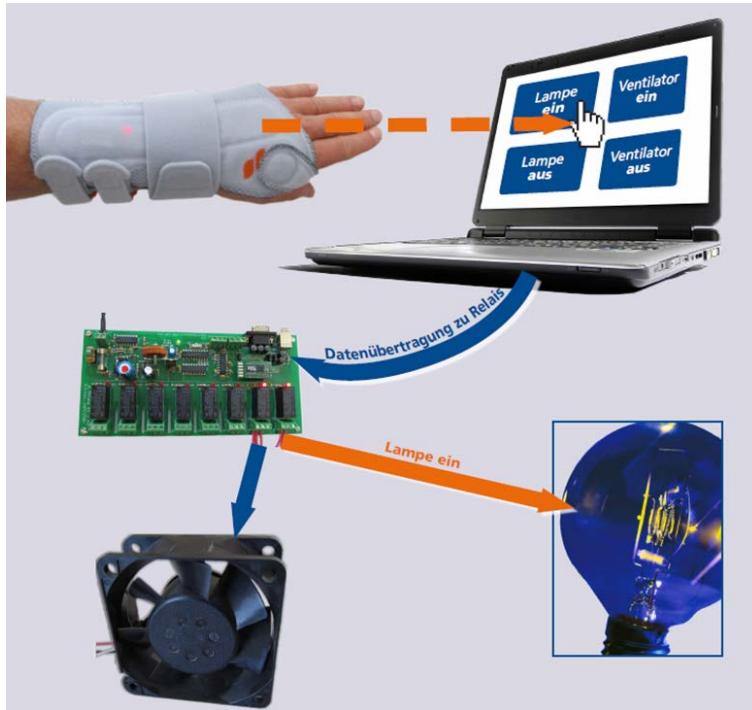


# Sichere Sensorsysteme für körpernahe AAL-Anwendungen durch Rapid Prototyping

SECURE SENSOR SYSTEMS FOR AAL APPLICATIONS CLOSE TO THE BODY BY RAPID PROTOTYPING

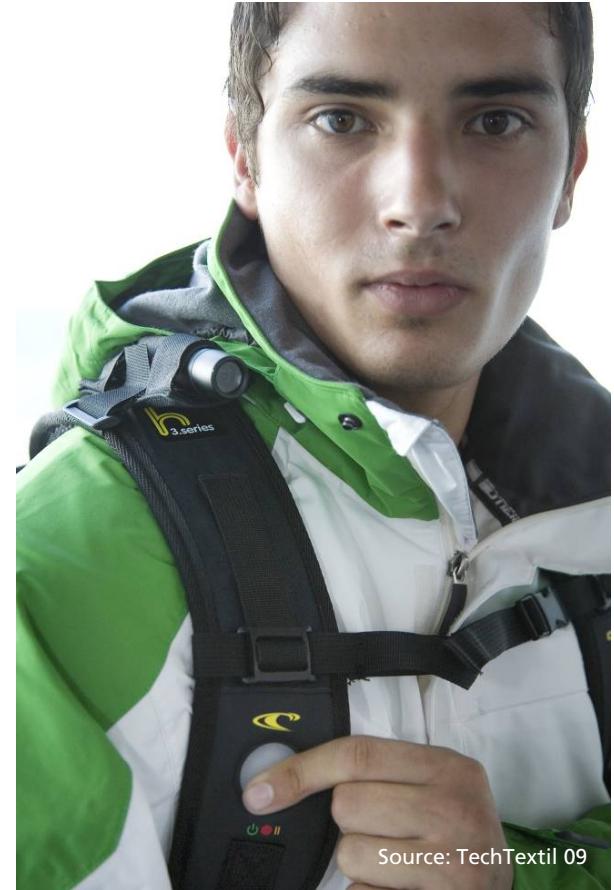
S. Rülke, U. Wetzker, G. Döring, S. Radke, T. Vörtler



# In Close Contact with the Human Body: Textile-based Sensor Systems

→ Smart Textiles, Smart Wearables, Interactive Textiles, eClothing, ...

- Symbiosis of textiles and integrated electronics → innovative clothing or accessories
  
- Electronics:
  - Sensors: temperature, motion, moisture, pH, ...
  - Actuators: display, heating, acoustic, mechanical, ...
  - Processors: control, communications, ...
  - Connections: bus, wiring, radio, ...
  - Power supply: battery, management, ...



# Applications for Textile-based Sensor Systems

## ■ Personal Healthcare, AAL

- Monitoring of physiological parameters (pulse, respiration, temperature, ...)
- Measurement of activity/performance (motion profiles, ...)
- Attention control; detection of presence/location
- Muscle stimulation (such as by electrical stimuli)

## ■ Consumer, Sports & Fitness

- Lifestyle (Fashion/Design)
- Training support (e.g. monitoring workout)

## ■ Security & Prevention

- Protective work clothing
- Emergency personnel (especially firefighters)

## ■ Military and Aerospace

# Rapid Prototyping

**The potential of textile-based assistance systems is still offset by significant problems with its introduction, including:**

- strategically: lack of standardization
- social: high demands on confidentiality and user acceptance
- technically: insufficient reliability, robustness, interoperability, power supply
- economic: high costs

**Approach to mitigate those risks and thus to improve the safety of products in the developing process:**

- Development of feature patterns representing main properties of the desired product and building upon it early performance evaluation (as well as system optimization) under realistic conditions

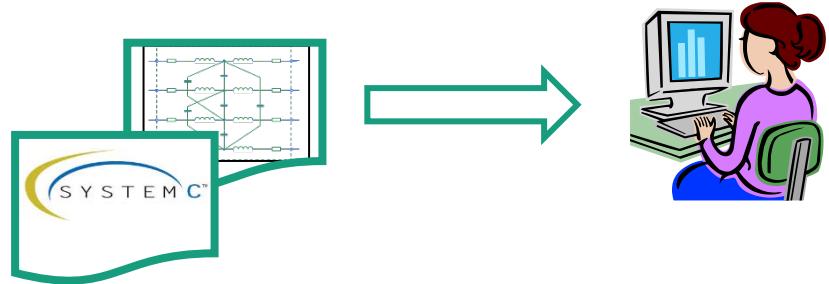
→ **Rapid Prototyping**

# Rapid Prototyping

Early deployment of prototypes to be developed for textile-based systems

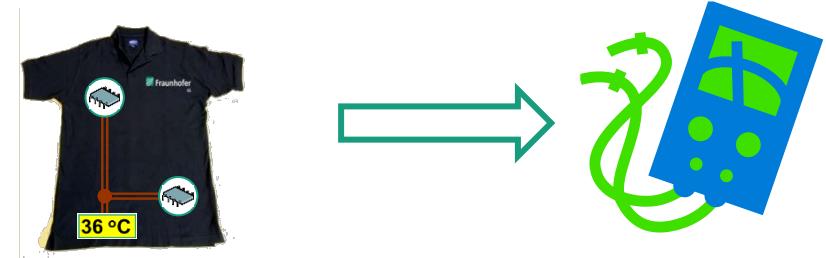
## ■ **Virtual Prototypes:**

Adequate models for model-based validation of functional and non-functional characteristics under realistic operating conditions



## ■ **Physical Prototypes:**

Reliable, reified functional pattern (networks of electronic components integrated in textiles) for the hands-on application test



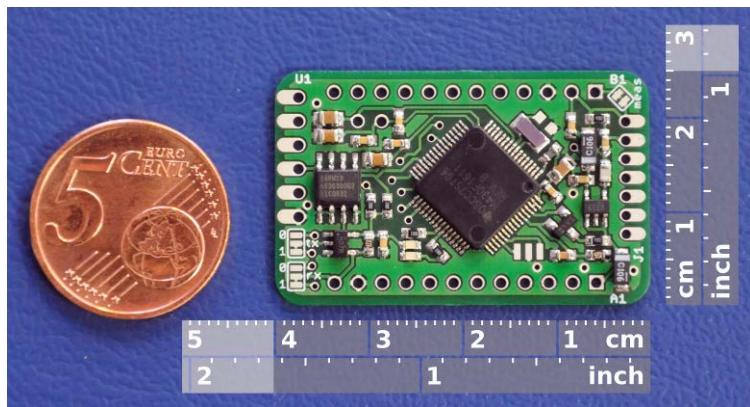
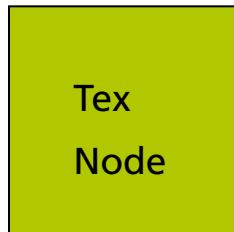
# Prototyping Platform

**Prototypes → represent textile-based networks of:**

- Sensors with basic functionality  
(currently only temperature, humidity, acceleration, air pressure, brightness, ...)
- A variable number of processor nodes  
(universal low-power µC MSP430 + embedded OS and memory → programmable)
- Actuators  
(Currently only LED modules)
- Communication structures
  - network-internal:
    - textile conductors  
(various flexible, partly stretchy tapes; electrical + mechanical connection)
    - Communication protocol  
(considering textile / AAL-specific requirements)
  - externally connected to a host computer:
    - bluetooth
- Detachable connection between building blocks and tapes  
(push button or magnet → simple component replacement)

# Prinzipien der Prototypen-Entwicklung

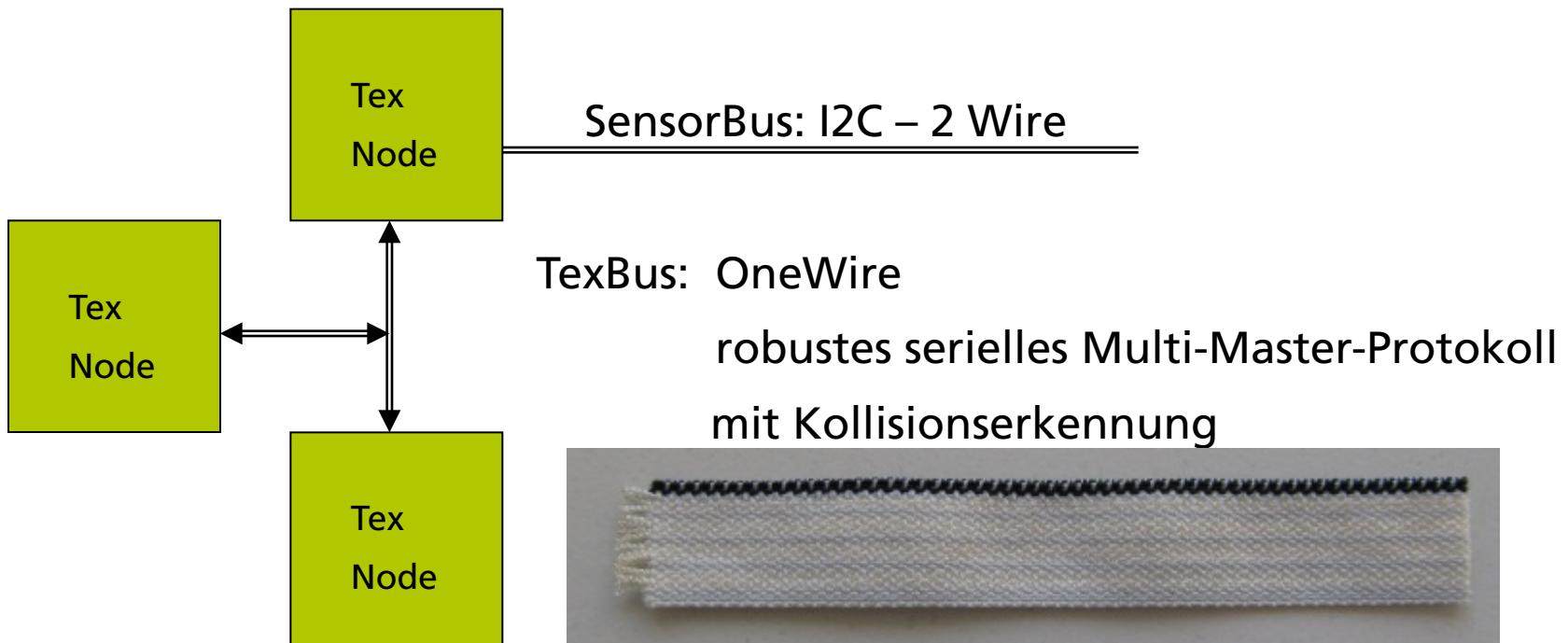
## Prozessorknoten (TexNode):



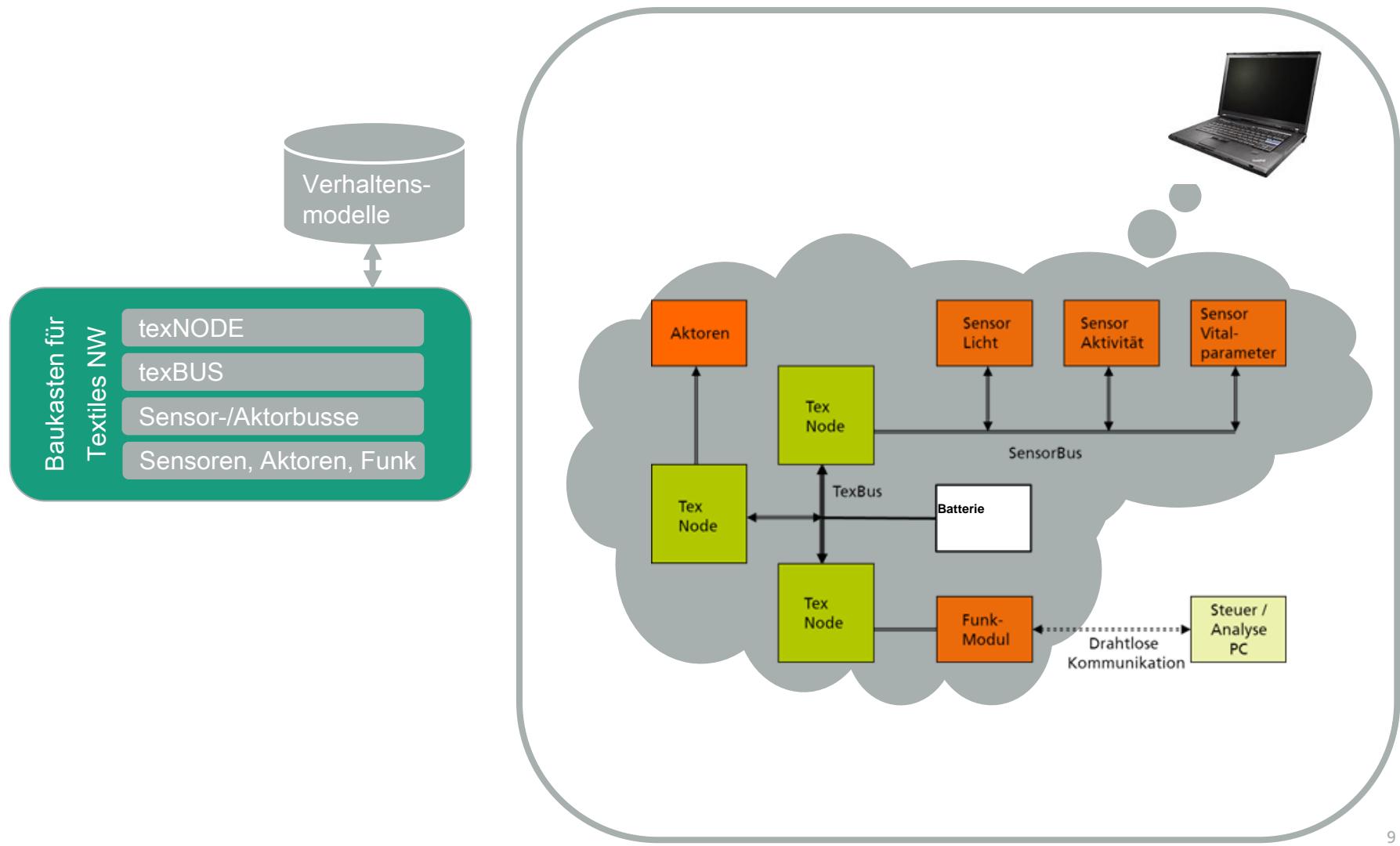
- HW: TI MSP430 µC, 1Mb F-RAM, USART (UART, SPI, I2C) 2x ADC, DAC 12 bit
- Ultra low Power  
UB: 1,8...3,6V  
330 uA /1 MHz  
1.1 uA Standby  
5 Power Save Modi  
Energiemonitoring
- SW: Contiki OS  
2kByte RAM, 40kByte ROM

# Prinzipien der Prototypen-Entwicklung

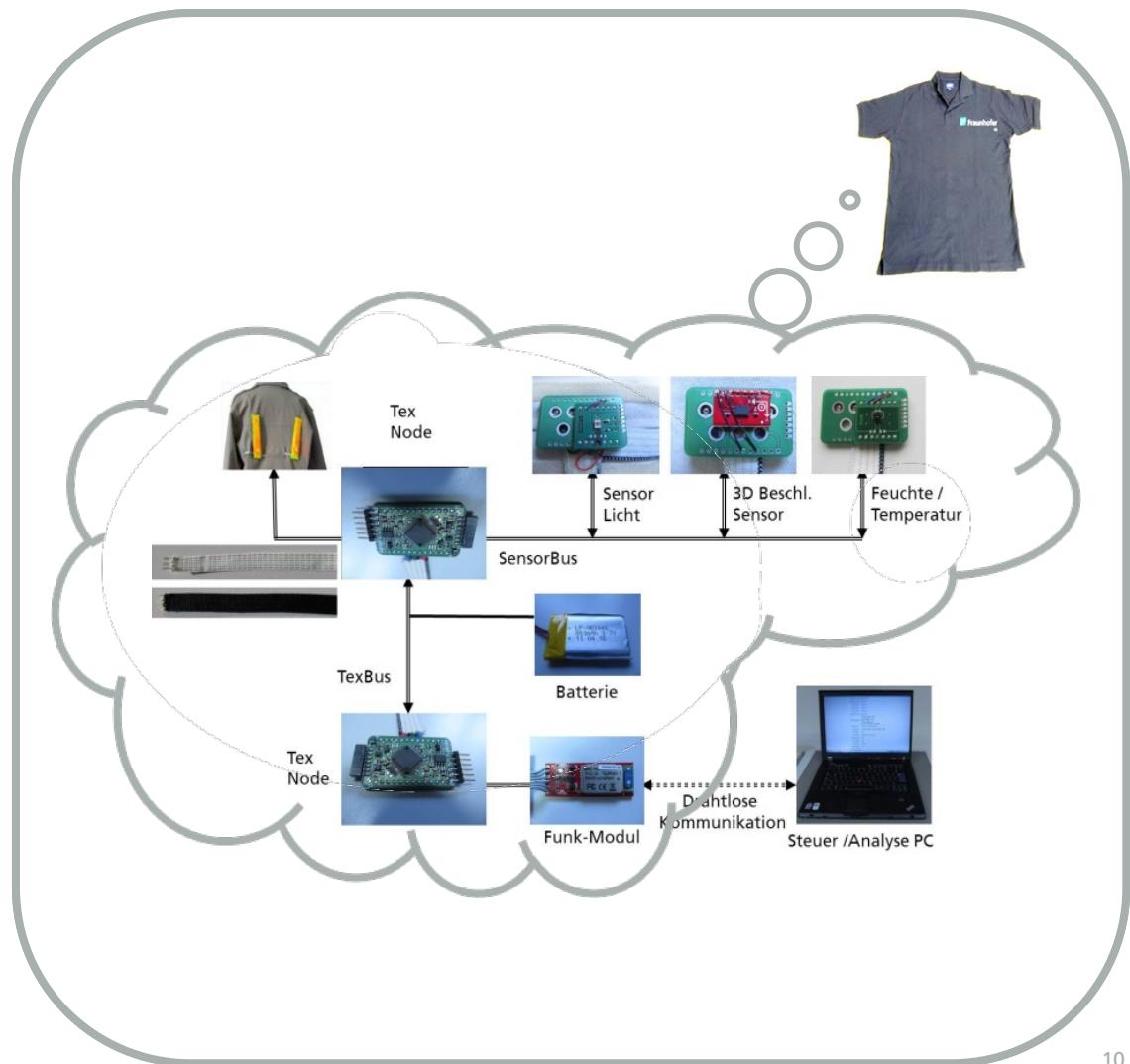
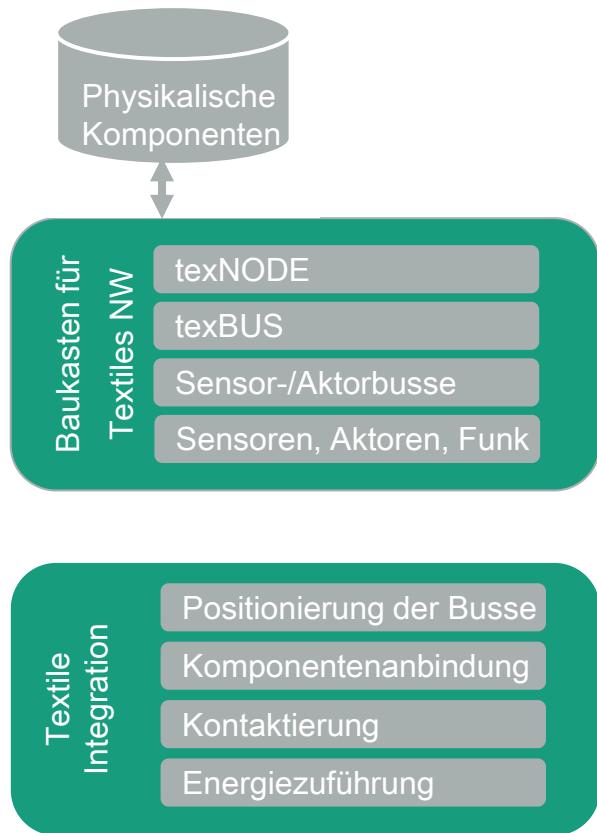
## Textile Bussysteme:



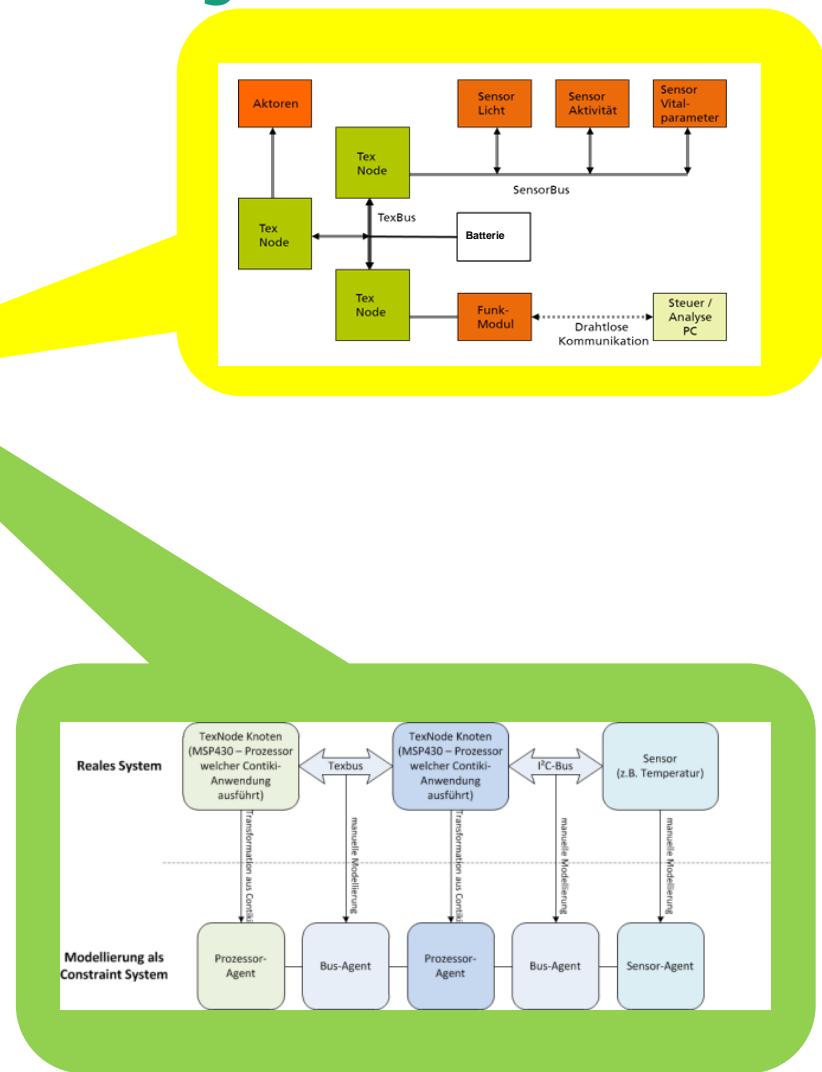
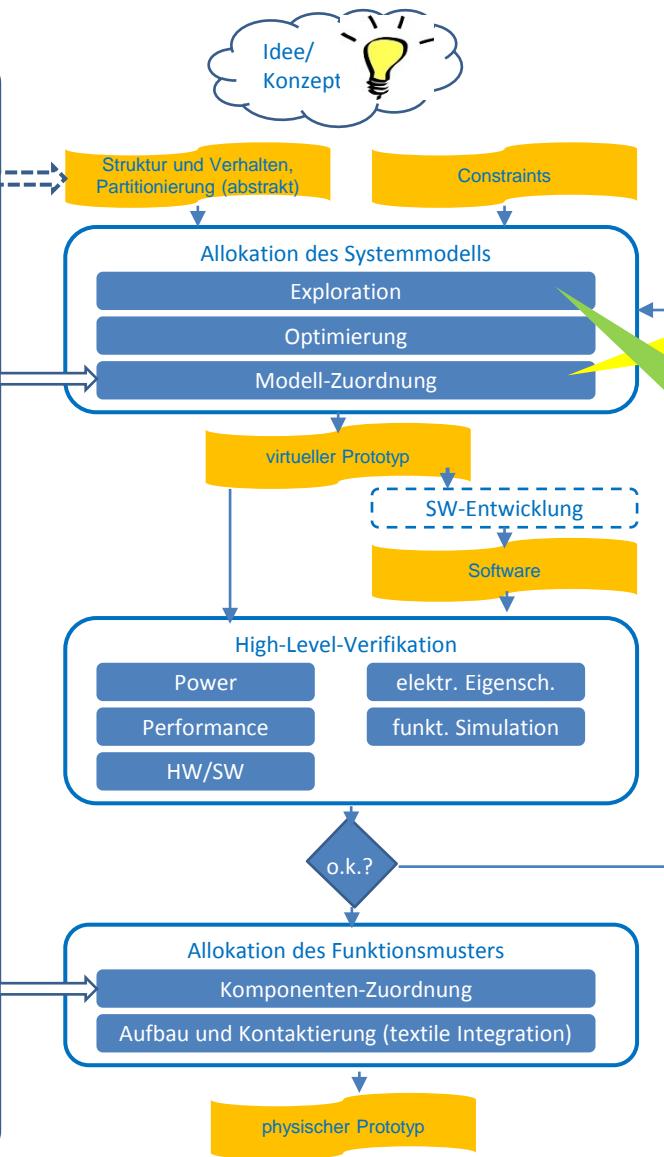
# Prinzipien der Prototypen-Entwicklung



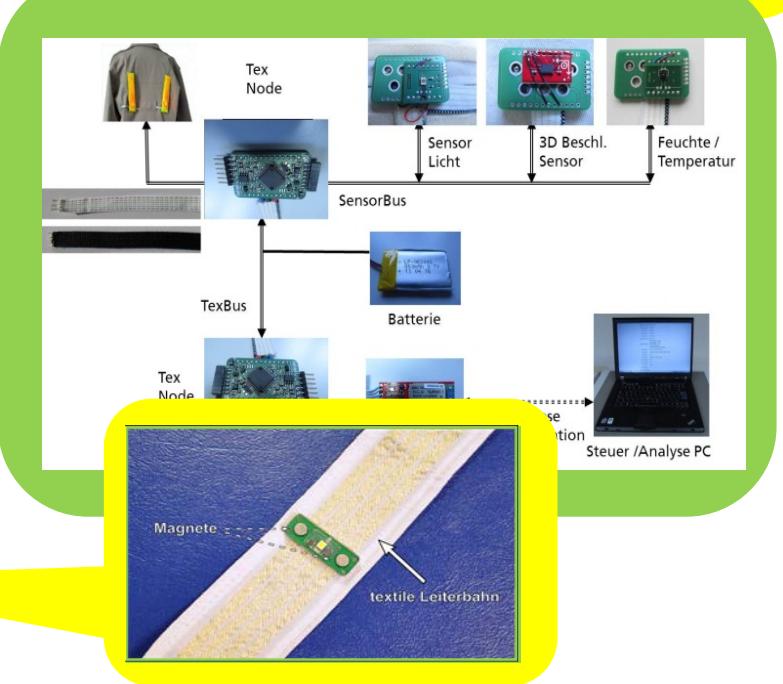
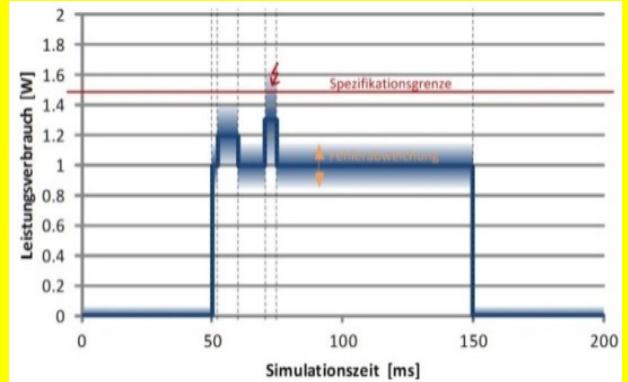
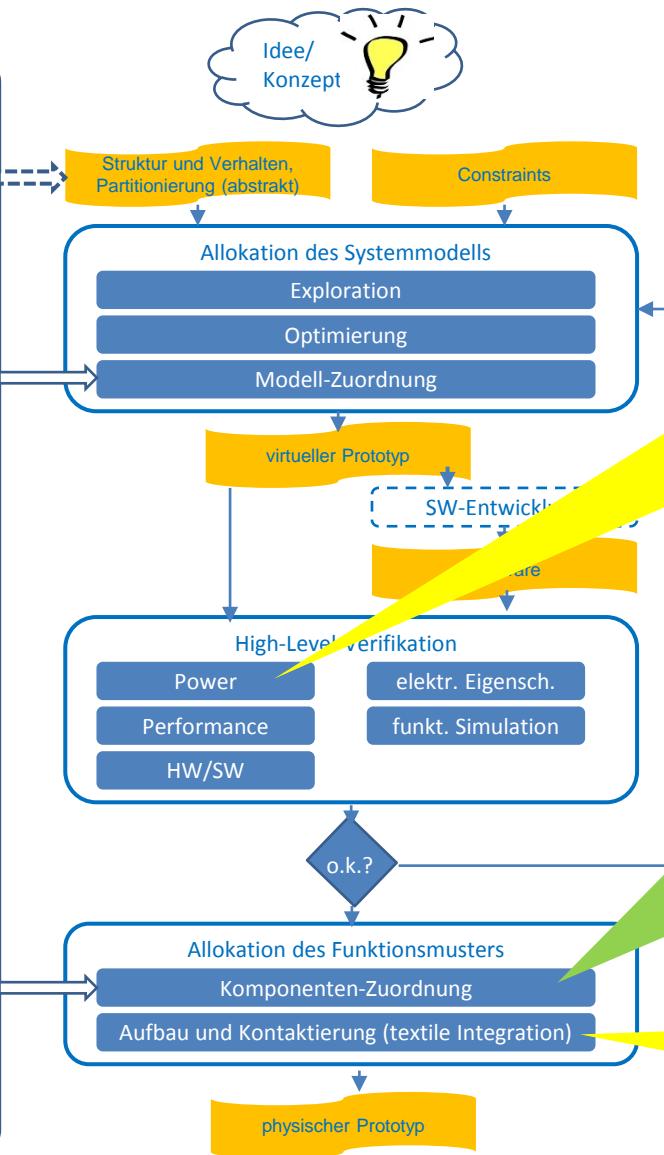
# Prinzipien der Prototypen-Entwicklung



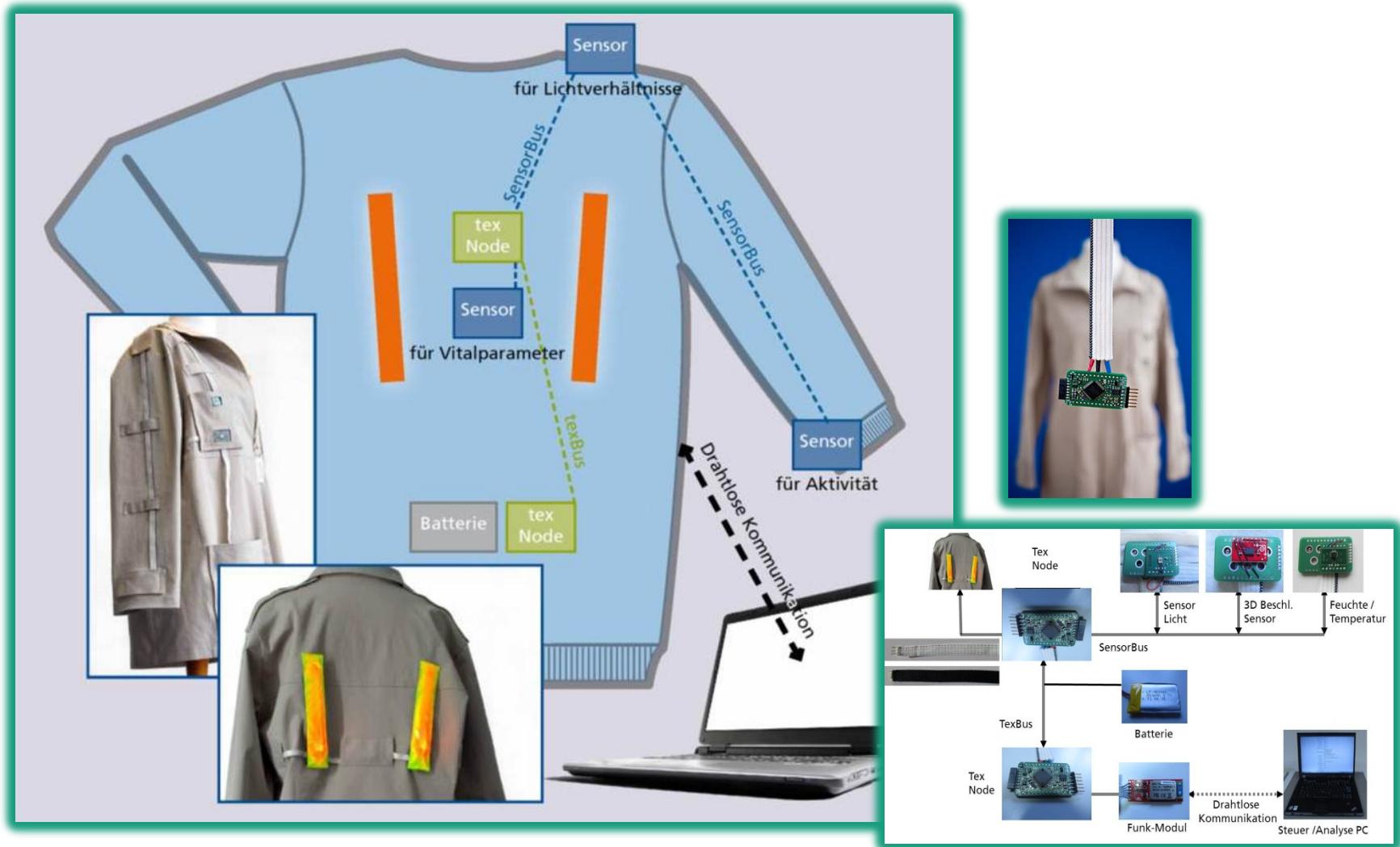
# Prinzipien der Prototypen-Entwicklung



# Prinzipien der Prototypen-Entwicklung



# EASyJACKET – Aktivitätsmonitoring und Assistenz



# EASyCONTROL – Gestenerkennung

Kontaktlose Steuerung - z.B. von Haushaltsgeräten – durch Gesten

- Unterstützung körperlich beeinträchtigter Menschen
- Sensor-NW incl. BlueTooth-Modul in Handgelenkbandage integriert
- SW zur Erkennung von verschiedenen Handbewegungen



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16