

# Towards smart working spaces with enhanced well-being and safety of elderly staff

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Lucerne University of  
Applied Sciences and Arts

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# Presentation plan



- Motivation and scope
- Stressful working spaces and environments
- Measurement and simulation
- System architecture and components
- Data management
- Data evaluation and interventions
- Applications and benefits

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TransSafe



- Contribute to a healthy lifestyle at safety-critical jobs
- Keep skilled senior employees longer on the job
- Better stress management
- Reduce potential stress related human errors
- Improve the safety record of service and provider
- Reduce health related working disability

## Operating Control Centres (OCC)

Public transport  
system control room

Similar environments:

- Air traffic control
- Power plants and electricity grid
- Logistic centres



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## OCC characteristics



- Supervising highly automated systems
- Potential for bore-out
- In case of incident very complex network has to be managed (stress)
- Safety relevant job: Mistakes can result in high or even fatal costs
- Employees need vast background knowledge



## Truck cockpit



### Similarities to

- Tram
- Bus
- Train
- Aircraft cockpit
- Construction machines
- Bridge (vessel)
- Etc.

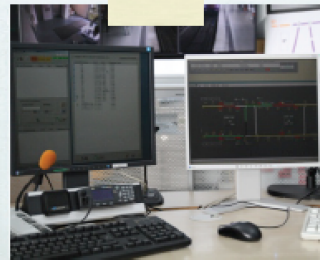
## Truck driver job characteristics



- Bad job reputation (hard to find new / young employees)
- Safety critical job. Mistakes can cost lives.
- Potential bore-out (e.g. long, straight, empty motorway at night)
- Potentially stressful (e.g. dense traffic, time pressure)



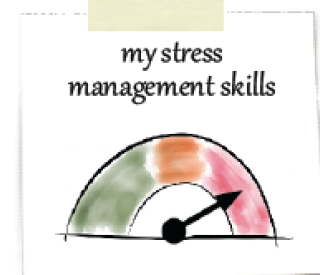
This is me



"I can sleep when I'm dead"



my mobile phone



my stress management skills

## OCC Dispatcher: John Idler

Age	56 years
Weight / size	86 kg / 1,85 m
Relationship status	divorced, 1 daughter
Hobbies	Travelling, hiking, cycling, jogging
Favorite movie/series	Top Gun
Dream job	Hotel tester

### His job:

**Aim.** John feels satisfied if he has dealt with interruptions of the underground lines successfully, and a good mixture of relaxation and action at work is perfect for him. He prefers to have enough leisure time in between shifts without having to act as a floater.

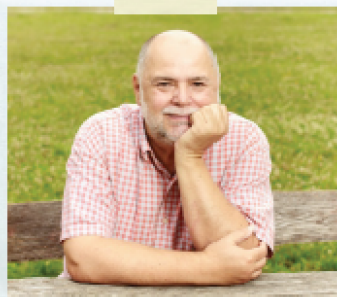
**Likes.** Mr. Idler loves to communicate and make jokes together with his colleagues. The favourite aspect of his job is the team work and the feeling that everybody cooperates and working steps interlock perfectly due to knowing each other and the job for a long time.

**Stressors.** The most burdensome events at work are accidents with personal damage. In general, being responsible for other people's wellbeing and paying attention constantly to what's going on "out there" means a high burden to him. In case of an accident or interruptions, many different tasks have to be handled at the same time, leading to a high noise level in the room.

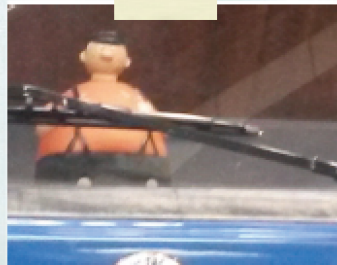
**Coping.** After critical incidents, John exchanges views with his colleagues to cope with the situation and try to learn from it for the future. In high-pressure situations, it sometimes happens that John starts shouting out loud or throws his computer mouse. In order to relax, John leaves the control room and reads the newspapers or listens to the radio in the recreation room. On his way home, he smokes a cigarette in his car and listens to his favorite songs to calm down.







This is me



"Hope to stay fit when I grow older"



my mobile phone

my stress management skills

## Truck Driver: Robert Mead

Age	59 years
Weight / size	110 kg / 1,85 m
Relationship status	married, 3 children
Hobbies	gardening, taking care of his grandchildren, going for a walk with his dog
Favorite movie/series	Bonanza
Dream job	Truck driver

### His job:

**Aim.** Robert's goal is to deliver the cargo in time, and to clock off early enough to be able to spend time with his family and friends.

**Likes.** Robert enjoys the freedom and silence of driving around (his "highway-feeling", as he calls it), for instance starting off at night and rainy weather in Germany, and seeing the sunrise with beautiful weather at the Lake Garda in Italy. Travelling to different countries and always meeting new people at truck stops makes him never feel bored.

**Stressors.** The worst thing about his job is the time pressure to deliver the cargo in time, given common traffic jams, construction zones and speed limits. In general, critical situations arising from the traffic frequently lead to stress, e.g. the dangerous behaviour of other road users, or the fear of overlooking someone. Although Mr. Mead considers himself a night owl, he has experienced situations of microsleep, and he knows that this is a common phenomenon among truck drivers.

**Coping.** When feeling tired or being upset, Robert likes listening to folk music or calling his family or friends to calm himself down or keep him awake. Sometimes, he also stops the truck for some minutes and takes a walk around it. Some of his colleagues drink coke when driving or alcohol before sleep, but he sticks with water in order to preserve his health.



# End user involvement

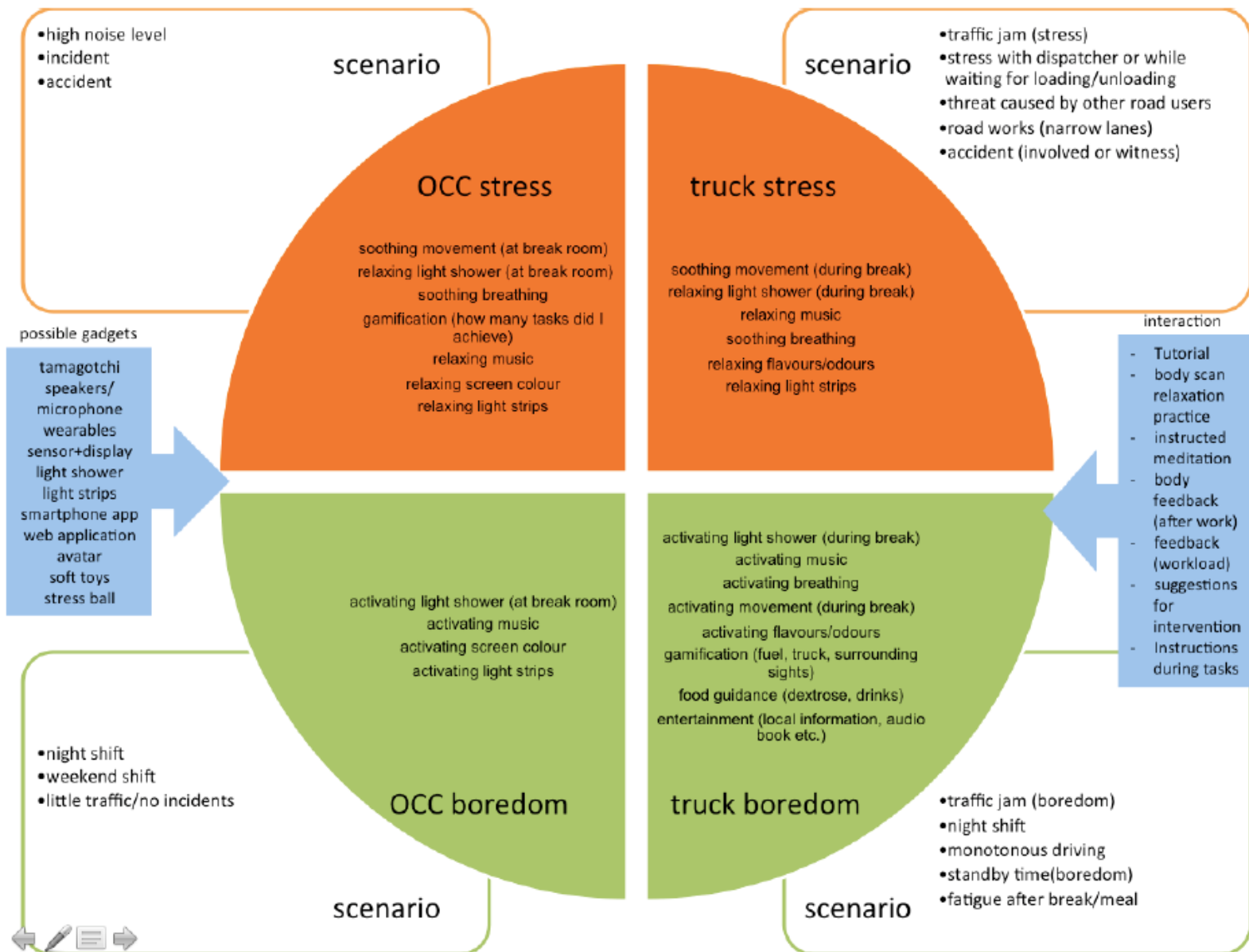
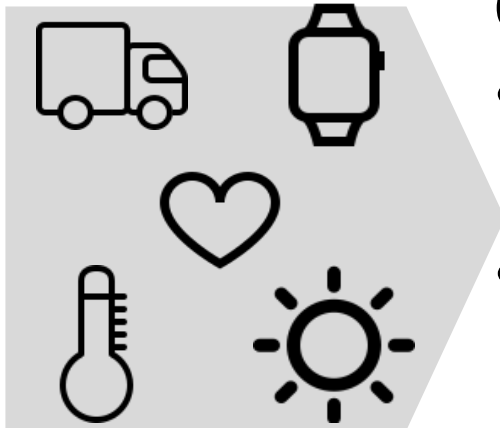


Figure 15: Matrix for the development of user scenarios

**Measurement sensors collect physiological data**

**Sensor choice criterias:**

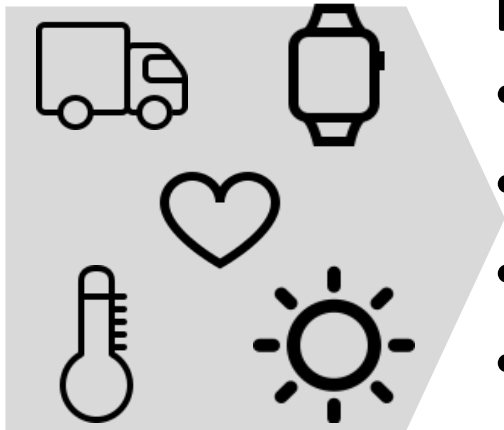
- Measurement accuracy
- Unobtrusiveness



**Chosen wearable sensor set:**

- Empatica E4 (Body T, acceleration, heartbeat/HRV, galvanic skin resp)
- Zephyr Bioharness (heart beat / HRV, acc, body T, respiration)
- Shimmer GSR Module (heart beat, galvanic skin response)

**Measurement sensors collect environmental data**



**Sensor choice criterias:**

- Measurement accuracy
- Unobtrusiveness

**Environmental sensors:**

- Temperature
- Humidity
- Loudness
- Light intensity
- In truck: sensors of vehicle (via CAN bus)



## Data acquisition in OCC simulator

### Physiological data measurement in OCC simulator



## Data acquisition in truck simulator



## Truck driving simulator



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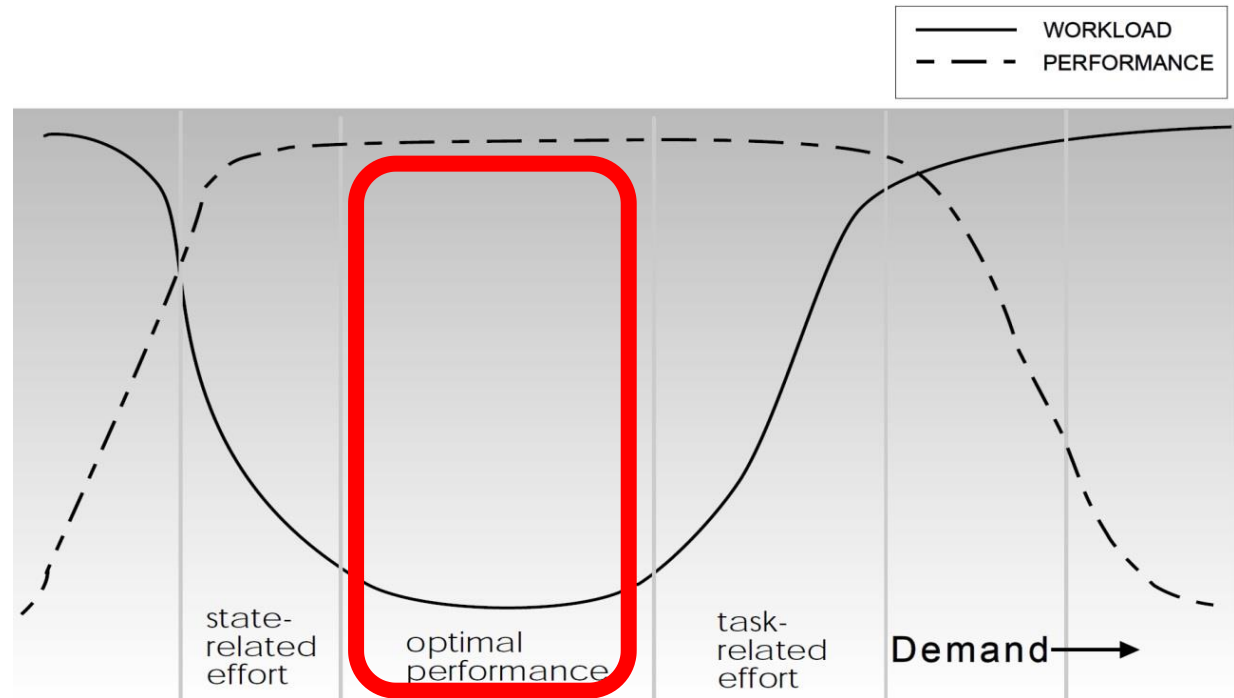
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## Truck Simulator with Virtual Reality ( Oculus Rift VR Glasses)

High  
Stress induction in  
simulator  
Simulated stress  
induction



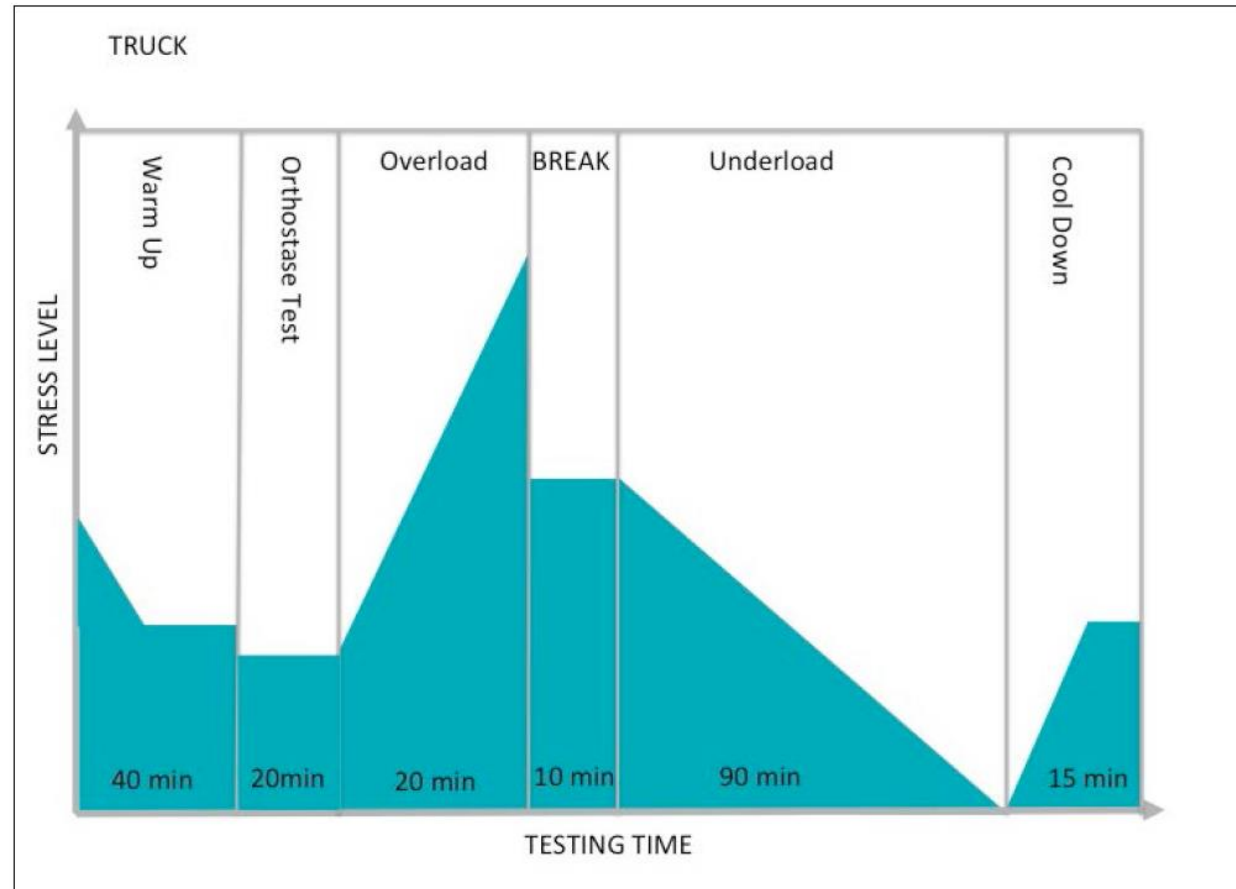
Low

De Waard, D., The measurement of drivers' mental workload, Groningen University, Traffic Research Center Netherlands, 1996



## Stress induction in simulator

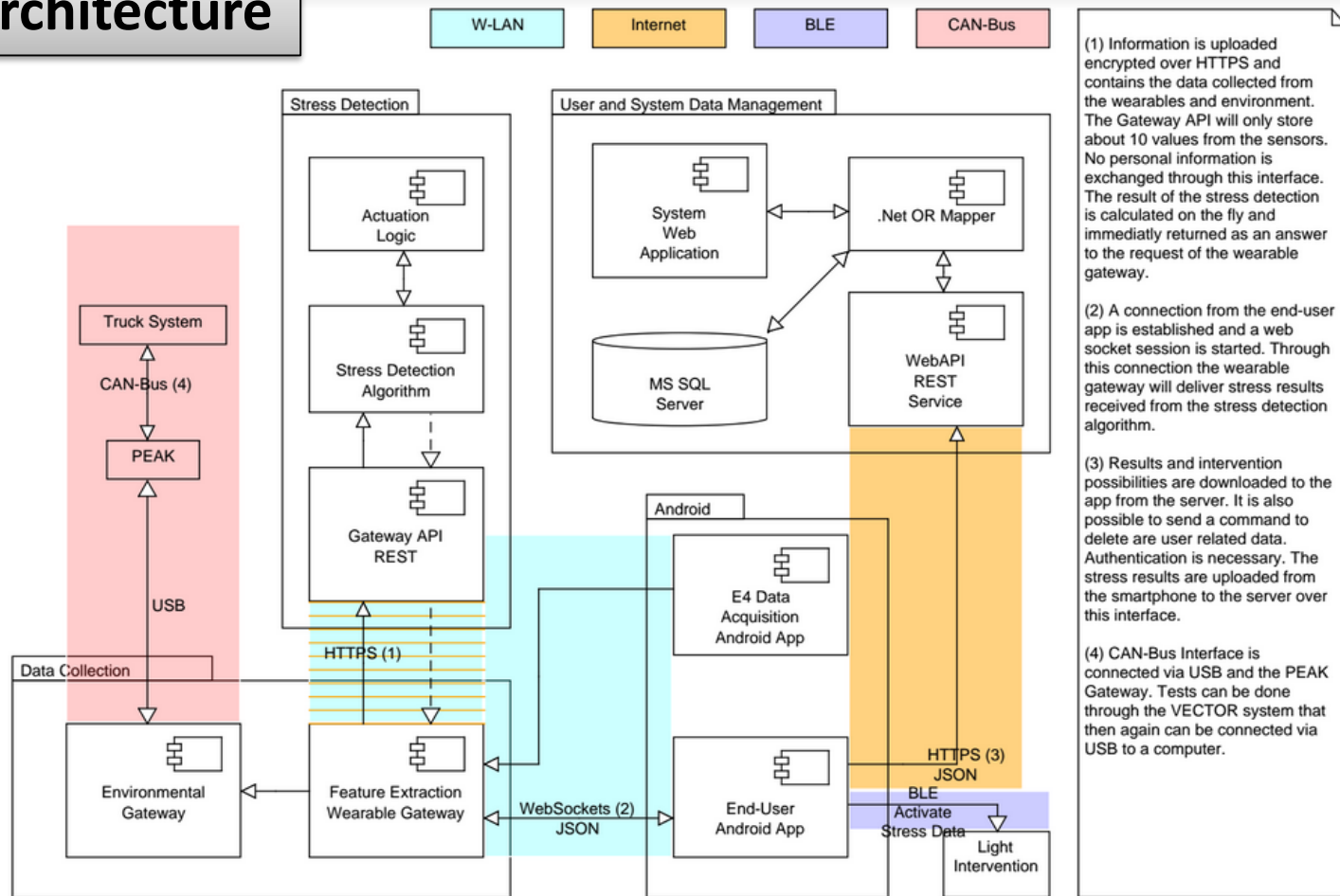
### Simulated stress induction



# System architecture and components



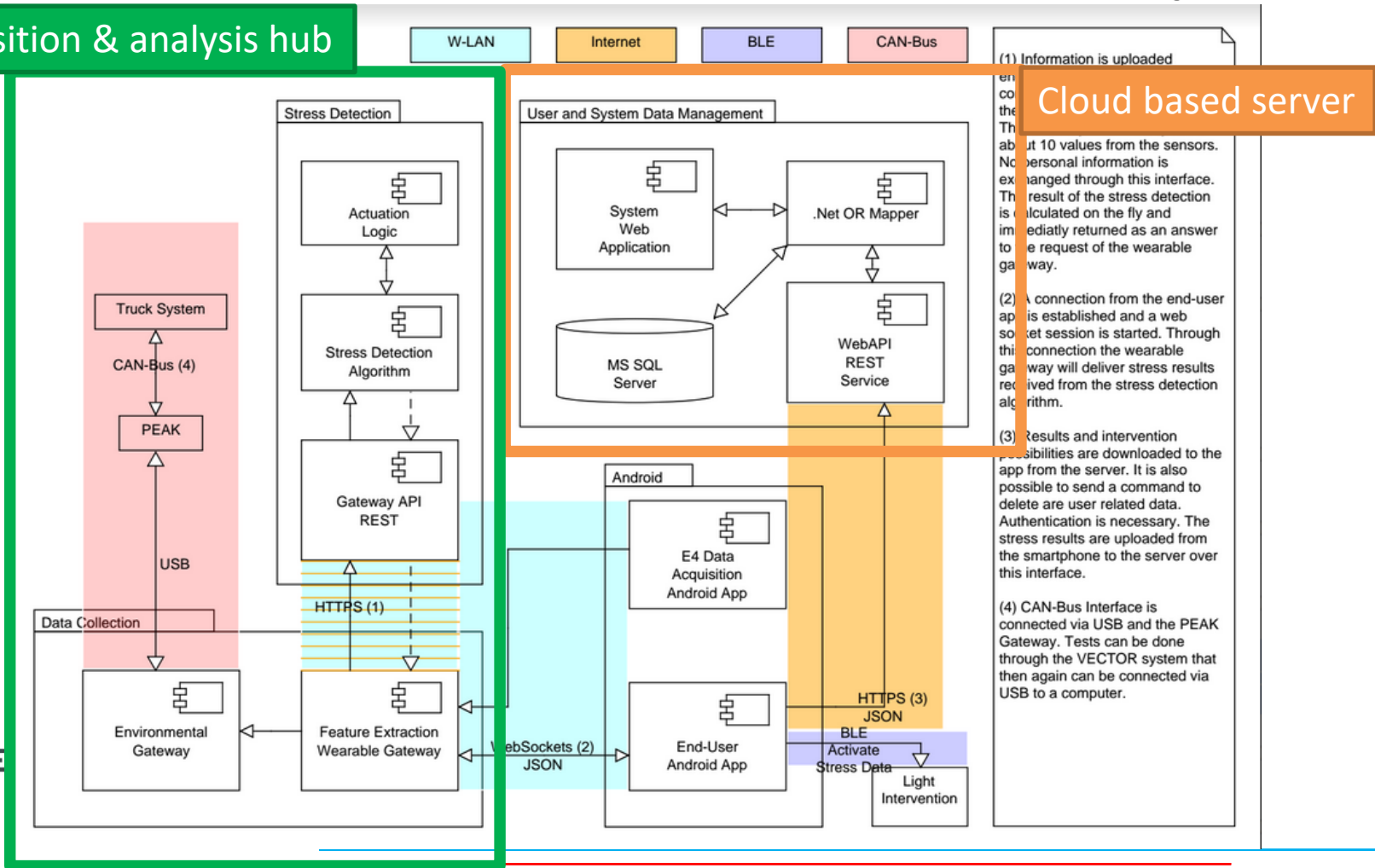
## System architecture



# Data management: System architecture

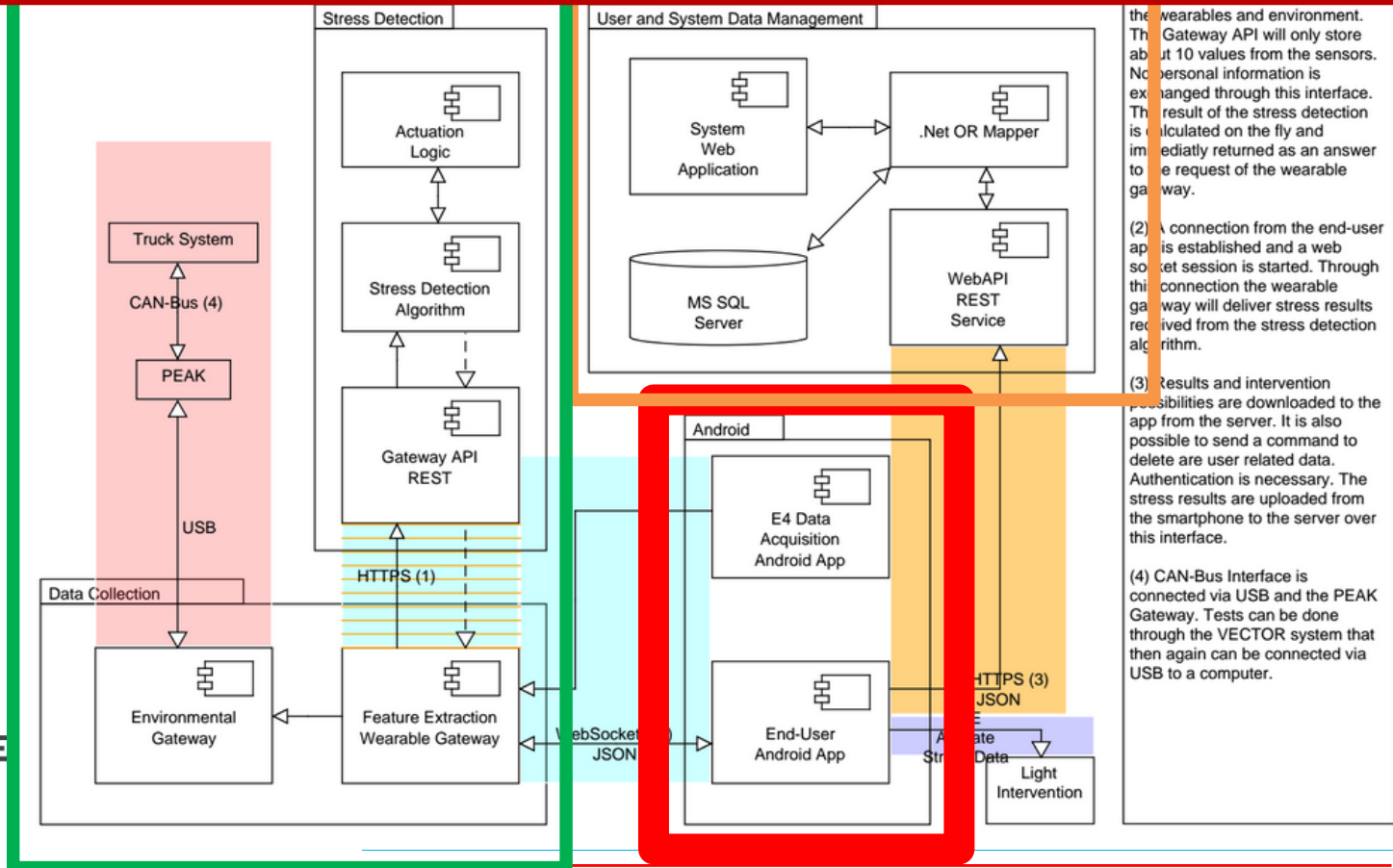


## Local acquisition & analysis hub



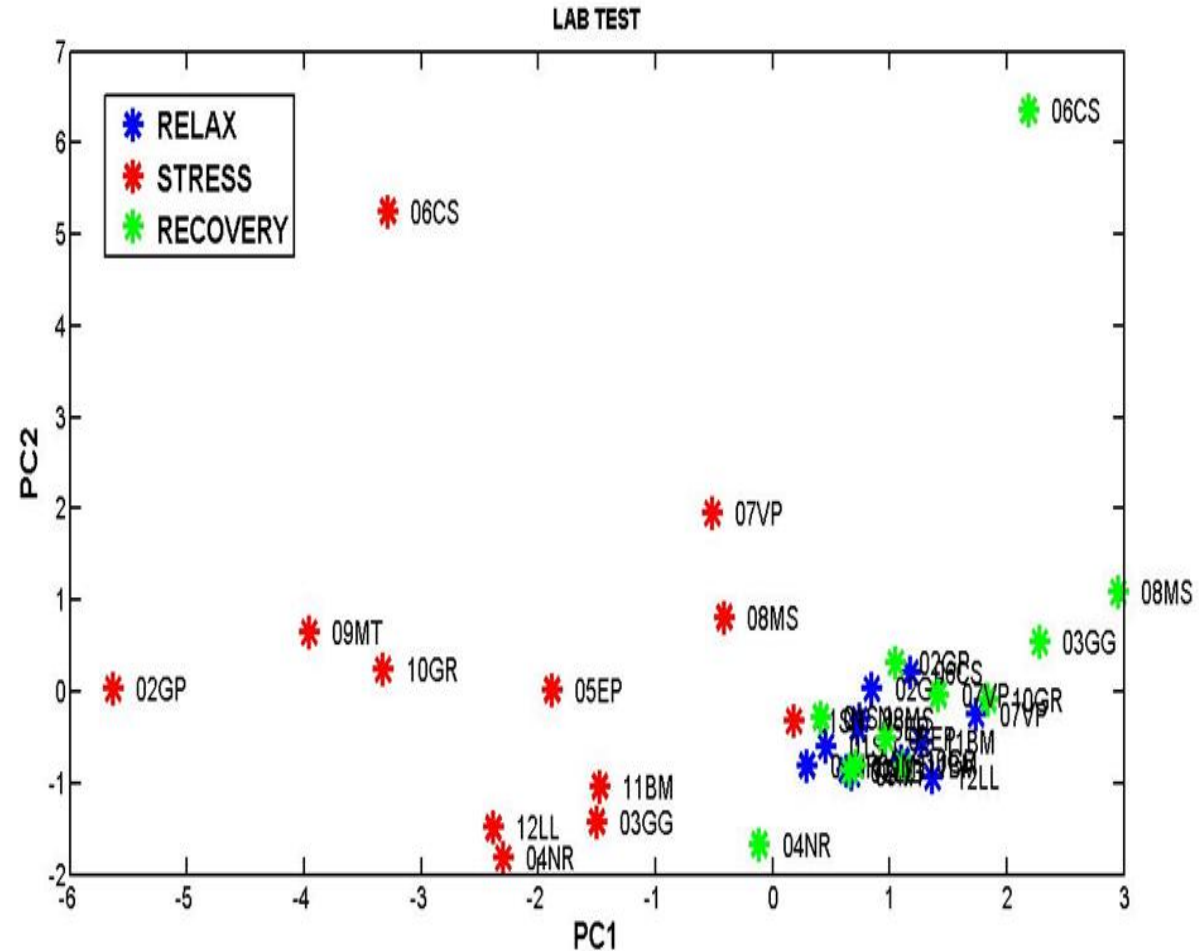
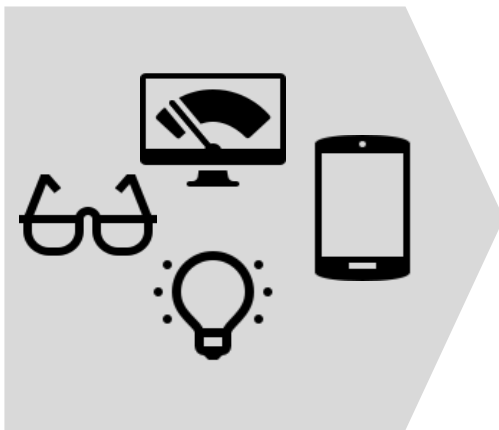
# Data management: Privacy and security by design

- Database in cloud receives encrypted stress related data, only.
- Acquisition and analysis of physiological data only performed locally (not in cloud).
- Smartphone of user is barrier between local system and cloud. (→ user can force disconnect at any time)





Support vector  
machine based  
algorithm evaluates  
data and determine  
the stress level



# Offering Interventions

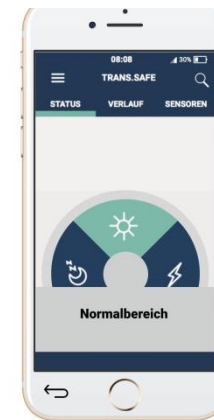


## Interventions by

- Realtime, unobtrusive feedback via smartphone offering
- Light shower (stimulating or calming light)
- Offering stress management tips (e.g. breathing exercise)
- In truck: activation of driving assistance systems, option to change environment (e.g. air conditioning, radio loudness)



Light intervention glasses developed in project.



App (former)

(new)

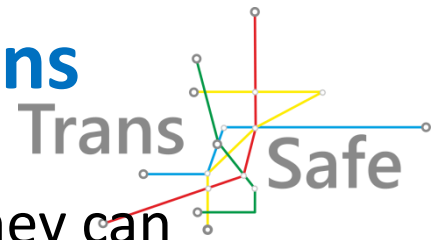
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# Limitations of the interventions



- Interventions must be unobtrusive otherwise they can contribute to stress potentially
  - Challenges at OCC and steering wheel:
    - No smartphone usage allowed
    - No light shower allowed
  - Users prefer interventions not visible to others
- ➔ The intervention capabilities of the Trans.Safe system will be used during breaks or before/after a shift – not during the work.
- ➔ The system does not make a relaxing job from a stressy one!

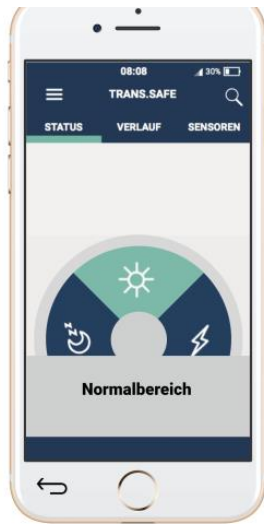
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**The stress level is unobtrusively presented on the smartphone**



**If stress detected:**

- Relaxation measures are suggested and prepared

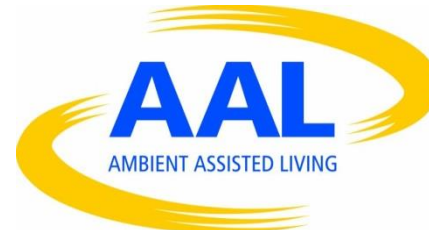
Health   
ROI 

**Benefits for industry:**

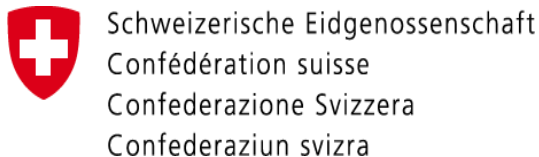
More balanced and healthier, experienced employees with less disability absence and increased efficiency



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# Questions & Answers



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