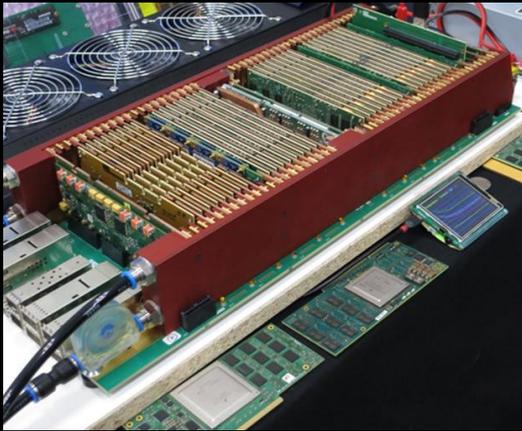


Human Centric Sensing and Computing

Bruno Michel

IEEE Fellow, Member IBM Academy of Technology, and US National Academy of Engineering

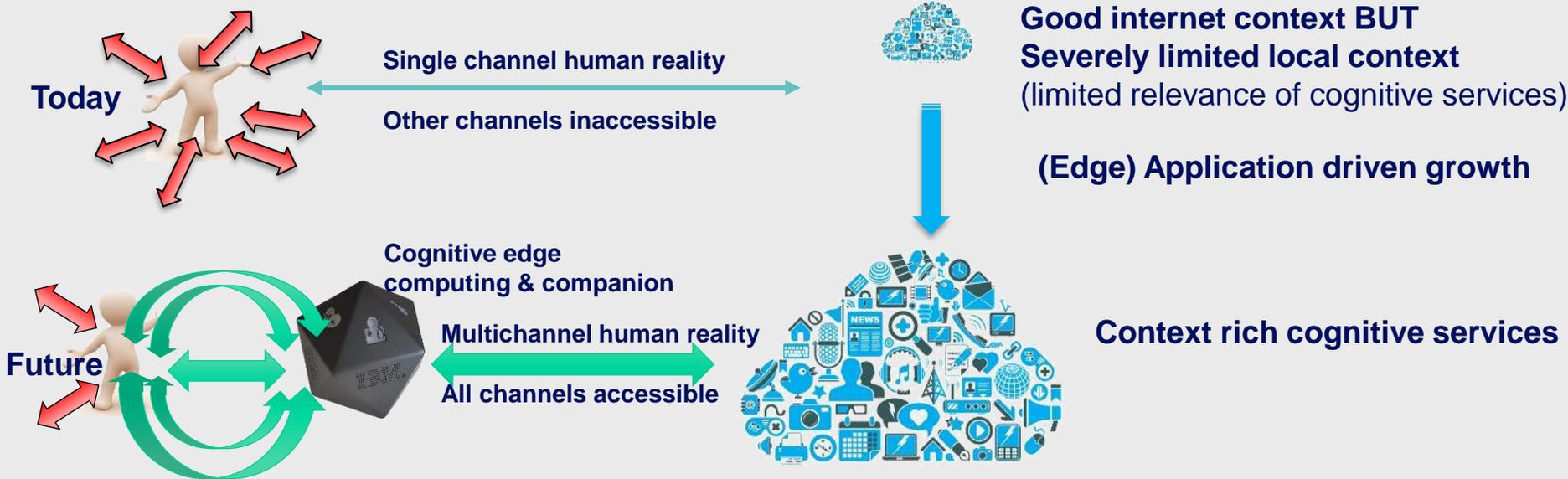


Human Centric Sensing and Computing Strategy



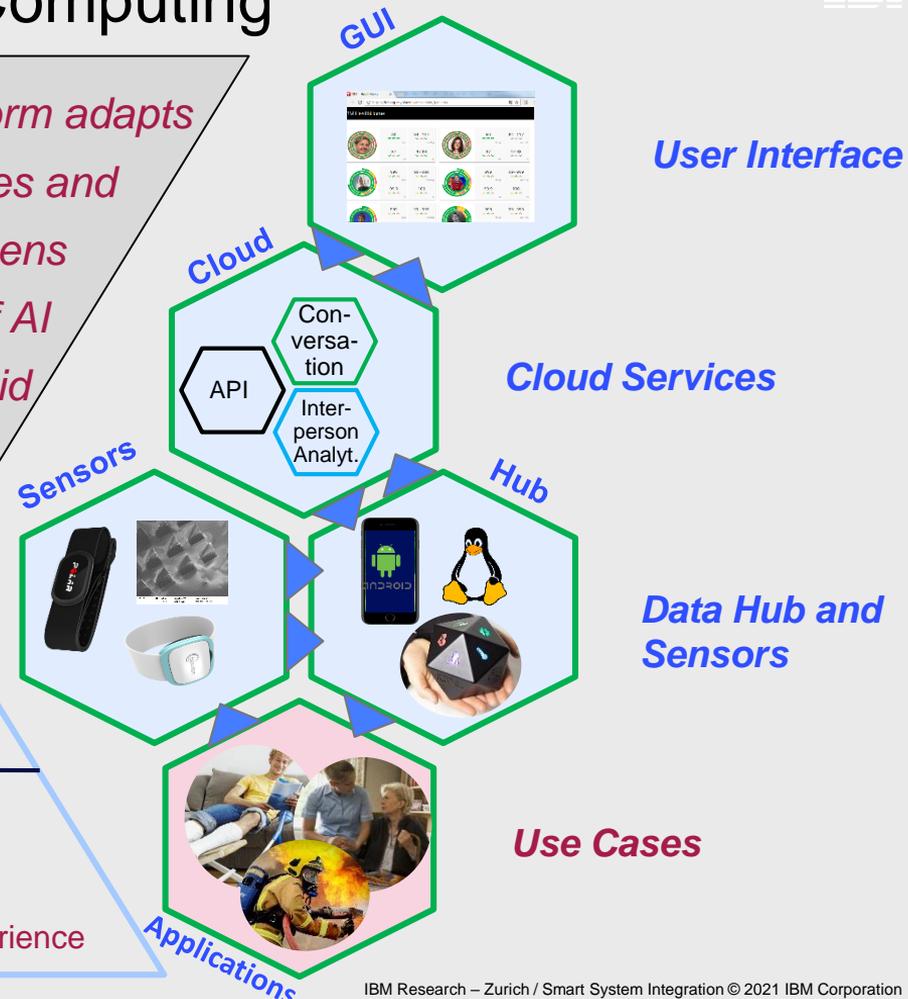
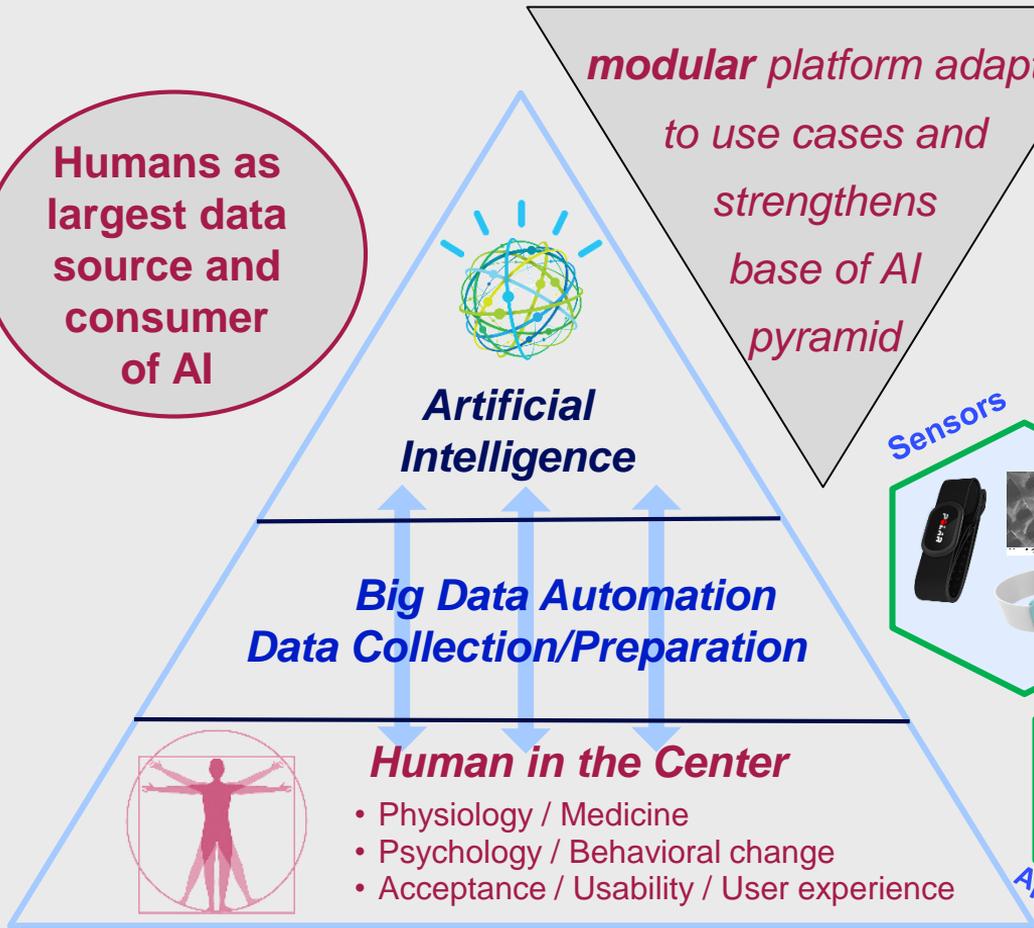
Context key for relevant personalized cognitive services in wellbeing and work safety

IoT / wearables revolutionize healthcare for chronic diseases and elderly care by enabling **data-driven preventive medicine**

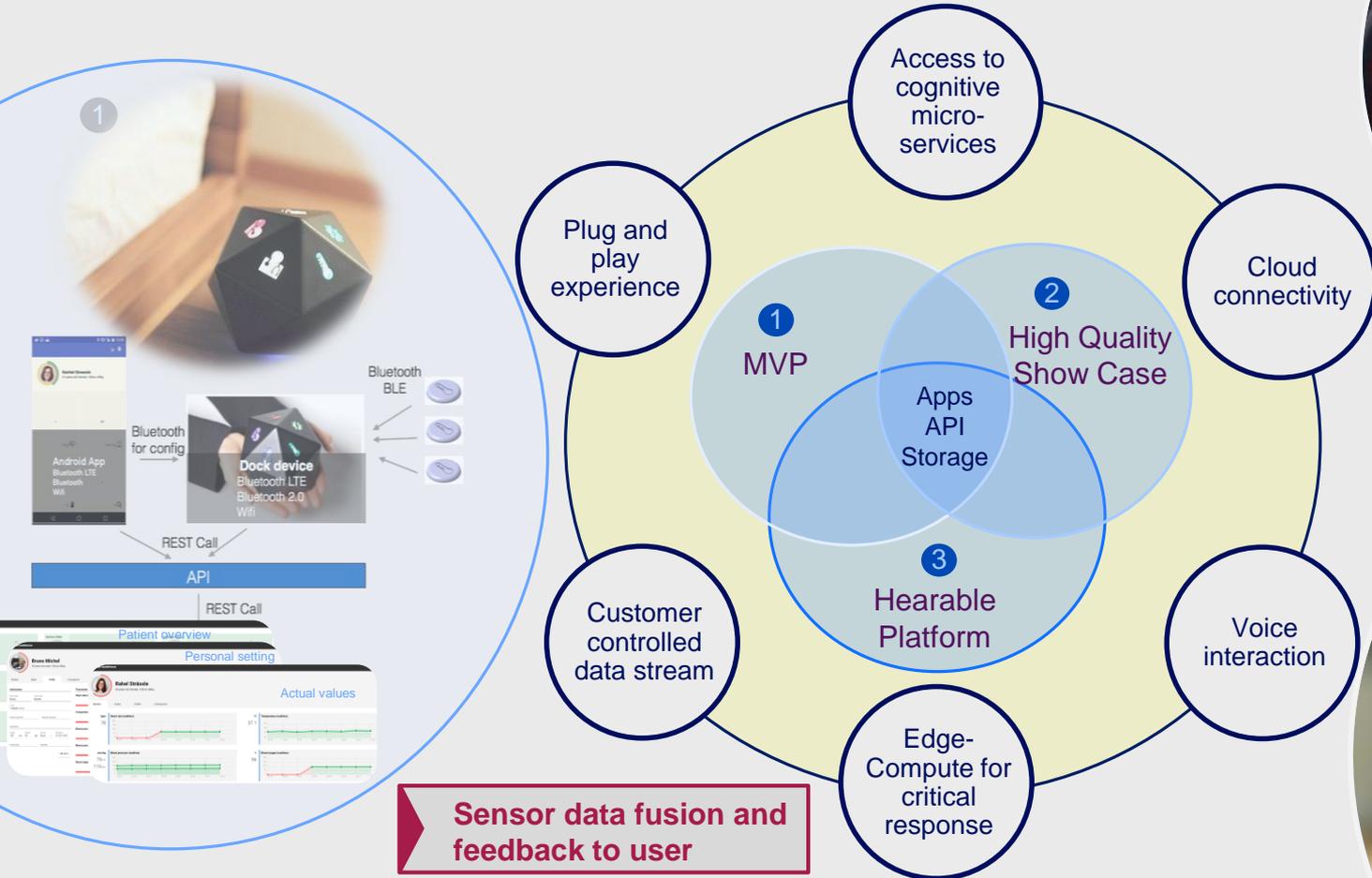


Human Centric Sensing and Computing

Humans as largest data source and consumer of AI



eCompanion: Platform Implementations



Stress – Impairs Performance, Decision Making & Safety



Impaired ability for critical tasks:
That rely on high neocortex performance



Benefits of real-time stress monitoring:

Training: Personalize training

Planning: Select skills AND stress-tolerance

Operation: Re-define missions, tasks, teams, and leaders

Stress “Measuring”:

State-of-the-Art: Invasive, slow, and impractical for real-time monitoring.

Our Solution: NON-invasive, real-time, differentiate physical and psychological stress

Use Case I: Monitoring during Firemen Training: DeStress



- Heart rate acquired with chest-belt
- Distinguish mental stress from physical stress within 30-60 seconds
- Test in firefighter training with acquisition, labelling, and learning

Assisted labelling and transfer learning to data from other sensors than ECG



Use Case II: Management of Chronic Lung Disease*

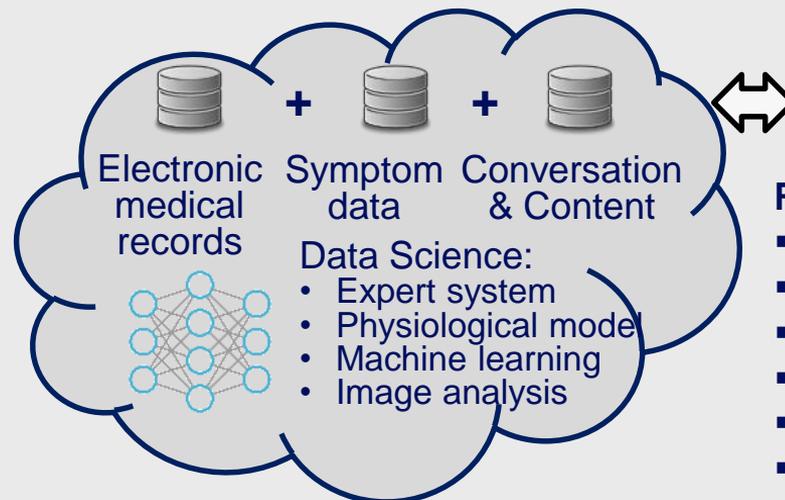


- Bi-directional communication patient – physician
- Symptom and activity tracking
- Prediction of exacerbations
- Personalized context

* Asthma and COPD: Congestive Obstructive Pulmonary Disease



Analog: Physician patient interaction



Recording:

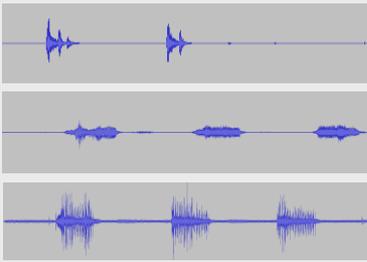
- Medication adherence
- Lung function
- Cough intensity
- Sputum color
- Activity and sleep
- Vital-signs
- Environmental parameters

Less suffering for those with chronic diseases

Quality of life management of COPD patients: CAir

Audio Recording

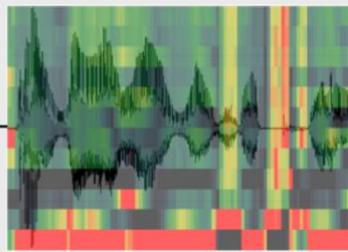
cough
wheeze
snore



Cough F1-score = 88%

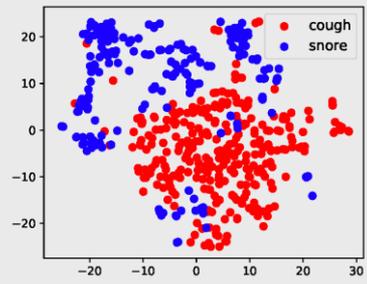
Feature Extraction

13 freq. bins



Mel-frequency cepstral coefficients (MFCC)
S. Vhaduri, T. Brunswiler, ICHI, (2019)

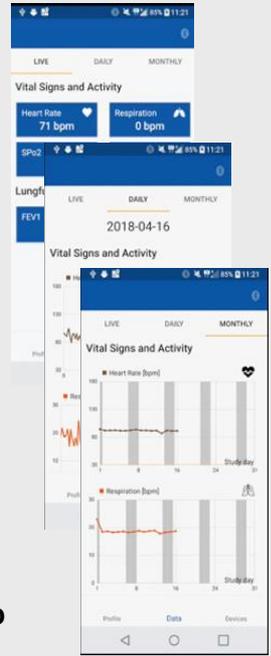
Classification,
e.g. k-nearest Neighbour
t-SNE of Cough and Snore



Confusion Matrix predicted class

		cough	hawking	pull nose	snore nose	snore throat	wheeze
cough	90	0	0	0	0	1	
hawking	1	14	0	0	0	0	
pull nose	1	0	9	1	0	0	
snore nose	0	0	0	23	0	0	
snore throat	0	1	1	1	11	1	
wheeze	0	0	0	0	0	22	

CAir Desk



Patient App

Device	Smart-phone Camera	Smart-phone Mic	Inhaler	Spirometer	Activity & vital sign tracker	Envrionmental Sensor
Parameter	Sputum color	Cough count	Medication time-stamp	Lung function	Steps, SPO2, electrodermal activity,...	Temperature, Humidity, particles & VOC

Continuous Patient Interaction and Support at Scale

Face-to-Face

Holistic interaction
Situational assess
Social bond, trust
Limited time, reach



Tele-Platform

Disease information
Questionnaires
Reminders
Limited scale



Virtual Agent (Chatbot)

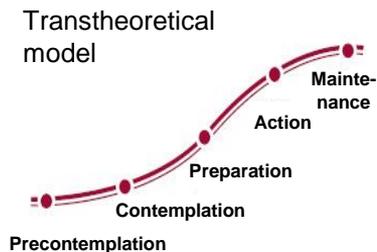
Behavioral change and therapy support at scale
Limited contextual and personalized appearance

Personality Traits



Personality insights

Behavioral Change Stages



Observation of progress

Just-in-time Intervention



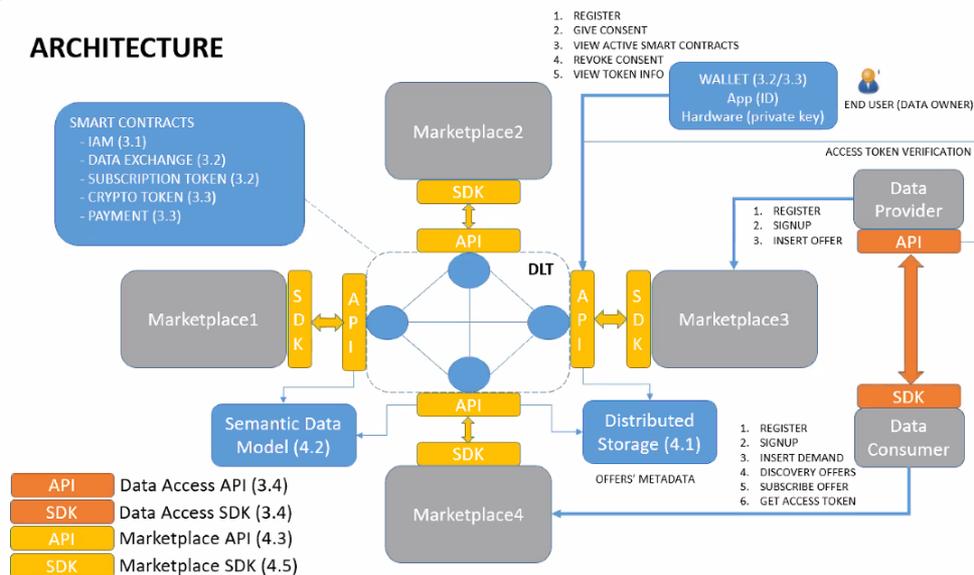
Digital-Triggers



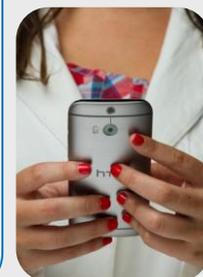
Functionalities of Wellbeing Pilot

- Monitor elderly, workers, patients, or athletes
- Service provided by care-givers, captains/supervisors, or coaches
- Privacy and GDPR need limited data lifetime
- Elderly Care data from ActivAge
- Work safety Data from Firefighter trainings
- Data on monitoring and coaching of people with chronic diseases

ARCHITECTURE



ACTIVAGE



Human Centric Sensing and Computing

Bridge gap to wearables with edge systems

Apply AI in healthcare and IoT

Convergence of ITC & Healthcare

ADL monitoring and classification

Preventive medicine

European digital Economy

Data not transferred to cloud but AI to the edge to improve autonomy, functionality, latency, reliability, and privacy

