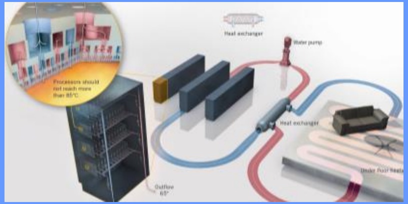
Panel IoT Ecosystems and Partnerships: Health or Human Centric Sensing and Computing

Datacenter Carbon Footprint



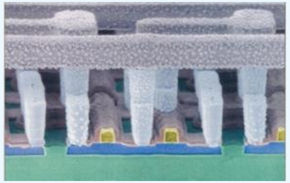
- Efficiency is 0.000’004%
- Volume used for compute <1 ppm

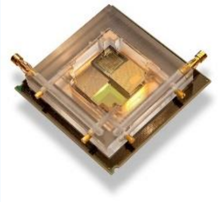
Energy Efficiency

Big Data

Cognitive Computing

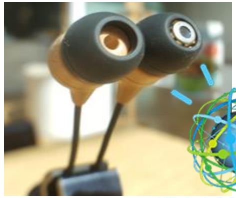
The End of Transistor Scaling





Dense and Efficient Systems Roadmap

IoT sensors and edge



IBM Watson

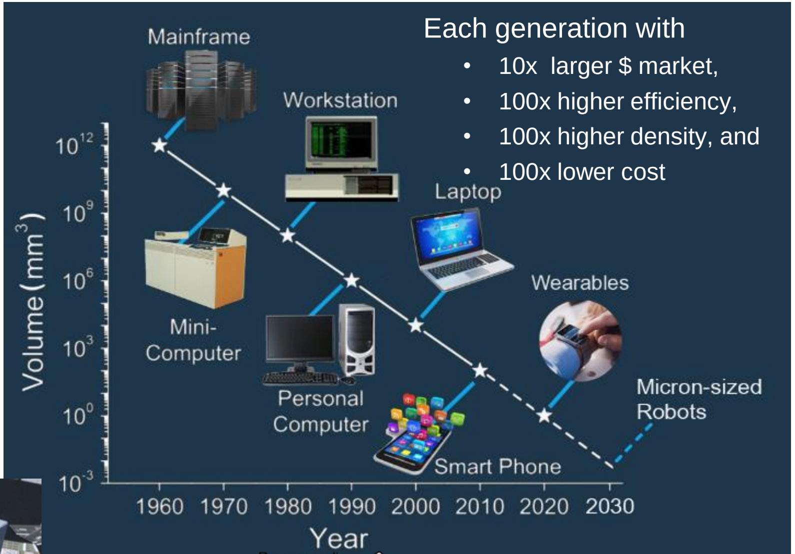
Wearables and Healthcare

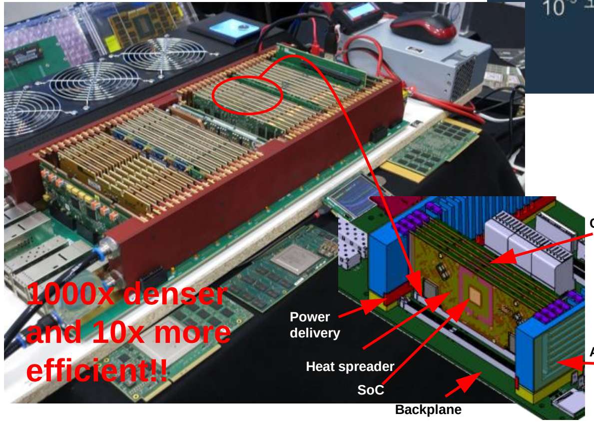
Bruno Michel, Mgr. Smart System Integration, PI Internet of the Body, IEEE Fellow
Member US National Academy of Engineering and Member IBM Academy of Technology
https://www.zurich.ibm.com/st/ **https://www.zurich.ibm.com/st/smartsystem/**

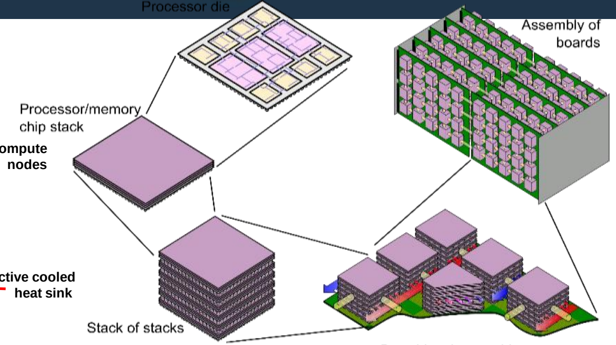
Bell's Law Demands more Integration

- Every 12-15 years restart new generation
- Hardware cost fraction decreases from 100% (mainframe) to <10% adding functionality
- Sensing and communication miniaturized
- Low thermal/electrical resistance enable density
- Sensing and computing meet in wearables
- **Remember: proximity improves efficiency!**
- **Efficiency and low cost due to Bell's law**

Figure. Jeff Holter with his original 38-kg radio-electrocardiograph recording device in 1947.





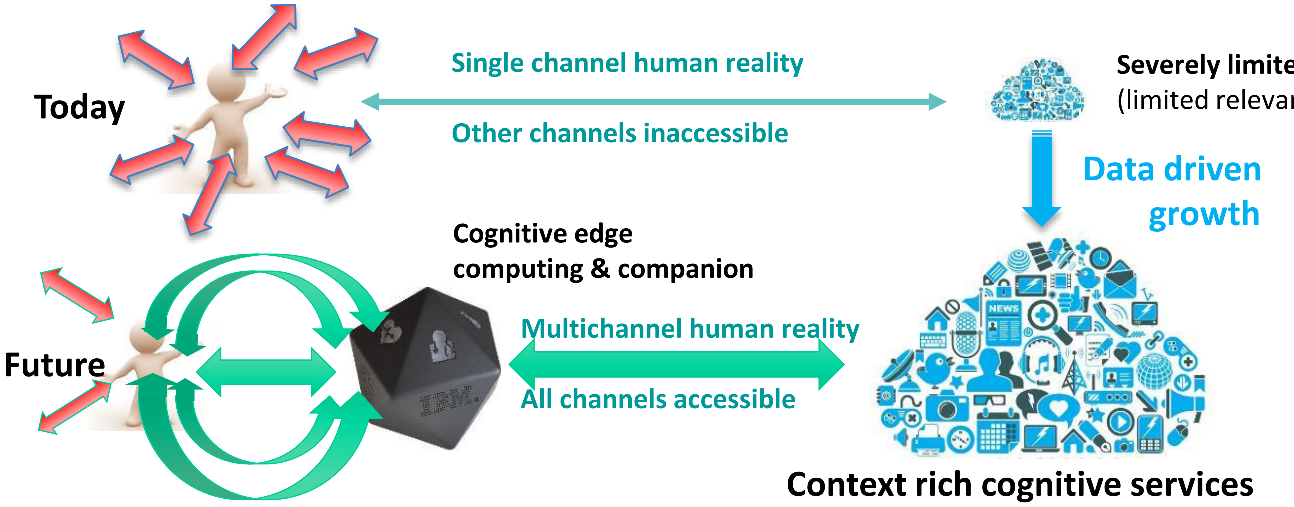


- **Data not transferred to cloud but AI transferred to the edge to improve efficiency**

Bruno Michel, bmi@zurich.ibm.com

Human Centric Sensing and Computing Strategy

- Cost and accessibility of healthcare, blockbuster drugs not personalized
- Stress strong link to human wellbeing
- **Human Centric Sensing and Computing:** Context key for relevant personalized cognitive services
- Personalized cognitive services in preventive medicine / coaching; work safety; wellbeing; elderly care
- Miniaturization for low-cost non-intrusive monitoring to reduce cost in acute and preventive medicine
- **Move intelligence to the edge instead of data to the cloud for solutions to be relevant to people**



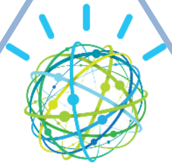
IoT / wearables will first revolutionize healthcare starting with chronic diseases and elderly care before enabling data-driven preventive medicine

Bruno Michel, bmi@zurich.ibm.com

IoB Platform Building blocks

Humans as largest data source and largest consumer of cognitive services

***modular, flexible and scalable** platform that adapts to use cases and strengthens base of AI pyramid*



Data Science
- SML Algorithms
- Deep Learning
- microservices

Data Collection/Preparation
- Gathering protocol
- Reliable Data
- Data Storage
- Data cleaning
- Segmentation, labeling
- Feature selection

Human in Center and Pyramid Base

- Physiology / Medicine
- Psychology / Behavioral change
- Acceptance / Usability / User experience

User Interface
- *Data*
- *Thresholds and trends*

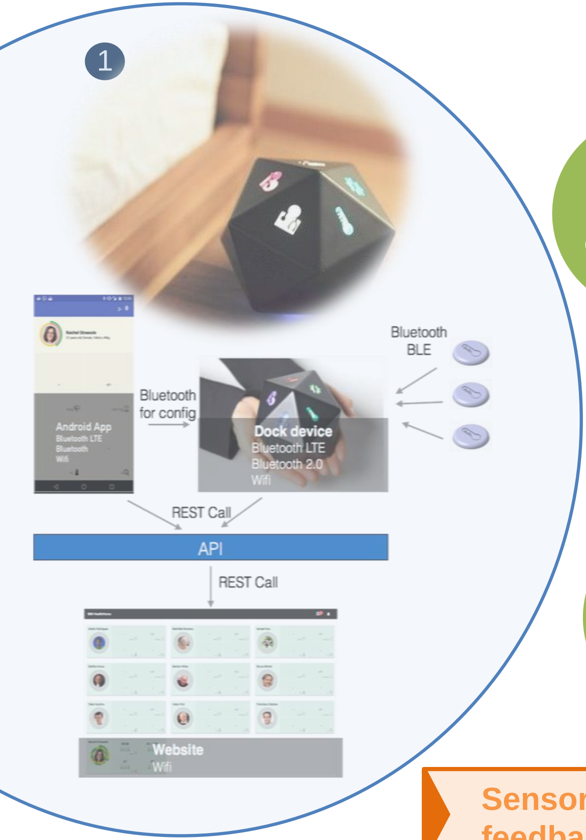
Cloud Services
- *Storage*
- *Big data science*

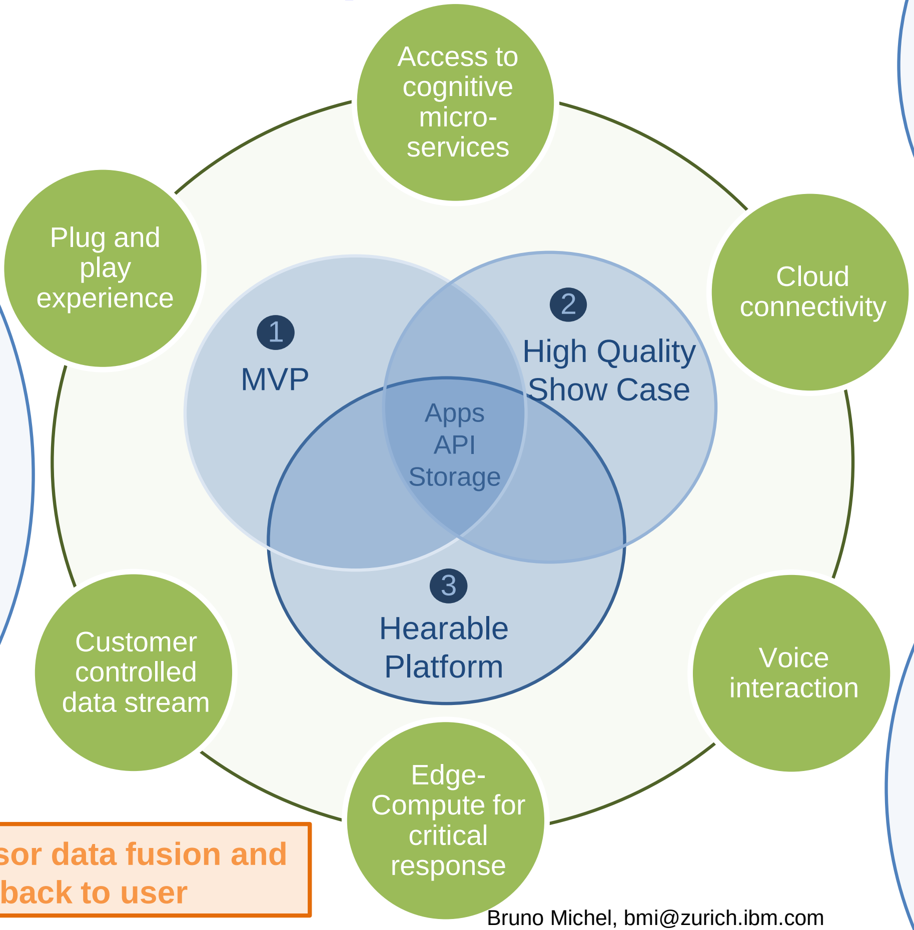
Data Hub and Sensors
- *Edge*
- *Communication*
- *Alerts*
- *Commercial and new sensors*

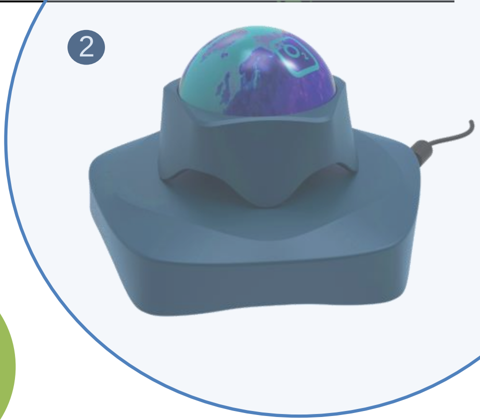
Use Cases
- *eCompanion – Future Hospital*
- *CAir – Chronic Disease Mgmt.*
- *FireFighter – Stress Detection*

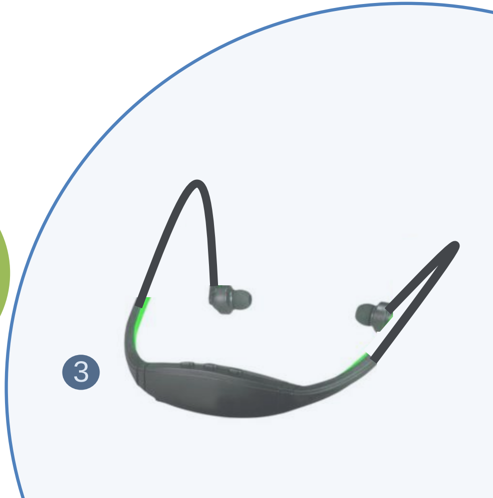
Bruno Michel, bmi@zurich.ibm.com

eCompanion: IoB Platform Implementations









Sensor data fusion and feedback to user

Bruno Michel, bmi@zurich.ibm.com

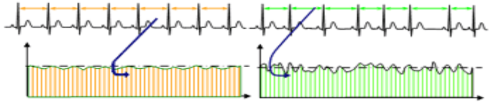
Use Case I: DeStress Monitoring during Firemen Training

Machine Learning Algorithm:

- Distinguish mental stress from parallel physical stress
- Best algorithm: C5 decision tree, with >80 % precision, Fscore and recall
- Detected all phases for unknown subjects

Implementation:

- Heart rate sensor to send RR-intervals via BLE to phone



Low HRV → Stressed

High HRV → Normal

Motivation: Stress Impairs Decision Making in Critical Situations

– Dangerous when someone panics

– Stress: Physiological or psychological

Project DeStress: Stress management for critical tasks

Bruno Michel, bmi@zurich.ibm.com

New firemen Stress Monitoring System

Vital signs monitoring

- Use on firemen, police, athletes, workplace etc.
- Use machine learning for classification
- Integrated acquisition, labelling, and learning
- Include breath, sweat etc.
- Project name: **DeStress**

- Heart rate (RR) data is acquired on the firefighter (user) with a pulse-tracker chest-belt.
- BLE data sent to android smartphone APP, that transfers them over a WiFi to the supervisor terminal.
- The supervisor terminal provides a user-interface to the supervisor and runs the real-time stress-detection algorithms and data-collection.

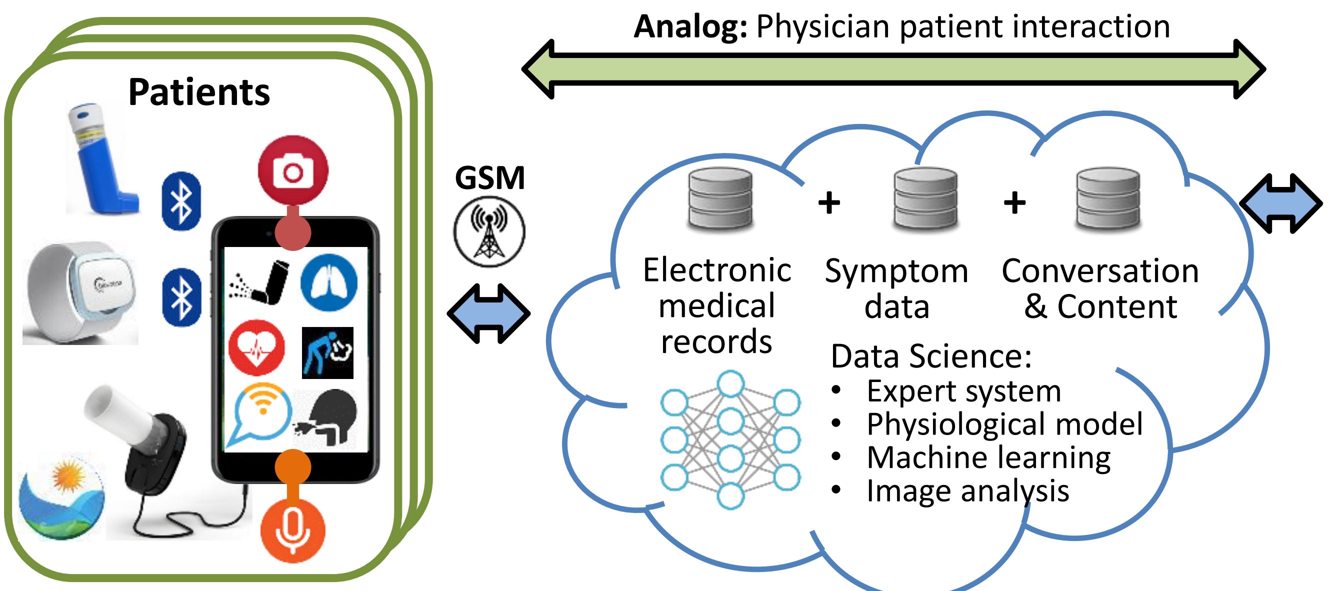
- Assisted labelling process implemented also for transfer learning to data from other sensors than ECG

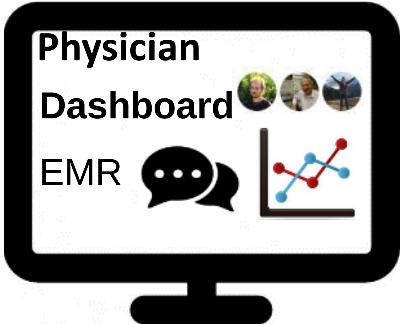
Bruno Michel, bmi@zurich.ibm.com

Use Case II: Management of Chronic Lung Disease*

- Bi-directional electronic communication between patient and physician.
- Continuous patient symptom and activity tracking.
- Prediction of exacerbations based on activity score .
- Personalized and context for virtual agent

*Asthma and COPD: Congestive Obstructive Pulmonary Disease





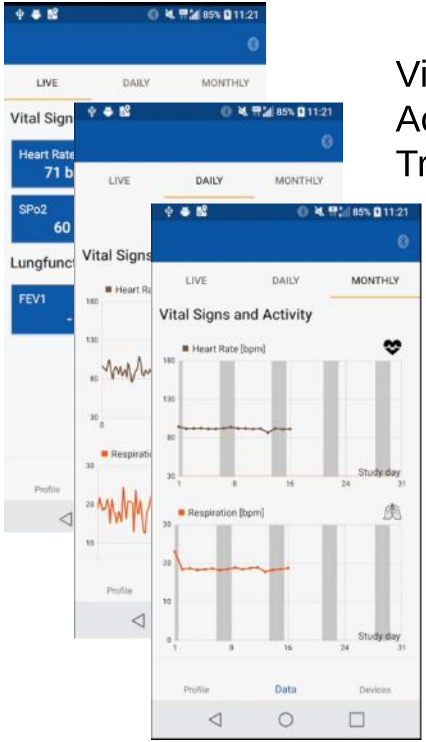
Recording:
- Medication adherence
- Lung function
- Cough intensity
- Sputum color
- Activity and sleep
- Vital-signs
- Environmental parameters

Less suffering for those with chronic diseases

Bruno Michel, bmi@zurich.ibm.com

CAir Patient App and Desk

Patient App



CAir Desk

Device	Parameter
Smart-phone camera	Sputum color
Smart-phone micro-phone	Cough count
Inhaler	Medication time stamp
Spirometer	Lung function
Activity & multi-vital sign tracker	Steps Energy expenditure Oxygenation Skin temperature Respiration rate Heart rate (var.) Electrodermal activity
Environ-mental sensor	Temperature Humidity Particle count VOC and CO_2

Bruno Michel, bmi@zurich.ibm.com

Continuous Patient Interaction and Support at Scale

Face-to-Face

Visits

Physician-patient

Holistic interaction
Situational assess
Social bond, trust

Limited time, reach

➕

Tele-Platform

Text based com.

Physician-patient

Disease information
Questionnaires
Reminders

Limited scale

➕

Virtual Agent (Chatbot)

Text based, dialogue (medical) or natural language (life-style)

Virtual agent to person communication

Behavioral change and therapy support at scale

Limited contextual and personalized appearance

📖 B. Celli, J. Med. Internet Res., (2016)

Personality Traits

The Big-5

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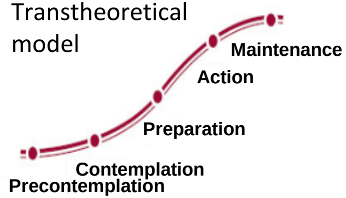
Personality insights

Behavioral Change Stages



📖 J. Prochaska, J. of Health Promotion, (1997)

⇧

Observation of progress

Just-in-time Intervention

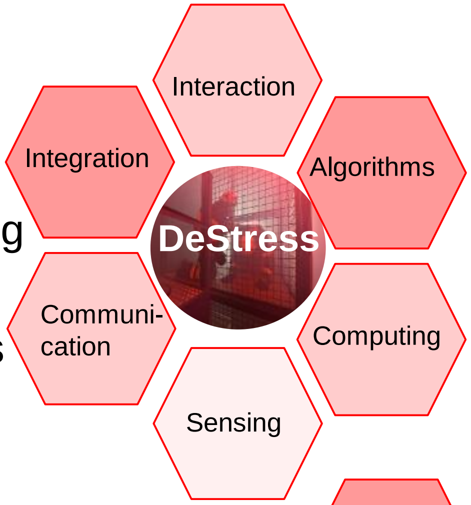
📖 Kowatsch, Design Science, (2017)

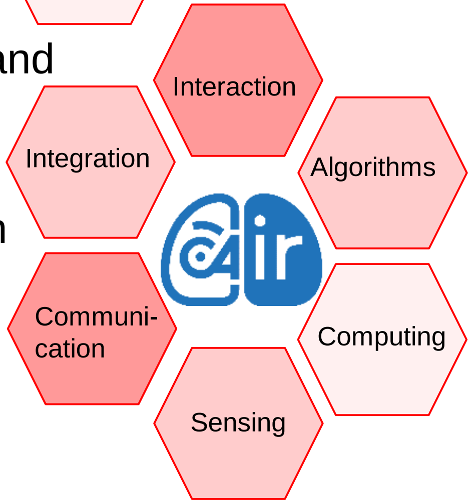
⇧

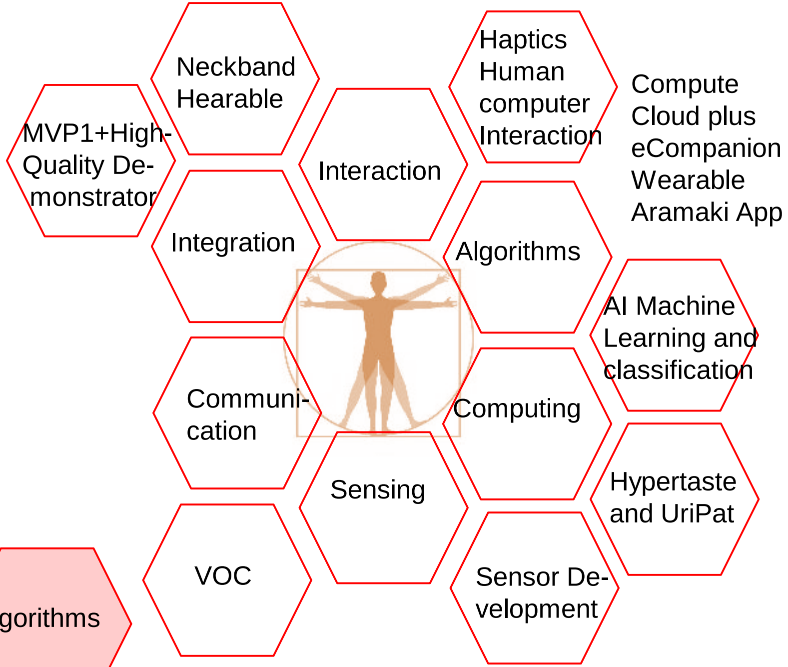
Digital-Triggers

Summary Outlook

- Integrated system for human centric sensing and computing
- Bridge technology gap to wearables with edge systems
- Build platform to apply AI in healthcare and IoT
- Support move from acute to chronic and finally preventive medicine
- Long-term monitoring (noninvasive wearable sensing) and coaching (with new interaction models)
- Use cases demonstrate exemplary the capabilities of the system







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

Thank you very much for your kind Attention!

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Bruno Michel, bmi@zurich.ibm.com