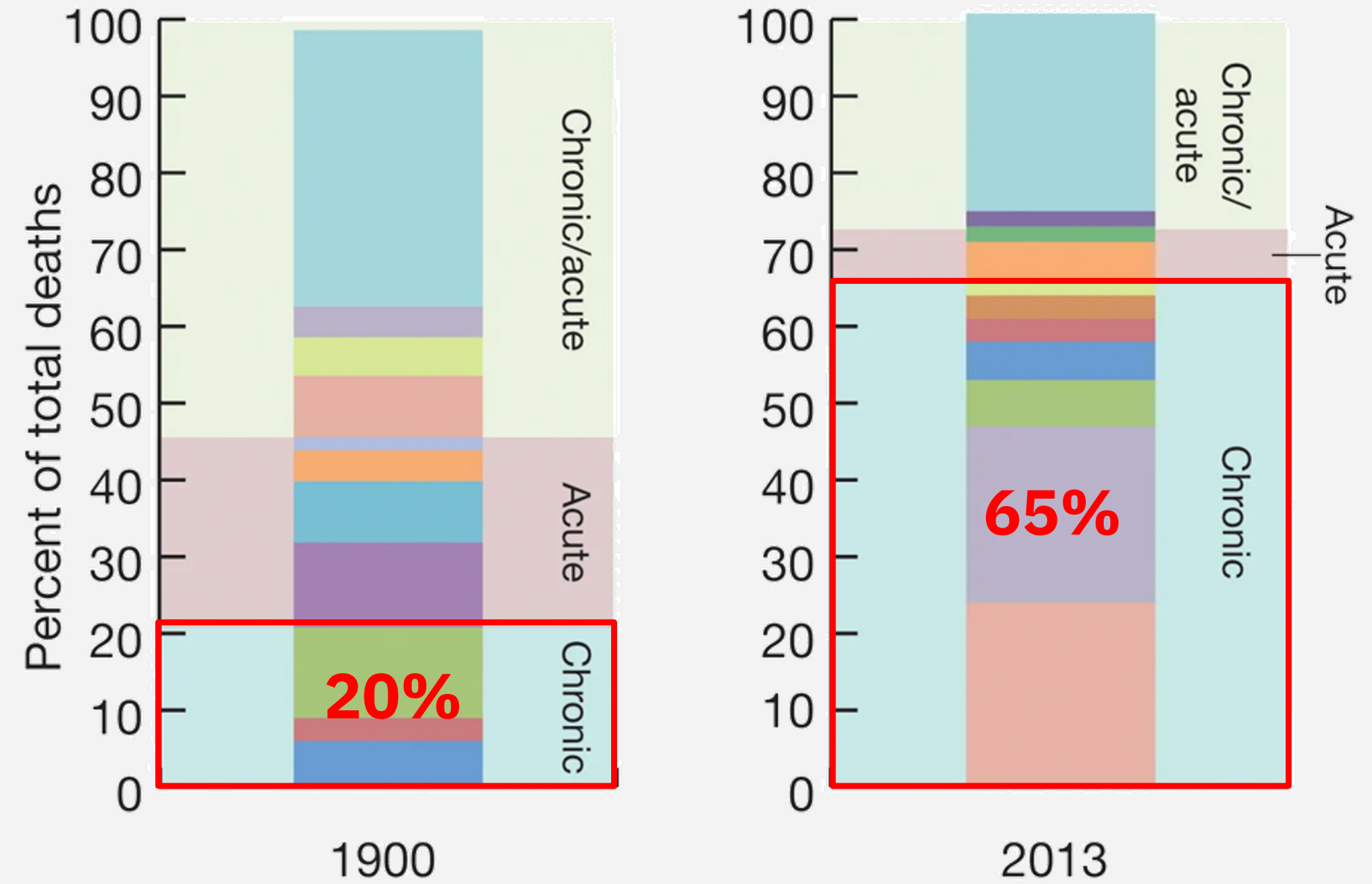


# Digital Health for Chronic Disease Management

*Objective Symptom & Disease Progress Reporting*

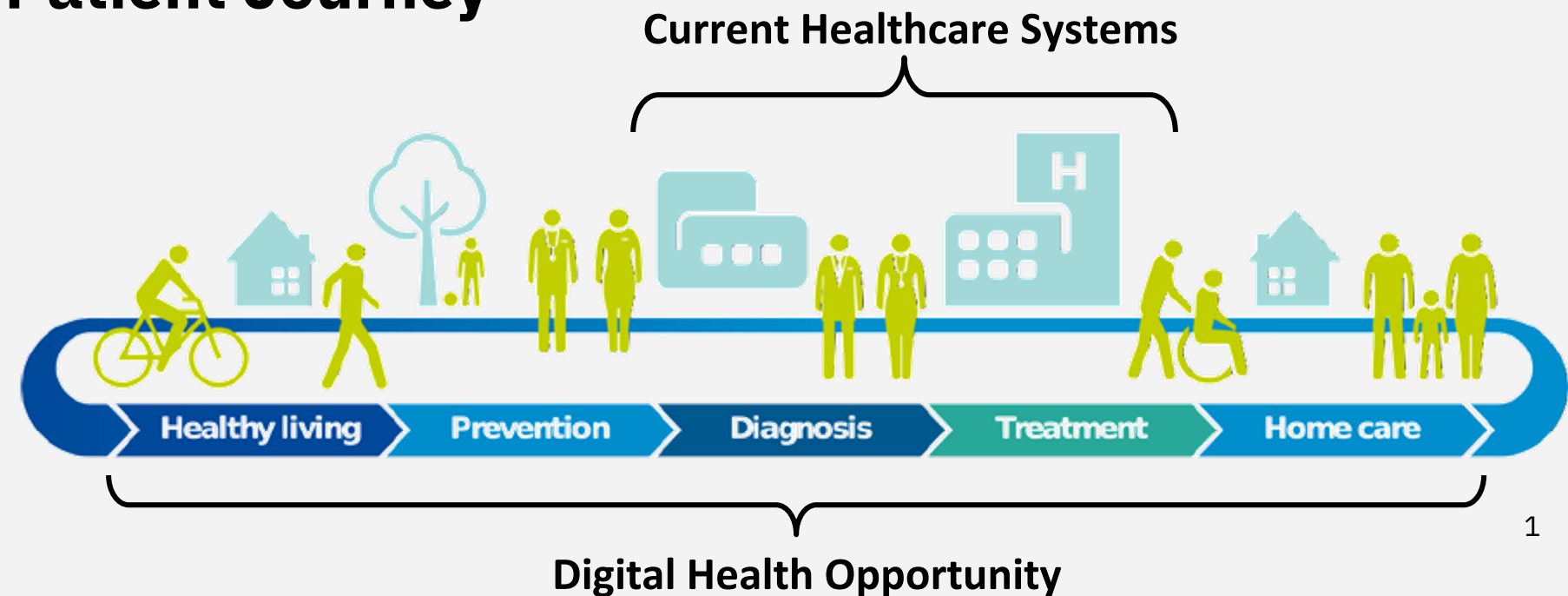
*Thomas Brunschwiler  
IBM Research – Zurich*

## Medical Challenge in this Century



J. Kvedar, Nature Biotechnology, (2016)

## Patient Journey



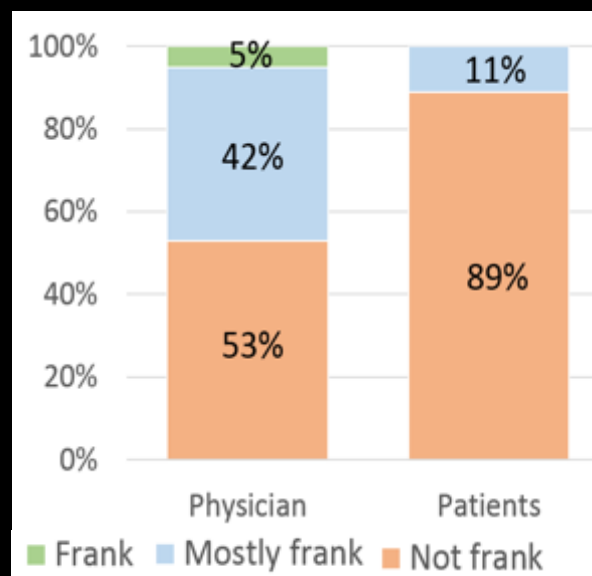
# Patient Self-Reports

## Patient Reported Outcomes Defines Medication



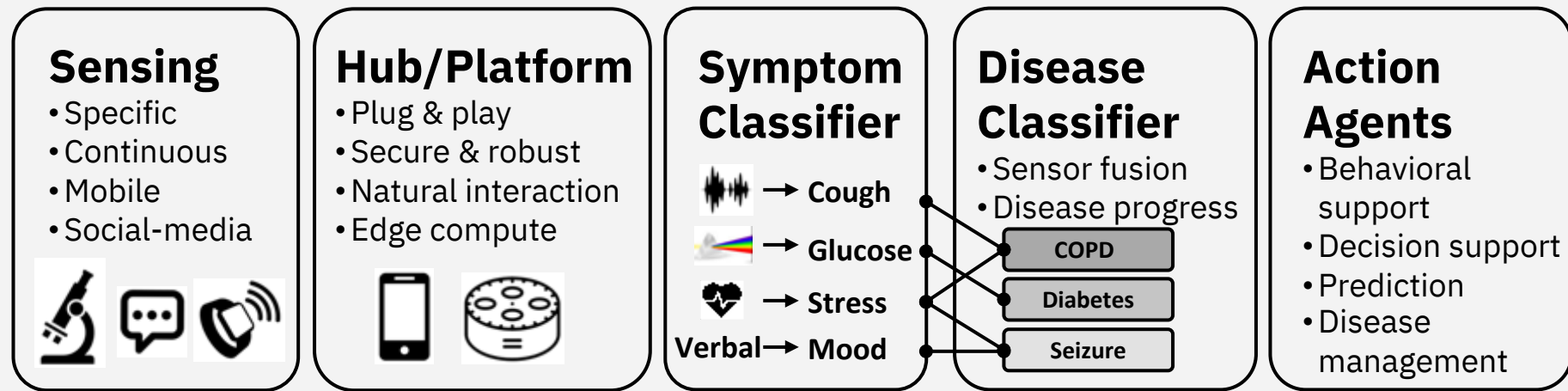
**Sparse:** during physician visits  
**Biased:** cultural aspects, social desirability, temporal discounting, perception, context, etc.

## Patient Frankness on Self-Reports



B. Celli, Int. J. COPD, (2017)

# Objective symptom & Disease Reporting



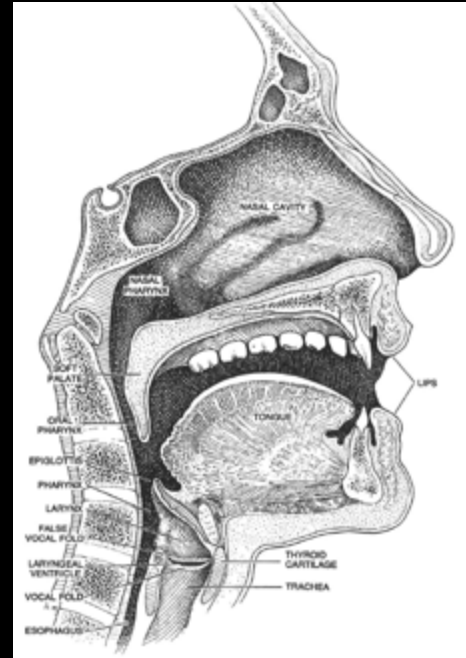
#	COPD Assessment Test (scale from 0 to 5, max. 40)
1	I never cough ⇔ I cough all the time
2	I have no phlegm(mucus) in my chest at all ⇔ My chest is completely full of phlegm(mucus)
3	My chest does not feel tight at all ⇔ My chest feels very tight
4	When I walk up a hill or one flight of stairs I am not breathless ⇔ When I walk up a hill or one flight of stairs I am very breathless
5	I am not limited doing any activities at home ⇔ I am very limited doing activities at home
6	I am confident leaving my home despite my lung condition ⇔ I am not at all confident leaving my home because of my lung condition
7	I sleep soundly ⇔ I don't sleep soundly because of my lung condition
8	I have lots of energy ⇔ I have no energy at all



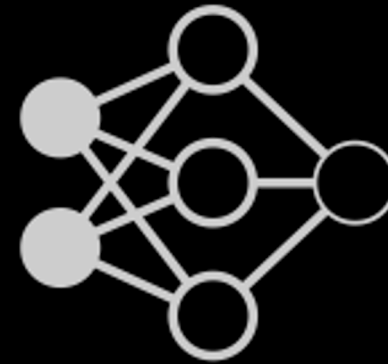
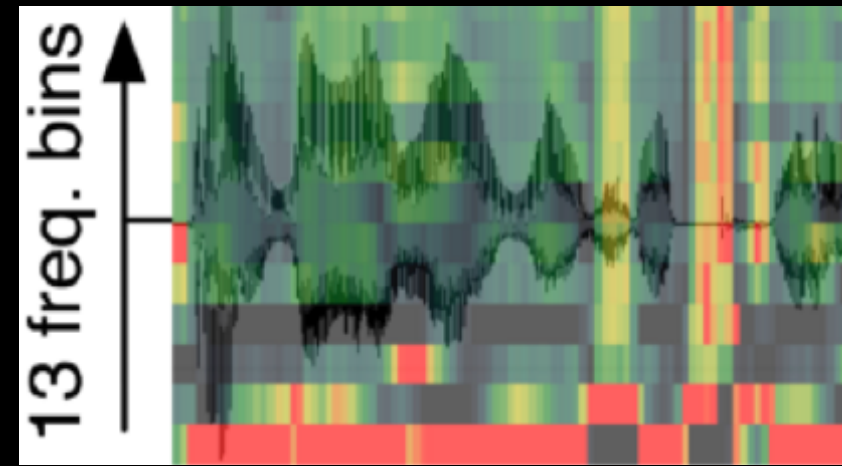


# Artificial Intelligence

## Digital Biomarkers



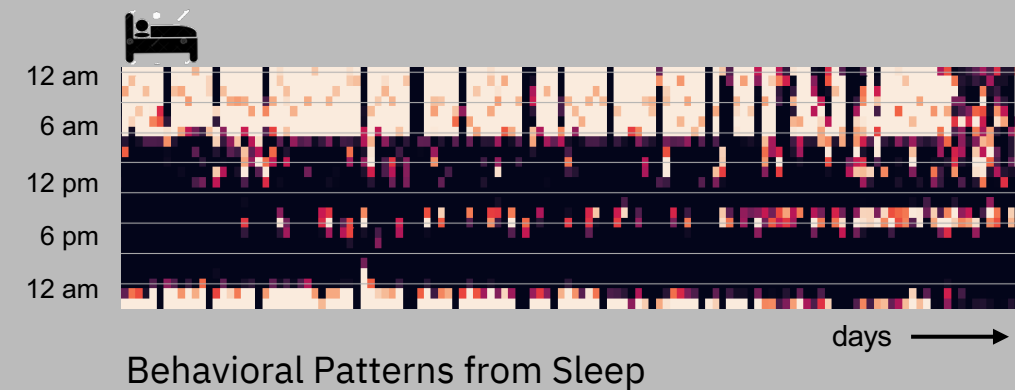
### Respiratory Sound Classifier



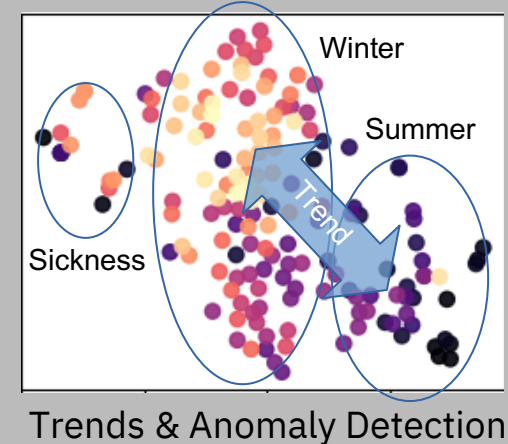
S. Vhaduri, T. Brunswiler, ICHI, (2019)

## Disease Progression

### Digital Diaries



### Health Patterns



# User Acceptance

## Usability & Privacy

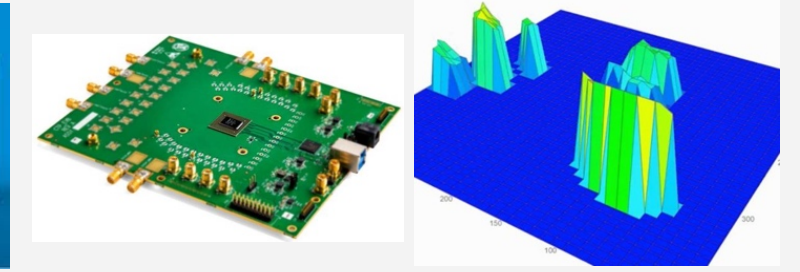
**Why:** Informed decisions demand personal data

### Approaches on Sensor Level

#### Wearables vs. Passive Sensors

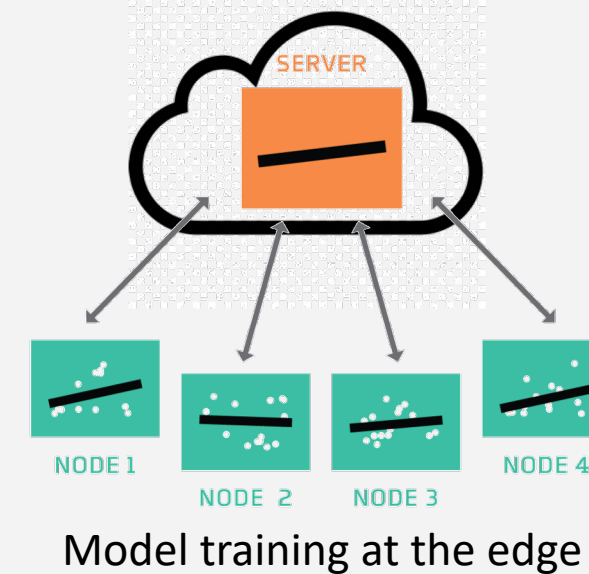


#### Limited Resolution Sensor

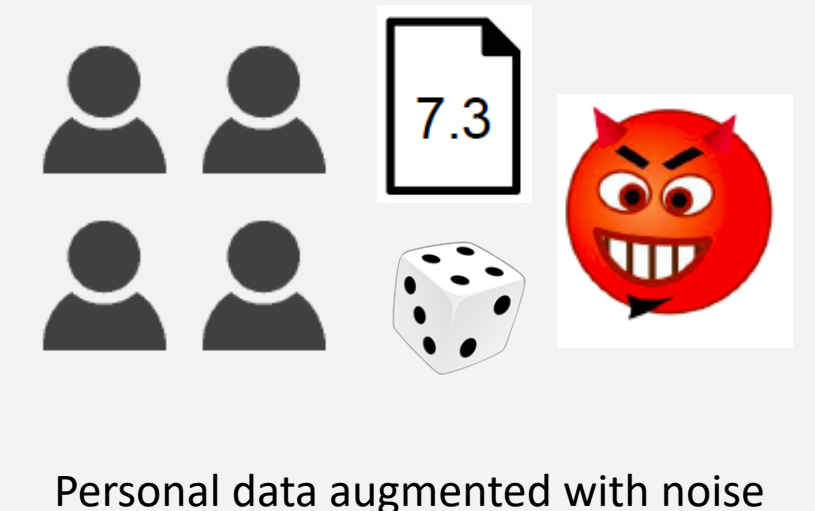


### Privacy Maintaining Machine Learning

#### Federated Learning



#### Differential Privacy



# Opportunities for Free Space Optics

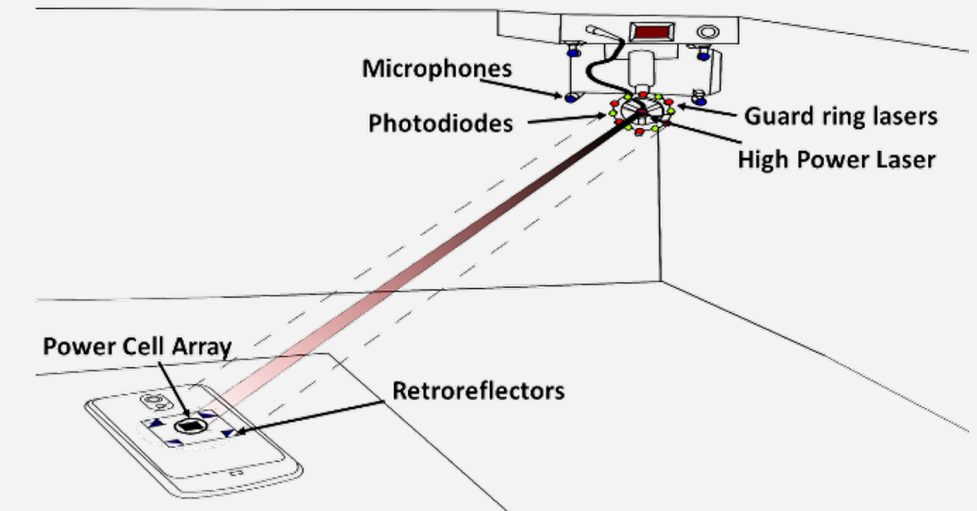
- 1) *Low-power communication*
  - device battery life-time
  - plug & play
- 2) *Optical powering of IoT-devices*
  - wire-less device deployment
- 3) *Optical sensing of*
  - physiological &
  - behavioral traits

## Examples *LiFi at Home for IoT-Devices*



pureLiFi

## *Distributed Laser Charging*



📖 V. Iyer, ACM, 2017

## *Fall-Detection*



IR-Sensor Strip (nevisQ)

## *Breath-Rate*



Depth Camera (Kinect)

📖 A. Procházka, Sensors, 2016

