Body Sensor Networks Lab (WS 17/18)

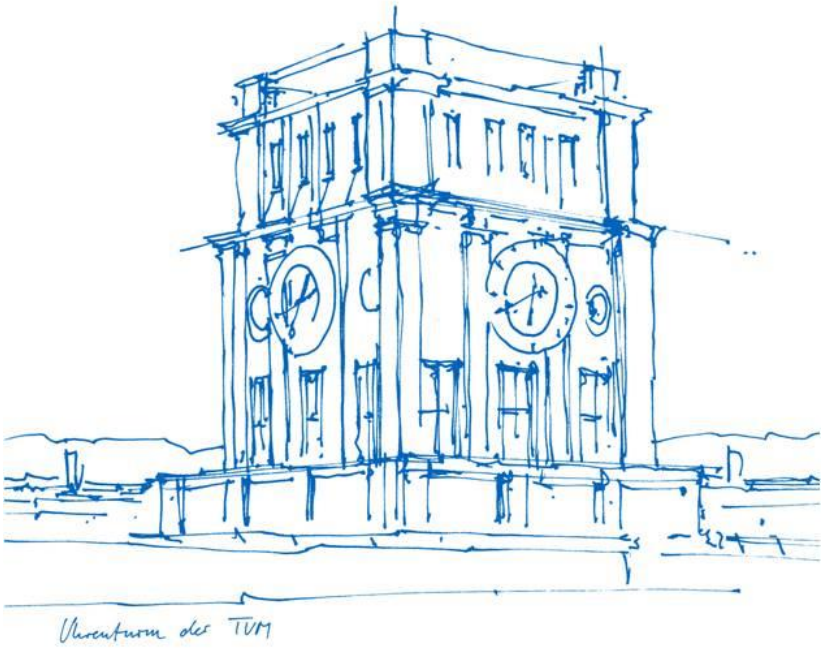
Swaminathan Narayanaswamy (Swami)

Technische Universität München

Fakultät für Elektrotechnik und Informationstechnik

Lehrstuhl für Realzeit-Computersysteme

16.11.2017



Agenda

- Introduction to Body Sensor Networks
  - What are Body Sensor Networks?
  - System architecture
  - Fields of work
  - Differences between Wireless Sensor Nodes and BSNs
  - Challenges in BSNs
  - Sensor examples
  - RCS – Hardware
  - Activity detection

- Short tutorial on Gantt chart

- Organizational
  - Group formation
  - Repository access provision

Definition of BSN

Formal definition (IEEE 802.15)

"A communication standard optimized for low power devices and operation on, in or around the human body (but not limited to humans) to serve a variety of applications including medical, consumer electronics / personal entertainment and other "

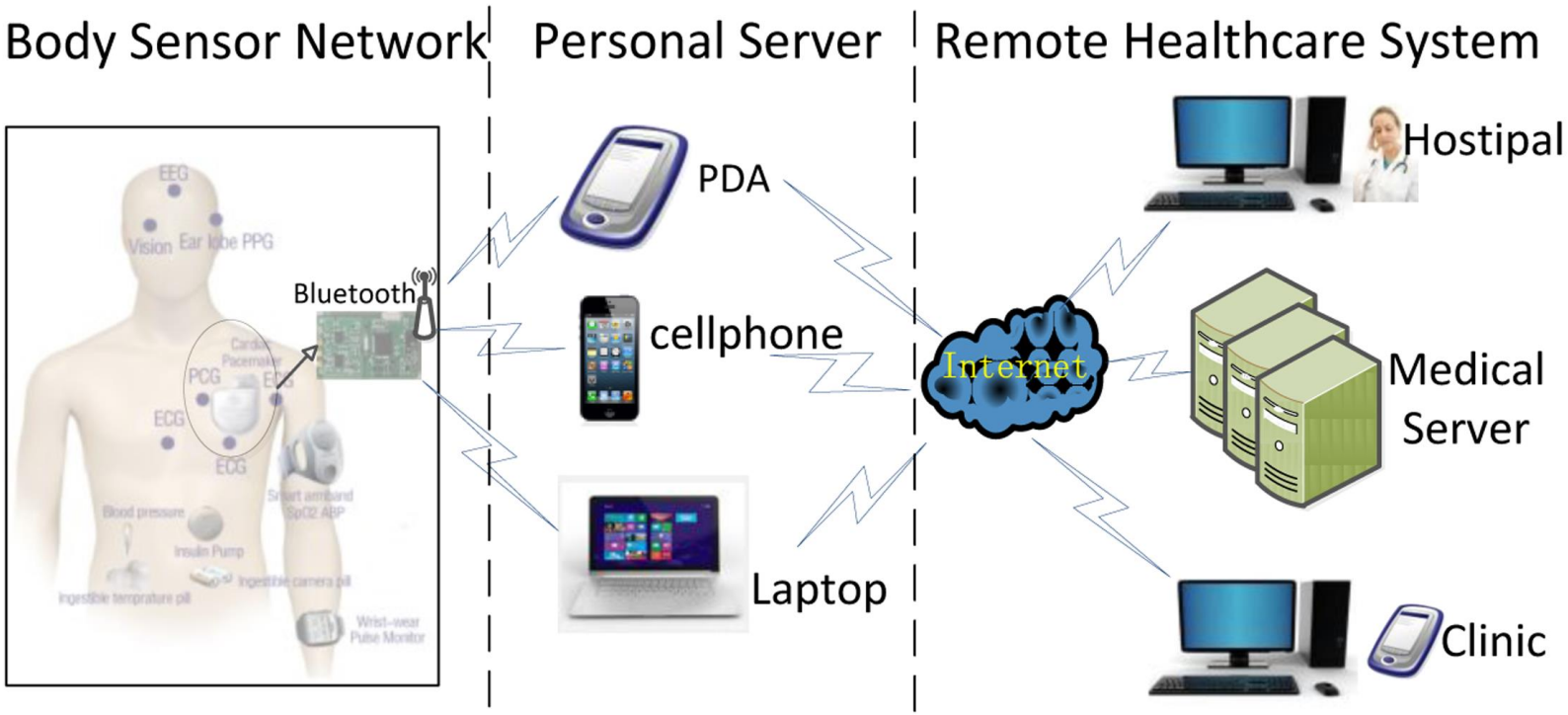
In common terms

"A Body Area Network is a system of devices in close proximity to a persons body that cooperate for the benefit of the user "

Definition

- Body Sensor Networks
  - Monitoring of body functions for medical and sports purposes
  - Several sensors for monitoring specific body functions
    - Blood sugar, blood pressure
    - Heart rate, ECG
    - Eyes, eyes implant
  - Data transfer
    - From sensor to a body gateway attached on the body
    - From there to central intelligence nodes
    - Broadcasted to appropriate medical facilities via wireless or wired transfer

System architecture (3-tier architecture)

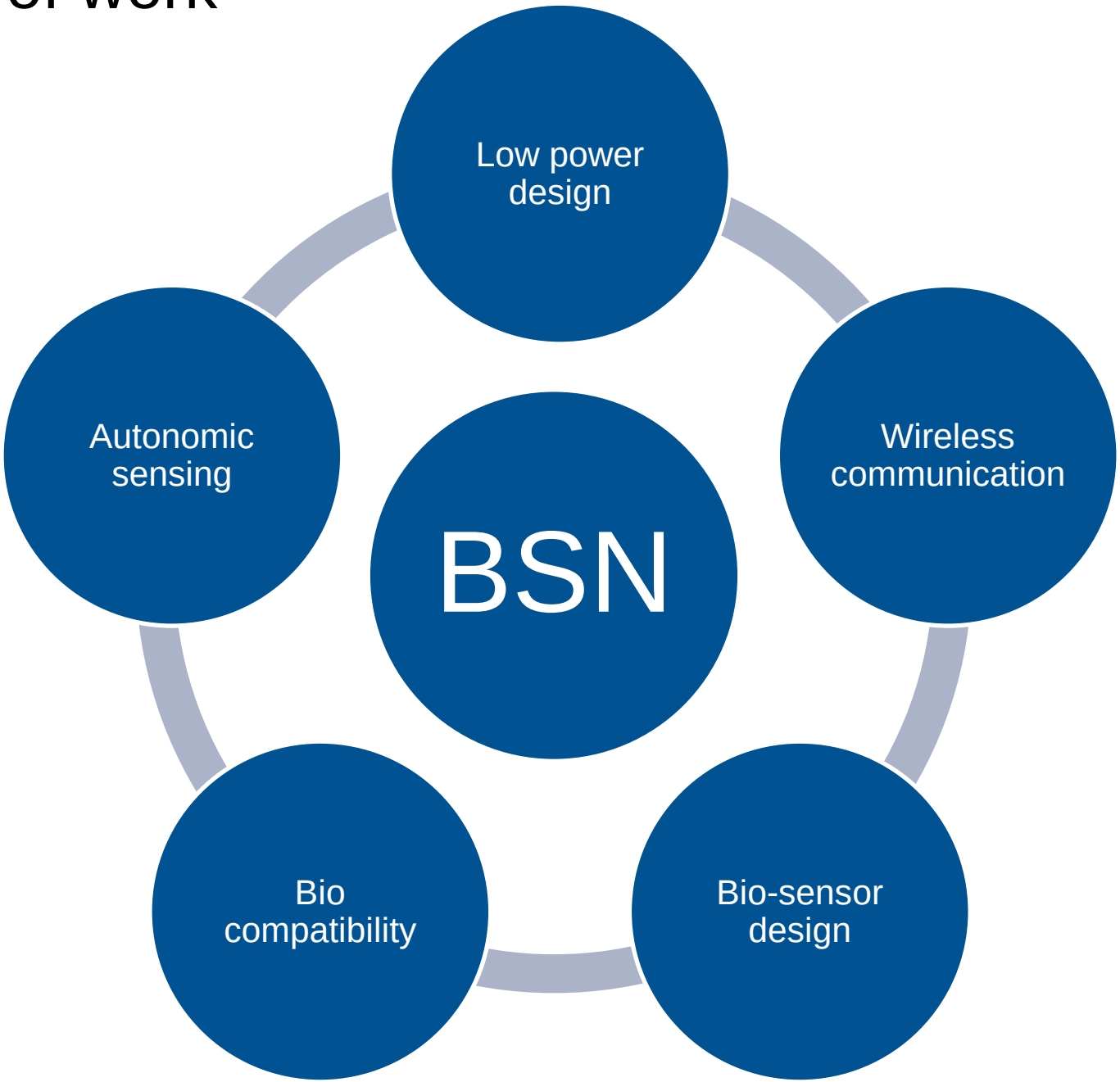


Tier - 1

Tier - 2

Tier - 3

Fields of work



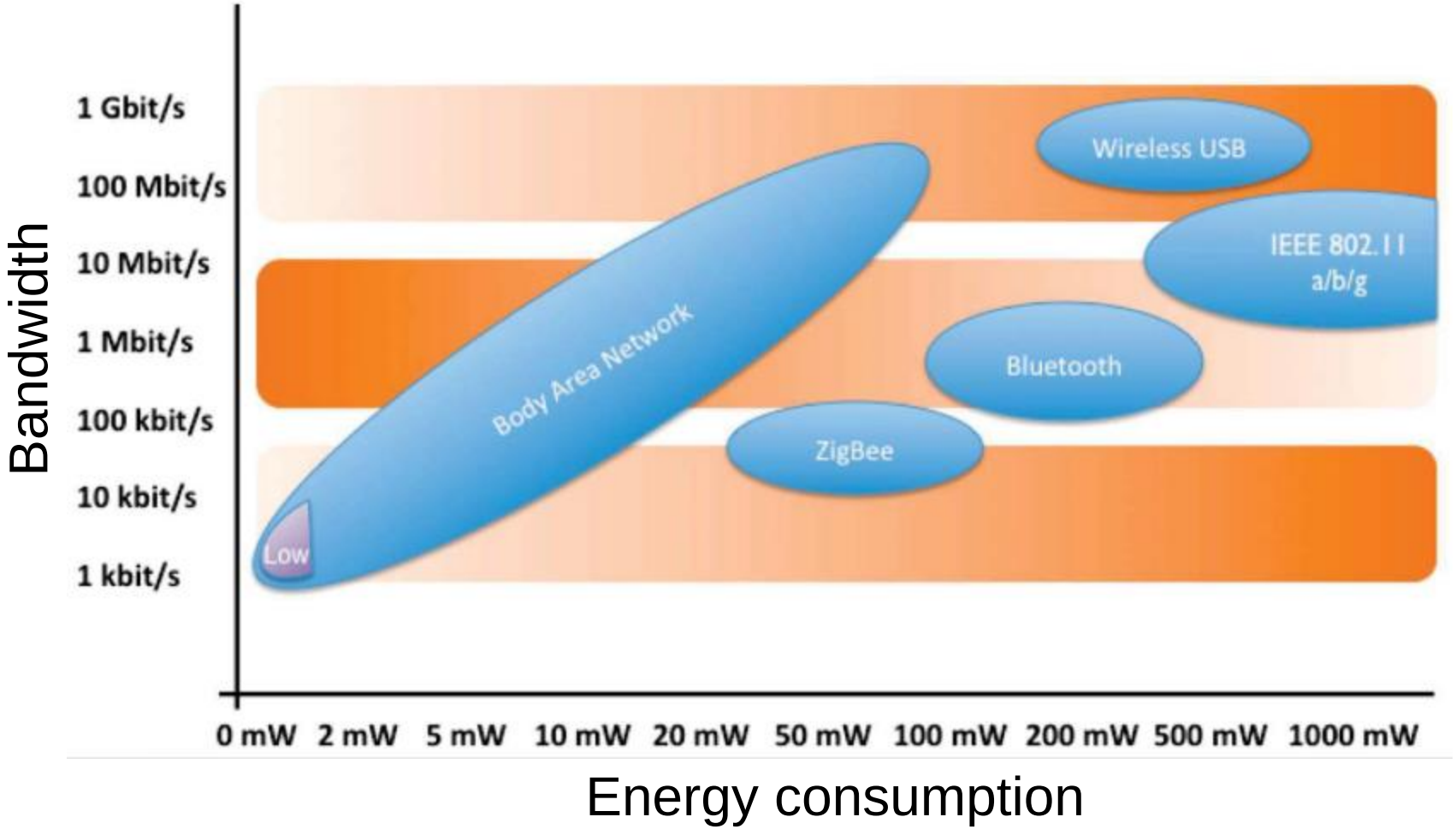
Wireless and Body Sensor Networks

WSN	BSN
Cover the environment	Cover the human body
Large number of nodes	Fewer sensor nodes
Multiple dedicated sensors	Single multitasking sensors
Lower accuracy	Robust & Accurate
Small size not limiting factor	Miniaturization
Resistant to weather,	Pervasive
Resistant to noise	Predictable environment
Resistant to asynchrony	Motion artefacts an issue
Early adverse event detection	Early adverse event detection
Failure reversible	Failure irreversible
Fixed structure	Variable structure

Wireless and Body Sensor Networks

WSN	BSN
Low level security	High security
Accessible power supply	Inaccessible power source
High power demand	Lower power availability
Solar,wind power	Thermal, piezoelectric energy
Replaceable/disposable	Biodegradeable
No biocompatibility needed	Biocompatible
Low context awareness	High context awareness
Wireless solutions available	Lower power wireless
Data loss less of an issue	Sensitive to data loss

Energy consumption vs. Datarate



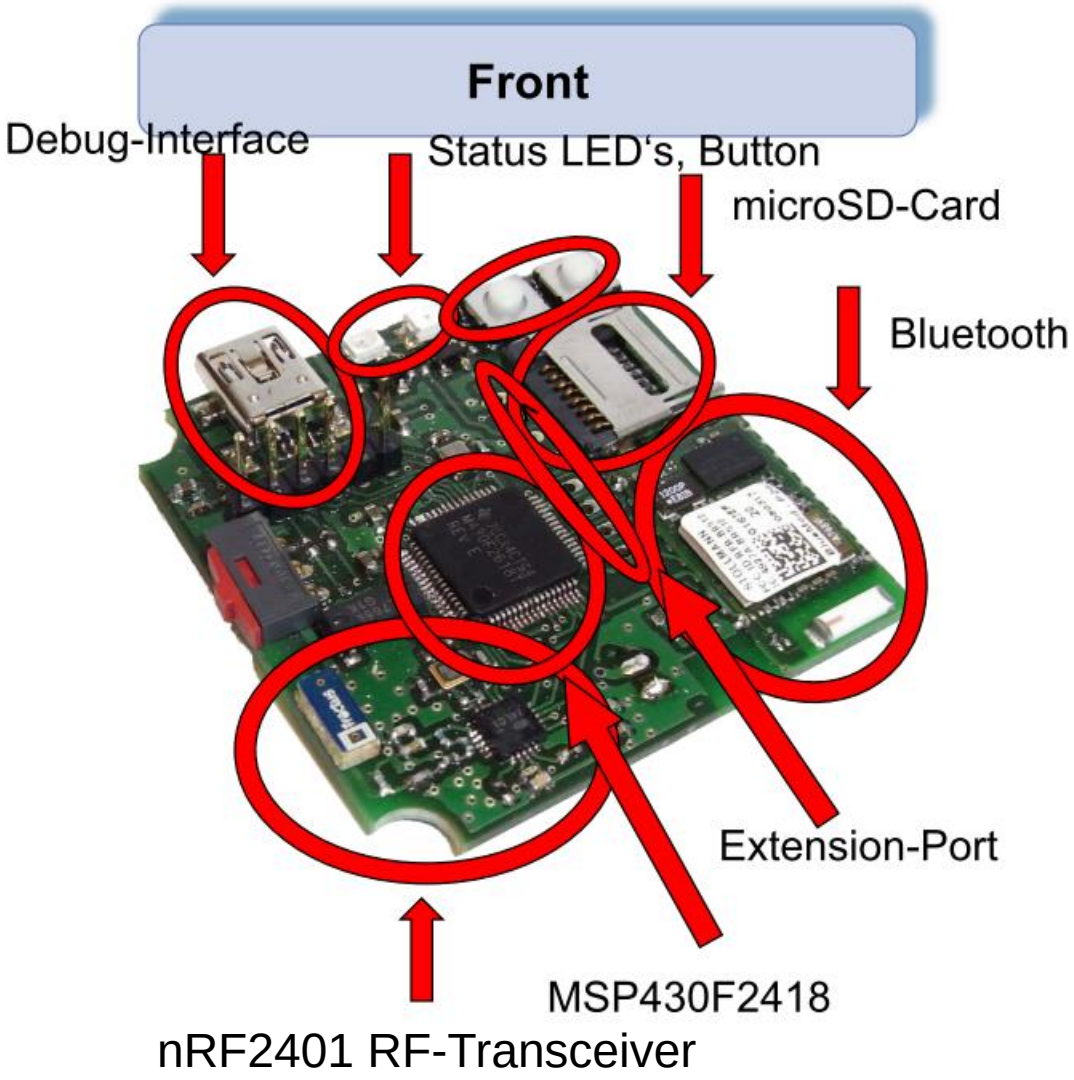
Challenges in Body Sensor Networks

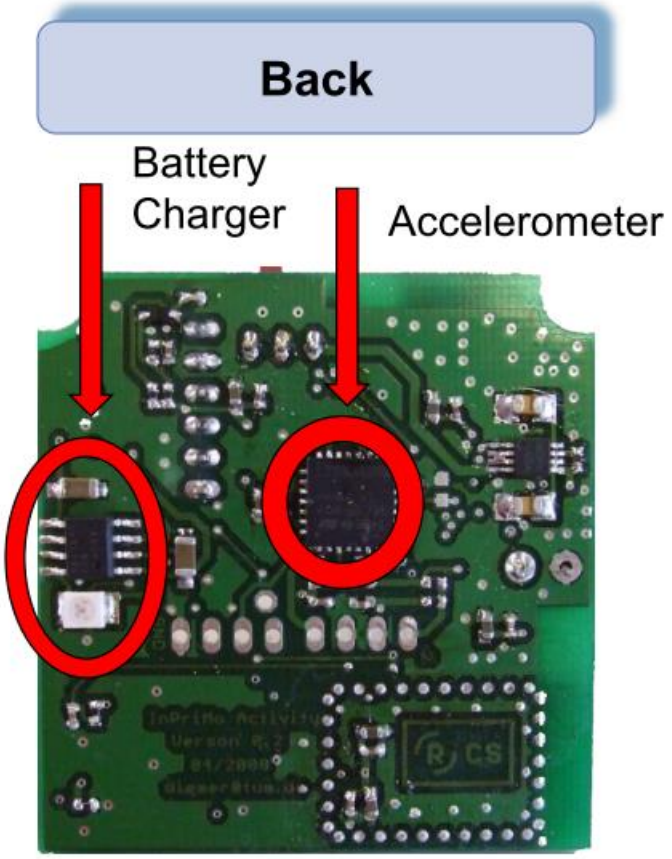
Parameter	Challenges
Power consumption	Ultra low-powered devices are required.
Idle listening time	Synchronization of all devices as per stimuli.
Packet collision and retransmission	During sudden outburst of stimuli, large volume of network traffic that requires smooth flow without collisions.
Bandwidth utilization	Bandwidth is limited due to the data handling capacity of BSNs. So effective use of bandwidth is critical.
Data storage	Challenging if the device size is also small. Distributed storage could be helpful.
Security	Operational resources are highly restricted. So high-level security protocols can lead to large overhead.
Synchronization	Final transmission to control room requires high-level of synchronization. Otherwise leads to delays, time lag and increased processing steps.
Prediction	Based on historical data certain algorithms for predicting health issues are required for its real success (heart attack).

Example sensors

- Breathing
- Pulse rate monitoring
- Body temperature detection
- EKG
- Blood oxygen (SpO_2)
- Blood pressure
- Blood glucose content
- Motion sensors and analysis
  - Pedometer
  - General movement of certain limbs
  - Accelerometer

RCS Sensor Node Hardware

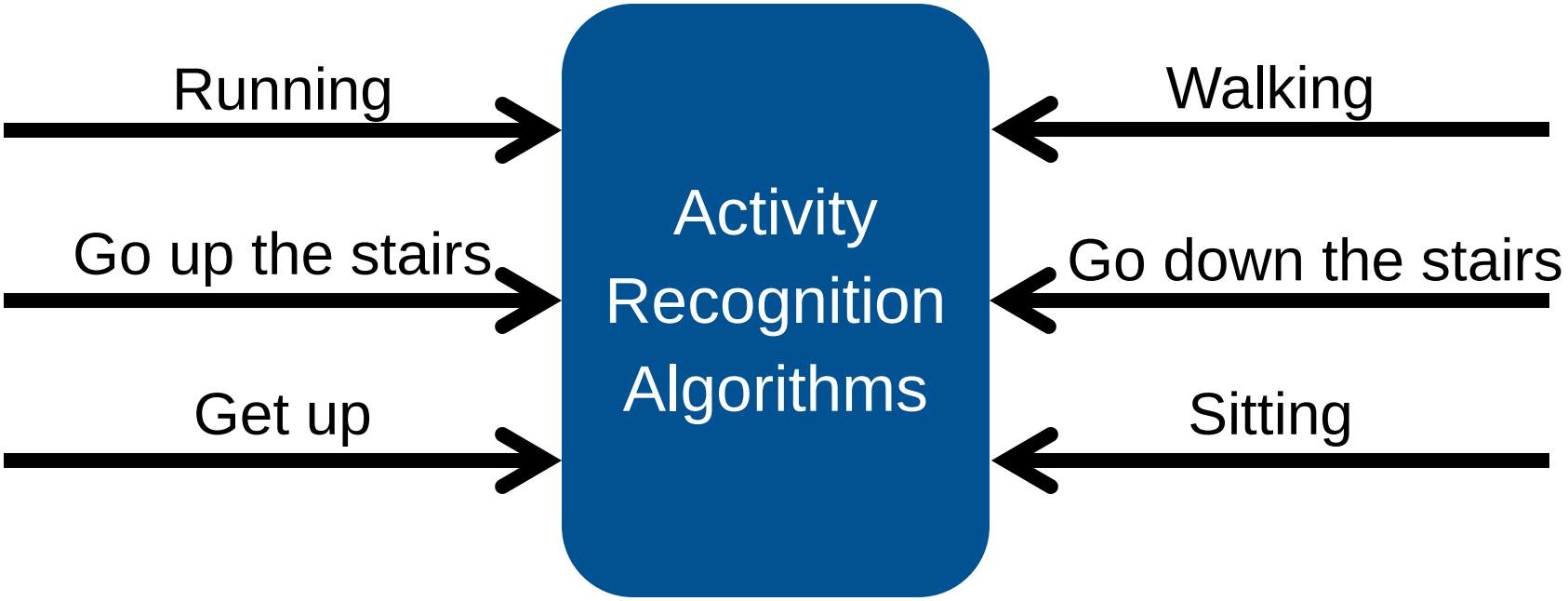




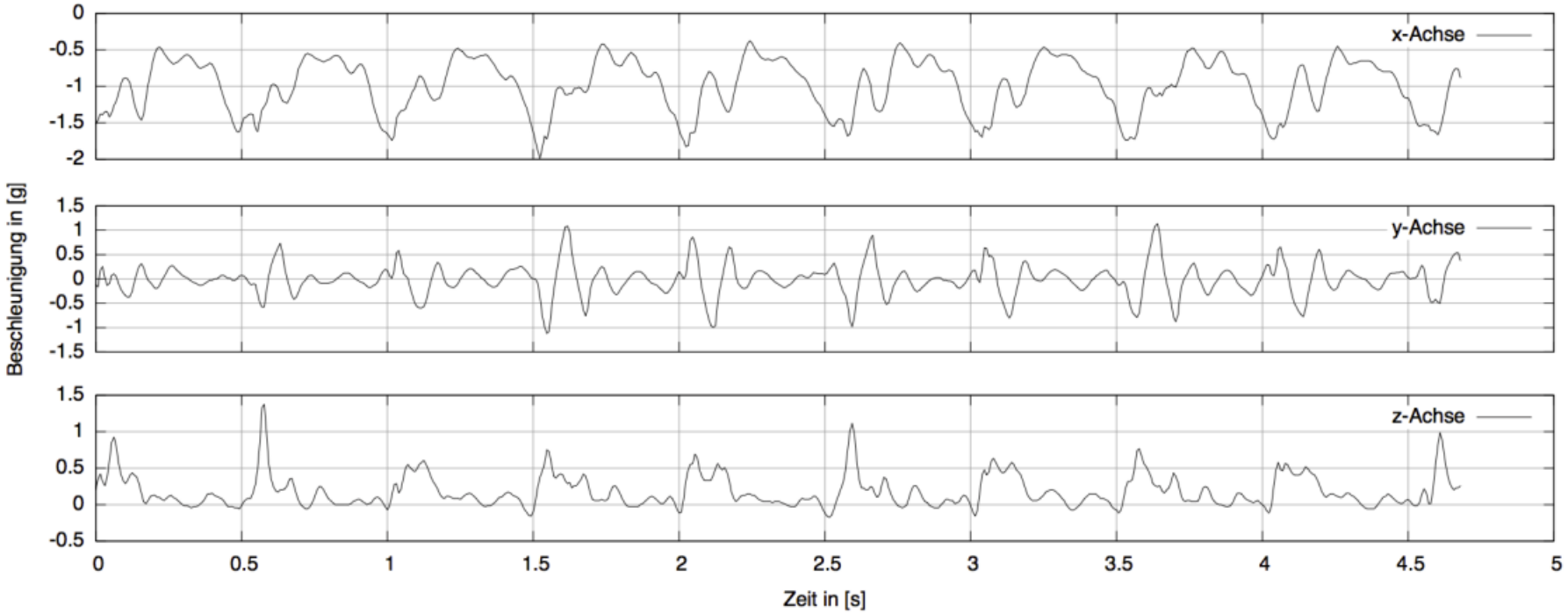
Technical Data

- Microcontroller
  - Texas Instruments: MSP430F2418
  - Ultra-low power consumption (0.5 µA – some mA)
  - Up to 16 MHz
  - 8 kBytes of RAM
  - 120 kBytes of Flash
- 3D – Accelerometer
  - ST – Microelectronics: LIS3LV02DQ
  - Range: -2g to +2g or -6g to +6g
  - Less than 0.8 mA @ 3.3 V in active mode, less than 10 µA in power-down mode
- RF Technology
  - Bluetooth module include Health Device Profile (HDP)
  - nRF24L01 (Nordic Semiconductors)

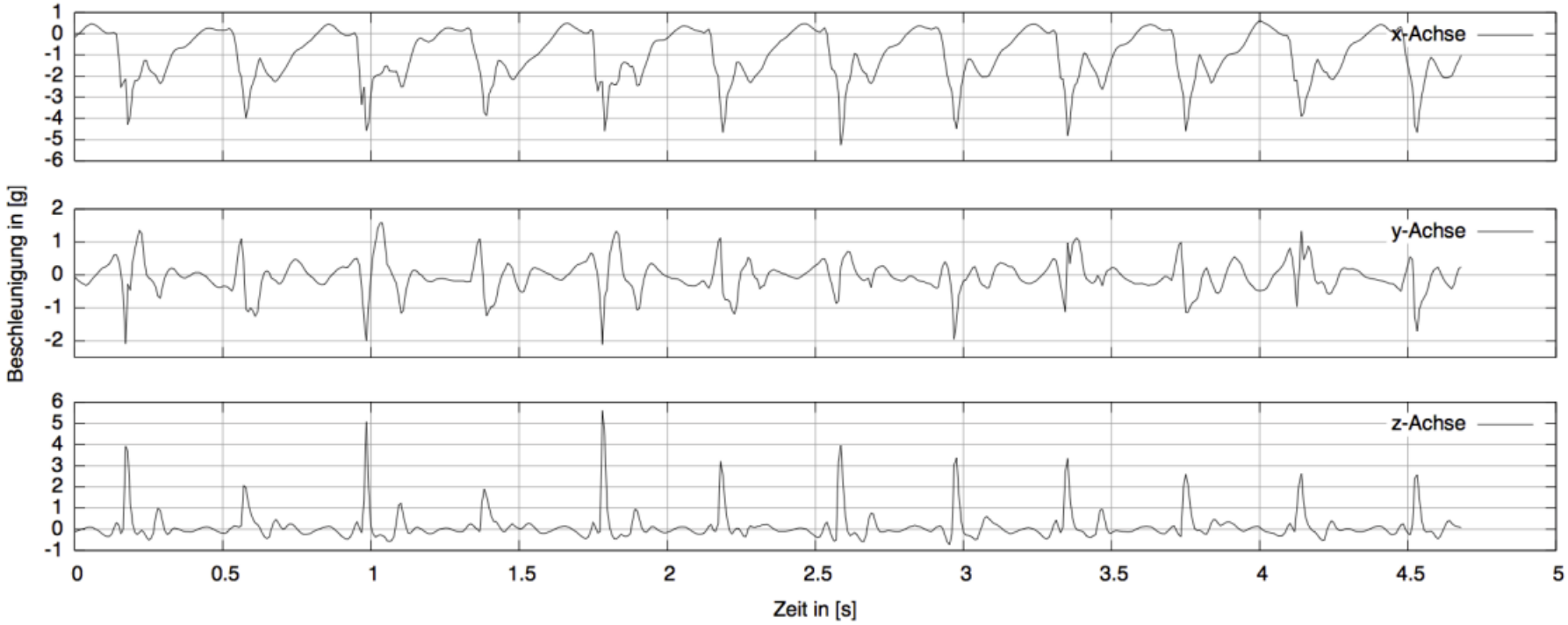
Activities


Running
Go up the stairs
Get up
Activity Recognition Algorithms
Walking
Go down the stairs
Sitting

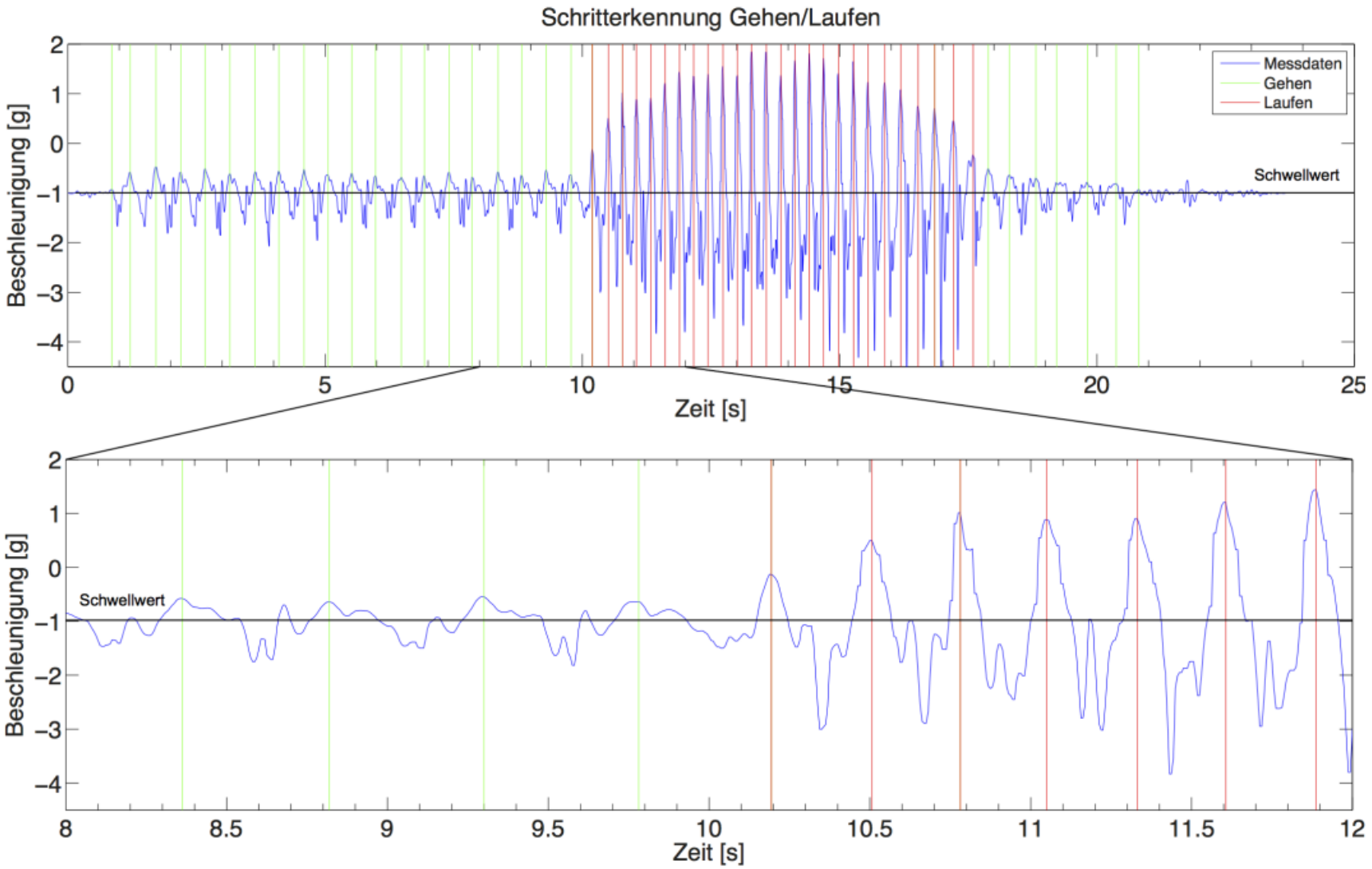
Acceleration data “Walking“



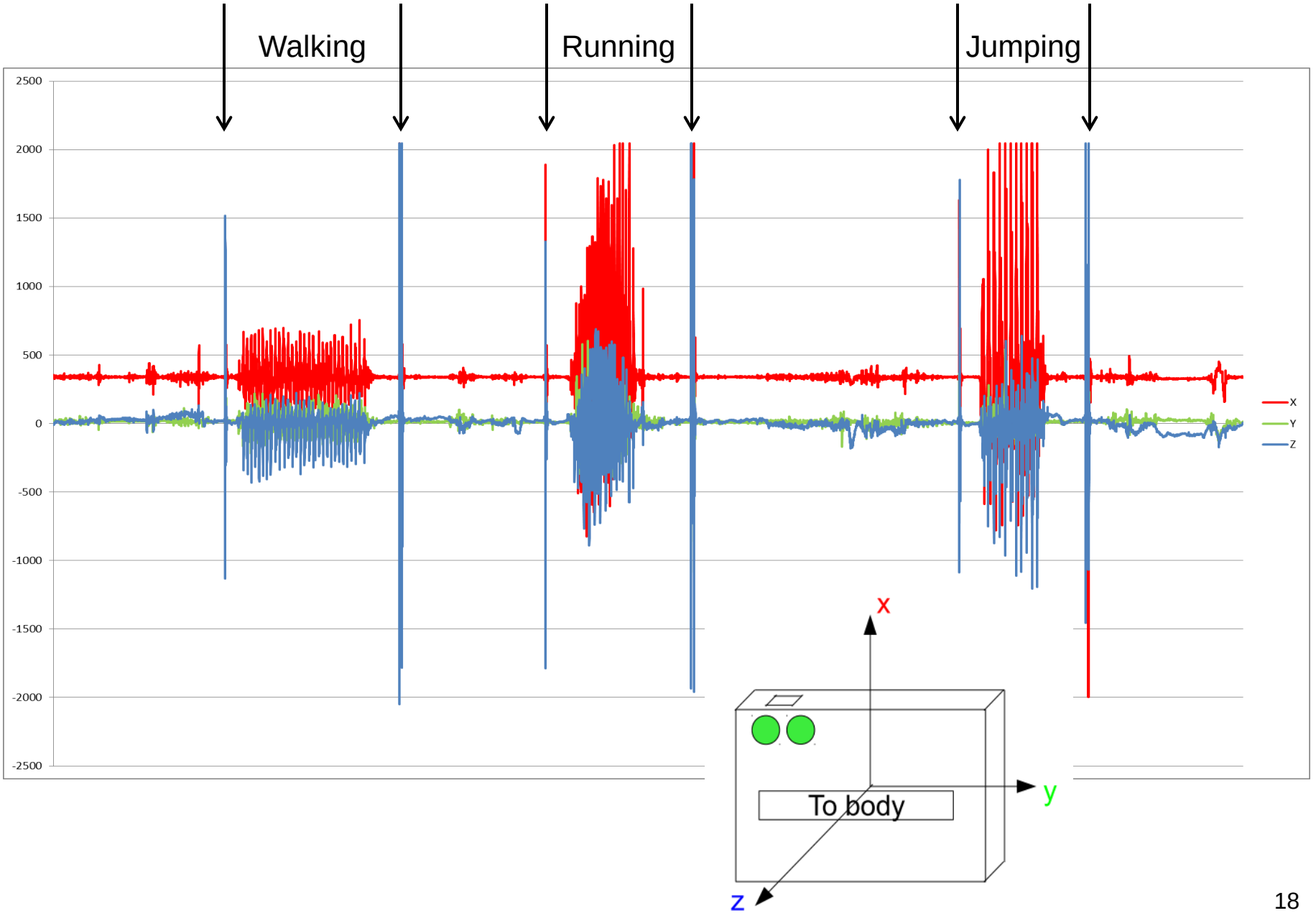
Acceleration data “Running“



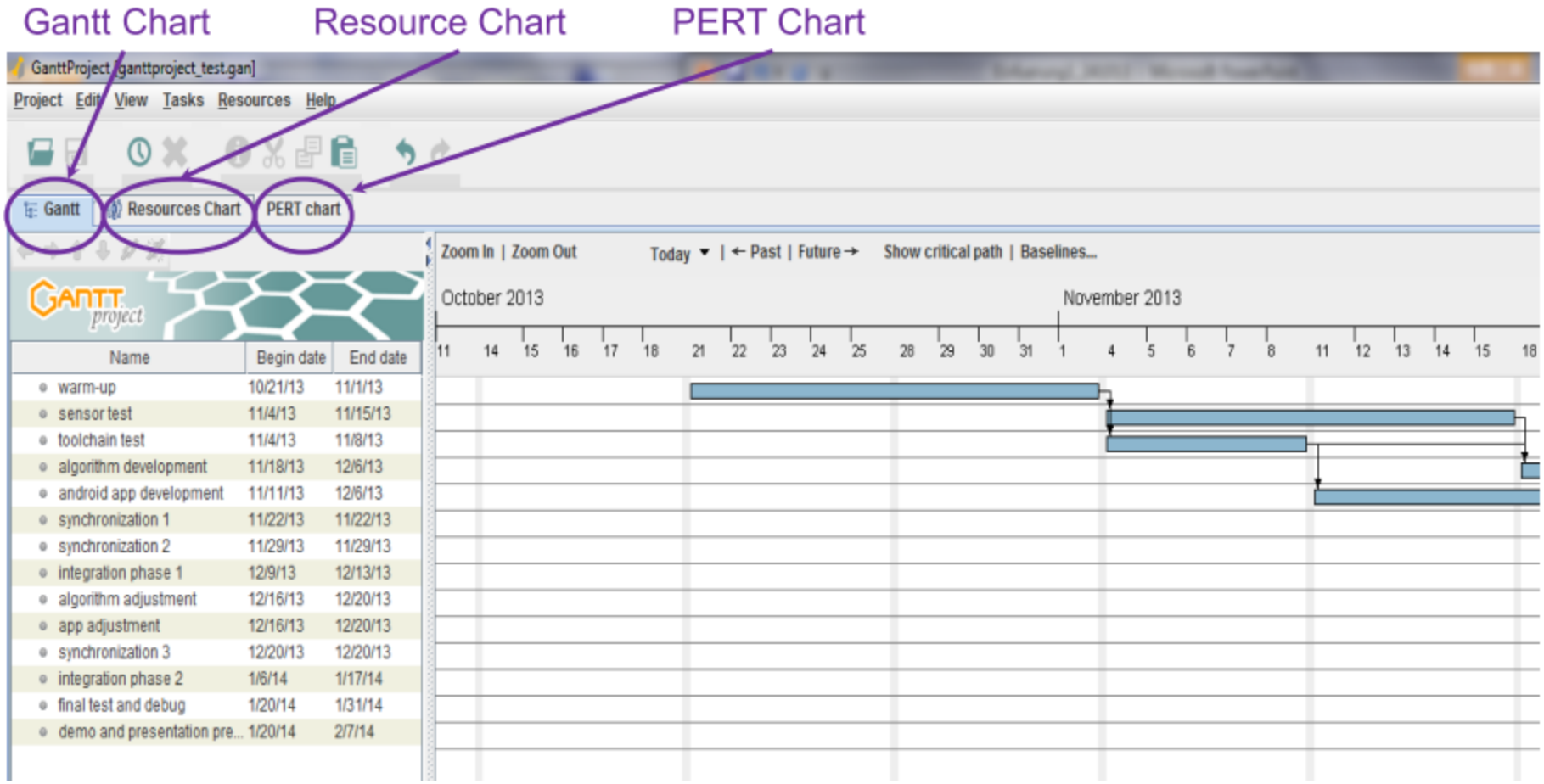
Activity detection



Activity detection example

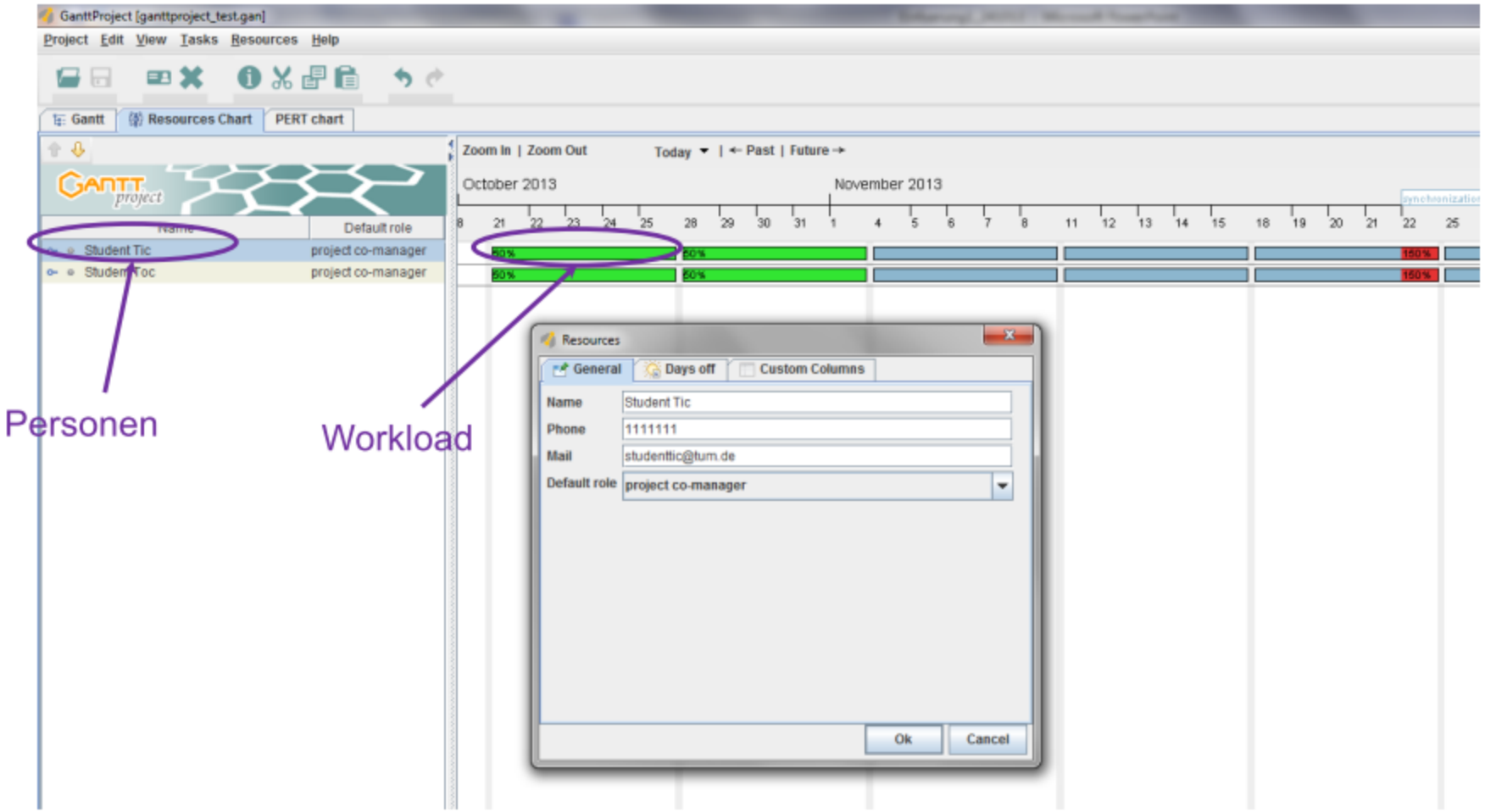


Gantt Project - Overview



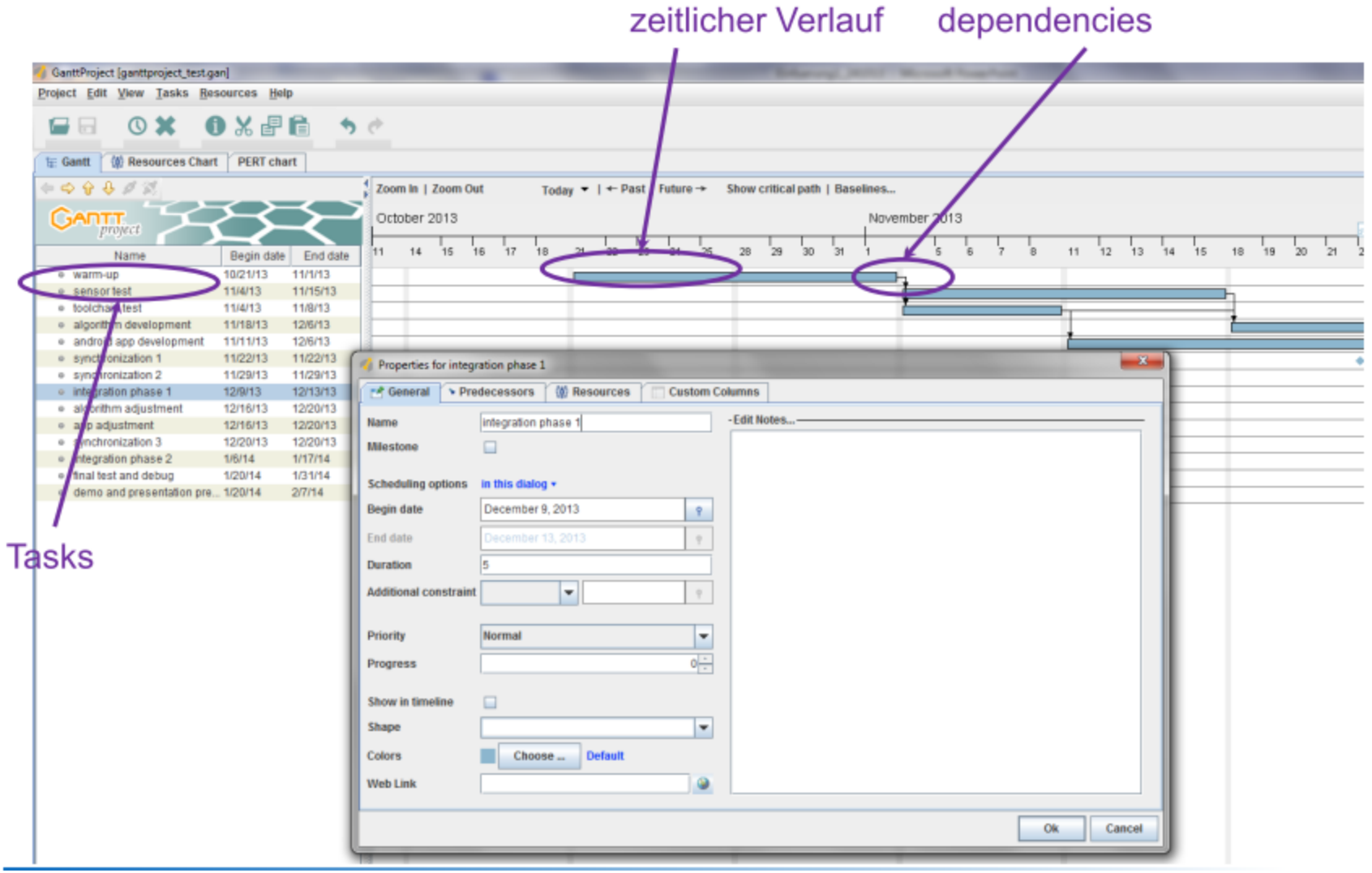
Gantt Project – Resource chart

- Resource - Person



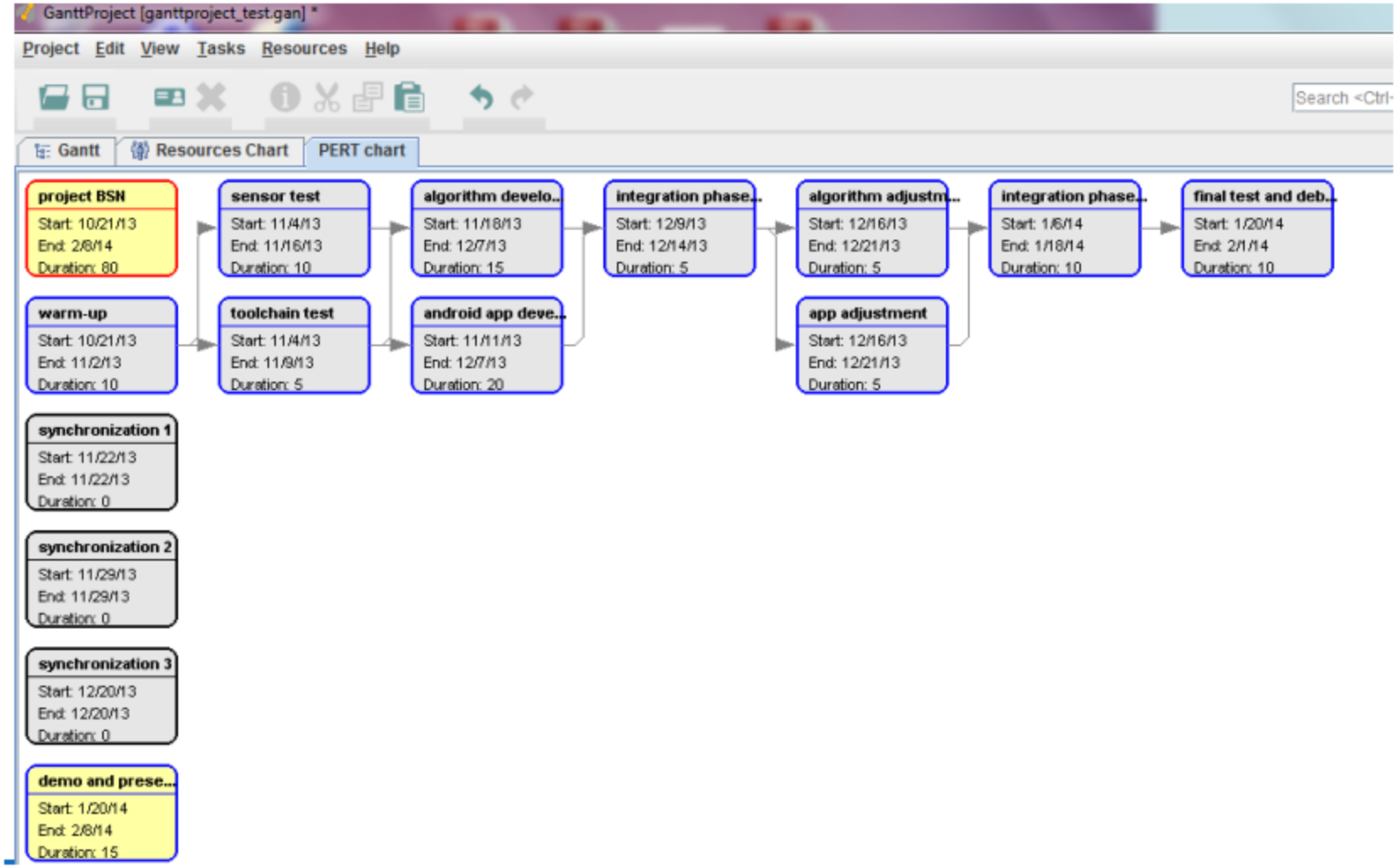
Gantt Project – Gantt chart

- Gantt chart - Tasks



Gantt Project – PERT chart

- PERT Chart – Task flow and dependencies



Gantt Project Links

- Ganttprojkt: http://www.ganttproject.biz
- Tutorial:

https://www.youtube.com/watch?v=5rHCSa5ad34&feature=youtu.be