UPPSALA UNIVERSITET

WCNES Projects

Course Overview (Period 2)

Distributed Embedded Systems

intro | TinyOS | Contiki

macro | time

lab

lab

lab

Wireless Communication

radio | short range

errors | energy

simulation

lab

Networking

localization | iot

video pres. | opposition

(lab)

exam

Goals

- Apply the knowledge learned in the first part of the course and make informed decisions to build/measure in a practical context.
- Produce a poster abstract/short paper that could be sent to a scientific conference (e.g., ACM SenSys or ACM MobiSys)
- Be creative and have fun.

The Challenge

20 sticks of spaghetti +

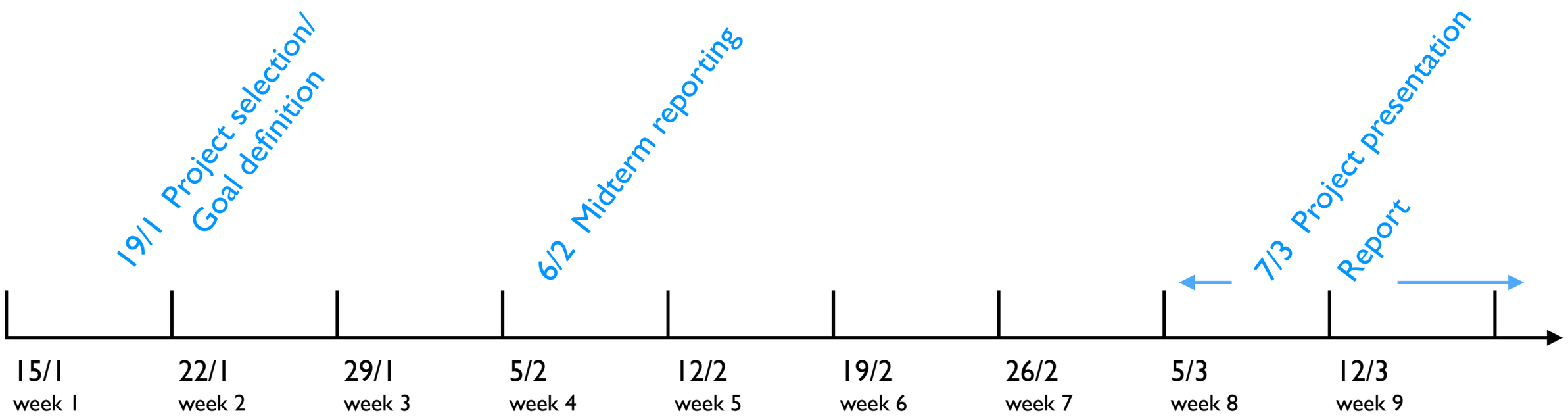
one yard tape +

one yard string +

one marshmallow

source: marshmallowchallenge.com

Timeplan

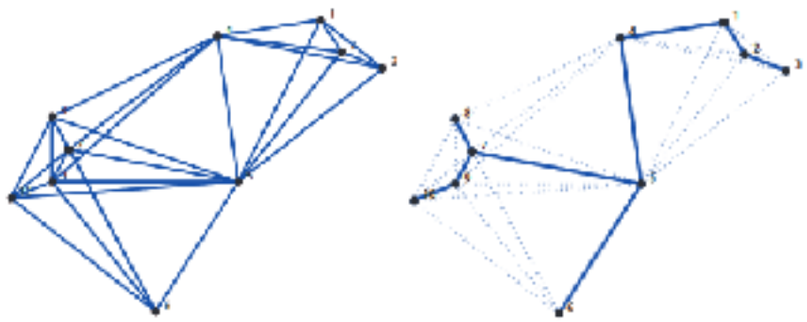


Goals

defined by you and the advisor

Topology Control for Massage Passing in Mobile Sensor Networks

Topology control plays an important role in information processing with distributed sensor networks. An important category of methods is based on finding the minimum spanning tree (MST) of the network.



Project Goal:

- Design and implement a distributed and dynamic MST algorithm for topology control in mobile sensor networks;
- Study the performance of the algorithm in terms of both efficiency (amount of time and messages to form a MST) and robustness (remain connected in case of nodes/link failure).

1. R. G. Gallager, P. A. Humblet, and P. M. Spira. 1983. A Distributed Algorithm for Minimum-Weight Spanning Trees. *ACM Trans. Program. Lang. Syst.* 5, 1 (January 1983), 66-77. DOI=http://dx.doi.org/10.1145/357195.357200
2. MIT Open Course: Distributed Algorithms, MST https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-852j-distributed-algorithms-fall-2009/lecture-notes/
3. Li, Xiaopeng, Hui Gao, Hong Cai, and Tiejun Lv. "Nonparametric belief propagation based cooperative localization: A minimum spanning tree approach." In *Wireless Communications and Networking Conference (WCNC), 2015 IEEE*, pp. 1775-1780. IEEE, 2015.

Energy Harvesting

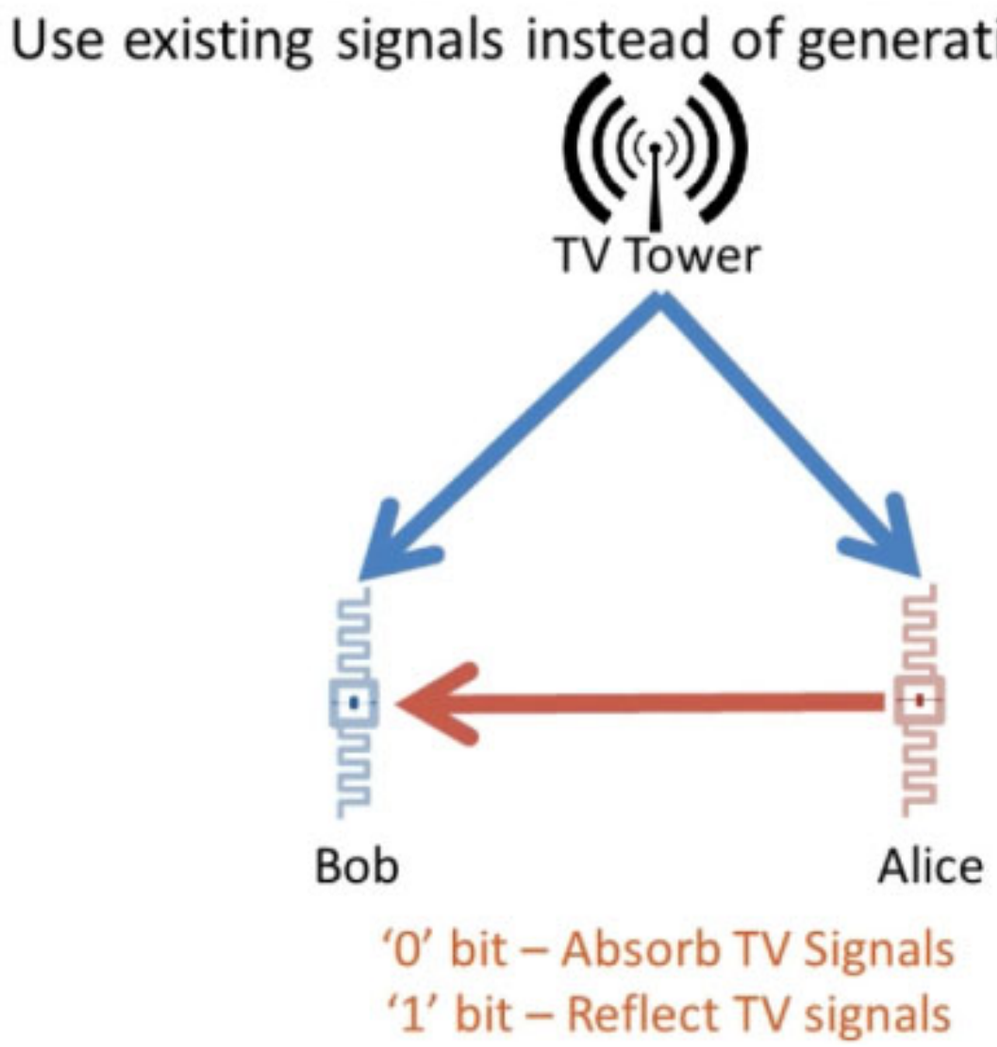
Use vibrations, radio signals or light to harvest energy to measure vibrations on Lidingöbro.

Project Goal:

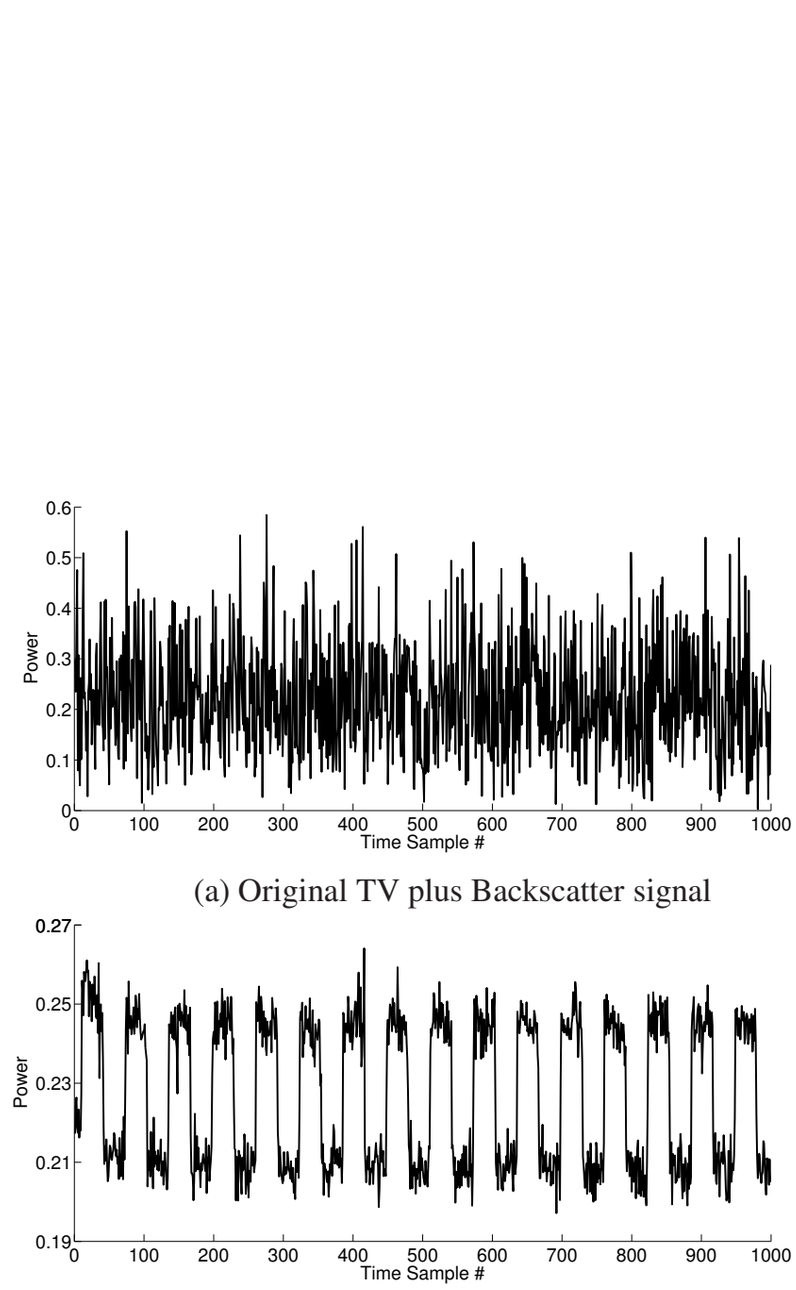
- compare different harvesting methods
- system design (wakeup, communication, etc.)

Backscatter

With backscatter communication, we reach up to 3.5km with only 70μA!

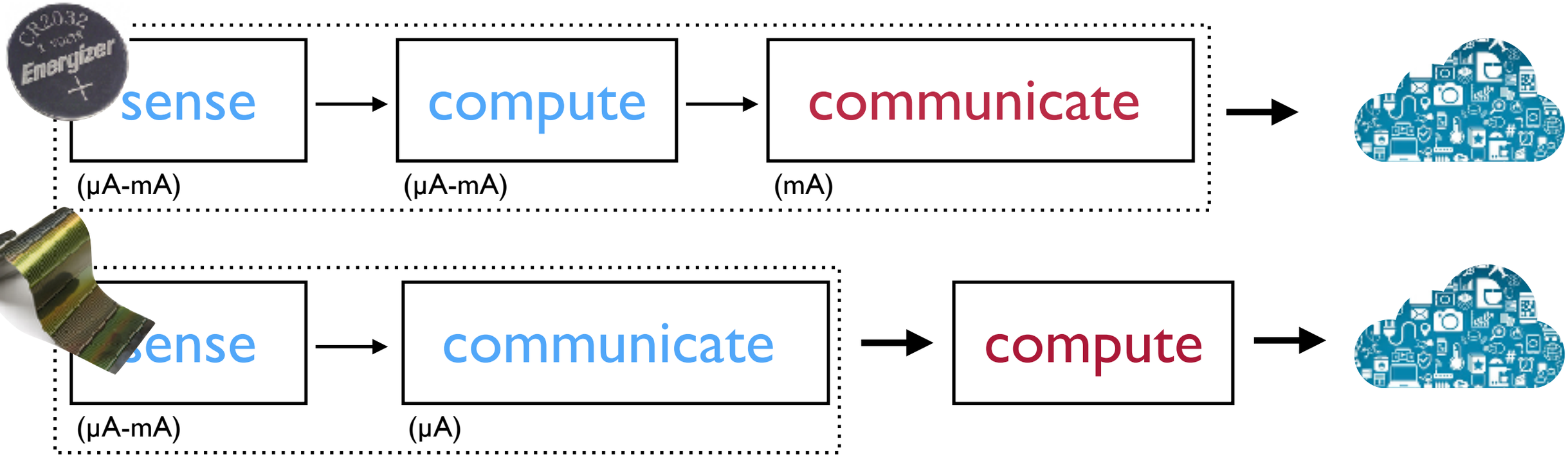


(a) Original TV plus Backscatter signal



(b) Signal After Averaging

Energy Harvesting aware Fog Device

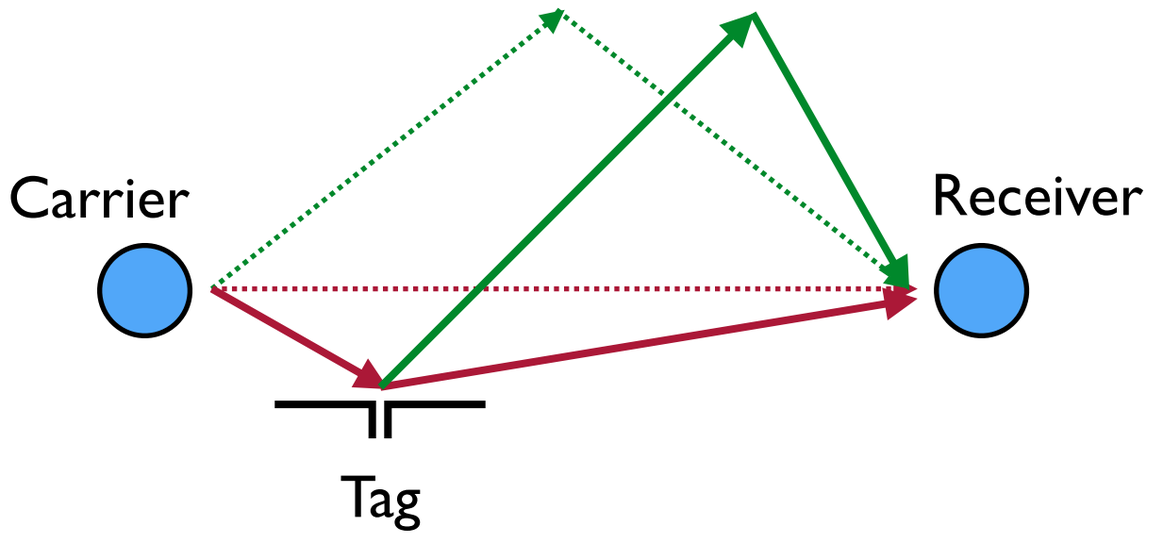


Backscatter communication enables to work on harvested energy. When communication is taking less energy than computation, it is attractive to off-load computation to the Fog/Cloud.

Goal:

- collect information about energy stored in devices (→sensing capability)
- infer average sensing period
- data analytics on the Fog device (e.g., machine learning)

Fading in Backscatter



Dual-fading problem:
Backscatter is much more sensitive to multi-path than conventional radio.

Goal:

- study multiple antennas at the carrier, tag and/or receiver
- find modulation to mitigate fading

MAC for Backscatter

Backscatter tags cannot yet receive data.
But they can detect energy, and backscattered signals add up (mixing process).

Goal: Investigate a MAC protocol for long-range backscatter.

- carrier sense?
- token from carrier generator?
- cdma?
- channel hopping
- LPWB (contention, schedule)

Bluetooth 5 Backscatter

Bluetooth 5 is designed for the IoT and smart cities.

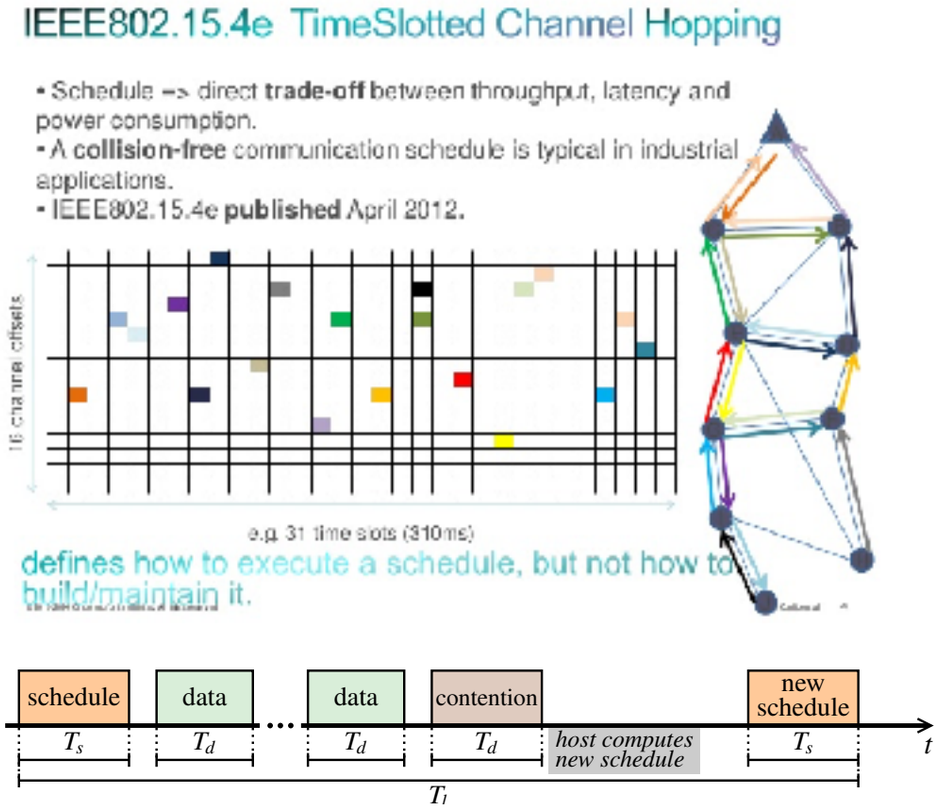
- long range

Goal:

- implement Bluetooth 5 modulation on a backscatter node
- perform measurements and compare with Bluetooth 5 transmitter

Adaptive Scheduling

… for timeliness sensitive applications



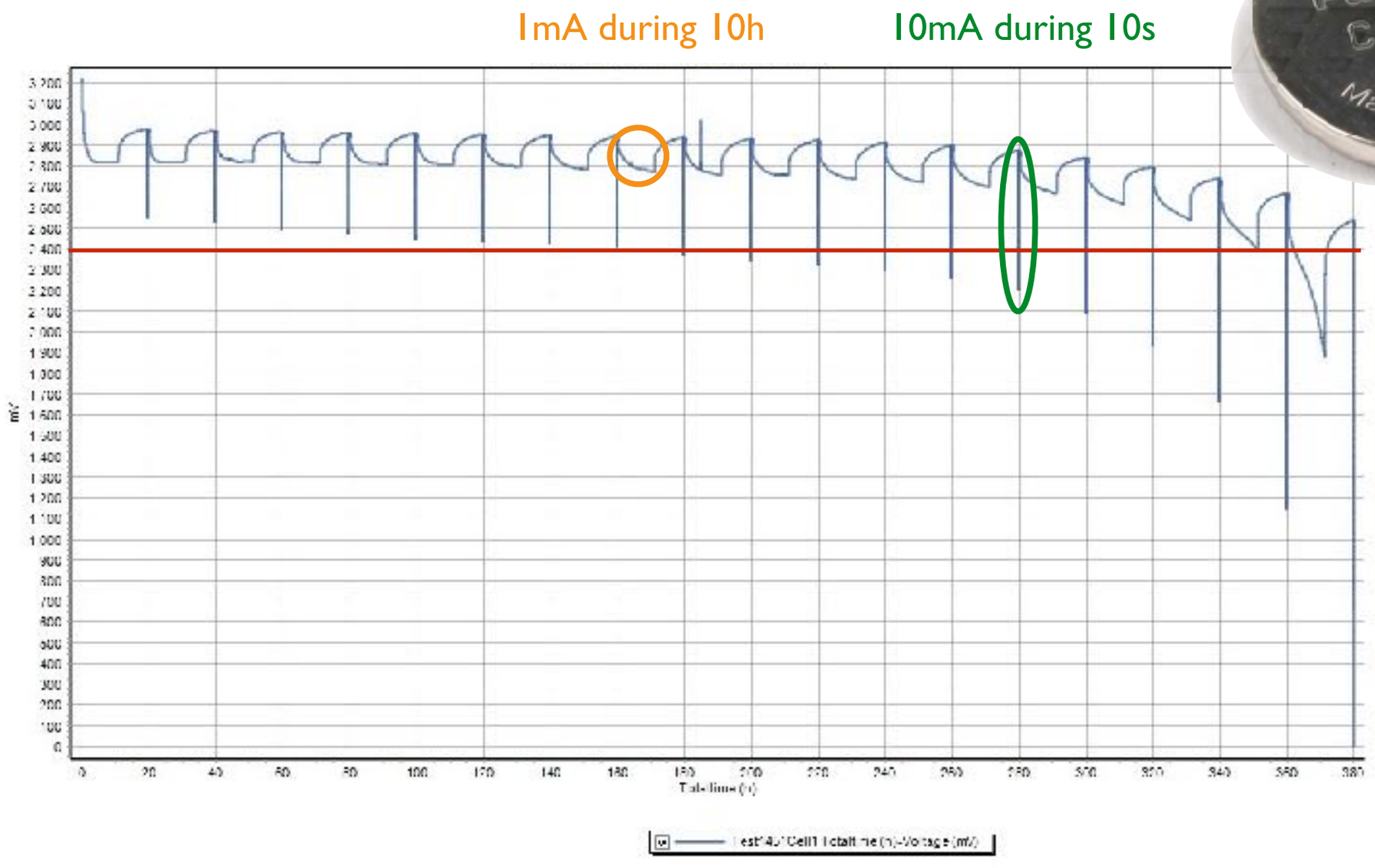
Problem: Coexistence of multiple sensors

Goal: MAC protocol that avoid interference and schedules nodes according to real-time requirements.

Optional: Augmented Reality demo

Low Battery Communication

Study battery behavior with WSN typical loads and improve simulation model.



Combined Projects?

The wireless communication and networked embedded systems aspect needs to be substantial (worth 5 credits or 12h per week per person)

Examples:

- implement a modulation
- do measurements in challenging conditions
- sense data and reliably transfer and analyze them

Not enough:

- connect a bluetooth/3G/WiFi module to solve the communication

Read background articles to explore different approaches and not re-inventing the wheel again.

You Define Your Goals!

S M A R T

WHO, WHAT, WHERE, WHEN, WHY, WHICH	FROM and TO	HOW	WORTHWHILE	WHEN
tell a team exactly what's expected, why it's important, who's involved, where it's going to happen and which attributes are important	help a team stay on track	neither out of reach nor below standard performance	relevant goals (when met) drive the team	helps a team focus their efforts

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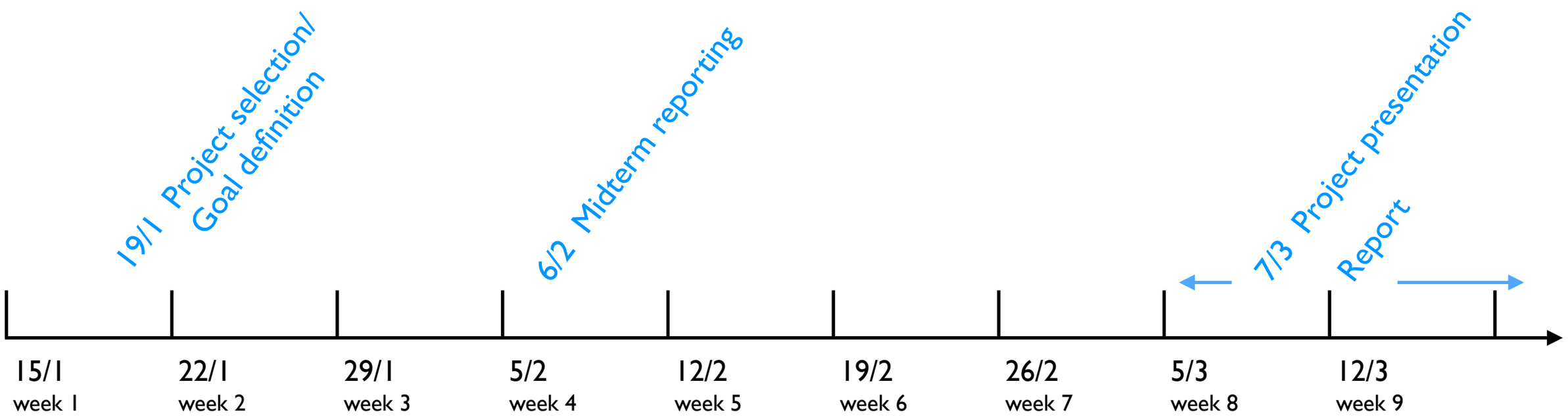


Goals

defined by you and the advisor

Marshmallow Challenge

- **Prototyping Matters**:
  The reason kids do better than business school students is kids spend more time playing and prototyping. They naturally start with the marshmallow and stick in the sticks. The Business School students spend a vast amount of time planning, then executing on the plan, with almost no time to fix the design once they put the marshmallow on top.

- **The Marshmallow is a Metaphor for the Hidden Assumptions of a Project**:
  The assumption in the Marshmallow Challenge is that marshmallows are light and fluffy and easily supported by the spaghetti sticks. When you actually try to build the structure, the marshmallows don't seem so light. The lesson in the marshmallow challenge is that we need to identify the assumptions in our project - the real customer needs, the cost of the product, the duration of the service - and test them early and often. That's the mechanism that leads to effective innovation.

Grading Criteria

The project assignments are graded on the project organization/process, the demo presentation and the deliverable report.

Suggestions for the grading factors:

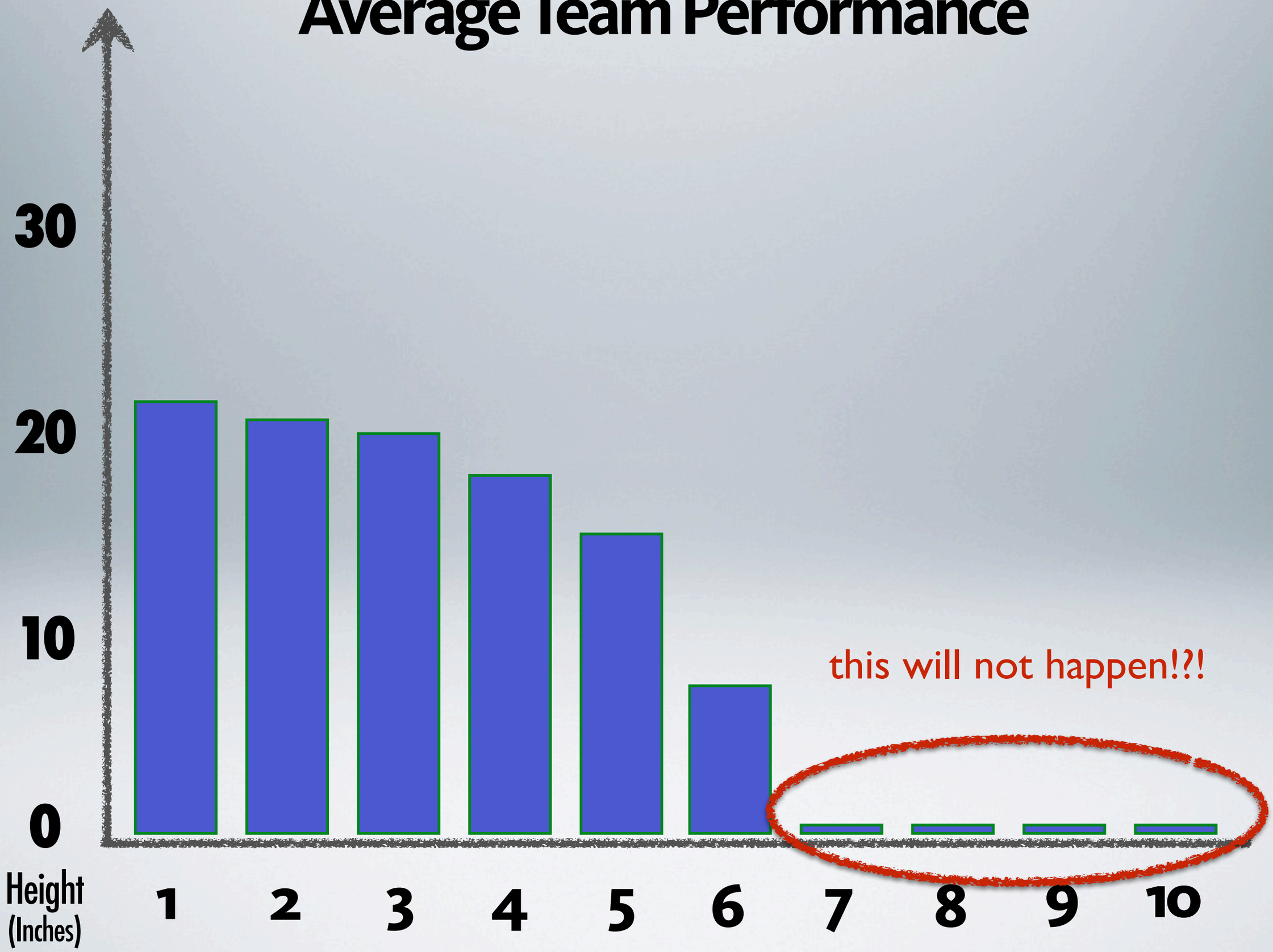
1. How well the goal is achieved.
2. How well goals are adapted to problems and new findings.
3. Ability to explore beyond expectations.
4. Organization and engagement of all team members.
5. Demonstration quality.
6. Quality of the report.

Group

Groups of 3-5 students

Formally, you will be given individual grades.
However, the grading criteria cover to a large extent how the group performs. In the normal case the same grade is given to all group members but in motivated cases individuals may get both lower and higher grades than the group grade. A lower grade for an individual is typically given when that individual is contributing considerably less to the group effort.

Average Team Performance



Project Room

You have a room where you can work and leave your equipment:

Room ITC/4404 (house 4 at Polacksbacken)
Code: 2319