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EWSN 2017 Dependability Competition

Logistics Information

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16.02.2017

Competition Venue and Schedule

Venue

- Competition and main conference are not in the same location!
  - Main conference in Norrlands nation (Västra Ågatan 14)
  - Dependability competition is in Uppsala University, Polacksbacken Campus (Lägerhyddsvägen 2)

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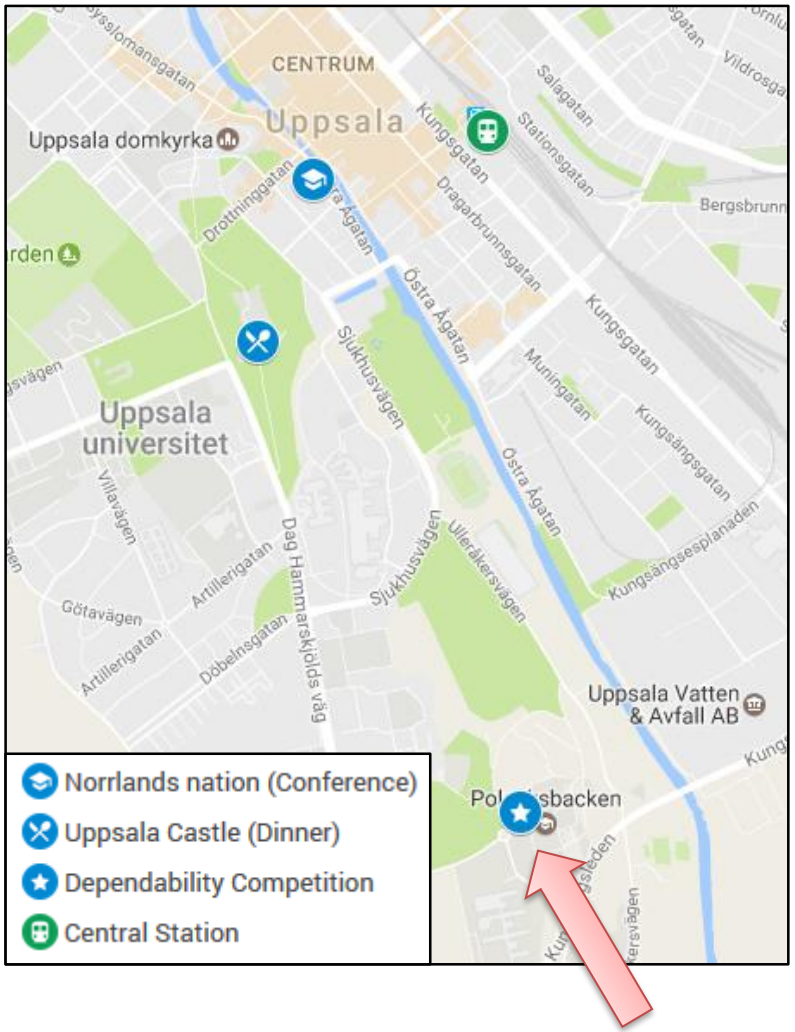
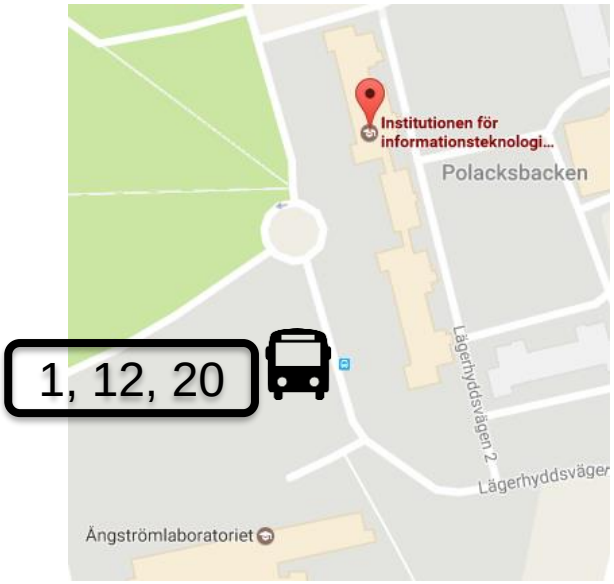


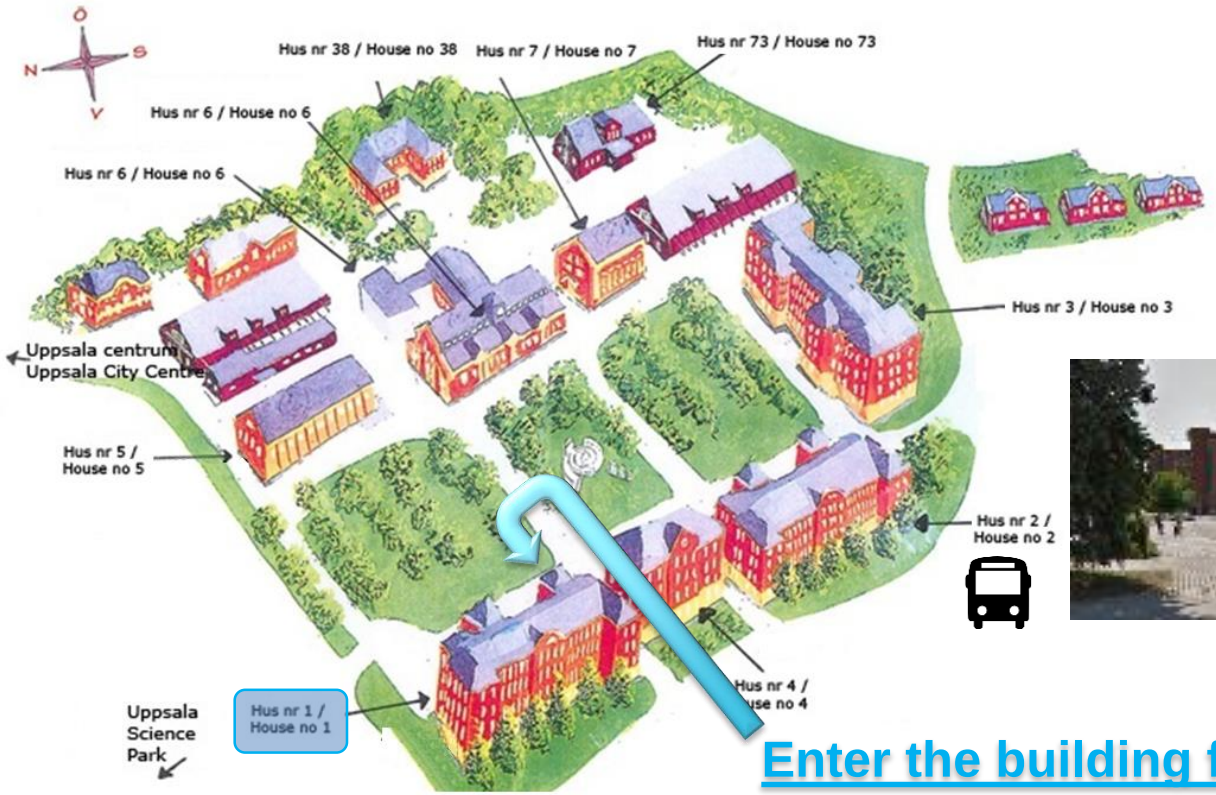
Venue

- Polacksbacken campus (Lägerhyddsvägen 2)
  - Closest bus stop is "`Polacksbacken`"
  - Buses 1, 12, 20 travel to/from the main train station
  - You can find more information on: https://www.ul.se/en/
  - Competition will take place in **hus 1** (building number 1)



Venue

- Polacksbacken campus (Lägerhyddsvägen 2)
  - Registration and competition in the 3rd floor, inside the laboratory room (datasal) 1312 and 1313



Enter the building from this door on the back!

This door will be open from 7:30 AM to 11:30 AM on Saturday. During registration, you will receive a key to enter/exit the building. If you are lost or arrive later, call: +4368181686760

Schedule

- Saturday, 18.02.2017 – Preparation Day
  - 08:00 - 08:30
    Registration
  - 08:30 - 09:00
    Welcome and overview of rules and evaluation procedure
  - 09:00 - 20:00
    Preparation and testing

→ Cold sandwiches, fruit, coffee, and biscuits will be available throughout the day

Schedule

- Sunday, 19.02.2017 – Evaluation Day
  - 08:30 - 09:30
    Team #1: RedFixHop with Channel Hopping
  - 09:30 - 10:30
    Team #3: Using OFPCOIN under Interference
  - 10:30 - 11:30
    Team #4: Towards Low-Power Wireless Networking that Survives Interference with Minimal Latency
  - 11:30 - 12:30
    Team #5: Robust Flooding using Back-to-Back Synchronous Transmissions with Channel-Hopping
  - 12:30 - 13:30
    Team #6: Tackling Cross-technology Interference using Spatial and Channel Diversity for Robust Data Collection

Schedule

- Sunday, 19.02.2017 – Evaluation Day
  - 13:30 - 14:30
    Team #7: Adaptive Time-Slotted Channel Hopping
  - 14:30 - 15:30
    Team #8: Dynamic Alternative Path Selection in Wireless Sensor Networks
  - 15:30 - 16:30
    Team #9: Synchronous Transmissions based Flooding for Dependable Internet of Things
  - 16:30 - 17:30
    Team #10: Energy-Efficient Network Flooding with Channel-Hopping
  - 17:30 - 18:30
    Team #11: Controlled Replication for Higher Reliability and Predictability in Industrial IoT Networks

Schedule

- Tuesday, 21.02.2017 – Awards

During main conference in Norrlands nation (Västra Ågatan 14)

- …
  12:00 - 13:00
  Lunch
- 13:00 - 13:25
  Announcement of results and awards ceremony
- 13:25 - 13:50
  Presentations of the three best teams
  (7 min each)
- 13:50 - 14:40
  Session II – “N stands for networks”
  …

→ Prepare in advance a set of slides to be presented!

Registration

- Will take place on Saturday 8:00 – 8:30
  - 3rd floor, laboratory room (datasal) 1312 and 1313
- Each registered contestant will receive:
  - A name tag with a card to enter/exit the building (the code to enter the lab rooms is `1819`)
  - A personal Wi-Fi password for the `UpUnet-S` network (please note that `Eduroam` also works in the building)
  - A USB stick with a copy of all EWSN 2017 proceedings

→ The card to enter/exit the building has to be returned on Sunday after the evaluation phase!

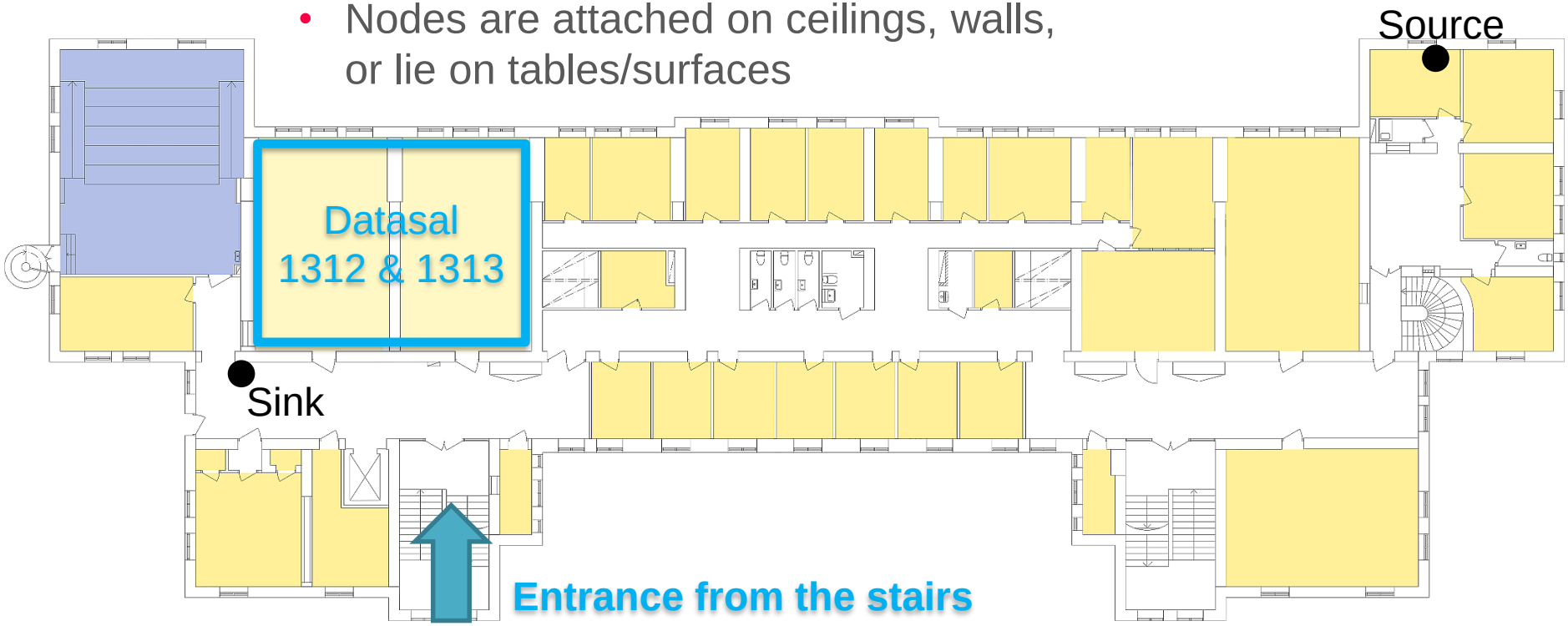
Registration

- All registered participants to the EWSN competition have also access to the complete conference program
  - Workshops, main conference program, posters & demos
  - Reception, conference dinner, and lunch on Mon/Tue/Wed
  - During the competition's preparation day (Saturday), cold wraps, salads, fruit, coffee and biscuits will be served to all participants (dinner is not provided)
  - During the competition's evaluation day (Sunday), fruit, coffee and biscuits will be served to all participants (lunch and dinner are not provided)
- All members of a team that want to actively participate to the competition must be registered in advance!

Evaluation Area and Scenario

Evaluation Area

- 3rd floor of Lägerhyddsvägen 2, Hus 1
  - Old military building, very thick walls
  - Covers an area of approx. 350-400 m^2
  - Dozens of nodes deployed in this area, including one generating events (source) and one collecting data (sink)
  - Nodes are attached on ceilings, walls, or lie on tables/surfaces

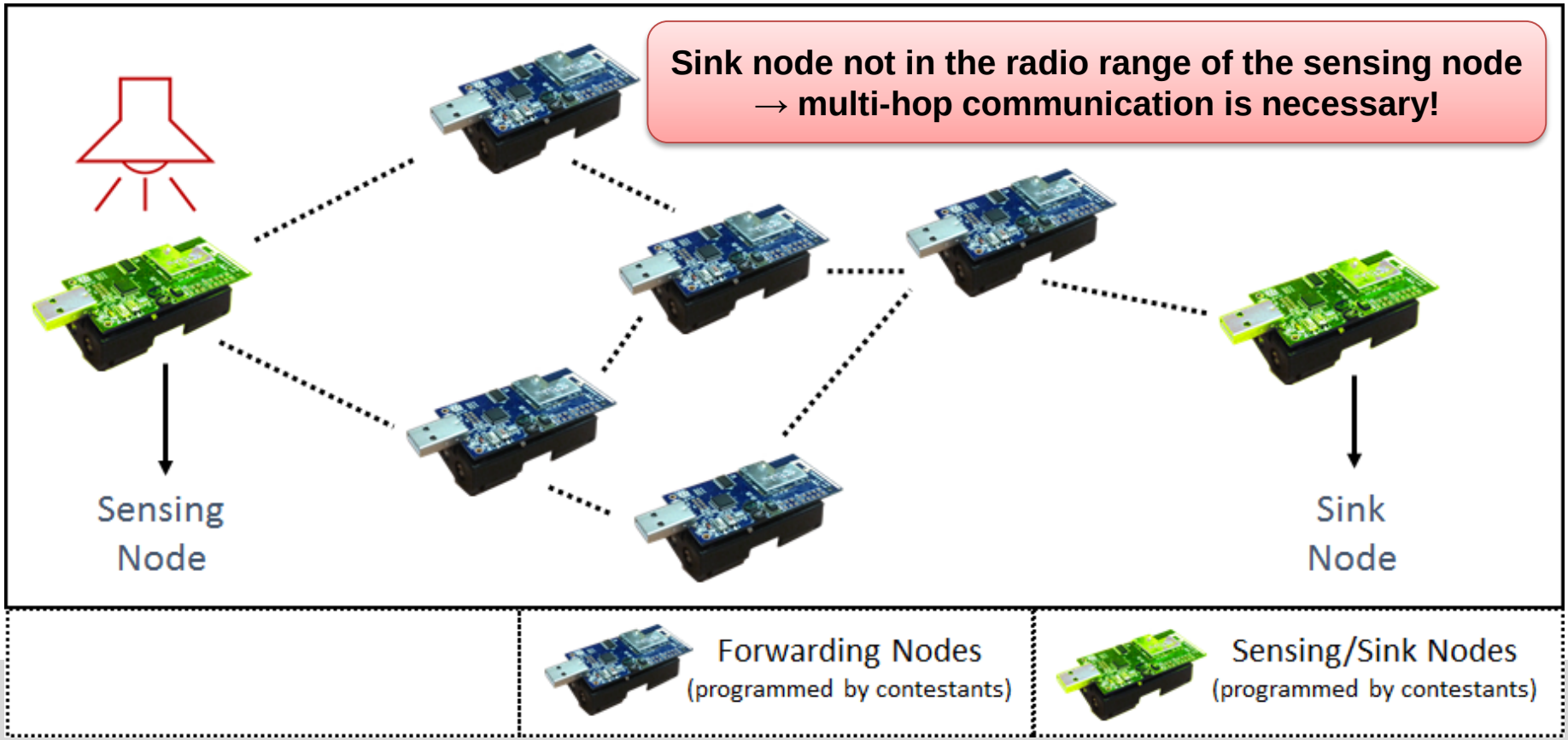


Evaluation Scenario

- Scenario emulating the operation of a sensor network monitoring discrete events in industrial settings
  - Occurrence of events must be immediately reported to a sink
  - Multi-hop network between sink and monitoring nodes
  - Several co-existing wireless devices crowding the RF spectrum

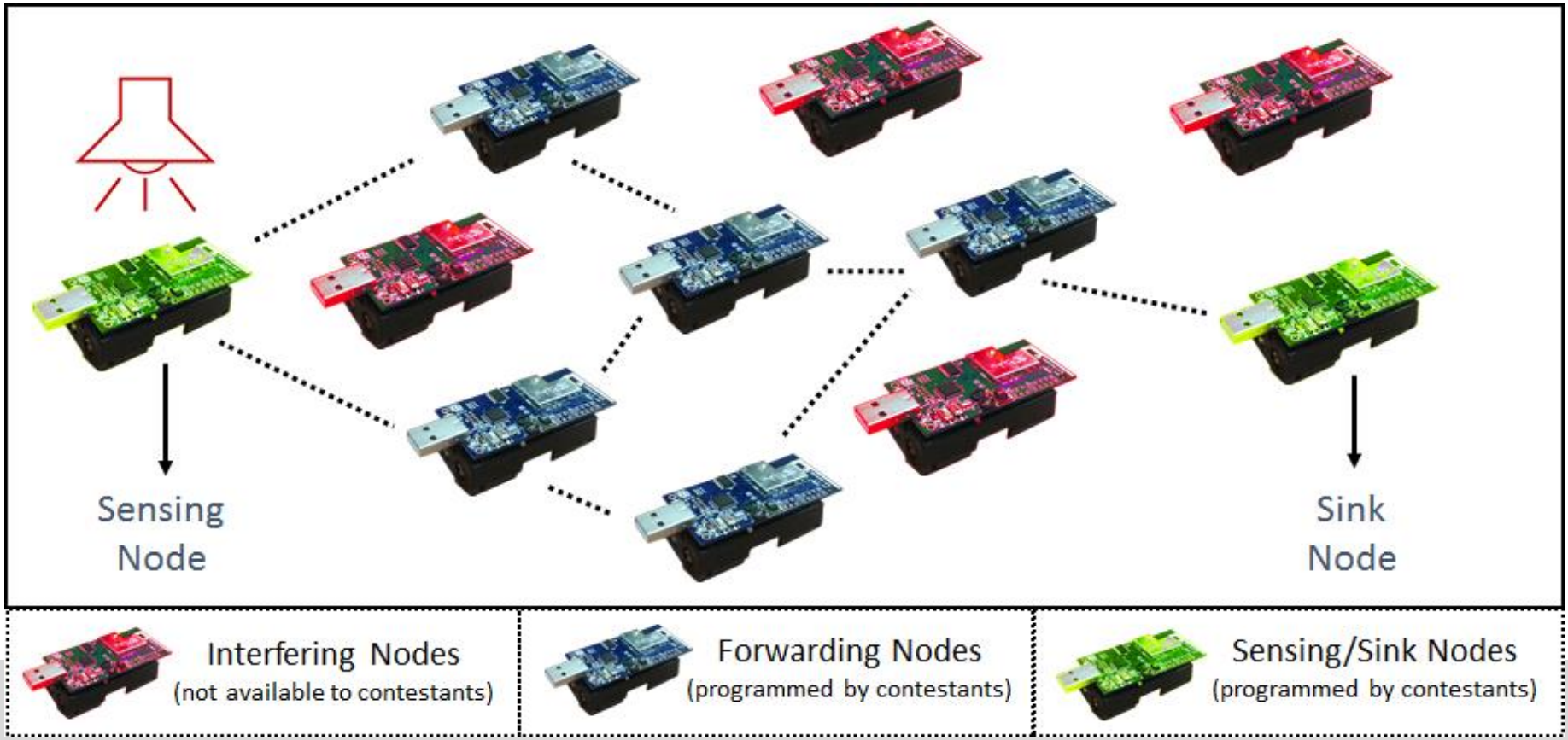
Evaluation Scenario

- Sensing node in proximity of light source (blinking LED)
  - Continuously monitoring its brightness using light sensors
  - Changes in LED status (on/off) need to be forwarded to a sink



Evaluation Scenario

- RF interference will be generated in the evaluation area
  - Surrounding devices will be used to generate interference
  - The generated interference will be started since time zero



Hardware

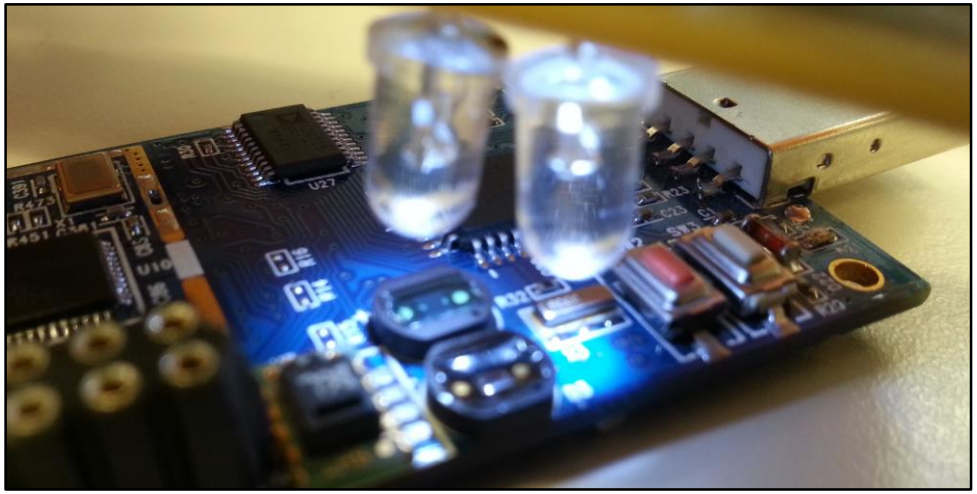
- Maxfor/Advanticsys replicas of TelosB/Tmote Sky nodes (MTM-CM5000-MSP)
  - With and without SMA antenna
  - All nodes powered via USB

- You cannot use your own nodes!
  - You are also not allowed to attach your own equipment to the testbed!
  - Passive RF spectrum scanning is allowed

https://www.advanticsys.com/shop/mtmcm5000msp-p-14.html

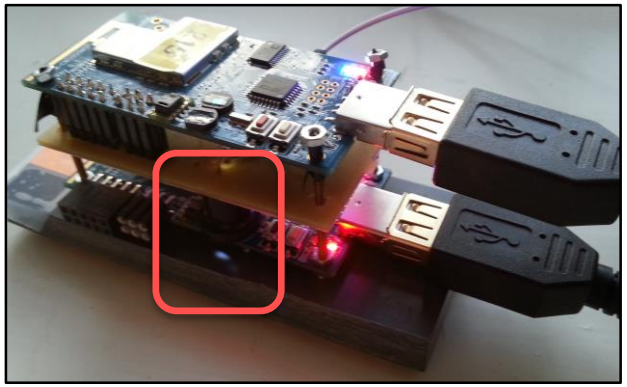
Light Source

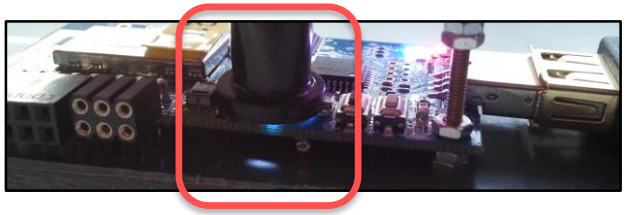
- The light source is a blinking LED controlled by a TelosB
  - LED is turned on/off according to a secret schedule
  - Initial state of the LED: `off`
  - At least `15` seconds before the first change in the LED status
  - At least `2` seconds in between each status change



Sensing Node

- The photodiodes of the sensing node are placed below the LED
  - Black cone makes sure there is no influence of ambient light on the measured light
  - Sampling strategy chosen and implemented by each contestant





- A threshold of `450` (at least for us) can reliably detect status changes:

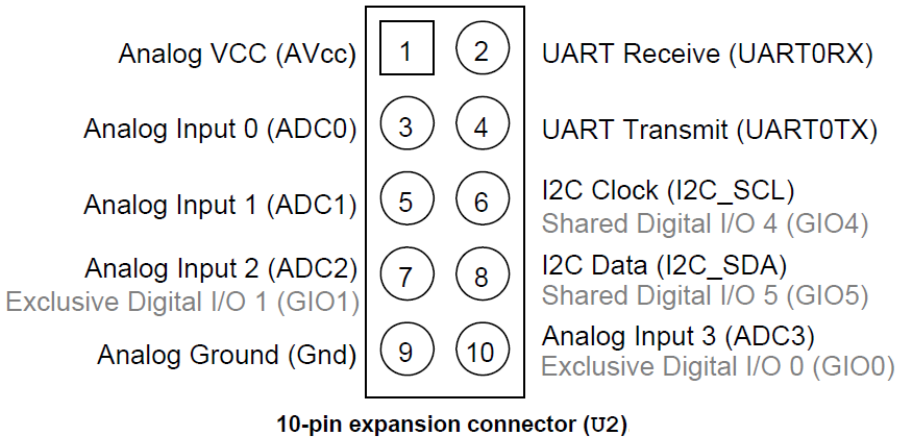
```
if((light_sensor.value(LIGHT_SENSOR_PHOTOSYNTHETIC) > 450) ||
    (light_sensor.value(LIGHT_SENSOR_TOTAL_SOLAR) > 450)) {
      // ...
  }
```

You'll have the chance to test the competition setup before Saturday: exploit this chance to make sure that you can correctly detect light changes!

Sink Node

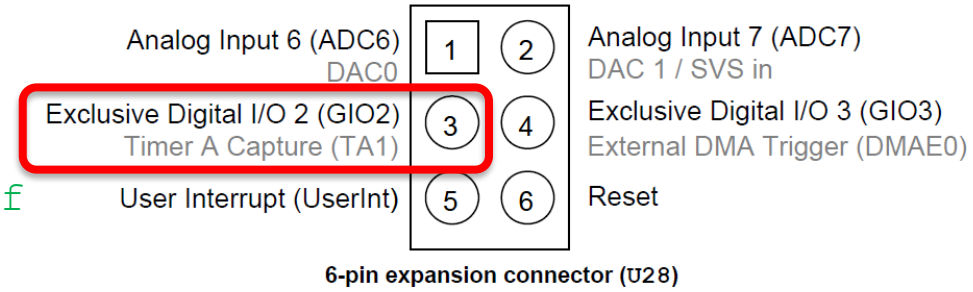
- A sink node receives the information about the LED status (on/off) and triggers one of its I/O pins accordingly
  - Use the GIO2 pin
  - Light on: GIO2 pin high
  - Light off: GIO2 pin low

We will measure the latency from the instant in which the LED status has changed to the one in which your GIO2 pin has changed!



- Code example in Contiki

```
// GPIO initialization
#define P23_OUT() P2DIR |= BV(3)
#define P23_SEL() P2SEL &= ~BV(3)
// Commands to turn GPIOs on and off
#define P23_1() P2OUT |= BV(3)
#define P23_0() P2OUT &= ~BV(3)
```



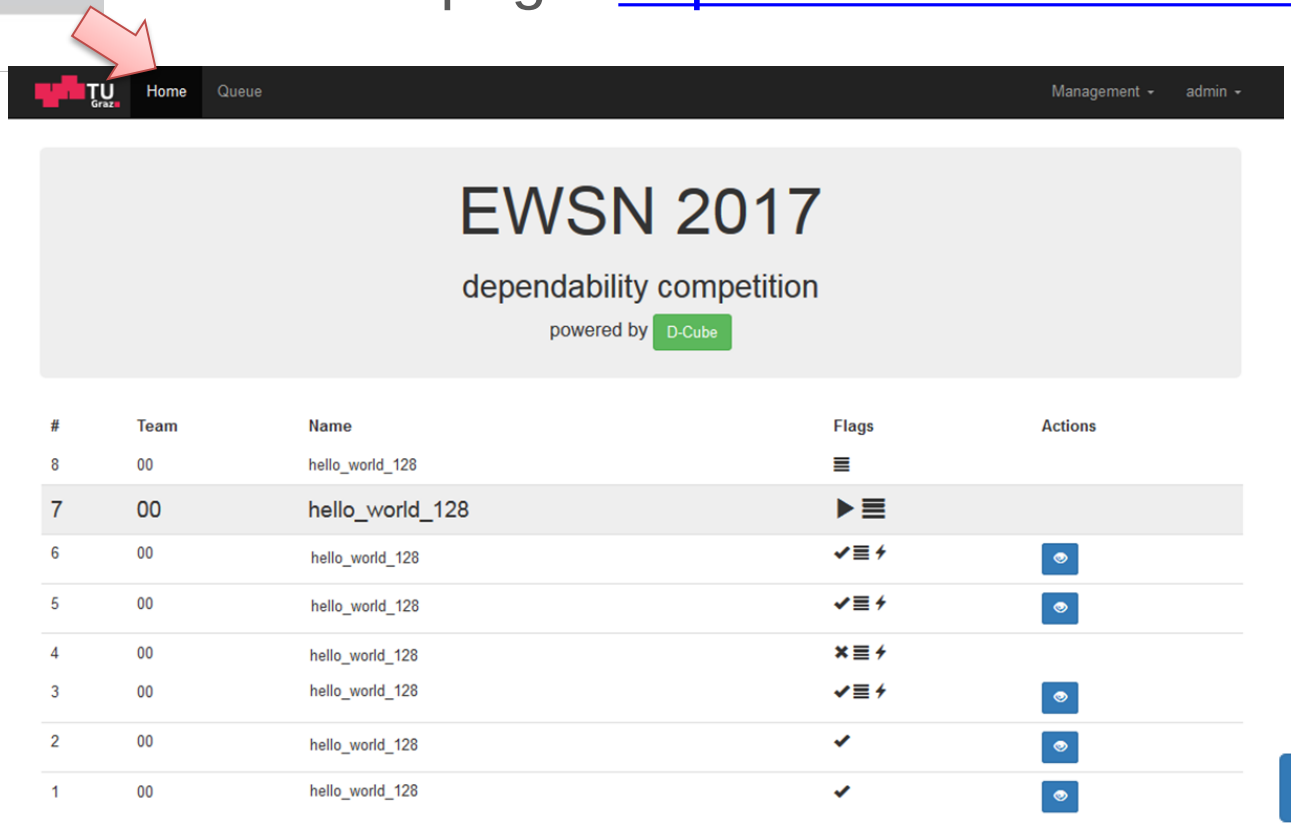
Nodes & Identities

- How many nodes?
  - 1 sensing node (capturing the status of the LED)
  - 1 sink node (receiving the information about the LED status)
  - 18 nodes can be used as forwarders to the sink
- Identity of sensing and sink nodes known beforehand
  - Sink node: 219 (00:12:74:00:13:ca:e4:ab)
  - Sensing node: 116 (00:12:74:00:16:bf:86:a0)
- Identity of forwarding nodes will not be revealed
  - Forwarding nodes will be shuffled before the evaluation day!
- Reading the node ID
  - One can use the 16-bit unsigned short value (219, 116) stored by Contiki in the 1 MB external flash → Contiki example
  - One can read the 48-bit unique ID chip (DS2411)

Firmware Upload and Results

Firmware Upload

- Each of you will receive credentials to access the Webpage: http://wsn-testbed.it.uu.se:5000/



- Home tab shows the list of experiments (completed, running, or queued for execution)

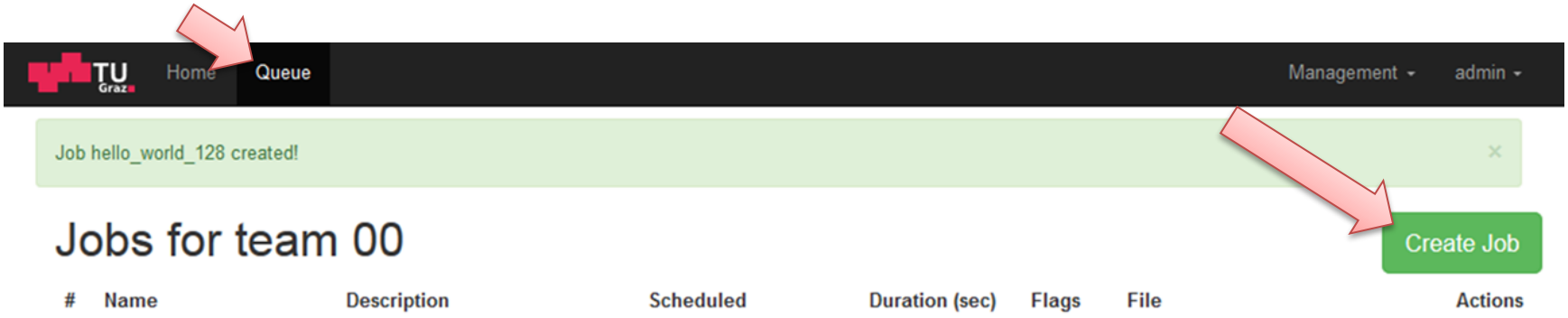
Currently running

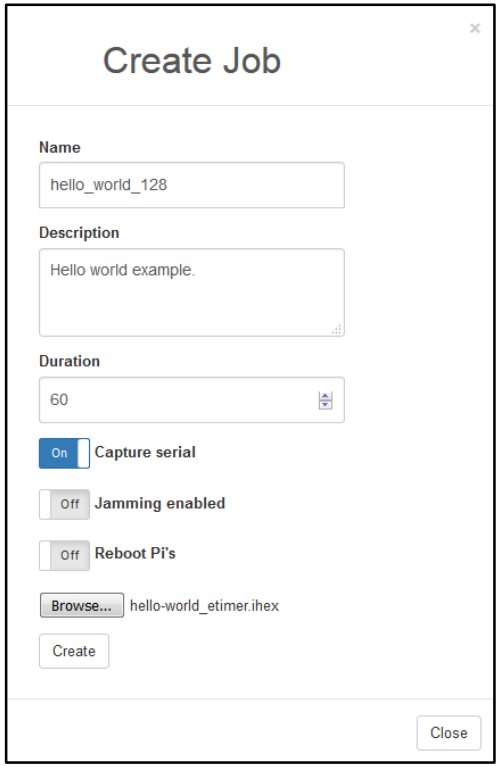
Successfully completed

Aborted or failed

Visualize results (anyone can see those!)

Firmware Upload

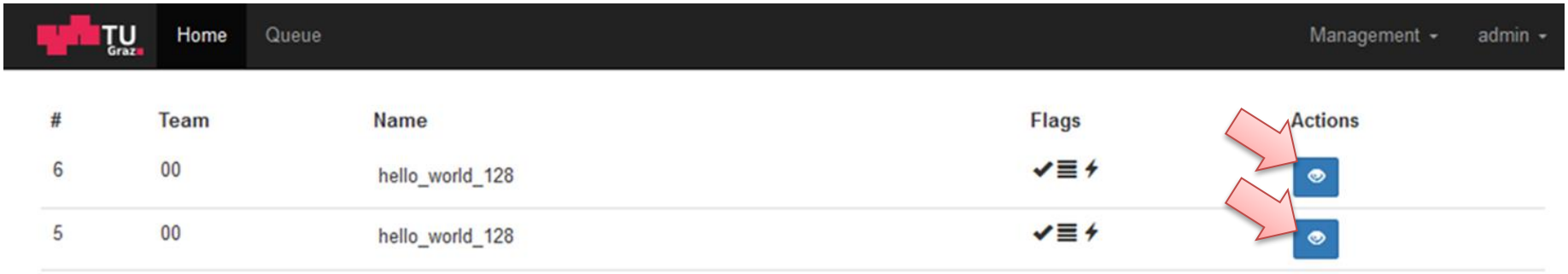


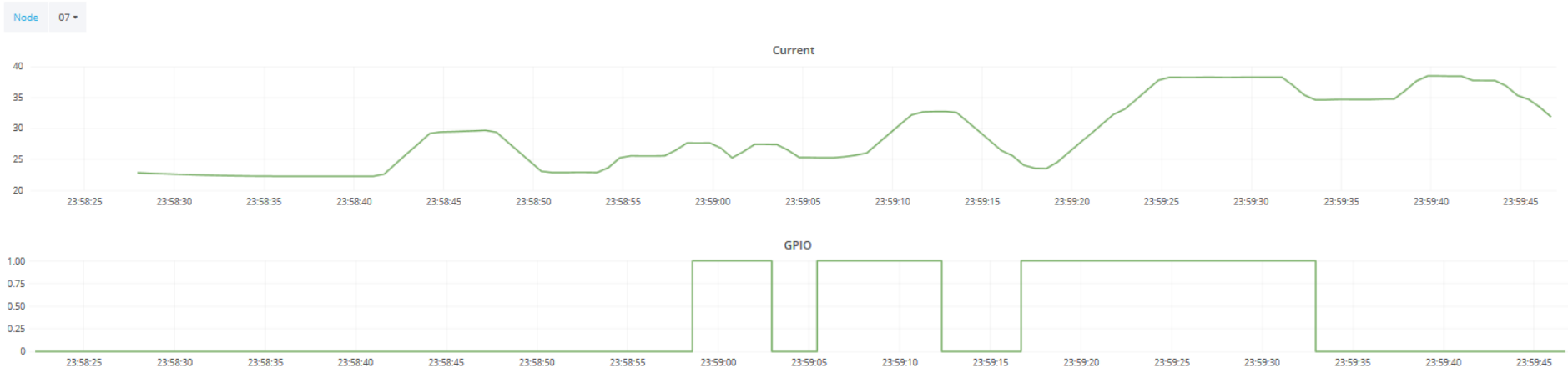


- Contestants can upload a single binary `ihex` file: this will be uploaded to all nodes in the network using a common MSP430 Bootstrap Loader
- You can decide if capturing serial output
  Please note: turning FTDI on/off severely affects energy consumption!
- You can decide if enabling the jammers surrounding the nodes and generate interference
  Please note: the jamming pattern will change during the final evaluation to avoid engineered solutions

Results of an Experiment

- Each team receives an e-mail with results & logs
- Graphical results can be checked by anyone by clicking on the blue button on the right side





Experimentation Schedule

- Preparation day
  - No pre-determined schedule: testbed allocated on-demand (first come, first served)
  - Teams that had the least test runs can ask for a higher priority

- Sunday (evaluation day)
  - Send your final `ihex` file to cboano@tugraz.at by Saturday, 18.02.2017 at 23:59 CET
  - The organizers will start the experiment

Experimentation Schedule

- Before competition 

  - Contestants will be able to program the nodes in the competition already in the days preceding the competition!
    - This should serve to the contestants to capture the light changes and calibrate their solution accordingly
    - All contestants should be able to communicate end-to-end
    - Duration of experiments is limited to 5 minutes
    - No interference can be generated

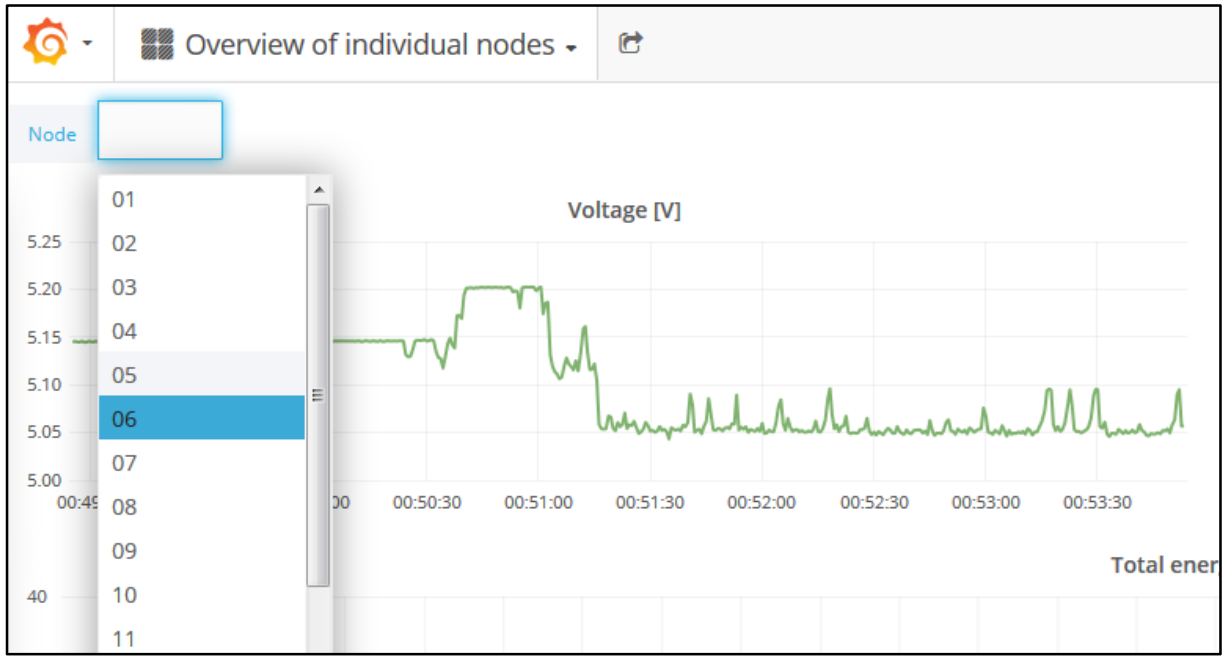
Experimentation Schedule

- Before competition 

  - Contestants will be able to program the nodes in the competition already in the days preceding the competition!
    - From Tuesday, 14.02.2017, 15:00 CET
    - until Friday, 17.02.2017, 15:00 CET
  - Maintenance will occur:
    - On Wednesday, 15.02.2017, between 15:00 and 22:00 CET
    - On Thursday, 16.02.2017, between 15:00 and 22:00 CET
  - Inform us in case of problems!
  - Please limit the amount of serial output, as the testbed infrastructure cannot handle extremely high traffic! 
  - The boot message right at the beginning of an experiment may not be captured in the logs 

Visualization in Grafana – FAQ

- What does the node ID (1 to 20) mean in Grafana?
  - This number is simply a dashboard identifier
  - It maps to the Raspberry Pi 3 used as observer node in D-Cube

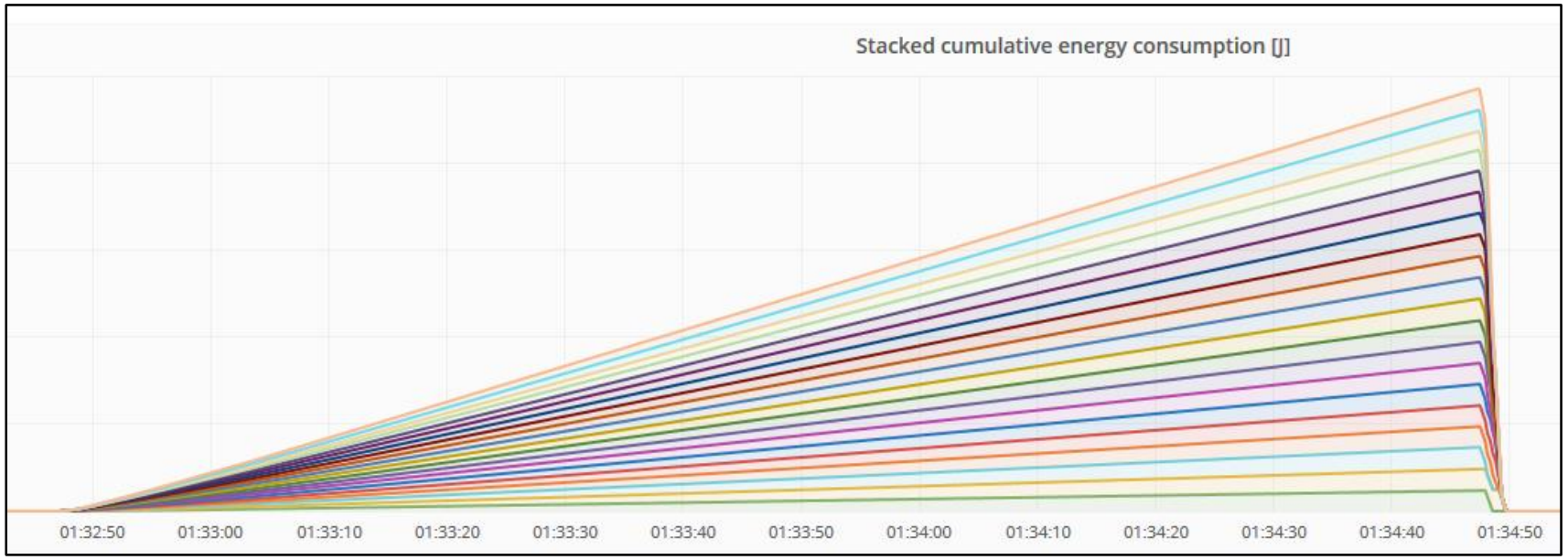


- The sensing node (116) is attached to the Raspberry Pi #12
- The sink node (219) is attached to the Raspberry Pi #07
- There is no mapping between node ID and Raspberry Pi

Visualization in Grafana – FAQ

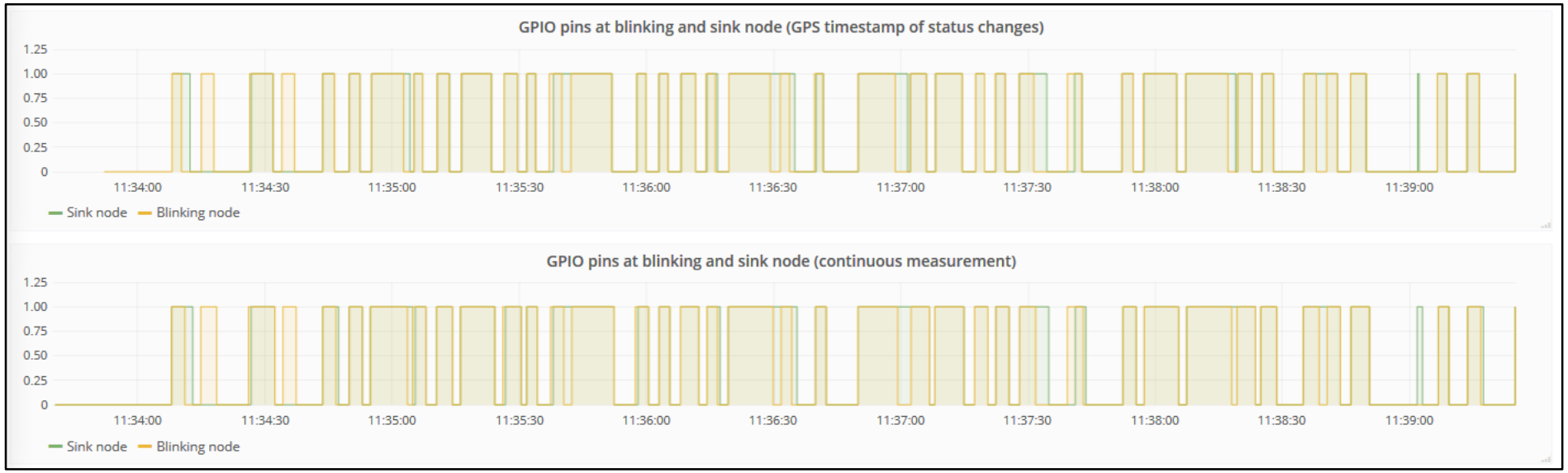
- What is the meaning of plots in "Experiment overview"?
  - The "stacked cumulative energy consumption" plots shows the consumption in Joules of each TelosB node

    → Note that the consumption of the whole TelosB node is measured (this includes USB circuitry, DC-DC converter, …)



Visualization in Grafana – FAQ

- What is the meaning of plots in "Experiment overview"?
  - Two plots for the "GPIO pins at blinking and sink node"
    - → When the LED blinks, the GPIO of the blinking node is toggled
    - → When the sink node receives your packets, it should toggle the GPIO pin accordingly

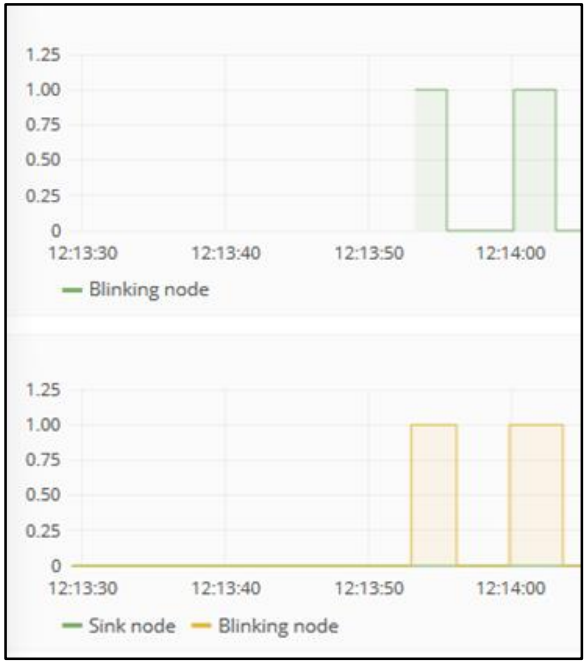


Visualization in Grafana – FAQ

- What is the meaning of plots in "Experiment overview"?
  - Two plots for the "GPIO pins at blinking and sink node"
    - → When the LED blinks, the GPIO of the blinking node is toggled
    - → When the sink node receives your packets, it should toggle the GPIO pin accordingly
  - We are measuring the status of these GPIO pins using (i) GPS modules that timestamp rising/falling edges and (ii) Raspberry Pi 3 nodes synched over NTP reading the pin state
    - → The "continuous measurements" plot refers to the Raspberry Pi 3 measurements: these values are averaged to minimize the number of datapoints (the averaging results essentially in an “OR” over time) and their resolution is the order of hundreds ms
    - → The "GPS timestamp of status changes" plot shows each detected change in the GPIO status. These values are not averaged, but Grafana can handle only 1 ms precision

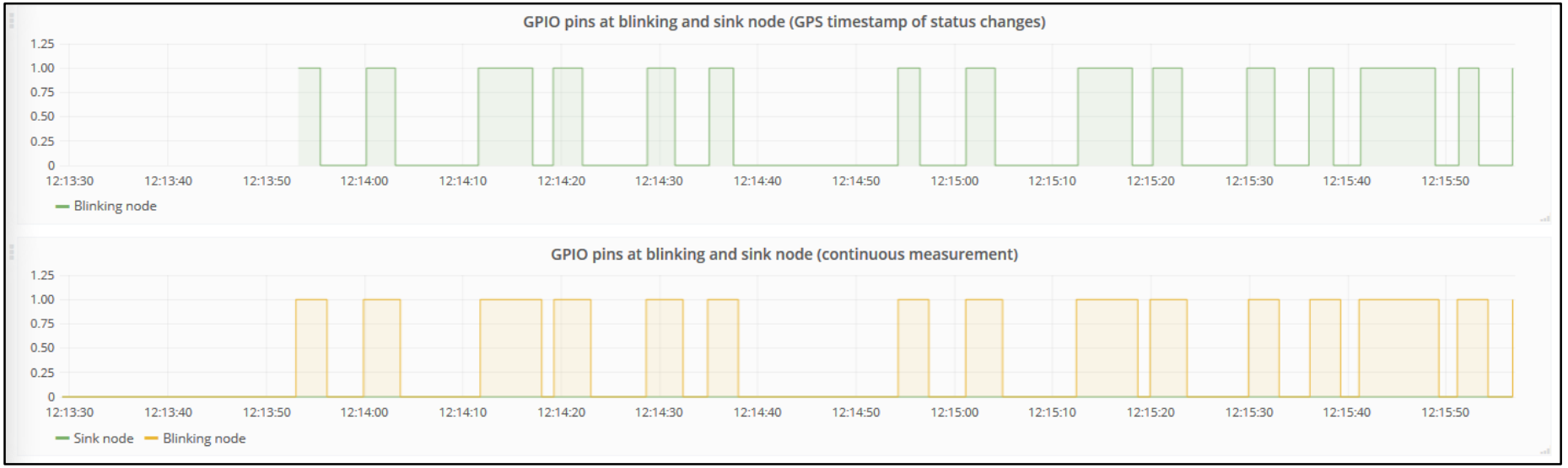
Visualization in Grafana – FAQ

- What is the meaning of plots in "Experiment overview"?
  - Two plots for the "GPIO pins at blinking and sink node"
  - Why two different plots?
    - → In the "continuous measurement" plot, the line of the sink node (yellow) is displayed also if the sink's GPIO was never toggled
    - → In the "GPS timestamp of status changes" plot, the line of the sink node (yellow) is missing in case the sink's GPIO was never toggled, because Grafana needs at least two points to draw a line



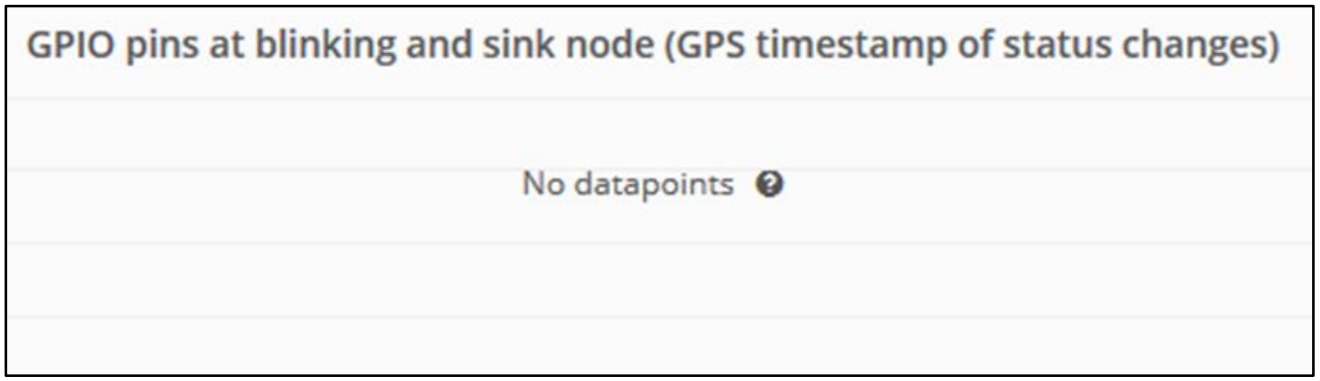
Visualization in Grafana – FAQ

- Why can’t I see the yellow line showing the sink in the "GPS timestamp of status changes" plot?
  - Grafana needs at least two points to draw a line
  - The yellow line of the sink node is missing in case the GPIO pin of the sink was never toggled



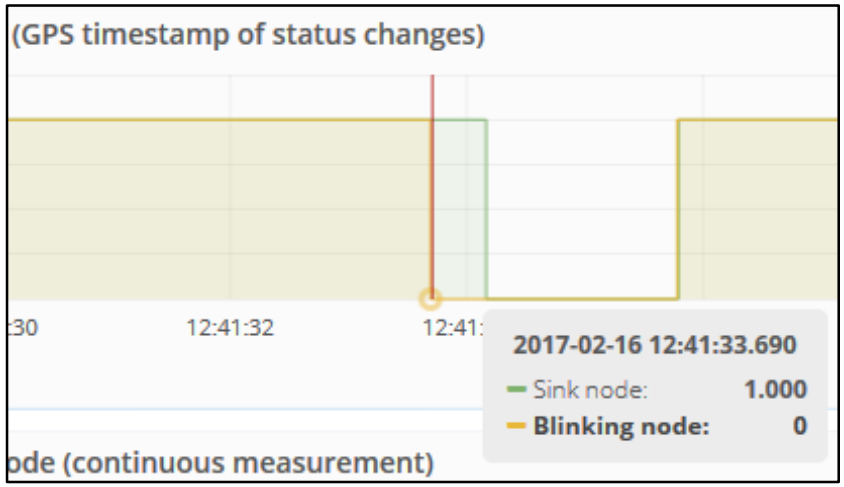
Visualization in Grafana – FAQ

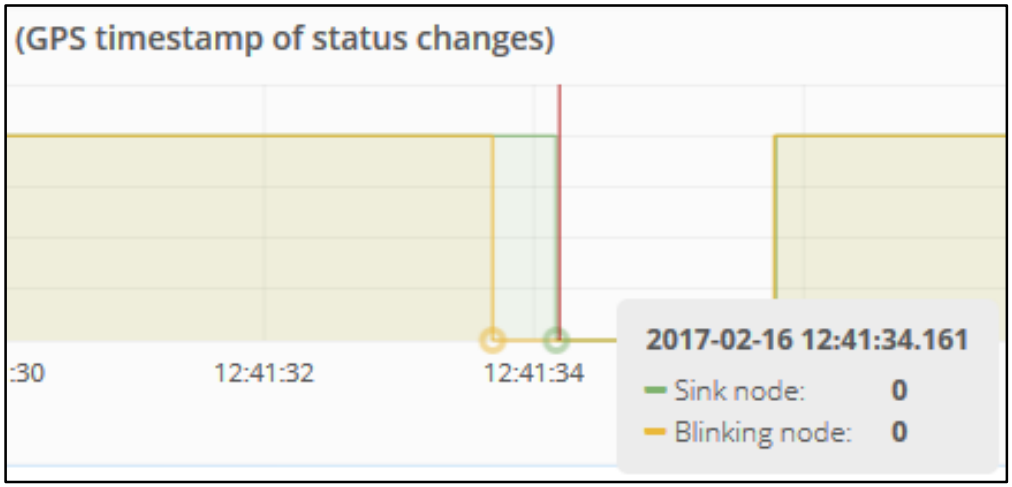
- Why is Grafana not displaying any point when I zoom in?
  - Grafana uses second resolution for the zoom
  - When zooming too much, the averaging may lead to a situation in which Grafana uses the same timestamp as startpoint and endpoint and cannot hence visualize a line



Visualization in Grafana – FAQ

- How can we get a rought undestanding of latency?
  - You can check the timestamp of individual delays by moving your mouse over a point
  - Remember that Grafana has a resolution of 1 ms and therefore some of the precision is lost during visualization

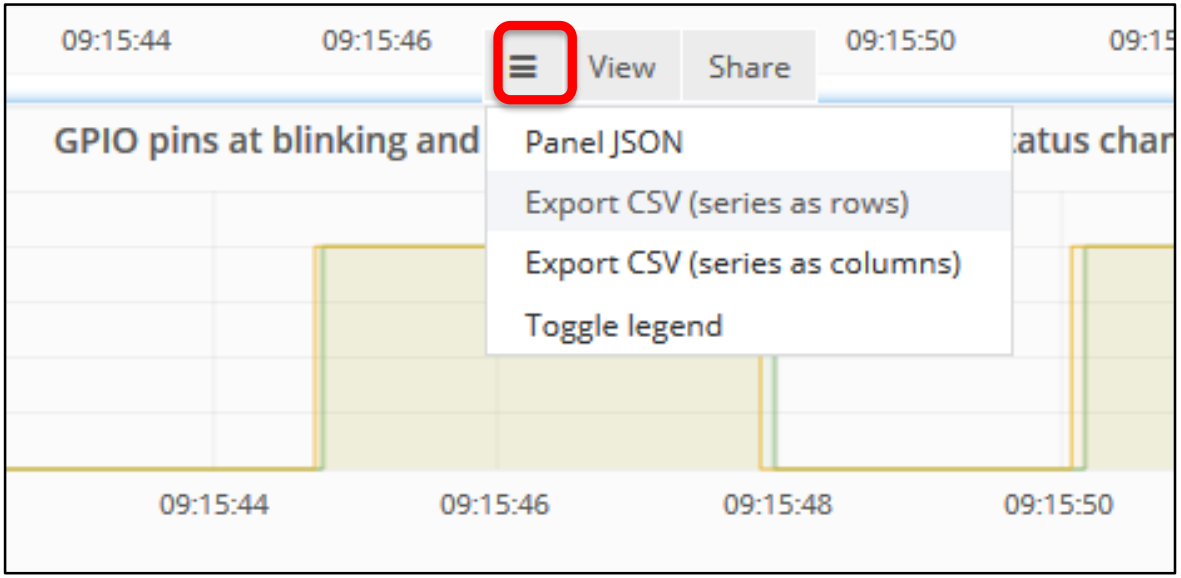




Blinking node toggled LED at: 12:41:33:690
Sink node toggled GPIO at: 12:41:34:161
Latency was: 471 ms

Visualization in Grafana – FAQ

- Can we export the data seen in Grafana?
  - Yes, CSV files can be exported by clicking on the title of the plot
  - Click on the menu icon and select "Export CSV"



	A	B	C
1	Time	1	2
2	2017-02-16T09:43:46.876Z	0.0840805771962	0.1951102
3	2017-02-16T09:43:47.501Z	0.152616695366	0.2566677
4	2017-02-16T09:43:48.126Z	0.221115444991	0.2613602
5	2017-02-16T09:43:48.751Z	0.289725498238	0.2663699
6	2017-02-16T09:43:49.376Z	0.336447792086	0.2709752

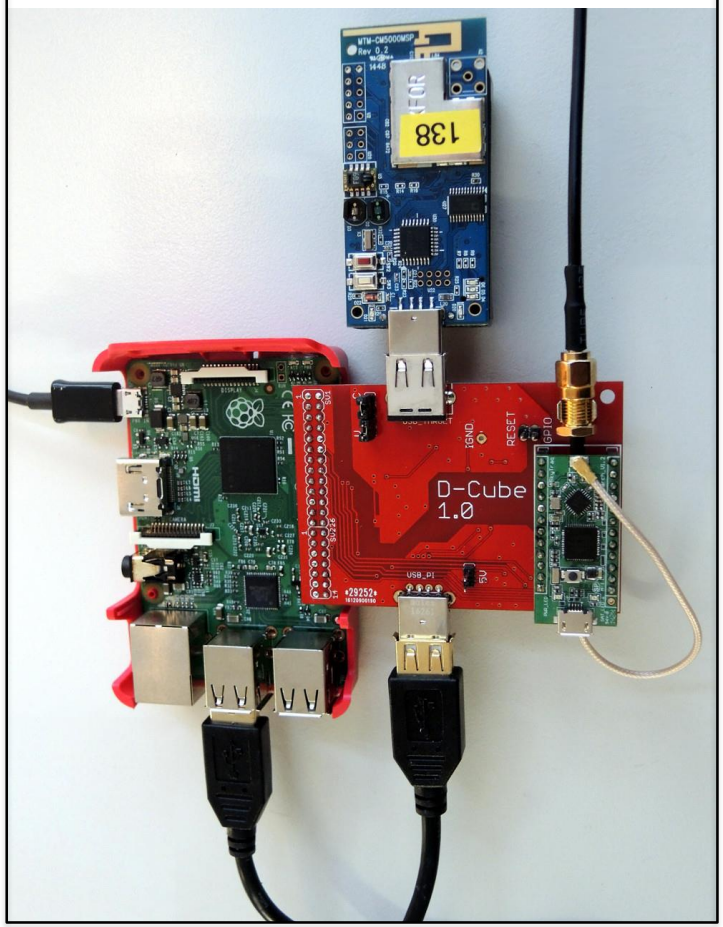
	A	B	C
1	Series	Time	Value
2	Sink node	2017-02-16T09:49:06.669Z	1
3	Sink node	2017-02-16T09:49:08.868Z	0
4	Sink node	2017-02-16T09:49:13.570Z	1
5	Sink node	2017-02-16T09:49:16.571Z	0
6	Sink node	2017-02-16T09:49:25.068Z	1
7	Sink node	2017-02-16T09:49:28.674Z	0

Benchmarking Tool

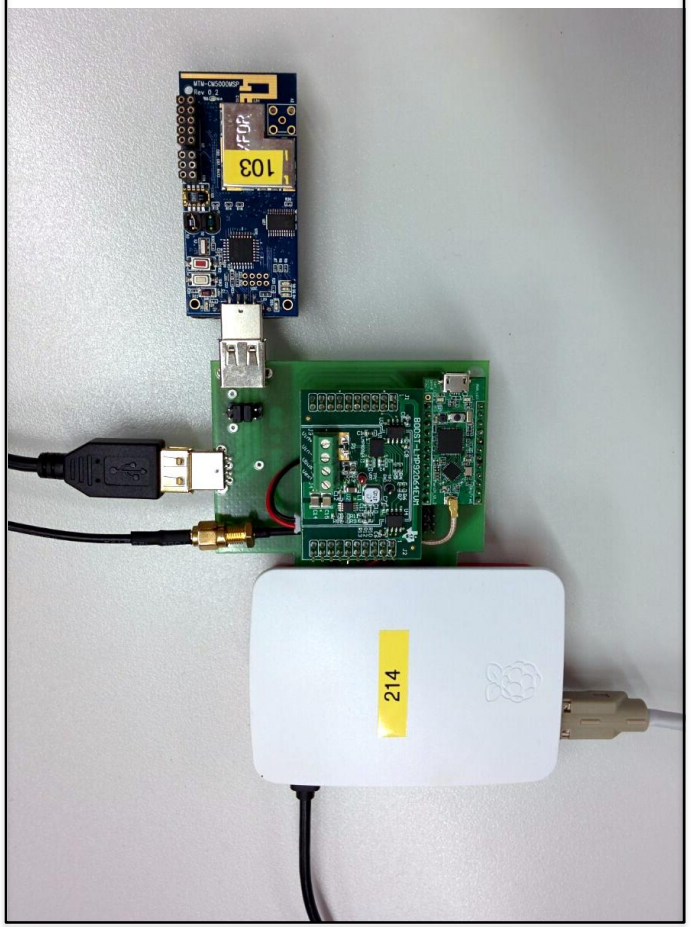
Benchmarking Tool: D-Cube

- More info on GitHub: https://github.com/TuGraz-ITI/D-Cube

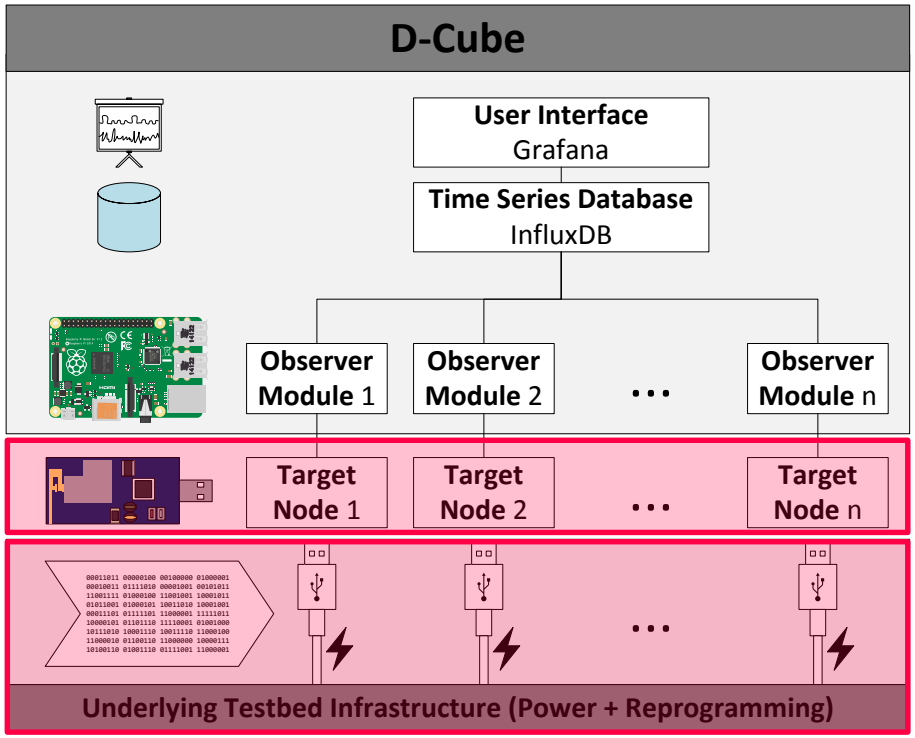
This year's prototype (EWSN'17)



Last year's prototype (EWSN'16)

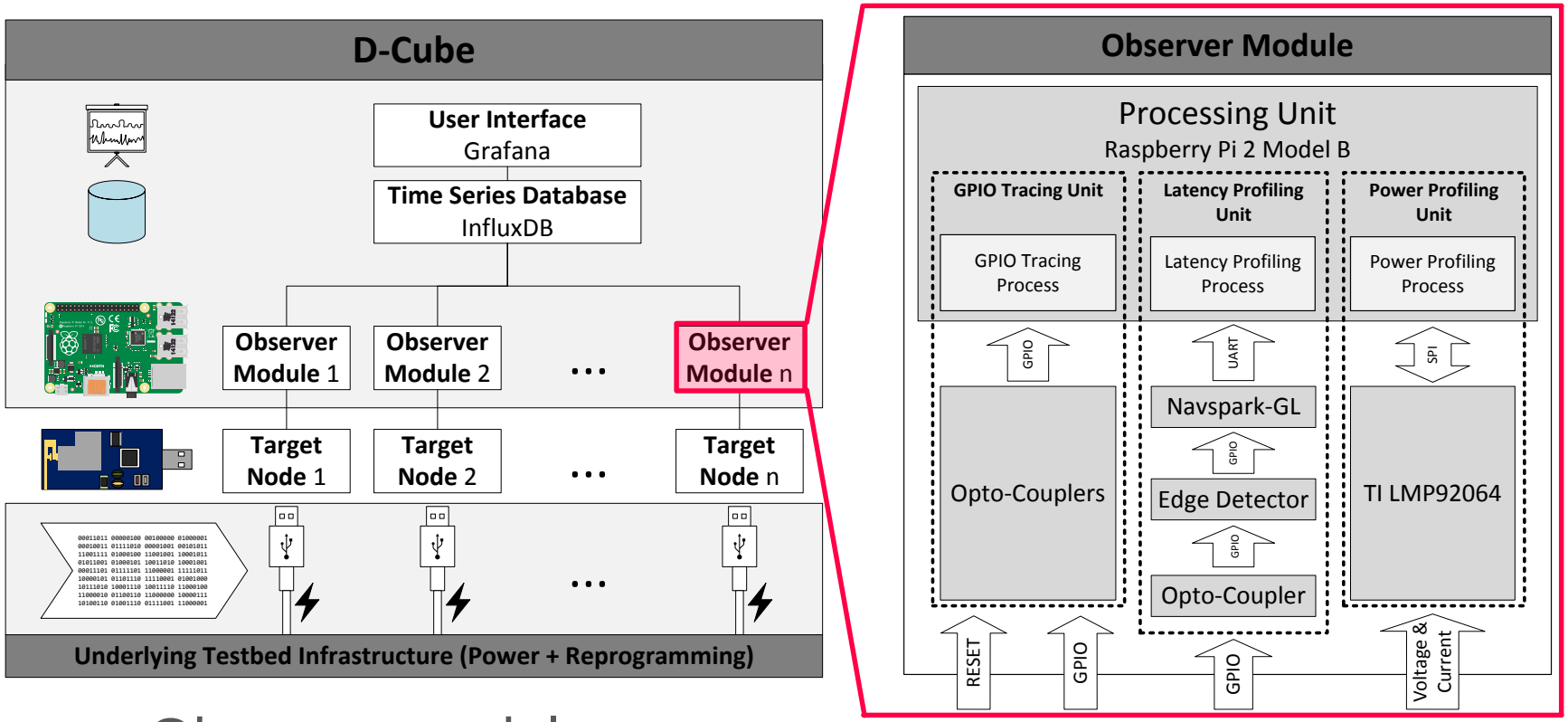


Benchmarking Tool: D-Cube



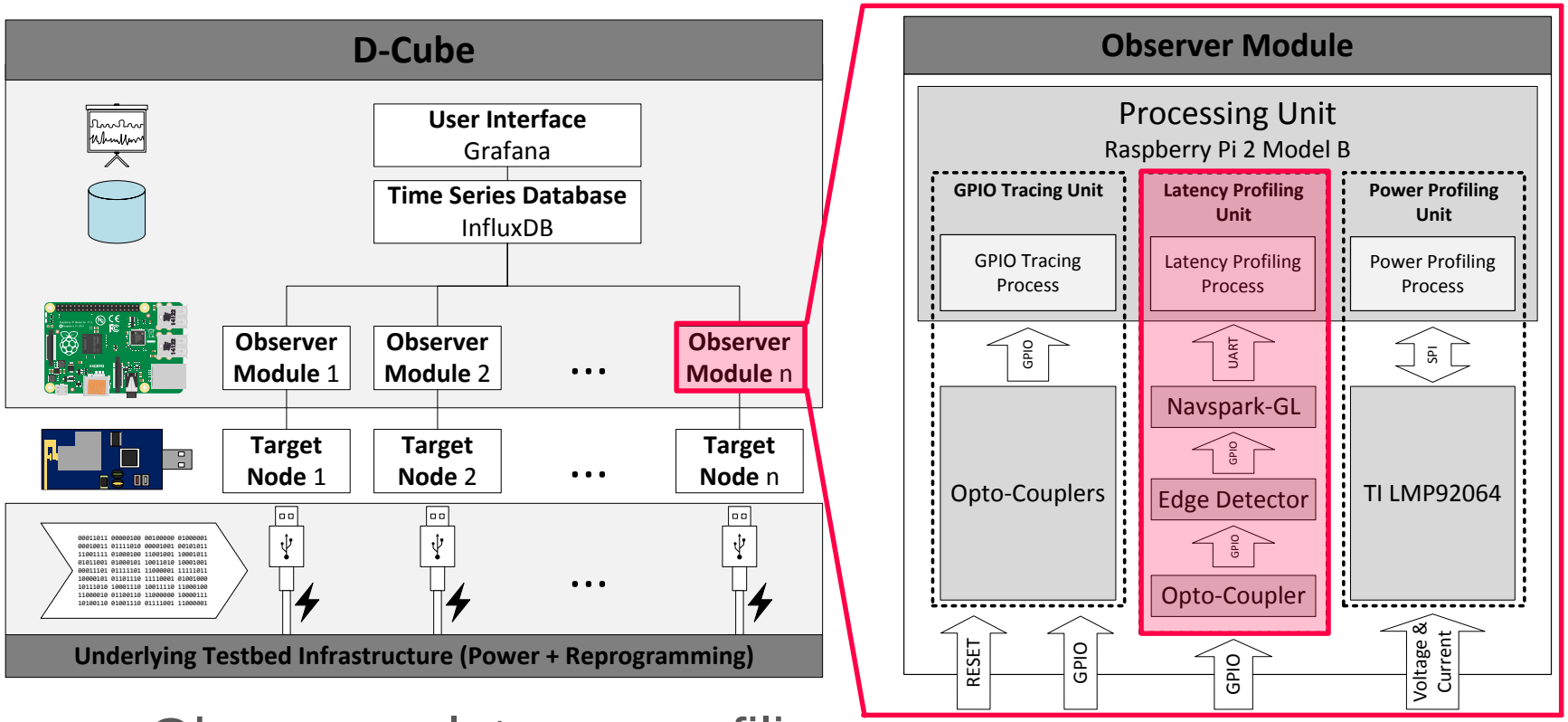
- Target nodes
  - → Devices running the code/system under test
  - → D-Cube agnostic to HW platform chosen as target
  - → MTM-CM5000-MSP nodes (TelosB replicas - 10 kB RAM)
- Underlying infrastructure
  - → Power + reprogramming of the target nodes
  - → Ideally allows to disable the UART interface

Benchmarking Tool: D-Cube



- Observer modules
  - → Each module monitors exactly one target node
  - → Raspberry Pi 3 + custom-made add-on Card (ADC+GPS)

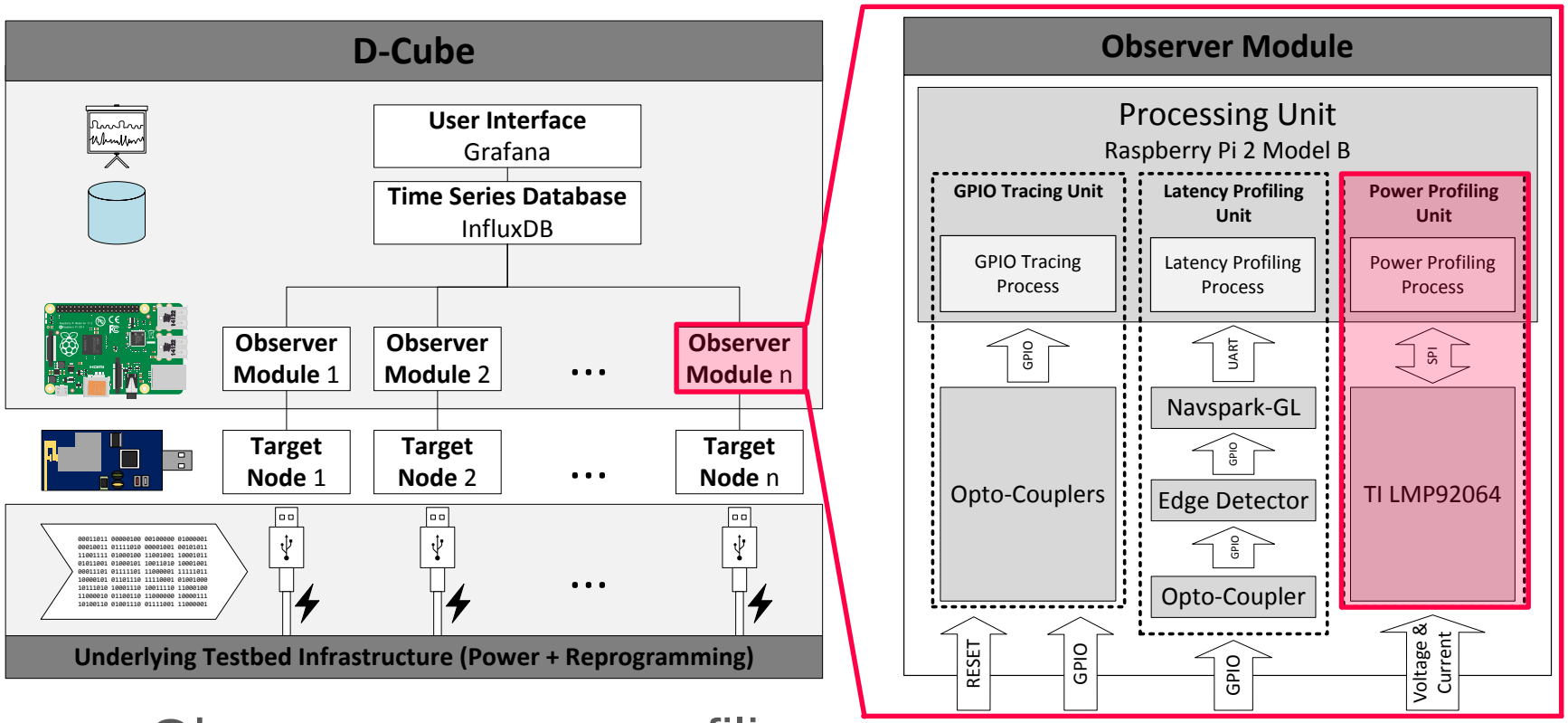
Benchmarking Tool: D-Cube



- Observers: latency profiling
  - → GPS module with timestamping support
    (NavSpark-GL: Arduino DevBoard with GPS/GLONASS)
  - → Modified to sample both rising and falling edge

http://navspark.mybigcommerce.com/navspark-gl-arduino-compatible-development-board-with-gps-glonass/

Benchmarking Tool: D-Cube

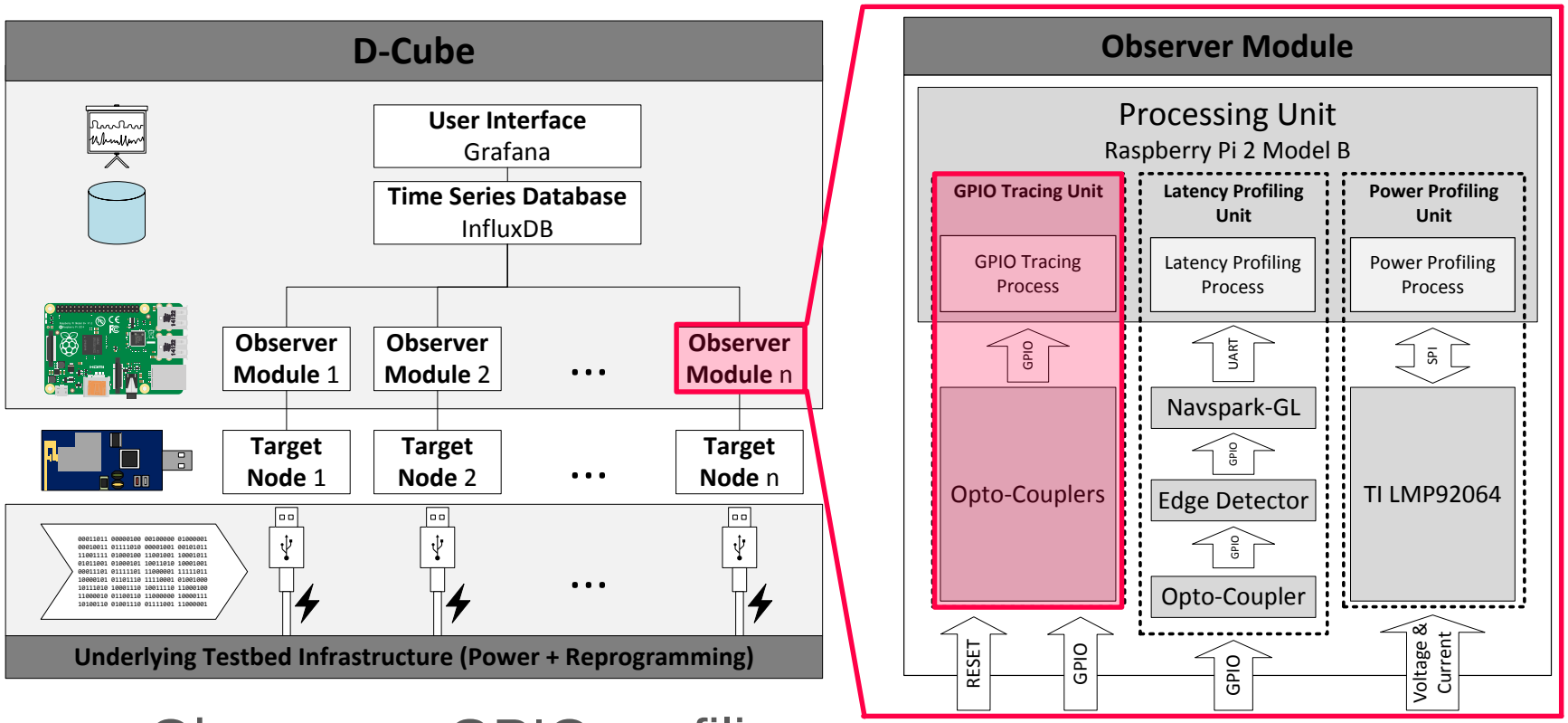


- Observers: power profiling

  → Simultaneous sampling ADC (TI LMP92064) read via SPI @ 62.5 kHz using a real-time process

  - Voltage channel: up to 10.82V with 2.82mV resolution
  - Current channel: up to 150.59mA with 39.22µA resolution

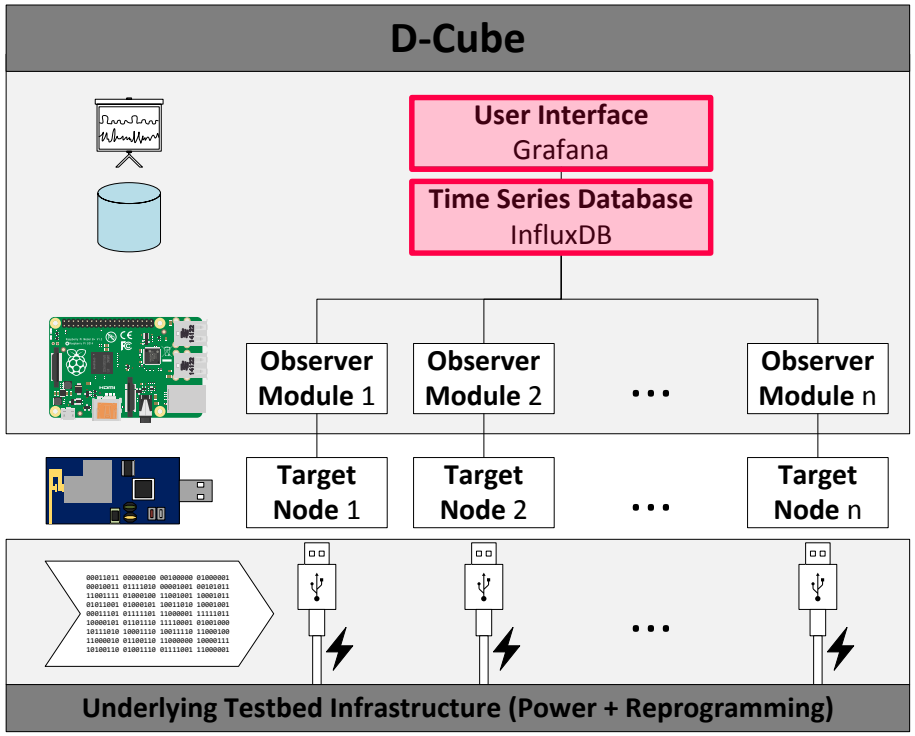
Benchmarking Tool: D-Cube



- Observers: GPIO profiling

  → GPIO changes are monitored using the same real-time process sampling the ADC

Benchmarking Tool: D-Cube

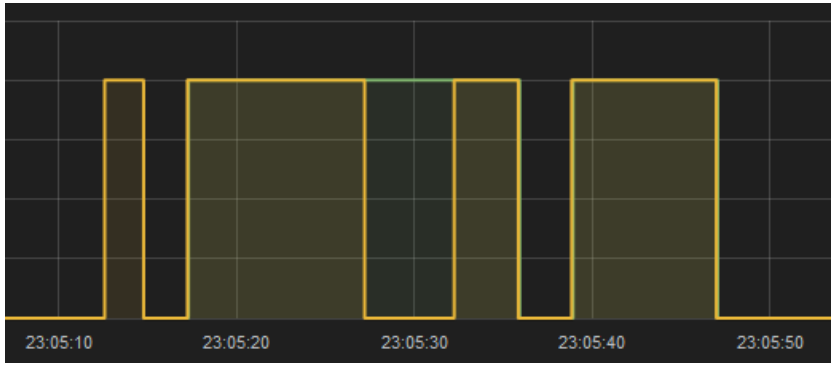


- Time Series database
  - → Collects and persistently stores the data from all observers
  - → InfluxDB (open-source)
  - → Nanosecond precision timestamps
- User Interface
  - → Acts as proxy to the database and gives real-time feedback
  - → Grafana (open-source)

Evaluation Metrics

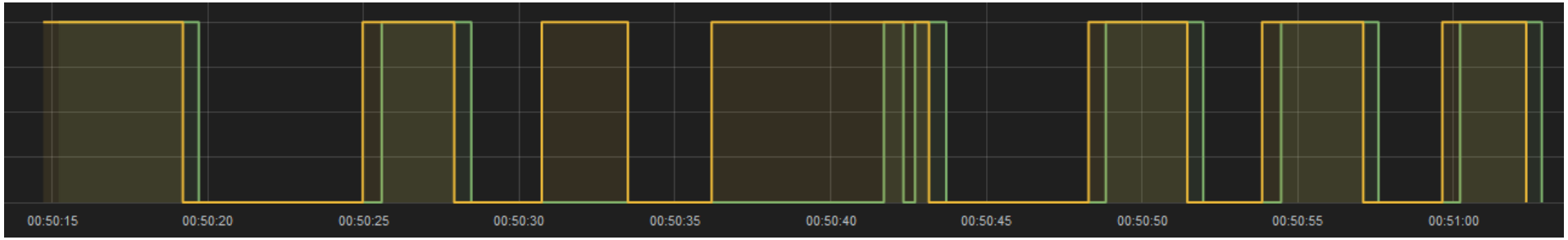
Evaluation Metrics

- Solutions will be evaluated according to three criteria:
  - Reliability of transmissions
    - → Number of changes in the LED status that were missed (i.e., that were not correctly reported to the sink)



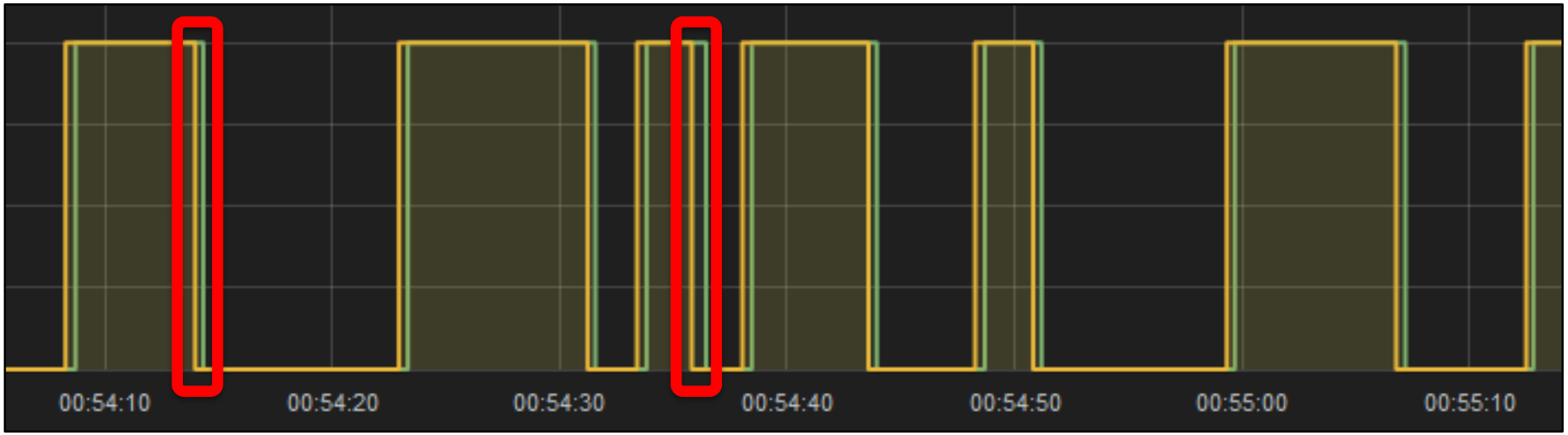
Sink node

Blinking node



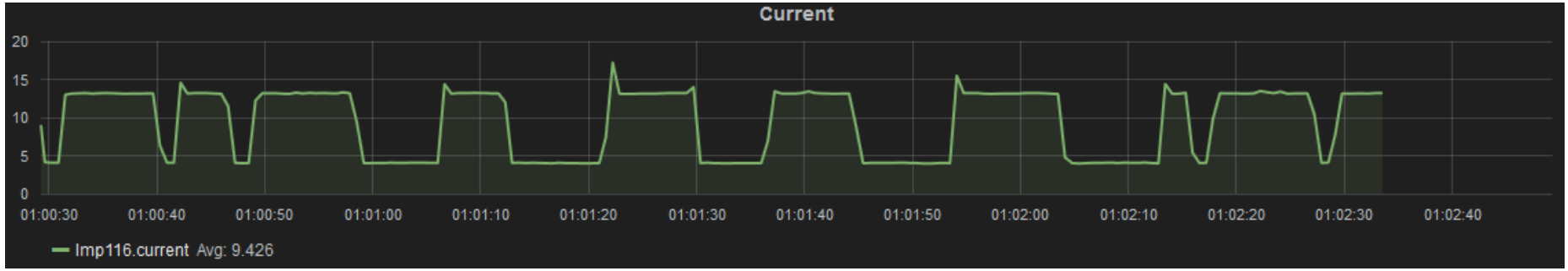
Evaluation Metrics

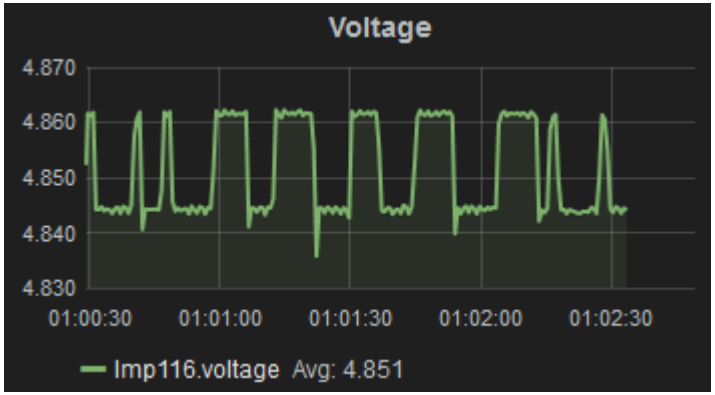
- Solutions will be evaluated according to three criteria:
  - End-to-end latency
    - → Time necessary to communicate a change in the LED status to the sink node
    - → Measured with sub-microseconds precision using GPS timestamps



Evaluation Metrics

- Solutions will be evaluated according to three criteria:
  - Energy-efficiency
    - → Overall power consumed by the nodes in the network (measured in hardware)





Evaluation Metrics

- Solutions will be evaluated according to three criteria:
  - Energy-efficiency
    - → Overall power consumed by the nodes in the network (measured in hardware)
    - → The energy consumption of all nodes will be measured (we will consider the sum across all nodes)
    - → Measurement is synchronized with the reset pin (i.e., all nodes will start measuring energy from boot) (i.e., node topology and discovery, if any, will account for the total energy consumption of the sensor nodes)
  - During the evaluation phase remember to disable your serial output in order to save energy!
  - Make sure not to leave any GPIO pin unnecessarily floating or active in order to save energy!

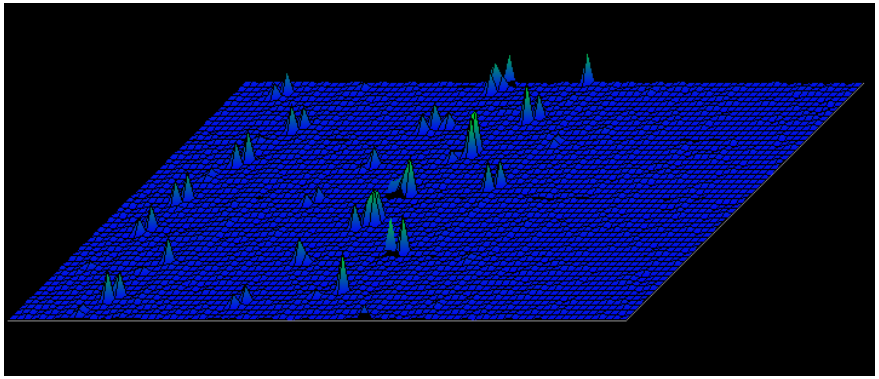
Awards Ceremony

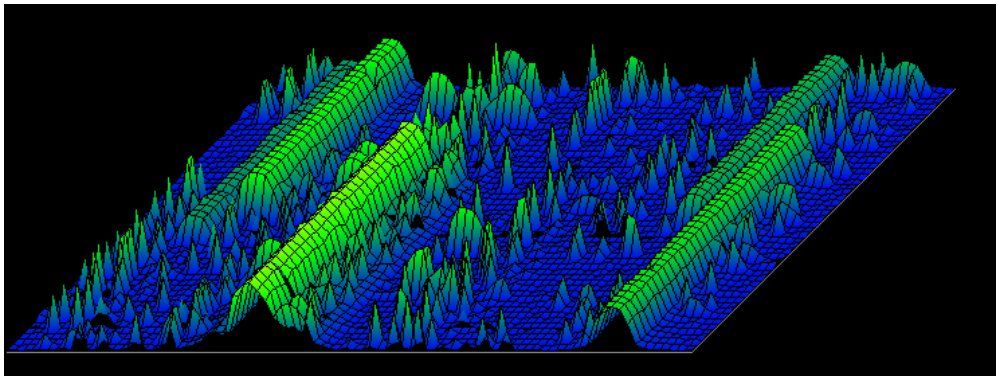
- For each criterion, a separate ranking will be derived
  - The team with the best rankings across all three metrics wins!
  - Details will be announced on Saturday after registration
- Top three teams will be awarded
- Announcement of the results will take place during the main conference track
  - Tuesday, 21.02.2017 at 13:00
  - Top three teams should be ready to give a short talk about their system!

Interference & Important Rules

Interference Generation

- Radio interference will be generated in the competition area
  - Several TelosB nodes running JamLab (http://soda.swedish-ict.se/4110/1/boano11JamLab.pdf)
  - JamLab's interference will reproduce the patterns of common appliances (e.g., Wi-Fi devices and microwave ovens)
  - Some of the frequencies will be periodically blocked!
  - Contestants can not assume that some IEEE 802.15.4 channels are constantly interference-free





Evaluation Day

- To ensure repeatable experiments, the surrounding Wi-Fi access points will be disabled
  - We will monitor the interference levels during the evaluation to make sure there is no suspicious activity
  - All teams should shut off all their electronic devices operating in the 2.4 GHz band before entering the building
  - Any contestant caught generating deliberate radio interference will be immediately disqualified!

Frequency Usage

- The TI CC2420 radio allows to send and receive packets also outside the 2.4 GHz band (roughly between 2230 MHz and 2730 MHz)
  - The use of frequencies below 2400 and above 2483.5 MHz are strictly forbidden!
  - No limitation about the usage of frequencies between 2400 and 2483.5 MHz

    → The use of any IEEE 802.15.4 channel (11 to 26) is allowed

  - Any detected violation will lead to a disqualification

Use of Own Equipment

- Contestants are free to use any device or tool during the preparation day, but:
  - It is not allowed to attach own equipment to or manipulate the testbed infrastructure
  - It is not allowed to deliberately jam the surrounding area while other teams are testing their solutions
- Violations to the above rules will lead to a disqualification!

Looking forward to see you in Uppsala!