Use of TUB test facilities TWIST

CREW Training days 2nd edition. Basic course

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January 14, 2014

Outline

1 Motivation

2 TWIST

3 Demo

TKN Telecommunication Networks Group

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TKN Telecommunication Networks Group

Motivation

- Design, implementation and evaluation of sensor network applications and communication protocols is difficult
- First design steps can often be made with the help of simulations
- Last steps require the use of real hardware, realistic environments and realistic experimental setups

Use a large-scale sensor network testbed with dedicated out-of-band signaling in a realistic setting

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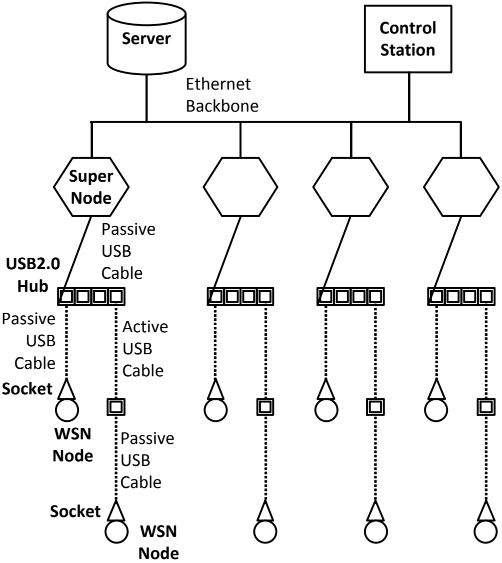
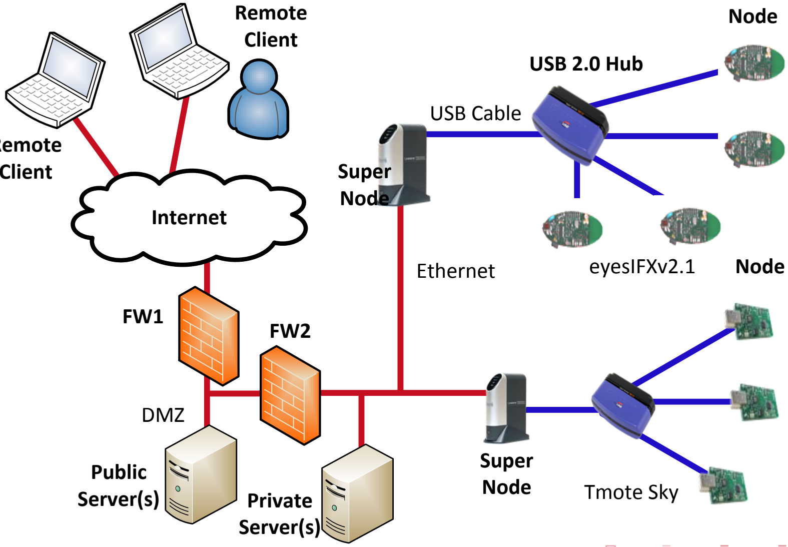
TWIST Architecture

TWIST

TKN Wireless Indoor
Sensor network Testbed



TWIST Components

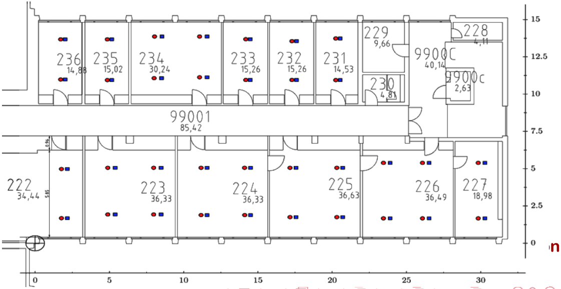


TWIST Features

- Basic services
  - Network-wide re-programming
  - Node configuration
  - Out-of-band extraction of debug information
- Additional features
  - Support for heterogeneous platforms
  - Active power control
  - Support for hierarchical networks
- Built on open standards, open architectures, open source

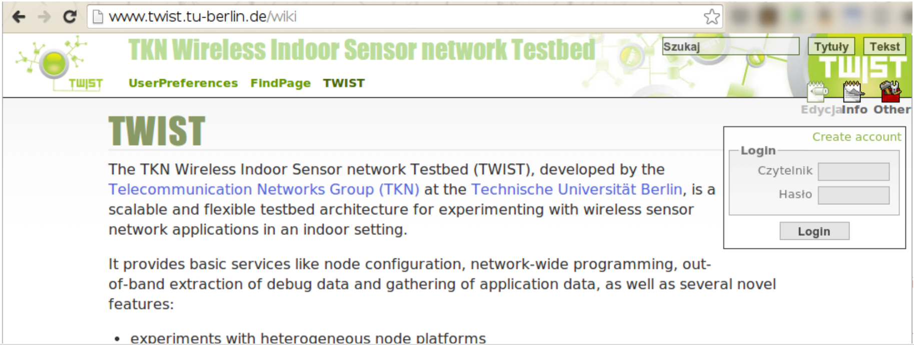
TWIST Instance at the TKN Building

- Spans 3 floors of the TKN office building
  - More than 1500m^2 of instrumented space
- Current configuration: *204 sensor nodes*
  - **102 Tmote Sky**
  - **102 eyesIFXv2**
  - 46 super nodes
  - 60 USB hubs
  - $>$ 1300m USB cabling



More Information

- V. Handziski, A. Köpke, A. Willig, *et al.*, "Twist: a scalable and reconfigurable testbed for wireless indoor experiments with sensor network", in *Proc. of the 2nd Intl. Workshop on Multi-hop Ad Hoc Networks: from Theory to Reality, (RealMAN 2006)*, Florence, Italy, 2006
- `http://www.twist.tu-berlin.de/`



TWIST

The TKN Wireless Indoor Sensor network Testbed (TWIST), developed by the Telecommunication Networks Group (TKN) at the Technische Universität Berlin, is a scalable and flexible testbed architecture for experimenting with wireless sensor network applications in an indoor setting.

It provides basic services like node configuration, network-wide programming, out-of-band extraction of debug data and gathering of application data, as well as several novel features:

- experiments with heterogeneous node platforms

Upgrade of TWIST Instance

- Spans 3 floors of the TKN office building
  - More than 1500m^2 of instrumented space
- Future configuration: *204 sensor nodes*
  - 102 Tmote Sky
  - ARM-Cortex M4 + Low-power WLAN
    - Tiva (ARM-Cortex M4) launchpad + low-power-wlan RF interface (CC3000)
  - MSP430F5529 + 868MHz RF
    - MSP-EXP430F5529 launchpads + CC110L booster RF interface (868 MHz)
  - MSP430 + Bluetooth LE
    - MSP430 boards + Bluetooth LE
  - BeagleBone Black Super Nodes

Expected time frame for deployment is Q1/Q2 this year

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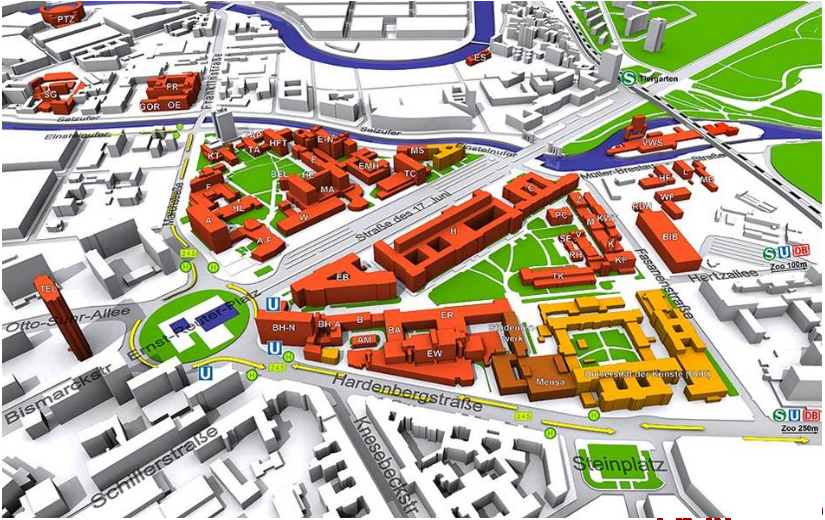
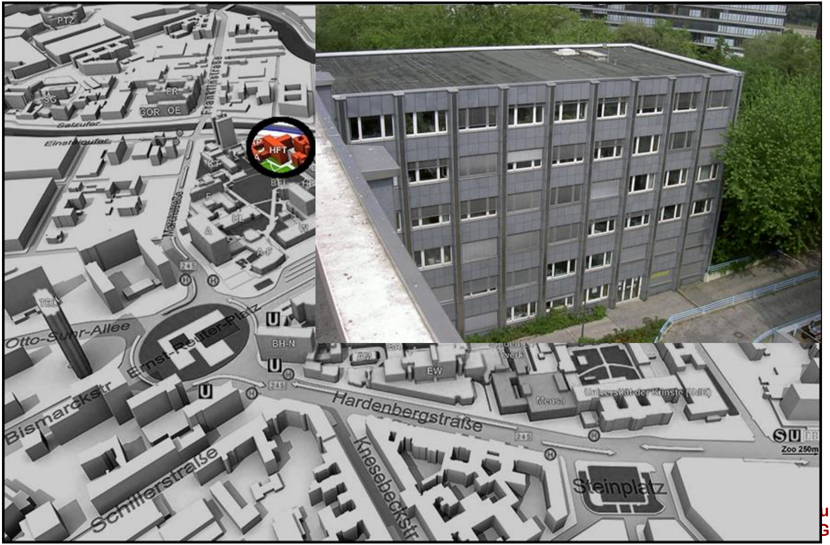
TKN Building Location plan



TKN Building Location plan



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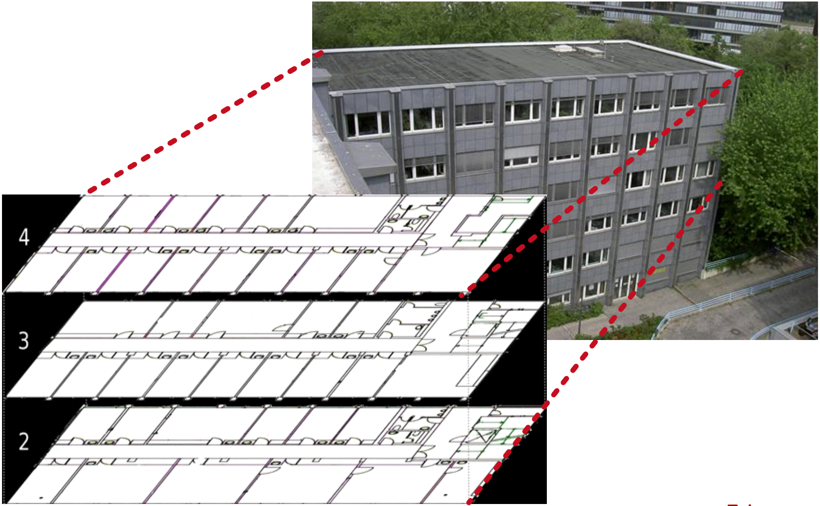
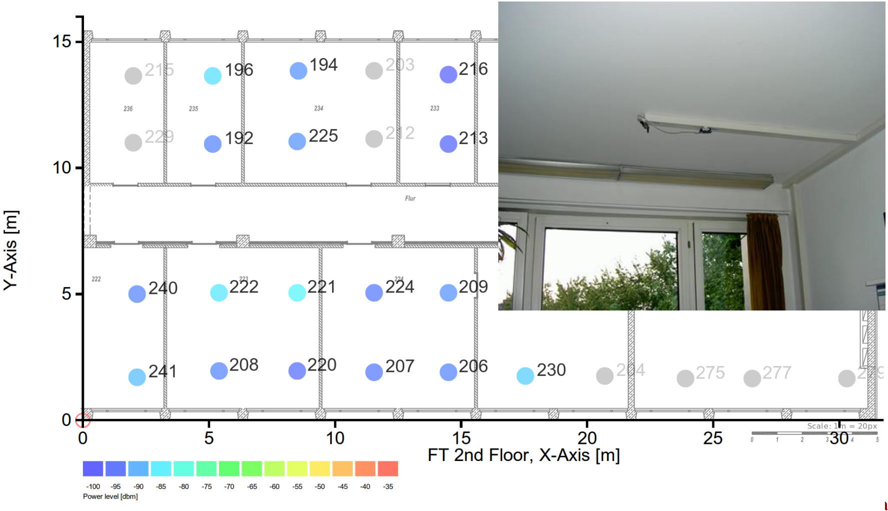
TKN Building Location plan



Floor plan

TKN Building Location plan



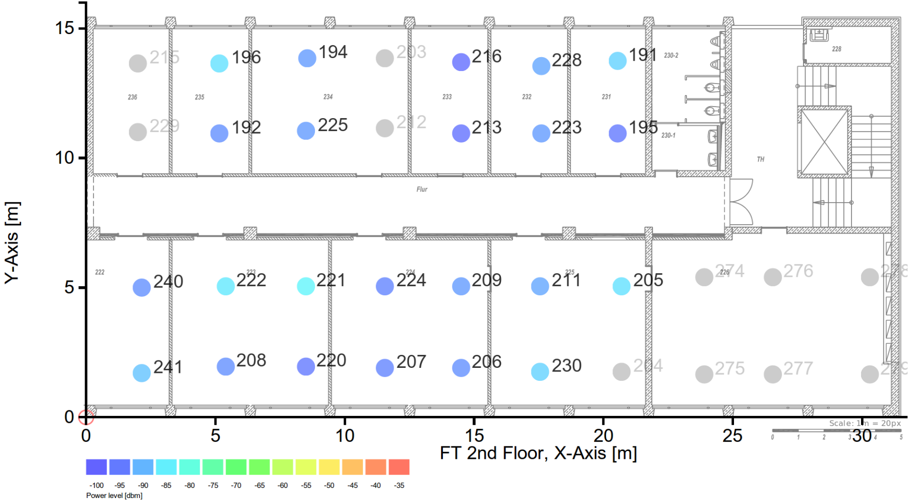
Demo Description

- Distributed spectrum sensing application
- Sensor node based jammer

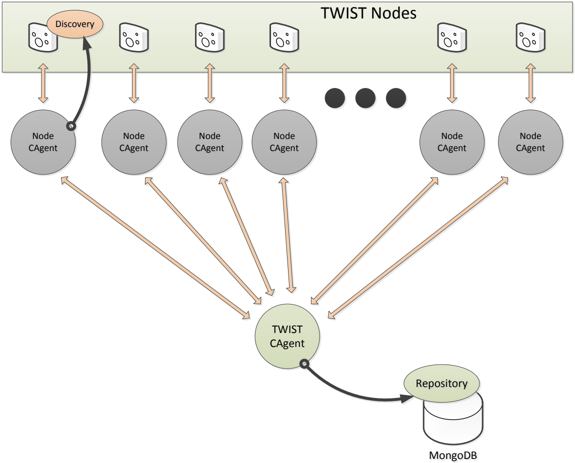
Shown functionalities

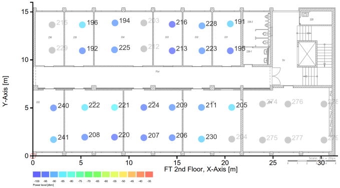
- TWIST sensor node management
- Remote control of the nodes
- Live visualization of the data

Resulting Spectrum Map



Current implementation





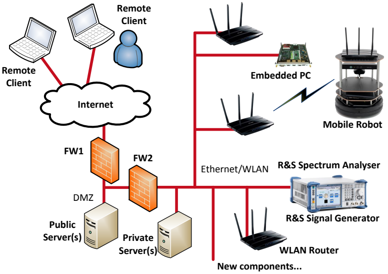
- ZeroMQ
- Google protobuffers

Demo Script

1. Prerequisites
   - Accept ▸ Terms of use and create user account
   - ▸ Reserve a job
2. ▸ Install custom sensor node image
   - Jammer application on one
   - Spectrum sensing application on all remaining nodes
3. Run visualization
4. ▸ Interact with a sensor network node in realtime
   - Get the spectrum sensing information
   - Control the jammer

Course C: Use of TUB test facilities TWIST

- Use of the distributed spectrum analyser for monitoring
- Interference generation with other devices
  1. Embedded PC controlled via OMF
  2. WLAN routers controlled manually
  3. Mobile robot controlled via native interface



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Bibliography I

[1] V. Handziski, A. Köpke, A. Willig, and A. Wolisz, “Twist: a scalable and reconfigurable testbed for wireless indoor experiments with sensor network”, in *Proc. of the 2nd Intl. Workshop on Multi-hop Ad Hoc Networks: from Theory to Reality, (RealMAN 2006)*, Florence, Italy, 2006.

[2] J. Hauer and V. Handziski. (2008). TWIST Web Interface Tutorial, [Online]. Available: `http://www.twist.tu-berlin.de/wiki/TWIST/Instances/TKN/Documentation/Tutorial`.

TKN Telecommunication Networks Group

Terms of Use

Granting access to TWIST is conditioned on an informal *contract* between the external users and TKN that contains information about:

- the nature of the intended experiments (due to the privacy implications);
- commitment to a reciprocal access to eventual testbed resources;
- agreement on proper acknowledgement of TWIST in the produced publications.

After we receive the above information (e-mail to `admin@twist.tu-berlin.de` is enough), and pending an approval by prof. Adam Wolisz, we will enable the account.

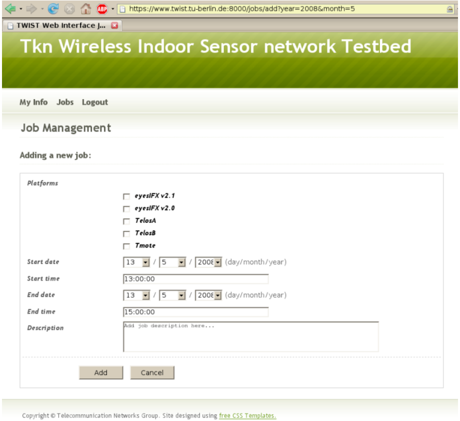
We maintain priority access policy for TKN users, so we can not guarantee the availability of the testbed for extended periods of time.

▸ Back to Demo Script

Job Reservation

- Press the **Login** button, enter your username and password and then click on **Sign in**.
- Click on **Jobs** and you will see a list of scheduled jobs.
- Find a time period for which nodes are not reserved by someone else.
- Then click on **Add** and you will see the Job Management page

▸ Back to Demo Script



https://www.twist.tu-berlin.de:8000/jobs/add?year=2008&month=5

TWIST Web Interface J...

Tkn Wireless Indoor Sensor network Testbed

My Info Jobs Logout

Job Management

Adding a new job:

Platforms
□ eyesIFX v2.1
□ eyesIFX v2.0
□ TelosA
□ TelosB
□ Tmote

Start date 13 / 5 / 2008 (day/month/year)

Start time 13:00:00

End date 13 / 5 / 2008 (day/month/year)

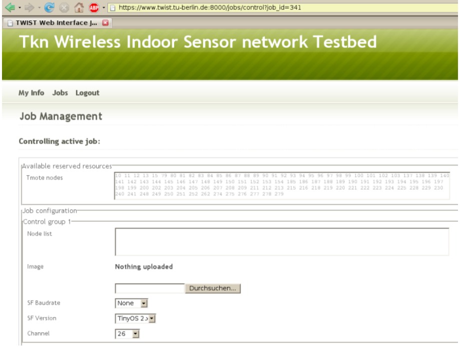
End time 15:00:00

Description Add job description here...

Copyright © Telecommunication Networks Group. Site designed using free CSS Templates.

Job Control

- The list of **Scheduled jobs** should now include your job.
- When your job is active apply a tick mark at the left side of the entry and press the **Control** button.



https://www.twist.tu-berlin.de:8000/jobs/control?job_id=341

TWIST Web Interface J...

Tkn Wireless Indoor Sensor network Testbed

Job Management

Controlling active job:

Available reserved resources

Tmote nodes: 10 11 12 13 15 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 202 203 204 205 206 207 208 209 211 212 213 215 216 218 219 220 221 222 223 224 225 228 229 230 240 241 248 249 250 251 252 262 274 275 276 277 278 279

Job configuration

Control group 1

Node list

Image: Nothing uploaded

SF Baudrate: None

SF Version: TinyOS 2.x

Channel: 26

▸ Back to Demo Script

Node Control

- Power on, power off functions
- Direct serial connection (Serial Forwarder)

```
ssh -nNxT -L 9013:localhost:9013 twistextern@www.twist.tu-berlin.de
```

  - To forward SF e.g. for node **209** use port **9209**
  - Once you have forwarded the port you can access the remote SerialForwarder like a local one.
  - However, when you start your client application make sure that it attaches to the correct port.
  - Password will be provided
  - It is possible to setup multiple SF at once

```
ssh -nNxT -L 9013:localhost:9013 -L 9209:localhost:9209 \
twistextern@www.twist.tu-berlin.de
```

▸ Back to Demo Script

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Automatic control via cURL [2] I

1. Authenticate

```
curl -L -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-d 'username=YOUR_USER_NAME' \
-d 'password=YOUR_PASSWORD' -d 'commit=Sign in' \
https://www.twist.tu-berlin.de:8000/__login__
```

2. Find the job_id

```
curl -L -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
https://www.twist.tu-berlin.de:8000/jobs | tidy
```

3. Control
   - Erase - *For job_id 346, erase nodes 12 and 13*

```
curl -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-F __nevow_form__=controlJob -F job_id=346 -F ctrl.grp1.nodes="12 13" \
-F erase=Erase https://www.twist.tu-berlin.de:8000/jobs/control
```

   - Install - *For job_id 346, install TestSerialBandwidth on nodes 12 and 13 and start serial forwarders*

Automatic control via cURL [2] II

```
curl -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-F __nevow_form__=controlJob -F job_id=346 -F ctrl.grp1.nodes="12 13" \
-F ctrl.grp1.image=@/opt/tos/tinyos-2.x/apps/tests/\
TestSerialBandwidth/build/telosb/main.exe \
-F ctrl.grp1.sfversion=2 -F ctrl.grp1.sfspeed=115200 \
-F install=Install https://www.twist.tu-berlin.de:8000/jobs/control
```

- Power Off - *For job_id 346, power off nodes 12 and 13*

```
curl -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-F __nevow_form__=controlJob -F job_id=346 -F ctrl.grp1.nodes="12 13" \
-F ’power_off=Power Off’ https://www.twist.tu-berlin.de:8000/jobs/control
```

- Power On - *For job_id 346, power on nodes 12 and 13*

```
curl -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-F __nevow_form__=controlJob -F job_id=346 -F ctrl.grp1.nodes="12 13" \
-F ’power_on=Power On’ https://www.twist.tu-berlin.de:8000/jobs/control
```

- Start Tracing - *For job_id 346, start tracing on nodes 12 and 13*

Automatic control via cURL [2] III

```
curl -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-F __nevow_form__=controlJob -F job_id=346 -F ctrl.grp1.nodes="12 13" \
-F 'start_tracing=Start Tracing' \
https://www.twist.tu-berlin.de:8000/jobs/control
```

- Stop Tracing - *For job_id 346, stop tracing on nodes 12 and 13*

```
curl -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-F __nevow_form__=controlJob -F job_id=346 \
-F ctrl.grp1.nodes="12 13" -F 'stop_tracing=Stop Tracing' \
https://www.twist.tu-berlin.de:8000/jobs/control
```

4. Collect data - To collect the specific trace file from archived job 336

```
curl -g -k --cookie /tmp/cookies.txt --cookie-jar /tmp/cookies.txt \
-d 'job_id=339' -d 'trace_name=trace_20080507_114824.0.txt.gz' \
-o trace_20080507_114824.0.txt.gz \
https://www.twist.tu-berlin.de:8000/jobs/archive/traces/download
```