TECHNISCHE UNIVERSITÄT
CHEMNITZ

Fakultät Elektrotechnik und Informationstechnik
Institut für Informationstechnik
Professur Schaltkreis- und Systementwurf

Zuverlässigkeitsprobleme von Funksensorik im Smart Home

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Introduction

- Reliability: describes the ability of a system or component to function under stated conditions for a specified period of time.

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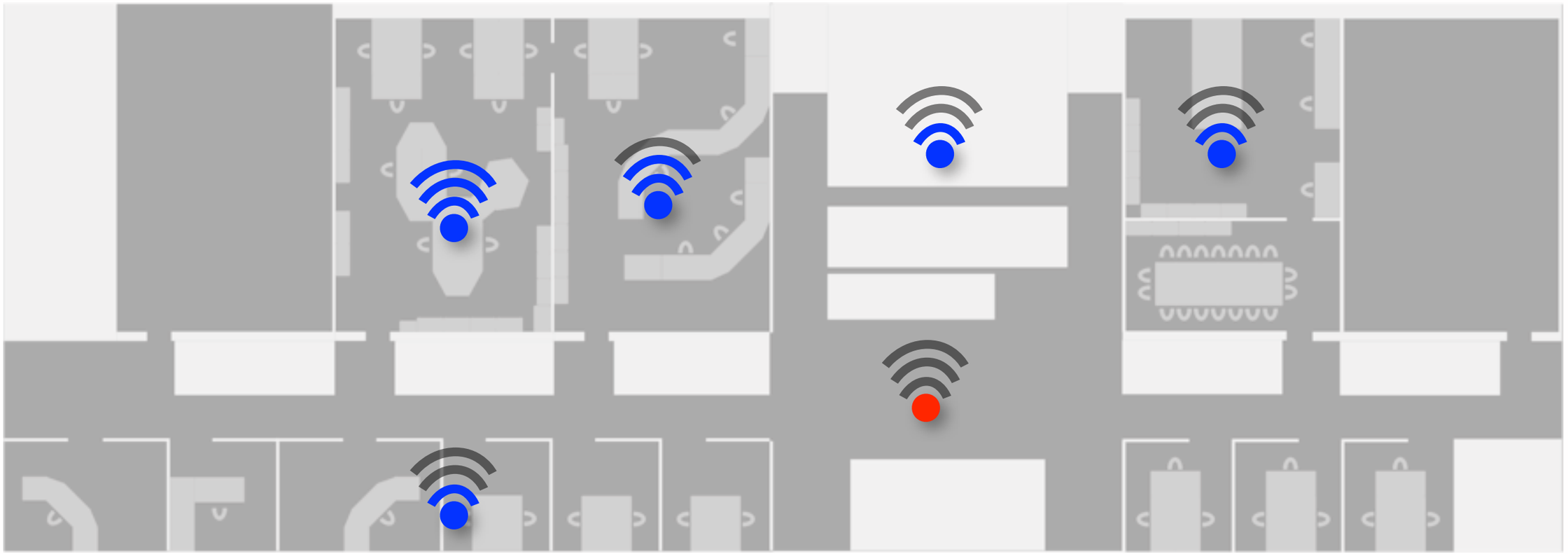
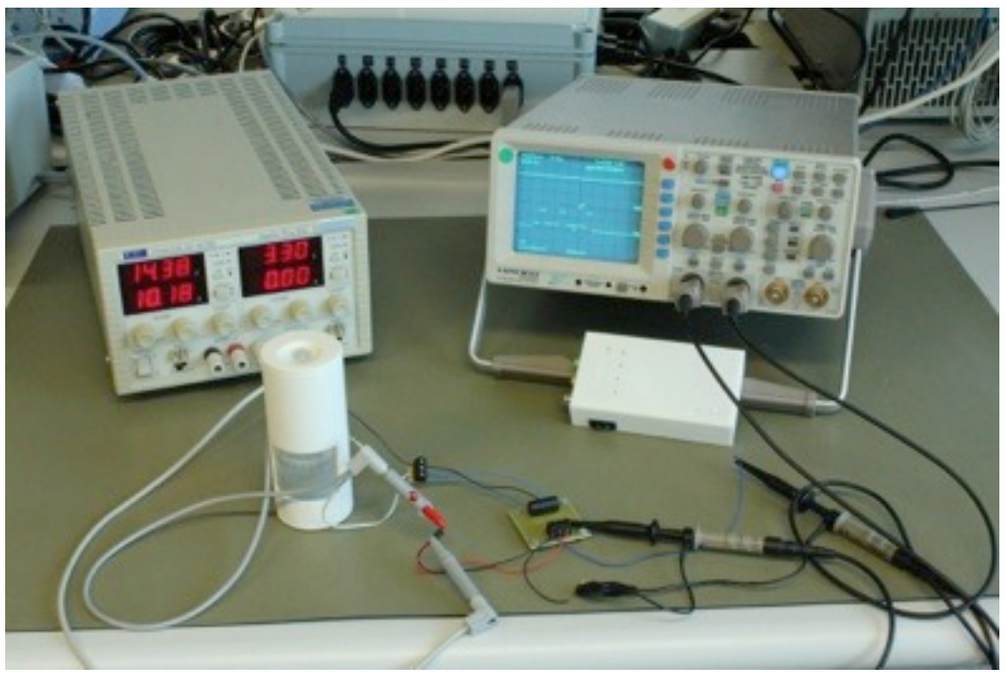
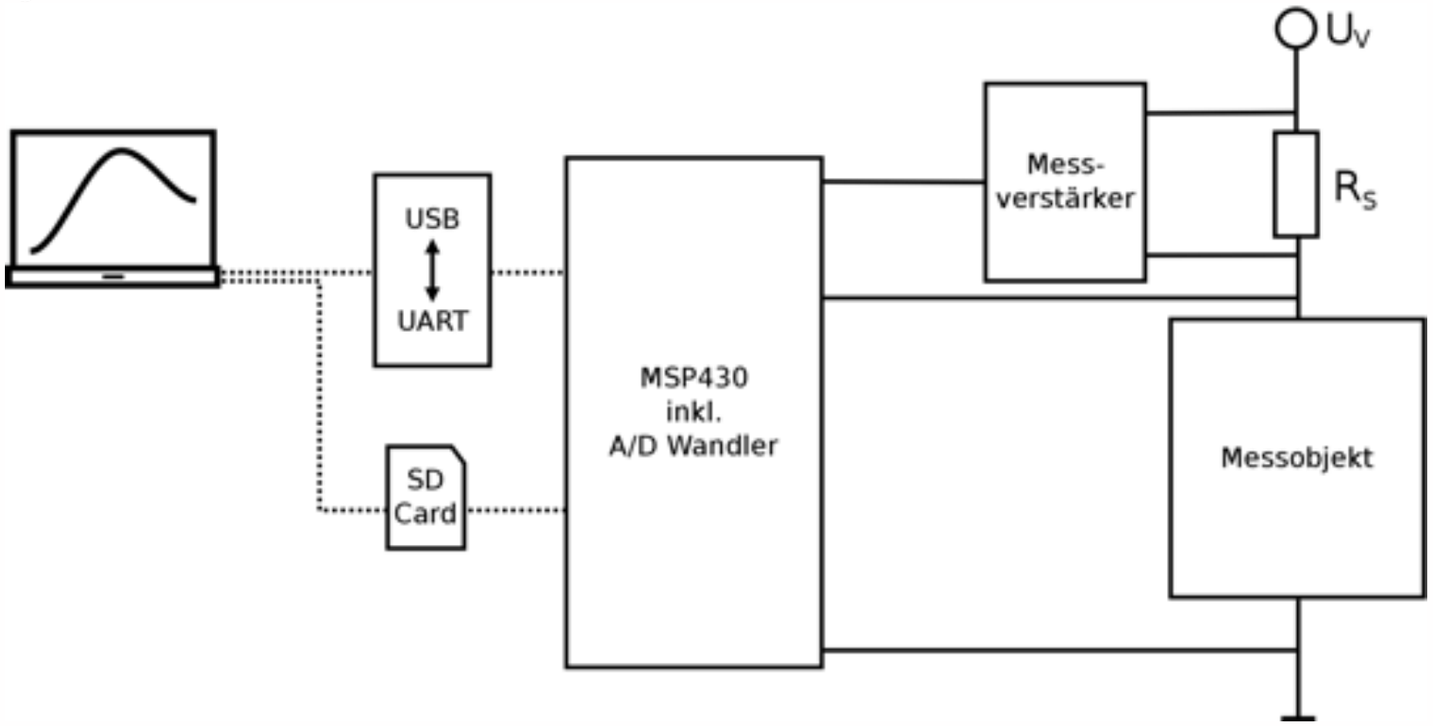


Power Consumption

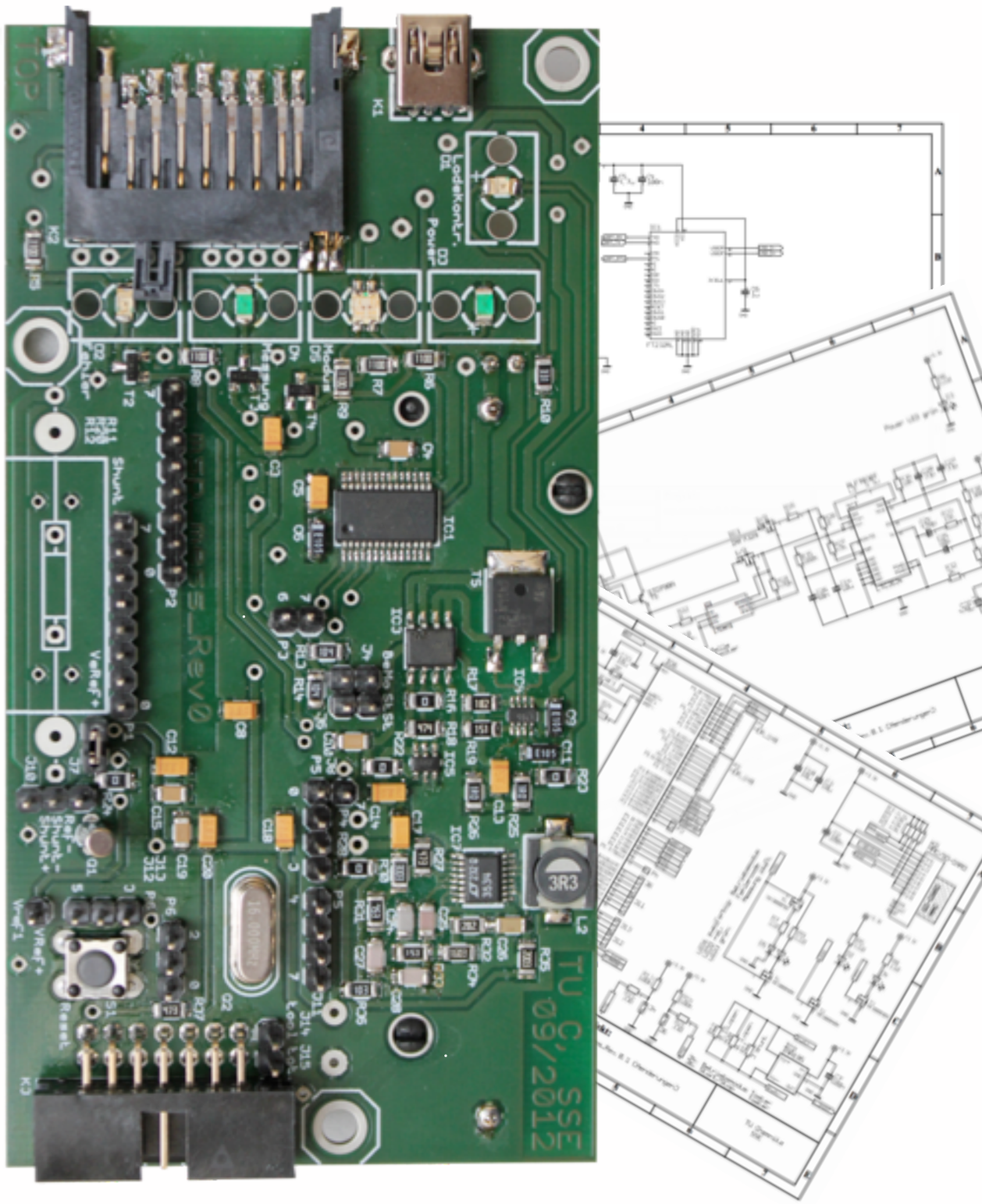
- Measurement of the current consumption of battery powered devices
- Lifetime is a hard criteria for the user
- Manufactors measure power consumption under ideal condition
- Tool to measure consumption of every device in real operation
- Distributed measurement system - interaction of different nodes





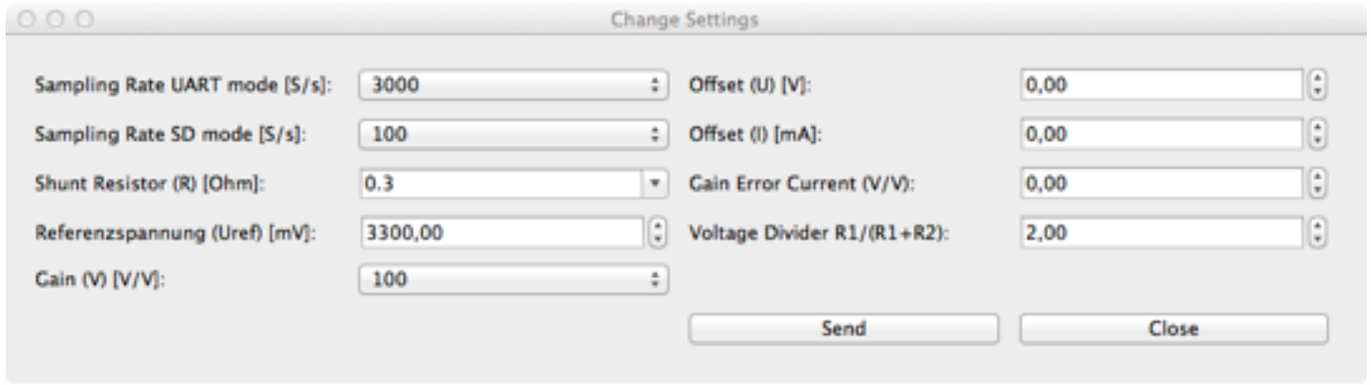
Power Consumption

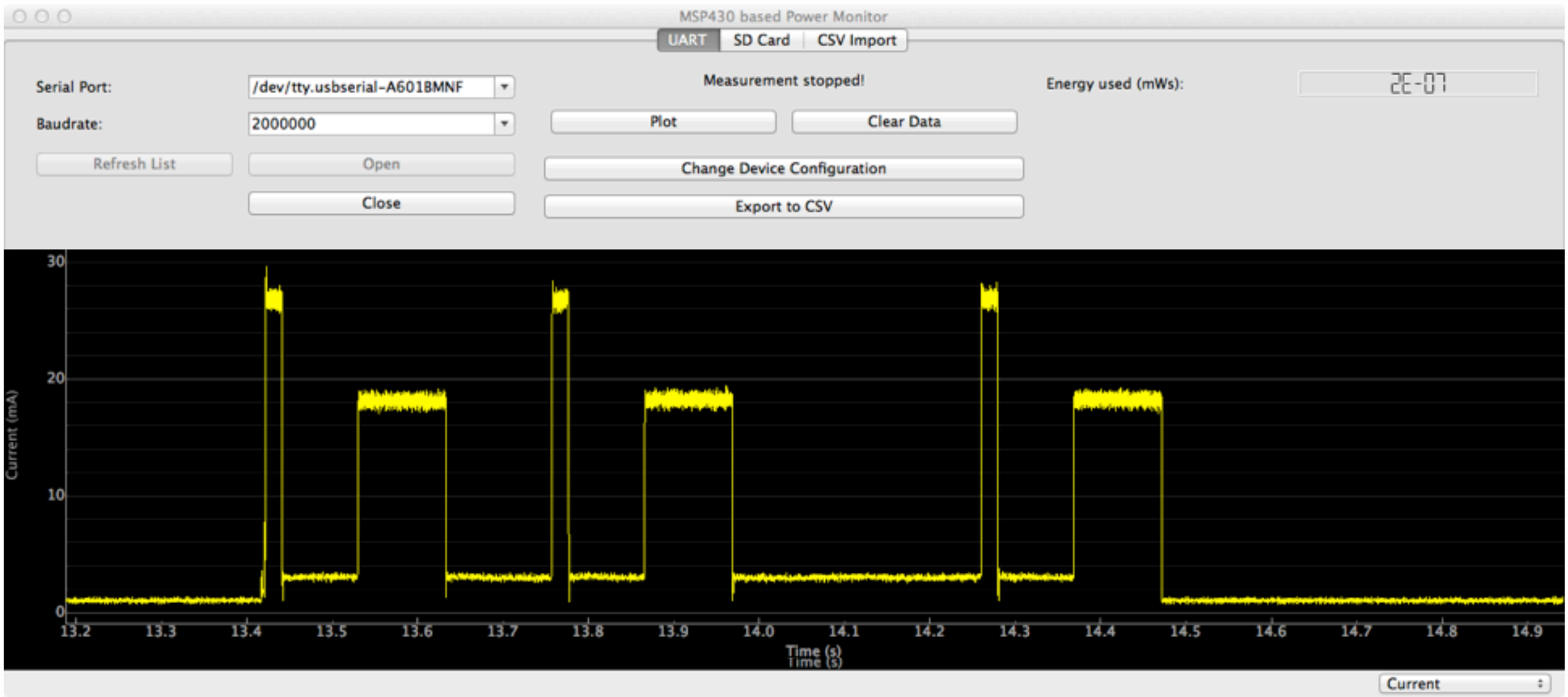
- Hardware:
  - Measurement Unit:
    - Shunt and Current Shunt Monitor
    - TI ADC12(Bit), Ref. = 3,3 V
  - Datalogger:
    - MSP430
  - Data Communication/Storage:
    - UART/FTDI 2Mbaud, SD Card (SPI)
  - Battery + Charger:
    - Li-Ion Typ18650, ~2500mAh
    - Linear Tech. (constant current)



Power Consumption

- Software
  - Python & Qt





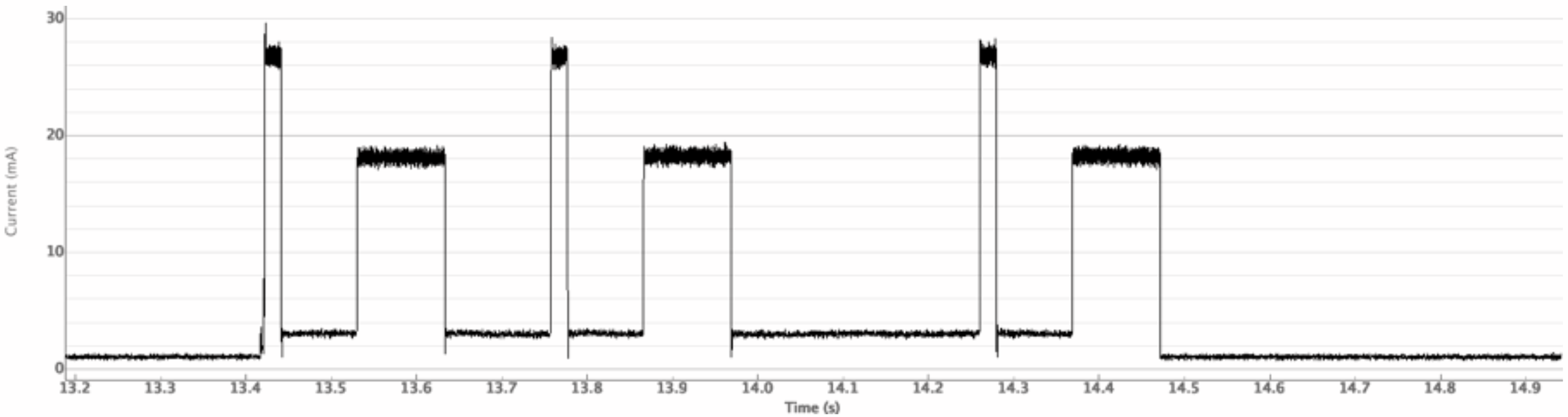
Power Consumption

- Design support
  - Measure power consumption while programming devices
  - Detect Hard-/Software failures
- Devices at the market
  - Compare different available devices
  - Reverse engineering

- Download: www.tu-chemnitz.de/etit/sse/szee/msp430leistungsmesser.html

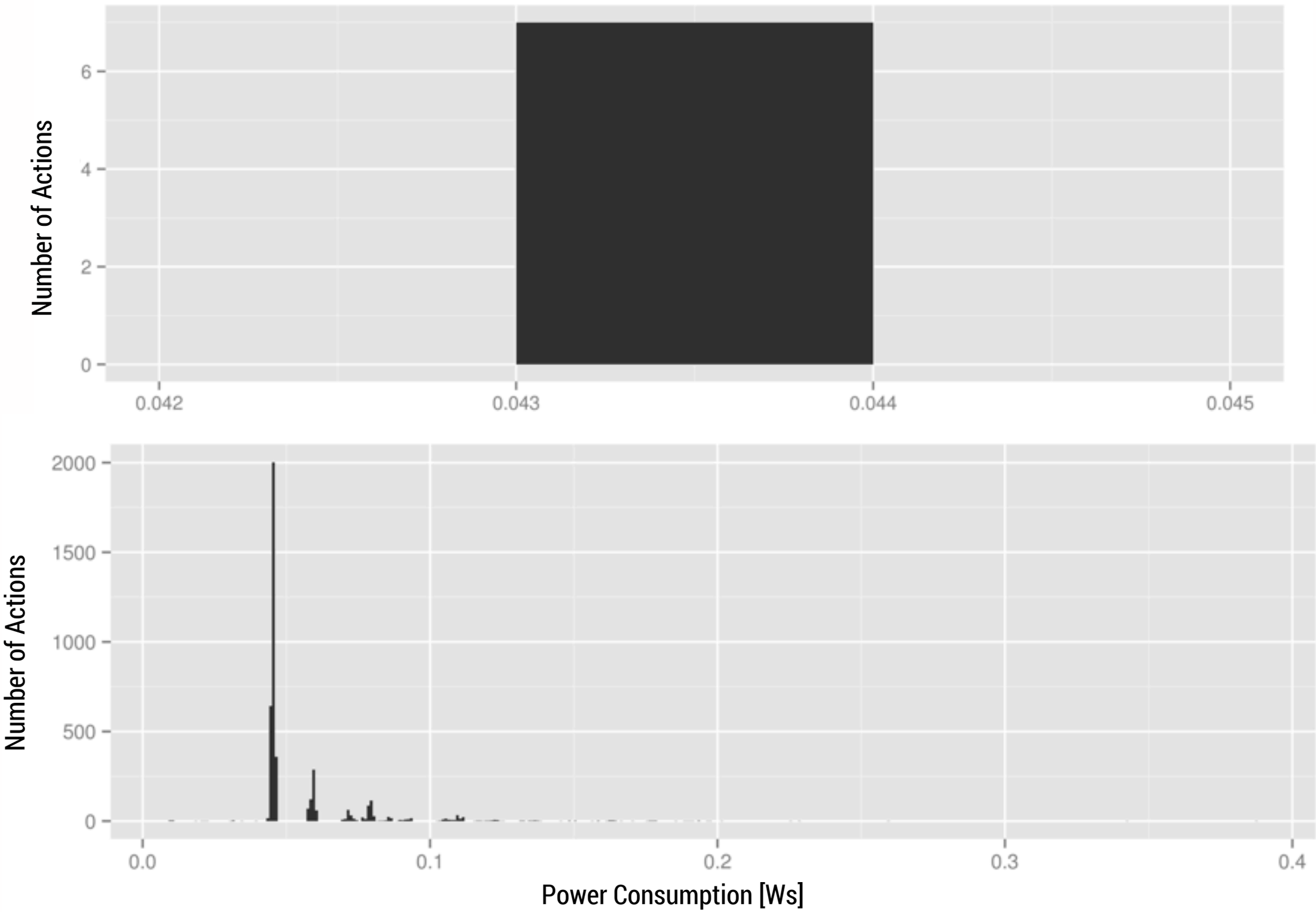
Power Consumption

- Capacity tails off by alternating load [1]
- Wireless sensor network:
  - Standby phase <-> active phase (RX, TX, uC running, ...)
  - Data communication needs high current for a short time

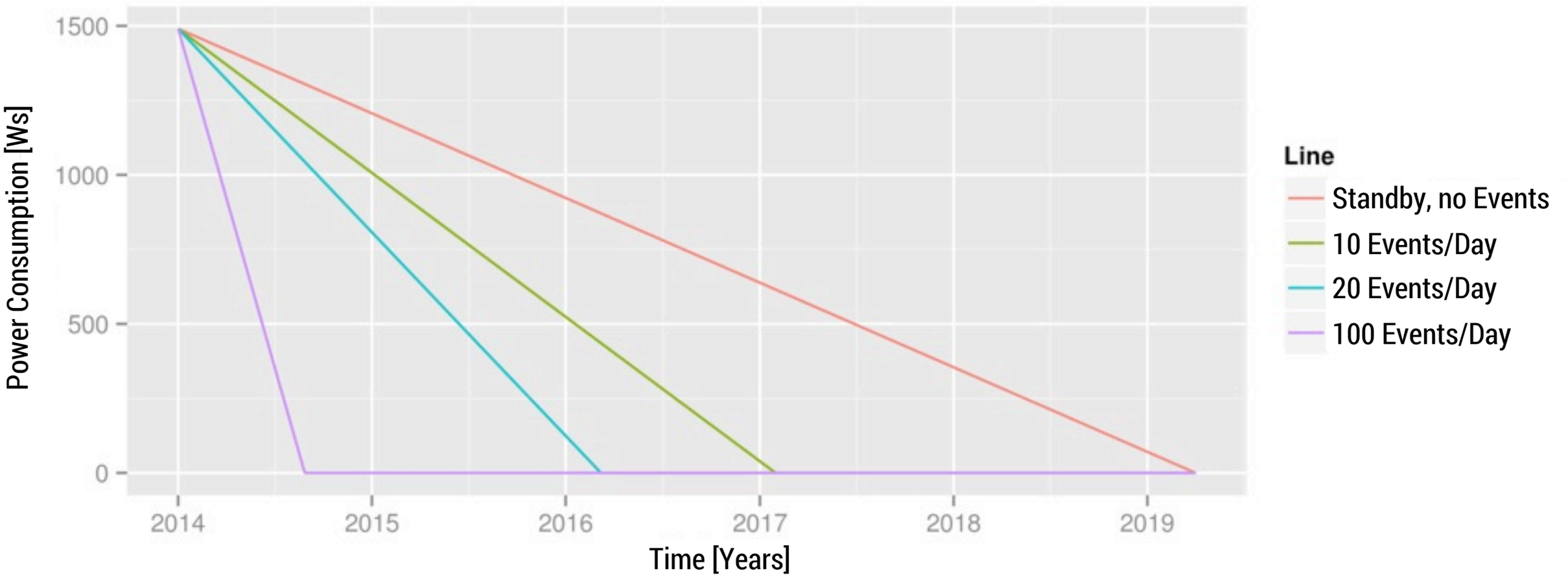


[1] Mathias Jensen. SWRA349: *Coin Cells at peak current draw*, Texas Instruments, 2010

Power Consumption



Power Consumption

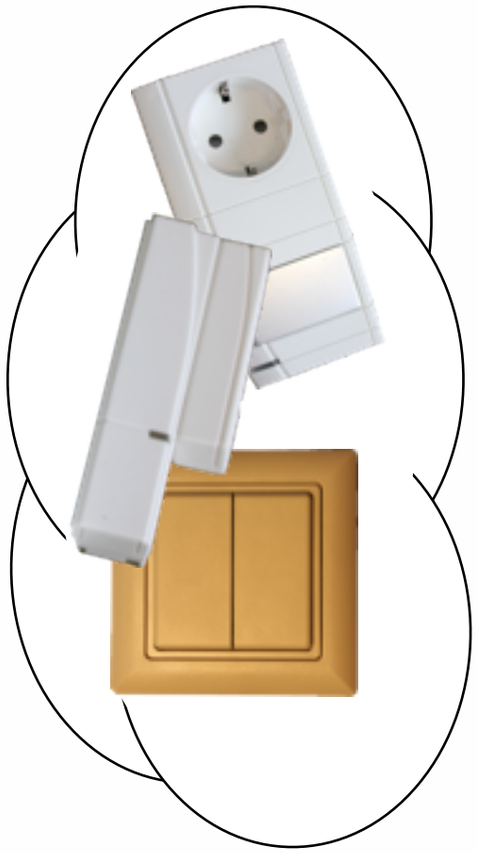


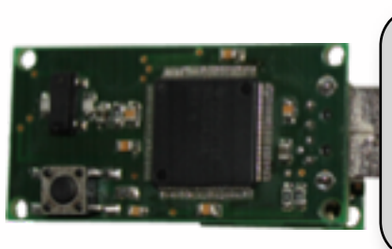
- Assumption:
  - Standby-Current 3uA
  - whole capacity of the battery can be used

SRD Network Analysis

- Supports design and monitoring data traffic in SmartHome Systems
- Routing becomes more interesting by increasing network dimension
- Secrurity becomes more important by higher distribution
- Increasing complexness by rise of functions

SRD Network Analysis

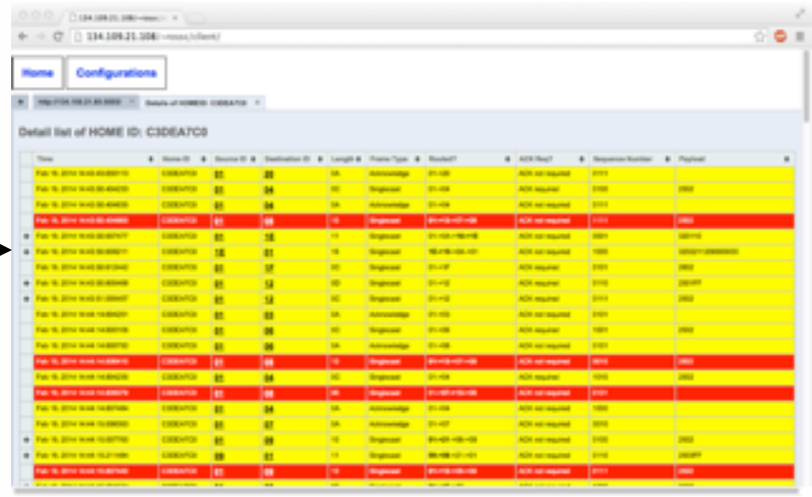




Log-PC

Log-PC

User Interface PC



- Collect radio packets
- Python Software
- Server application

- Display evaluated data packets
- PHP Software
- Client application

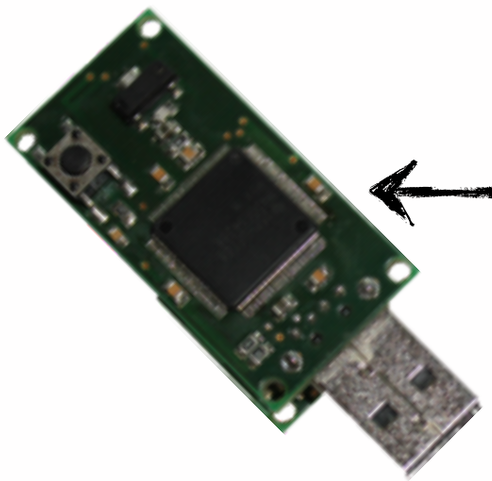
SRD Network Analysis

- Hardware
  - Transceiver:
    - TI CC1125
  - Controller:
    - MSP430
- Data Communication
  - UART/FTDI
  - Raw Data to Log-PC

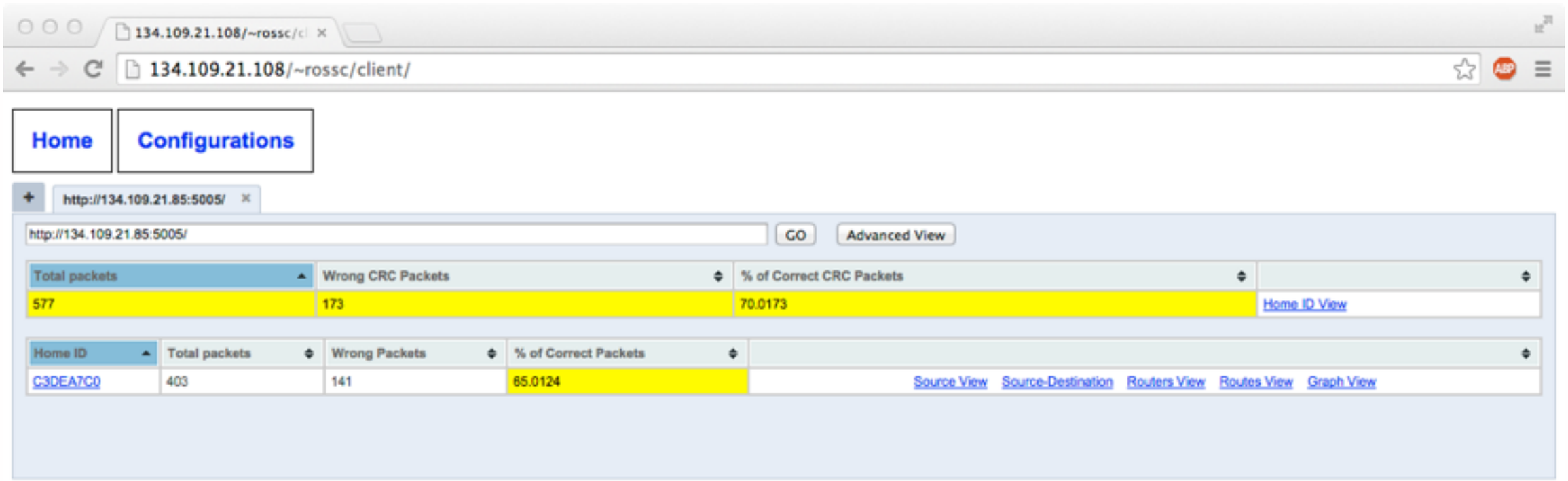
Data Rate	Frequency (EU)	Coding	Modulation
9.6 kbit/s	868.42 MHz	Manchester	FSK
40 kbit/s	868.40 MHz	NRZ	FSK
100 kbit/s	869 MHz	NRZ	GFSK

HomeID	Source NodeID	Frame Control	Length	Destination NodeID	Payload	FCS

Preamble	Start of Frame	Data Payload	End of Frame



SRD Network Analysis



SRD Network Analysis

134.109.21.108/~rossc/client/

Home | Configurations

http://134.109.21.85:5005/ | Details of HOMEID: C3DEA7C0

Detail list of HOME ID: C3DEA7C0

	Time	Home ID	Source ID	Destination ID	Length	Frame Type	Routed?	ACK Req?	Sequence Number	Payload
	Feb 19, 2014 14:43:43.655113	C3DEA7C0	01	20	0A	Acknowledge	01->20	ACK not required	0111	
	Feb 19, 2014 14:43:50.404233	C3DEA7C0	01	04	0C	Singlecast	01->04	ACK required	0100	2502
	Feb 19, 2014 14:43:50.404635	C3DEA7C0	01	04	0A	Acknowledge	01->04	ACK not required	0111	
	Feb 19, 2014 14:43:50.404863	C3DEA7C0	01	08	10	Singlecast	01->13->07->08	ACK not required	1111	2502
+	Feb 19, 2014 14:43:50.607477	C3DEA7C0	01	1E	11	Singlecast	01->0A->16->1E	ACK not required	0001	320110
+	Feb 19, 2014 14:43:50.609211	C3DEA7C0	1E	01	16	Singlecast	1E->16->0A->01	ACK not required	1000	3202211200000000
	Feb 19, 2014 14:43:50.612442	C3DEA7C0	01	1F	0C	Singlecast	01->1F	ACK required	0101	2602
+	Feb 19, 2014 14:43:50.805468	C3DEA7C0	01	12	0D	Singlecast	01->12	ACK required	0110	2501FF
+	Feb 19, 2014 14:43:51.005457	C3DEA7C0	01	12	0C	Singlecast	01->12	ACK required	0111	2502
	Feb 19, 2014 14:44:14.604251	C3DEA7C0	01	03	0A	Acknowledge	01->03	ACK not required	0101	
	Feb 19, 2014 14:44:14.605106	C3DEA7C0	01	06	0C	Singlecast	01->06	ACK required	1001	2502
	Feb 19, 2014 14:44:14.605750	C3DEA7C0	01	06	0A	Acknowledge	01->06	ACK not required	0101	
	Feb 19, 2014 14:44:14.606410	C3DEA7C0	01	08	10	Singlecast	01->13->07->08	ACK not required	0010	2602
	Feb 19, 2014 14:44:14.804235	C3DEA7C0	01	04	0C	Singlecast	01->04	ACK required	1010	2502
	Feb 19, 2014 14:44:14.806079	C3DEA7C0	01	08	0E	Singlecast	01->07->13->08	ACK not required	0101	
	Feb 19, 2014 14:44:14.807484	C3DEA7C0	01	04	0A	Acknowledge	01->04	ACK not required	1000	
	Feb 19, 2014 14:44:15.006063	C3DEA7C0	01	07	0A	Acknowledge	01->07	ACK not required	0010	
+	Feb 19, 2014 14:44:15.007765	C3DEA7C0	01	09	10	Singlecast	01->21->08->09	ACK not required	0100	2502
+	Feb 19, 2014 14:44:15.211484	C3DEA7C0	09	01	11	Singlecast	09->08->21->01	ACK not required	0110	2503FF
	Feb 19, 2014 14:44:15.807440	C3DEA7C0	01	09	10	Singlecast	01->12->06->09	ACK not required	0111	2502

SRD Network Analysis

134.109.21.108/~rossc/client/

Home | Configurations

http://134.109.21.85:5005/

http://134.109.21.85:5005/ GO Advanced View

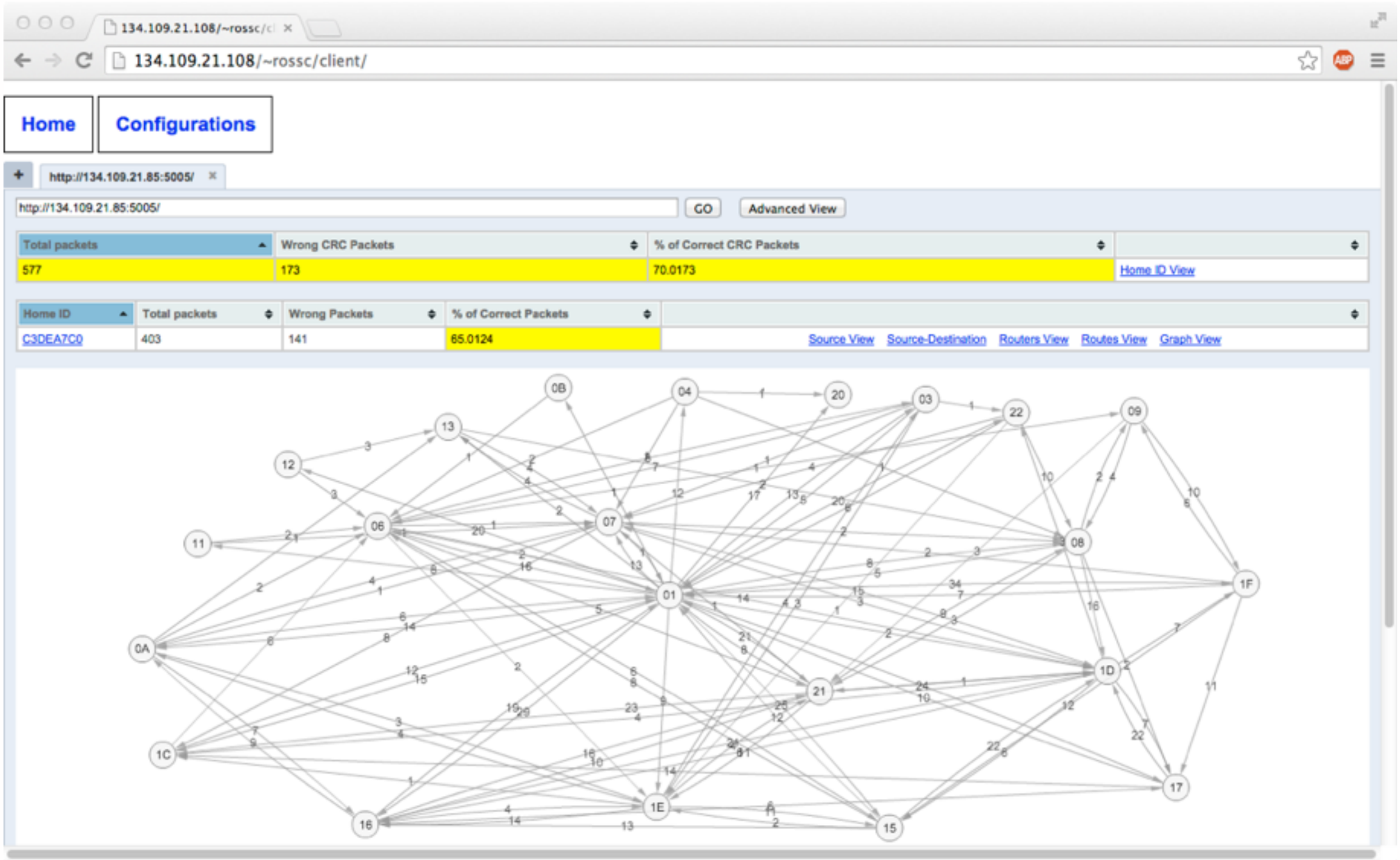
Total packets	Wrong CRC Packets	% of Correct CRC Packets	
577	173	70.0173	Home ID View

Home ID	Total packets	Wrong Packets	% of Correct Packets	
C3DEA7C0	403	141	65.0124	Source View Source-Destination Routers View Routes View Graph View

Routes View of HomeID: C3DEA7C0

Route(Source node => Routing node => ... => Destination node)	# of use
01 => 20	17
01 => 12	14
01 => *16* => *21* => 1E	11
01 => *17* => *1C* => 1D	10
01 => 1F	10
01 => 21	9
01 => 22	9
01 => *15* => *16* => 1D	9
01 => *1C* => 1D	8
01 => *15* => 1D	8
01 => *22* => *08* => 1D	8
01 => *17* => 1D	8
01 => 03	8
01 => *16* => 1D	8
01 => *1F* => *15* => 1D	8
01 => *1F* => *17* => 1D	8
01 => 06	8

SRD Network Analysis



Conclusion

- Tool for Analysis of:
  - power consumption and empty battery prediction
  - monitoring radio communication
- Evaluation of power consumption of different distributors and empty battery prediction
- Recording and evaluation of Z-Wave communication in a real home installation

Thanks

The presented work is part of the project „Generic Platform for System Reliability and Verification“ (03IPT505X), funded by the „German Ministry for Education and Research“ (BMBF) within the „InnoProfile - Unternehmen Region“ framework.