Computer-aided design of communications circuits and systems on FPGA and USRP platforms for green communication

Presented by Zdravka Tchobanova

More about me

- Zdravka Tchobanova - Ph. D. student

- Department "Technology and management of communication systems", Faculty of Telecommunications, Technical University-Sofia, Bulgaria

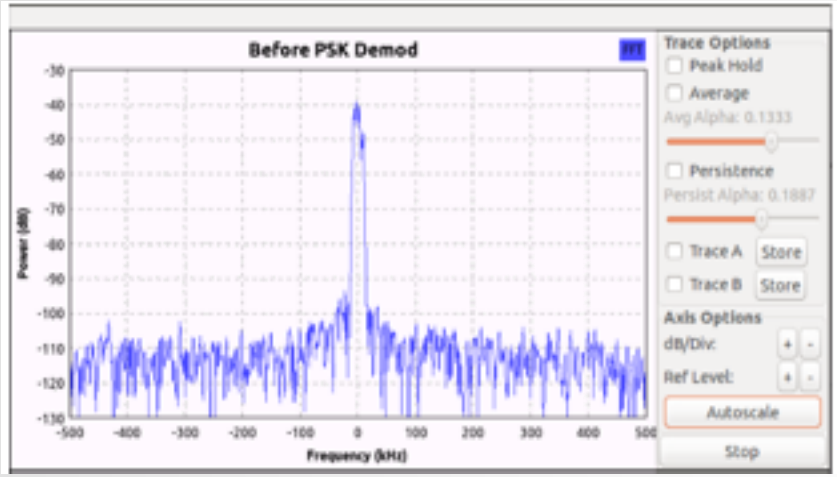
- Computer-aided design and effective implementation of algorithms and architectures for communications on platforms with programmable circuits and universal peripherals for software radio

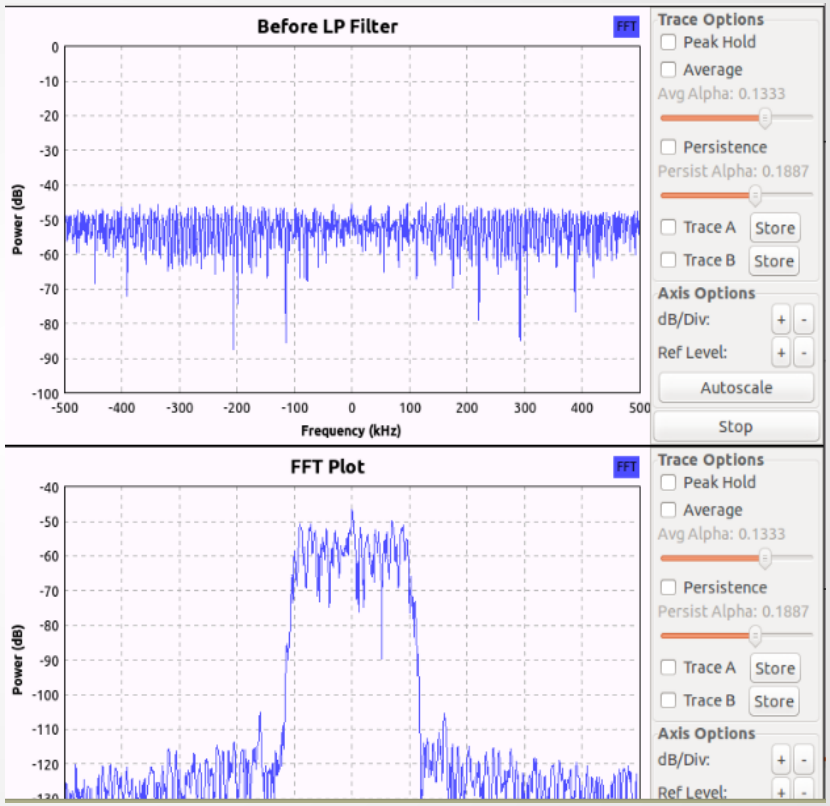
- Tutor: Galia Marinova, Associate professor, Ph.D.

Current developments

- Implementation of USRP and GNU Radio for reception, processing and recovering of a QPSK modulated signal
- Cooperative spectrum sensing with Energy detector
- Power consumption estimation of a USRP and of a Kasami pseudo-random suit generator circuit design on FPGA using Vivado 2014 tool of Xilinx.

USRP : QPSK demodulator

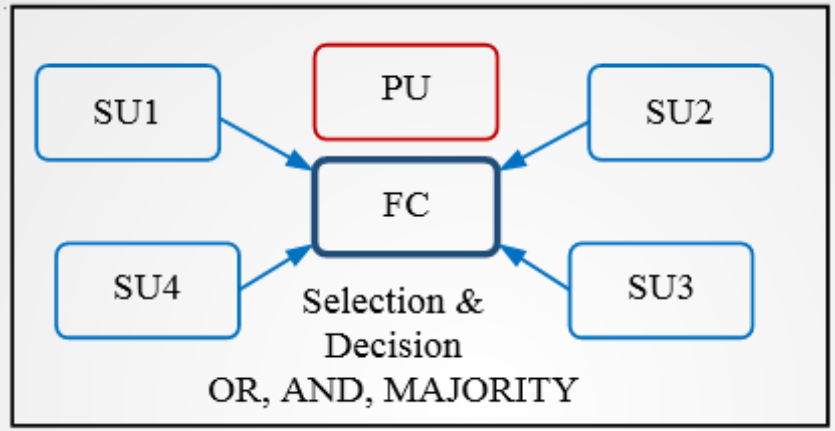




The steps of signal processing:

filtering and demodulation

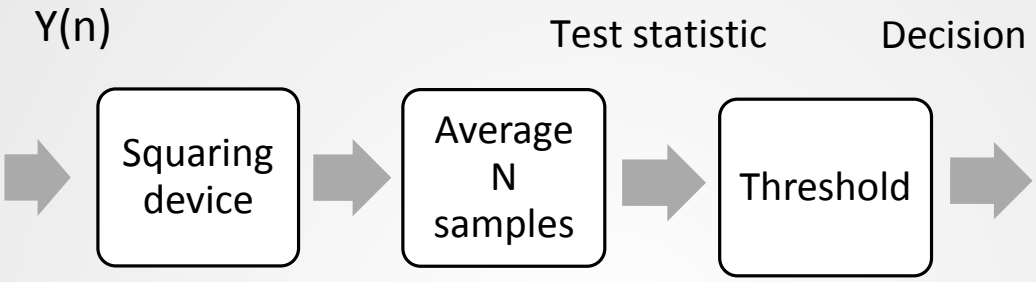
Cooperative spectrum sensing



Block diagram of the centralized model of cooperative sensing system.

The FC combines sensing results and makes the global decision by “and”, “or” and majority rule.

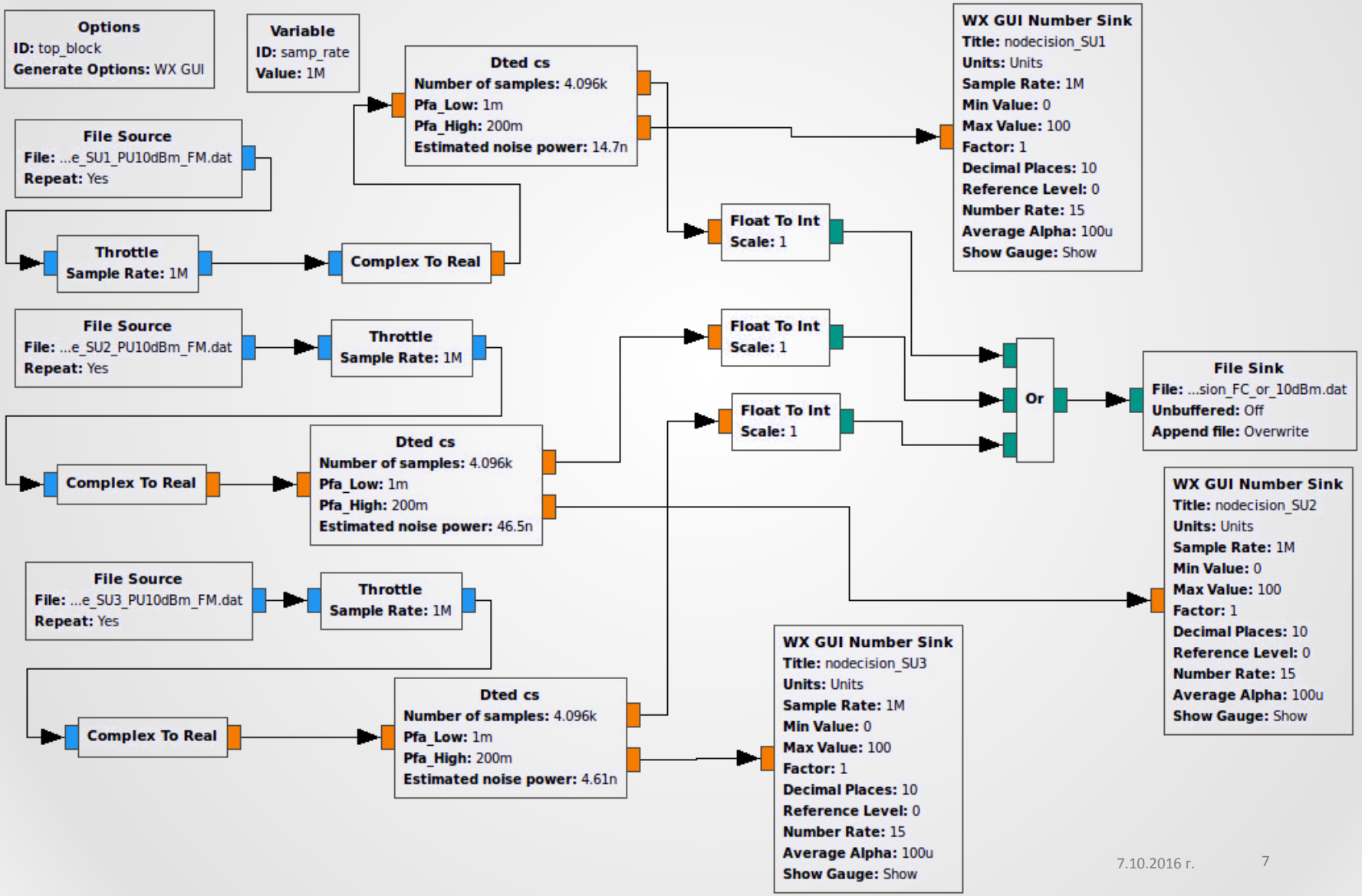
Energy Detector spectrum sensing



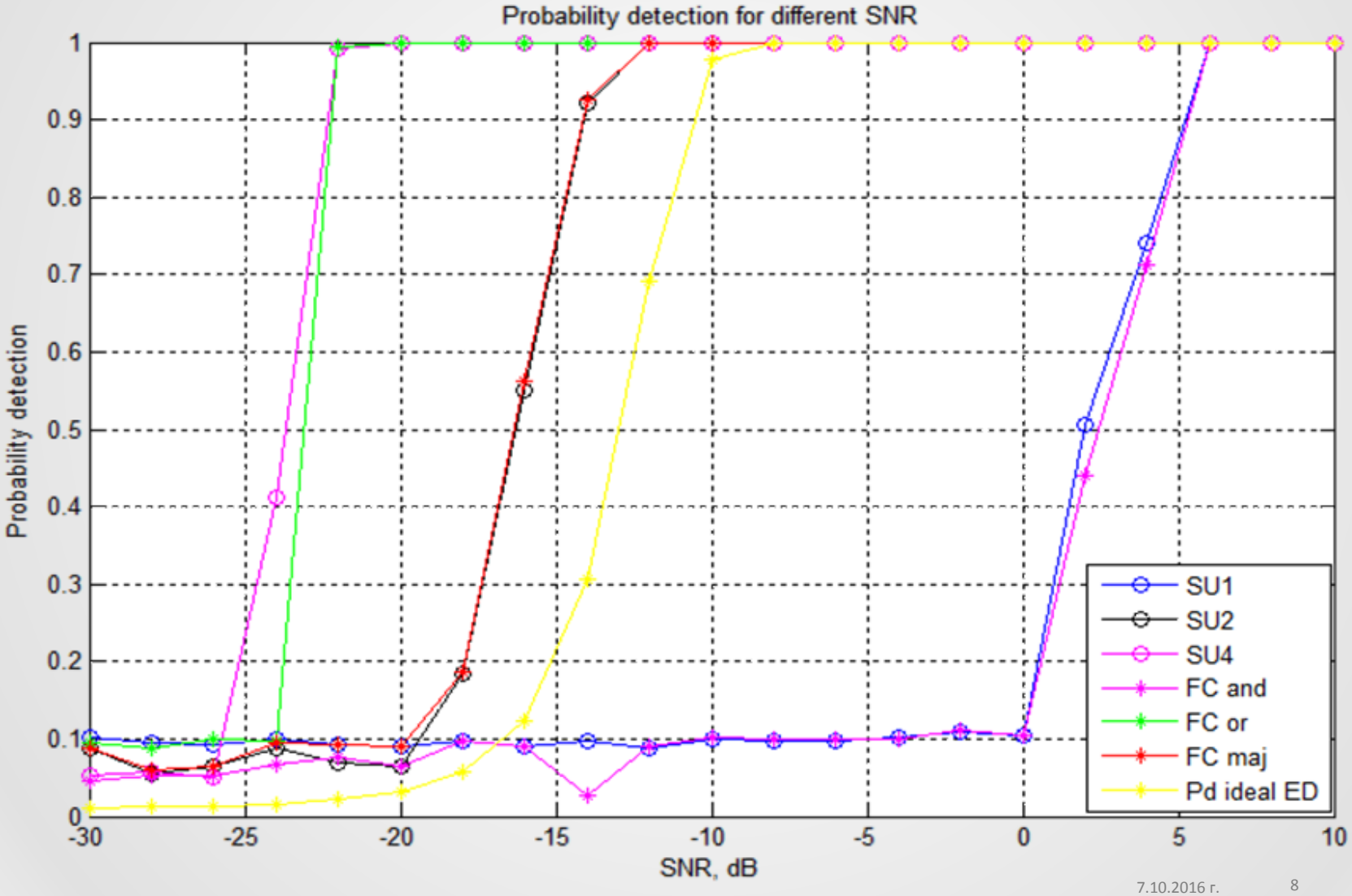
Energy Detector Block diagram

ED collects the energy for each channel and compares this energy with a threshold that is used for making decision: if there is a signal in the channel or not.

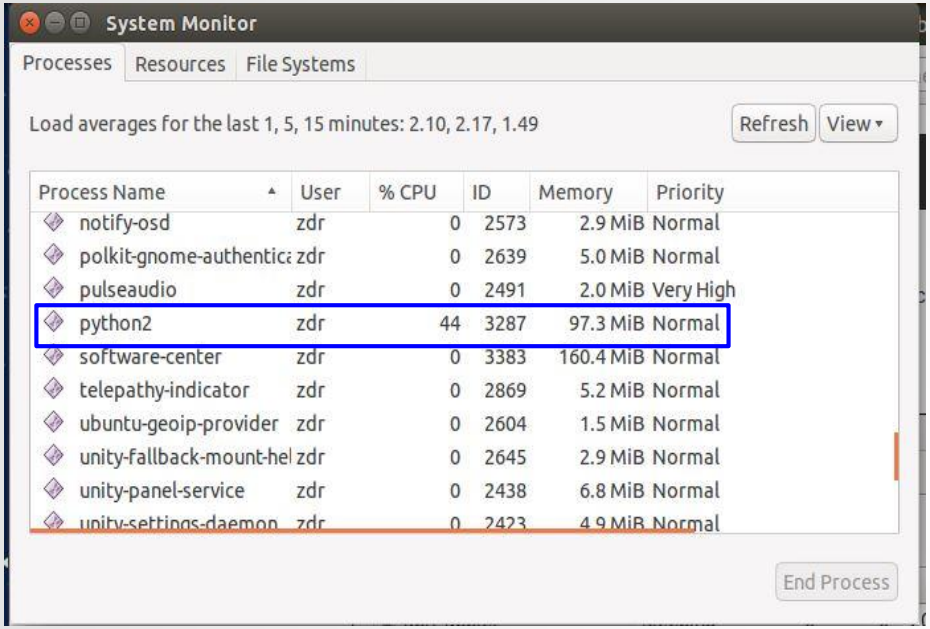
Test Bed

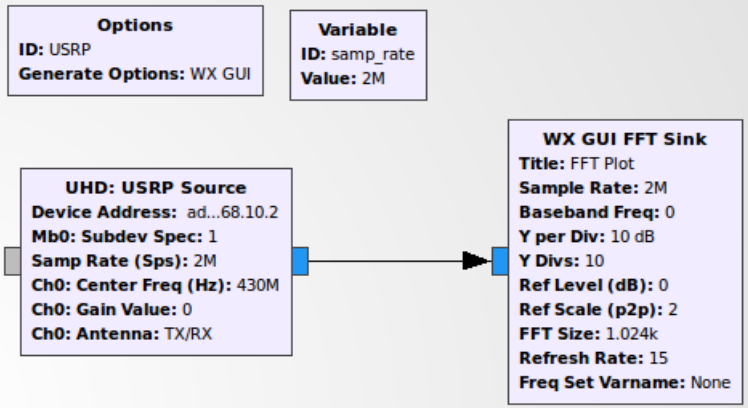

Options
ID: top_block
Generate Options: WX GUI
Variable
ID: samp_rate
Value: 1M
Dted cs
Number of samples: 4.096k
Pfa_Low: 1m
Pfa_High: 200m
Estimated noise power: 14.7n
WX GUI Number Sink
Title: nodecision_SU1
Units: Units
Sample Rate: 1M
Min Value: 0
Max Value: 100
Factor: 1
Decimal Places: 10
Reference Level: 0
Number Rate: 15
Average Alpha: 100u
Show Gauge: Show
File Source
File: ...e_SU1_PU10dBm_FM.dat
Repeat: Yes
Throttle
Sample Rate: 1M
Complex To Real
Float To Int
Scale: 1
File Source
File: ...e_SU2_PU10dBm_FM.dat
Repeat: Yes
Throttle
Sample Rate: 1M
Float To Int
Scale: 1
Or
File Sink
File: ...sion_FC_or_10dBm.dat
Unbuffered: Off
Append file: Overwrite
Complex To Real
Dted cs
Number of samples: 4.096k
Pfa_Low: 1m
Pfa_High: 200m
Estimated noise power: 46.5n
Float To Int
Scale: 1
WX GUI Number Sink
Title: nodecision_SU2
Units: Units
Sample Rate: 1M
Min Value: 0
Max Value: 100
Factor: 1
Decimal Places: 10
Reference Level: 0
Number Rate: 15
Average Alpha: 100u
Show Gauge: Show
File Source
File: ...e_SU3_PU10dBm_FM.dat
Repeat: Yes
Throttle
Sample Rate: 1M
Complex To Real
Dted cs
Number of samples: 4.096k
Pfa_Low: 1m
Pfa_High: 200m
Estimated noise power: 4.61n
WX GUI Number Sink
Title: nodecision_SU3
Units: Units
Sample Rate: 1M
Min Value: 0
Max Value: 100
Factor: 1
Decimal Places: 10
Reference Level: 0
Number Rate: 15
Average Alpha: 100u
Show Gauge: Show

Results


Probability detection for different SNR
Probability detection
SNR, dB
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-30
-25
-20
-15
-10
-5
0
5
10
SU1
SU2
SU4
FC and
FC or
FC maj
Pd ideal ED

Estimate USRP's energy consumption

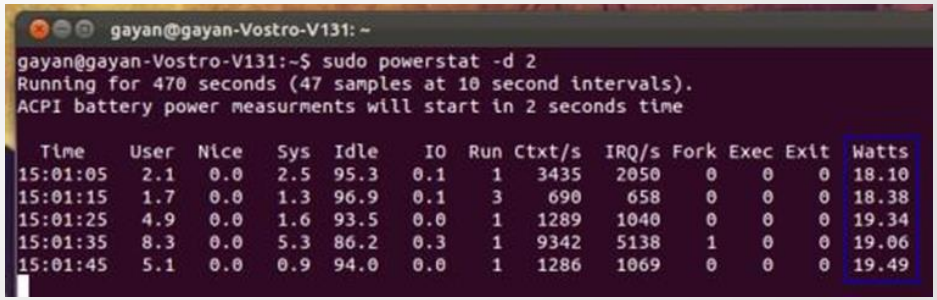




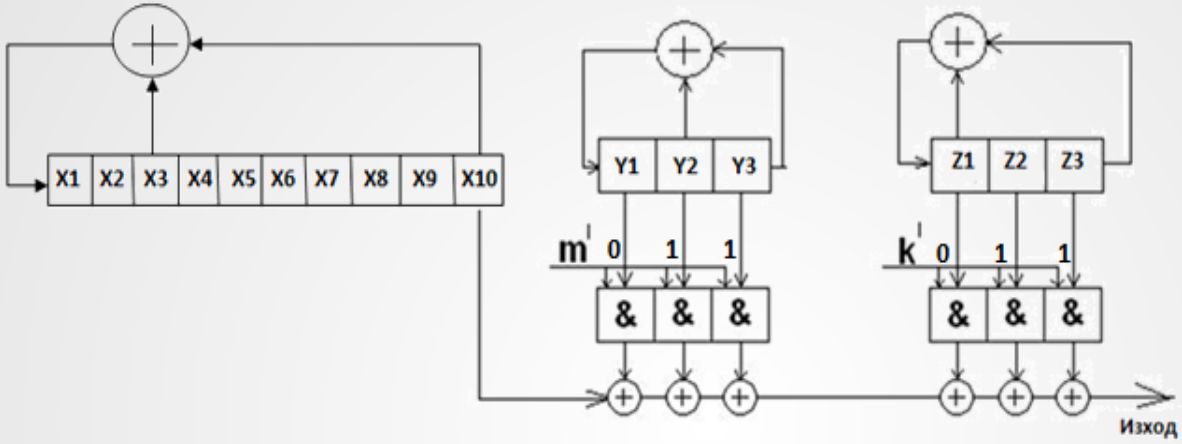
Flowgraph of a receiver

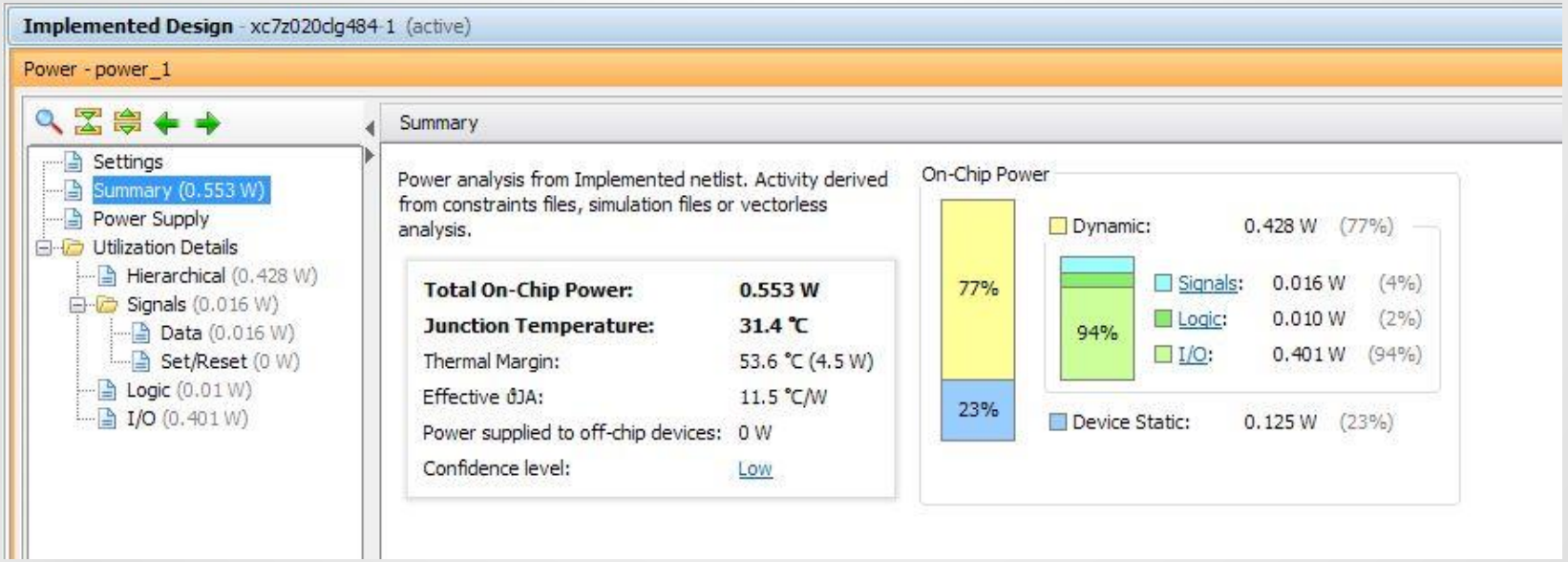
Gnome System Monitor tool

Powerstat: Power Consumption Calculator for Ubuntu Linux



Estimate circuit's energy consumption





Power summery

Further work

- Cooperative spectrum sensing with uncertainty
- Defining projects' constrains from electromagnetic emission standards in communication
- Optimization for reducing projects' electromagnetic emission for communication circuits
- Optimization of communication circuits projects and systems for reducing energy consumption

Questions?