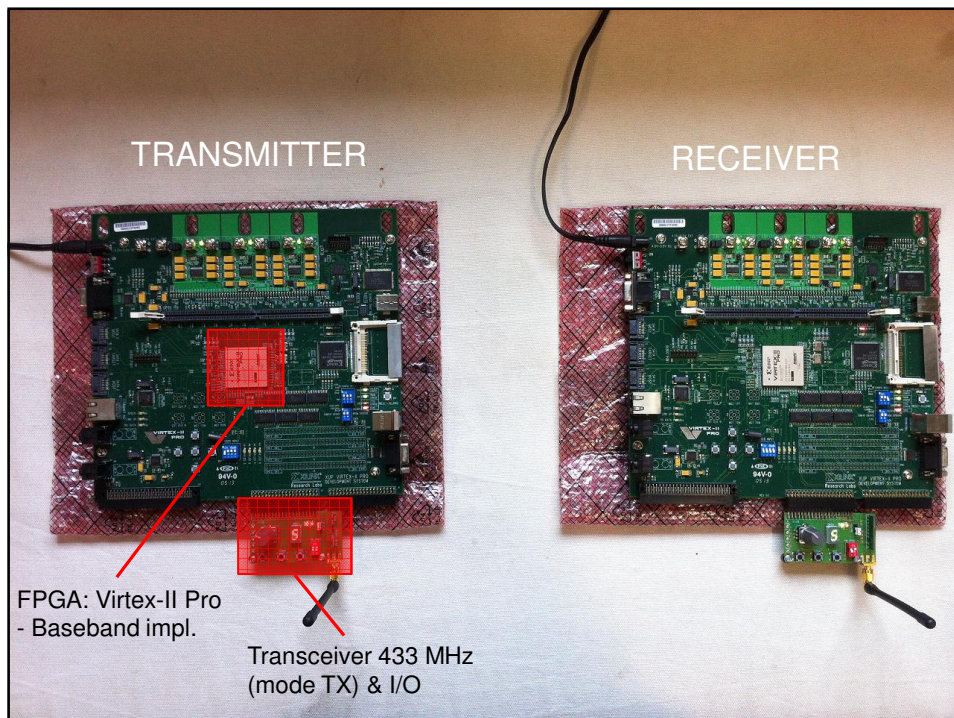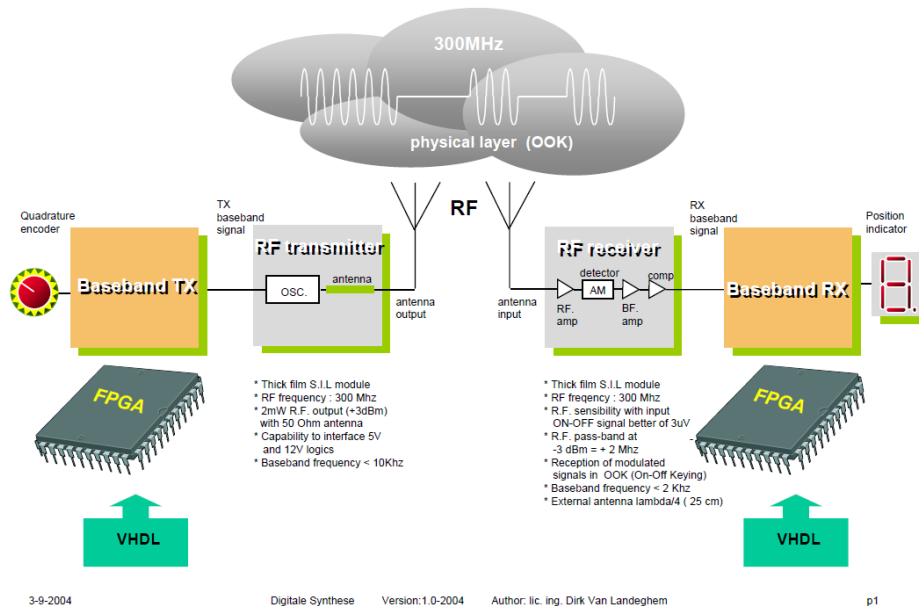# Lab Digital Synthesis

- 9 lab sessions, 1.5 hours
- Permanent evaluation, last lab session evaluation
- What?
  - Digital Electronics: VHDL ➔ FPGA
  - Wireless transmit-receive system
  - Direct Sequence Spread Spectrum (DSSS) technology

Spread Spectrum Wireless Communication

FPGA: Virtex-II Pro
- Baseband impl.

Transceiver 433 MHz
(mode TX) & I/O

TRANSMITTER

RECEIVER

Assignment

- **Prepare demo!**
  - Send 4 bit binary word using DSSS technology
  - Input on TX with up/down pushbutton (or rotary encoder), readout on 7-seg
  - Output on RX using 7-seg

- **DSSS: Direct Sequence Spread Spectrum**
  - Originally developed for military purposes
 - GPS systems
  - GSM

DSSS – What?

- Traditional RF: send on 1 frequency
  - disadvantages:
    - Easily traceable
    - Jamming

- DSSS = spread frequency spectrum
  - More difficult to trace
  - Jamming difficult
  - More users per channel (different PN code)
  - Possibly under noise floor

As the pulses in time get shorter, the frequency bandwidth gets larger
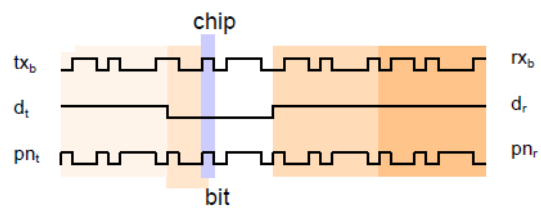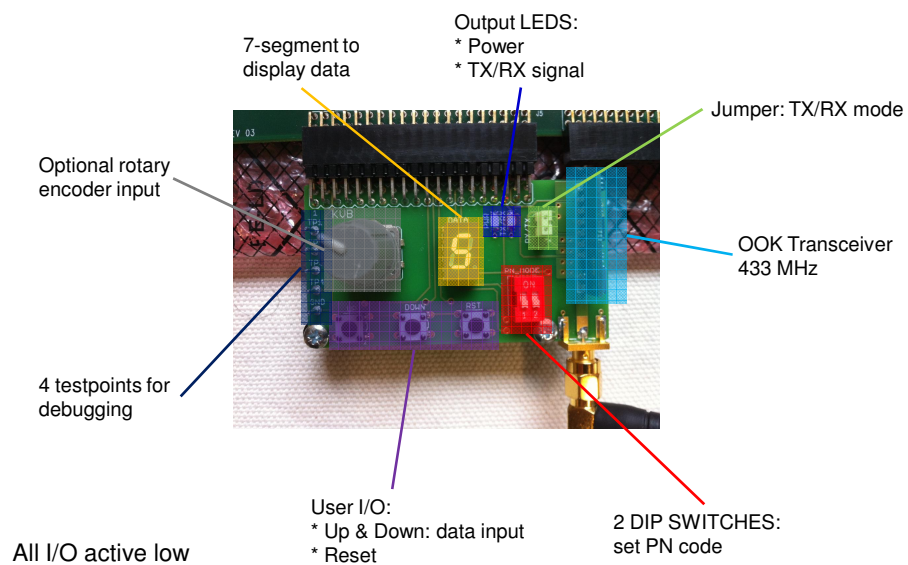
B_s

B_c

f

t

T_c

T_s
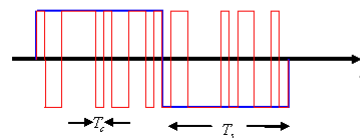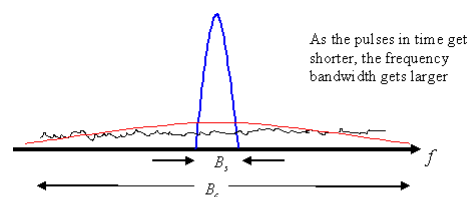
DSSS – How?

- XOR input data with PN code
  - XOR = Conditional inverter
  - 2 times XOR'ed data = original data
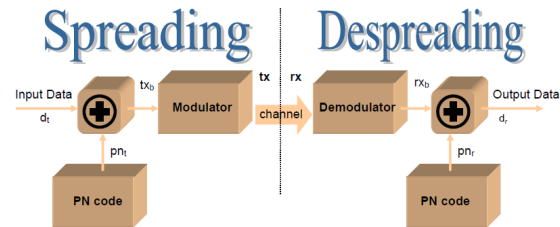
- Data: # bits: packet
- Every bit XOR with PN code: chips
  - Chips have higher frequency
- Note: we use 3 possible PN codes


Hardware: transceiver module

7-segment to display data

Output LEDS:
* Power
* TX/RX signal

Jumper: TX/RX mode

Optional rotary encoder input

OOK Transceiver 433 MHz

4 testpoints for debugging

User I/O:
* Up & Down: data input
* Reset

2 DIP SWITCHES: set PN code

All I/O active low

Workflow

- Write VHDL code
- Simulation of VHDL code } Modelsim
- Synthesize VHDL code } Xilinx ISE
- Bit-file download } Xilinx Impact
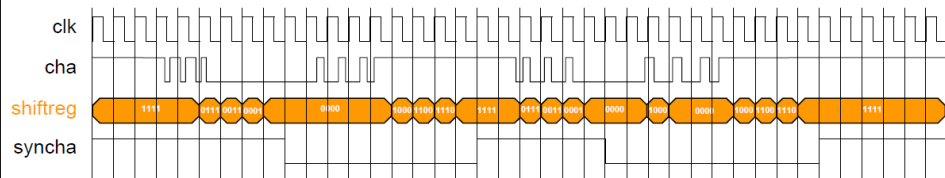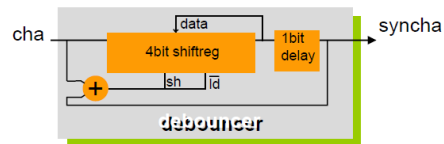
Attention!

- Make use of two process method
  - See PDF (fsm.pdf): http://telescript.denayer.wenk.be/~kvb/Labo_Digitale_Synthese/
- Work modular: testbench for each block
- Add comments (will be quoted)!
- Take backups (own responsibility)
- Simulations run from USB stick are slower
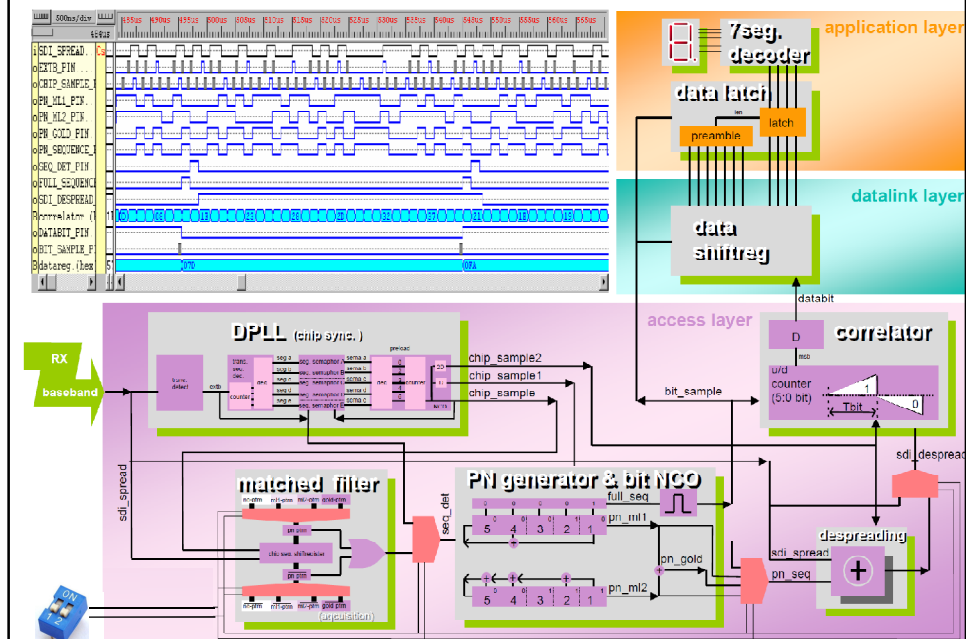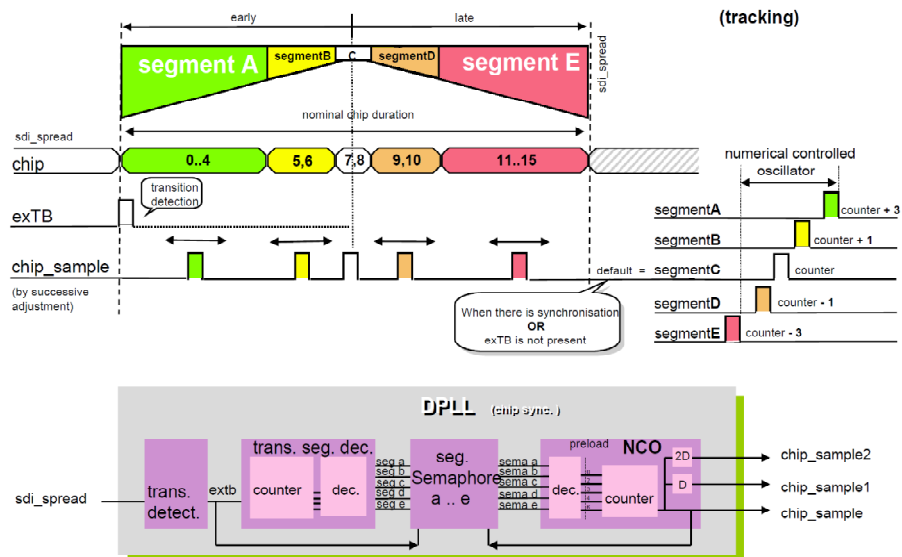- Walkthrough with counter (telescript)

Spread Spectrum TX : Baseband
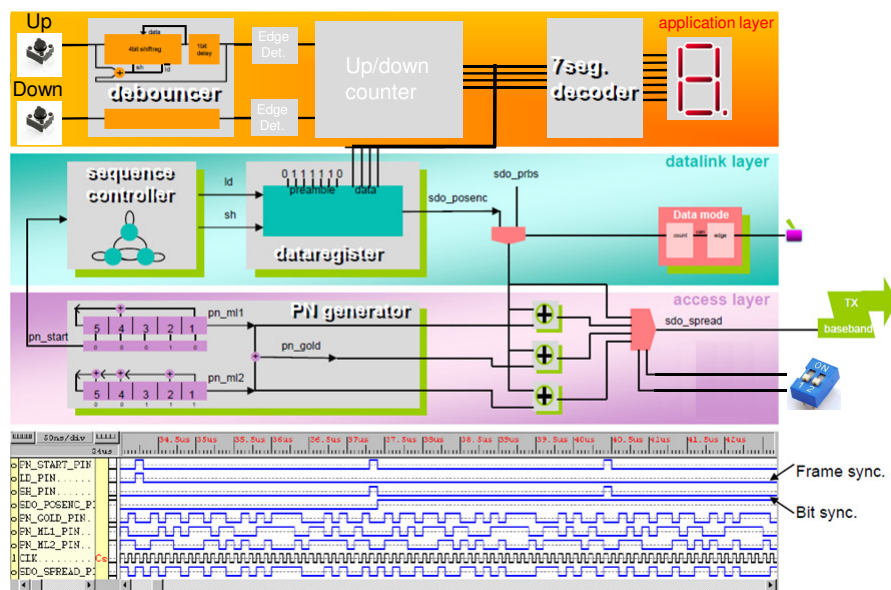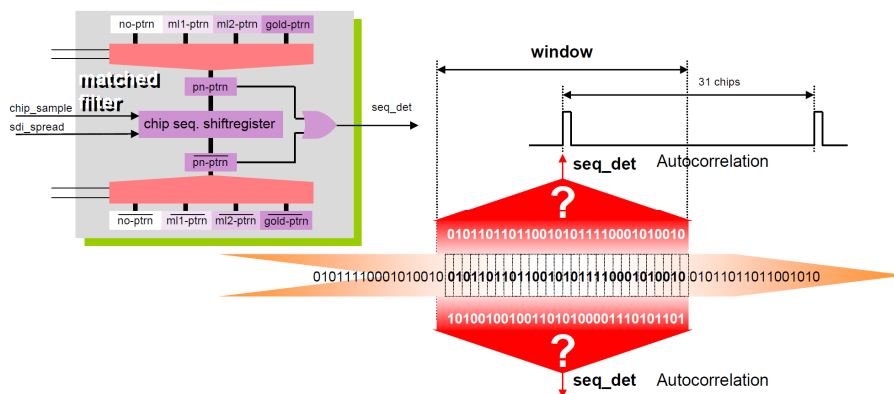
Spread Spectrum TX : Debouncer

Spread Spectrum RX : Baseband

Baseband RX Chip Synchronisation (tracking)

Baseband RX   PN matched filter (acquisition)

Baseband RX Correlator (integrate & dump)