LUND UNIVERSITY

# IC-project 1
# Project Proposal 2015

JOACHIM RODRIGUES, LUND UNIVERSITY, EIT

# Contents

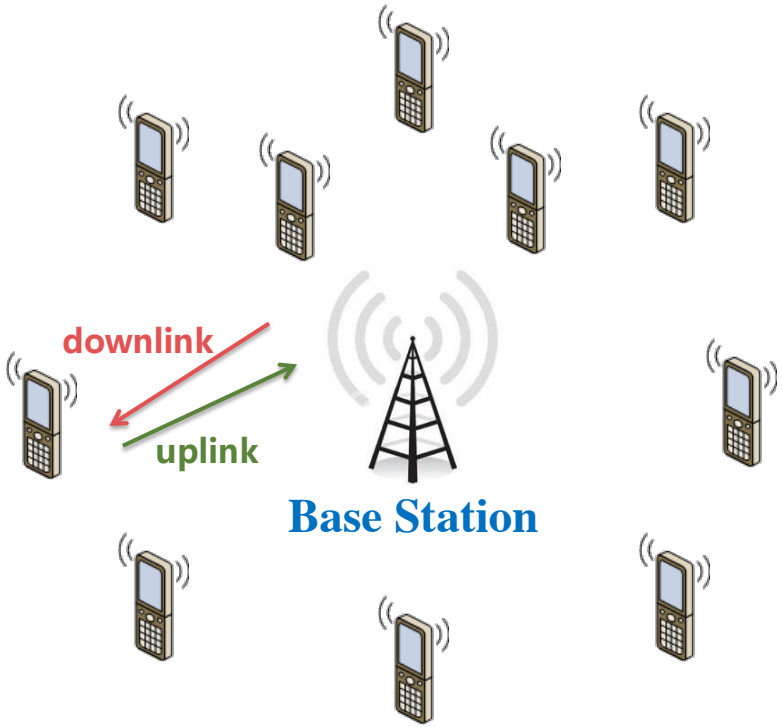
- This document presents the project which will be offered in the digital track of ETIN35
- Please get an idea of the different projects and contact the project supervisor for more information
- By March 13th you need to send an email to Joachim Rodrigues where you state:
  - 1st preference
  - 2nd preference
  - Project partner

LUND UNIVERSITY

# Projects

- Channel Estimation-Steffen Malkowsky
- Successive Interference Cancellation -Steffen Malkowsky
- QR Decomposition- Hemanth Prabhu
- RISC processor- Michal Stala

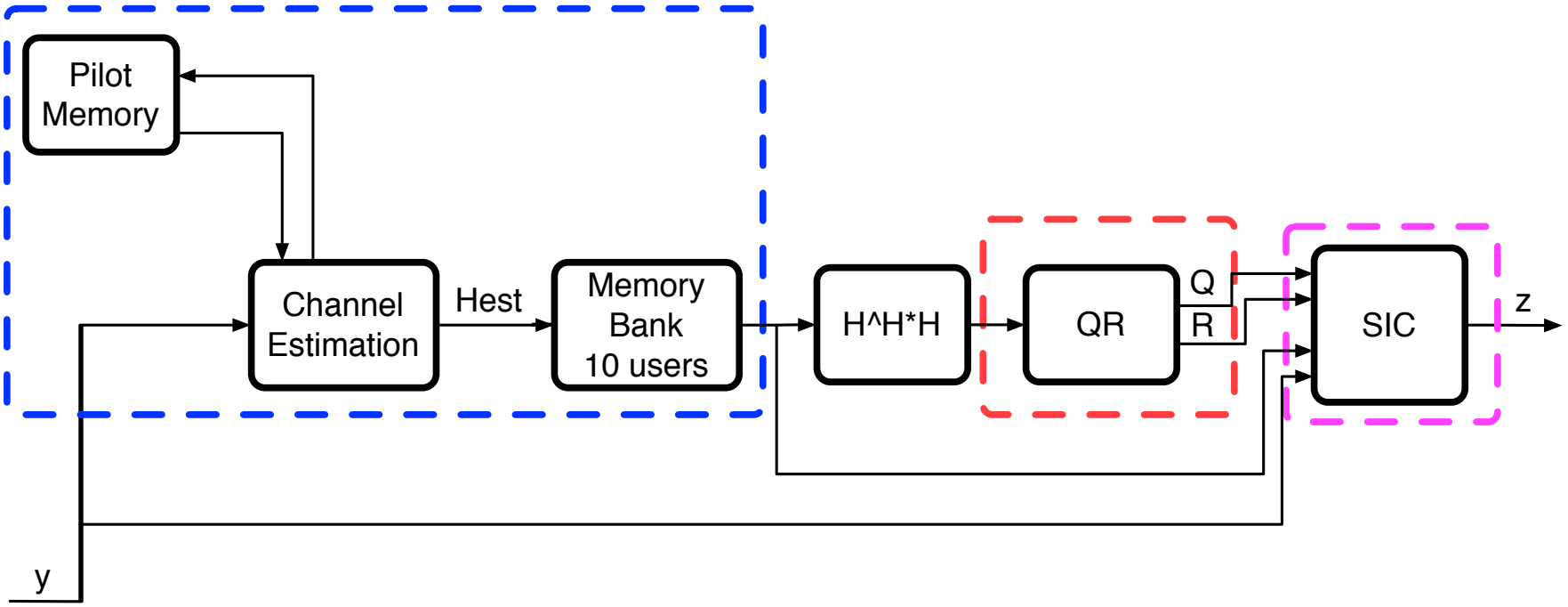
# System View I




$$y_{100\times 1} = H_{100\times 10} * s_{10\times 1} + n_{100\times 1}$$

LUND UNIVERSITY

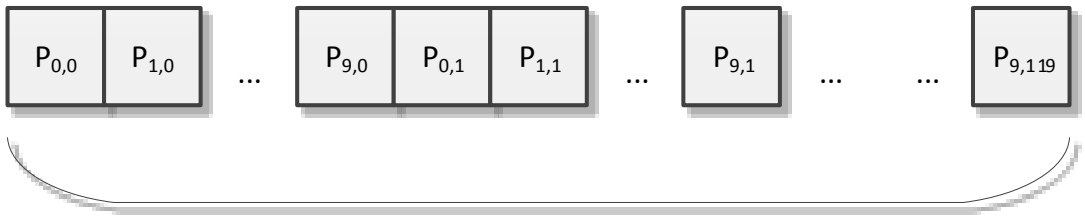
# System View II




LUND UNIVERSITY

# Channel Estimation (one user) I
# - Steffen Malkowsky

1 sample per input valid, every 10th subcarrier




Overall 1200 subcarriers (120 estimates, interpolate rest)

Model input valid as random

Perform least square, i.e., divide by pilot

Store estimates in memories

LUND UNIVERSITY

# Channel Estimation (one user) II
# - Steffen Malkowsky

Grade 3:

On-the-fly linear interpolation between the estimates

Grade 4/5:

Compare more advanced on-the-fly interpolation, e.g. second order, cubic spline or Lagrangian interpolation

Optimize throughput

Do something better than Least-squares

LUND UNIVERSITY

# Successive Interference Cancellation I - Steffen Malkowsky

Assume Q, R and Hest matrices are given at input (pre-buffer if necessary)

Vector y is received

Build pseudoinverse of H and calculate first symbol

Subtract symbol from received values and calculate next symbol

10 users

Hard detection

# Successive Interference Cancellation II- Steffen Malkowsky

Grade (4)/5:

- Build Matlab model for SIC (with help)
- Generate input values for Q, R and H in Matlab
- Implement in VHDL
- Optimize throughput

# QR Decomposition
# - Hemanth Prabhu

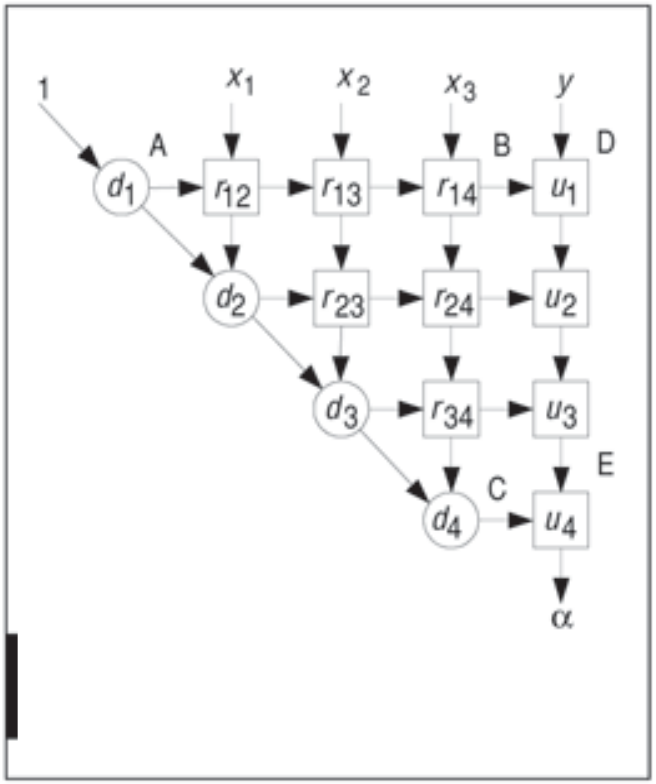
- In this project the students will design a QR-decomposition accelerator.
- QRD is a well known linear algebra method, mainly used for solving linear equations.
- It is extensively used in signal processing and communication systems.

$$A = QR, \quad Q = \begin{pmatrix} q_1 & \dots & q_n \end{pmatrix}, \quad R = \begin{pmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ 0 & r_{22} & & r_{2n} \\ \vdots & & \ddots & \vdots \\ 0 & & 0 & r_{nn} \end{pmatrix}$$

LUND UNIVERSITY

# QR Decomposition
# - Hemanth Prabhu

- Student need to perform QRD using "Given's Rotation".
- Use "CORDIC" processing elements to perform arithmetic's.
- Systolic Array
  - Highly parallel architecture
  - Easy implementation




LUND UNIVERSITY

# QR Decomposition

## - Hemanth Prabhu

---

- Grade 4 :

  Floating point model in Matlab.

  Fixed point model in CatapultC or C++ (optional)

  Cordic Processing elements for Given's Rotation

- Grade 5 :

  Fully working systolic array based Given's Rotation.

  Area/power comparison with state-of-art implementation.

LUND UNIVERSITY

# Mini-MIPS project (Michal Stala)

- 32-bit RISC with a subset of MIPS instructions.
  - Grade 3: Fully verified pipelined Mini-MIPS.
  - Alt 1
    - » Grade 4 : Xilinx Ethernet I/O
    - » Grade 5 : Extra functionality (accelerator or extended instruction set)
  - Alt 2
    - » Grade 4/5 : Viterbi decoder in Catapult
  - Alt 3
    - » Grade 4/5 : open for suggestions (Multicore?)
- Prerequisite course:
  - EITF35 Introduction to Structured VLSI Design
  - EITF20 Computer Architecture

LUND UNIVERSITY

# Mandatory tasks

- Task 1: behavior modeling
- Task 2: synthesizable pipelined implementation
- Task 3: P&R in 65nm CMOS
- Task 4: Verification in FPGA