The Hogthrob Project
(2004 – 2007)

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Hogthrob consortium: DIKU, DTU, KVL,
IO Technologies
Danish Committe for Pig Production
The Project

Developing a Sensor Network Infrastructure for Sow Monitoring
- Sensor Nodes on a chip
- Sensor Network Model
- Monitoring Application

Goals:
- Functionalities
  - Tracking
  - Detecting Heat Period
  - ...
- Low Cost (~1 €)
- Low Energy (2 years lifetime)
Sow Monitoring

Initial application model
(state machine):
- Sleep (8h / 2h)
- Awake
- Active
- Heat

Some issues:
- State transitions managed by timer + sensing
  - Different duty cycles (processing / sending)
  - Refined model based on observations of pig behavior
- Trade-offs:
  - Sleeping vs. (Sensing and Networking)
  - In-channel wakeup vs. Additional, low power radio
  - Embedded detection model vs. Feed to a server-based detection model
The Nodes (V0)

• FPGA (Xilinx Spartan3)
  – Co-design Hardware/Software
    • Hardware accelerators (radio, sensors)
  – Different MCUs
    • Clock-based (open core) vs. Asynchronous
    – Also Spec mote, Picoradio at UC Berkeley, Galore project at UCLA
• AVR Core
  – To ease start-up
  – As timer module (counter of limited size, cannot sleep for hours) and AD converter
• Add-on radio board
  – 2.4 GHz radio (NVLSI)
  – Transmit quickly to avoid interferences
• Add-on sensor board
  – Motion detector, possibly microphones

Some issues:
• Explore the design space for a sensor node on a chip
  – Calibrate energy consumption
  – Analog-digital design
  – Modelling
• 2.4 Ghz single channel is a new point on the design space
  – Trade-off store vs. Send
A First Lesson

Component-based design:

– Commodity electronics
  • Designing a board is not that hard
    – Careful about radio characteristics
  • Layout and production left to the digital design specialists next door

– Component Based Programming (TinyOS)
  • Modified baseband, MAC
  • Signal Processing