NTNU | Norwegian University of Science and Technology

Master Project/Thesis Topics

Self determination and privacy in the IoT Cloud

New Approaches for Robotics Software

Michael Engel

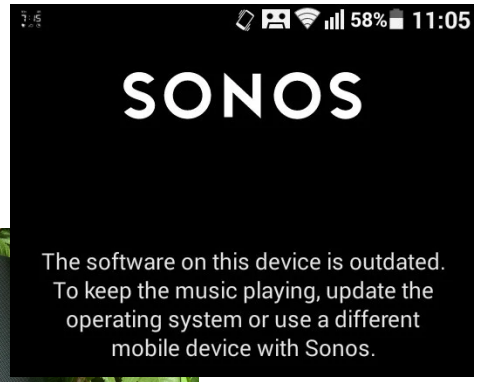
Topics

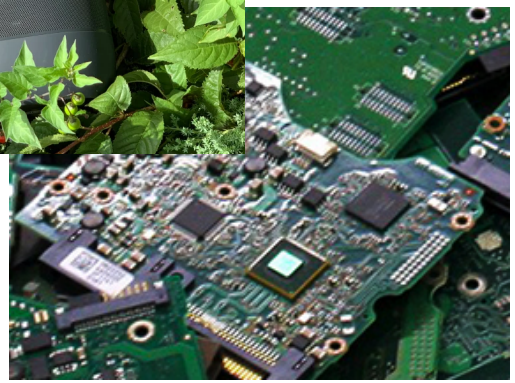
- **Self determination and privacy in the IoT Cloud:**
  - IoT devices and services are interconnected in the Cloud
  - Enable user control over where their data is stored
  - Decouple device functionality from Cloud service availability

- **New approaches for mobile robot software**
  - Joint project with Rudolf Mester
  - Object recognition/image processing
  - System software architecture + model-driven development
  - This project:
    - *Statecharts meet microkernel messaging*

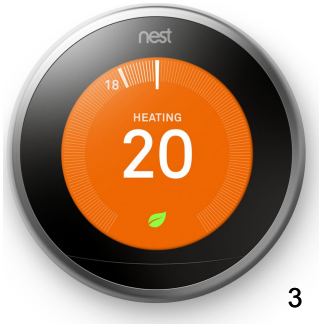
Cloud: the problem, not a solution

- ***Forced obsolescence – bad sustainability***
  - IoT devices and smart phones receive software updates for a short time only
  - Devices stop working when a Cloud service is discontinued
  - Many devices end up in the landfill long before they physically stop functioning





- ***Difficult data protection and privacy***
  - Sensitive personal data stored in the Cloud
    - Personal health data
    - Presence in rooms
  - Who has access to this data?



- ***How can we improve on this?***

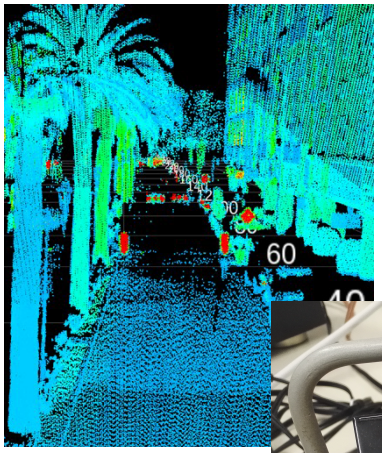
Take back control of hardware!

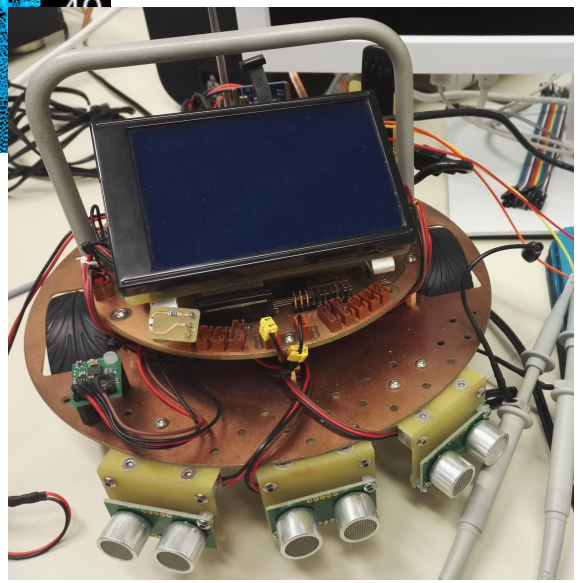
- Let's build the ***Personal Digital Habitat***
  - Enable interaction and communication between all your personal devices
  - Control the location of your code and data – in the Cloud or on a personal system
- ***Basis: The Inferno OS***
  - An OS built for the network
  - An efficient communication protocol (9p)
  - Small, efficient, portable
  - Efficient language VM for portability
- ***Several project parts – OS to compilers!***

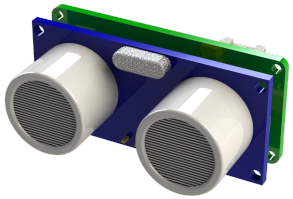
S. M. Dorward, R. Pike, D. L. Presotto, D. M. Ritchie, H. W. Trickey and P. Winterbottom, "The Inferno operating system," in *Bell Labs Technical Journal*, vol. 2, no. 1, pp. 5-18, Winter 1997

We’re building a robot!

- ***High performance embedded***
  NVidia Jetson
  - 8 64-bit ARM cores
  - GPU 512 CUDA cores
    1.4 TFLOPS
- ***Sensor fusion***
  - Lidar
  - 3D Sensor
  - Camera
  - Ultrasonic
  - …
- ***How can we program all this?***



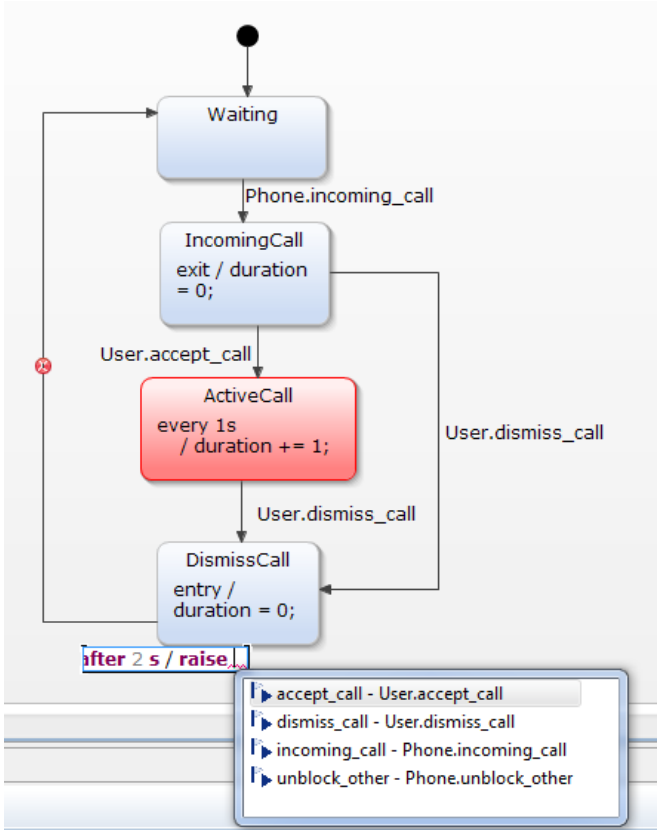




…not this one, this is one we designed in Germany…

Robotics software

- ***Model-driven development***
  - Use **StateCharts** as extended state machines to program robots
  - Program high-level behavior
  - Modelling of communication between robot components
- Integration with a distributed OS
  - Again using the 9p protocol
  - Parts of the robot have their own operating environment
- ***Several project parts***
  – Hardware to OS to compilers, again



Example: StateChart programming using YAKINDU

Introduction to the Plan 9 File Protocol 9P – http://man.cat-v.org/plan_9/5/intro

Peter Marwedel: Embedded System Design, 4th Ed., Springer 2021, ISBN 978-3-030-60910-8

Harel, David. "Statecharts: A visual formalism for complex systems." Science of computer programming 8.3 (1987)

Interested? Get in touch!

…also if you have ideas for your own project
in the areas of operating systems and compilers…

- Michael Engel

  michael.engel@ntnu.no

  https://folk.ntnu.no/michaeng/

- …more background on my projects on my personal blog:

  https://multicores.org