# Real-Time Robotics with state-of-the art open source software: case studies

## An industry centric introduction

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Peter Soetens & Ruben Smits

# Chapter I
# Real-Time and the Robotics Industry

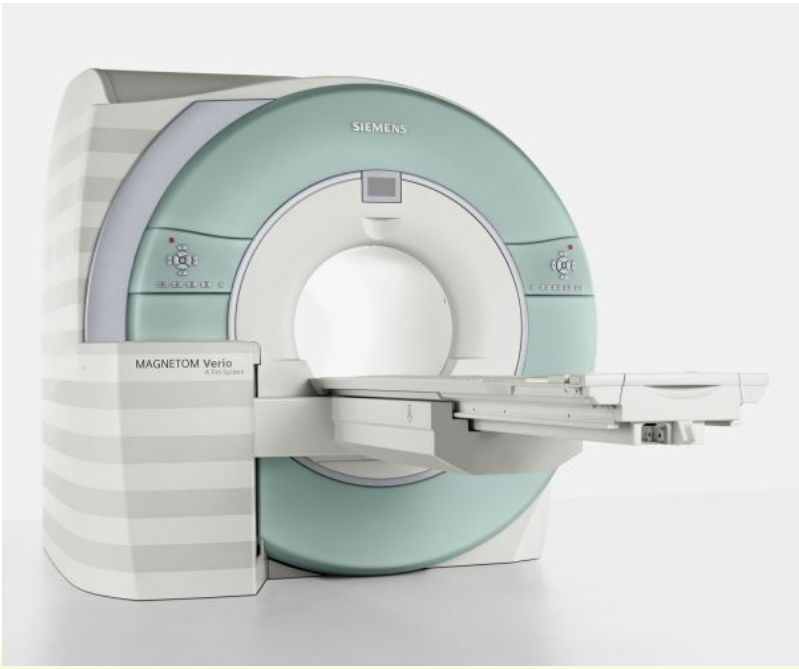
# Q: Who is interested in Hard Real-Time ?

(raise your hand)

# Q: What's your sector?

- Medical Robotics
  - Someone who doesn't care ?

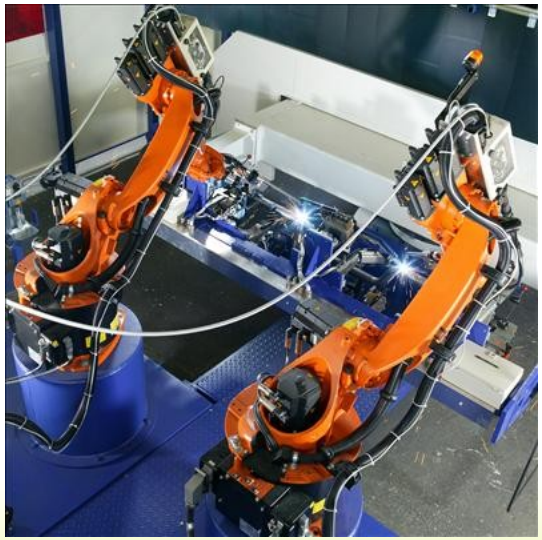
Intuitive Surgical

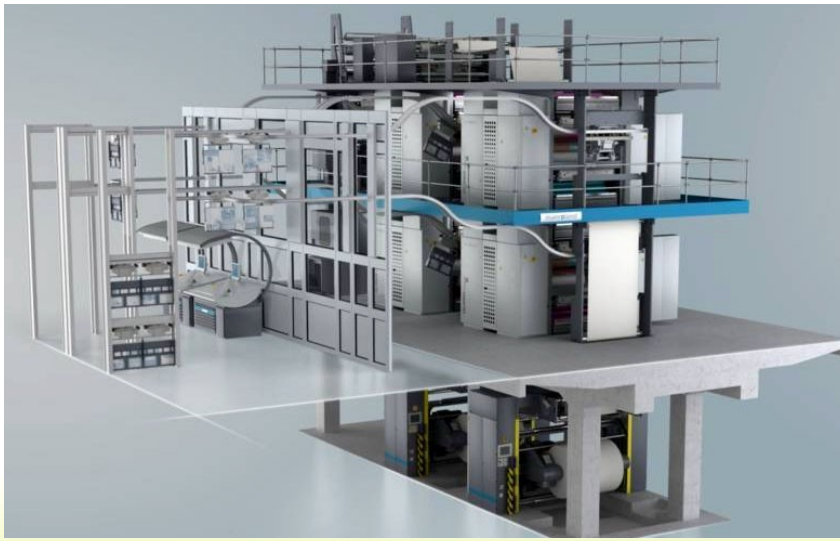



Siemens

# Q: What's your sector?

- Industrial Robotics (manufacturing)
  - Someone who doesn't care ?



# Q: What's your sector?

- Service Robotics
  - Someone who doesn't care ?

Fraunhofer IPA


Willow Garage

PAL Robotics

# When does HRT kick in ?

Source: Skybotix.com


Source: Onera, France

# More on Service Robotics

- Quotes
  - “Vision: With a high enough frame rate you don't need RT”
  - “Service robots plan a motion, they don't *control* a motion
  - “There is no market for Service Robotics as long as service robots don't do real-time control”

# The industry of robotics

- What does it take to bring our robots to the market ?
  - Reliable in it's intended environment
  - Safe in the presence of humans
  - Reasonably priced
- If the service robotics companies of today are looking for a sustainable future, they'll have to reach these goals.

# Chapter II
# Open Source Robotics

There is too much (to learn).

# Open Source for Robotics

- Frameworks and Middlewares
- Simulators
- Libraries

# Robotics Middlewares

- Remember RoSta (Robotics Standards)
  - Even they didn't manage to classify all of them
  - You can easily name ten open source frameworks
  - There are hundreds of in-house made

# Robotics Middlewares

- Most used America's/Europe (subjective)
  - ROS (US/EU)
  - Player-Stage (US/EU)
  - OROCOS (EU)
- Noteworthy in Asia:
  - OpenRTM (Japan)
  - OPRoS (South Korea)
- Diversity == GOOD ?

# Diversity in Middlewares

- Example of Positive effects?
  - Choosing a different balance of design choices
- Example of Negative effects?
  - Locked-in algorithms/drivers
  - Non-trivial interoperability
  - Duplicate efforts

# Robotics Simulation Tools

- Gazebo
  - Player protocol
  - ROS protocol
- Morse
  - Yarp
  - ROS
  - Pocolibs
  - Plain unix sockets

# Robotics Libraries

- Many of good quality
  - OpenCV (Vision)
  - Point Cloud Library (Laserscan processing)
  - OpenSlam
  - GearBox
  - KDL
  - BFL
  - Comedi (daq, IO), soem (Ethercat)
- Diversity == GOOD !

# The big question

- In our robotics industry...
  - What is being used of all this software ?
    - Way too little
  - How suitable is it in an industrial (marketable) setting ?
    - Requires know-how of what to pick for which task
- Audience...?

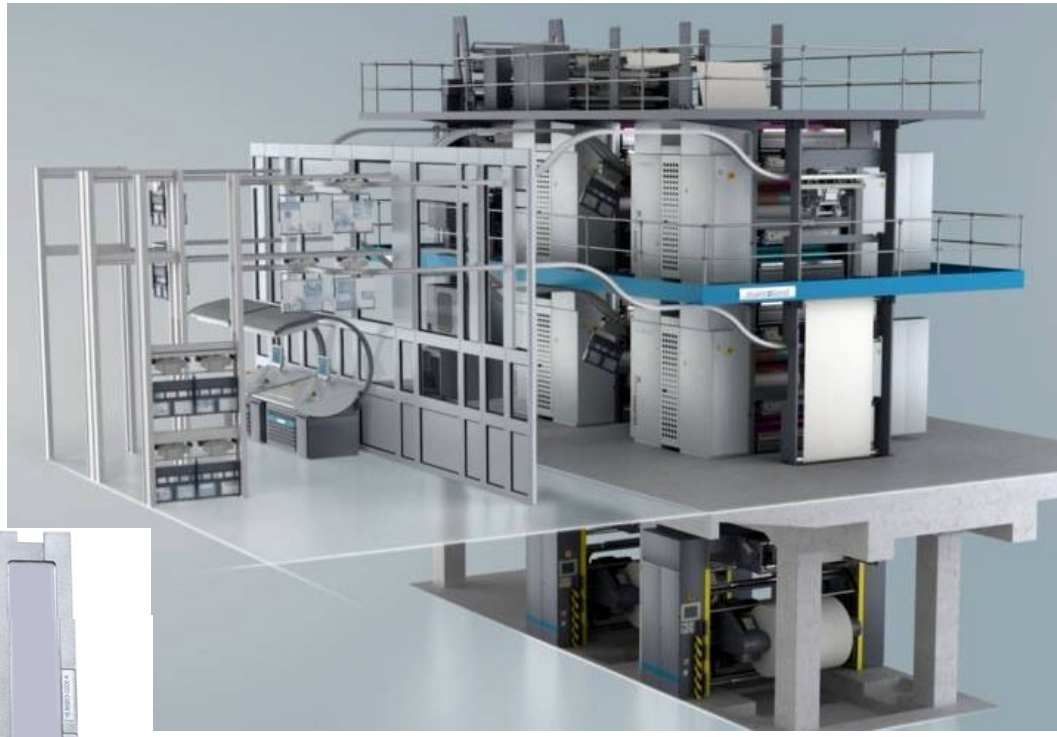
# Chapter III
# Open Source and the Robotics Industry

# RT-Controllers in industry

- Which RTOS to pick ?
  - Plenty of (RT)OS'es to pick from
- VxWorks/GreenHills/QNX – standard industrial case
- Windows CE 5/6/7 – RT backed by Microsoft
- Linux with RT extensions
  - Xenomai
  - RTAI
  - Preempt-RT

# Industrial Cases

- Manroland Printing Systems
  - Modular unit Controller
  - PowerPC embedded system
  - Xenomai control tasks
  - Regular Linux processes

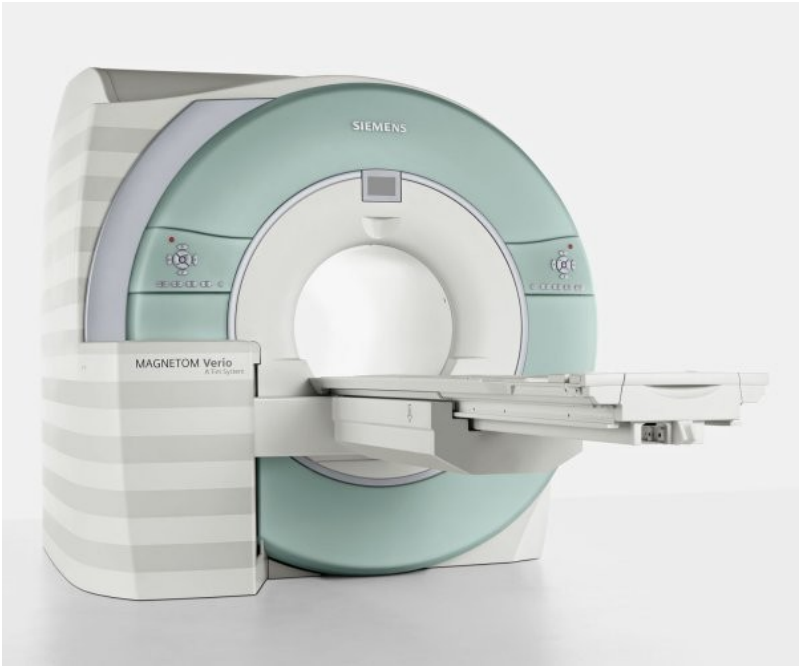



Source: XUM 2009

# Industrial Cases

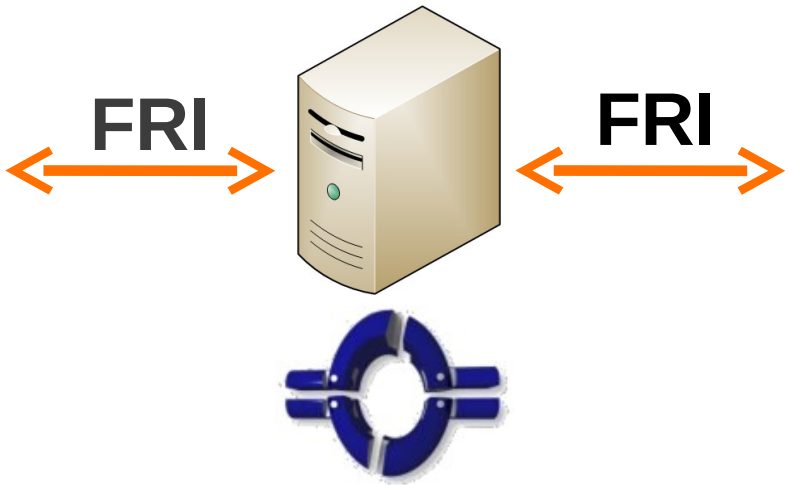
- Siemens MRI Scanner
  - Measurement and Reconstruction System runs Xenomai RT-Extension
  - Position/patient control
  - Sample states and signals
  - milisecond range loops

(source: XUM 2009)



# Interfacing an Industrial Robot

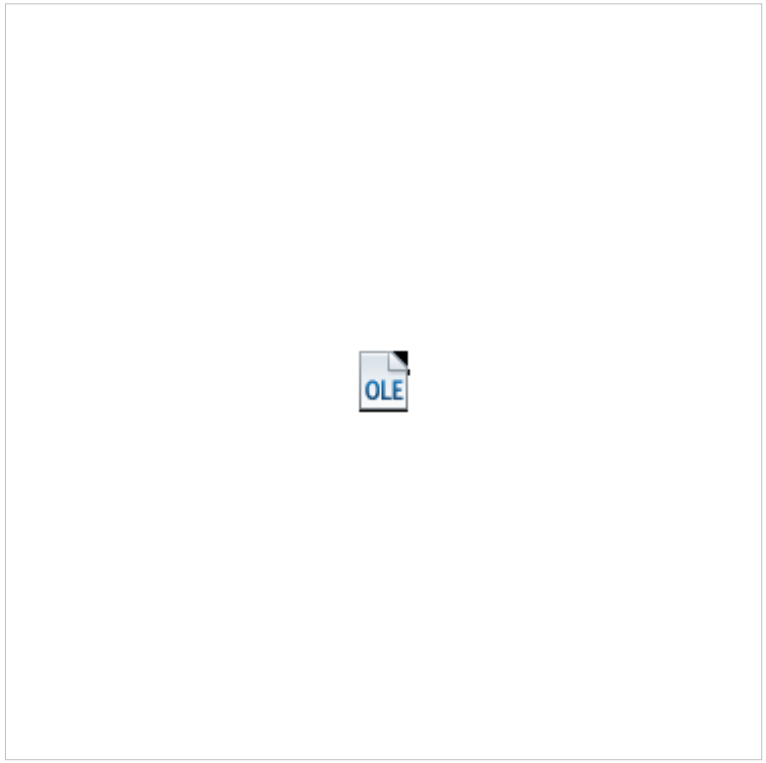
- Project at KU Leuven with KUKA Roboter
- Fast-Research-Interface (FRI) over UDP




**The Orocos Project**
***Smarter control in robotics & automation!***

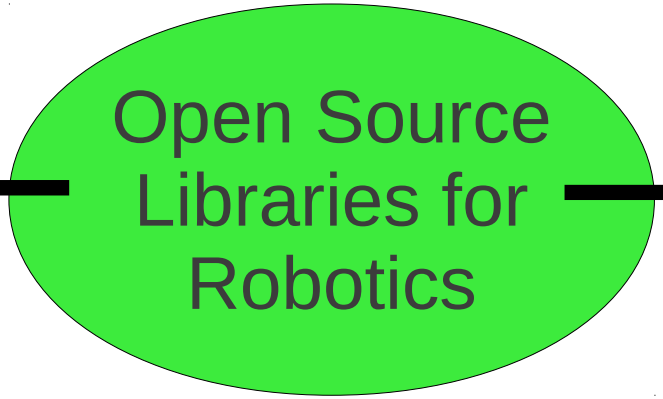
Orocos used to exchange joint positions between two LWRs

# LWR with Open Source Software



# Interfacing any Industrial Robot

New robotics applications



# Concluding Remarks

- Medical robotics is a wide open field for new robotic developments
- Service robotics is solving a lot with open source, but still not marketable enough
- Even if industrial robot vendors don't use open source internally, they can offer us a way to develop new applications