

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

An industry centric introduction

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Vasteras, Sweden

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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 ?



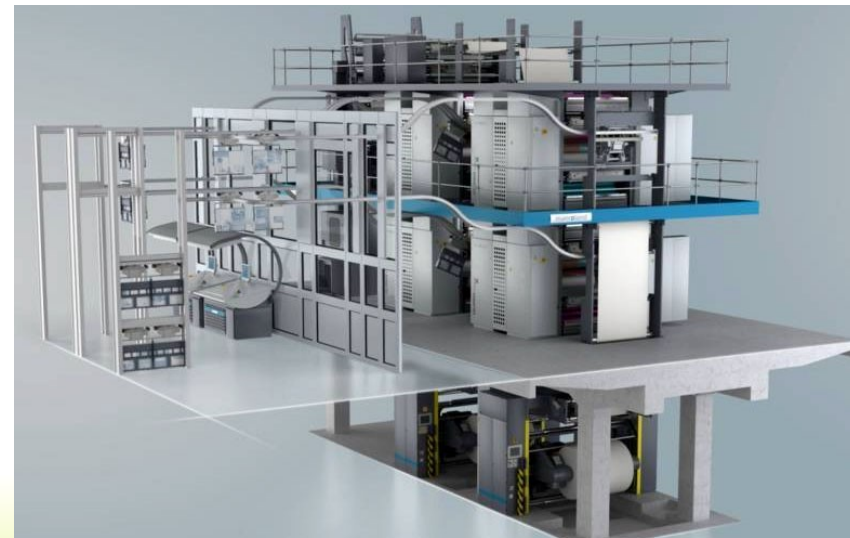
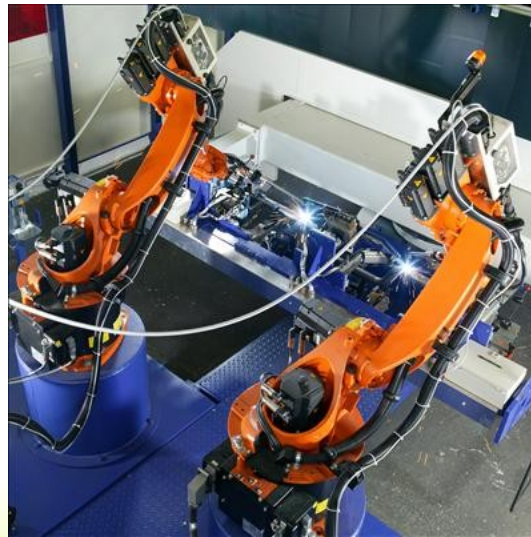
Intuitive Surgical



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

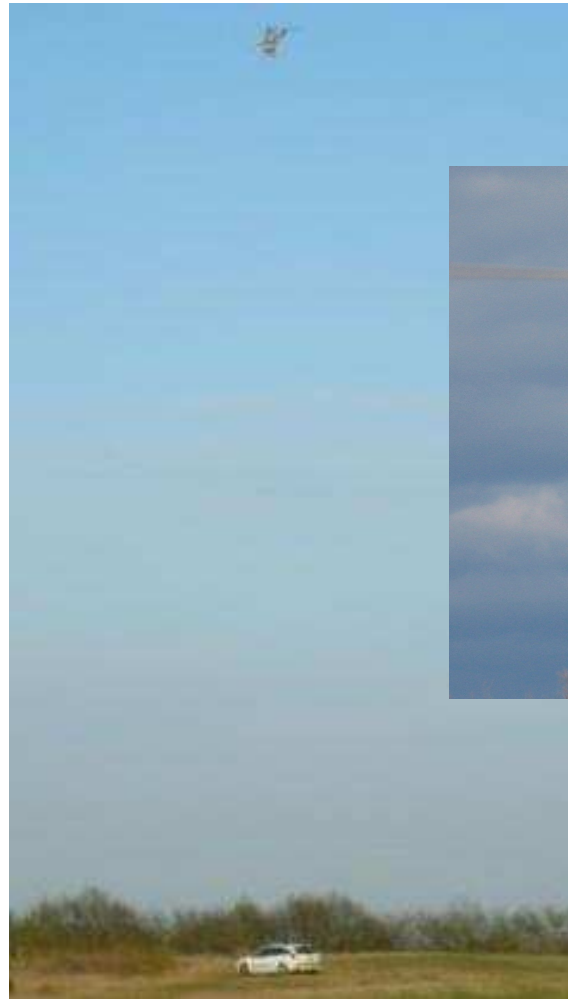


PAL Robotics

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

Open Source for 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

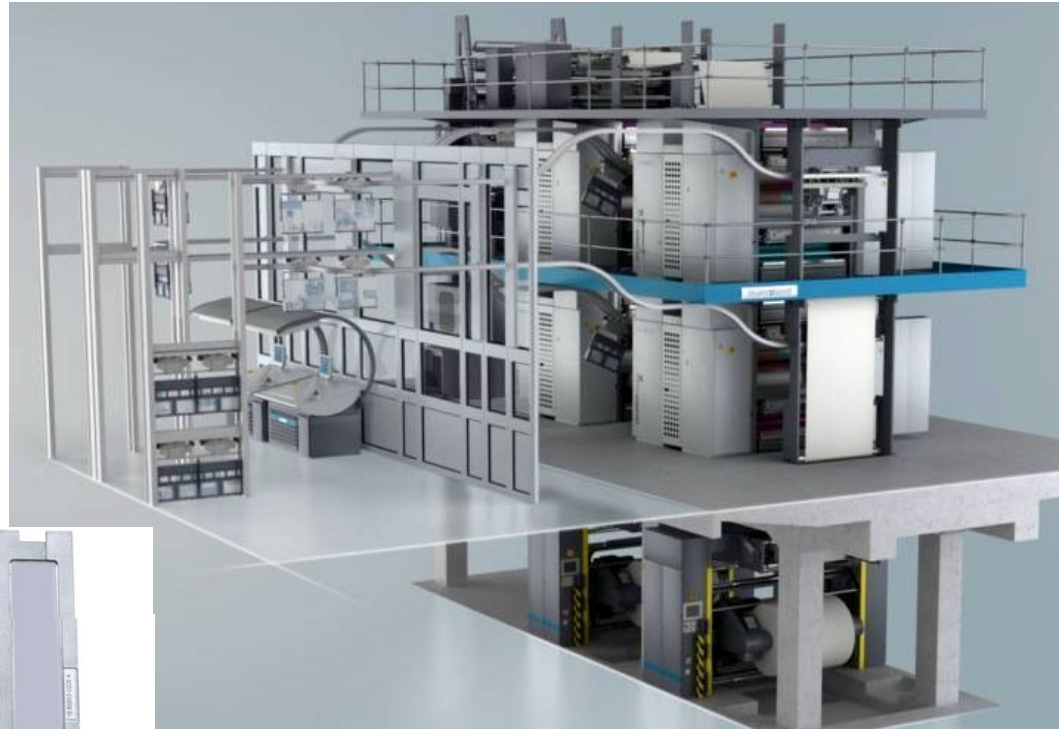
Open Source and the Robotics Industry

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

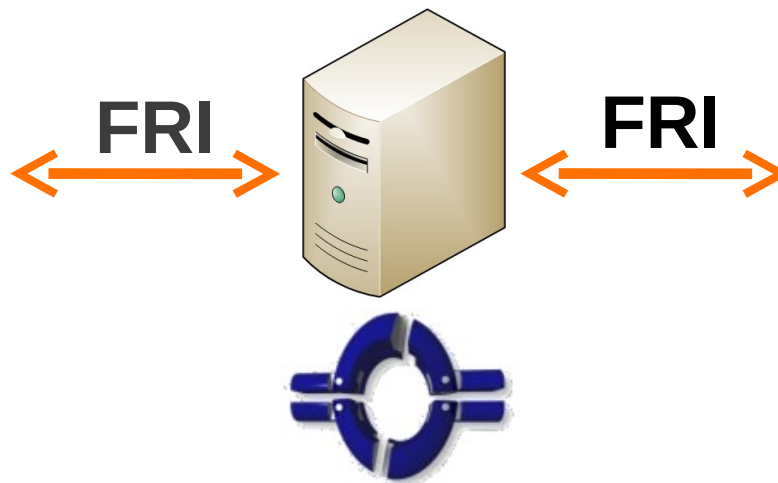
- Siemens MRI Scanner
 - Measurement and Reconstruction System runs Xenomai RT-Extension
 - Position/patient control
 - Sample states and signals
 - milisecond range loops

(source: XUM 2009)



Interfacing an Industrial Robot

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

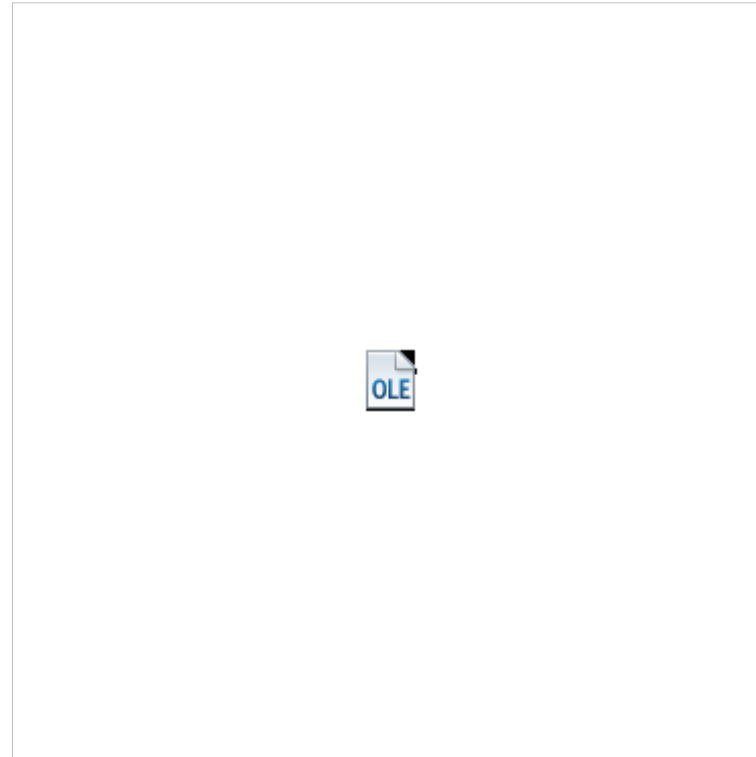


The OrocOS Project
Smarter control in robotics & automation!



OrocOS used to exchange joint positions between two LWRs

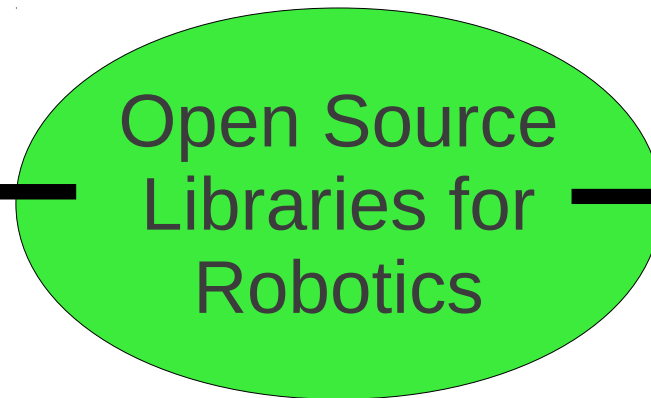
LWR with Open Source Software



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