Comments on Academia-Industry Collaboration based on the Bosch Experience in the PR2 Beta Program

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Research and Technology Center North America

Bosch

Bosch Group

- Founded 1886, privately held (Robert Bosch Foundation and Bosch Family)
- ~300.000 employees, ~47b Euro revenue (2010)
- Divisions: Automotive, Industrial Technology, Consumer Goods, Building Technologies, Solar Technologies
- Largest Automotive Supplier worldwide

Bosch Corporate Research

- 1300 employees
- Offices in Germany, USA, Japan, China, Singapore, Russia

Bosch Research and Technology Center NA

- Offices
  - Palo Alto, CA
  - Pittsburgh, PA
  - Cambridge, MA

- Topics
  - HMI design, car infotainment, web technologies
  - energy materials and technologies, complex simulations
  - software engineering
  - MEMS sensors, IC design, wireless solutions
  - autonomous technologies/systems

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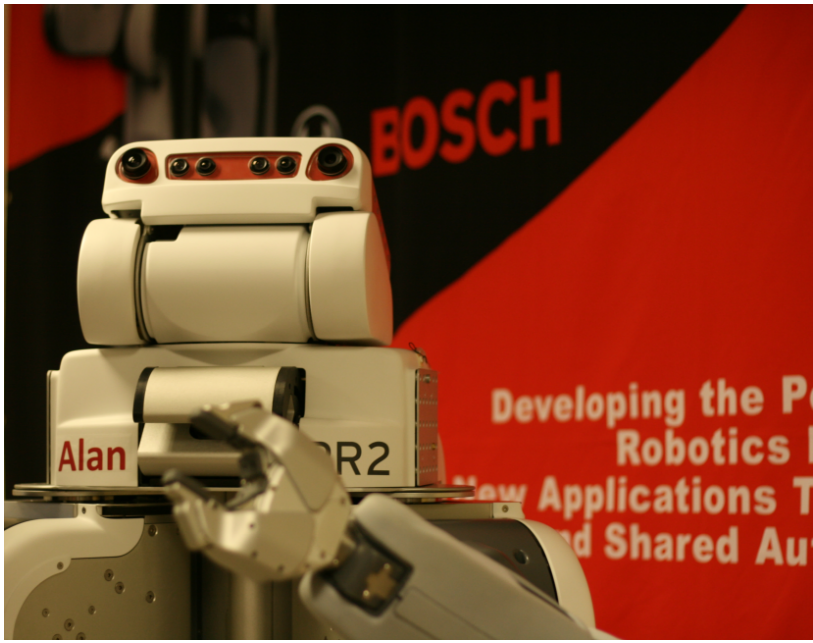
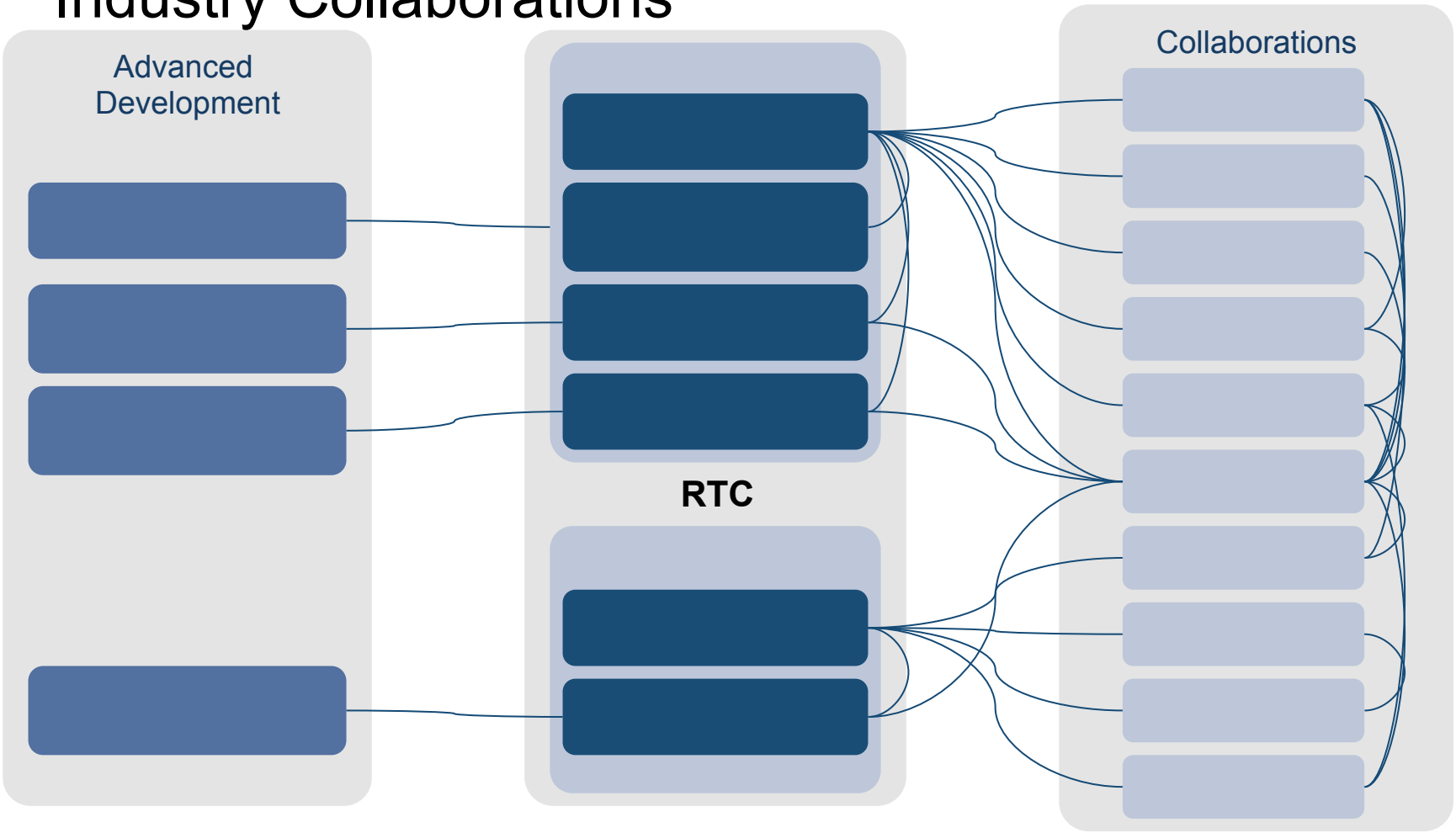
Robotics

PR2 Beta Program

- Participant in the Willow Garage's PR2 Beta Program
  - 10 top academic research institutes
  - Bosch is the only corporate participant
- Development and contribution to open source software
- Collaboration with Willow Garage and the PR2 community



Industry Collaborations

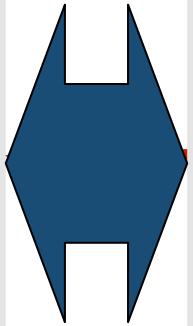


Academia-Industry Collaboration

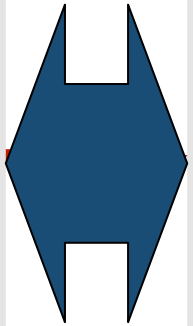
Advanced Development

"high reliability required"

(see next slide)



Applied Research



Academic Research

"problem solved when experiment worked once"

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Safety Goals acc. ISO 26262

Allowable dangerous failures per hour of operation

Safety Integrity Level

IEC EN 61508			
mittlere **Wahrscheinlichkeit** eines gefahrbringenden Ausfalls bei Anforderung der Sicherheitsfunktion **PFD**	**Rate** gefahrbringender Ausfälle der Sicherheitsfunktion [Fehler/h] **PFH**	IEC EN 61508 **SIL**	ISO CD 26262 **ASIL**
-	-	QM	QM
>= 10^{-2} bis < 10^{-1}	>= 10^{-6} bis < 10^{-5} < 10.000 FIT	1	A
>= 10^{-3} bis < 10^{-2}	>= 10^{-7} bis < 10^{-6} < 1.000 FIT	2	B / C
>= 10^{-4} bis < 10^{-3}	>= 10^{-8} bis < 10^{-7} < 100 FIT	3	C / D
>= 10^{-5} bis < 10^{-4}	>= 10^{-9} bis < 10^{-8} < 10 FIT	4	-

http://www.uwe-lindenberg.de

1 FIT = 1 Fehler / 10^9 h

continuous system

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How to bridge the gap?

- Industrial Requirements
  - Quality
  - Reliability
  - Reusability

- Academia
  - Current success measures for Academia
    - Productivity: total number of papers
    - Impact: citations of papers

How to bridge the gap?

- ROS / PR2 Beta Program Approach
  - Academia and industry in one program
  - Common basis is open source repository
  - Requirement to open source commitments
  - Request to open source code related to publications
  - Establishing standard for academia
  - Quantitative software metrics

- Results
  - Increased exchange of code
  - Interaction between sites
  - Repeatability of results
  - Reusability of algorithms through standardization

How to bridge the gap?

- What can be improved?
  - Quality
  - Reliability

- Additional Incentives
  - Qualitative software metrics

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Summary

- Industry-academia collaboration
  - Potential gap in objectives
- Academic incentive is number of papers
  - Results may not repeatable, algorithms not reproducible
- Academia-industry-collaboration based on open source collaboration
  - Can help bridge the gap

http://www.boschresearch.com
http://www.ros.org/wiki/bosch-ros-pkg
http://bosch-ros-pkg.sourceforge.net