robuBOX®

Technical Presentation

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Advanced
Robotics
Solutions

Advanced Robotics Solutions
for Transport, Cleanliness, Security and Health

The company

Mission

Provide advanced service robotics solutions for :

- transport
- cleanliness
- security
- health

Profile

- created in 1985 (spin-off INRIA)
- 30 employees
- Turnover : 3,5 M€
- Fund raising in 2006 : 1,5 M€

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Advanced Robotics Solution provider

All details and videos available at www.robosoft.fr, Corporate section

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Solutions	Modules	Technology

Mobile platforms

- robuCAR
- robuCAB
- robuROC
- robuLAB
- robuBOAT

Manipulators

- robuARM

Other

- Vision
- Positioning

INRIA (F), CNRS (F), EDF (F), SNCF (F), ESA (NL), SAGEM (F), NEC (J), BAE (UK), DGA (F), AIRBUS…

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For Cleanliness

Automatic floor cleaning
GSF (F), COMAC (I), Henkel (D)…
- AutovacC
- C100

Glass-roof automatic cleaning
Louvre, Stade de France, Hôpital G.Pompidou (F)…
- Grand stade de France
- HEGP (European Hospital)
- Pyramide du Louvre

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Solutions	Modules	Technology

For Transport

Automatic refueling
Toulouse, Biarritz (F), Chicago (USA), La Haye (NL)…
- robuFILL

Automatic people transportation
Simserhof (F) : 150 000 passengers / year
- robuRIDE
- robuCAB

Automatic goods transportation
Valeo (F), Caterpillar (B), Copenhagen hospital(SE)
- Nestor
- Nomad
- Valeo

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Solutions | Modules | Technology

For Security

All-terrain mobile platform for monitoring, recognition, mine clearance…

- robuROC 4
- robuROC 6

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Solutions	Modules	Technology

For Health

Tele-echography

- ESTELE

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Solutions | Modules | Technology

Other

Robotization

- Vehicules
- processes

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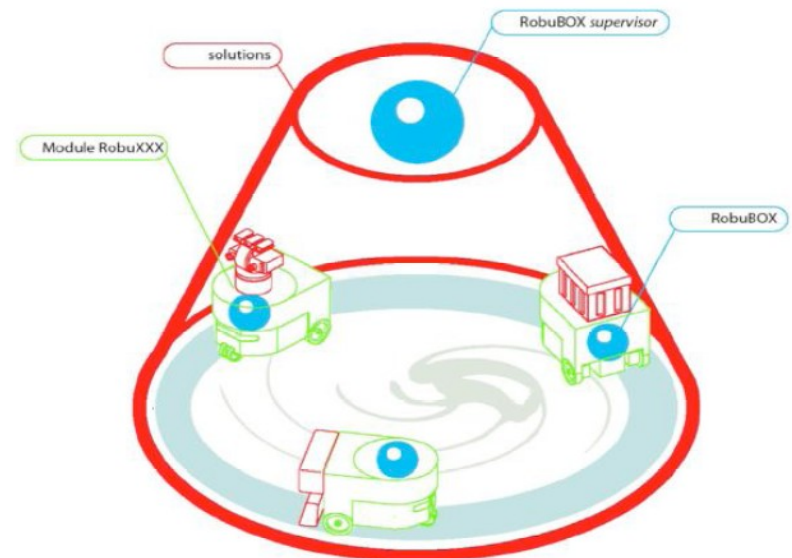Advanced Robotics Solutions
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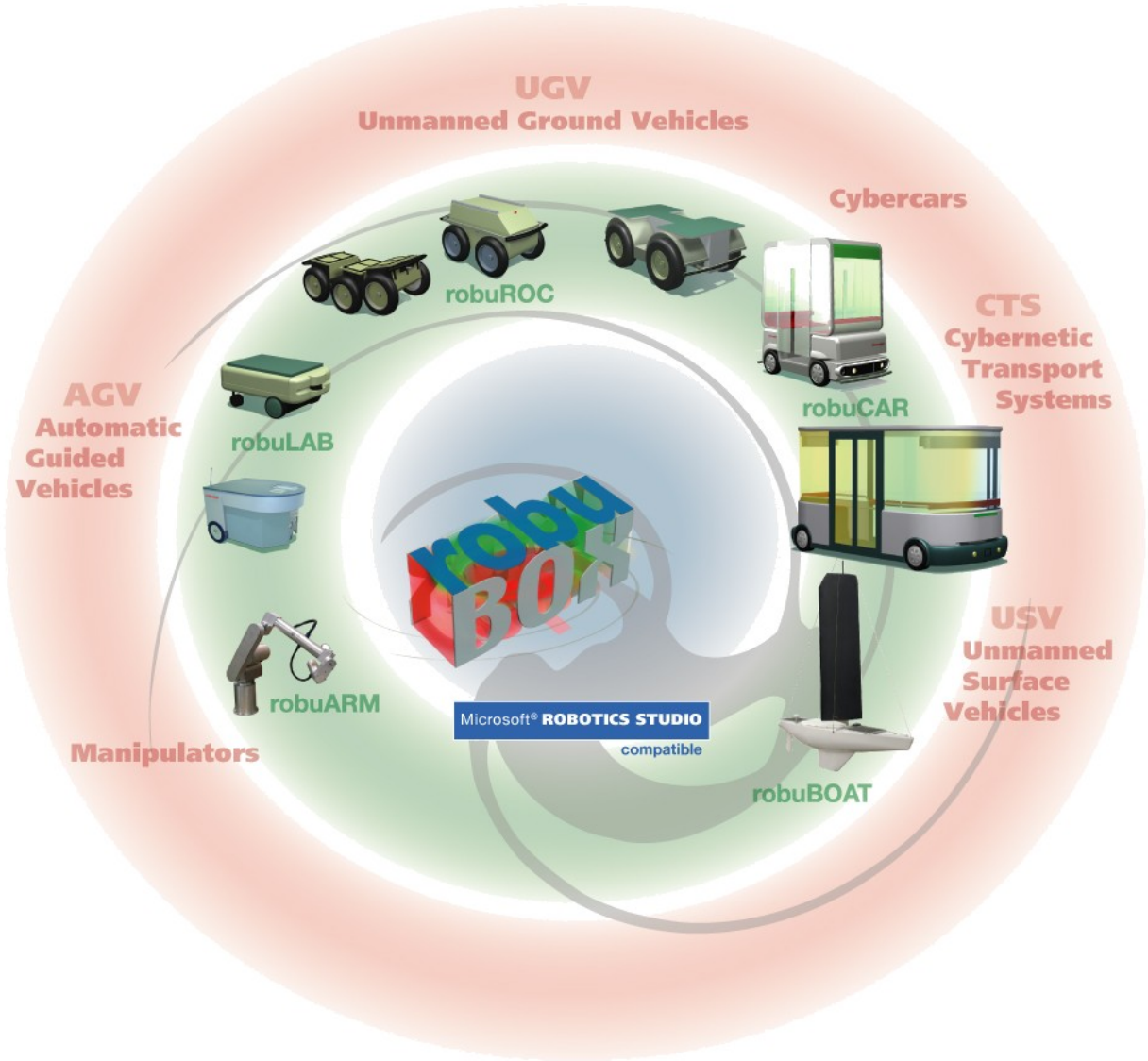
Expectations for a service robot

- Localize itself and sense the environment
- Data fusion to improve robustness and precision
- Build a map of the environment through SLAM
- Generate a trajectory to reach a goal
- Follow this trajectory
- Have a reactive behavior
- Collaborate in a fleet of robots
- Interact with humans
- Perform visual servoing
- …

- Implement your top-notch algorithms to reach the killer application!

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Software Requirements ?

- Interfaces with hardware: sensors / actuators
- Framework allowing easy generation of control architectures
- Robotics algorithms library
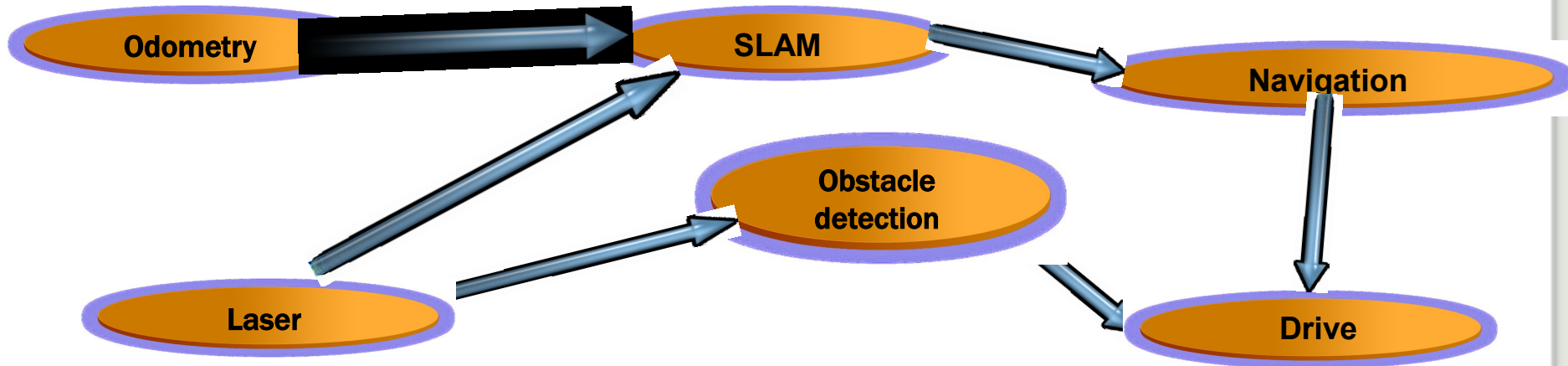- Realistic simulations
- Distribution
- Reliable time-basis
- …

robuBOX ®:

- Based on Microsoft ® Robotics Studio

Runtime

- *Concurrency*
- *Infrastructure Services*

Development

- *Simulation engine*
- *Visual Programming Language*
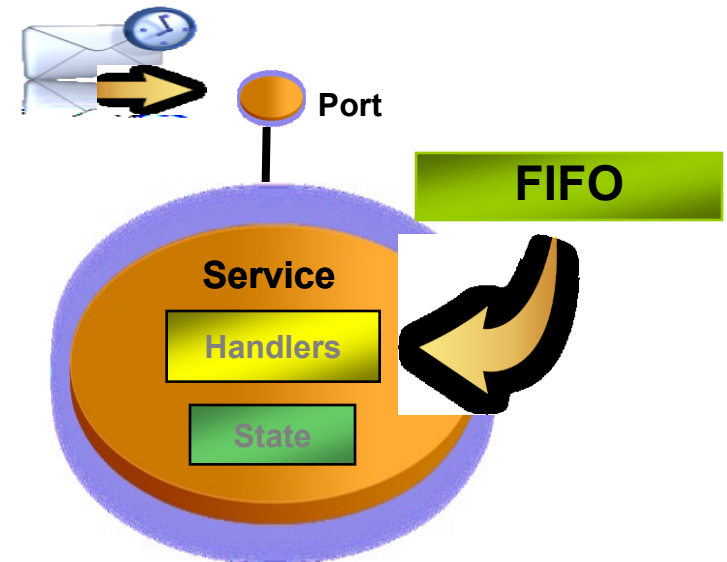
Services

- *Tutorials*
- *Samples*

Service Oriented architecture

- A robotic architecture is a composition of loosely-coupled services concurrently executing across nodes/platforms
- Interactions described using service contracts
- Control architecture can be used for basic control up to autonomous control of a single robot but also for supervision, mission planning or decision making in fleets/swarms of robots.
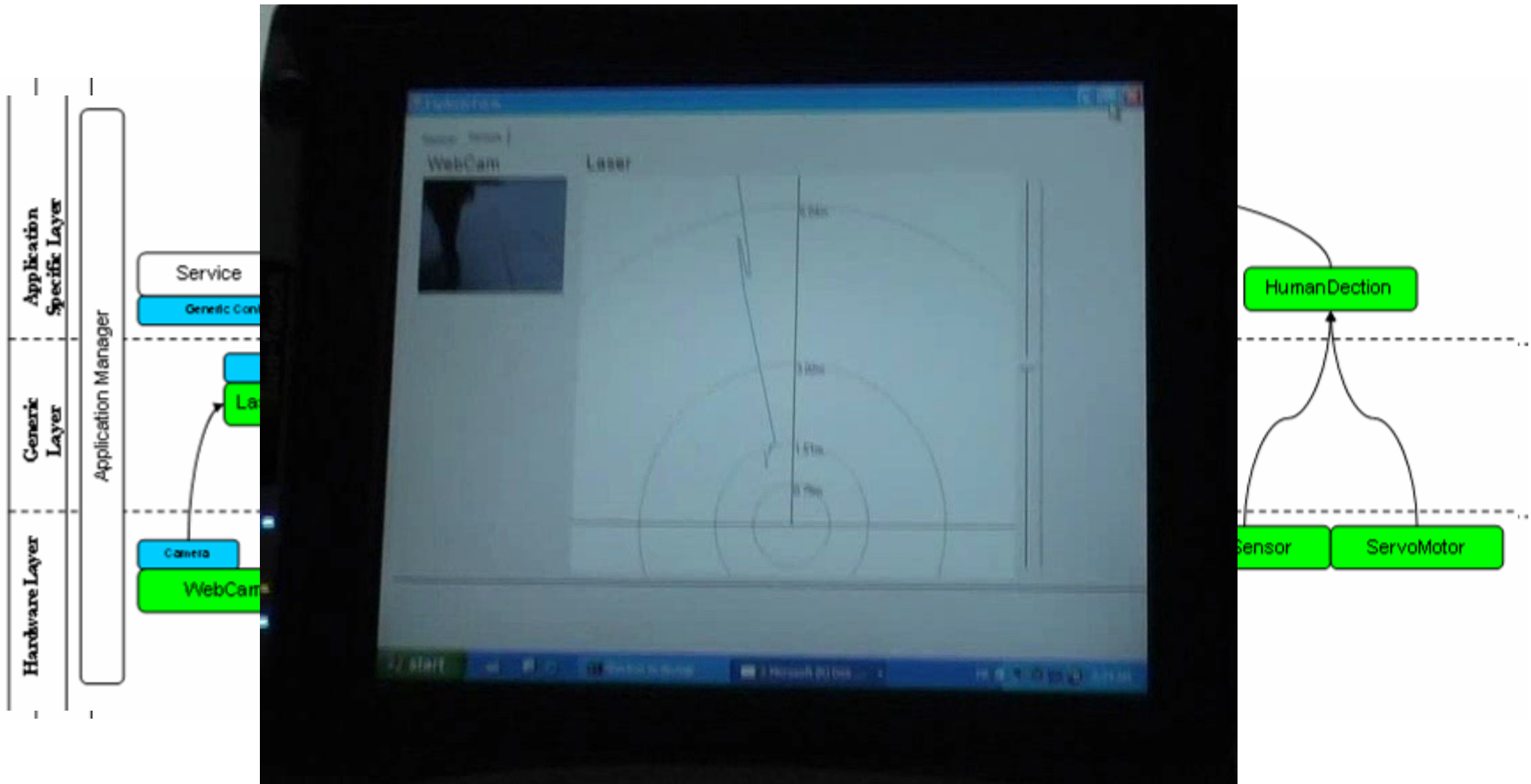
Service: a basic building block

- A Service has:
    - Structured State
    - Communication ports
    - Behavior
    - Set of dependant "Partners"
    - Contract

- Operations:
    - State retrieval and manipulation
    - Create & Terminate
    - Notifications

robuBOX® Control Architectures:

- Describe any robotics application, possibly dynamically modified
- Defined by required services + interactions
- Have common features:
  - Services structured in 2 layers: Hardware & Application
  - DevicesManager:
    - core service, transversal between layers
    - First service to be lauched
    - Manages correct initialization of hardware and correct execution of application
  - Generic interfaces between services:
    - goal = easy and fast application definition through re-use of services
    - Many interfaces defined by robuBOX

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Example of real application using robuBOX ®:

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robuBOX® features:

- RobuBOX-Core
    - Design and execution of the robotics architecture
    - Centralized on a robot or distributed on multi-robots & multi-CPUs.

- Collection of Services specialized for:
    - Drivers for robotics actuators, sensors and communication bus
    - Robotics algorithms, functions, behaviors, GUIs: from obstacle detection to path following, fleet management and autonomous navigation.
    - Simulation models of Robosoft's robots in MSRS dynamic simulations.

- Generic interfaces definitions for data definition and exchange
    - allows easy re-use of services
    - allows easy integration of new algorithms in existing architecture

- Reference Designs
    - For control architectures of most of service robotics applications.

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Top 5 reasons to use robuBOX® :

- Perform optimal and riskless design of robot controllers.
  - Use reference designs of architectures provided with robuBOX.
- Speed up algorithms tuning and optimization:
  - The same software runs in simulation and on the real robot
  => save your walls !
- Re-use :
  - No need to redevelop all your controller for a new project
  - Re-use all existing services in future architectures
  => save precious time & energy !
- Benchmark algorithms:
  - Keep the same architecture,
  - Only change the service to be benchmarked
  => Run the same experiment on the robot or on simulation.
- Share developments among developers or partners:
  - Specify the interfaces between services
  - Run dummy services or simulations and Start working!
  => No need to wait for final developments from your partners

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Where has robuBOX been applied?

- One research robot built for robuBOX/MSRS : robuLAB10

- Robosoft Off-the-shelf robots:

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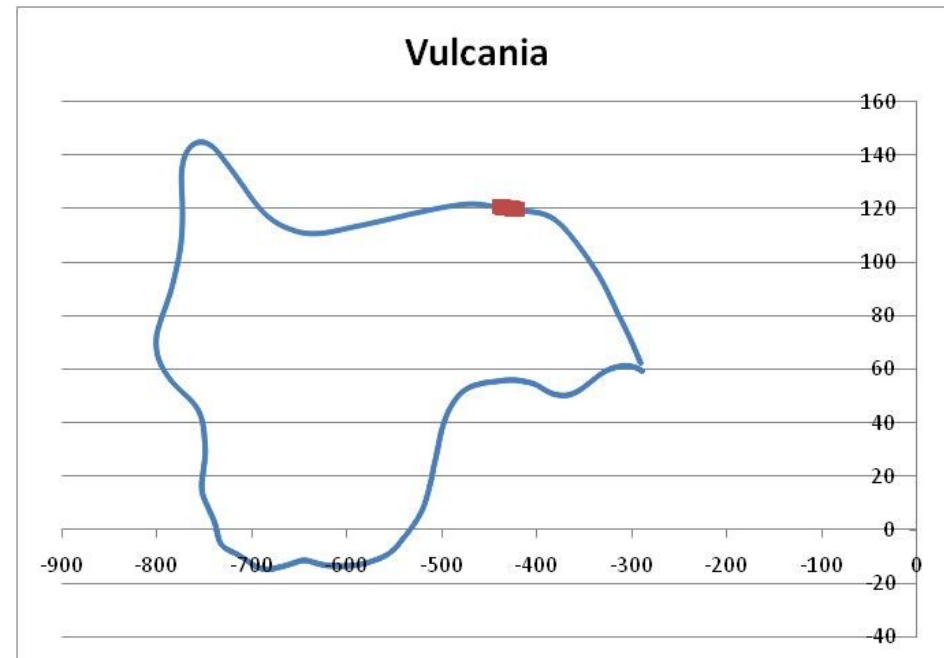Robotics
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Where has robuBOX been applied?

several one-off robotic solutions:

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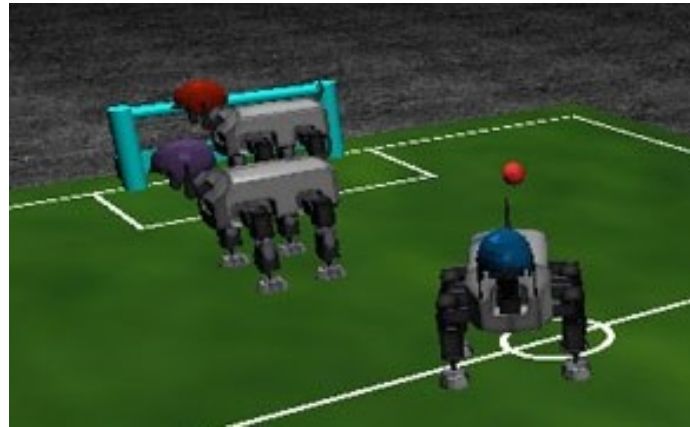
2008: robuRIDE: Vulcania Theme Park, France

- Step1: Site reconnaissance
  - RTK GPS
  - Lambert93 projection

2008: robuRIDE: Vulcania Theme Park, France

- Step 2: Software architecture using robuBOX and Microsoft Robotics Developers Studio

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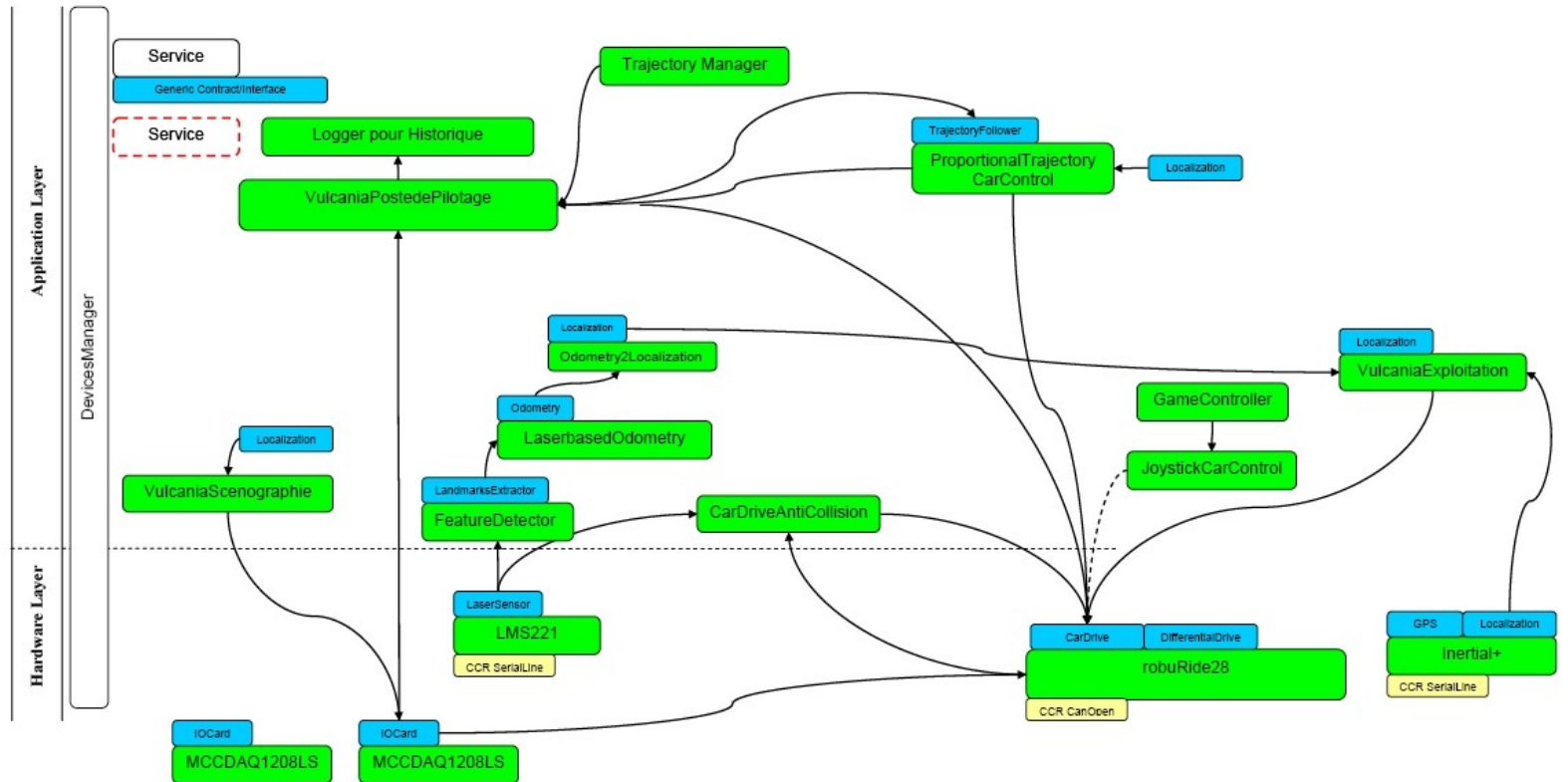
2008: robuRIDE: Vulcania Theme Park, France

Step 3: from GPS to 3D models and dynamic simulations for control laws tuning and application development
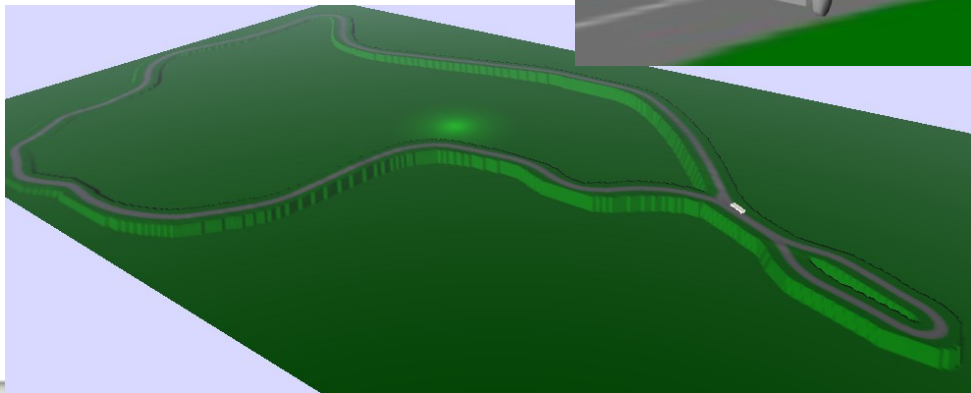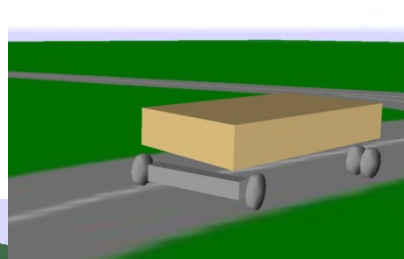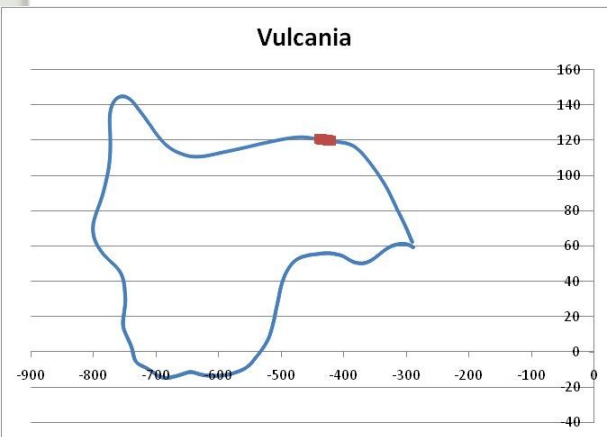
Vulcania

3D modeling of the trajectories using MSRS and robuBOX

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2008: robuRIDE: Vulcania Theme Park, France

- Step4: Deployment on the real robot
- Grand Opening in March 19.

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What hardware technology is supported ?

- ## Real Time Management:
  - robuBOX now runs on Windows Xpe.
  - Connected to microcontrollers or intelligent speed controllers through CANopen or TCP/IP.
  - Windows CE will soon be supported, in close cooperation with Microsoft.

- ## Many sensors/actuators/com. buses are supported:
  - Span from ultrasounds, laser range finders, inclinometers and inertial units to RTK differential GPS, vision sensors and frame grabbers.
  - CanOpen, and I2C buses are supported, serial line, Modbus as well as TCP/UDP client server applications, or web services.
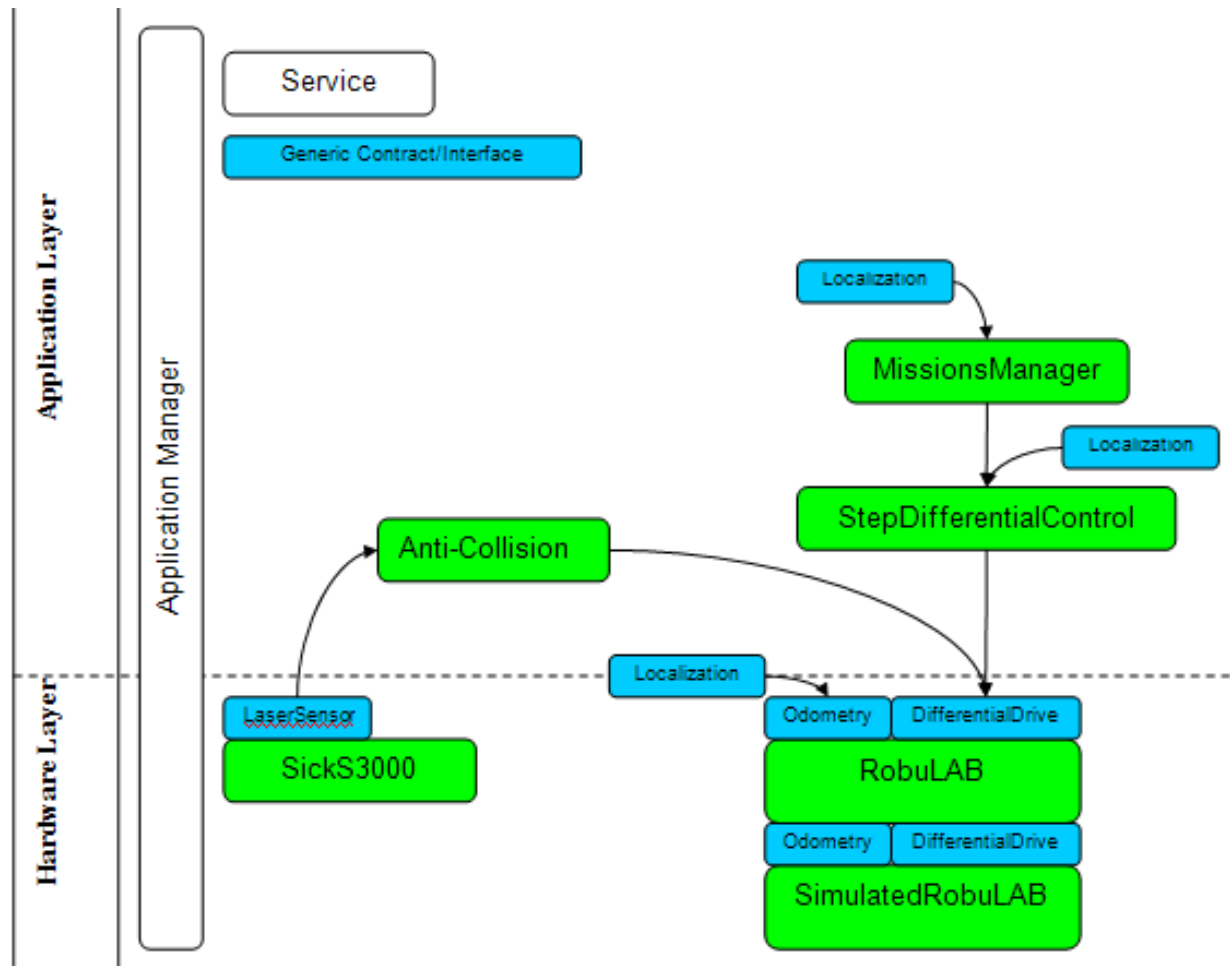
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Reference robotics applications provided with robuBOX® :

- Remote tele-operation
- Elementary moves
- Exploring the world
- Supervision of fleets of Robots

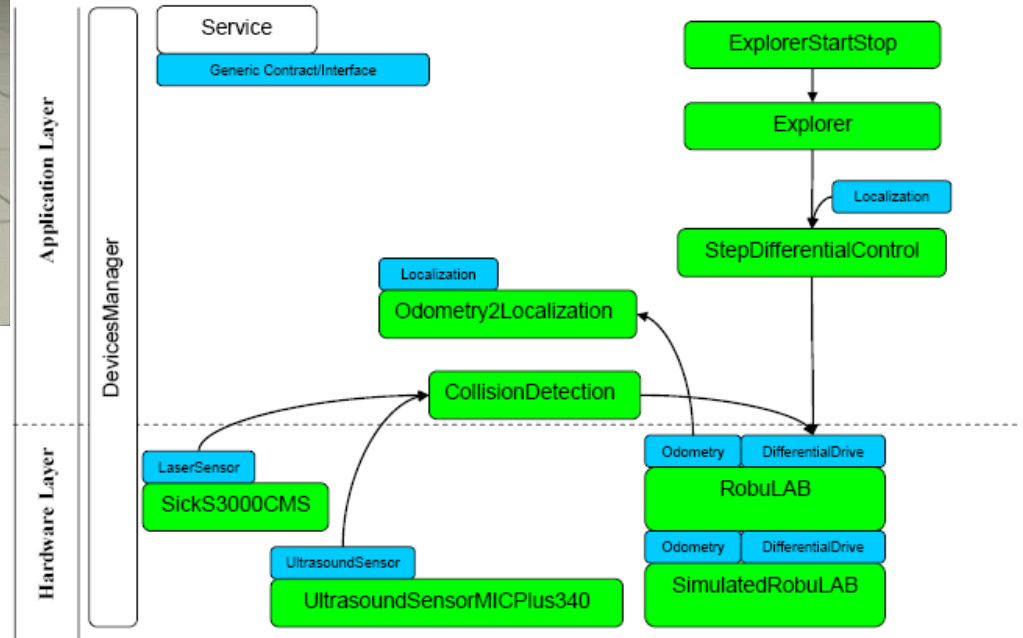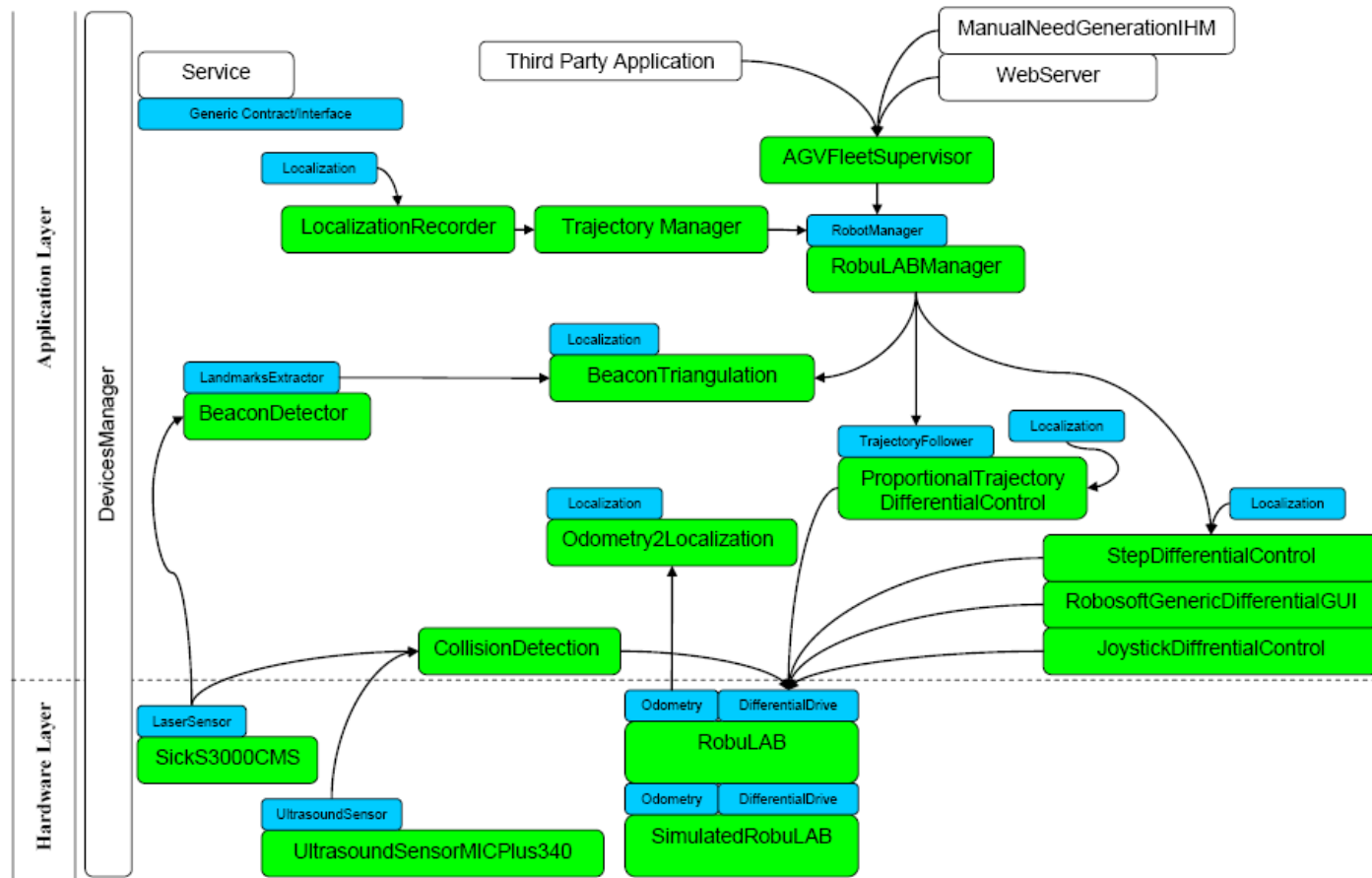# Remote Tele-operation
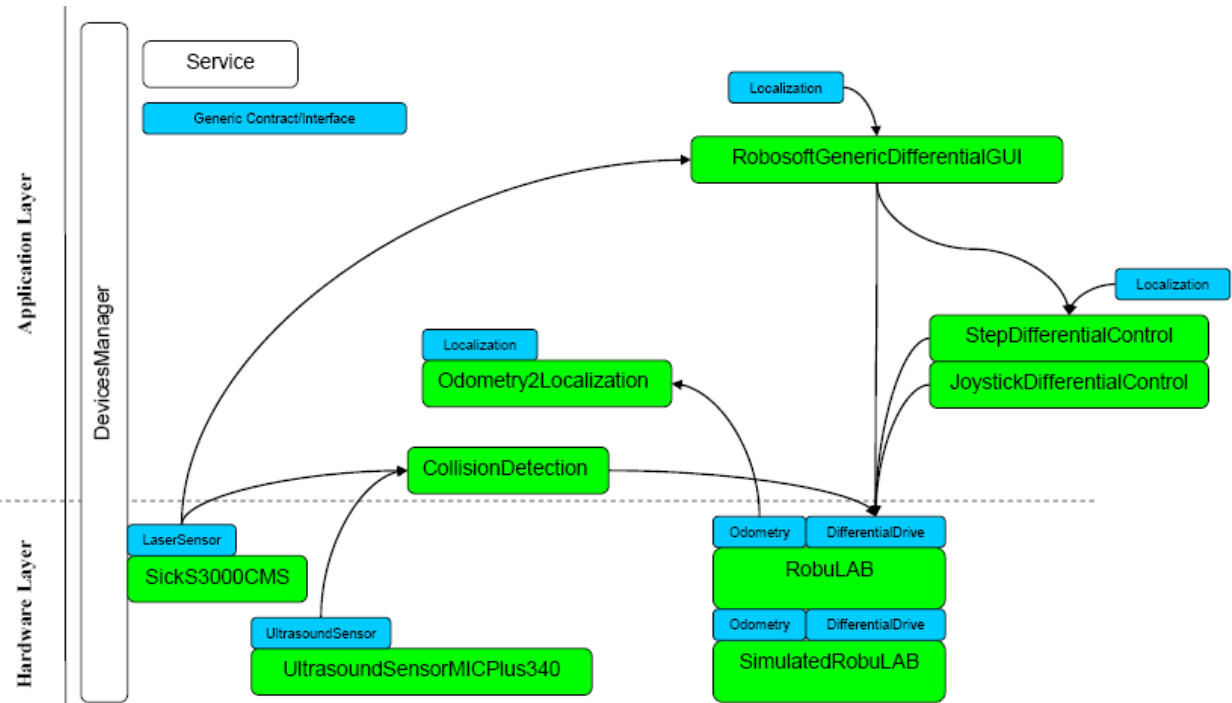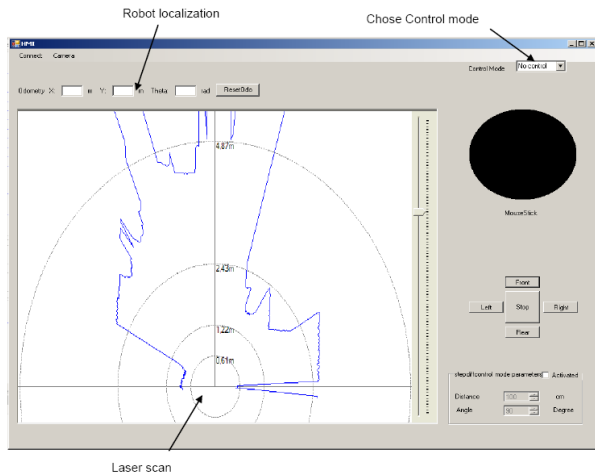
Elementary Displacements

Exploring the world

Supervision of fleets of robots and Mission management

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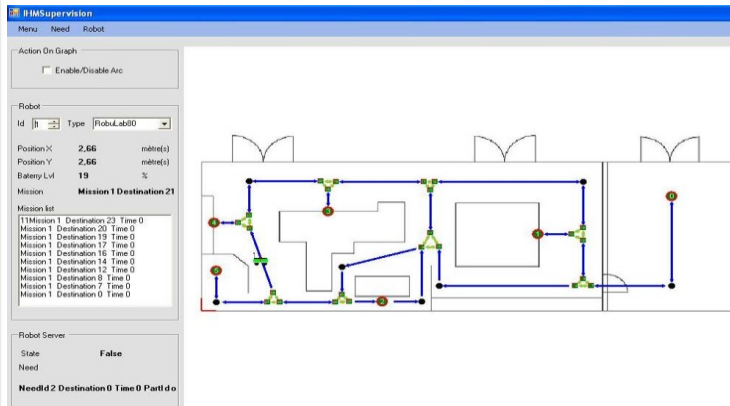for Transport, Cleanliness, Security and Health

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Supervision of fleets of robots and Mission management

- Goods and people automatic transportation,
- Navigation in a network of available roads
- Dynamic optimization and automatic itinerary specification

Robots high level management:

- Identification of collision threats,
- Priorities management at intersections and on one-way roads,
- Preventive failure detection and alarms…

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How can I use robuBOX for my robotics developments?

- You can redevelop all your robot's controller (services & architecture)

- You can use robuBOX provided services and reference designs.

- You can develop the additional services required to implement your top notch algorithms or hardware devices not supported yet.

- You can interface with third party applications, even running a different OS on a remote CPU : use WebServices , UDP/TCP server, Serial Communication… to interact with them.

- You then just need to customize the controller architecture !

Can I interface robuBOX with third party software?

- Yes! This is performed everyday for Robosoft's professional solutions.

- MSRS third party services is straight forward.
  Robosoft interfaces with Stanford Research Institute (SRI) algorithm. (SLAM mapping, RobuBusiness2007 & 2008)
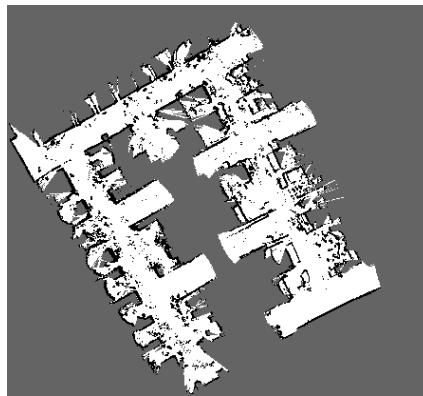

- Windows compatible libraries is simple: link to the library when compiling.

- Non windows based software is also possible:
  Interface through serial line or CanOpen, HTTP Get/Post, TCP or UPD client/servers, as well as REST and SOAP WebServices

4 steps to design Robotics control Architectures using robuBOX®:

1. Select the services you need from the robuBOX® collection.

2. Develop additional services that implement some specific algorithms.

3. Define your SOA architecture, using robuBOX generic Interfaces to communicate data between services.

4. Test your architecture in simulations and deploy your robuBOX ®.

Deploy robuBOX on your robot or…

… run it in realistic simulation:

- Only change is the driver to use: hardware driver or simulated entity
- **Exact same control architecture as services use standard interfaces**
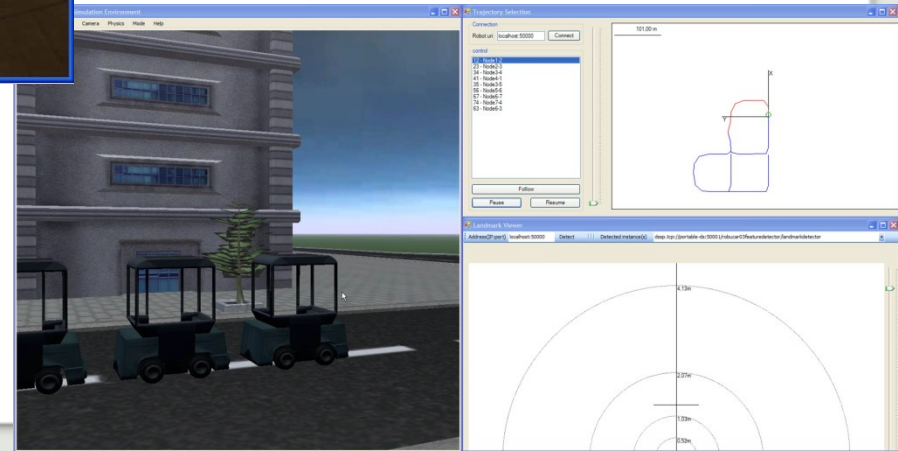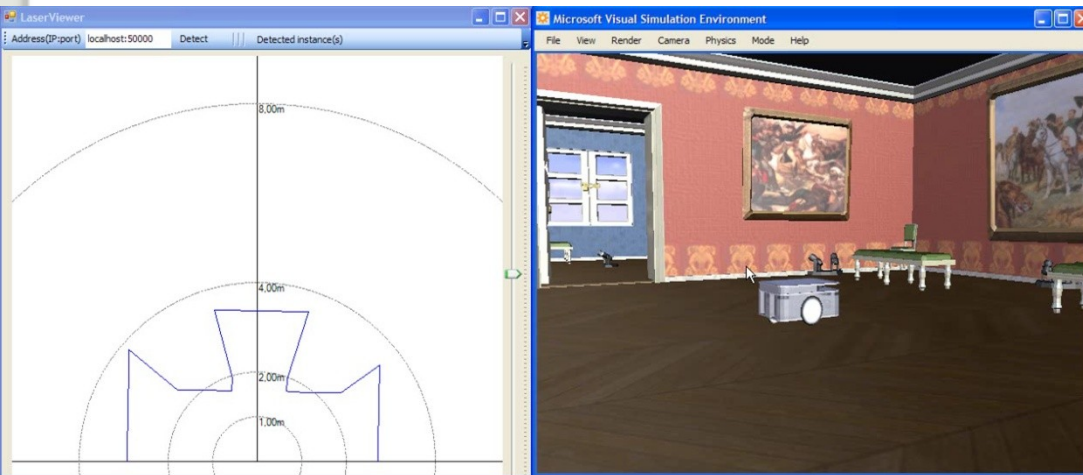
Need more information before starting your robuBOX developments??

- www.robosoft.com

- www.robubox.com

- www.microsoft.com/robotics

- sales@robosoft.fr