

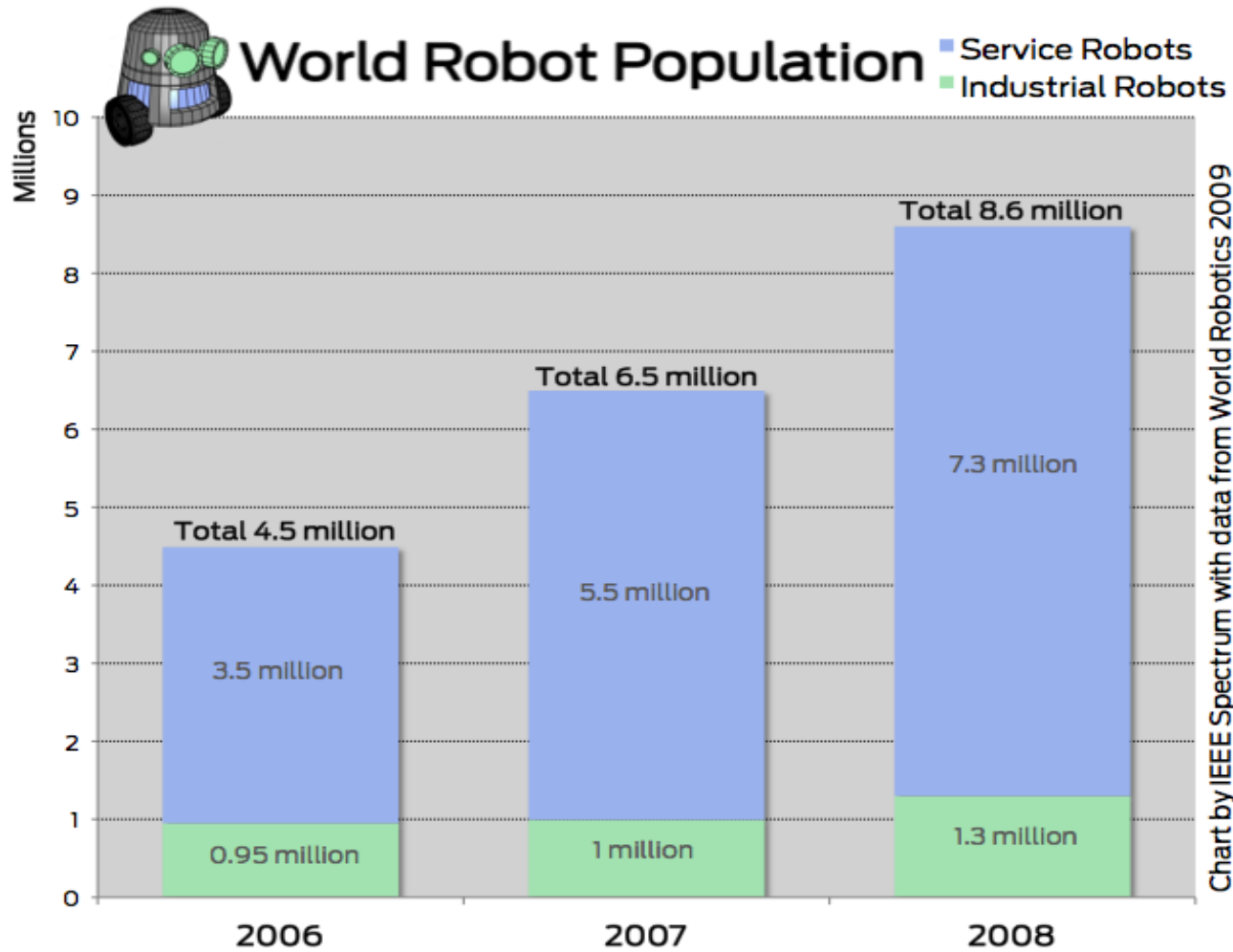
# Robotic Simulators



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# How Many Robots?



Source: World Robotics 2009

## *But...*

- Robots can be damaged
- High Cost
- Test Repeatability
- Environment Factors



# Why Simulators?

No physical dependency on the actual machine!

## Cost

- No cost for any robot or equipment
- No risk or damage, no maintenance
- No human risk

## Time

- Simulations can be run in parallel
- No battery recharge

## Experiments

- Any environment, any robot, any sensor
- Experimental repeatability
- Scalability



*400.000\$ for a beer???*



# Choosing the Right Simulator

“The best simulator does not have to resemble reality in the most accurate way. The power of a simulator is to fit to our needs.” (Elron, 1983)

## What are we simulating?

behavior-based, multi-robot, motion, interaction, manipulation, ...

## How are we simulating?

rendering (3D, 2D, console), physics, ...

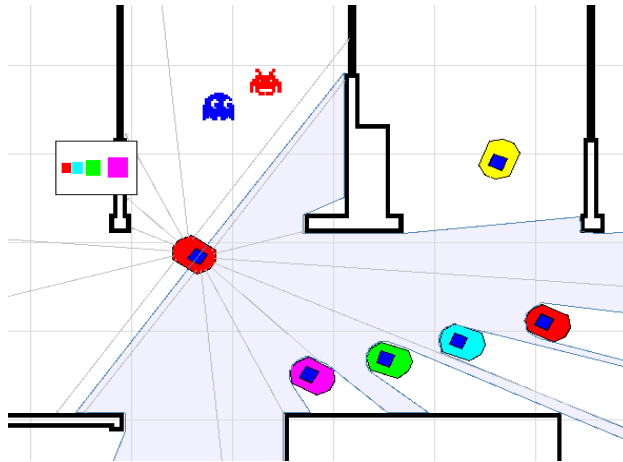
## Do we need to migrate to real platforms?



# Robotic Simulators



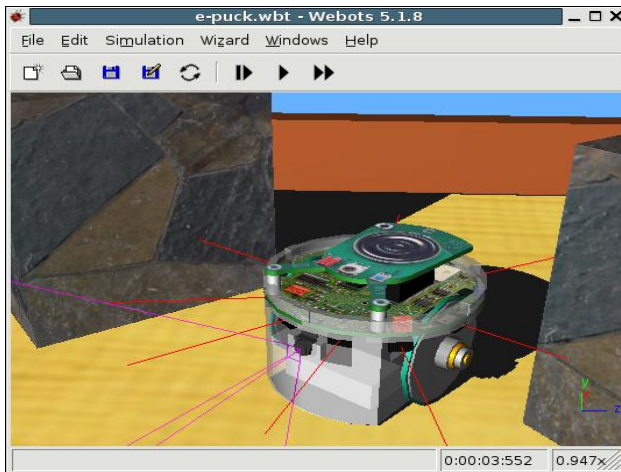
**Gazebo**



**Stage**



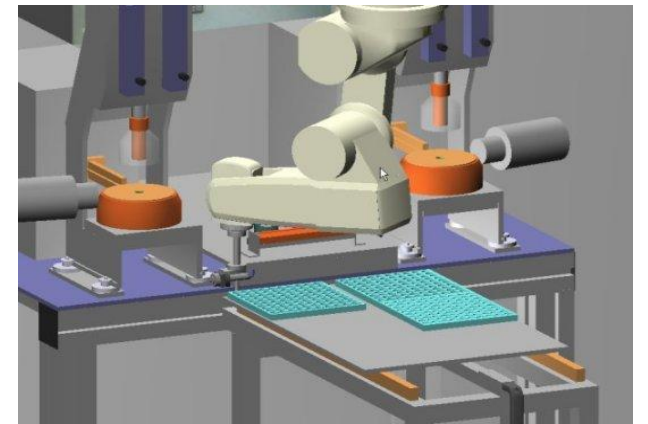
**USARSim**



**Webots**



**MS Robotics Studio**



**COSIMIR**



# Player/Stage/Gazebo

## Long term project

- Started in 2000
- Moved to SourceForge in 2001
- Gazebo (3D simulator) development started in 2003

## Player

A robot device interface  
(universal driver)

Hides hardware details

Common interfaces

Many devices supported

## Stage

Scalable 2.5D multiple  
robot simulator

Light simulation

Large number of robots  
( $O(10)$  -  $O(100)$ )

## Gazebo

High-fidelity 3D multiple  
robot simulator

Open Dynamics Engine

OpenGL

Small number of robots  
( $O(1)$  -  $O(10)$ )

Adopted for DARPA  
Robotics Challenge

