

Towards Live Programming in ROS with PhaROS and LRP

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and Noury Bouraqadi¹



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Robotic Application Lifecycle

1. Develop / Borrow Parts

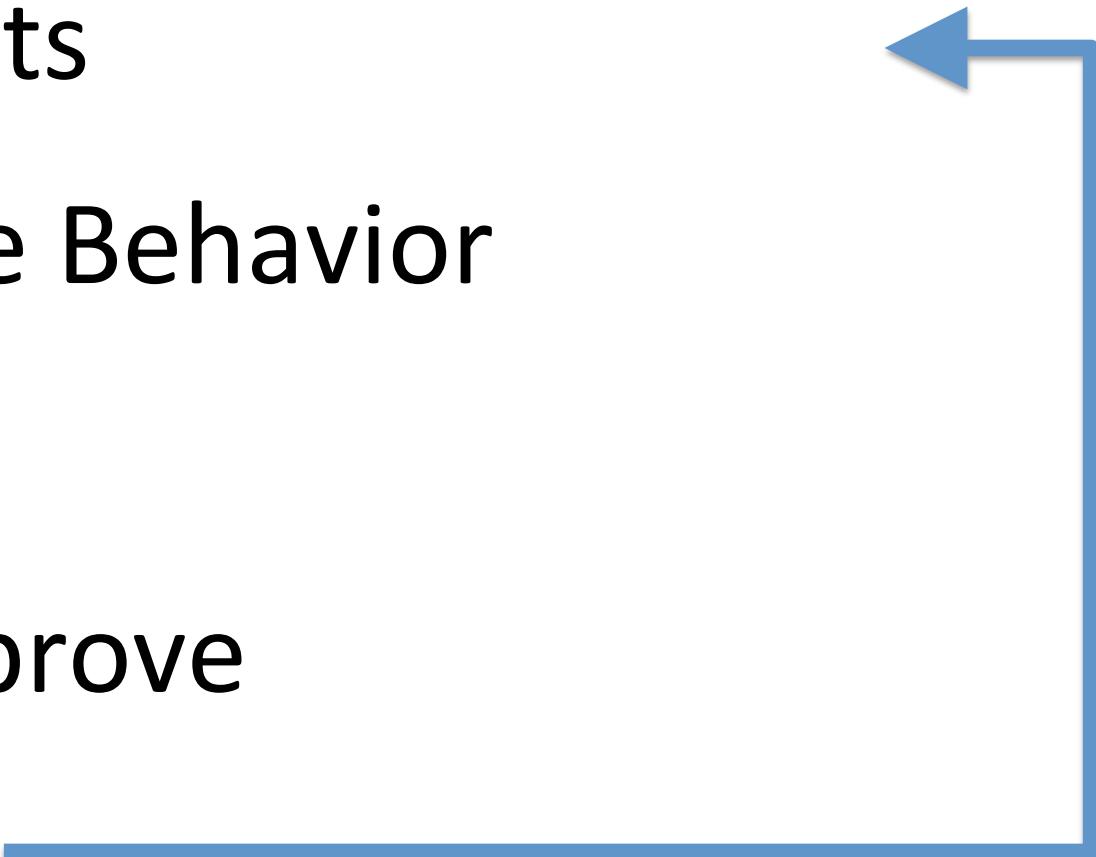
2. Assemble Parts

3. Run + Analyze Behavior

4. Stop

5. Fix bugs / Improve

6. Goto step 2



ROS Robotic Application Lifecycle

1. Develop / Borrow **ROS Packages**

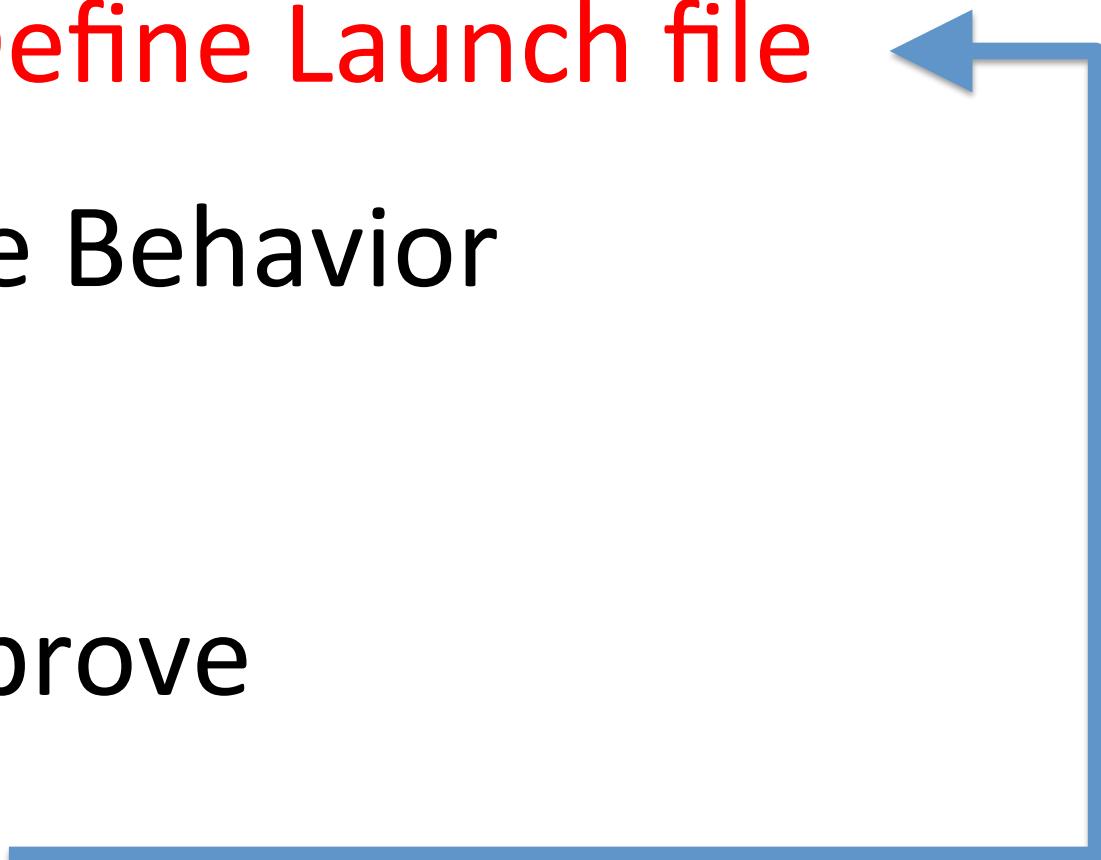
2. Assemble = Define Launch file

3. Run + Analyze Behavior

4. Stop

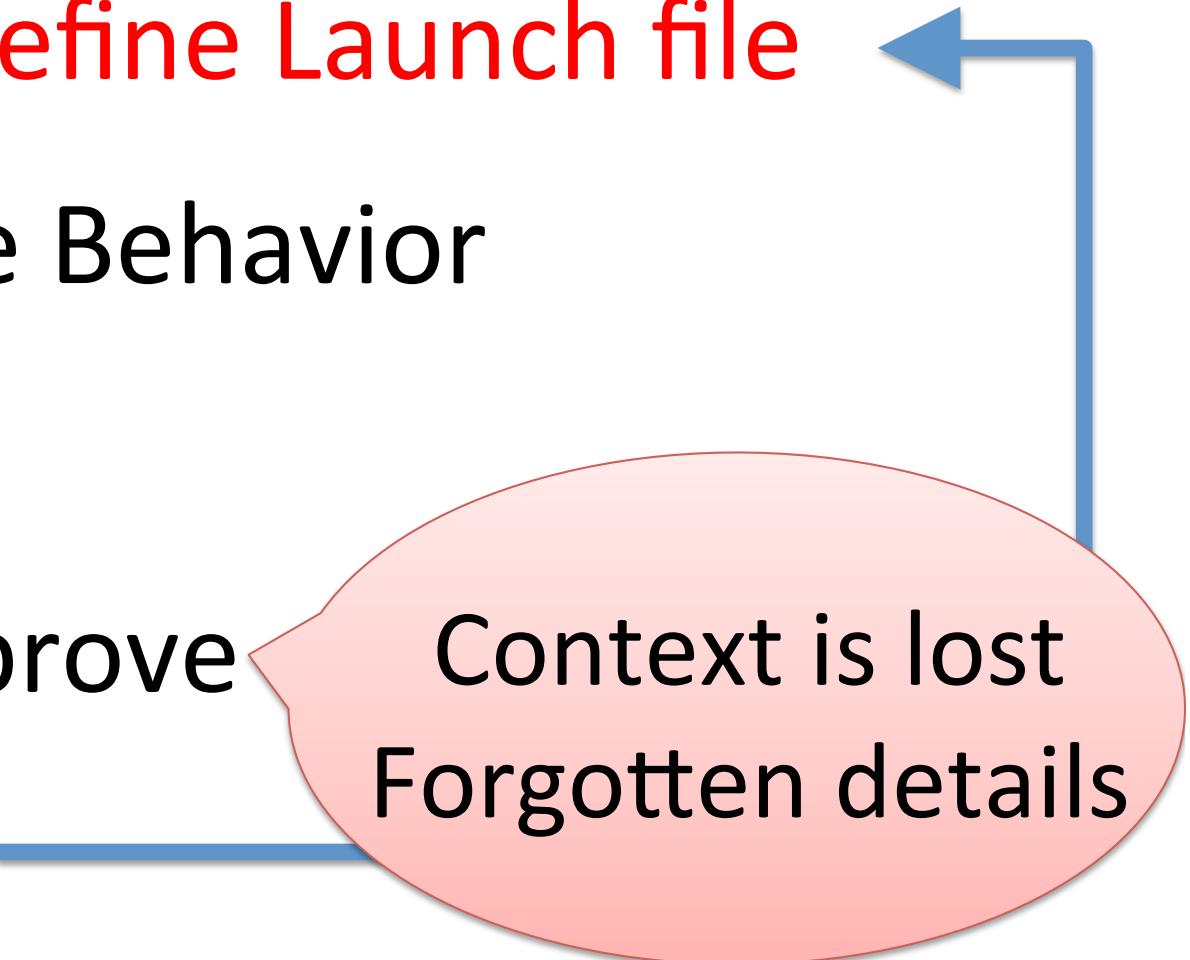
5. Fix bugs / Improve

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ROS Robotic Application Lifecycle

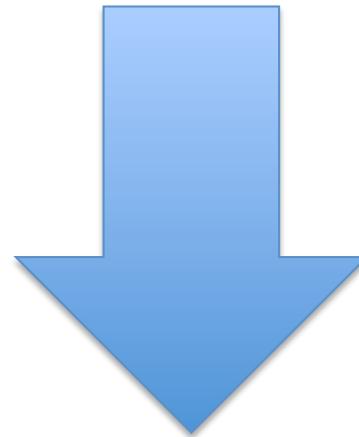
1. Develop / Borrow **ROS Packages**
2. Assemble = Define Launch file
3. Run + Analyze Behavior
4. Stop
5. Fix bugs / Improve
6. Goto step 2



Context is lost
Forgotten details

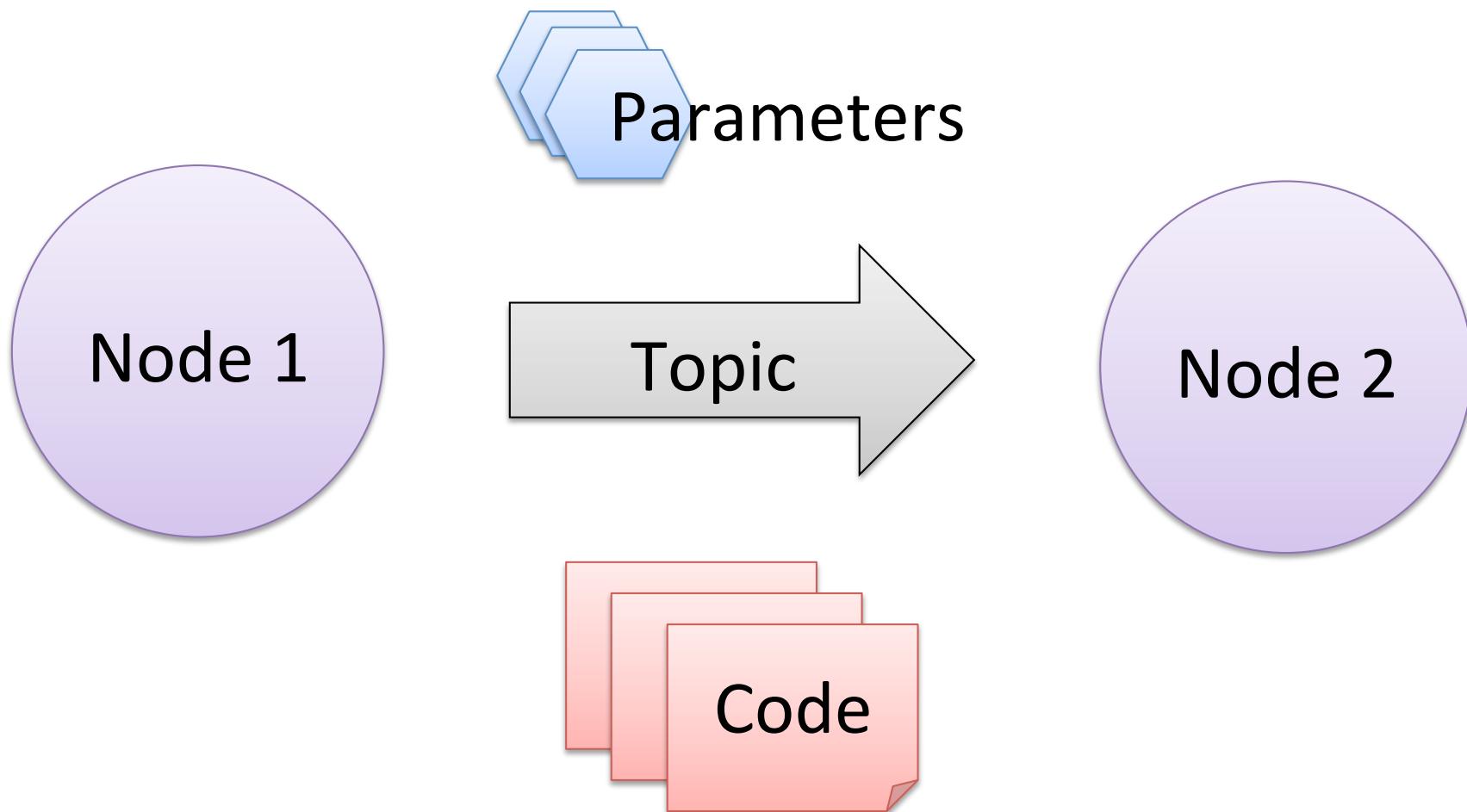
Live Programming

Edit program at Run-time

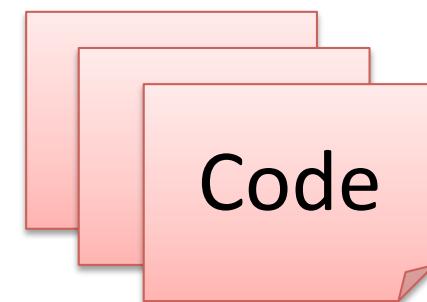
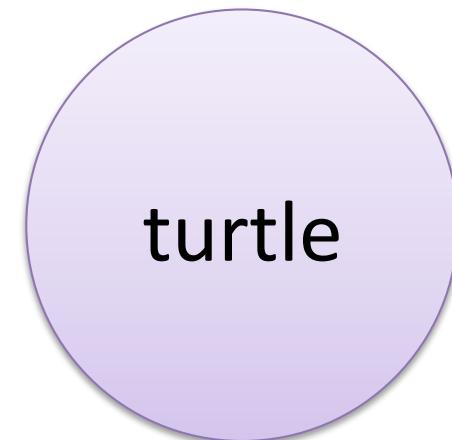
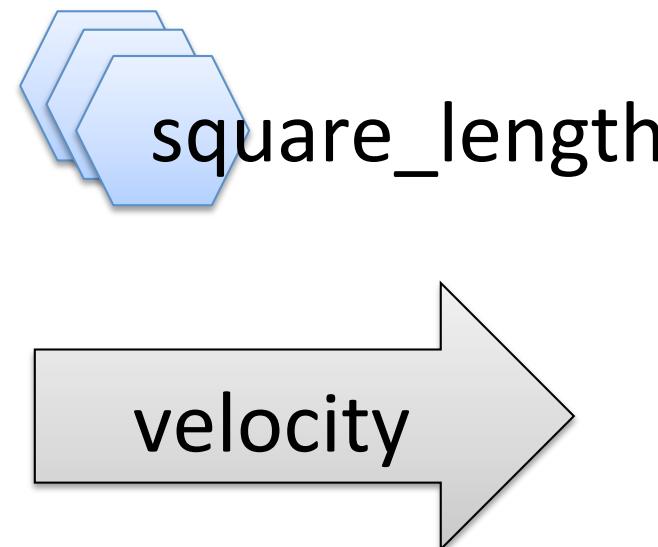
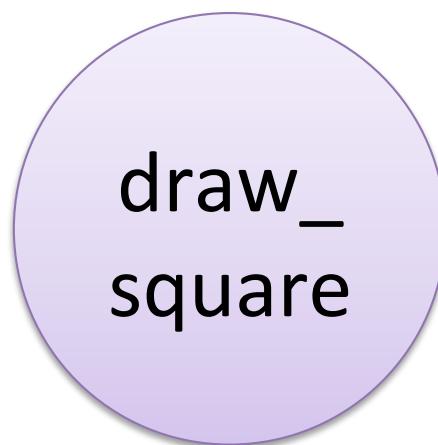


Immediate Feedback

Programming with ROS

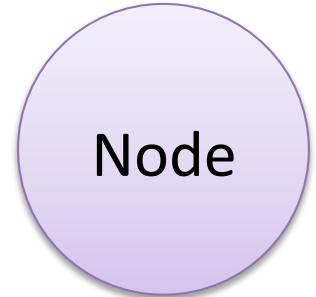


ROS Example

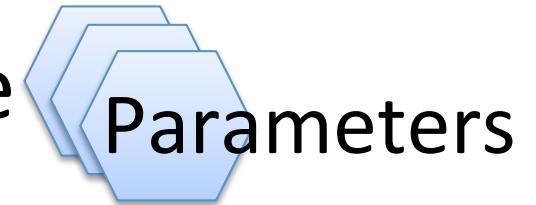


Requirements for **Live** Programming with ROS

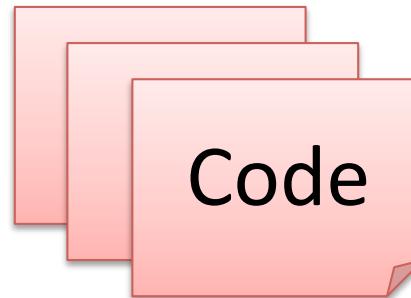
1. Stop/Start = Replace individual nodes



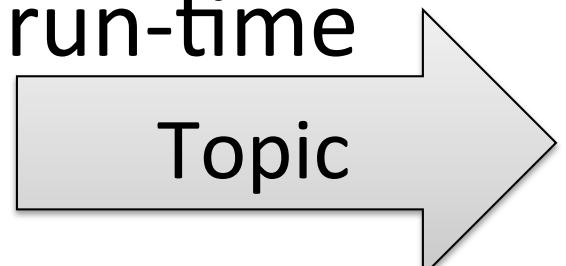
2. Change parameters at run-time



3. Change code at run-time

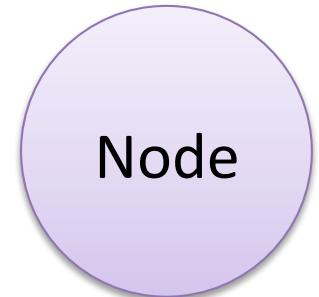


4. Change connections = topics at run-time



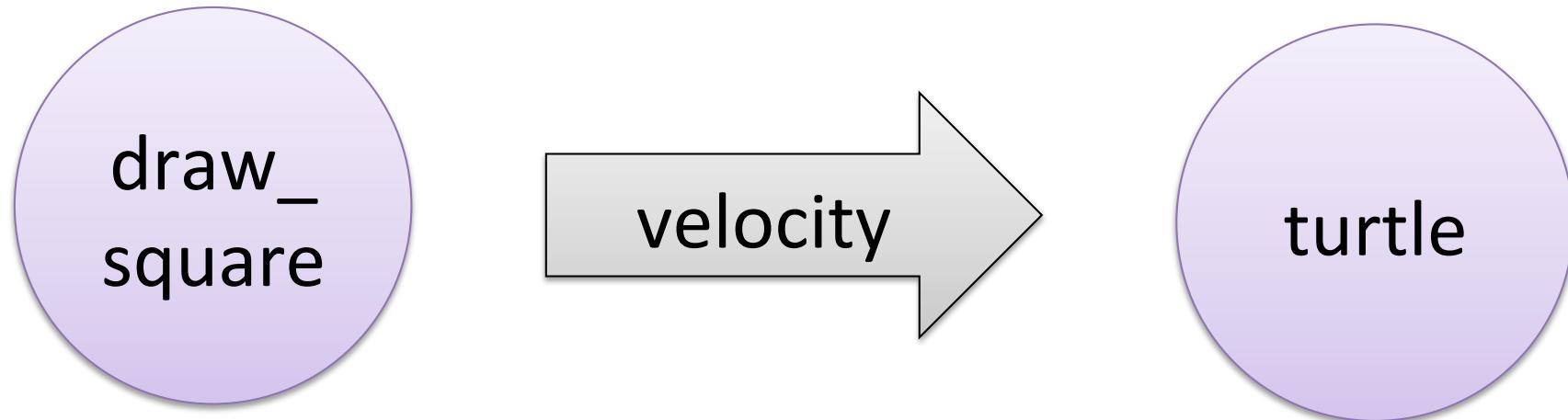
Requirement 1

- Start/Stop Start = Replace individual nodes
- Problem in ROS :
 - Application = 1 .launch static file
 - Command line Changes are lost
 - Bug when restarting individual nodes



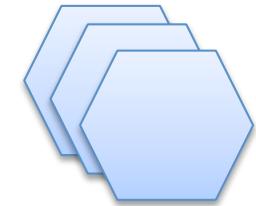
Requirement 1

- Start/Stop Start = Replace individual nodes
 - Problem in ROS :
 - Application = 1 .launch static file
 - Bug when restarting individual nodes
 - Example restarting a turtle



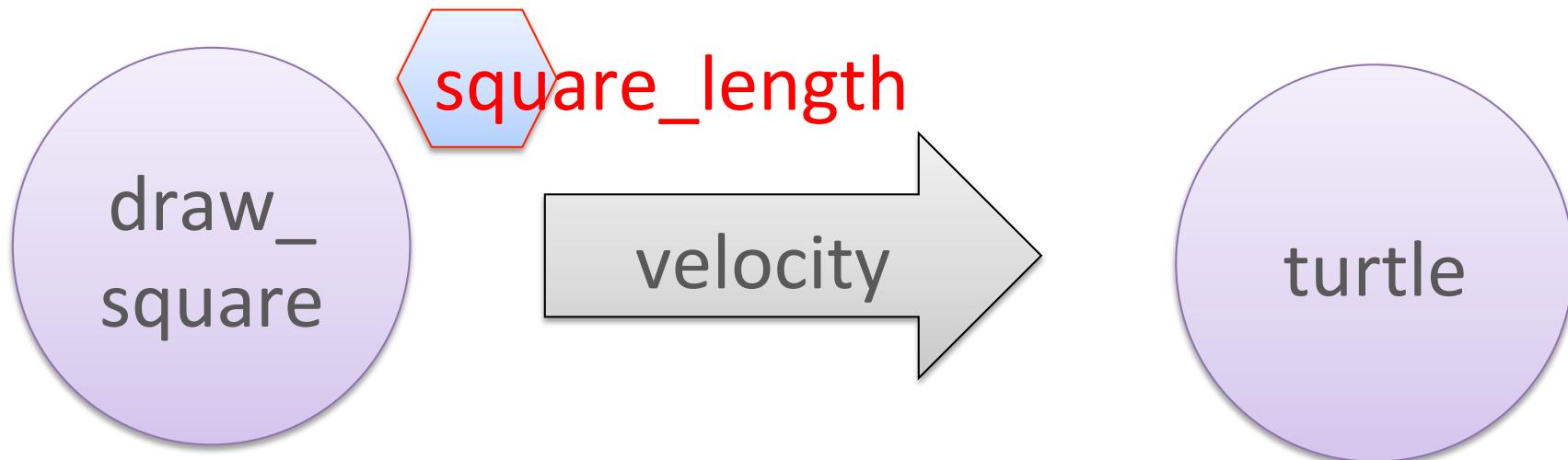
Requirement 2

- Change node parameters at run-time
- Problem in ROS :
 - Parameters fixed in launch file/rosrun command line
 - Changing them → restart the full app



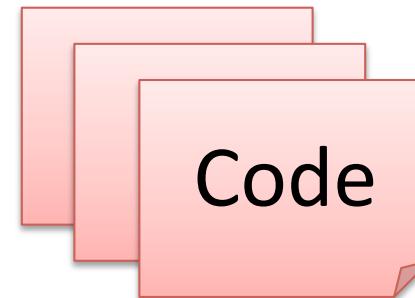
Requirement 2

- Change node parameters at run-time
- Problem in ROS :
 - Parameters fixed in launch file/rosrun command line
 - Changing them → restart the full app
- Example : Change square_length



Requirement 3

- Change node code at run-time
- Problem in ROS :
 - Use of C/C++ mainly
 - No Hot Code Swapping



Requirement 4

- Change node connections at run-time
 - Change topics names (remape / name space)
- Problem in ROS :
 - Topic names are fixed at launch time



Proposal

- Highly reflective and Dynamic
 - “Everything happens at run-time”



Proposal

- Highly reflective and Dynamic
 - “Everything happens at run-time”
- DSL for hierarchical state machines
 - Integrated with Pharo



LRP

Proposal

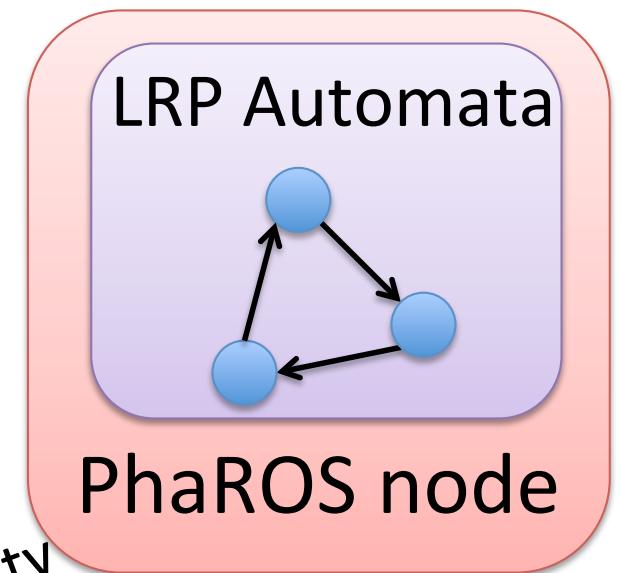
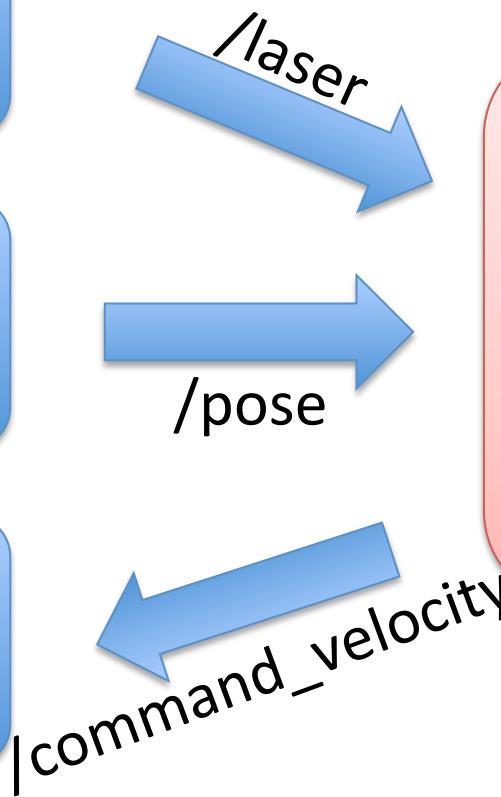
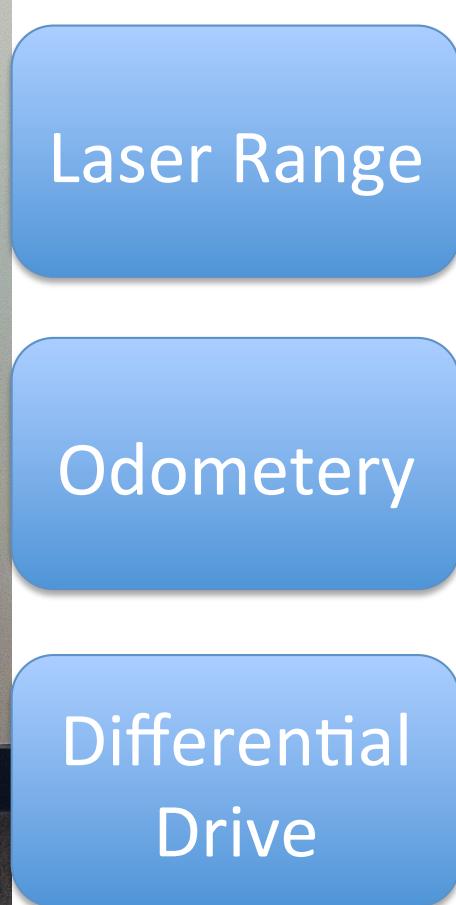
- Highly reflective and Dynamic
 - “Everything happens at run-time”
- DSL for hierarchical state machines
 - Integrated with Pharo
- PhaROS : ROS Client for Pharo
 - Nodes developed in Pharo



LRP

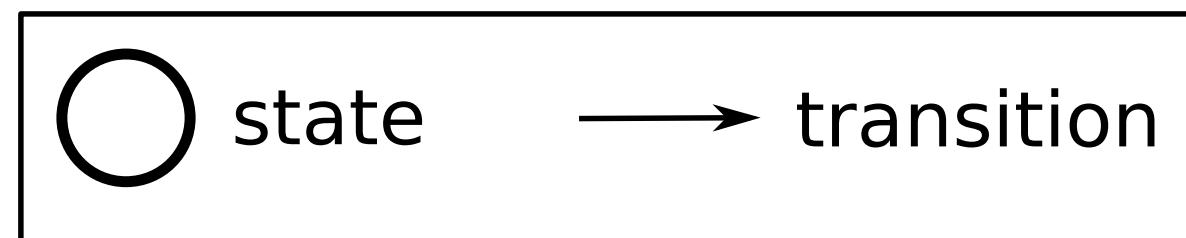
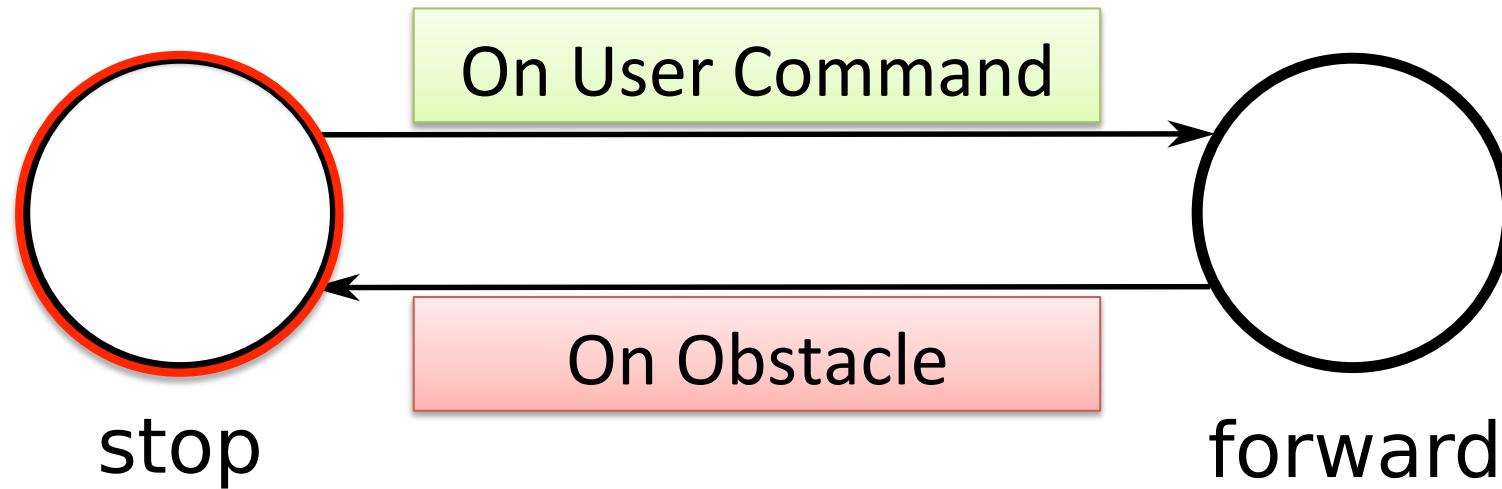


LRP + PhaROS in Action

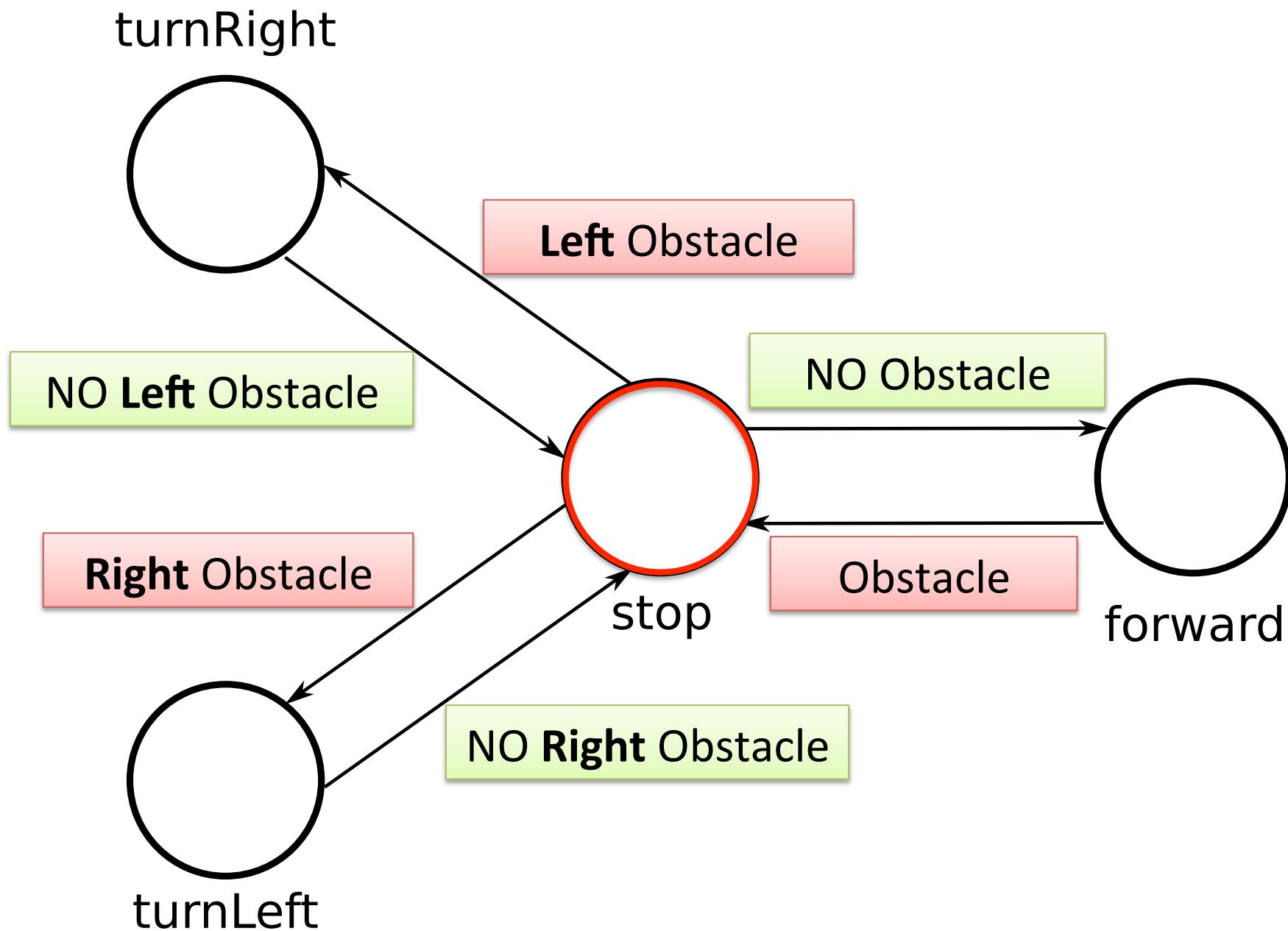


ROS Graph

Example 1: Stop on Obstacle



Example 2: Obstacle Avoider



Example Video

Code Editor:

```

+Var +Mac +State +Trans +Event Machines: Selected
(var min_distance := [0.5])
(var robulab := [RobulabBridge uniqueInstance])
(machine Tito
    ; States
    (state forward
        (onentry [robulab value forward: f_vel value]))
    (state stop
        (onentry [robulab value stop]))
    (state turnLeft
        (onentry [robulab value turn: t_vel value]))
    (state turnRight
        (onentry [robulab value turn: t_vel value negated]))
    ; Transitions
    (on obstacle forward -> stop t-stop)
    (on noObstacle stop -> forward t-forward)
    (on rightObstacle stop -> turnLeft t-lturn)
    (on leftObstacle stop -> turnRight t-rturn)
    (on noObstacle turnLeft -> stop t-tlstop)
    (on noObstacle turnRight -> stop t-trstop)
    ; Events
    (event obstacle [robulab value isThereAnObstacle:
min_distance value])
    (event noObstacle [(robulab value
isThereAnObstacle: min_distance value) not])
    (event rightObstacle [robulab value
isThereARightObstacle: min_distance value])
    (event leftObstacle [robulab value
isThereALeftObstacle: min distance value])
)

```

Machines:

- Tito

Variables:

min_distance	0.5
robulab	a Robulab
f_vel	0.25
t_vel	0.5

Selected Machine: Tito



State Transition Diagram:

```

graph LR
    stop((stop)) -- "t-trstop" --> turnRight((turnRight))
    stop -- "t-tlstop" --> turnLeft((turnLeft))
    stop -- "t-stop" --> forward((forward))
    turnLeft -- "t-lturn" --> stop
    turnRight -- "t-rturn" --> stop
    forward -- "t-forward" --> stop

```

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