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Innovative Teaching Approaches in development of Software  
Designed Instrumentation and its application in real-time  
systems

# Theory of Robotics Systems

Introduction to ROS

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## Innovative Teaching Approaches in development of Software Designed Instrumentation and its application in real-time systems

Faculty of Technical  
Sciences



Ss. Cyril and Methodius  
University  
Faculty of Electrical Engineering  
and Information Technologies



Zagreb University of  
Applied Sciences



School of Electrical  
Engineering  
University of Belgrade



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# Teorija Robotskih Sistema

Uvod u ROS

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# Uvod u ROS

- ROS (Robot Operating System) je *open-source*, meta operativni sistem namenjen robotima.
- Obezbeđuje sve servise koje očekujemo da ima svaki operativni sistem
  - Apstrakcija hardvera, kontrola *low-level* uređaja, upravljanje procesima i druge
- Više o samom ROS-u <http://wiki.ros.org/>





## ROS filizofija

- Peer to peer - Svaki od programa komunicira preko definisanog API-a:
  - ROS messages, services, etc.
- Distributivnost - Programi mogu biti pokrenuti na više računara dok se komunikacija odvija preko mreže.
- Više jezičnost - ROS moduli mogu biti napisani u bilo kom jeziku za koji postoji klijentska biblioteka:
  - C++, Python, MATLAB, Java, etc.
- Open-source - Velika većina ROS programa je open-source i besplatna za korišćenje



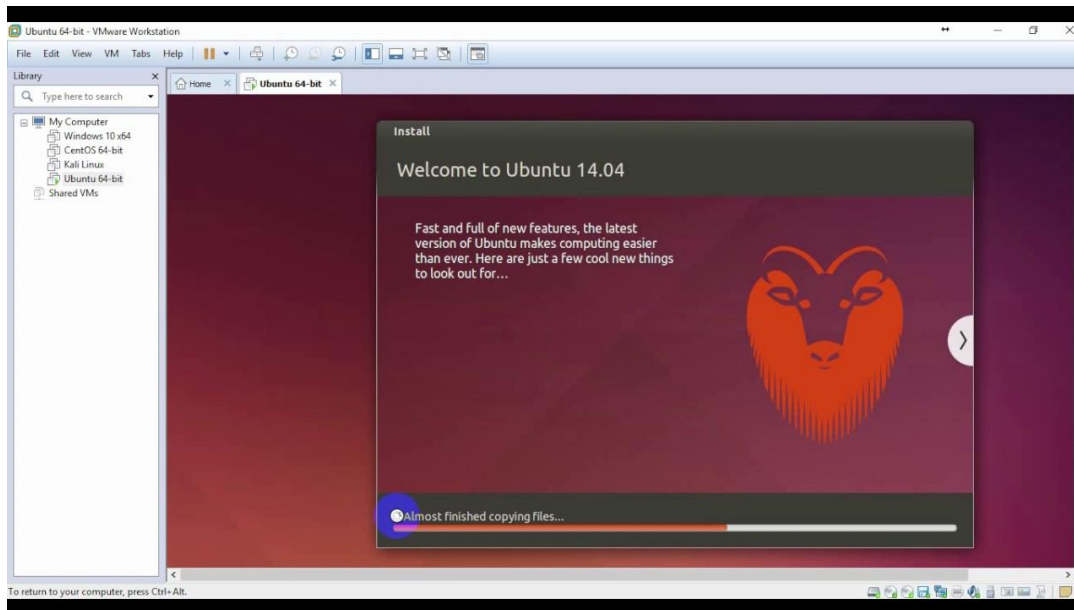


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# Konfiguracija razvojnog okruženja

- VMware Workstation 15: Softver za pokretanje virtuelne mašine.
- Podešenu virtuelnu mašinu je moguće preuzeti sa [linka](#).



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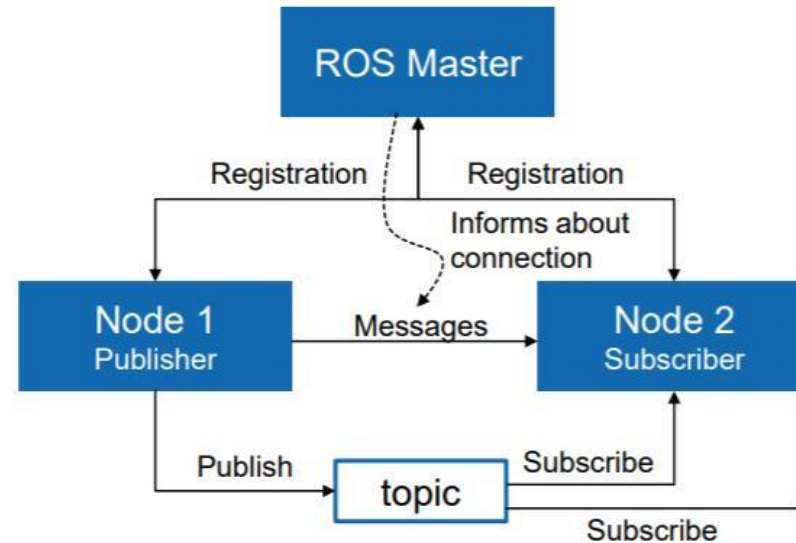


## Osnovni činioci ROS sistema

- ROS Master: Pokreće se na početku, nadgleda rad ostalih nodova.
  - `roscore`
- ROS Nod: Predstavlja programe(skripte) koji se izvršavaju pod ROS-om.
  - `roslaunch package_name node_name`
- ROS Topik: Međusobna komunikacija vrši se kroz mehanizam topika. Jedan nod šalje informacije (publisher) ili prima informacije (subscriber) sa određenog topika.
  - `rostopic list`



# Struktura dva noda u komunikaciji





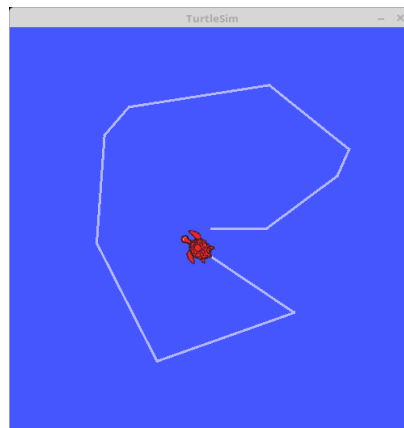
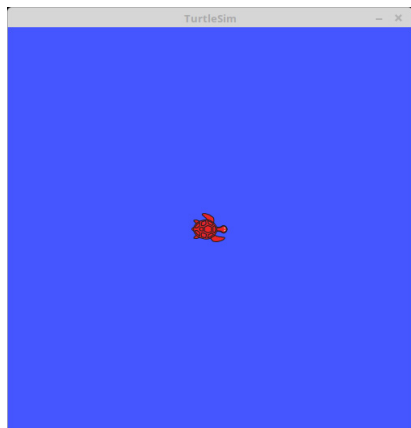


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# Pokretanje prvih ROS nodova

- Pokrenuti ROS Master nod komandom: `roscore`
- Pokrenuti ROS Nod `turtlesim_nod`: `roslaunch turtlesim turtlesim_nod`
- Pokrenuti ROS Nod za teleoperaciju: `roslaunch turtlesim turtle_teleop_key`
- Napomena: svaka komanda treba biti pozvana u zasebnom terminalu!!!



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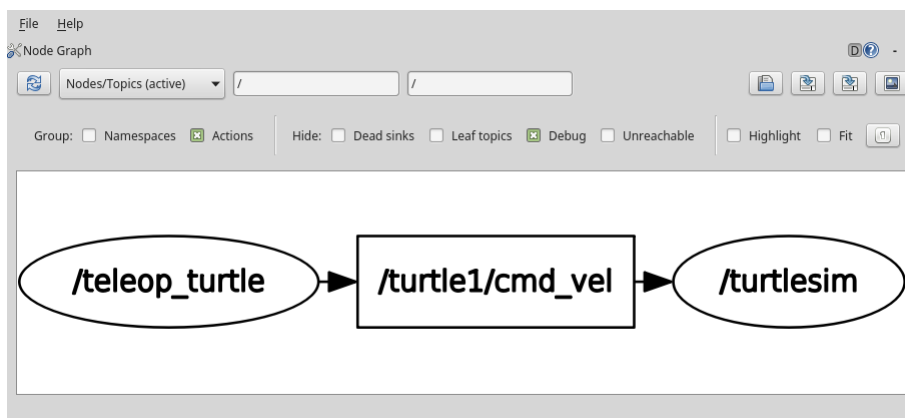


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# Pregled aktivnih nodova i njihova medjusobna povezanost

- Naredbom `rqt_graph` dobijamo informaciju o aktivnim nodovima. Krugovi predstavljaju nodove, kvadrati topike dok strelica pokazuje smer protoka informacija.



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# Kreiranje ROS paketa

- Novi paket je potrebno kreirati u workspace folderu (`cd ~/catkin_ws/src`).
- Kreiranje paketa se izvršava naredbom:
  - `catkin_create_pkg hello_world std_msgs rospy`
- Paket `hello_world` je napravljen u workspace folderu i sadrži sledeće komponente:
  - Src folder u kome se smeštaju programski kodovi
  - CMakeList.txt u kome se nalaze informacije o bildovanju paketa
  - Package.xml u kome se definiše ime paketa, verzija, autori, ...

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# Kreiranje ROS paketa

- U src folderu treba kreirati prazne skripte u koje se kasnije upisuje programski kod:
  - `cd ~/catkin_ws/src/hello_world/src` (pristup odgovarajućem folderu)
  - `touch hello_world_publisher.py` (naredba za kreiranje fajla)
  - `touch hello_world_subscriber.py` (naredba za kreiranje fajla)

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# Kreiranje hello\_world\_publisher.py noda

```
#!/usr/bin/env python

import rospy
from std_msgs.msg import String

def talker():
    pub = rospy.Publisher('hello_pub', String, queue_size = 10)
    rospy.init_node('hello_world_publisher', anonymous=True)
    r = rospy.Rate(10)
    while not rospy.is_shutdown():
        str = 'hello_world %s' % rospy.get_time()
        rospy.loginfo(str)
        pub.publish(str)
        r.sleep()

if __name__ == '__main__':
    try:
        talker()
    except rospy.ROSInterruptException:
        pass
```





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# Kreiranje hello\_world\_subscriber.py noda

```
#!/usr/bin/env python

import rospy
from std_msgs.msg import String

def callback(dana):
    rospy.loginfo(rospy.get_caller_id() + "I heard %s", dana.data)

def listener():
    rospy.init_node('hello_world_subscriber', anonymous=True)
    rospy.Subscriber('hello_pub', String, callback)
    rospy.spin()

if __name__ == '__main__':
    listener()
```

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# Priprema skripte za pokretanja

- Da bi se omogućilo pokretanje skripte, iz komandne linije je potrebno dozvoliti da neki fajl bude izvršni:
  - `chmod +x hello_world_publisher.py`
  - `chmod +x hello_world_subscriber.py`
- Ukoliko se koristi Python nije potrebno kompajliranje workspace-a, dok ukoliko se koristi C++ nakon svake izmene potrebno je izvršiti kompajliranje!!!







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# Pokretanje kreiranih nodova

- Na početku mora biti pokrenut master nod: roscore
- Zatim pokrećemo iz zasebnih terminala dva kreirana noda:
  - `roslun hello_world hello_world_publisher.py`
  - `roslun hello_world hello_world_subscriber.py`

```
robot@robot:~$ roslun http://localhost:11311/11313
[INFO] [155142956.242471]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.24
[INFO] [155142956.242483]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.24
[INFO] [155142956.442458]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.44
[INFO] [155142956.542524]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.54
[INFO] [155142956.642473]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.64
[INFO] [155142956.742460]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.74
[INFO] [155142956.842515]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.84
[INFO] [155142956.942444]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142956.94
[INFO] [155142957.042444]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.04
[INFO] [155142957.142440]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.14
[INFO] [155142957.242440]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.24
[INFO] [155142957.342461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.34
[INFO] [155142957.442461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.44
[INFO] [155142957.542461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.54
[INFO] [155142957.642461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.64
[INFO] [155142957.742461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.74
[INFO] [155142957.842461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.84
[INFO] [155142957.942461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142957.94
[INFO] [155142958.042461]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.04
[INFO] [155142958.142443]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.14
[INFO] [155142958.242222]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.24
[INFO] [155142958.342869]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.34
[INFO] [155142958.442290]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.44
[INFO] [155142958.541041]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.54
[INFO] [155142958.641961]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.64
[INFO] [155142958.741627]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.74
[INFO] [155142958.841961]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.84
[INFO] [155142958.941627]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142958.94
[INFO] [155142959.041627]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142959.04
[INFO] [155142959.141627]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142959.14
[INFO] [155142959.242450]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142959.24
[INFO] [155142959.342450]: /hello_world_subscriber: 2729, 1551429248822 heard hello_world 155142959.34
```

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