University of Ljubljana
Faculty of Electrical Engineering

COLLABORATIVE ROBOTICS CENTRE

robolab

Vodenje robotov – ROS
TRANSFORMACIJE

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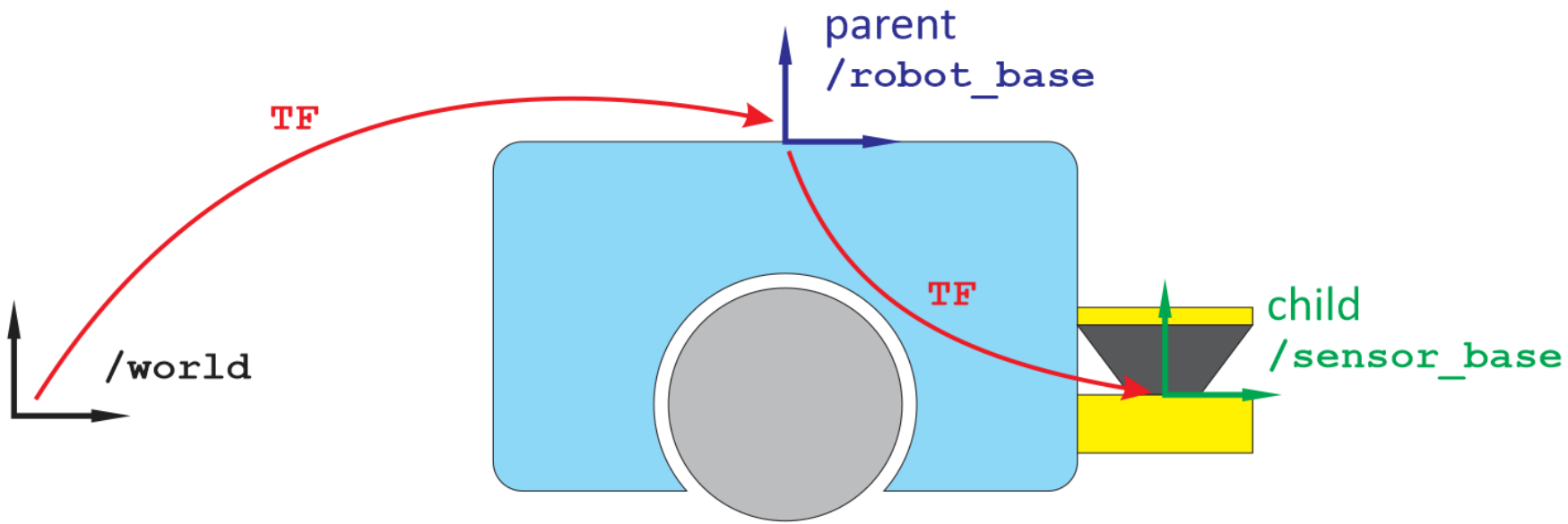
www.robolab.si
www.cobotic.si

TRANSFORMACIJE

- TF2
- Robot State Publisher
- URDF
- Joint State Publisher
- Orodja

TRANSFORMACIJE

transformacija med dvema koordinatnima sistemoma

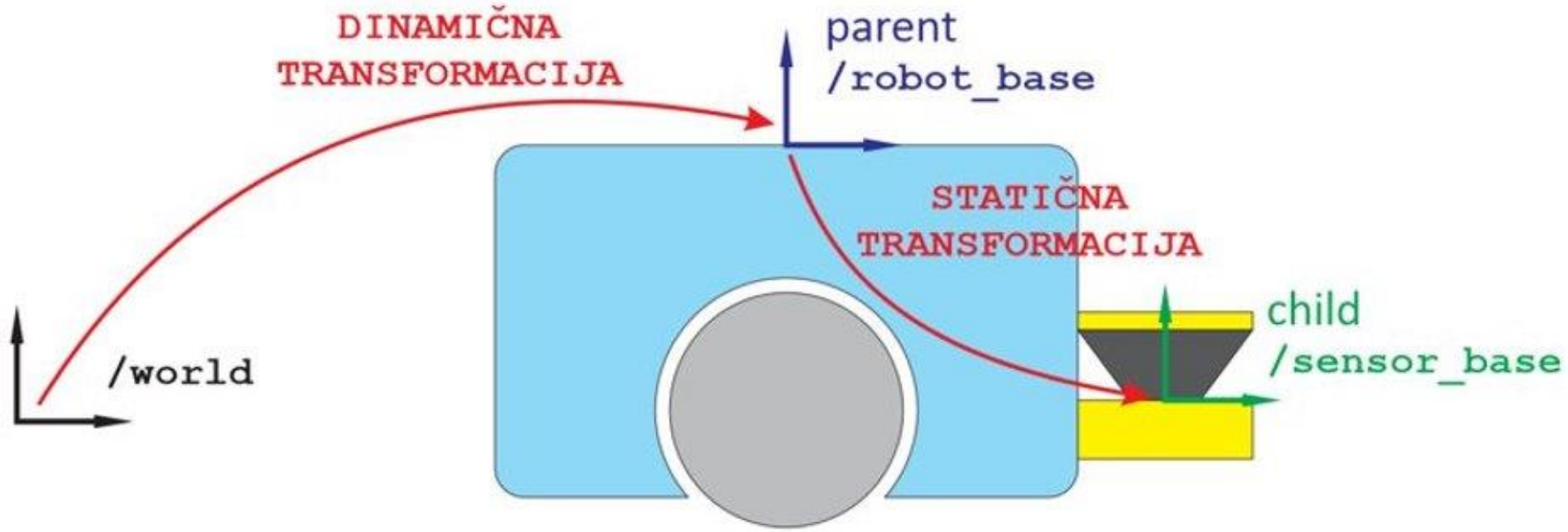


TF2

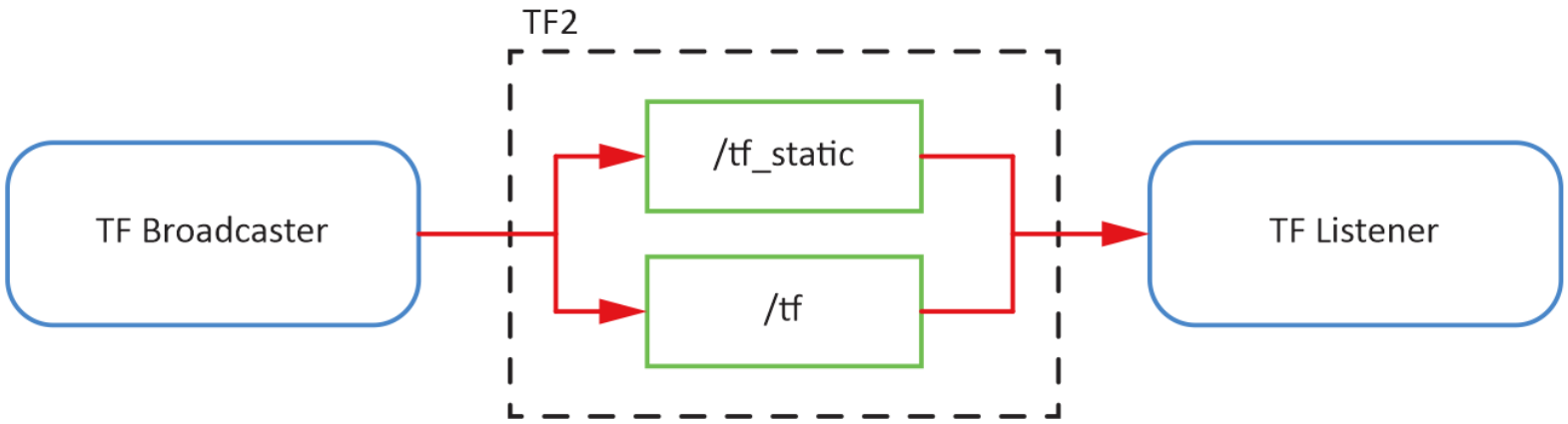
Statična transformacija – se ne spreminja s časom

Dinamična transformacija – se lahko spreminja s časom

- timestamp



TF2



static_transform_publisher

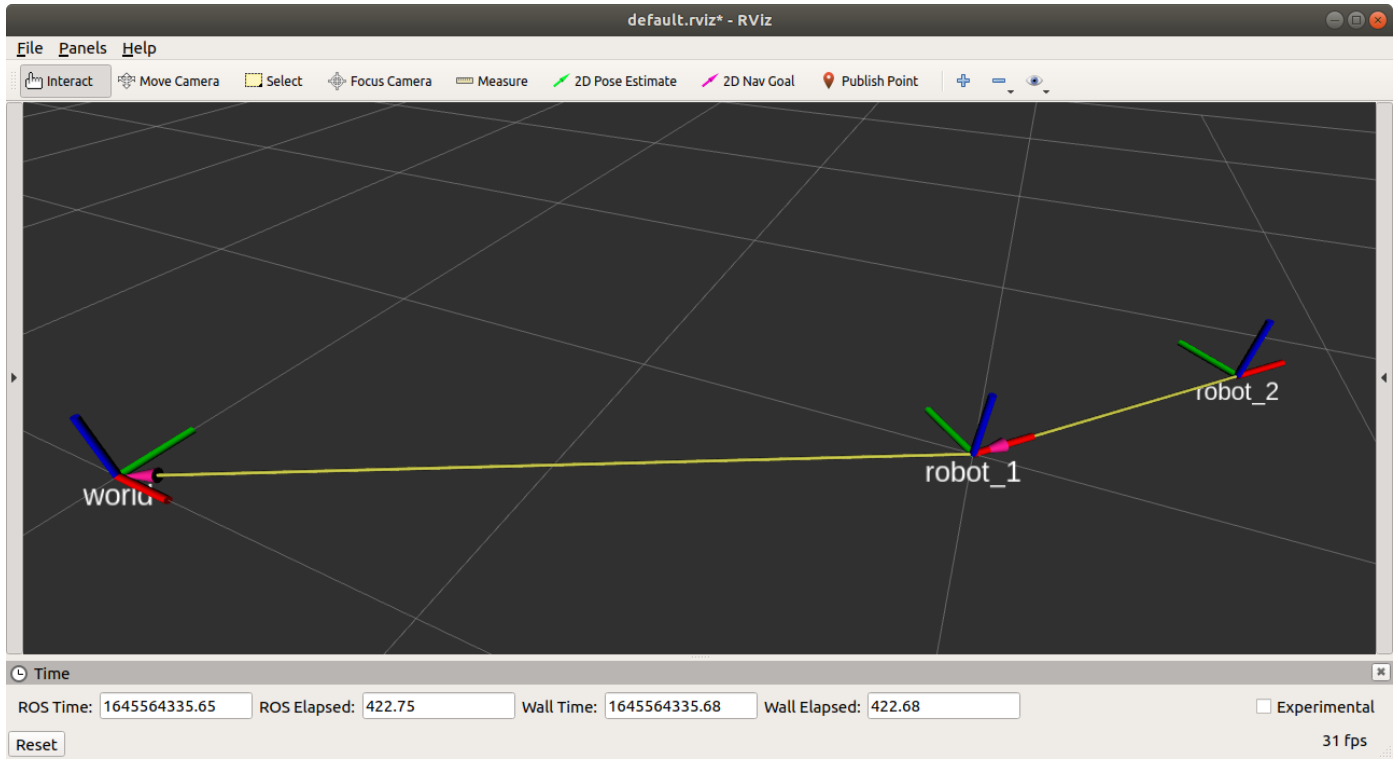
Pošiljanje statične transformacije

```
rosrun tf2_ros static_transform_publisher
          x y z yaw pitch roll parent_frame child_frame
```

static_transform_publisher

Pošiljanje statične transformacije

```
>> roslaunch vodenje_robotov display_tf.launch
>> rosrun tf2_ros static_transform_publisher 2 1 0 1.57 0 0 world robot_1
```



TramsformBroadcaster

```
import tf2_ros
import geometry_msgs.msg

br = tf2_ros.TransformBroadcaster()

trans = geometry_msgs.msg.TransformStamped()

br.sendTransform((pose x, y, z),
                 (orientaton quat x ,y, z, w),
                 rospy.Time.now(),
                 child_name,
                 parent_name)
```

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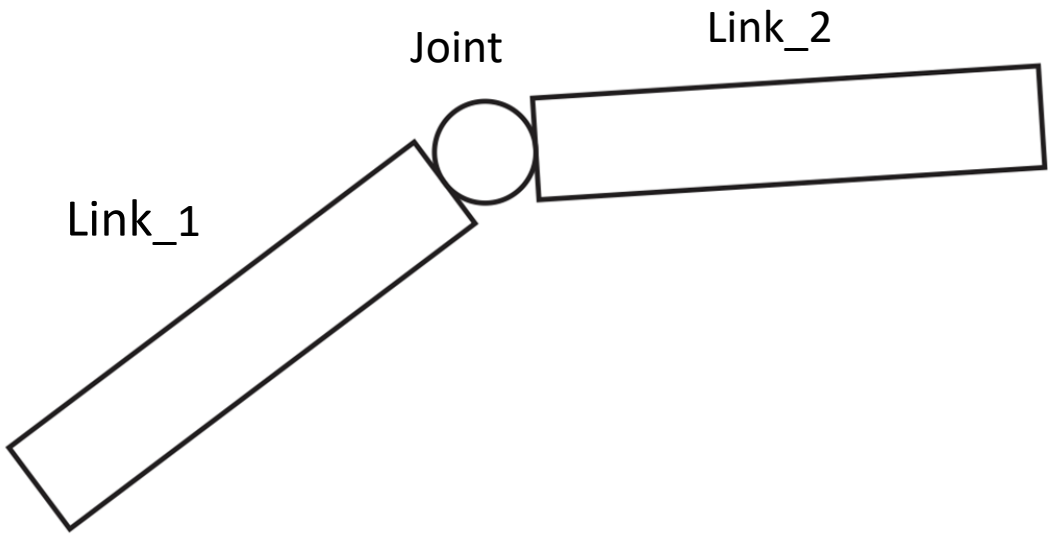
TransformListener

```
import tf2_ros

listener = tf2_ros.TransformListener()

trans = listener.lookupTransform(frame_1, frame_2, rospy.Time(0))
```

MEHANIZEM

Mehanizem sestavljajo:

- links (segmenti)
- joints (sklepi)



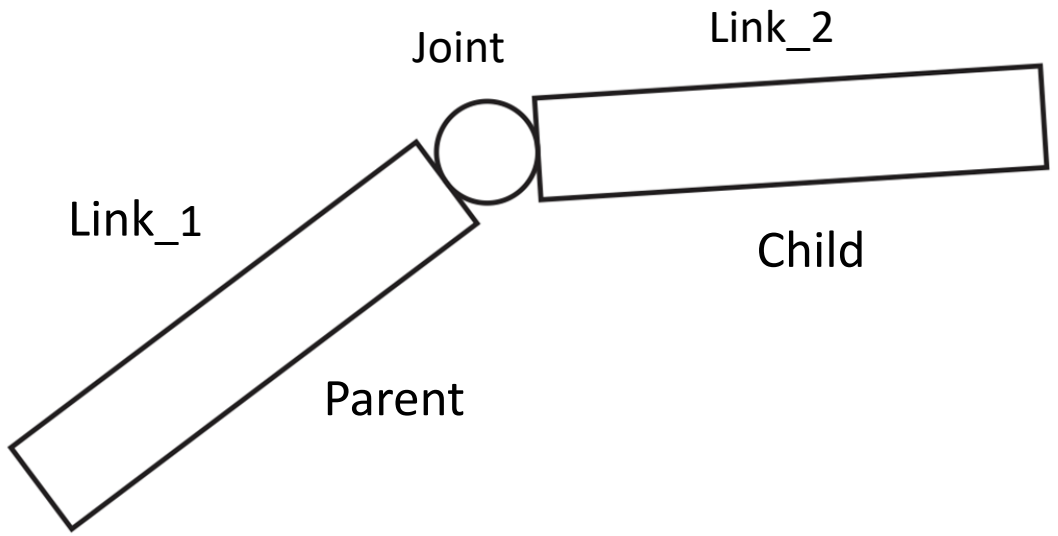
MEHANIZEM

Mehanizem sestavljajo:

- links (segmenti)
- joints (sklepi)

Povezava med dvema segmentoma:

- Parent
- Child



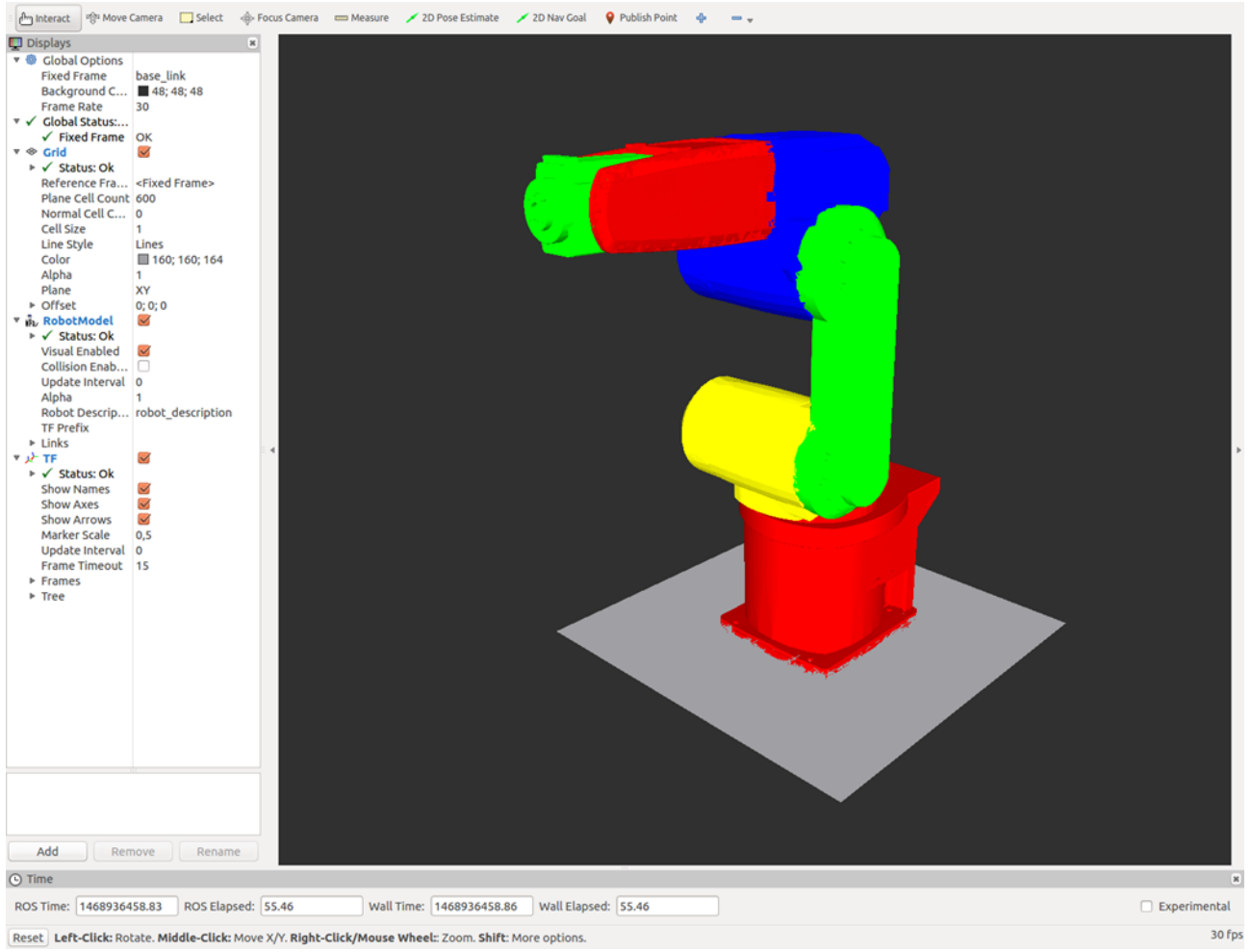
URDF datoteka

Unified Robot Description Format (URDF)

- XML datoteka

Vsebina:

- robot
- sensor/proposals
- link
- transmission
- joint
- gazebo
- sensor
- model_state
- model

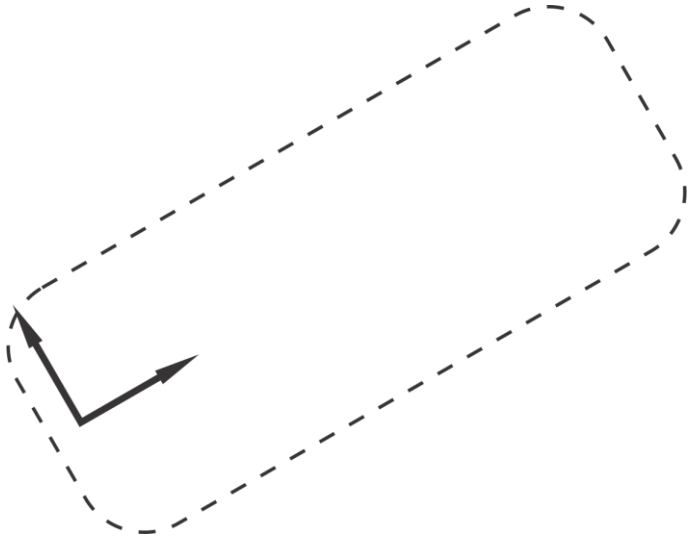


URDF

```
<?xml version="1.0"?>
<robot name="my_robot">
   ...
   <link> ... </link>
   <joint> ... </joint>
   ...
</robot>
```

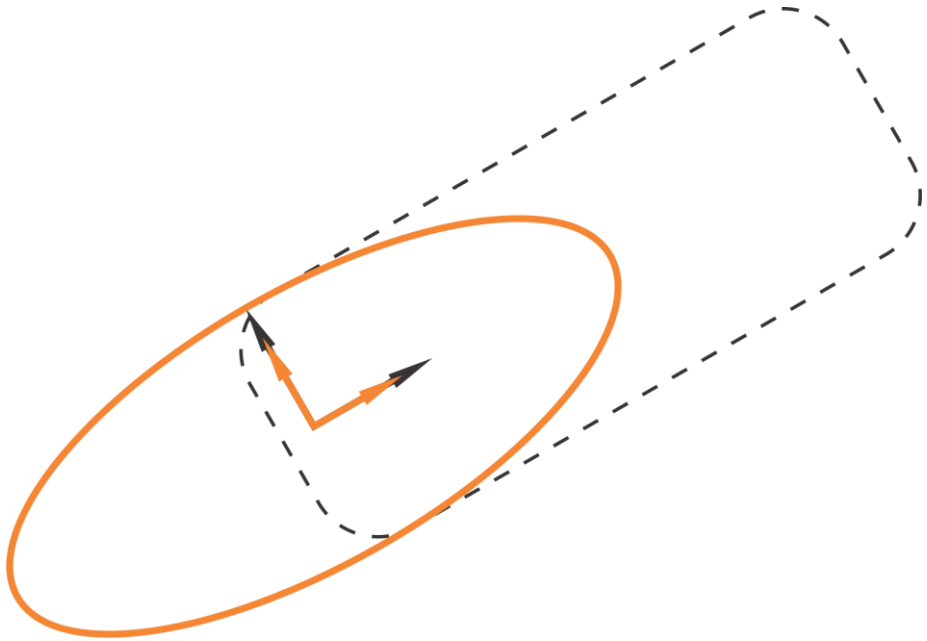
URDF Link

```
<link name="my_link">
   <visual> ... </visual>
   <collision> ... </collision>
   <inertial> ... </inertial>
</link>
```



URDF Link

```
<visual>
    <geometry>
    <origin>
    <material>
</visual>
```



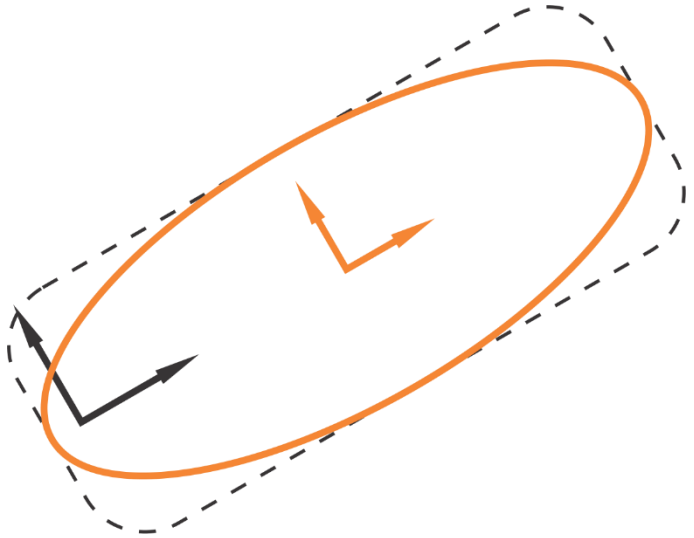
Oblika:

- Box (dimenzije stranic)
- Cylinder (radij in dolžina)
- Sphere (radij)
- Mesh (ime datoteke .dae)

URDF Link

```
<visual>
    <geometry>
    <origin>
    <material>
</visual>
```

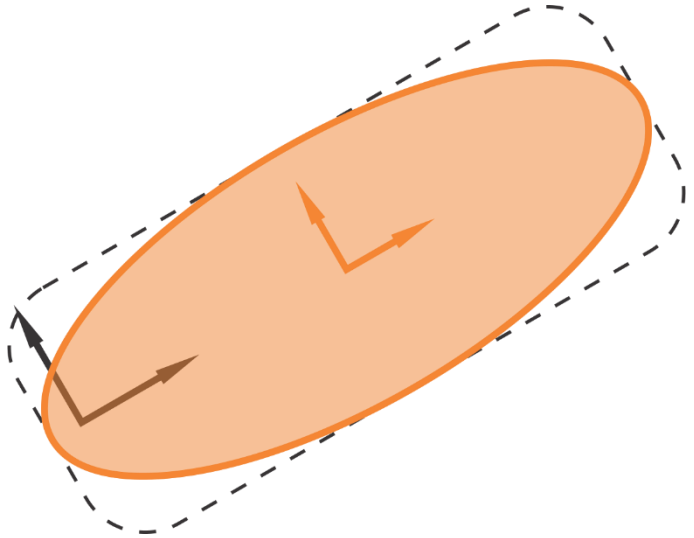
Origin – premik oblike iz KS segmenta



URDF Link

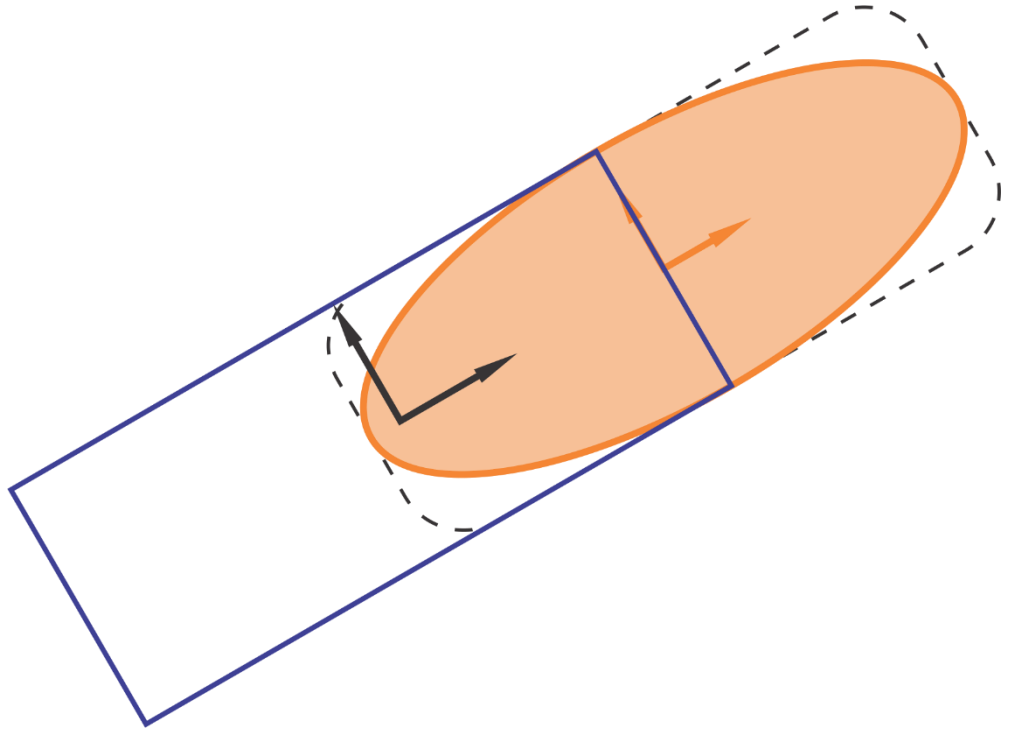
```
<visual>
    <geometry>
    <origin>
    <material>
</visual>
```

Material – barva segmenta



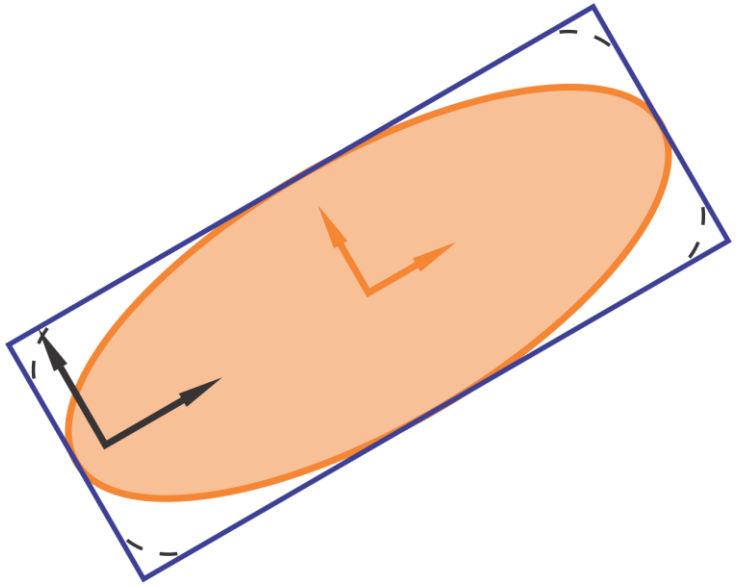
URDF Link

```
<collision>
    <geometry>
    <origin>
</collision>
```



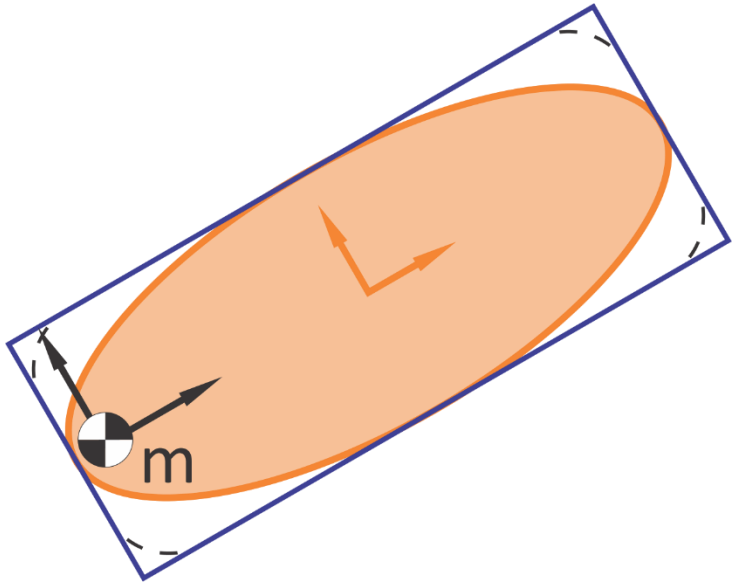
URDF Link

```
<collision>
    <geometry>
    <origin>
</collision>
```



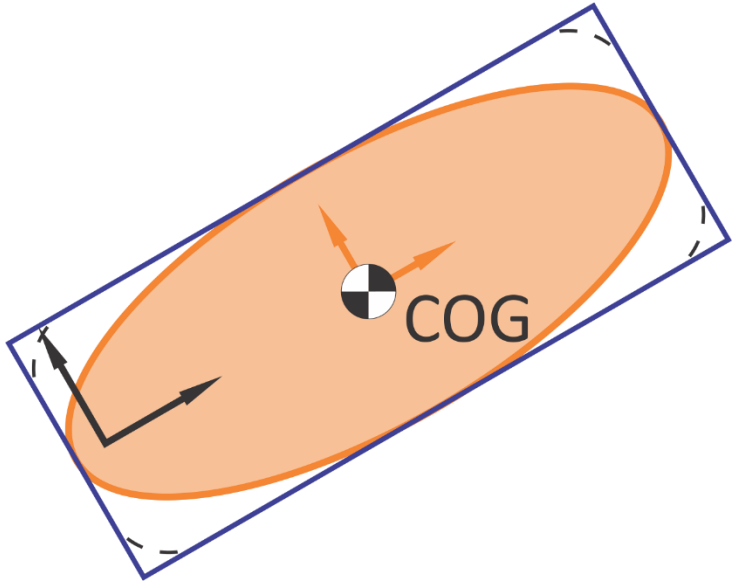
URDF Link

```
<inertial>
    <mass>
    <origin>
    <inertia>
</inertial>
```



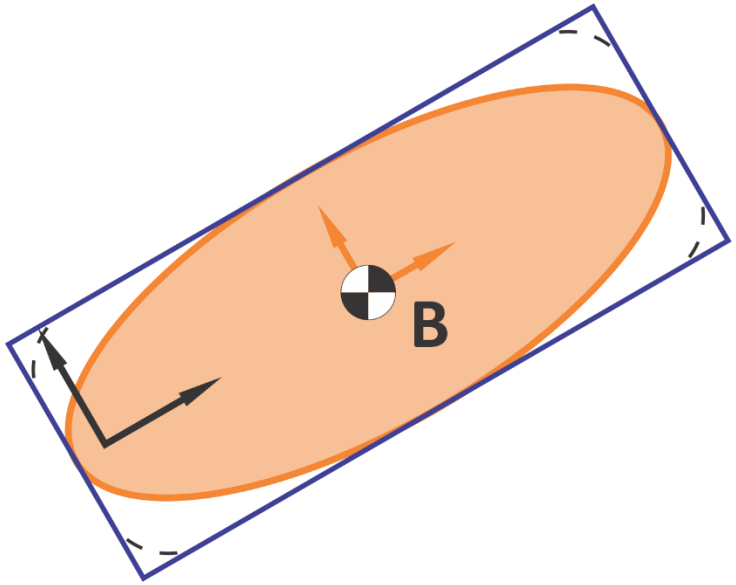
URDF Link

```
<inertial>
    <mass>
    <origin>
    <inertia>
</inertial>
```



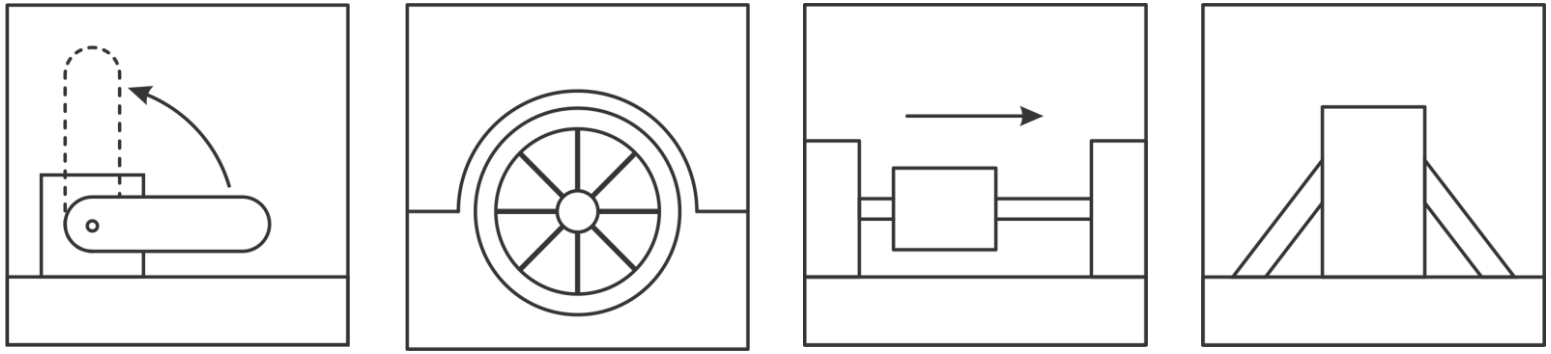
URDF Link

```
<inertial>
    <mass>
    <origin>
    <inertia>
</inertial>
```



URDF Joint

```
<joint name="my_joint" type="...">
   <parent>
   <child>
   <origin>
   <axis>
   <limit>
</joint>
```



Type: revolute, continuous, prismatic, fixed, planar, floating

URDF Joint

```
<joint name="my_joint" type="...">
   <parent>
   <child>
   <origin>
   <axis>
   <limit>
</joint>
```

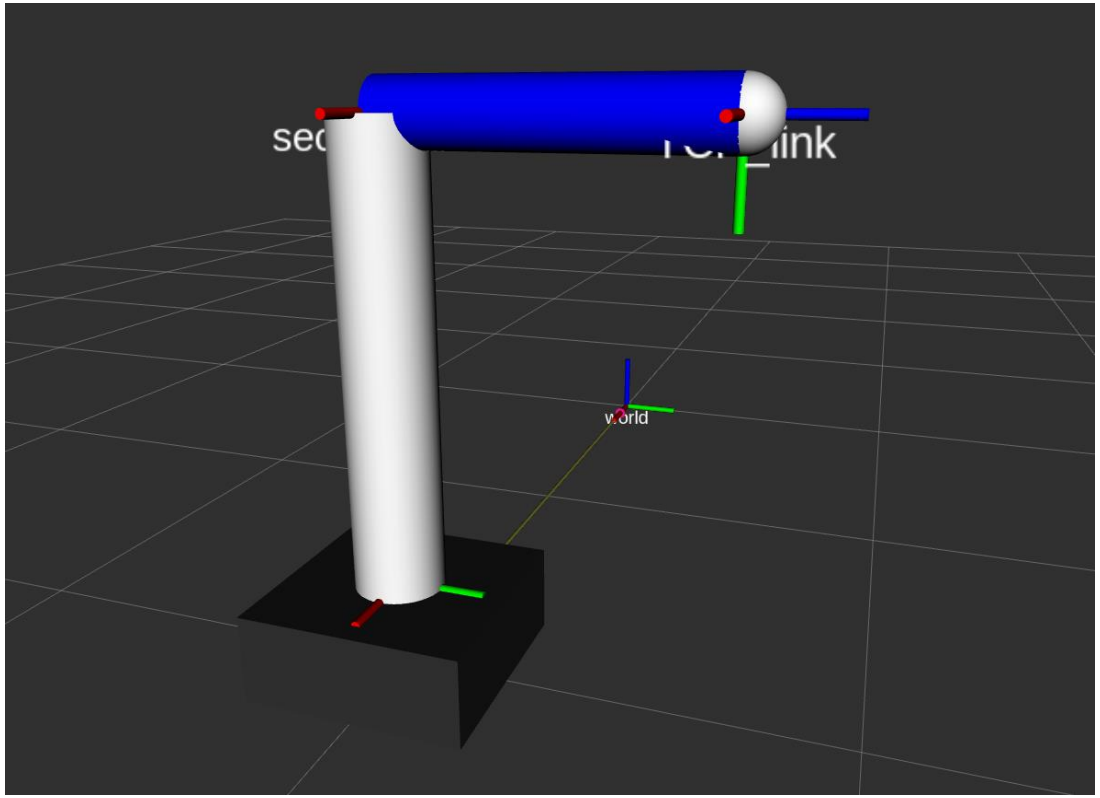
Origin – relacija med parent in child pred gibanjem

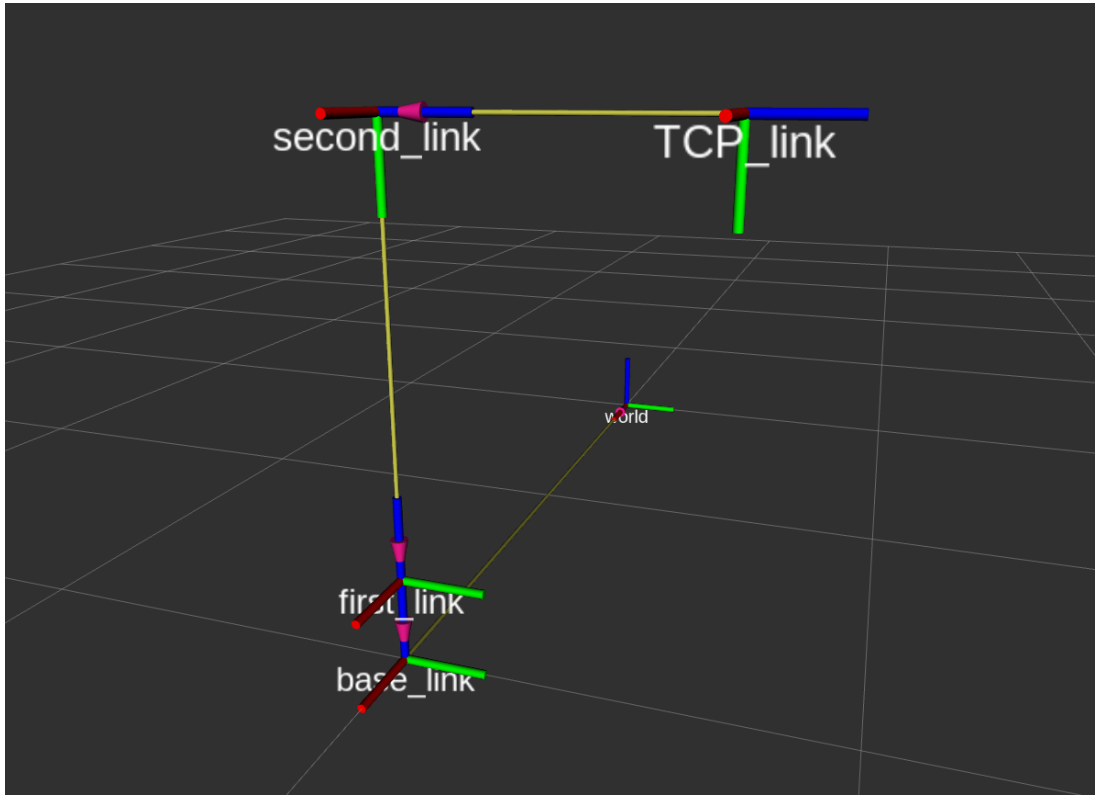
Axis – smerni vektor sklepa

Limit – omejitev pozicije, hitrosti, navora

URDF PRIMER

```
>> roslaunch vodenje_robotov display_robot2.launch
```





URDF in TF

URDF

drevo, sestavljen iz

SEGMENTOV

ki jih povezujejo

SKLEPI

TF

drevo, sestavljeno iz

KOORDINATNIH SISTEMOV

ki jih povezujejo

TRANSFORMACIJE

robot_state_publisher

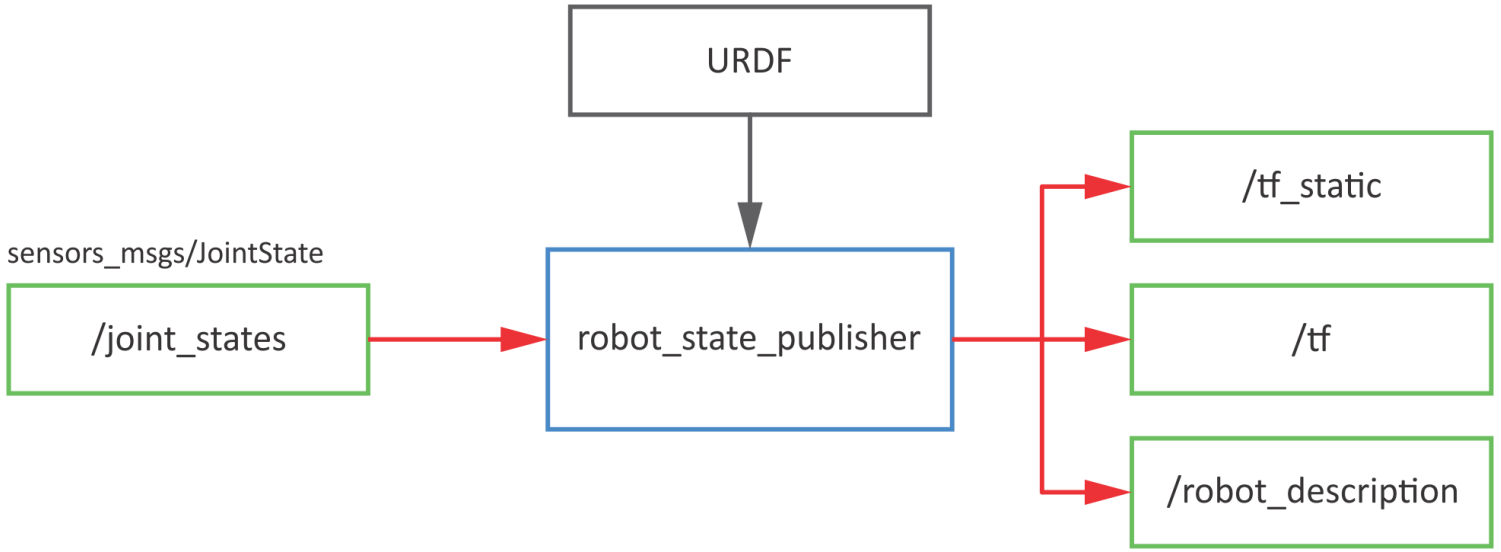
- iz URDF dobi podatke o transformacijah > broadcast TF

- Fiksni sklepi > statična transformacija
- Premikajoči se sklepi > dinamična transformacija
  - informacija o vrednosti sklepa

robot_state_publisher

- iz URDF dobi podatke o transformacijah > broadcast TF

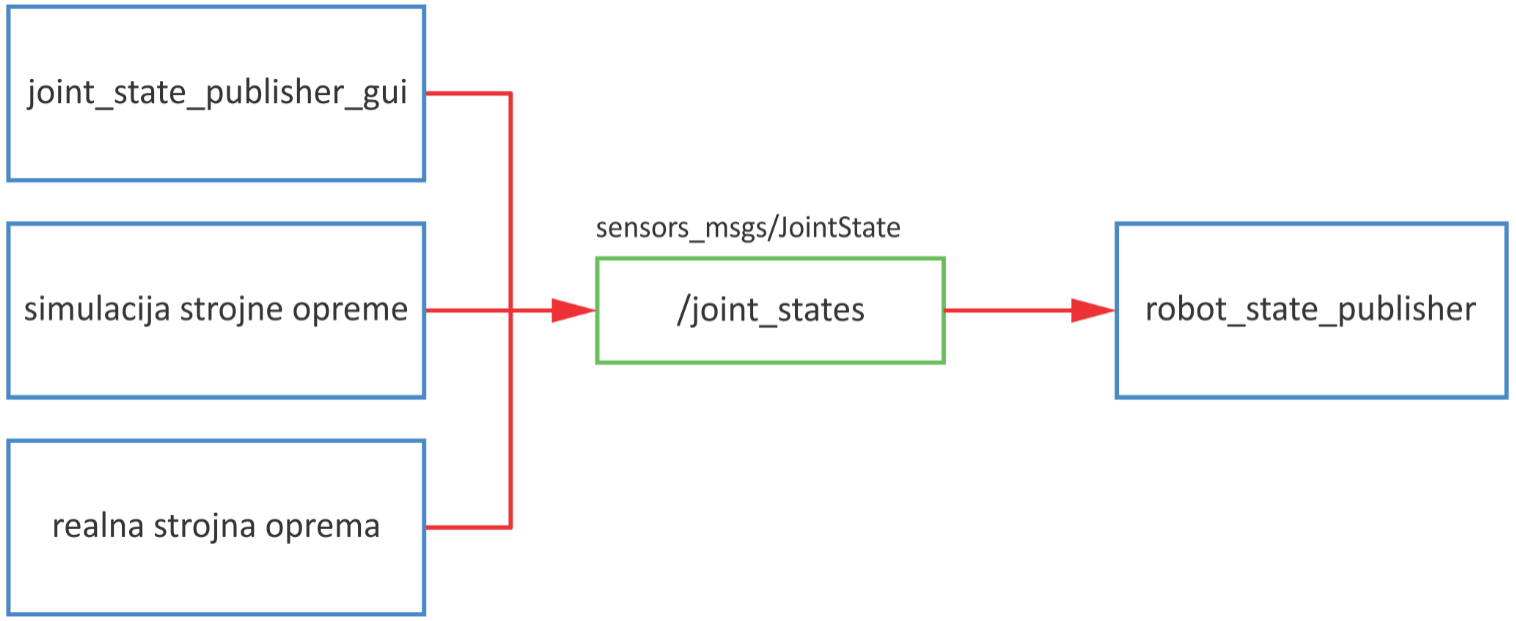
- Fiksni sklepi > statična transformacija
- Premikajoči se sklepi > dinamična transformacija
  - informacija o vrednosti sklepa



JointState

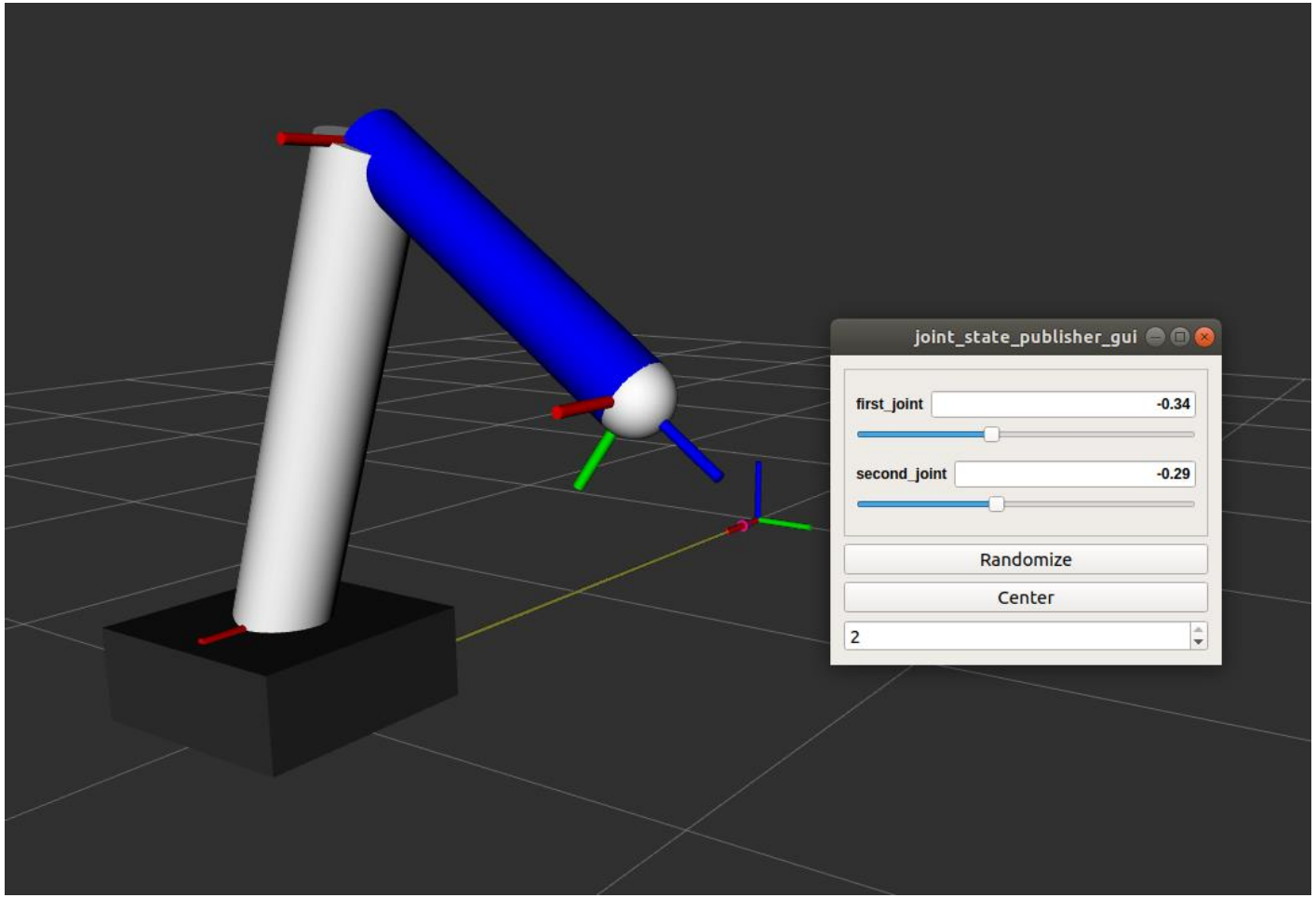
JointState

- pozicija (position)
- hitrost (velocity)
- navor (effort)



joint_state_publisher_gui

- pogleda `/robot_description`
- poišče sklepe
- generira drsnike za posamezni sklep
- pošlje vrednosti na `/joint_states`



ORODJA

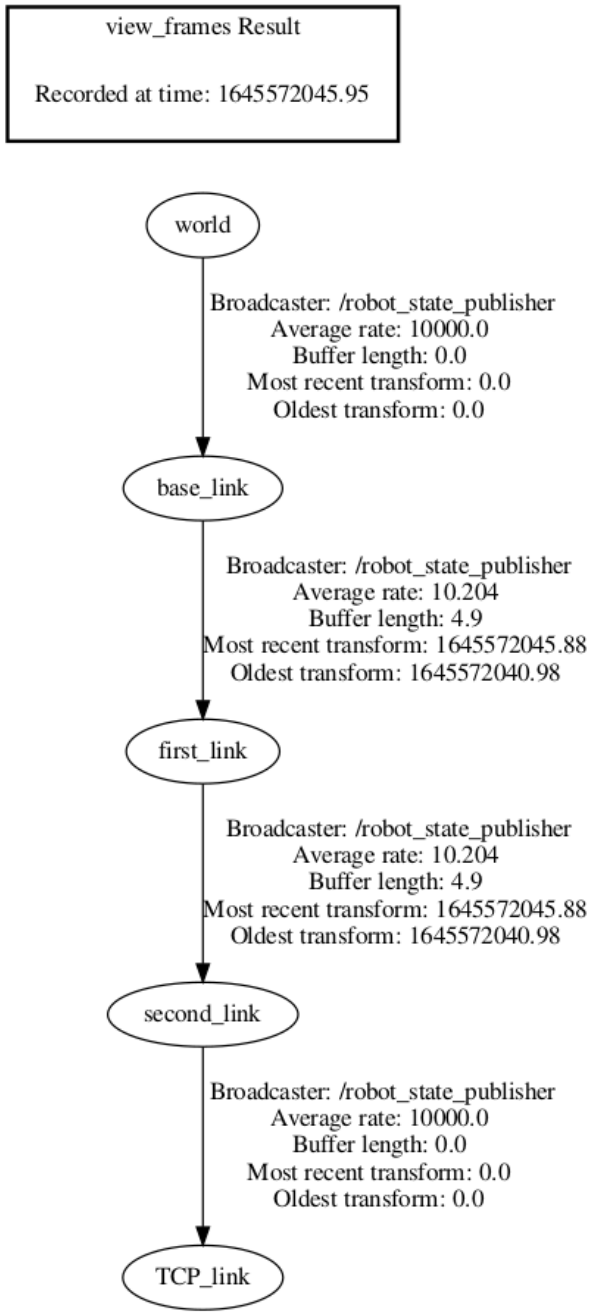
- view_frames
- rqt_tf_tree
- /tf, /tf_static
- tf_echo
- RVIZ

```
>> sudo apt install ros-melodic-ft2-tools
```

ORODJA

view_frames (PDF)

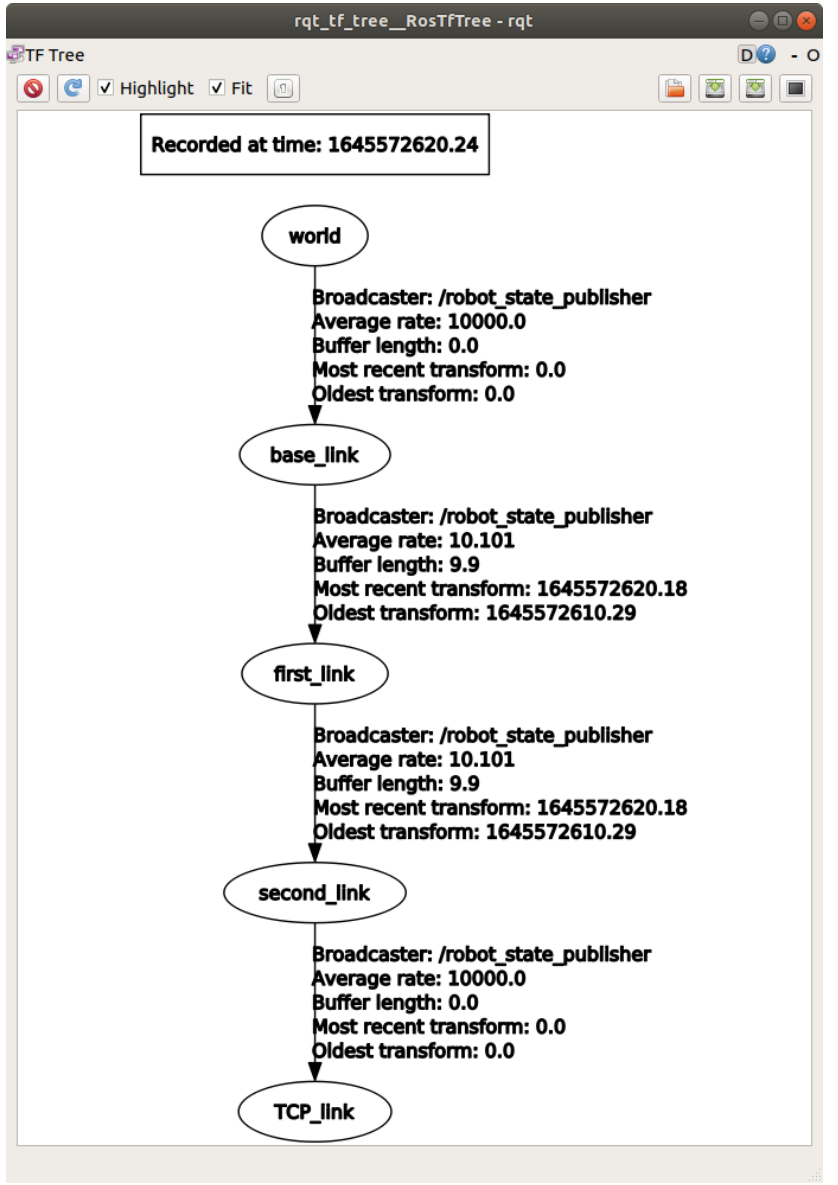
```
>> roscd
>> cd ../src
>> rosrun tf2_tools view_frames.py
```



ORODJA

rqt_tf_tree

```
>> rosrun rqt_tf_tree rqt_tf_tree
```



ORODJA

/tf

/tf_static

```
>> rostopic echo -n1 /tf
```

```
header:
  seq: 0
  stamp:
    secs: 1645572709
    nsecs: 484879970
  frame_id: "first_link"
child_frame_id: "second_link"
transform:
  translation:
    x: 0.0
    y: 0.0
    z: 1.0
  rotation:
    x: -0.800909148599
    y: 0.0
    z: 0.0
    w: 0.598785884678
```

ORODJA

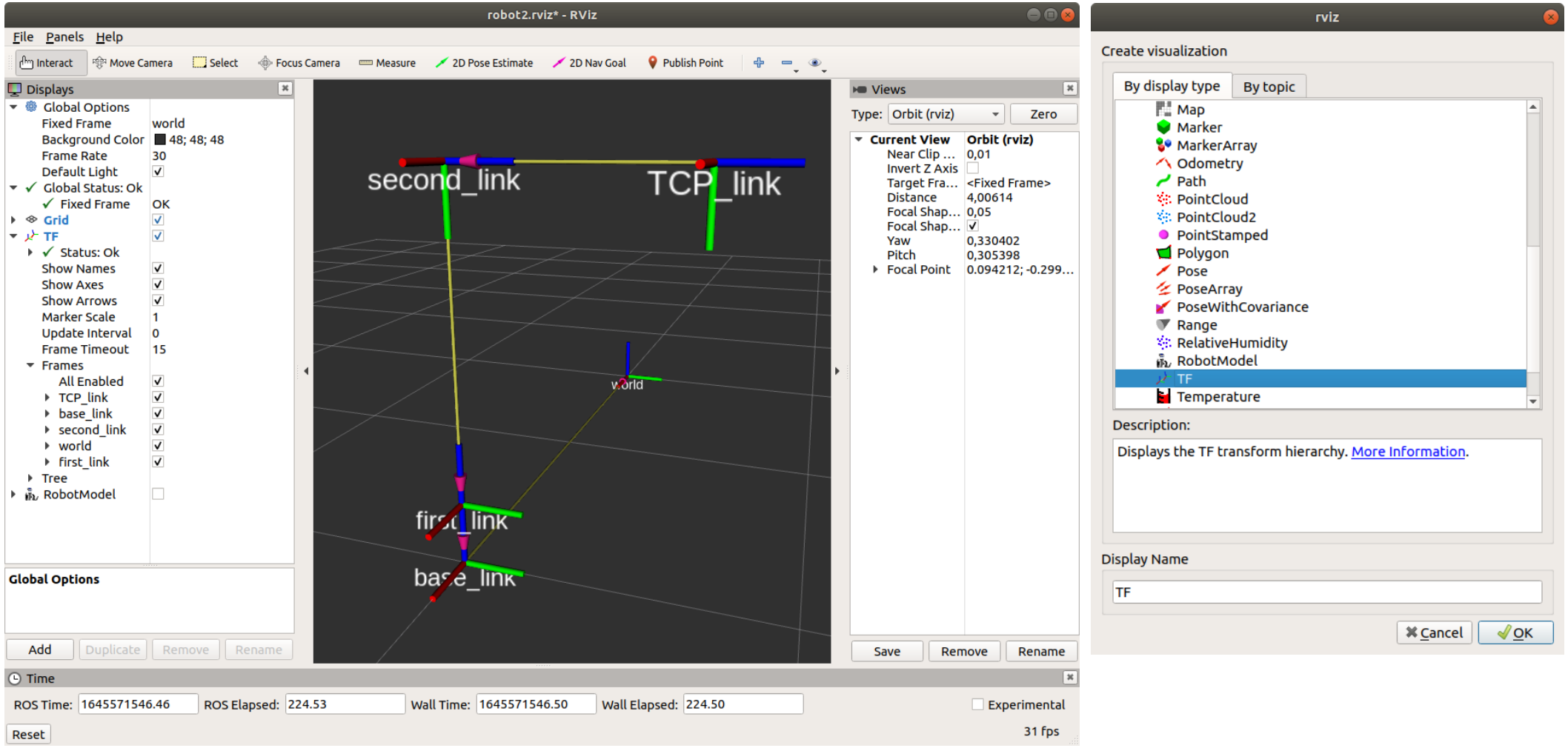
tf_echo (transformacija med dvema KS)

```
>> rosrun tf tf_echo base_link TCP_link
```

```
At time 1645572979.885
- Translation: [0.000, 0.898, 0.736]
- Rotation: in Quaternion [0.890, 0.000, 0.000, -0.457]
            in RPY (radian) [-2.193, 0.000, 0.000]
            in RPY (degree) [-125.666, 0.000, 0.000]
```

ORODJA

RVIZ


robot2.rviz* - RViz
File Panels Help
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
Publish Point
Displays
Global Options
Fixed Frame world
Background Color 48; 48; 48
Frame Rate 30
Default Light
Global Status: Ok
Fixed Frame OK
Grid
TF
Status: Ok
Show Names
Show Axes
Show Arrows
Marker Scale 1
Update Interval 0
Frame Timeout 15
Frames
All Enabled
TCP_link
base_link
second_link
world
first_link
Tree
RobotModel
Global Options
Add
Duplicate
Remove
Rename
second_link
TCP_link
world
first_link
base_link
Views
Type: Orbit (rviz)
Zero
Current View Orbit (rviz)
Near Clip ... 0,01
Invert Z Axis
Target Fra... <Fixed Frame>
Distance 4,00614
Focal Shap... 0,05
Focal Shap...
Yaw 0,330402
Pitch 0,305398
Focal Point 0.094212; -0.299...
Save
Remove
Rename
Time
ROS Time: 1645571546.46
ROS Elapsed: 224.53
Wall Time: 1645571546.50
Wall Elapsed: 224.50
Experimental
Reset
31 fps
rviz
Create visualization
By display type
By topic
Map
Marker
MarkerArray
Odometry
Path
PointCloud
PointCloud2
PointStamped
Polygon
Pose
PoseArray
PoseWithCovariance
Range
RelativeHumidity
RobotModel
TF
Temperature
Description:
Displays the TF transform hierarchy. More Information.
Display Name
TF
Cancel
OK