

# Getting Started with the Intel® RealSense™ Robotic Development Kit

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# Agenda

- Introducing the Intel® RealSense™ Robotic Development Kit
- Accessing Depth and RGB Data from the Intel RealSense R200
- Using Depth and RGB for Human Detection and Following
- Using Depth Data for Mapping and Navigation on a Robot

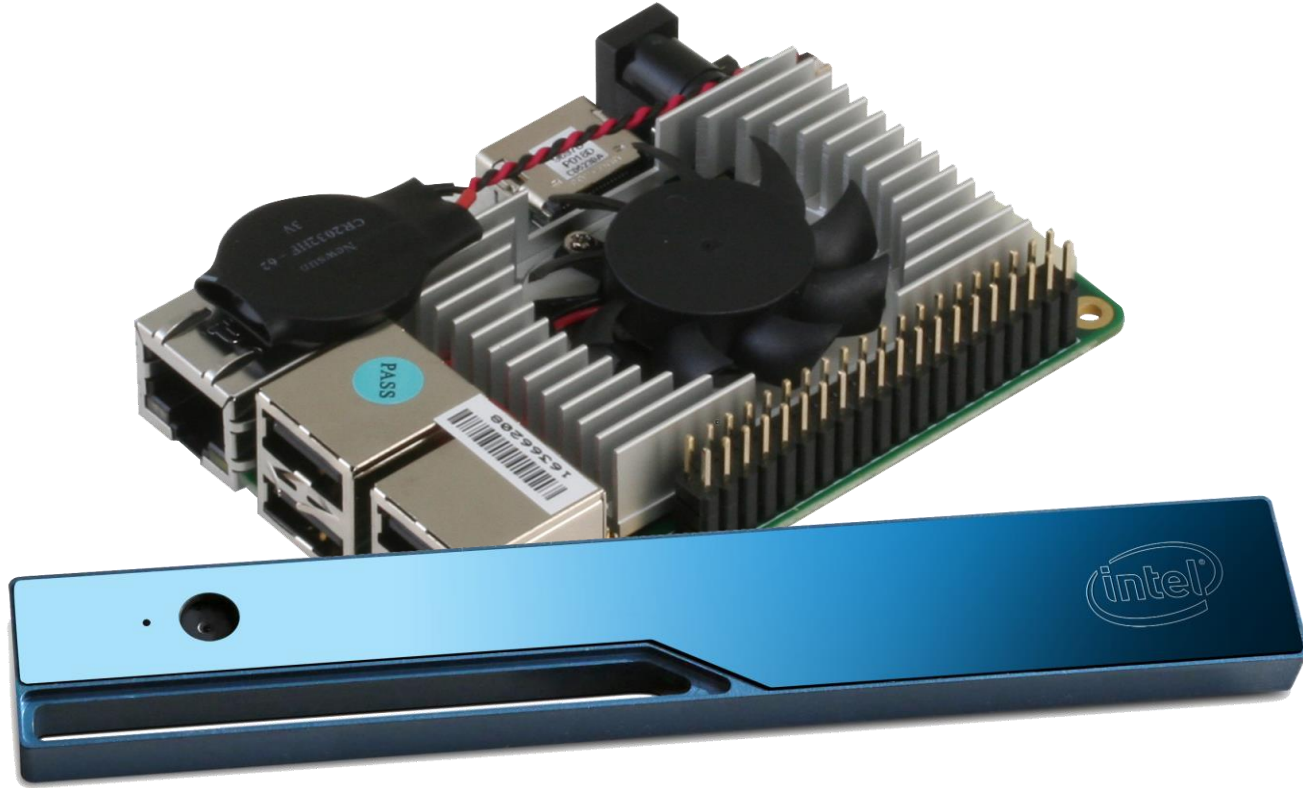
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# Intel® RealSense™ Robotics Development Kit



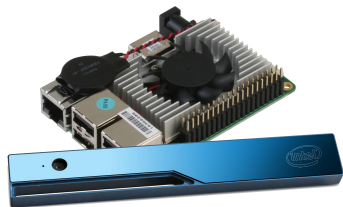
# Intel® RealSense™ Robotics Development Kit



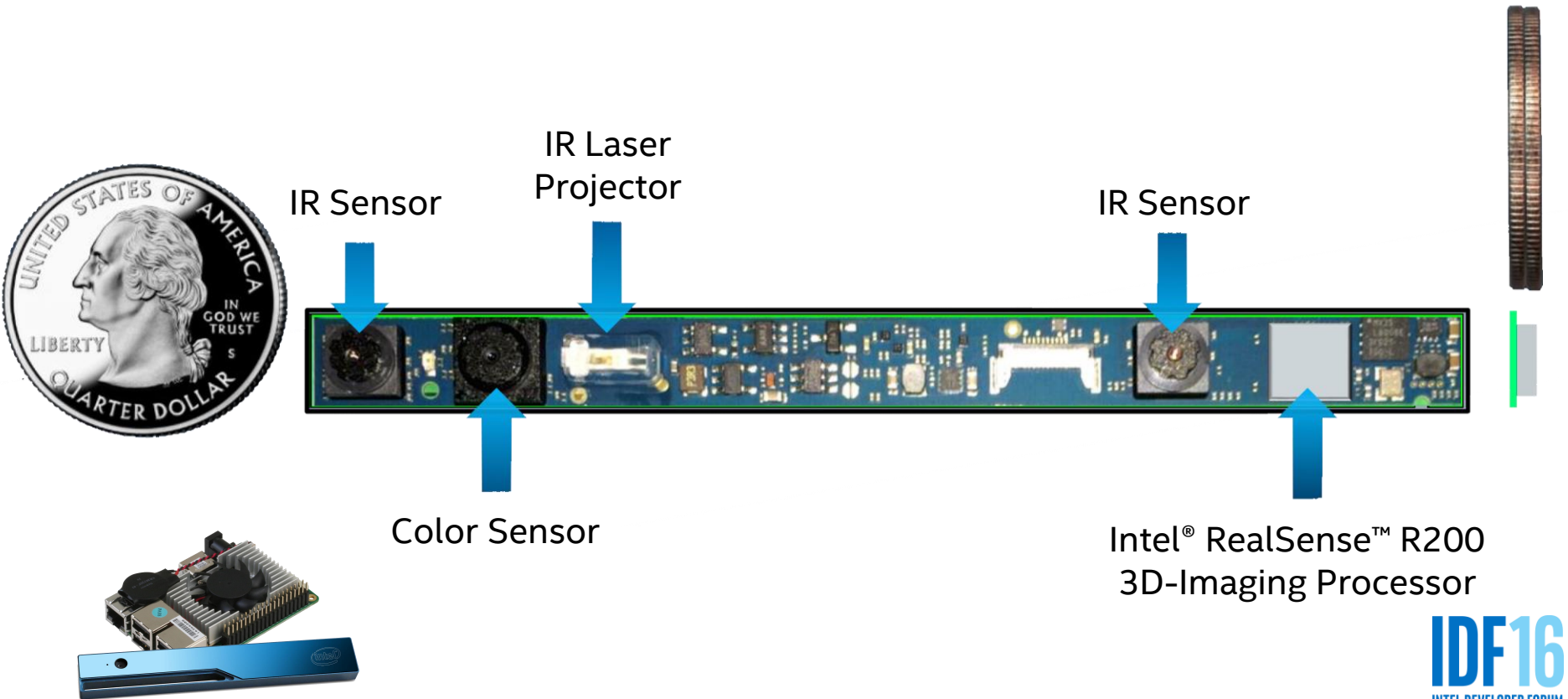
# Intel® RealSense™ Robotics Development Kit

Kit contains:

- Intel® RealSense™ 3D camera R200
- Intel® Atom™ x5-Z8350 processor single board computer
  - 40-pin general purpose I/O interface
  - USB 3.0 OTG and USB 2.0
  - Full-speed gigabit Ethernet
  - HDMI\*
- Open source with support for Ubuntu\*
- Power supply and cables

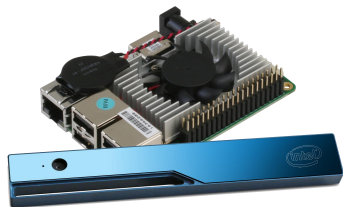


# Intel® RealSense™ 3D Camera R200



# Intel® RealSense™ 3D Camera R200

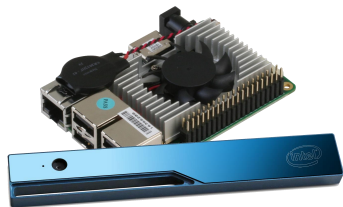
	Color	Depth (IR)
Active Pixels	1920x1080	640x480
Aspect ratio	16:9	4:3
Frame rate	30 FPS	30/60/90 FPS
Field of view (D x V x H)	77x47x70 (Cone)	70x46x59 (Cone)
Effective Range	-	0.6m – 3.5m





# Intel® RealSense™ Robotics Development Kit

***Everything you need to build a robot  
with advanced computer vision  
capabilities, in a box***





open source  
initiative

 ROS<sup>\*</sup>

# Where to get it

The screenshot shows a web page for the 'Intel RealSense Robotic Development Kit' recipe. At the top, there's a navigation bar with 'Contact', 'Log in', and 'Register' links. Below this, the page is titled '01 Developer Journey' and 'THE RECIPES THE JOURNEYS'. The main heading is 'INTEL REALSENSE ROBOTIC DEVELOPMENT KIT' in large blue letters. Below the heading, it says 'By Jketreno' and 'From Zero to Hero: Getting up and running with the Intel RealSense Robotic Development Kit'. The level is marked as 'Beginner' and it's noted as being published '1h' ago. A short description states: 'Getting the Intel RealSense Robotics Development Kit (RDK) up and running is a straightforward process.' There are three tags: 'RealSense', 'Robots', and 'ROS'. A 'WRITE A COMMENT' button is visible. On the right side, there is a 3D rendering of the Intel RealSense Robotic Development Kit box, which features the 'up' logo, the text 'bring the joy', a QR code, and the website 'www.up-board.org'. The box also shows an image of the RDK hardware and a laptop.

<https://01.org/developerjourney/recipe/intel-realsense-robotic-development-kit>

# ROS in 8 steps

```
$ sudo sh -c 'echo "deb http://packages.ros.org/ros/ubuntu
$(lsb_release -sc) main" > /etc/apt/sources.list.d/ros-
latest.list'

$ sudo apt-key adv --keyserver hkp://ha.pool.sks-keyservers.net
--recv-key 0xB01FA116

$ sudo add-apt-repository ppa:ubilinux/up

$ sudo apt-get update

$ sudo apt-get install linux-upboard ros-indigo-desktop-full
ros-indigo-realsense-camera

$ sudo rosdep init

$ rosdep update

$ echo "source /opt/ros/indigo/setup.bash" >> ~/.bashrc
```

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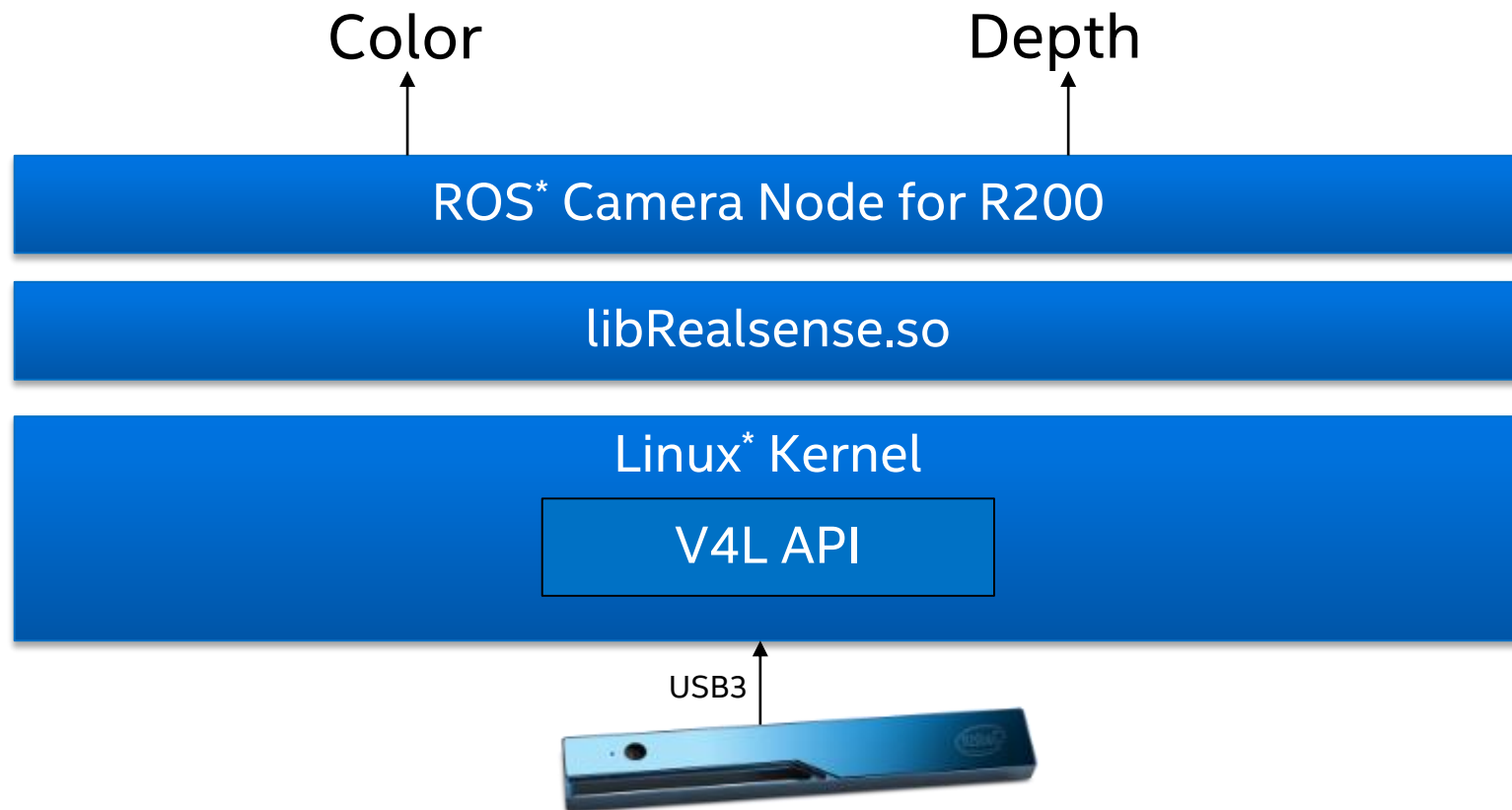
# Color + Depth



+



# System Architecture



# Accessing Data

```
#include <librealsense/rs.hpp>

main() {
    rs::context ctx;
    rs::device * dev = ctx.get_device(0);
    dev->enable_stream(rs::stream::depth, 640, 480, rs::format::z16, 60);
    dev->enable_stream(rs::stream::color, 640, 480, rs::format::rgb8, 60);

    dev->start();
    while(dev->wait_for_frames()) {
        dev->get_frame_data(rs::stream::depth, &depth_frame);
        dev->get_frame_data(rs::stream::color, &color_frame);
    }
}
```

**Initialize and enable  
streams**



# Accessing Data

```
#include <librealsense/rs.hpp>

main() {
    rs::context ctx;
    rs::device * dev = ctx.get_device(0);
    dev->enable_stream(rs::stream::depth, 30);
    dev->enable_stream(rs::stream::color, 60);

    dev->start();
    while(dev->wait_for_frames()) {
        dev->get_frame_data(rs::stream::depth);
        dev->get_frame_data(rs::stream::color);
    }
}
```

Retrieve stream data

# RDK Demo

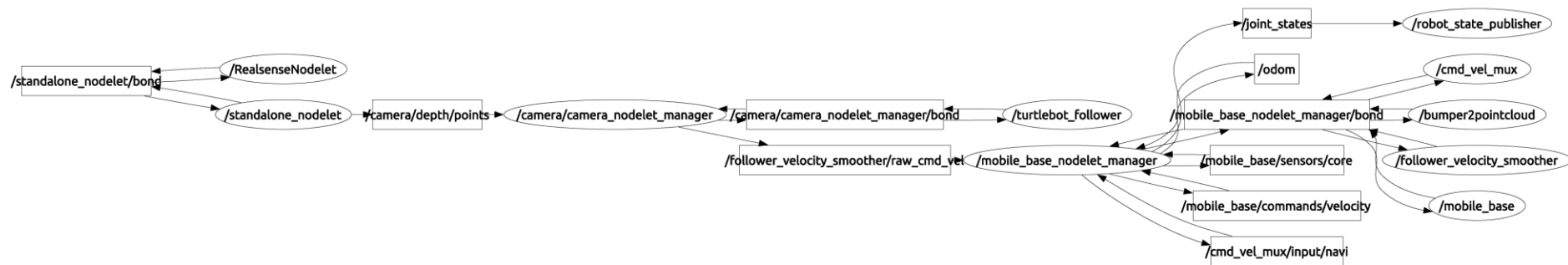
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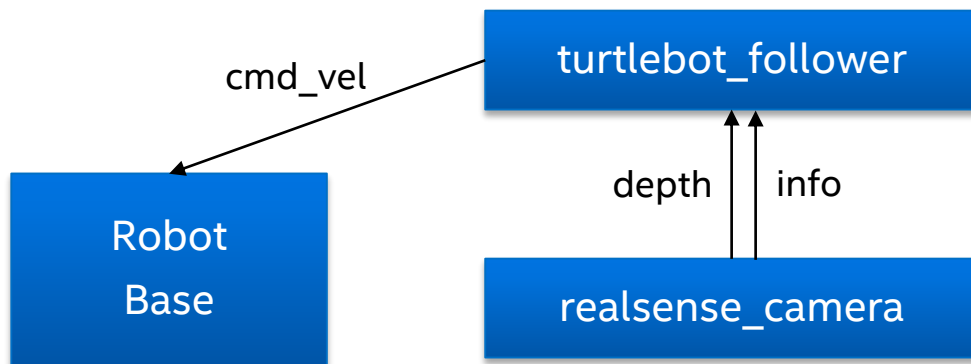
# Simple Follow Me

- Find the centroid from the points in a point cloud
- Send navigation commands to the robot base to center it in field of view

# Simple Follow Me (Detailed View)



# Simple Follow Me



# RDK Follow Me Demo

# Agenda

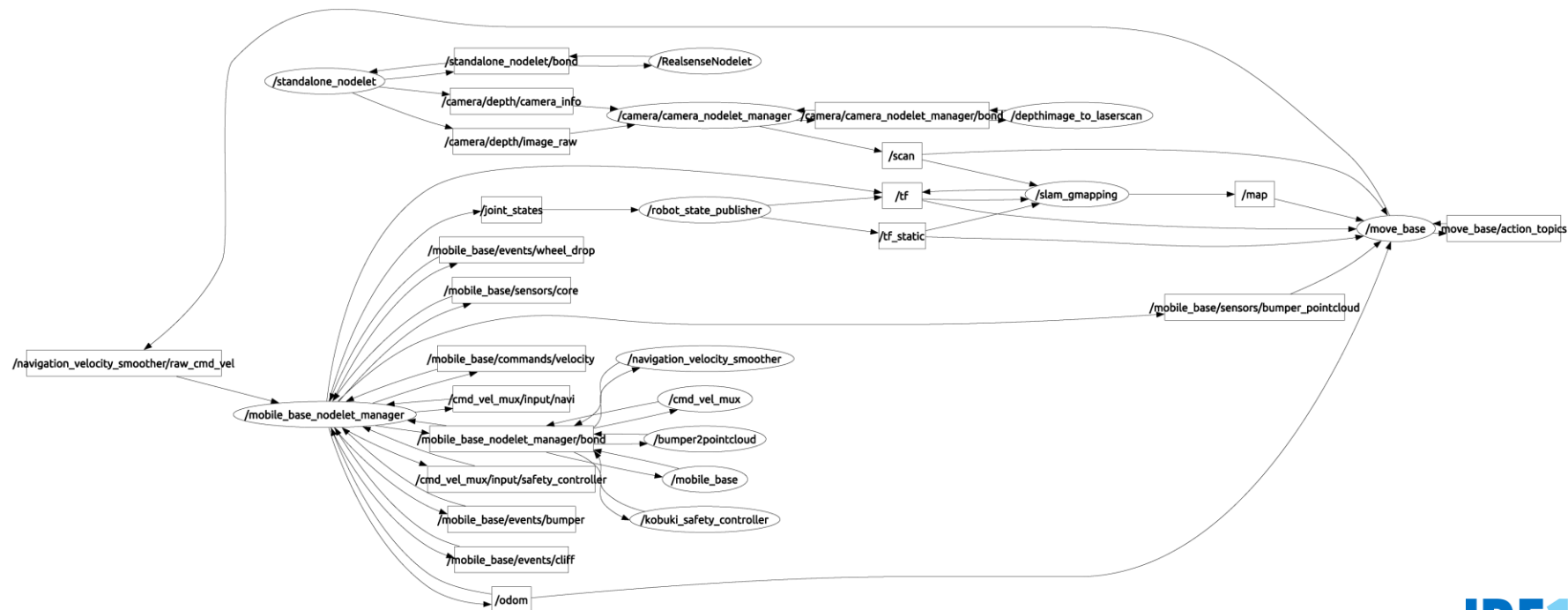
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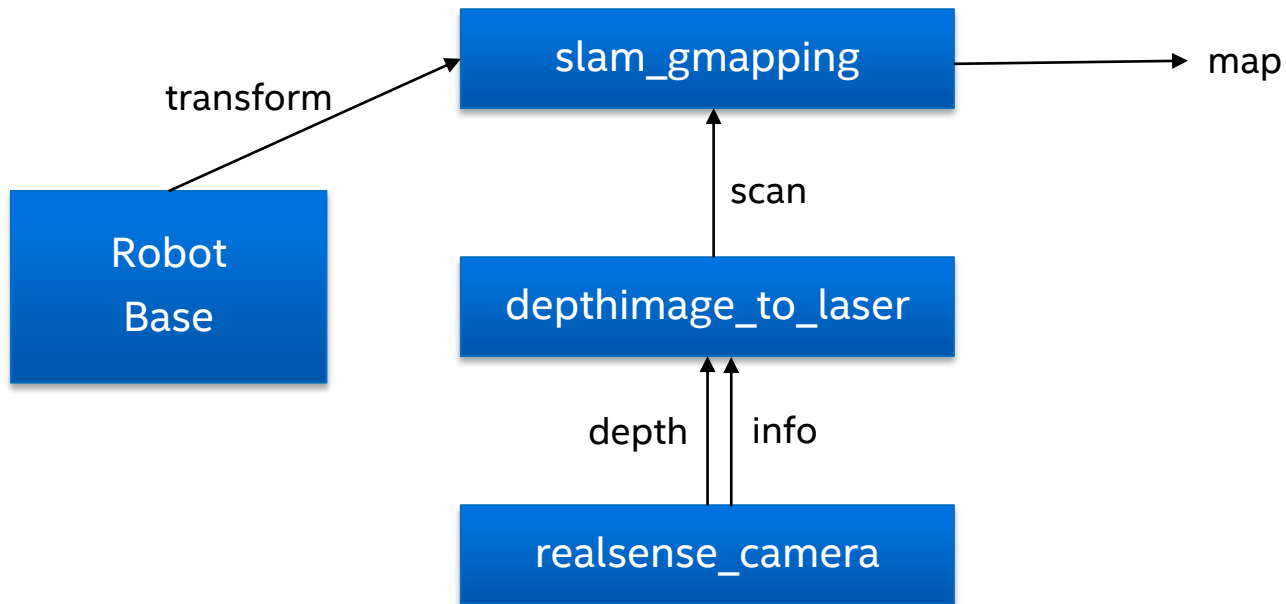
# Mapping and Navigation

- Simultaneous Localization and Mapping (SLAM)
  - Build/update a map from perspective of Robot
  - Keep track of Robot's position in that map

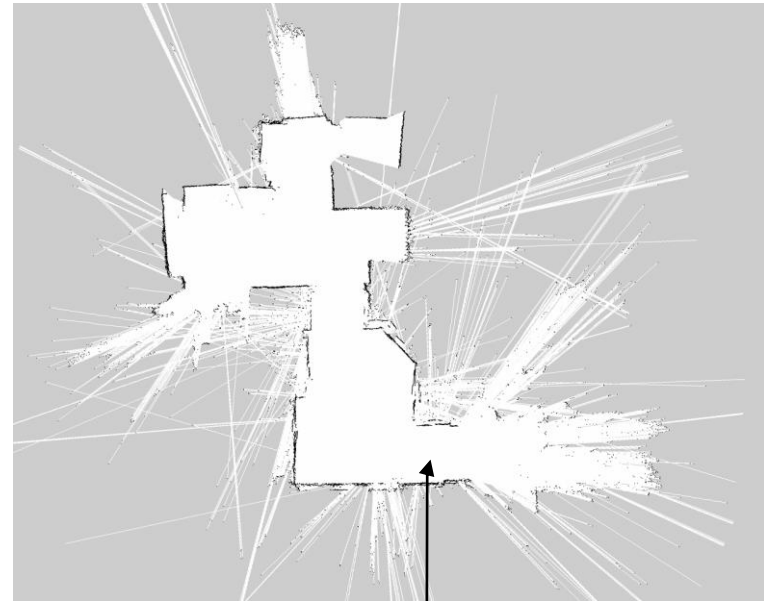
# Mapping (Detailed View)



# Mapping

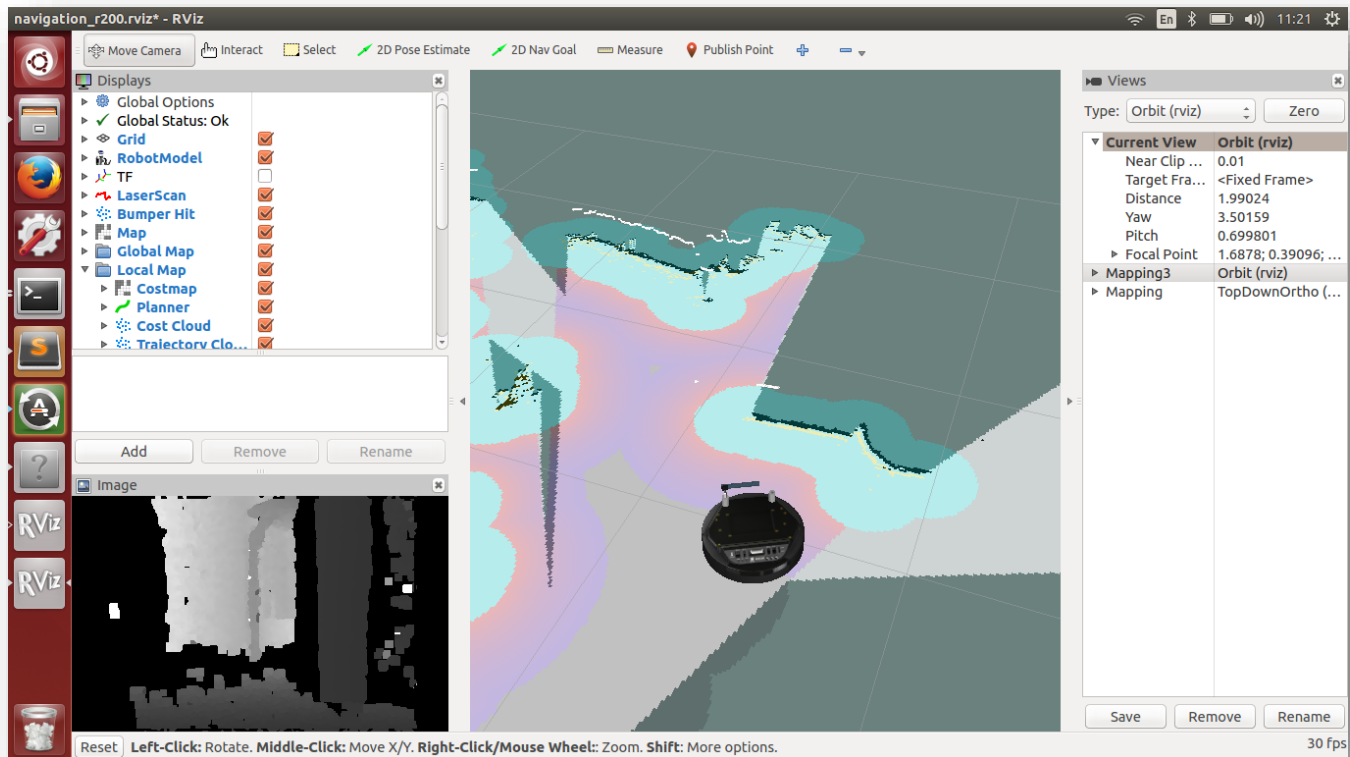


# Occupancy Map

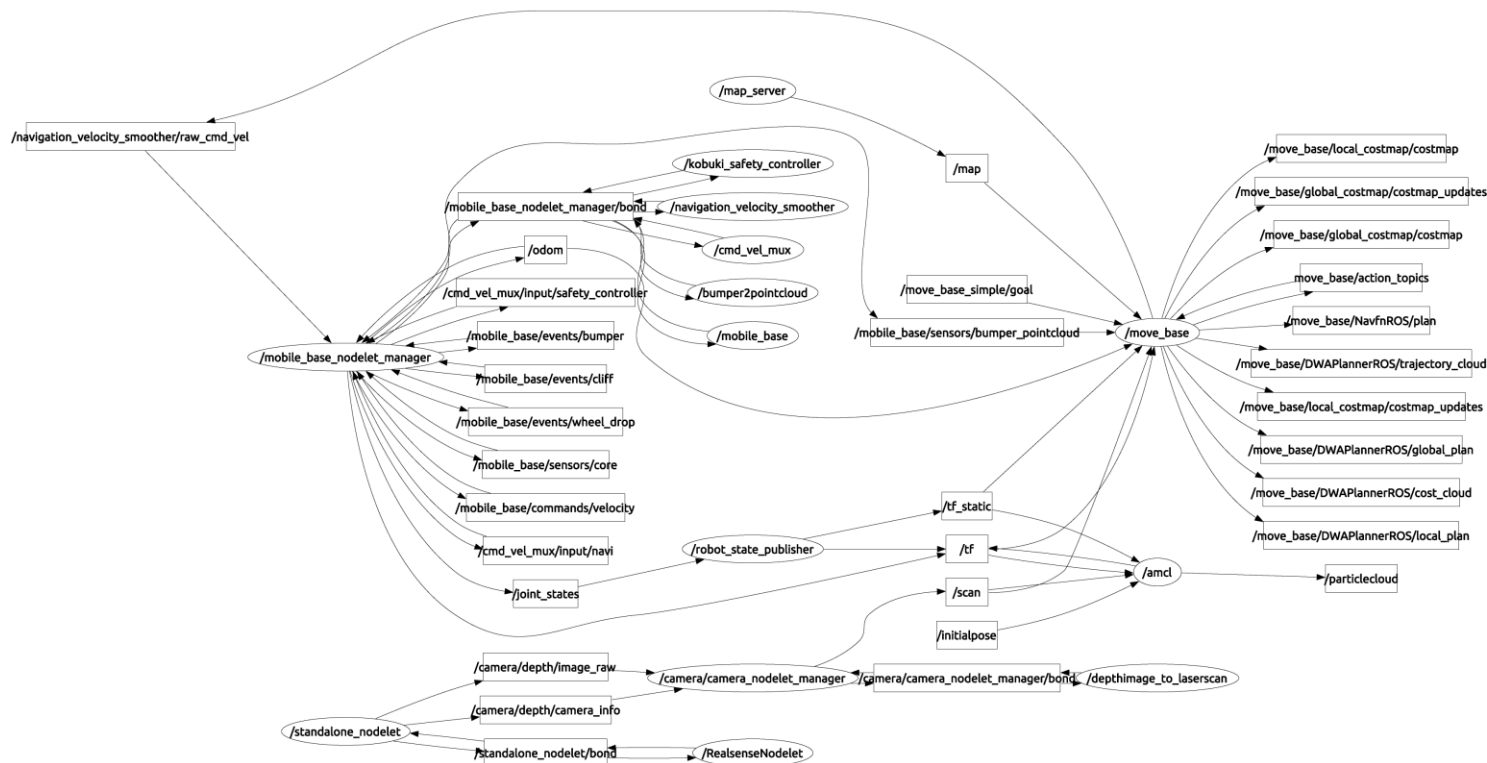


# RDK Mapping Demo

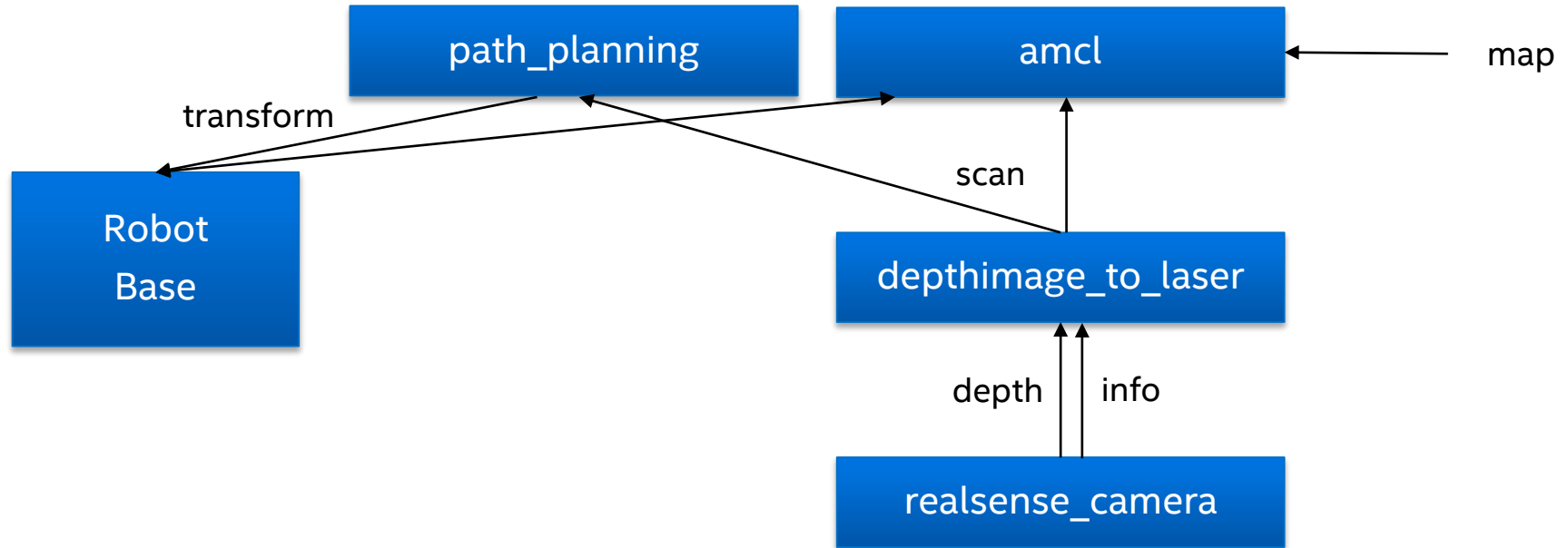
# Navigation Using Map



# Navigation Using Map (Detailed View)



# Navigation Using Map





# Demo: Navigation

# Intel® Joule™ Developer Kit



- Development platform for rapid prototyping and easy transition to volume production (SOM)
- Higher performance, lower power consumption, in a smaller form factor
- Wi-Fi\* and Bluetooth\*, 4K video, MIPI CSI & DSI, up to 48 GPIO
- Multiple OSs supported, including reference Linux\* IoT OS, Ubuntu\*, Snappy, and Windows\* IoT Core
- Enhanced support for Intel® RealSense™ technology
- Developer kit includes module, expansion board, Wi-Fi antennas, USB cable, and SD card with software

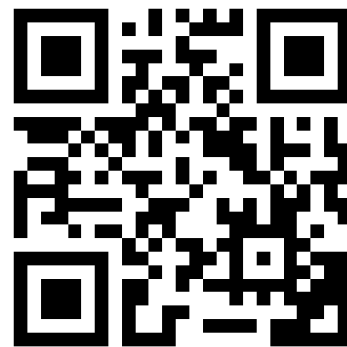
***Rapid prototype-to-production for robotics development***

# Summary and Next Steps

- The Intel® RealSense™ Robotics Development Kit enables you to easily add advanced computer vision capabilities to your robot
- The Intel RealSense Robotics Development Kit supports open source, supporting the rich robotics support provided by the ROS\* community

# Additional Sources of Information

- A PDF of this presentation is available from our Technical Session Catalog: [www.intel.com/idfsessionsSF](http://www.intel.com/idfsessionsSF). This URL is also printed on the top of Session Agenda Pages in the Pocket Guide
- Demos at New Technology Zone in IDF Showcase
- More web based info:
  - Using the Intel® RealSense™ Robotics Development Kit:
    - <https://01.org/developerjourney/recipe/intel-realsense-robotic-development-kit>
  - Using the Intel RealSense Depth Camera with ROS\*
    - <http://wiki.ros.org/RealSense>



# Technical Sessions in New Devices & Services Track

## Tuesday, August 16, 2016

- 11:00 AM – 12:00 PM** *NDSBZ01* — Intel® Knowledge Builder for Intel® Curie™ Module and Intel® Quark™ SE Microcontroller **Level 2 Room 2007**
- 1:15 PM – 2:15 PM** *SOFTS02* — ChromeOS\* and coreboot\* on Intel® Architecture – An Engineering Primer for Developers, Partners, OEMs and ODMs  
**Level 2 Room 2006**
- 2:30 PM – 3:30 PM** *NDSTS01* — Building Intel® Curie™ Products Starting from Arduino 101\* Boards **Level 2 Room 2004**
- 4:00 PM – 5:00 PM** *NDSTS02* — Intel® Curie™ Technology: Transforming Experiences **Level 2 Room 2004**
- 4:00 PM – 5:00 PM** *VRGTS04* — The Sensification of Virtual Reality Using Intel® RealSense™ Technology **Level 2 Room 2005**

## Wednesday, August 17, 2016

- 11:00 AM – 12:00 PM** *IOTTI01* — Accelerating Innovation with Next-generation Intel® Atom™ Processor-based Platform **Level 2 Room 2016 Tech & Business Insight**
- 11:00 AM – 12:00 PM** *NDSTS03* — Intel® Robotics Overview **Level 2 Room 2004**
- 1:15 PM – 2:15 PM** *NDSTI01* — Intel® RealSense™ Technology: Adding Human-like Sensing to Devices **Level 2 Room 2016 Tech & Business Insight**
- 2:30 PM – 3:30 PM** *NDSTS04* — Deliver Amazing Connected Drone Experiences with the Intel® Aero Platform for UAV **Level 2 Room 2004**
- 4:00 PM – 5:00 PM** *NDSTS05* — Getting Started with the Intel® RealSense™ Robotic Development Kit **Level 2 Room 2004**

## Thursday, August 18, 2016

- 9:30 AM – 10:30 AM** *IOTTS06* — Portable Particulate Matter Sensor Powered with Intel® Curie™ Module **Level 2 Room 2008**

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