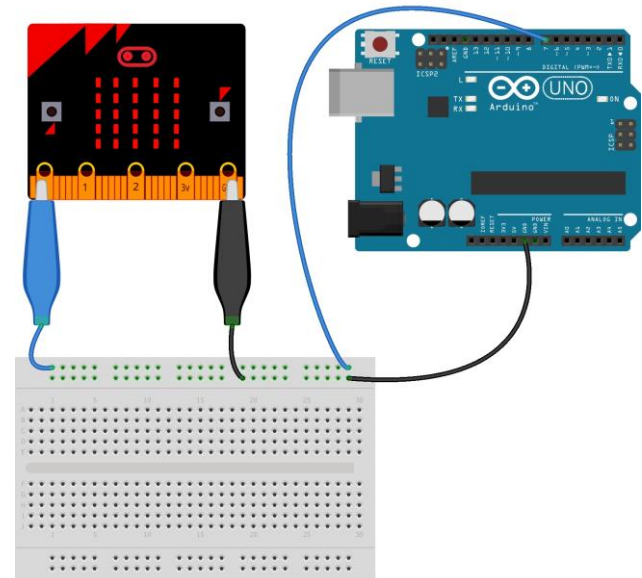
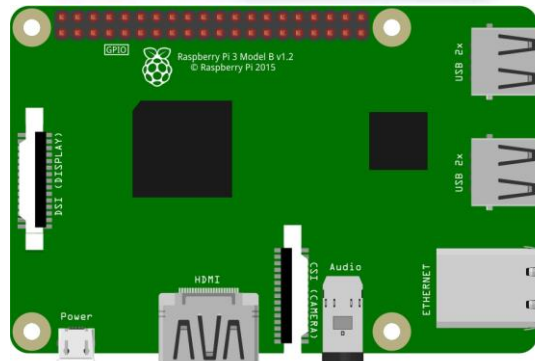
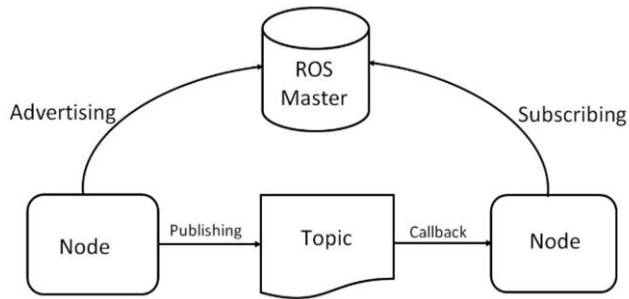


Hands On With ROS

Class 5: Exploring a Publisher-Subscriber ROS Controller



March 27, 2020
Don Wilcher

Class 5: Exploring a Publisher-Subscriber ROS Controller

```
7 /home/isaac@roboon-desktop:~/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://roboon-desktop:40015/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roslauncher: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roboon-1]: started with pid [2024]
ROS_MASTER_URI=http://roboon-desktop:11311/
setting /run_id to 326d8a4970-11e0-9758-b0278b0a7583
process[roboon-11]: started with pid [1933]
started core service [/roboon]
```

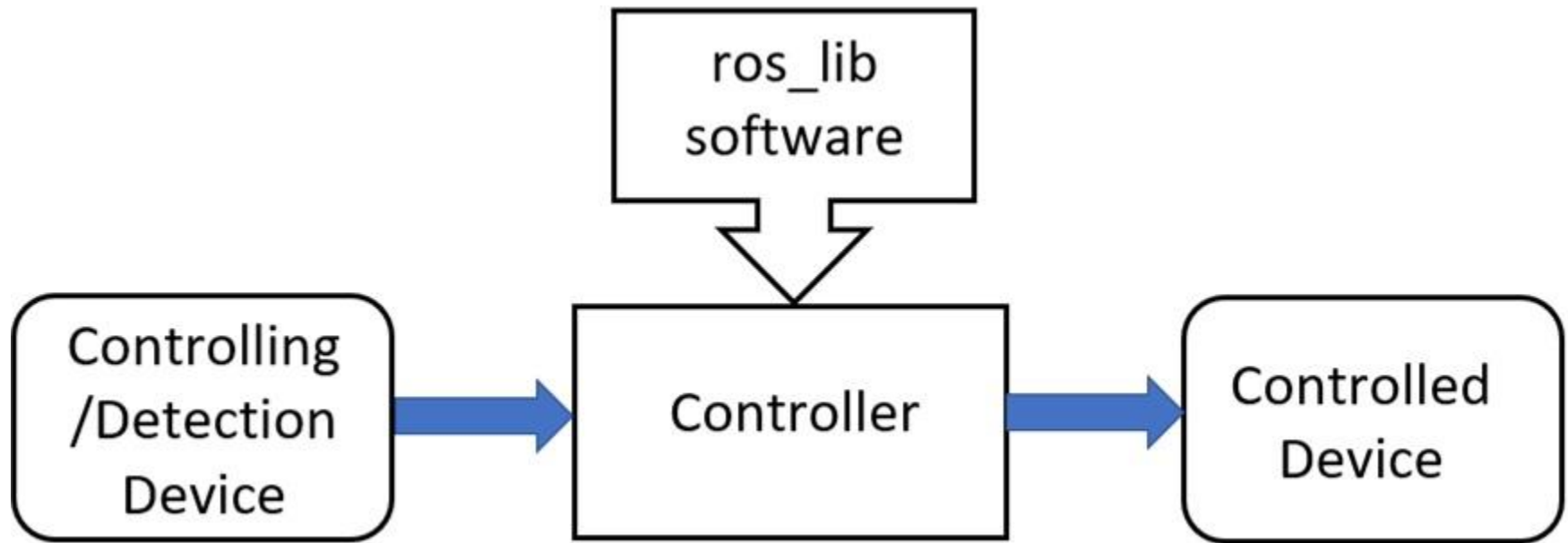
Agenda

- Enhancing the Pushbutton ROS Concept
- ROS Control Concepts
 - a) Transistor Driver Circuit
 - b) Programmable Switch Controller
- Lab Project: Build a Simple Pushbutton Controller

Enhancing the Pushbutton ROS Concept...

```
ros@roscore:~/rosdev-desktop-11317/
ros$ cd ~$ view search terminal output
Done checking log file disk usage, usage is okay.
started roslaunch server http://rosdev-desktop-400517/
ros_core version: 1.14.3
SUMMARY
NAME
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3
NODES
auto-starting new master
process[master]: started with pid [2090]
ros_init[1]: started with pid [2091]
setting /roscd to /home/rosdev-desktop-11317/
process[roscd]: started with pid [2092]
started core service [/roscd]
```

How do we enhance the Pushbutton ROS example to control devices?



A ROS based Controller Concept Block Diagram

Enhancing the Pushbutton ROS Concept...

```
~/ros_ws/src/roscpp_ws$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://mrdon-desktop:48511/
ros_core version 1.14.3

SUMMARY
=====
PARAMETERS
 * /roscpp_ws: roscpp_ws
 * /roscpp_ws: 1.14.3
NODES
-----
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d0ba1-947b-11e9-9758-b278b9a7583
process[roscpp-1]: started with pid [2035]
started core service [/roscpp]
```

The BIG IDEAS



With the use of the Pushbutton ROS example, a variety of controller device concepts can be rapidly developed.



Exploring other consumer and industrial applications besides robotics using ROS.



Allows additional ROS research among technical educators, makers, engineers, and hobbyists

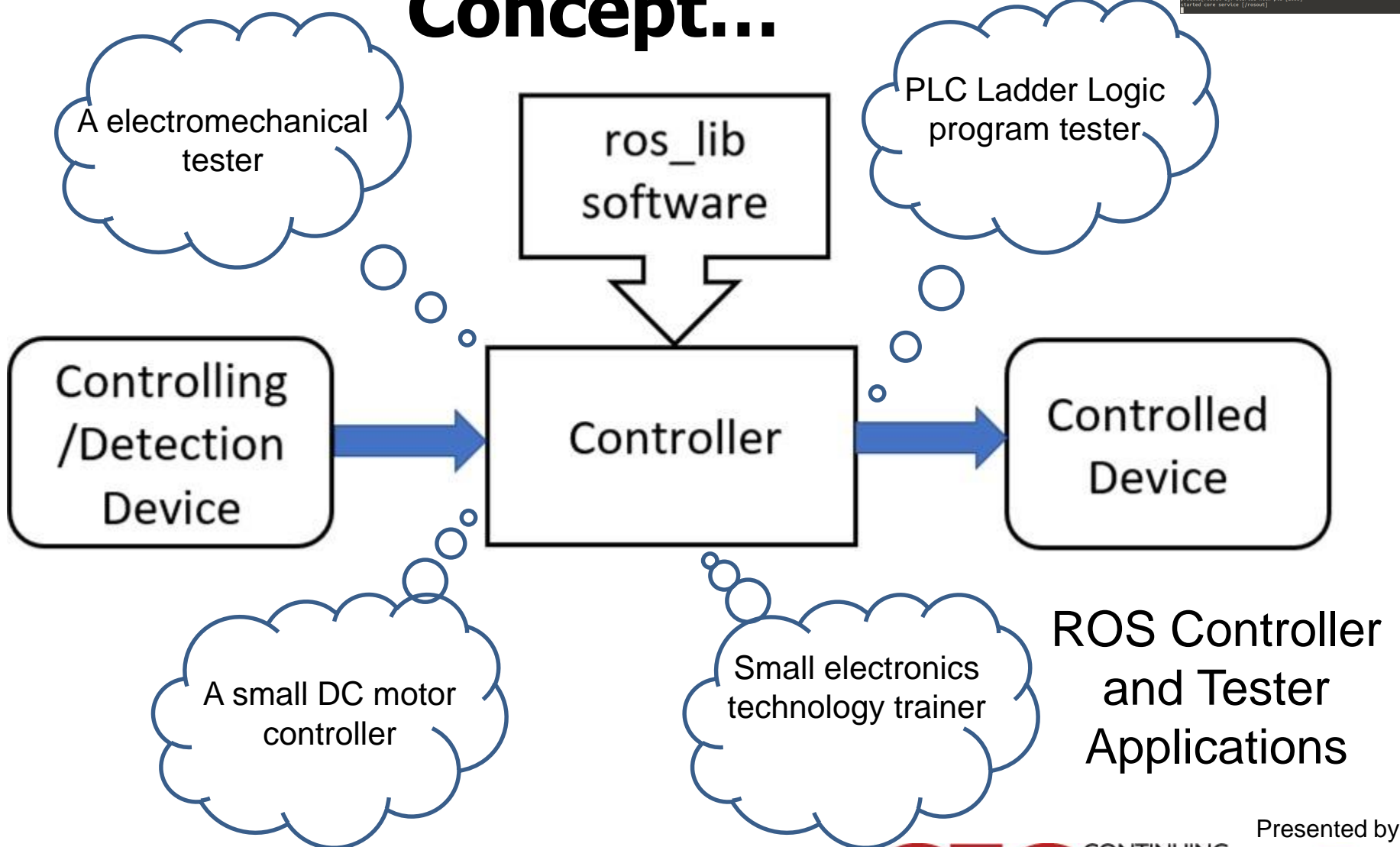
Enhancing the Pushbutton ROS Concept...

```
~/ros_ws/src/roscpp_ws$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://mrdon-desktop:48511/
ros_core version 1.14.3

SUMMARY
=====
PARAMETERS
 * /roscpp_ws: roscpp_ws
 * /roscpp_ws: roscpp_ws
 * /roscpp_ws: roscpp_ws

NODES
-----
auto-starting new master
process[roscpp_ws]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d0a8-947b-11e9-9758-b270b9a7563
process[roscpp_ws]: started with pid [2035]
started core service [/roscpp_ws]
```



Question 1



What are the four components used to build a ROS Controller and Tester Applications?

ROS Control Concepts

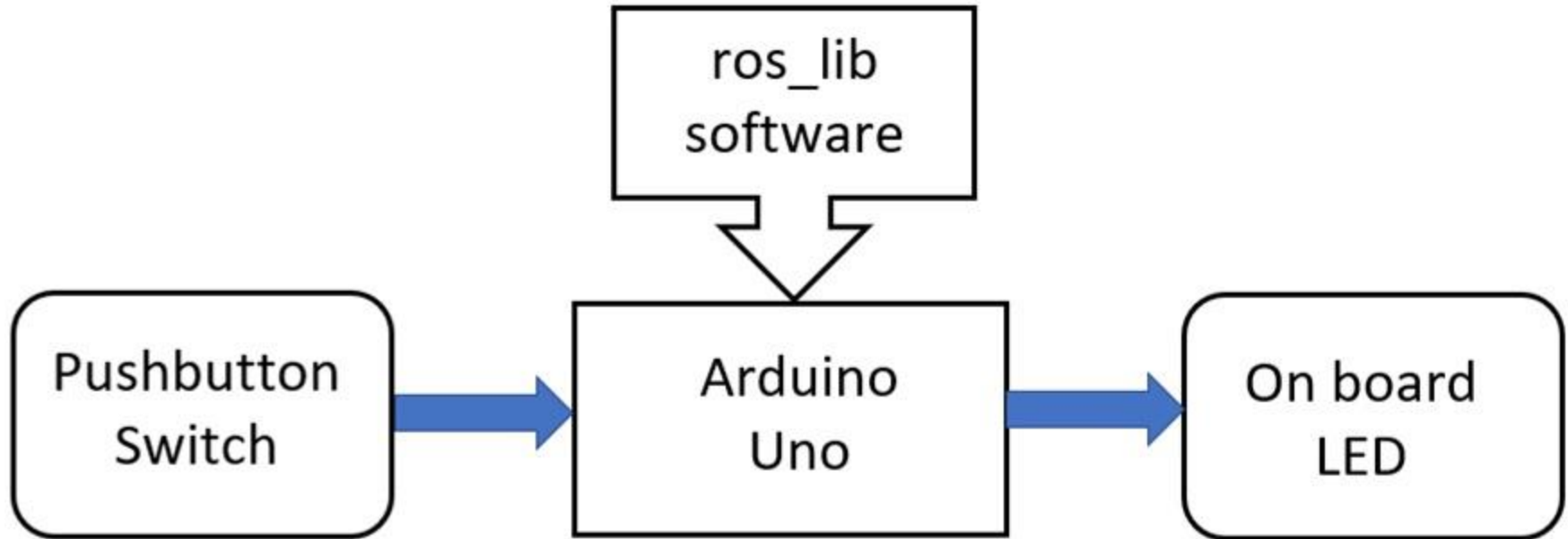
```
~/ros_ws/src/nrodon-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://nrodon-desktop:40011/
ros_core version: 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://nrodon-desktop:11311/

setting /run_id to 320d8aa-947b-11e9-975b-ba2780a75e3
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```

ROS Controller Concept 1



ROS Control Concepts...

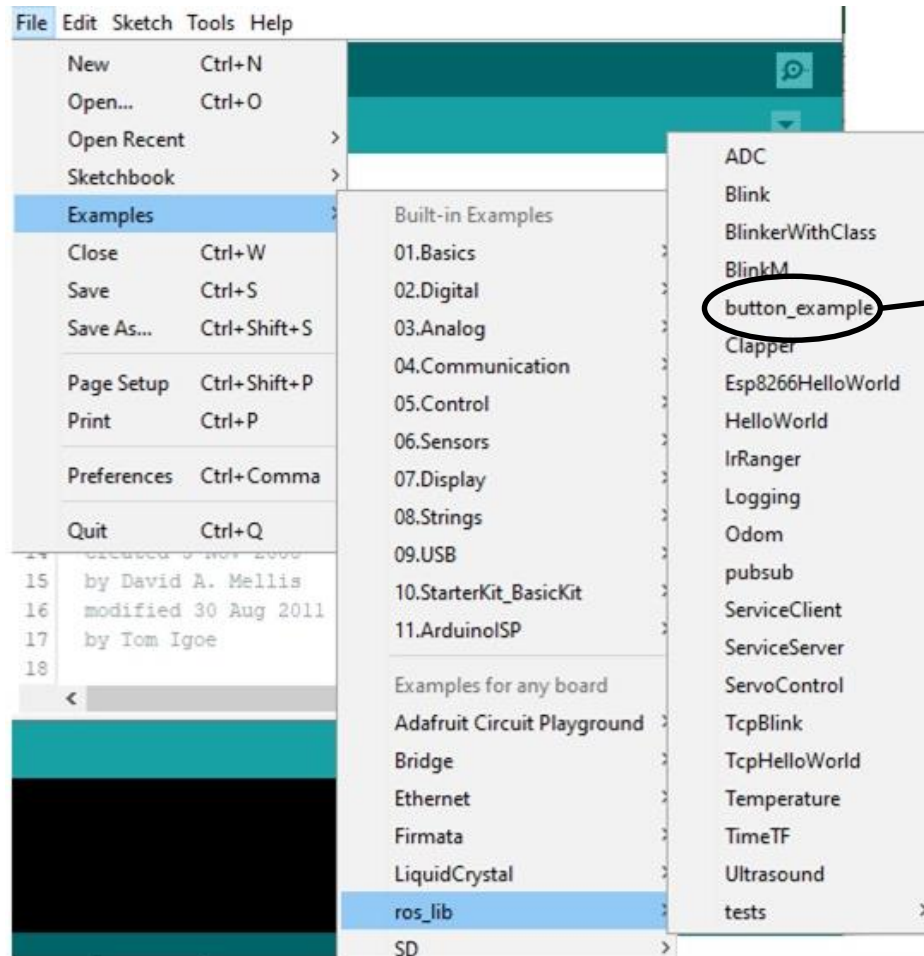
ROS Controller Concept 1

```
~/ros_ws/src/melon-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://melon-desktop:4001/
ros core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://melon-desktop:11311/

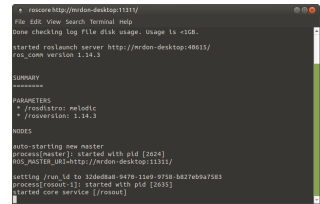
setting /run_id to 320d8a8-9476-11e9-9758-b2780a7563
process[roscpp]: started with pid [2033]
started core service [/roscpp]
```



ros_lib:
Upload the
button_example Sketch

ros_lib:
The *button_example* Sketch provides the pushed topic for publishing!

ROS Control Concepts...



ROS Controller Concept 1

```
const int button_pin = 7;  
const int led_pin = 13;
```

Can make modifications here!

```
bool last_reading;  
long last_debounce_time=0;  
long debounce_delay=50;  
bool published = true;  
  
void setup()  
{  
  nh.initNode();  
  nh.advertise(pub_button);  
  
  //initialize an LED output pin  
  //and a input pin for our push button  
  pinMode(led_pin, OUTPUT);  
  pinMode(button_pin, INPUT);  
}
```

ros_lib:
button_example Sketch

ROS Control Concepts...

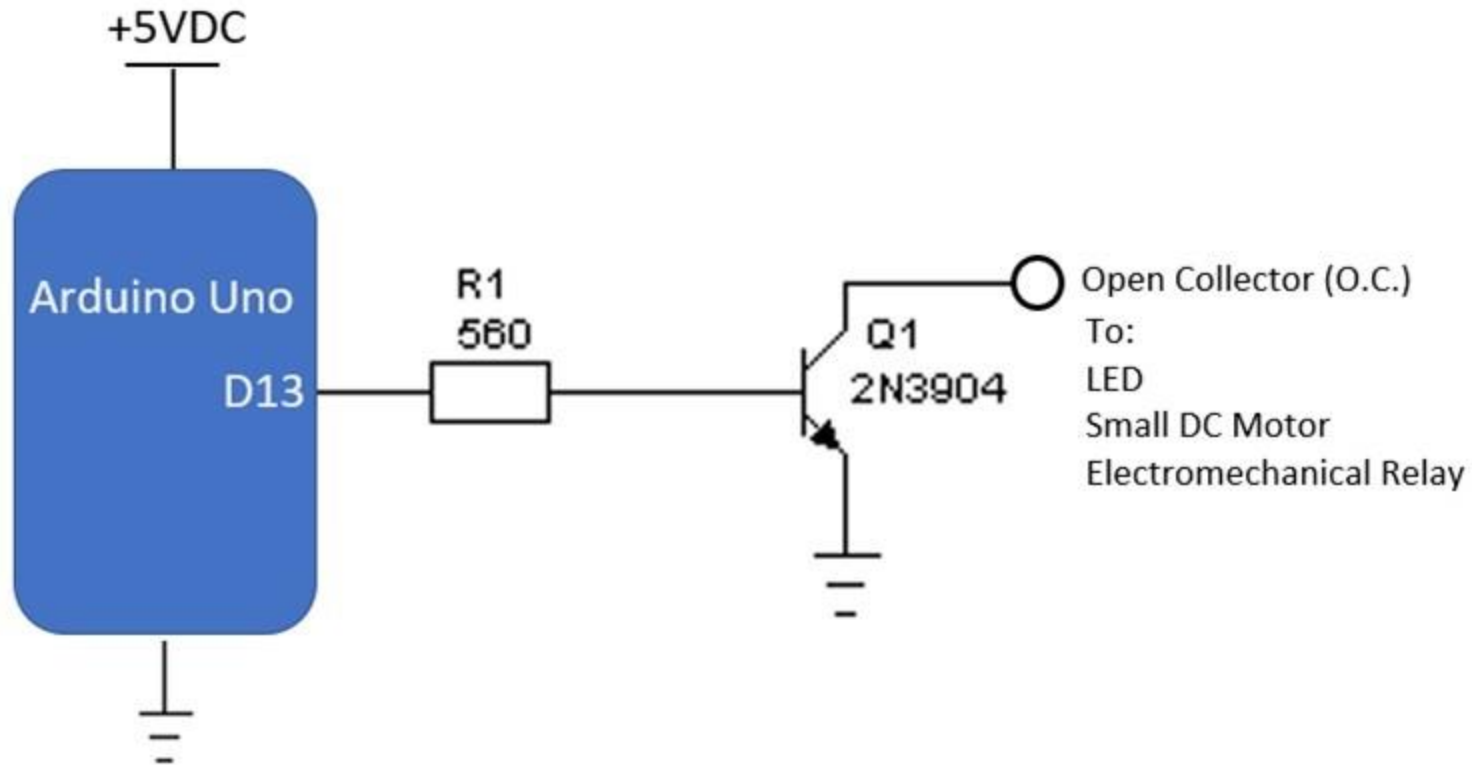
ROS Controller Concept 1: Open Collector Transistor Driver Circuit for the Arduino Uno

```
~/ros_ws/src/roscpp/roscpp$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://roscpp-desktop:4001/
ros_core version 3.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /roscpp_core: 3.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://roscpp-desktop:11311/

setting /run_id to 320d8a8-9476-11e5-9758-b278b0a7563
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```



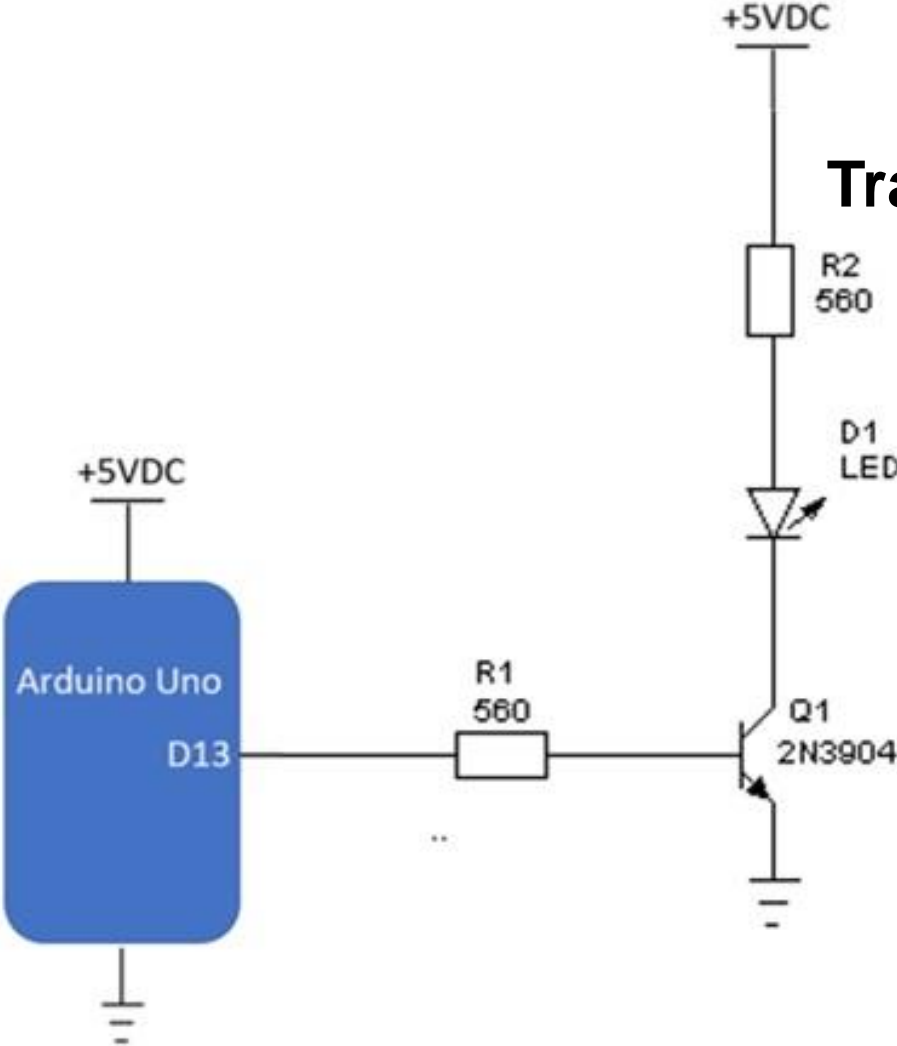
ROS Control Concepts...

```
~/ros_ws/src/roscpp/roscpp$ catkin_make
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://roscpp-desktop:4001/
ros_core.service 3.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /roscpp__log: /roscpp
NODES
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://roscpp-desktop:11311/

setting /run_id to 320d8a4-9476-11e9-9758-b278b9a75e3
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```

O.C Circuit Example: Transistor LED Driver Circuit



ROS Control Concepts...

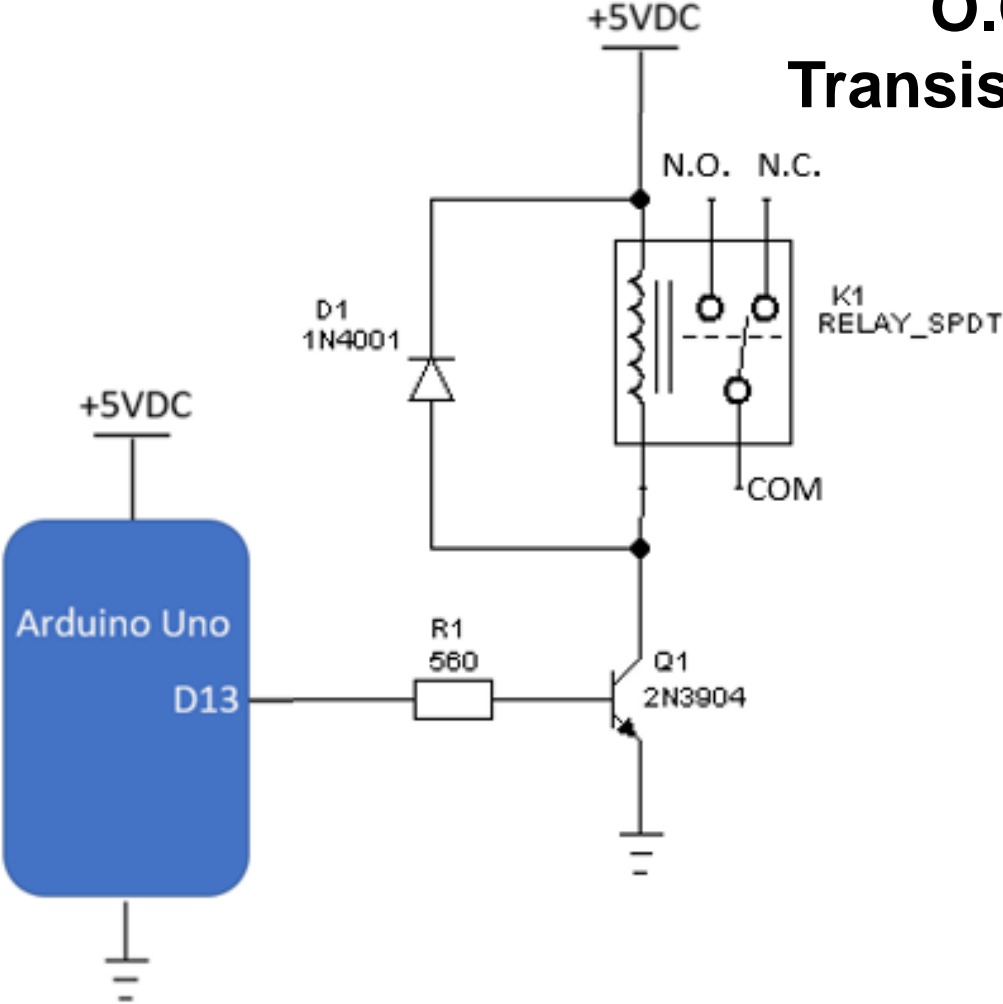
```
~/ros_ws/src/roscpp/roscpp$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://roscpp-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_core: roscpp_core
 * /roscpp_core__name: roscpp_core

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://roscpp-desktop:11311/

setting /run_id to 320d8a4-947b-11e5-975e-b278b0a7563
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```

O.C Circuit Example: Transistor Relay Driver Circuit



ROS Control Concepts...

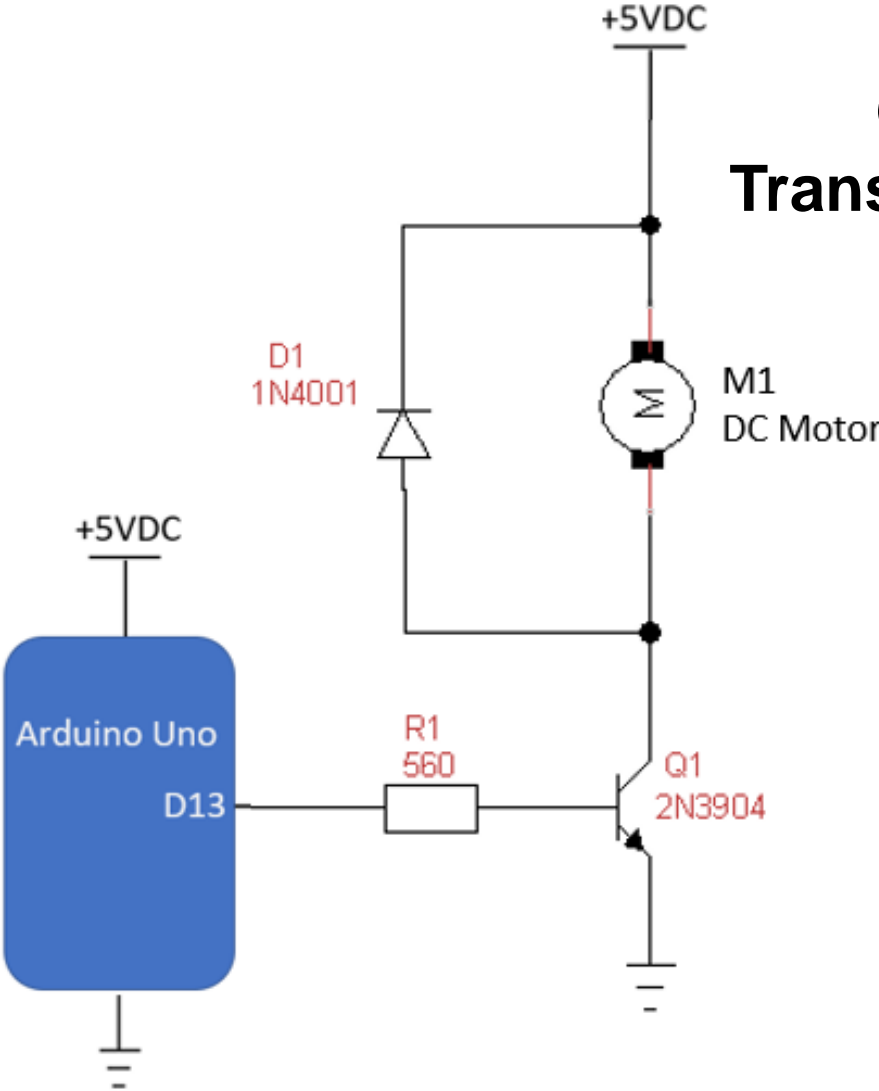
```
~/ros_ws/src/roscpp/roscpp$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://roscpp-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /roscpp__ns: /14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [1024]
ROS_MASTER_URI=http://roscpp-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-b278b0a7563
process[roscpp-1]: started with pid [1033]
started core service [/roscpp]
```

O.C Circuit Example: Transistor Motor Driver Circuit



Question 2



What is the primary component used to create an electronic driver circuit?

ROS Control Concepts...

```

~/ros_ws/src/nrodon-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.

started roslaunch server http://nrodon-desktop40611/
ros_core version 3.14.3

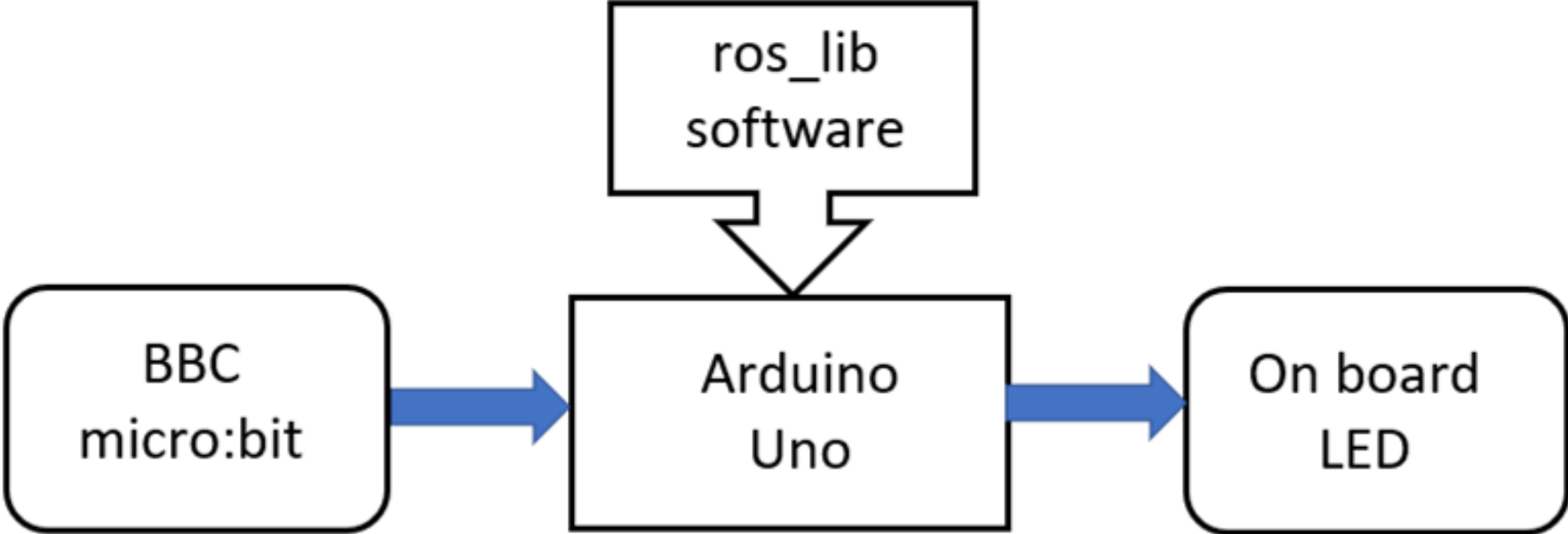
SUMMARY
-----
PARAMETERS
 * /roslauncher: melodic
 * /roswersion: 3.14.3

NODES
  auto-starting new master
  process_executor (started with pid [1024])
  ROS_MASTER_URI=http://nrodon-desktop11311/

setting /run_id to 32d68a8-9476-11e9-9758-ba27809a7583
process_executor-1: started with pid [12433]
started core service [/roscpp]
  
```

**Programmable
Switch
Controller**

**ROS
Controller
Concept 2**



ROS Control Concepts...

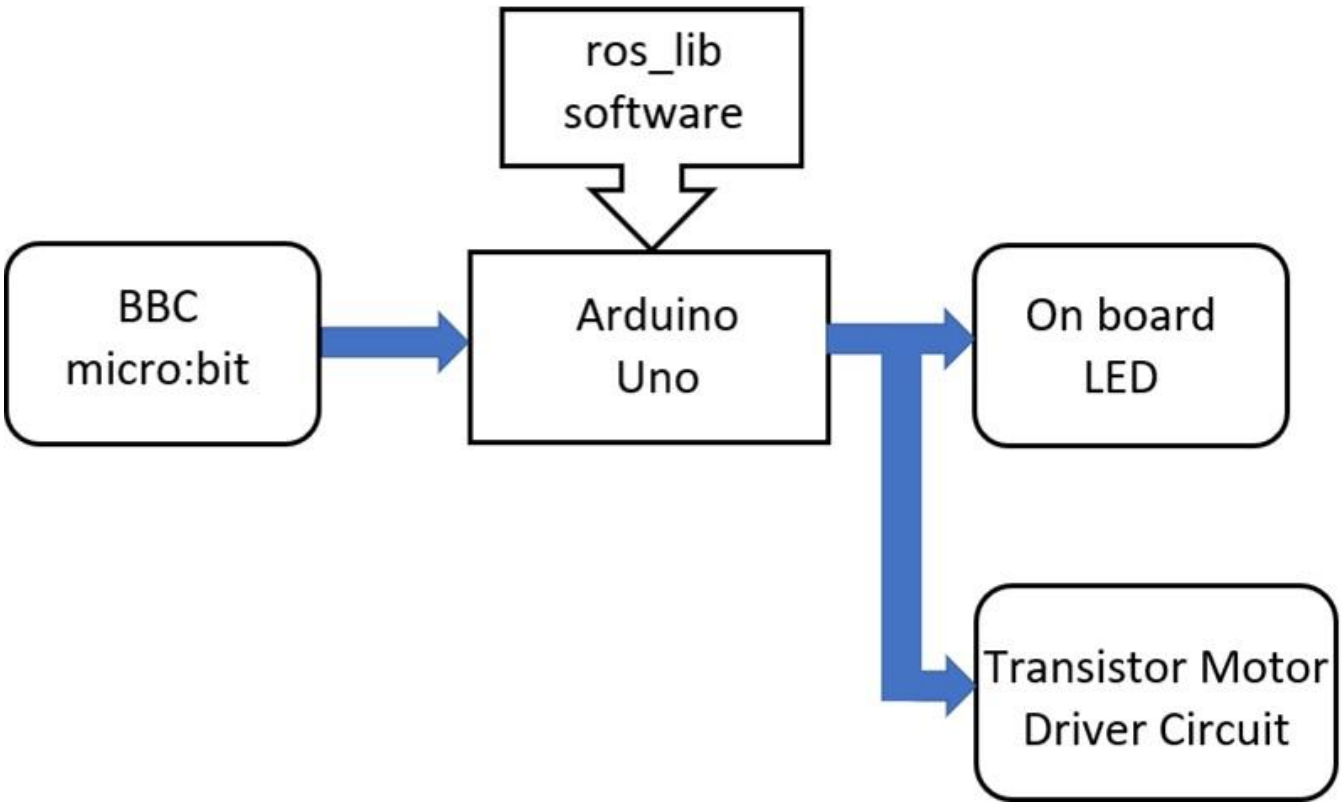
```
~/ros_ws/src/roscpp_tutorials/roscpp_tutorials$ catkin_make
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rodon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_tutorials: roscpp_tutorials
 * /roscpp_tutorials: 1.14.3

NODES
-----
auto-starting new master
process[roscpp_tutorials]: started with pid [2024]
ROS_MASTER_URI=http://rodon-desktop:11311/

setting /run_id to 320d8ba8-9476-11e9-9758-b2780b97583
process[roscpp_tutorials]: started with pid [2033]
started core service [/roscpp_tutorials]
```

ROS Controller Concept 2a



ROS Control Concepts...

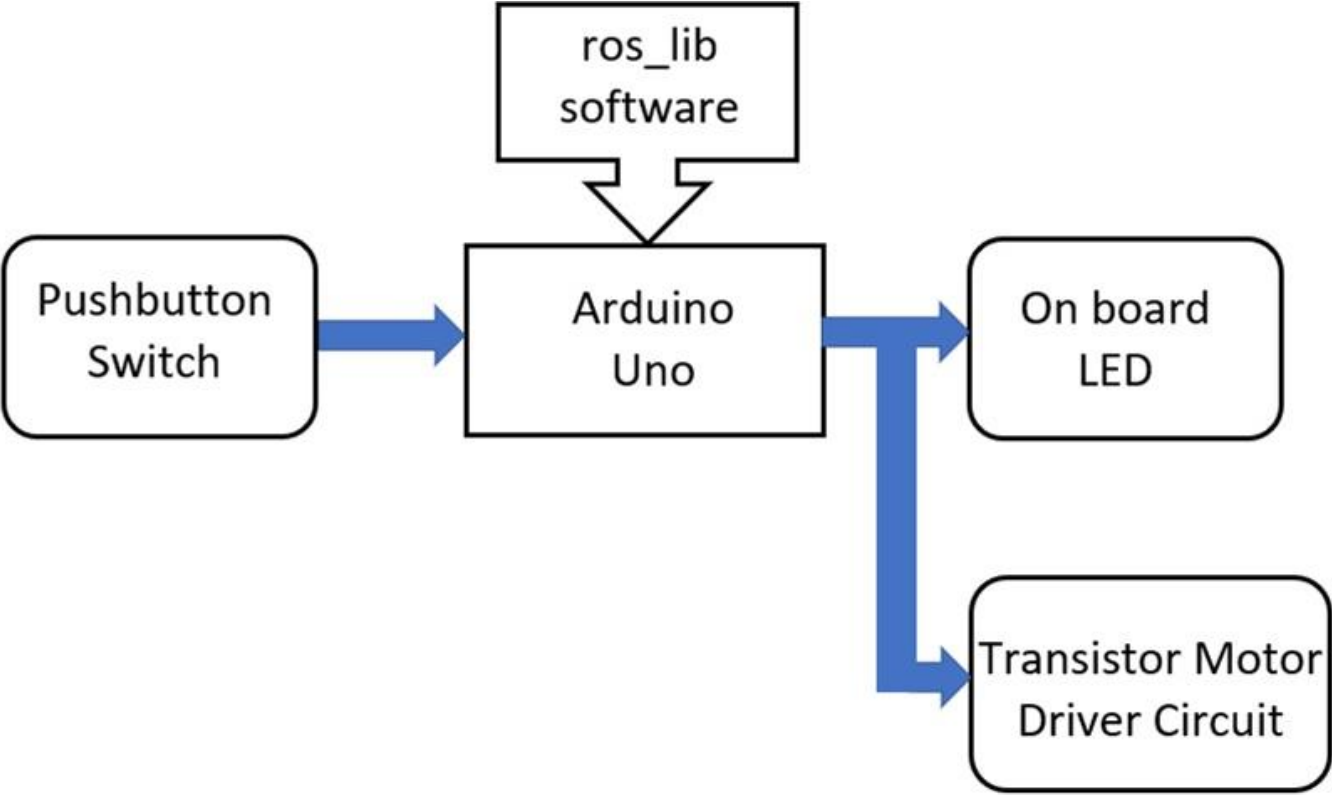
```
~/ros_ws/src/nrodon-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://nrodon-desktop48611/
ros_core.service 3.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://nrodon-desktop11311/

setting /run_id to 320d8a8-9476-11e9-9758-b278b9a75e3
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```

ROS Controller Concept 2b



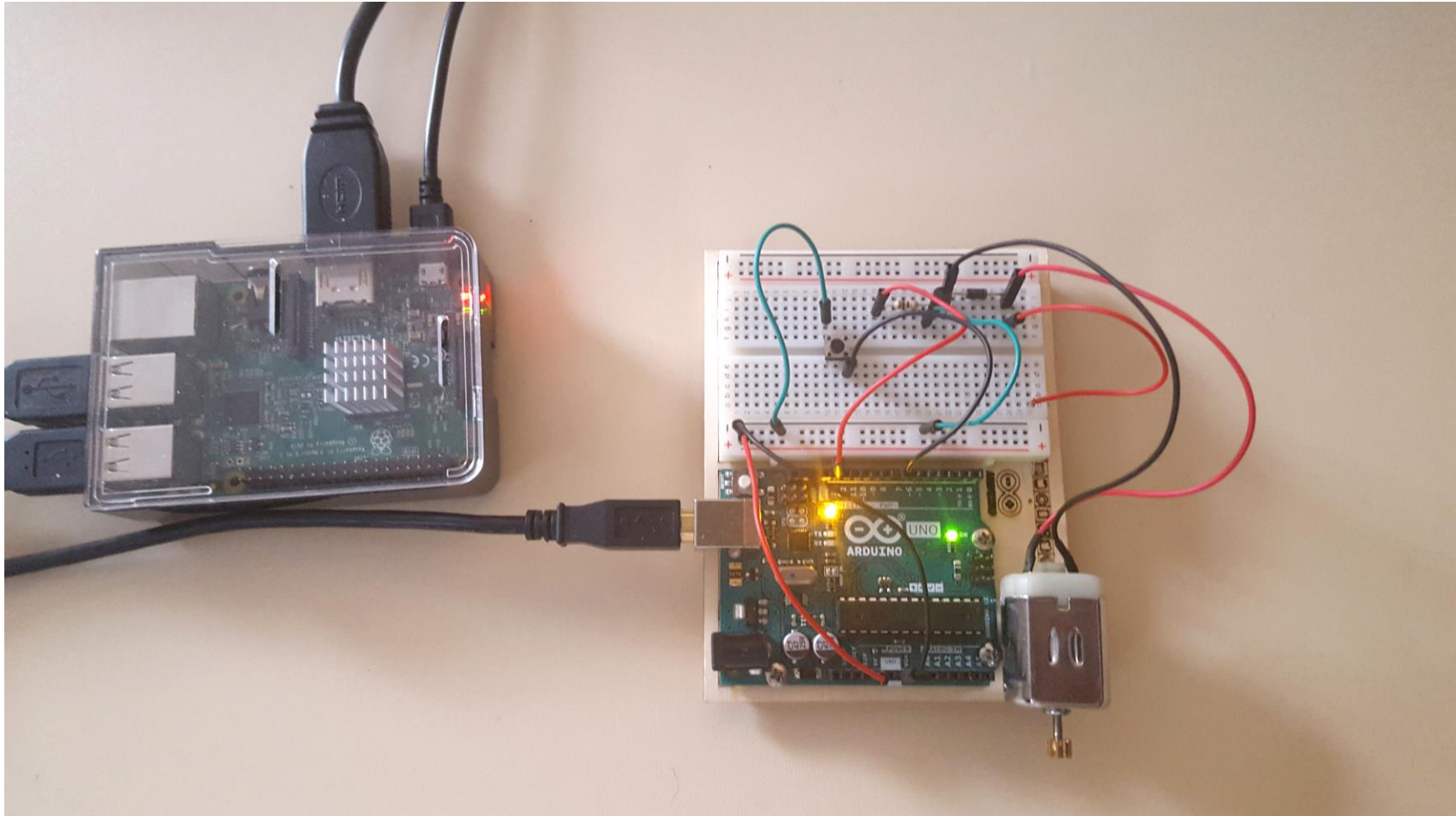
Lab Project: Build A ROS Simple Pushbutton Controller

```
~/ros_ws/src/roscpp/roscpp$ catkin_make
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://mrdon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /rosws: /roscpp

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311

setting /run_id to 320d8aa-947b-11e9-9758-ba2780a75e3
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```



Lab Project: Build A ROS Simple Pushbutton Controller...

```
~/ros_ws/src/roscpp_tutorials$ catkin_make
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://nrdon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_tutorial: roscpp_tutorial
 * /roscpp_tutorial: 1.14.3

NODES
-----
auto-starting new master
process[roscpp_tutorial]: started with pid [2024]
ROS_MASTER_URI=http://nrdon-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-ba2780b97583
process[roscpp_tutorial]: started with pid [2033]
started core service [/roscpp_tutorial]
```

Lab Objectives:

- Learn how attach a Raspberry Pi to an Arduino.
- Learn how to communicate with a ROS node.
- Learn how to display the dynamic graph of the pushbutton rostopic.
- Learn how to control a dc motor using the rostopic pub echo command.

ROS Control Concepts...

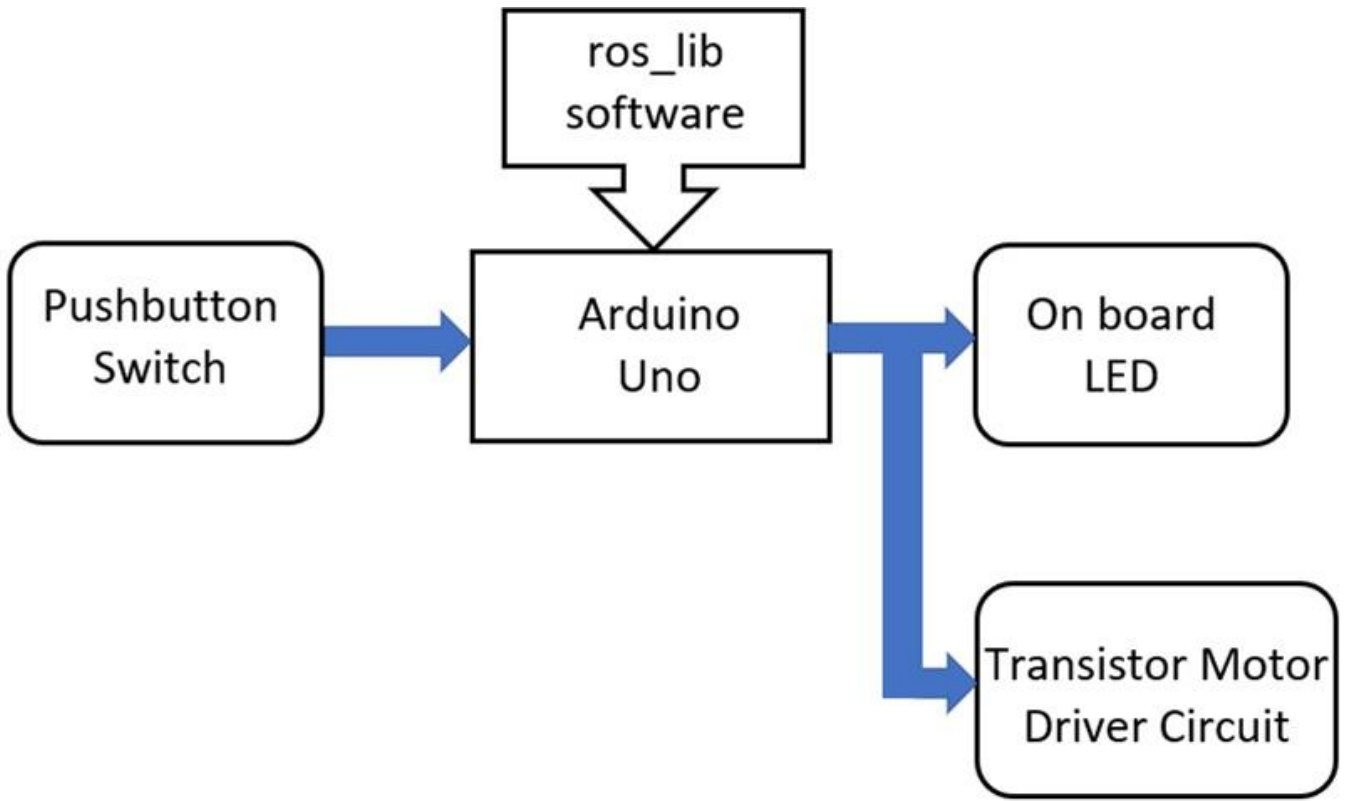
```
~/ros_ws/src/roscpp/roscpp
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rodon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /roswsdir: ~/ros_ws

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://rodon-desktop:11311/

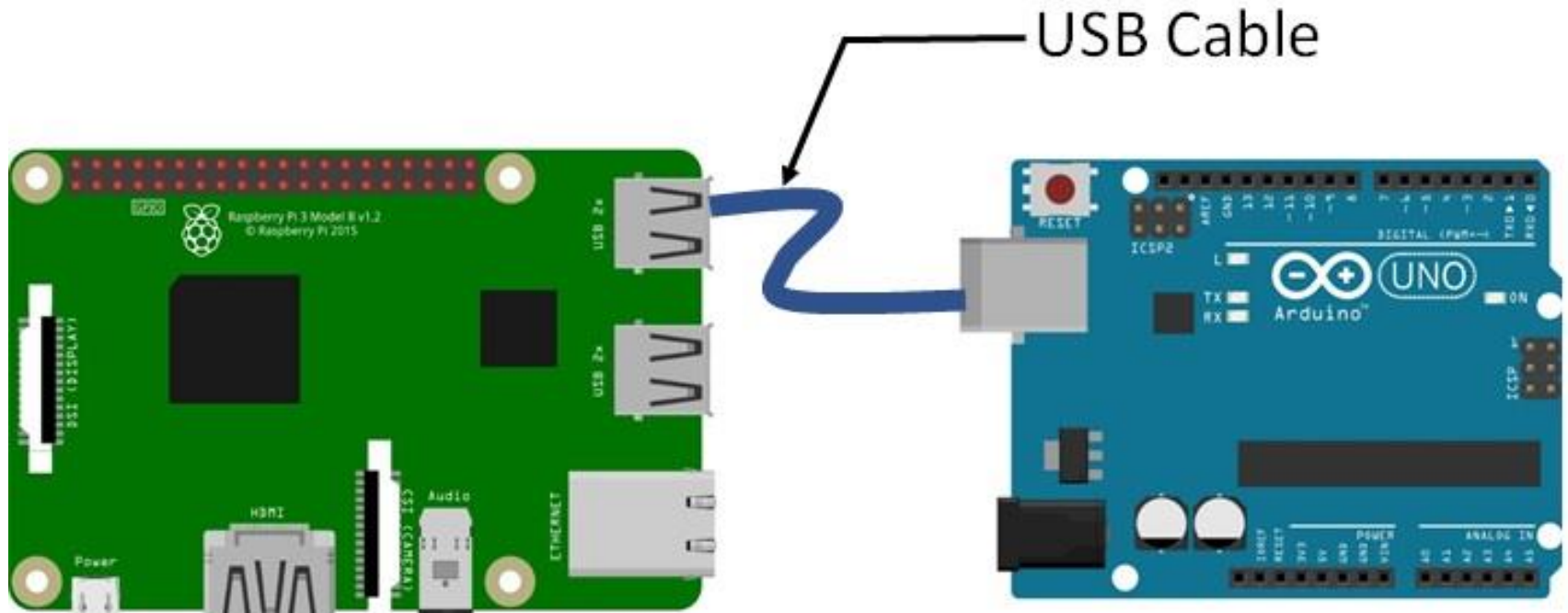
setting /run_id to 320d8ba8-947b-11e5-9758-b278b0a75e3
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```

ROS Controller Concept 2b



How to attach a Raspberry Pi to an Arduino?...

```
* rosrun http://mrdon-desktop:1311/
File Edit View Search Terminal Help
Now checking log file disk usage. Usage is <10%.
started roslaunch server http://mrdon-desktop:4051/
ros_core version 1.14.3
-----
SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
   /rosversion: 1.14.3
NODES
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:1311/
setting /run_id to 3260d88-9476-3269-9750-ba270b9a7551
process[roscpp-1]: started with pid [2033]
started core service [/rostop]
|
```



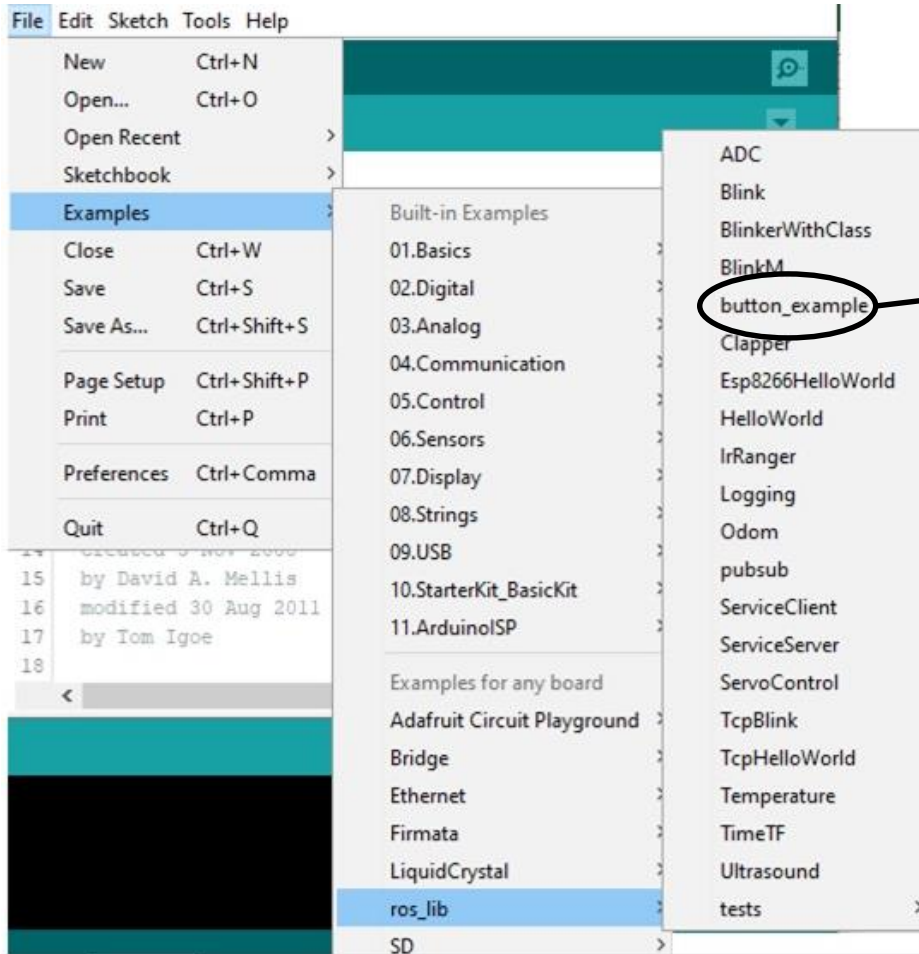
Serial communication between the Raspberry Pi 3 and Arduino Uno

How to attach a Raspberry Pi to an Arduino?...

```
* rosrun http://mrdon-desktop:1311/
File Edit View Search Terminal Help
Now checking log file disk usage: usage is <1GB.
started roslaunch server: http://mrdon-desktop:40011/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3
NODES
----
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:1311/

setting /run_id to 3260d848-9476-11e9-9750-ba270a97583
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```



ros_lib:
Upload the *button_example* Sketch

ros_lib:
The *button_example* Sketch provides the pushed topic for publishing!

Lab Project: Build A ROS Simple Pushbutton Controller...

```
~/ros_ws/src/roscpp_tutorials/roscpp_tutorials$ catkin_make
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://roscpp_tutorials-ubuntu:4001/
roscpp_tutorials: version 1.14.3

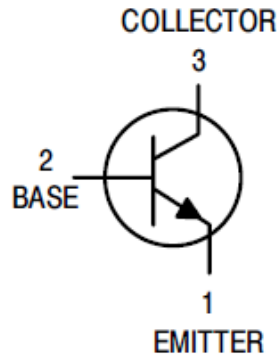
SUMMARY
-----
PARAMETERS
 * /roscpp_tutorials: roscpp_tutorials
 * /roscpp_tutorials: 1.14.3

NODES
-----
auto-starting new master
process[roscpp_tutorials]: started with pid [2024]
ROS_MASTER_URI=http://roscpp_tutorials-ubuntu:11311/

setting /run_id to 320d8a8-947b-11e5-9758-b278b0a7563
process[roscpp_tutorials]: started with pid [2033]
started core service [/roscpp_tutorials]
```

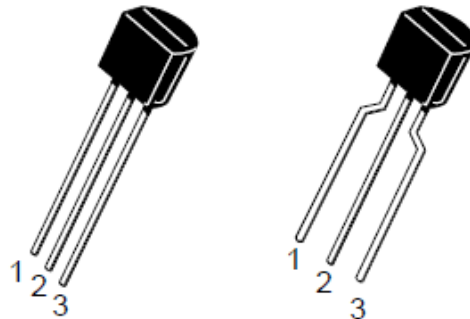
ON Semiconductor®

<http://onsemi.com>



Note: Q1 can be a MPS2222A or 2N3904 NPN Transistor. The pinout of each transistor are equivalent.

TO-92
CASE 29
STYLE 1



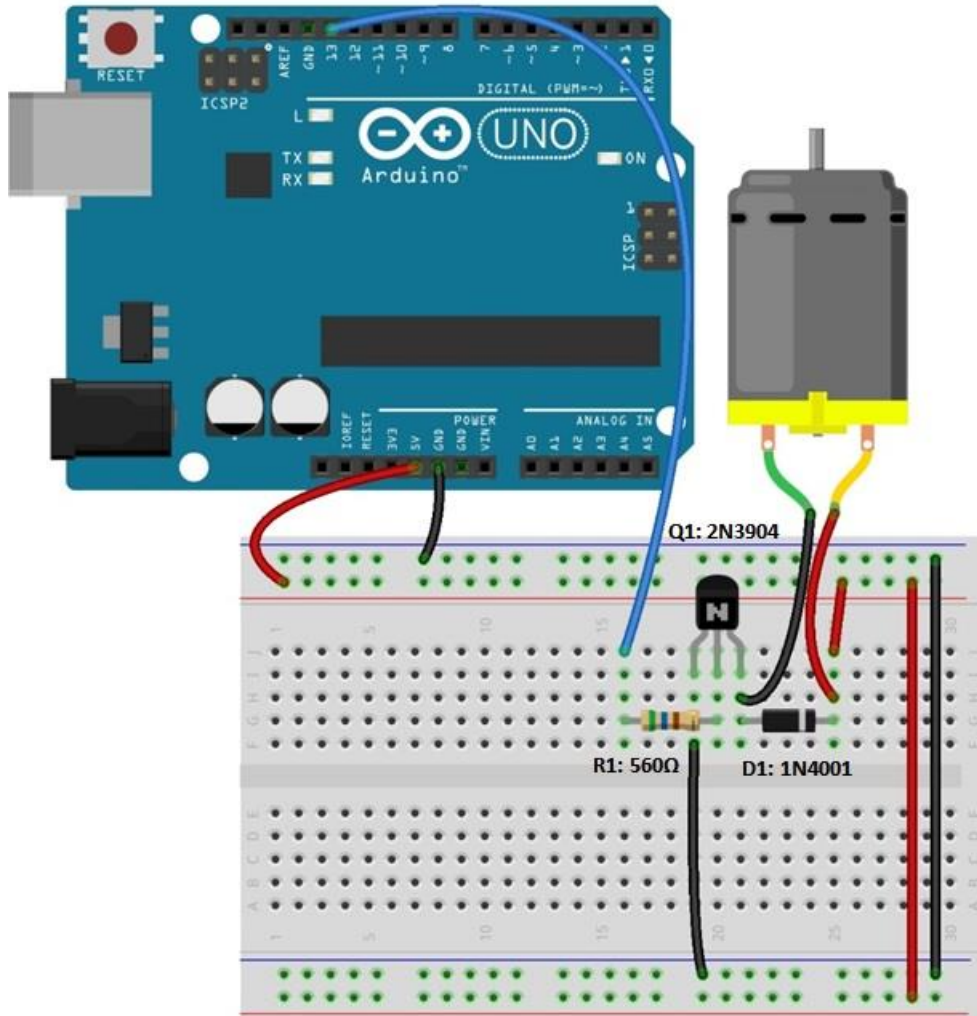
Lab Project: Build A ROS Simple Pushbutton Controller...

```
~/ros_ws/src/roscpp/roscpp$ catkin_make
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://roscpp-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
   /roscpp_core: 1
   /roscpp_core_version: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://roscpp-desktop:11311/

setting /run_id to 320d8a8-947b-11e5-9758-b2780a7563
process[roscpp-1]: started with pid [2035]
started core service [/roscpp]
```



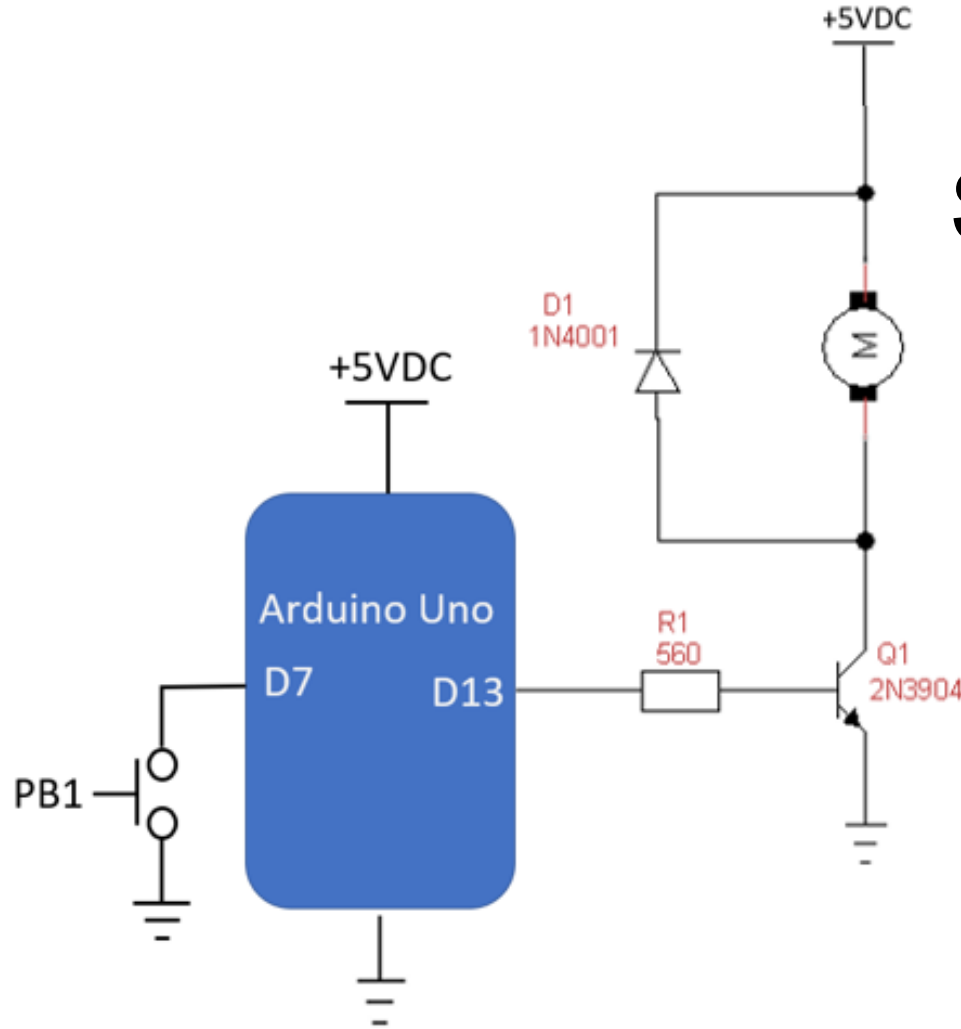
Simple Pushbutton Controller Electrical Wiring Diagram

Lab Project: Build A ROS Simple Pushbutton Controller...

```
~/ros_ws/src/roscpp/roscpp$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rondon-desktop:4001/
ros_core.service 3.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /roscpp__log: /var/log/roscpp
NODES
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://rondon-desktop:11311/

setting /run_id to 320d8a4-947b-11e9-975e-ba2780a75e3
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```



Simple Pushbutton Controller Electronic Circuit Diagram

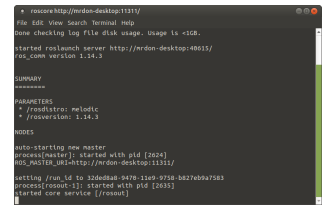
Note: Q1 can be a MPS2222A or 2N3904 NPN Transistor



Question 3

Of the driver circuits discussed in slides 11-13, what circuit was selected for the ROS Simple Pushbutton Controller?

How to attach a Raspberry Pi to an Arduino?



Open a linux terminal: At the prompt type: `roscore`.

```
roscore http://mrdon-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://mrdon-desktop:40615/
ros_comm version 1.14.3

SUMMARY
=====

PARAMETERS
* /roscore: melodic
* /rosversion: 1.14.3

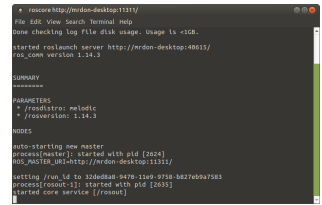
NODES

auto-starting new master
process[master]: started with pid [2624]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 32ded8a8-9470-11e9-9758-b827eb9a7583
process[rosout-1]: started with pid [2635]
started core service [/rosout]
```

roscore running in an active window

How to communicate with a ROS node?...



```
~/ros_ws/src/roscpp_tutorials$ catkin_make
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rondon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_tutorials/roscpp_tutorials
 * /roscpp_tutorials/roscpp_tutorials

NODES
-----
auto-starting new master
process[roscpp_tutorials]: started with pid [2024]
ROS_MASTER_URI=http://rondon-desktop:11311/

setting /run_id to 32d6d8a1-947b-11e9-9758-b278b0a7563
process[roscpp_tutorials]: started with pid [2033]
started core service [/roscpp_tutorials]
```

To run the roserial client application for communicating with the attached Arduino Uno, open a new window and type the following *ros_lib* command after the prompt.

\$ rosrun roserial_python serial_node.py /dev/*serial port*.

Note: *serial port* is the communication port used on the Arduino Uno to talk to the Raspberry Pi.

For example: ttyACM0 is the Arduino Uno's serial port to communicate with the Raspberry Pi.

How to communicate with a ROS node?...

Open linux terminal: `roslaunch rosserial_python serial_node.py` running

```
mrdon@mrdon-desktop: ~  
File Edit View Search Terminal Help  
mrdon@mrdon-desktop:~$ roslaunch rosserial_python serial_node.py /dev/ttyACM0  
[INFO] [1583114175.513932]: ROS Serial Python Node  
[INFO] [1583114175.547573]: Connecting to /dev/ttyACM0 at 57600 baud  
[INFO] [1583114177.668262]: Requesting topics...  
[INFO] [1583114177.708511]: Note: publish buffer size is 280 bytes  
[INFO] [1583114177.715263]: Setup publisher on pushed [std_msgs/Bool]
```

```
~/ros_ws/src/mrdon-desktop11311/  
File Edit View Search Terminal Help  
Done checking log file disk usage. Usage is 1GB.  
started roslaunch server http://mrdon-desktop:4001/  
ros_core version 1.14.3  
  
SUMMARY  
-----  
PARAMETERS  
 * /roslaunch: roslaunch  
 * /rosworkon: 1.14.3  
  
NODES  
-----  
auto-starting new master  
process[roslaunch]: started with pid [1024]  
ROS_MASTER_URI=http://mrdon-desktop:11311/  
  
setting /run_id to 320d8a8-947b-11e5-9758-b278b0a7563  
process[roslaunch-1]: started with pid [1033]  
started core service [/roslaunch]
```

How to display the Binary message?...

```
~/ros_ws/src/roscpp_ws$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 41GB.
started roslaunch server http://rondon-desktop:40011/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_ws: melodic
 * /roscpp_ws: 1.14.3

NODES
-----
auto-starting new master
process[roscpp_ws]: started with pid [2024]
ROS_MASTER_URI=http://rondon-desktop:11311/

setting /run_id to 320d8aa-947b-11e9-9758-b278b0a7563
process[roscpp_ws]: started with pid [2033]
started core service [/roscpp]
```

To watch the binary message (True or False), open a new terminal window and type the following *ros_lib* command after the prompt.

\$ rostopic echo pushed

How to display the Binary message?...

```
~/roscat1311/mrdon-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://mrdon-desktop:40011/
ros_comm version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roslaunch: roslaunch
 * /roscat1311: 1.14.3

NODES
-----
auto-starting new master
process[roscat1311]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-b278b0a7563
process[roscat1311]: started with pid [2033]
started core service [/roscat]
```

```
• mrdon@mrdon-desktop: ~
File Edit View Search Terminal Help
mrdon@mrdon-desktop:~$ rosrund serial_python serial_node.py /dev/ttyACM0
[INFO] [1583114175.513932]: ROS Serial Python Node
[INFO] [1583114175.547573]: Connecting to /dev/ttyACM0 at 57600 baud
[INFO] [1583114177.668262]: Requesting topics...
[INFO] [1583114177.708511]: Note: publish buffer size is 280 bytes
[INFO] [1583114177.715263]: Setup publisher on pushed [std_msgs/Bool]
```

rosserial running in an active window

How to display the Binary message?...

```
~/roscpp1131/mrdon-desktop1131/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://mrdon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: rostopic
 * /roswsname: 1.14.3

NODES
auto-starting new master
process[roscpp1131]: started with pid [1024]
ROS_MASTER_URI=http://mrdon-desktop:1131/

setting /run_id to 320d8a8-947b-11e9-9758-b27809a7563
process[roscpp1131]: started with pid [1033]
started core service [/roscpp1131]
```

Open linux terminal: press and release button “A” on micro:bit

```
mrdon@mrdon-desktop: ~
File Edit View Search Terminal Help
mrdon@mrdon-desktop:~$ rostopic echo pushed
data: False
---
data: True
---
data: False
---
data: True
---
data: False
---
data: True
---
data: False
---
data: True
---
data: False
---
data: True
---
█
```

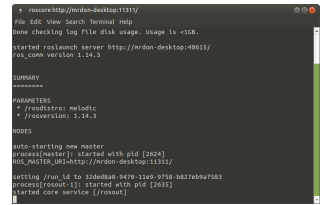
rostopic running in an active window

Question 4



What `ros_lib` command is used to display the binary (True or False)?

How to display a dynamic graph of the pushbutton rostopic?...



```
mrdon@mrdon-desktop: ~  
File Edit View Search Terminal Help  
mrdon@mrdon-desktop:~$ sudo apt-get install ros-melodic-rqt  
[sudo] password for mrdon:  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
The following packages were automatically installed and are no longer required:  
  apt-clone archdetect-deb cryptsetup-bin dpkg-repack gir1.2-json-1.0  
  gir1.2-nm-1.0 gir1.2-nma-1.0 gir1.2-timezonemap-1.0 gir1.2-xkl-1.0  
  grub-common libdebian-installer4 libpng12-0 libtimezonemap-data  
  libtimezonemap1 os-prober python3-icu python3-pam rdate  
Use 'sudo apt autoremove' to remove them.  
The following NEW packages will be installed:  
  ros-melodic-rqt  
0 upgraded, 1 newly installed, 0 to remove and 31 not upgraded.  
Need to get 2,232 B of archives.  
After this operation, 14.3 kB of additional disk space will be used.  
Err:1 http://packages.ros.org/ros/ubuntu bionic/main arm64 ros-melodic-rqt arm64  
  0.5.0-0bionic.20190602.130423  
  404 Not Found [IP: 2600:3402:200:227::2 80]  
E: Failed to fetch http://packages.ros.org/ros/ubuntu/pool/main/r/ros-melodic-rqt/ros-melodic-rqt_0.5.0-0bionic.20190602.130423_arm64.deb 404 Not Found [IP: 2600:3402:200:227::2 80]  
E: Unable to fetch some archives, maybe run apt-get update or try with --fix-missing?
```

Installing *rqt*

How to display a dynamic graph of the servo rostopic?...

```
~/roscat@mrdon-desktop:~$  
File Edit View Search Terminal Help  
Done checking log file disk usage. Usage is 41GB.  
started roslaunch server http://mrdon-desktop:40011/  
ros_core version 1.14.3  
  
SUMMARY  
-----  
PARAMETERS  
 * /rostopic: melodic  
 * /rosversion: 1.14.3  
  
NODES  
-----  
auto-starting new master  
process[roscat]: started with pid [2024]  
ROS_MASTER_URI=http://mrdon-desktop:11311/  
  
setting /run_id to 320d8a8-947b-11e9-9758-b278b0a7563  
process[roscat-1]: started with pid [2033]  
started core service [/roscat]
```

```
mrdon@mrdon-desktop: ~  
File Edit View Search Terminal Help  
mrdon@mrdon-desktop:~$ rosrn rqt_graph rqt_graph  
libEGL warning: DRI2: failed to authenticate
```

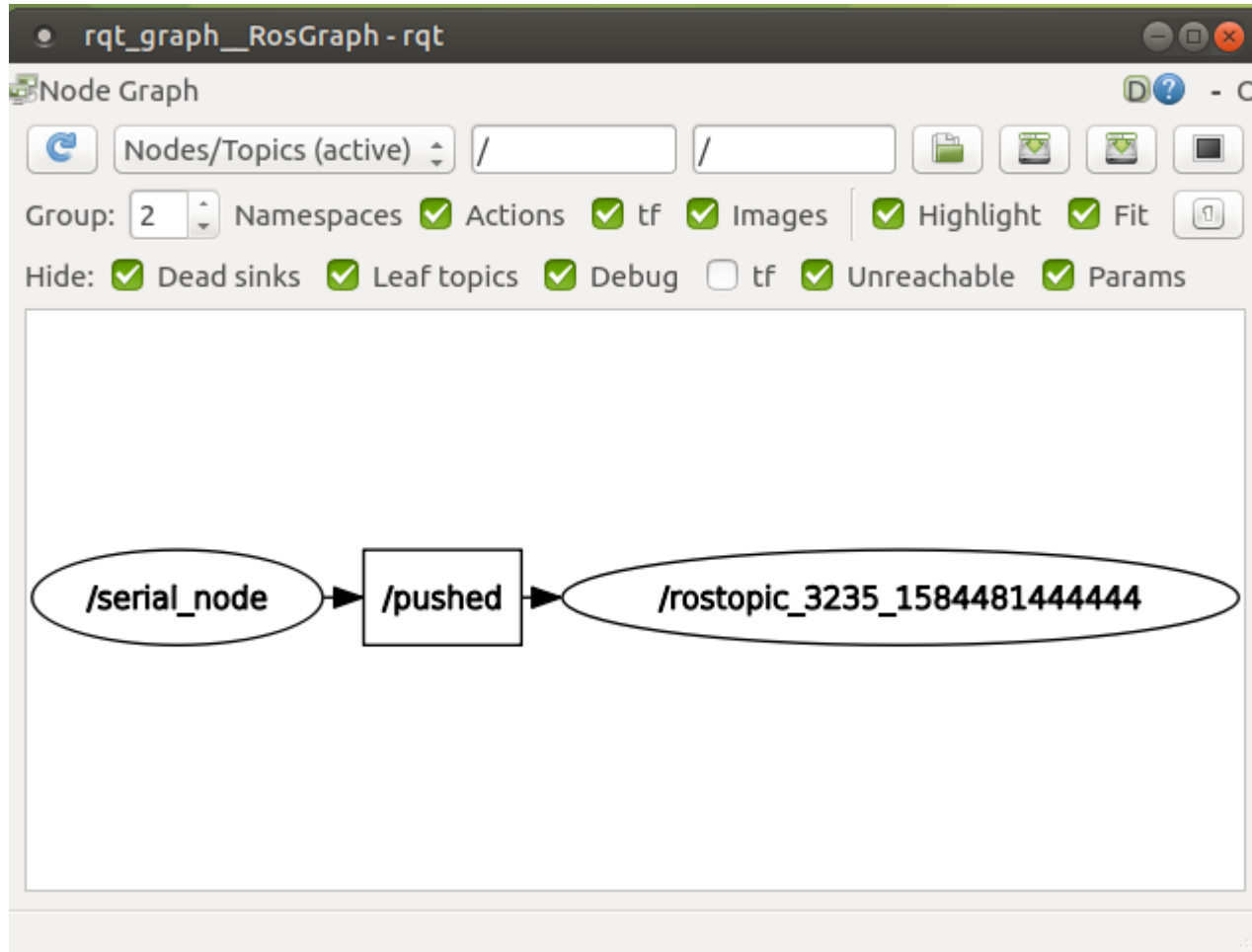
Running *rqt_graph*

How to display a dynamic graph of the pushed rostopic?...

```
r: rosrun http://mendon-desktop:11317/
File Edit View Search Terminal Help
Done Checking log file: done escape: escape to: stop
Started roslaunch server http://mendon-desktop:4051/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: melodic
 * /rosversion: 1.14.3

NODES
auto-starting new master
process[master]: started with pid [2644]
ROS_MASTER_URI=http://mendon-desktop:11317
setting /run-id to 3d0404d-8097-11e5-970e-0a27000973d3
process[roscpp-1]: started with pid [2635]
started core service [/roscpp]
```



pushed *rqt_graph*
Place your mouse over `/pushed` to highlight the ROS Nodes. Nodes will be displayed blue and green and topic(s) in red.

Question 5



What color is displayed for topics viewed in the pushed rostopic dynamic graph?

Congratulations!

