Building a Remote Control Robot with Automotive Grade Linux

Leon Anavi
Konsulko Group
leon.anavi@konsulko.com
Embedded Linux Conference Europe 2017
23-25 October, Prague, Czech Republic

Konsulko Group

Agenda

Konsulko Group

- **Overview of AGL**
- **Selecting hardware components and building a simple remote controller robot**
- **Integrating and contributing additional software to the upstream of AGL**
- **Conclusions**
- **Q&A**

The Experiment

Konsulko Group

Could other industries benefit from the features of Automotive Grade Linux (AGL)?

Requirements

Konsulko Group

Common requirements for an embedded Linux distribution for Internet of Things (IoT):

- **Build system and a development toolchain**
- **Security**
- **Over the air software updates**
- **Graphics and audio stack**

Automotive Grade Linux

Konsulko Group

- **Project of the Linux Foundation**
- **In-Vehicle-Infotainment (IVI) GNU/Linux distribution**
- **Based on the Yocto Project and OpenEmbedded**
- **Founded in 2014**

AGL Members

Konsulko Group

Platinum

DENSO

mazda

Panasonic

RENESAS

SUZUKI

TOYOTA

Gold

HONDA
The Power of Dreams

NTT DATA
NTT DATA MSE Corporation

Silver

AISIN AW CO.,LTD.

Continental

Mercedes-Benz

DRIMAES

FUJITSU TEN

irdeto

MITSUBISHI ELECTRIC

NISSAN

Pioneer

QUALCOMM

WIND

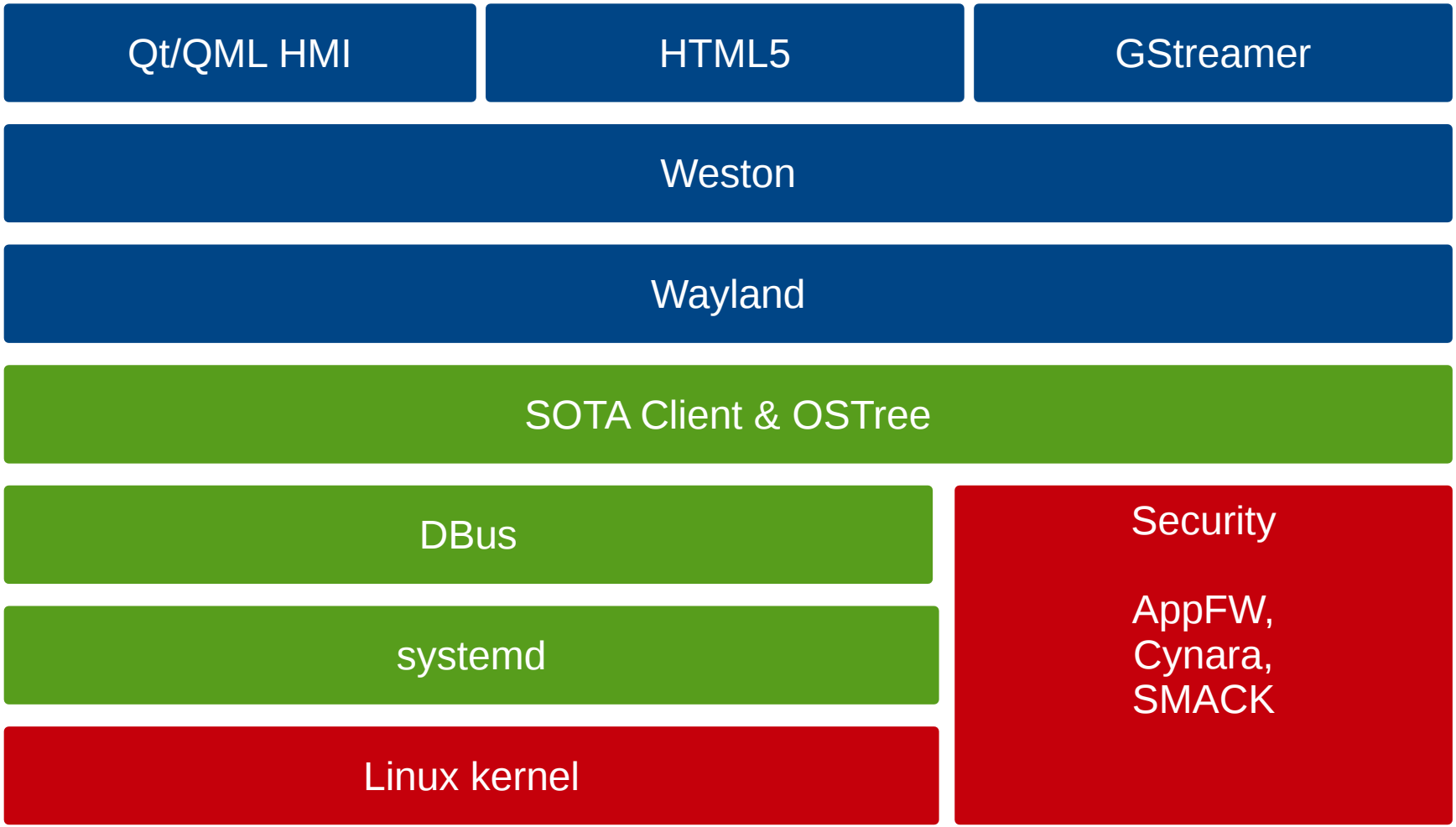
AGL Releases

Konsulko Group

- **Funky Flounder 6.0.0 – scheduled for Jul 2108**
- **Electric Eel 5.0.0 – scheduled for Dec 2017**
- **Daring Dab 4.0.0 – Jul 2017**
- **Charming Chinook 3.0.0 – Jan 2017**
- **Brilliant Blowfish 2.0.0 – Jul 2016**
- **Agile Albacore 1.0 – Jan 2016**
- **AGL Unified Code Base (UCB) – 4 Jan 2016**

AGL Core Technologies

Konsulko Group



AGL Yocto/OE Layers

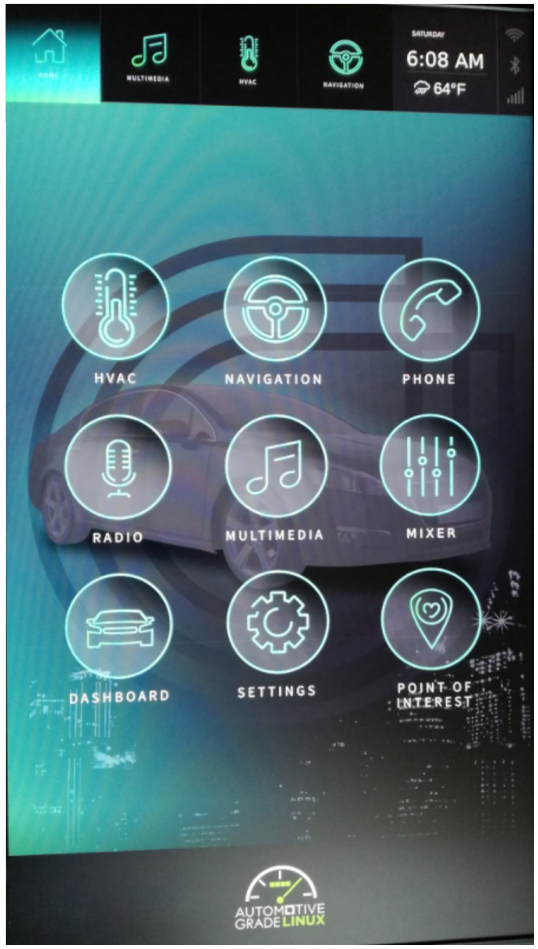
Konsulko Group

- **poky**
- **meta-agl**
- **meta-agl-demo**
- **meta-agl-devel**
- **meta-agl-extra**
- **meta-intel-iot-security**
- **meta-oic**
- **meta-qt5**
- **meta-updater**

AGL Supported Devices

Konsulko Group

- Renesas Gen3 and Gen2 boards
- Intel Joule & Minnowboard
- TI DRA7xx EVM (Vayu)
- Raspberry Pi 2/3
- Dragonboard 610-c
- i.MX6 SABRE & HummingBoard



AGL Developer Tools

Konsulko Group

- **Git & Repo**
- **Gerrit** https://gerrit.automotivelinux.org/
- **Jenkins** https://jenkins-new.automotivelinux.org/
- **JIRA** https://jira.automotivelinux.org/
- **Wiki** https://wiki.automotivelinux.org/
- **New documentation site** http://docs.automotivelinux.org/

Building a RC Robot

Konsulko Group

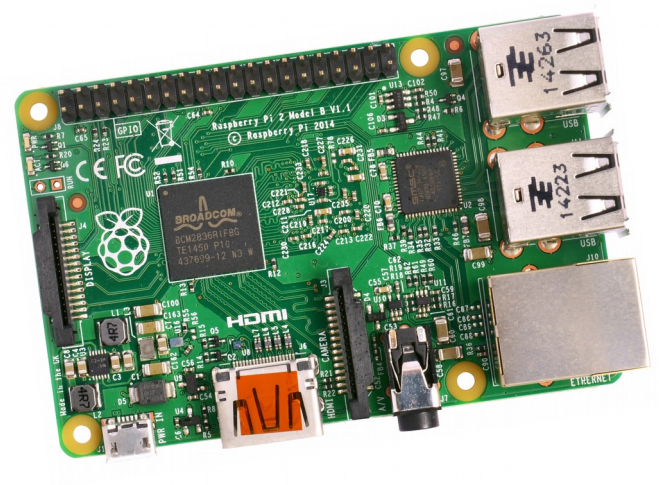
Required hardware:

- **Single board computer**
- **Chassis and DC motors**
- **Motor driver**
- **Sensors**
- **Batteries**

Why Raspberry Pi 3?

Konsulko Group

- **Low cost credit-card-sized computer**
- **Good software support in AGL**
- **Variety of add-ons**
- **Huge community**



Motor Controllers

Konsulko Group

Some DC motor controllers for Raspberry Pi to consider:

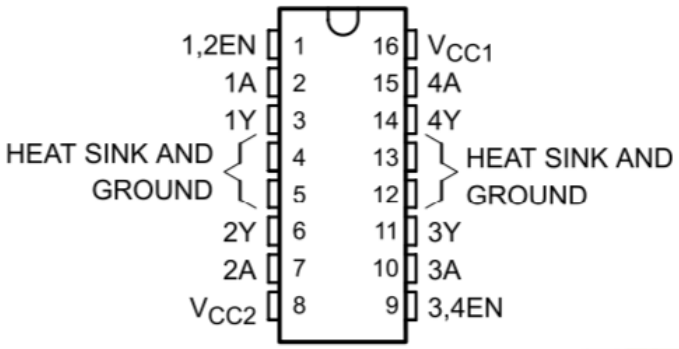
- **ZeroBorg (TI DVR 8833)**
- **Picon Zero (TI DRV8833)**
- **Explorer pHAT (TI DVR8833)**
- **RasPi Robot Board (TB6612FNG)**
- **RTk.RPi.MCB (SN754410)**

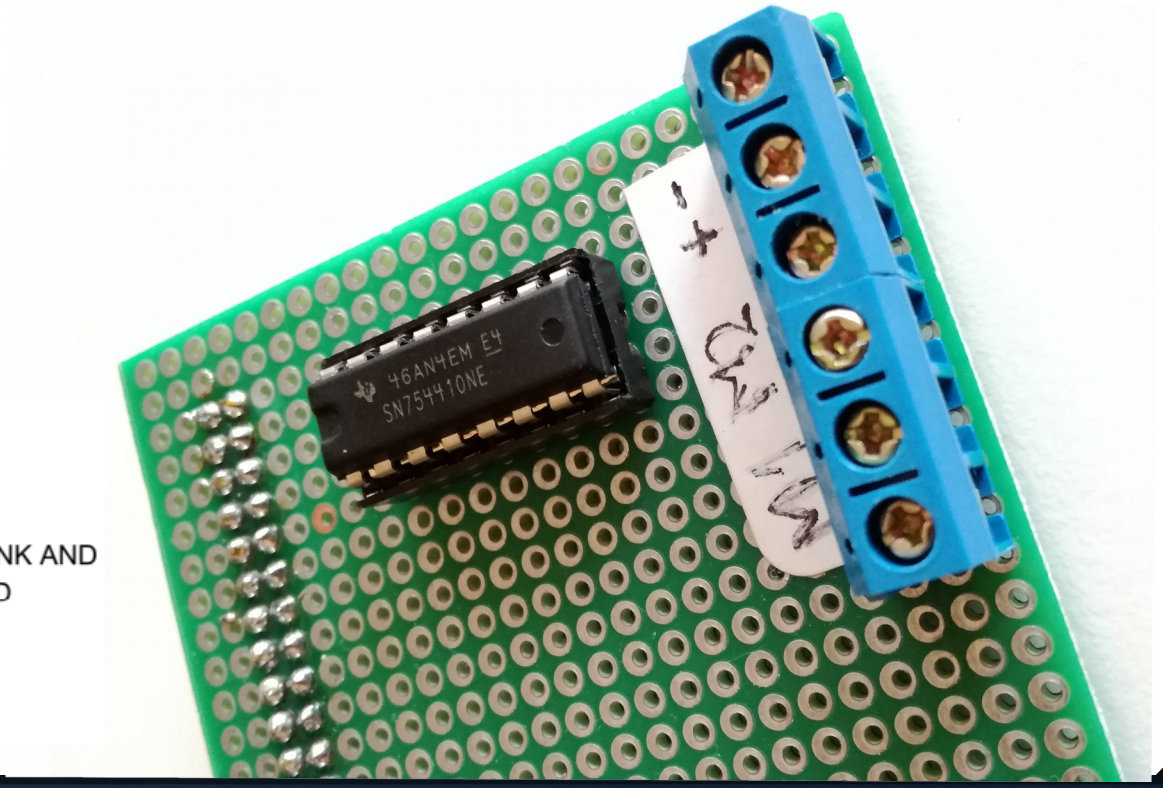
DIY Motor Driver Board

Konsulko Group

Half-H motor drivers:

- **TI DVR8833**
- **TI L293D**
- **TI SN754410**





Controlling the Motors

Konsulko Group

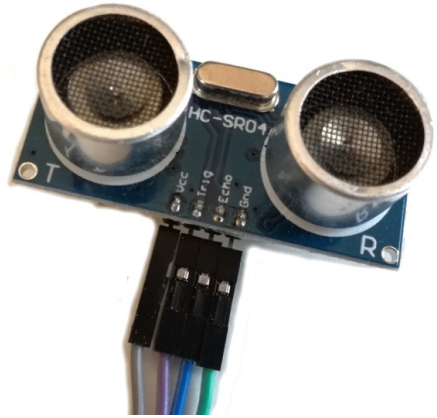
- **Software emulated PWM**
- **WiringPi library**
- **2 DC motors controlled by SN754410 and powered by 4 AA batteries**

```
// Set pin mode
pinMode(motor1pin1, OUTPUT);
pinMode(motor1pin2, OUTPUT);
pinMode(motor2pin1, OUTPUT);
pinMode(motor2pin2, OUTPUT);

//Software PWM
enablePWM(motor1pin1, speedMax);
enablePWM(motor1pin2, speedMax);
enablePWM(motor2pin1, speedMax);
enablePWM(motor2pin2, speedMax);
```

```
void forward(int speed)
{
  softPwmWrite(motor1pin1, speed);
  softPwmWrite(motor2pin1, speed);

  motor1(HIGH, LOW);
  motor2(HIGH, LOW);
}
```

Sensors

Konsulko Group



- **Ultrasonic sensor (HC-SR04)**
- **IR line tracking (TCRT5000)**
- **Triple Axis Compass Magnetometer (HMC5883L)**
- **Other I2C sensors for measuring temperature, humidity, colors, light, etc.**
- **Raspberry Pi Camera module V2**

Communication

Konsulko Group

Built-in features in Raspberry Pi 3:

- **WiFi**
- **Ethernet**
- **Bluetooth Low Energy (BLE)**

Extended capabilities through add-ons:

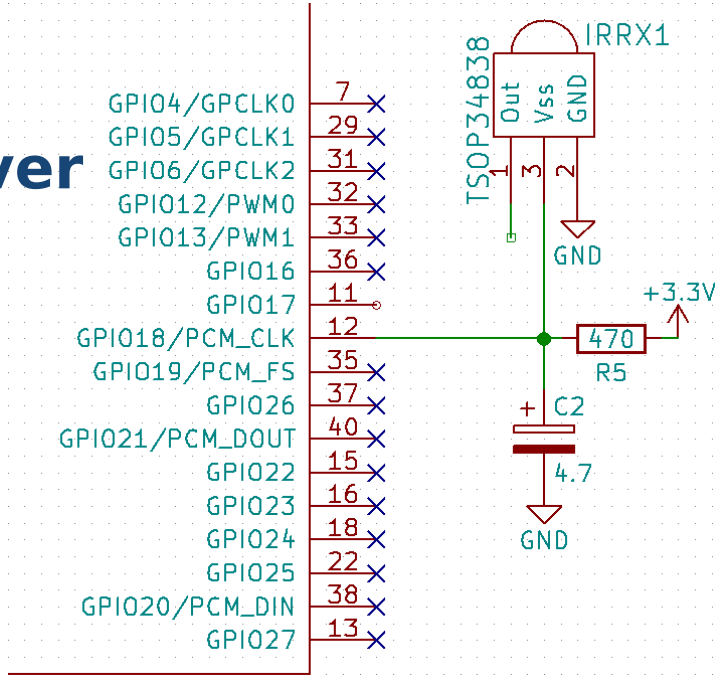
- **433MHz radio transmission**
- **Infrared receiver**

Example: IR Receiver

Konsulko Group

Hardware:

- **TSOP34838 Infrared Receiver**

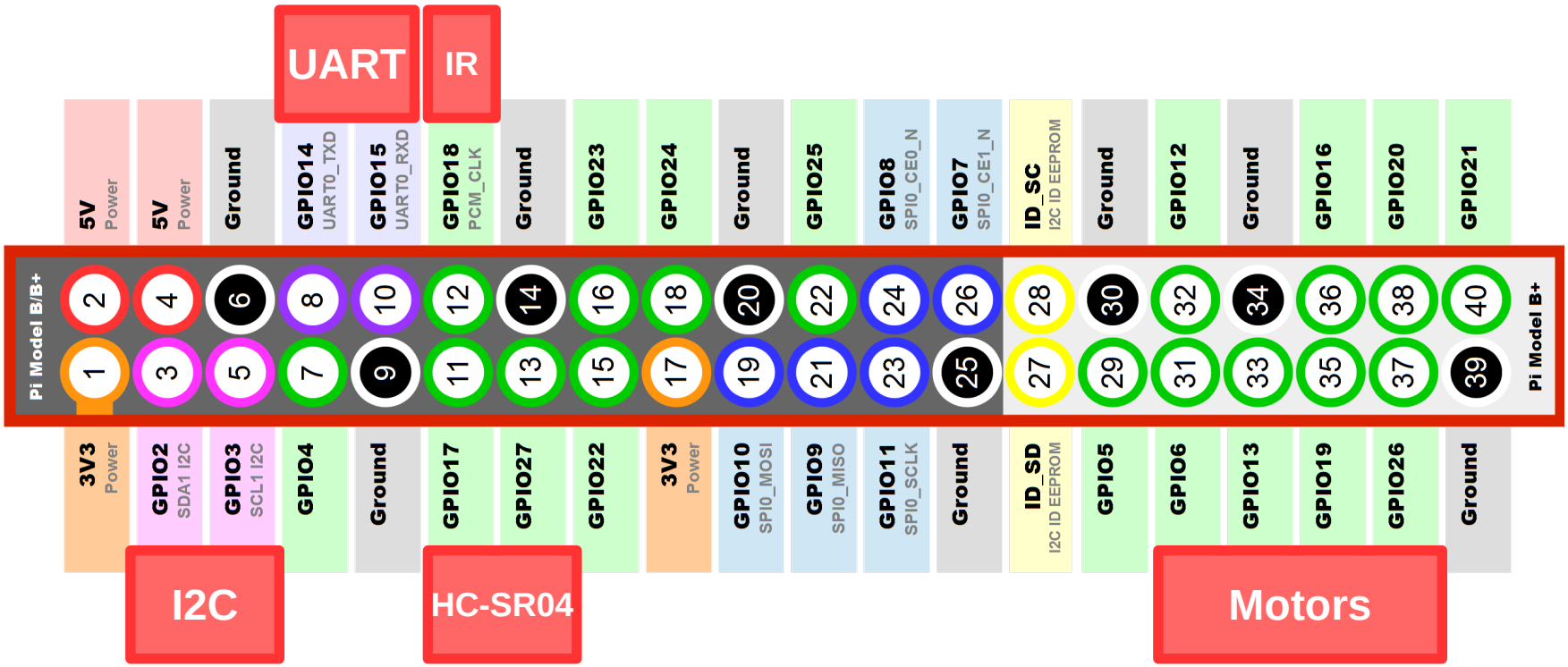


Software:

- **LIRC (Linux Infrared Remote Control)**

Putting Things Together

Konsulko Group



Building AGL

Konsulko Group

- **Get the source code:**

```
repo init -u https://gerrit.automotivelinux.org/gerrit/AGL/AGL-repo
repo sync
```

- **Setup the build environment:**

```
source meta-agl/scripts/aglsetup.sh -m raspberrypi3 agl-demo agl-netboot agl-appfw-smack
```

- **Build an image:**

```
bitbake agl-image-minimal
```

AGL Images

Konsulko Group

Common AGL targets are:

- **agl-image-minimal**
- **agl-image-ivi**
- **agl-demo-platform**

Customizing the Image

Konsulko Group

The quickest way to modify AGL image is to:

- Add new Yocto/OE layers to **conf/bblayers.conf**
- Expand the image through **conf/local.conf**, for example:

```
INSTALL_image_append = "lirc"
```

Contributing to AGL upstream

Konsulko Group

- **Report an issue or a new feature in JIRA**
- **Modify the source code**
- **Include references to the JIRA issue in the Git commit messages**
- **Contribute to the upstream following the AGL Gerrit workflow**

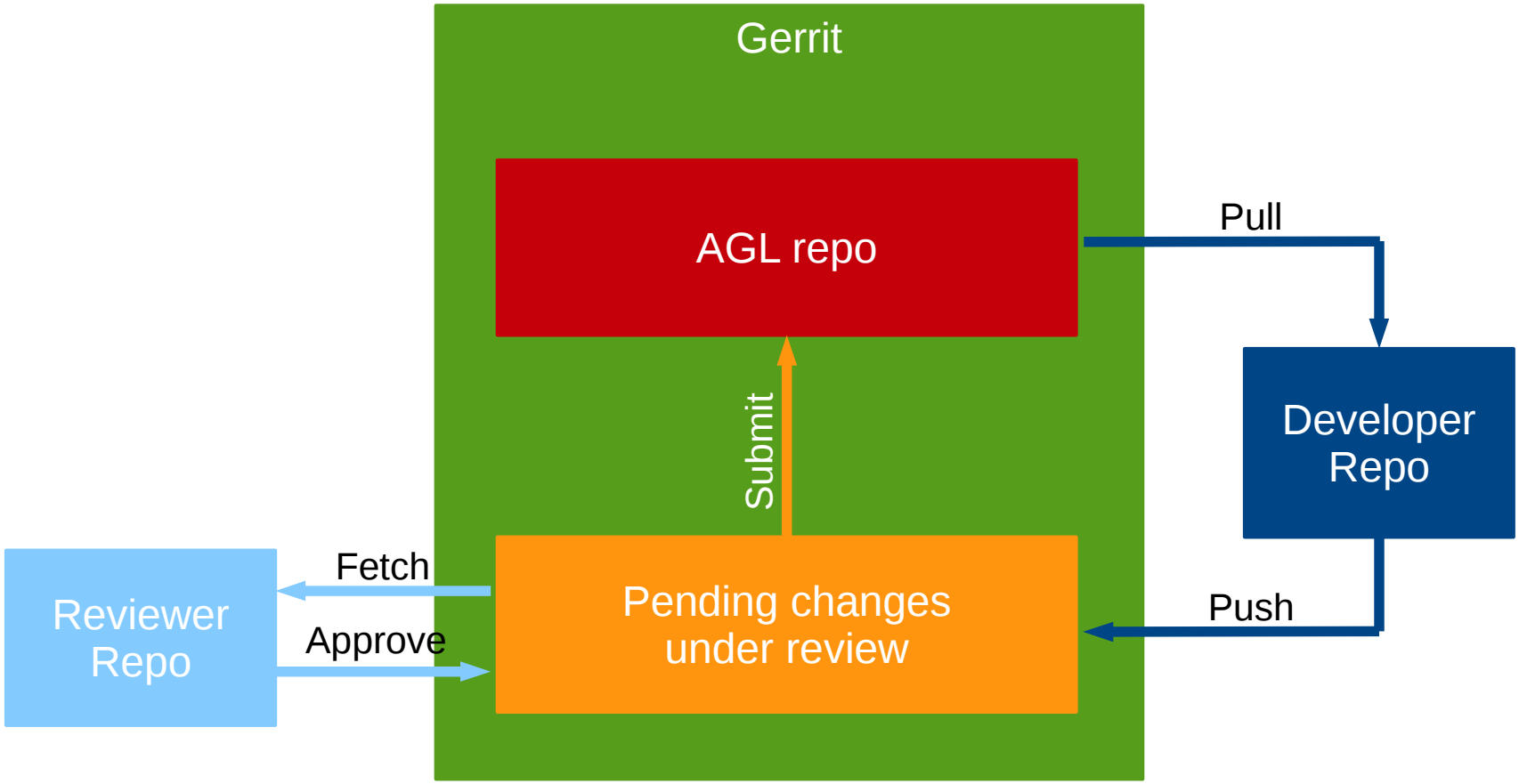
What is AGL Gerrit?

Konsulko Group

- **Gerrit is web-based team code collaboration tool for code reviews of Git repositories**
- **Gerrit is free and open source software written in Java and available under Apache License v2**
- **Create an account for AGL Gerrit at identity.linuxfoundation.org and get started**

AGL Gerrit Workflow

Konsulko Group



AGL Communication Channels

Konsulko Group

- **AGL mailing list**

  https://lists.linuxfoundation.org/mailman/listinfo/automotive-discussions

- **Weekly Developer Call**

  (Tuesday 14:00 - 15:00 UTC)

  https://wiki.automotivelinux.org/dev-call-info

- **IRC**

  channel #automotive on freenode.net

Conclusions

Konsulko Group

- **Open source is compressing the development cycle for a faster route to the market**
- **AGL is based on a top of already proven open source software technologies**
- **AGL is entirely open source project that offers an open source software stack useful not only to the automotive industry but also to various Internet of Things (IoT)**

What's next?

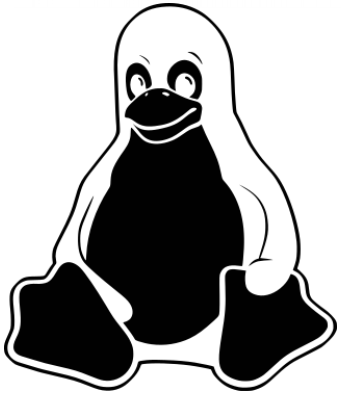
Konsulko Group

- **Designing using KiCAD an open source hardware Raspberry Pi add-on board for controlling the RC robot**

- **Releasing a stable final version of AGL Electric Eel 5.0.0 by the end of 2017**
- **Starting AGL Funky Flounder 6.0.0 at the beginning of 2018**

Thank You!

Konsulko Group



Useful links:

- http://docs.automotivelinux.org/
- https://wiki.automotivelinux.org/start
- https://wiki.automotivelinux.org/agl-distro/agl-raspberrypi
- https://github.com/leon-anavi/rpi-examples

- https://www.slideshare.net/leonanavi/building-a-remote-control-robot-with-automotive-grade-linux/