

Automotive Grade Linux on Raspberry Pi: How Does It Work?

onlinexperiences.com/scripts/Server.nxp

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

Q&A WITH SPEAKER SPEAKER BIO

VIDEO

Enter question here... NEW QUESTION

Automotive Grade Linux on Raspberry Pi: How Does It Work?

Leon Anavi / Konsulko Group

#ossummit

THE LINUX FOUNDATION

The screenshot shows a web-based video player interface. At the top, there are navigation links for the 'OPEN SOURCE SUMMIT' and 'Embedded Linux Conference' events. Below these are two tabs: 'Q&A WITH SPEAKER' (which is active) and 'SPEAKER BIO'. On the left side of the main video area, there is a white sidebar with a text input field labeled 'Enter question here...' and a button labeled 'NEW QUESTION'. The main video frame displays a presentation slide with a dark blue and purple abstract background. The slide features the 'OPEN SOURCE SUMMIT' logo and the title 'Automotive Grade Linux on Raspberry Pi: How Does It Work?'. Below the title, it lists the speakers: 'Leon Anavi / Konsulko Group'. At the bottom of the slide, there is a hashtag '#ossummit'. In the bottom right corner of the video frame, the 'THE LINUX FOUNDATION' logo is visible. The overall interface has a modern, clean design with a color scheme of red, purple, and black.



Q&A WITH SPEAKER SPEAKER BIO



Leon Anavi
Senior Software Engineer
Konsulko Group

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VIDEO

**Automotive Grade Linux on Raspberry Pi:
How Does It Work?**

Leon Anavi
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leon@anavi.org
Embedded Linux Conference North America 2020

Konsulko Group





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The video player interface shows a presentation slide with a green header and footer. The header features the Konsulko Group logo. The main content area contains a bulleted list of services:

- Services company specializing in Embedded Linux and Open Source Software
- Hardware/software build, design, development, and training services
- Based in San Jose, CA with an engineering presence worldwide
- <http://konsulko.com/>

At the bottom of the slide, the text reads "EiC NA 2020, Leon Anavi, Automotive Grade Linux on Raspberry Pi: How Does It Work?". In the bottom right corner of the video player, there is a small thumbnail of Leon Anavi's face.





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Agenda

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- Automotive Grade Linux
- Raspberry Pi
- Building an AGL image for Raspberry Pi
- Understanding how AGL works on Raspberry Pi
- Conclusions
- Q&A

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Automotive Grade Linux (AGL)

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



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The screenshot shows a video player interface for the Embedded Linux Conference North America. The title bar reads "AGL Members". The main content area displays logos of various AGL members, including DENSO, MAZDA, Panasonic, RENESAS, SUZUKI, TOYOTA, and HONDA. Below these, there are several rows of smaller logos representing various automotive and technology companies. A small video preview window in the bottom right corner shows a man, identified as Leon Anavi, speaking. The bottom of the screen has a green footer bar with the text "ELC NA 2020, Leon Anavi, Automotive Grade Linux on Raspberry Pi: How Does It Work?"





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VIDEO

AGL Core Technologies

Konsulko Group

Qt/QML HMI	HTML5	GStreamer
Weston with agl-shell-dekstop		
Wayland		
SOTA Updates: OSTree & Aktualizr		
PipeWire	Security	
systemd		AppFW, Cynagora, SMACK
Linux kernel		

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VIDEO

Yocto/OpenEmbedded Layers in AGL

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- poky
- meta-agl
- meta-agl-cluster-demo
- meta-agl-demo
- meta-agl-devel
- Meta-agl-extra
- meta-agl-telematics-demo
- meta-openembedded
- meta-security
- meta-virtualization
- meta-qt5
- meta-updater
- neta-spdxscanner
- meta-clang
- BSP layers: [meta-raspberrypi](#), [meta-intel](#), [meta-ti](#), [meta-renesas-rcar-gen3](#), [meta-sancloud](#), etc

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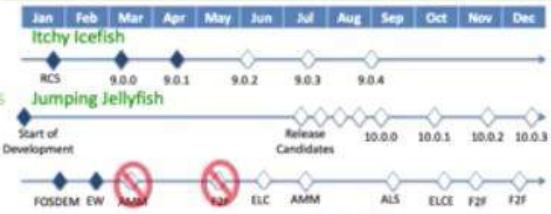
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AGL Releases

- Twice per year release cycle
- Releases are named on fishes
- Latest stable release is Itchy Icefish
- <https://wiki.automotivelinux.org/agl-distro/release-notes>
- <https://wiki.automotivelinux.org/schedule>

2020 AGL Schedule

As of 27 April 2020



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AGL Supported Devices



- Renesas R Car Starter Kit gen3 board
- Most Intel 64-Bit hardware platforms (including Minnowboard Max/Turbot)
- Quick EMULATOR (QEMU) or VirtualBox
- Raspberry PI 3 and 4
- Various supported ports and/or older AGL releases for multiple other hardware platforms: i.MX6, Dragonboard 410, TI Vayu, Renesas Porter, Intel Cyclone V, Raspberry Pi 2, etc.
- https://wiki.automotivelinux.org/agl-distro?#supported_hardware

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Raspberry Pi

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- Series of small single-board computers developed by the Raspberry Pi Foundation
- All models feature a Broadcom system on a chip (SoC) and ARM CPU
- Designed primary to promote teaching of basic computer science but also very popular in the maker community for hobby projects and demonstrations

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VIDEO

40,395 300 2044 Close Stream

Raspberry Pi Milestones

- 2009 - Raspberry Pi Foundation
- 2012 - The 1st Raspberry Pi
- 2014 - Raspberry Pi B+
- 2016 - Raspberry Pi Zero
- 2016 - Raspberry Pi 3
- 2016 - Raspberry Pi 3 B
- 2018 - Raspberry Pi 3 B+
- 2019 - Raspberry Pi 4 B

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AGL Raspberry Pi Milestones

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- 2015 - Mauro Chehab at that time working for Samsung OSG (Open Source Group) ported Tizen based on Yocto/OpenEmbedded to Raspberry Pi 2
- 2016 - GENIVI Dev Platform was ported to Raspberry Pi 2
- 2016 - AGL was ported to Raspberry Pi 2
- 2016 - Support for Raspberry Pi 3 was added in AGL
- 2019 - Support for Raspberry Pi 4 was added in AGL

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VIDEO

Building AGL for Raspberry Pi (1/2)



- Prepare Repo Tool:

```
mkdir -p ~/bin  
export PATH=~/bin:$PATH  
curl https://storage.googleapis.com/git-repo-downloads/repo > ~/bin/repo  
chmod a+x ~/bin/repo
```

- Download source code:

```
mkdir agl-rpi  
cd agl-rpi  
repo init -b master -u https://gerrit.automotivelinux.org/gerrit/AGL/AGL-repo  
repo sync
```

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VIDEO

Building AGL for Raspberry Pi (2/2)

Konsulko Group

- Set up build environment:

```
source meta-agl/scripts/aglsetup.sh -m raspberrypi4 agl-demo agl-appfw-smack
```

- Launch the build process:

```
bitbake agl-demo-platform
```

- The build from scratch takes a significant amount of the time depending on your Internet connection speed and the hardware capabilities of the build machine



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VIDEO

AGL Features and Raspberry Pi Models



- Supported Raspberry Pi models in the AGL master as of the moment:

raspberrypi4
raspberrypi3

- AGL features:

agl-demo
agl-appfw-smack
agl-sota
agl-netboot

`source meta-agl/scripts/aglsetup.sh -h`

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Q&A WITH SPEAKER SPEAKER BIO



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VIDEO

Flashing the Image on MicroSD Card

Konsulko Group

- Output Image location in build machine for Raspberry Pi 4:

```
tmp/deploy/images/raspberrypi4-64/agl-demo-platform-raspberrypi4-64.wic.xz
```

- Extract the wic.xz and flash it on a microSD card

```
sudo umount [sdcard device]
xzcat [output image] | sudo dd of=[sdcard device] bs=4M status=progress
sync
```

- Plug the microSD card in the Raspberry Pi and turn it on (the first boot of AGL takes a bit longer)

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VIDEO

Common AGL Images

Konsulko Group

- [agl-demo-platform](#)
- [agl-image-ivi - base for IVI targets](#)
- [Agl-cluster-demo-platform - cluster demo image](#)
- [agl-image-boot - just enough to boot](#)
- [agl-image-minimal - minimal filesystem with APIs](#)
- [agl-image-weston - minimal filesystem with Weston](#)

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VIDEO

Booting the image

Konsulko Group

- Serial output from AGL on raspberry Pi 4:

```
Automotive Grade Linux 9.90.0+snapshot raspberrypi4-64 ttyS0
raspberrypi4-64 login: root
raspberrypi4-64:~# uname -a
Linux raspberrypi4-64 4.19.115-v8 #1 SMP PREEMPT Tue Mar 10 00:00:00 UTC
2020 aarch64 aarch64 aarch64 GNU/Linux
```

- Serial baud rate: 115200

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VIDEO

The screenshot shows a video player interface for a presentation titled "AGL on Raspberry Pi 4 Screenshots". The video player has a green header bar with the title and a "Konsulko Group" logo. Below the header are three screenshots of the AGL interface on a Raspberry Pi 4. The first screenshot shows a home screen with various icons. The second screenshot shows a climate control interface with temperature controls set to 16°. The third screenshot shows a detailed AGL system information screen with text: "AGL: 9.90.0+snapshot-20200618 (jetson)" and "Kernel: 4.19.135-v8". At the bottom of the video player is a green footer bar with the text "EiC NA 2020, Leon Anavi, Automotive Grade Linux on Raspberry Pi: How Does It Work?". In the bottom right corner of the video player, there is a small video feed window showing Leon Anavi speaking.





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VIDEO

Weston on AGL

Konsulko Group

```
[[0;1;32m*[0m weston@display.service - Weston Wayland Compositor
 Loaded: loaded (/lib/systemd/system/weston@.service; static; vendor preset: disabled)
 Drop-In: /lib/systemd/system/weston@.service.d
 -weston-init.conf
 Active: [[0;1;32mactive (running)[0m since Tue 2020-03-10 00:01:47 UTC; 3 months 9 days ago
 Main PID: 768 (weston)
 Tasks: 1 (limit: 1703)
 Memory: 28.8M
 CGrou... /system.slice/system-weston.slice/weston@display.service
 -768 /usr/bin/weston --idle-time=0 --tty=7 -log=/run/platform/display/weston.log

 Mar 10 00:01:46 raspberrypi4-64 systemd[1]: Starting Weston Wayland Compositor...
 Mar 10 00:01:47 raspberrypi4-64 systemd[1]: Started Weston Wayland Compositor.
```

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VIDEO

Supported Raspberry Pi Peripherals in AGL



- HDMI monitors
- Raspberry Pi official 7" touchscreen display
- WiFi
- Bluetooth
- Various 3rd party add-on boards and HATs

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Q&A WITH SPEAKER SPEAKER BIO



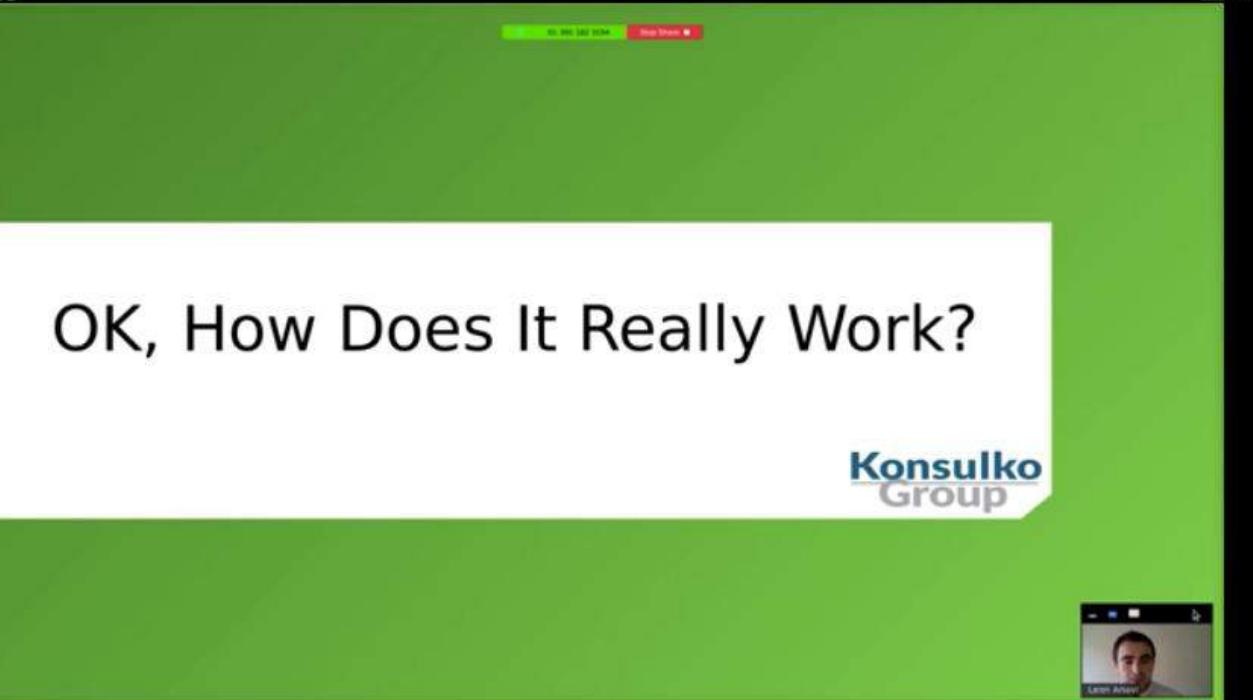
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VIDEO



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VIDEO

The Yocto Project

Konsulko Group

- Open source collaborative project of the Linux foundation for creating custom Linux-based systems for embedded devices using the OpenEmbedded Build System
- OpenEmbedded Build System includes BitBake and OpenEmbedded Core
- Poky is a reference distribution of the Yocto Project provided as metadata, without binary files, to bootstrap your own distribution for embedded devices
- Bi-annual release cycle

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VIDEO

Yocto Project Releases

Codename	Version	Release Date	Support Level
Gatesgarth	3.2	Oct 2020	Dreaming
Dunfell	3.1	April 2020	Long Term Stable
Zeus	3.0	October 2019	Stable
Warrior	2.7	April 2019	Stable
Thud	2.6	Nov 2018	Stable
Sumo	2.5	April 2018	Community
Rocko	2.4	Oct 2017	Community

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VIDEO

AGL Repo Manifests



- As of today `default.xml` is based on Yocto release Dunfell:

```
<project name="poky" path="external/poky" remote="yocto"  
revision="a44b8d2856a937ca3991cbf566788b0cd541d777" upstream="dunfell" />  
<project name="meta-gplv2" path="external/meta-gplv2" remote="yocto"  
revision="60b251c25ba87e946a0ca4cdc8d17b1cb09292ac" upstream="dunfell" />  
<project name="openembedded/meta-openembedded" path="external/meta-openembedded" remote="github"  
revision="b1aa5f785094d25765657f1df7db0748680ae7fb" upstream="dunfell" />
```

- Use other manifest from AGL/AGL-repo for a specific AGL release:
`icefish_9.0.0.xml`, `halibut_8.0.6.xml`, `guppy_7.0.4.xml`, etc.

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VIDEO

00:00:00:000
Stop Stream

meta-raspberrypi

- General Yocto/OpenEmbedded Board Support Package (BSP) layer for the Raspberry Pi boards
- Depends on layers from meta-openembedded: meta-oe, meta-multimedia, meta-networking, meta-python
- Provides specific variables as knobs to enable/disable hardware specific features: `ENABLE_I2C`, `ENABLE_SPI_BUS`, `RPI_USE_U_BOOT`, `ENABLE_UART`, etc.
- For AGL `VC4DTBO` must be set to `vc4-fkms-v3d` to support Wayland, Weston and the apps on both HDMI and the official Raspberry Pi 7" touch screen display

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VIDEO

meta-raspberrypi

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- New features and bug fixes are accepted as GitHub pull requests: <https://github.com/agherzan/meta-raspberrypi>
- Maintained by Andrei Gherzan with more than 90 contributors
- Documentation: <https://readthedocs.org/projects/meta-raspberrypi/>

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Q&A WITH SPEAKER SPEAKER BIO



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VIDEO

Meta-raspberrypi in AGL



- Script `meta-agl/scripts/aglsetup.sh` for Raspberry Pi initializes the build environment with `conf/local.conf` and `conf/bblayers.conf`
- Yocto/OE layer `meta-agl/meta-agl-bsp` contains sub-layers with AGL hardware specific configurations
- Configurations from `conf/include/agl_raspberrypi4.inc` or `conf/include/agl_raspberrypi3.inc` are automatically included in `conf/local.conf` depending on the targeted Raspberry Pi model

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VIDEO

AGL on Raspberry Pi 4

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- Uses U-Boot as a bootloader
- GPU memory is set to 256MB
- UART is enabled
- Includes kernel modules
- Includes WiFi and Bluetooth firmware

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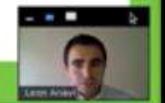
VIDEO

Software Over the Air (SOTA) Updates



- The **agl-sota** feature enables support for software over the air (SOTA) updates in AGL images
- Libostree (OSTree) and Aktualizr provide a "git-like" model for committing, downloading and automated provisioning of bootable filesystem trees to a fleet of vehicles
- Yocto/OE layers meta-updater and meta-updater-raspberrypi provide the SOTA implementation for AGL on Raspberry Pi
- For more details:
<https://wiki.automotivelinux.org/subsystem/agl-sota/ostree>
<https://docs.ota.here.com/getstarted/dev/raspberry-pi.html>

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VIDEO

AGL Developer Tools



- Git & Repo
- Gerrit <https://gerrit.automotivelinux.org/>
- GitHub <https://github.com/automotive-grade-linux>
- JIRA <https://jira.automotivelinux.org/>
- Wiki <https://wiki.automotivelinux.org/>
- Documentation <http://docs.automotivelinux.org/>
- Jenkins for CI and Lava + Fuego for running test

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VIDEO

AGL Gerrit

- Free and open source web-based team code collaboration tool for code reviews
- Create an account at identity.linuxfoundation.org to get started
- <https://gerrit.automotivelinux.org/>

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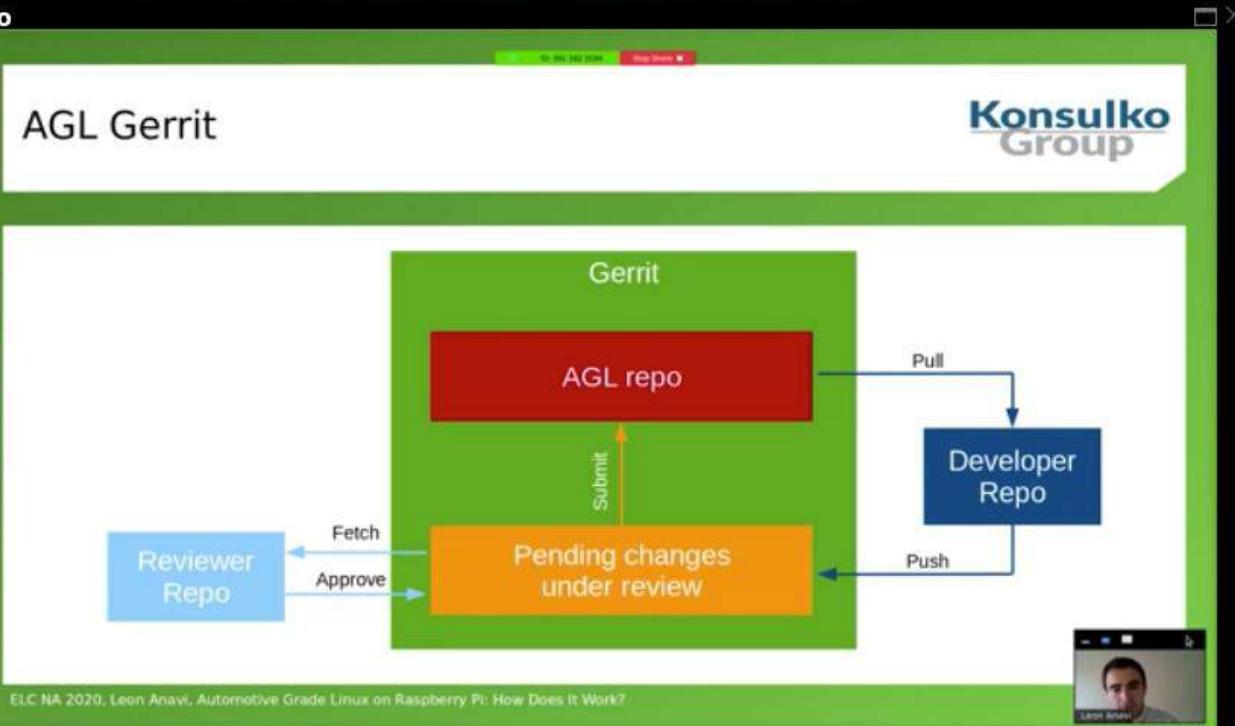
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VIDEO

Merged Change in AGL Gerrit

Konsulko Group

Gerrit CHANGES YOUR DOCUMENTATION BROWSE LEON ANAVI REVERT

Merged as g8f9814 22872: agl_raspberrypi3.inc: Switch to firmware KMS

Updated Nov 07, 2019 Owner Leon Anavi Assignee Set assignee... Reviewers Jan-Simon Moeller, Walt Miner, Tadao Tanikawa, AND 8 MORE ADD REVIEWER CC ADD CC Repo AGL/meta-agl Branch halibut Parent 0af20f5 Topic No topic Hashtags ADD HASHTAG

REPLY

agl_raspberrypi3.inc: Switch to firmware KMS

Switch to firmware KMS with appropriate Linux kernel and Mesa versions to support both HDMI and the official 7" Raspberry Pi touch screen display on Raspberry Pi 3B+ and 4. Device tree changes are not required for firmware KMS.

Bug-AGL: SPEC-2465

Change-ID: 15fbff62c8151b7eb79ab1f96419d9c62469a1554e Signed-off-by: Leon Anavi <leon.anavi@konsulko.com>

Relation chain

- raspberrypi450_local.conf.inc: Update... (Merged)
- agl_raspberrypi3.inc: Switch to firmware... (Merged)
- bcm2835-bootfiles.bbappend: Update... (Merged)
- linux-raspberrypi_4.19.bb: Update to 4... (Merged)
- rpi-config: Set max_framebuffers to 21... (Merged)

Submitted together

- AGL/meta-agl: halibut: agl_raspberrypi450_local.conf.inc: Update... (Merged)
- AGL/meta-agl: halibut: agl_raspberrypi3.inc: Set max_framebuffers to 21... (Merged)
- AGL/meta-agl: halibut: bcm2835-bootfiles.bbappend: Update... (Merged)
- AGL/meta-agl: halibut: linux-raspberrypi_4.19.bb: Update to 4... (Merged)
- AGL/meta-agl: halibut: rpi-config: Set max_framebuffers to 21... (Merged)

Cherry picks

- master: agl_raspberrypi3.inc: Switch to firmware KMS

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VIDEO

AGL Communication Channels



- AGL mailing list
<https://lists.automotivelinux.org/g/agl-main>
- Weekly Developer Call
(Tuesday 14:00 - 15:00 UTC)
<https://wiki.automotivelinux.org/dev-call-info>
- IRC
channel #automotive on freenode.net

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Conclusion
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- Automotive Grade Linux is a collaborative open source project that is bringing together automakers, suppliers and technology companies to accelerate the development and adoption of a fully open software stack based on Linux for the connected car.
- Raspberry Pi is a community supported hardware platform compatible with AGL that is useful for getting started and proof of concept demonstrations.
- Join Automotive Grade Linux by contributing to the development, testing and/or the documentation of the project!

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Thank You!

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Useful links:

- <https://www.automotivelinux.org/>
- <https://docs.automotivelinux.org/>
- <https://wiki.automotivelinux.org/agl-distro/agl-raspberrypi>
- Pre-built binary images:
https://wiki.automotivelinux.org/agl-distro?&#supported_hardware

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