HOW WE RUN AGL
ON I.MX PROCESSORS?

SCALABLE I.MX PROCESSOR OVERVIEW
AND INSTRUCTION TO BUILD AGL

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SECURE CONNECTIONS
FOR A SMARTER WORLD

I.MX PROCESSORS

i.MX Application Processors Core Values

- **Scalability**
  - CPU (single/dual/quad, asymmetric), GPU, I/O
  - Software: Linux, Android, QNX, Windows-embedded, RTOS
  - Industry-leading ecosystem and partnerships
  - Pin compatibility and software portability

- **Integration**
  - Automotive/Industrial/Consumer peripheral sets
  - Qualifications: AEC-Q100, JEDEC Industrial and Consumer
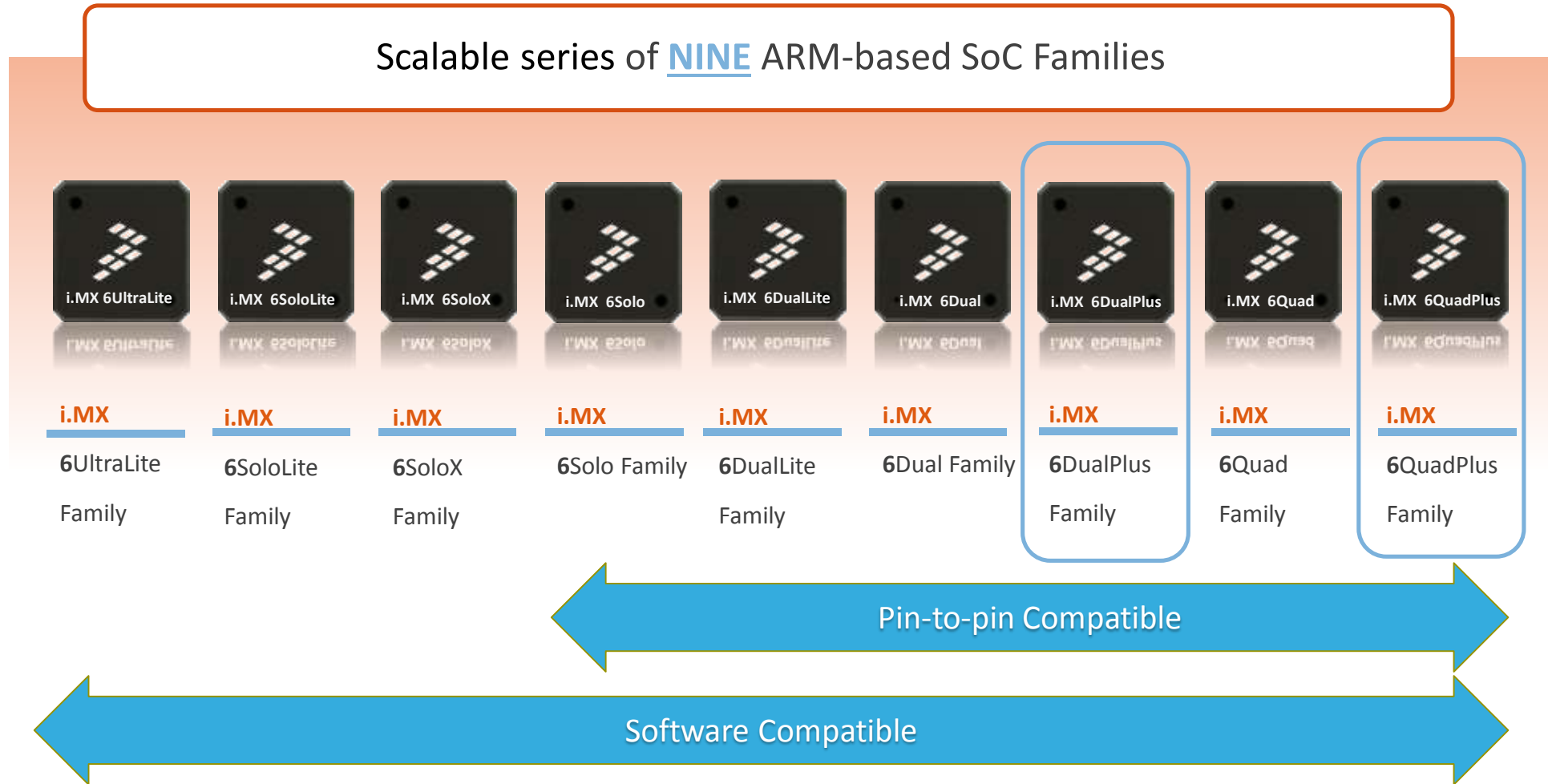
- **Trust**
  - Market knowledge/expertise in industrial, consumer and automotive
  - Longevity: minimum of 10-15 years in all markets
  - Consistency of supply, product availability
  - Quality, robustness, zero-defect methodology
  - Security and safety

- **Ease of Adoption**
  - Communities, innovation, support
  - Design collateral, distribution
  - System solutions: SoC, sensors, PMIC, IoT comms, SBC

i.MX 6 Series: Supreme Scalability and Flexibility
Leverage One Design Into Diverse Product Portfolio

Scalable series of **NINE** ARM-based SoC Families

i.MX 6UltraLite	i.MX 6SoloLite	i.MX 6SoloX	i.MX 6Solo	i.MX 6DualLite	i.MX 6Dual	i.MX 6DualPlus	i.MX 6Quad	i.MX 6QuadPlus
i.MX	**i.MX**	**i.MX**	**i.MX**	**i.MX**	**i.MX**	**i.MX**	**i.MX**	**i.MX**
6UltraLite Family	**6**SoloLite Family	**6**SoloX Family	**6**Solo Family	**6**DualLite Family	**6**Dual Family	**6**DualPlus Family	**6**Quad Family	**6**QuadPlus Family

← Pin-to-pin Compatible →

← Software Compatible →

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i.MX 6 At a Glance

Red indicates change from column to the left

i.MX 6 UltraLite
- Single ARM® Cortex®-A7 up to 528 MHz
- 128 KB L2 cache, NEON™, VFP, TrustZone®
- X16 LPDDR2, DDR3/LV-DDR3
- 2X 10/100 Mb/s + IEEE 1588
- 2X 12-bit ADC (1 with resistance touch control)
- 10/100 Ethernet MAC

i.MX 6 SoloLite
- Single ARM, Cortex-A9 up to 1.0 GHz
- 256 KB L2 cache, NEON, VFPvd16 TrustZone
- 2D graphics
- 32-bit DDR3 and LPDDR2 at 400 MHz
- Integrated EPD controller
- 10/100 Ethernet MAC

i.MX 6 SoloX
- Single Cortex-A9 up to 1.0 GHz
- Single Cortex®-M4 up to 200 MHz
- 256 KB L2 cache, NEON, VFP, TrustZone
- 3D and 2D graphics
- 32-bit DDR3 and LPDDR2 at 400 MHz
- Dual Gigabit Ethernet MAC w/ hardware AVB support
- PCIe® controller plus PHY
- LVDS controller plus PHY
- Analog camera interface
- 8-channel, 12-bit ADC
- MLB and FlexCAN controllers

i.MX 6 Solo
- Single Cortex-A9 up to 1.0 GHz
- 512 KB L2 cache, NEON, VFPvd16 TrustZone
- 3D graphics with one shader
- 2D graphics
- 32-bit DDR3 and LPDDR2 at 400 MHz
- Gigabit Ethernet MAC
- Integrated EPD controller
- HDMIv1.4 controller plus PHY
- LVDS controller plus PHY
- PCIe controller plus PHY
- MLB and FlexCAN controllers

i.MX 6 DualLite
- Dual Cortex-A9 up to 1.0 GHz
- 512 KB L2 cache, NEON, VFPvd16 TrustZone
- 3D graphics with one shader
- 2D graphics
- 64-bit DDR3 and 2-channel 32-bit LPDDR2 at 400 MHz
- Gigabit Ethernet MAC
- Integrated EPD controller
- HDMIv1.4 controller plus PHY
- LVDS controller plus PHY
- PCIe controller plus PHY
- MLB and FlexCAN controllers

i.MX 6 Dual
- Dual Cortex-A9 up to 1.2 GHz
- 1 MB L2 cache, NEON, VFPvd16 TrustZone
- 3D graphics with four shaders
- Two 2D graphics engines
- 64-bit DDR3 and 2-channel 32-bit LPDDR2 at 533 MHz
- Gigabit Ethernet MAC
- Integrated SATA-II
- HDMIv1.4 controller plus PHY
- LVDS controller plus PHY
- PCIe controller plus PHY
- MLB and FlexCAN controllers

i.MX 6 DualPlus
- Dual Cortex-A9 up to 1.2 GHz*
- 1 MB L2 cache, NEON, VFPvd16 TrustZone
- Enhanced 3D graphics with four shaders
- Enhanced Two 2D graphics engines
- Prefetch & Resolve Engine
- Gigabit Ethernet MAC
- Optimized 64-bit DDR3 and 2-channel 32-bit LPDDR2 at 533 MHz
- Integrated SATA-II
- HDMIv1.4 controller plus PHY
- LVDS controller plus PHY
- PCIe controller plus PHY
- MLB and FlexCAN controllers

i.MX 6 Quad
- Quad ARM, Cortex-A9 up to 1.2 GHz
- 1 MB L2 cache, NEON, VFPvd16 TrustZone
- 3D graphics with four shaders
- Two 2D graphics engines
- 64-bit DDR3 and 2-channel 32-bit LPDDR2 at 533 MHz
- Gigabit Ethernet MAC
- Integrated SATA-II
- HDMIv1.4 controller plus PHY
- LVDS controller plus PHY
- PCIe controller plus PHY
- MLB and FlexCAN controllers

i.MX 6 QuadPlus
- Quad Cortex-A9 up to 1.2 GHz*
- 1 MB L2 cache, NEON, VFPvd16 TrustZone
- Enhanced 3D graphics with four shaders
- Enhanced Two 2D graphics engines
- Prefetch & Resolve Engine
- Gigabit Ethernet MAC
- Optimized 64-bit DDR3 and 2-channel 32-bit LPDDR2 at 533 MHz
- Integrated SATA-II
- HDMIv1.4 controller plus PHY
- LVDS controller plus PHY
- PCIe controller plus PHY
- MLB and FlexCAN controllers

Consumer   Industrial   Automotive

* 1.0 GHz available now. For 1.2 GHz, contact NXP for availability

i.MX 6QuadPlus / i.MX 6Dual Plus Applications Processor

Multiple fabric and IP changes to improve the overall memory and graphics performance while minimizing software changes.

- **Key Features:**

  - Updated 3D, 2D and OpenVG GPUs

  - New pre-fetch and resolve modules to improve IPU / display efficiency

  - Fabric modifications to improve memory bandwidth

  - Pin compatible with existing i.MX 6Dual/6Quad processors

  - Multiple i.MX 6Dual/6Quad errata fixes

i.MX 6QuadPlus/DualPlus Block Diagram

Specifications

- **CPU:**
  i.MX 6QuadPlus**:** 4x Cortex-A9 @ 800MHz/852MHz/1GHz/1.2 GHz*
  i.MX 6DualPlus: 2x Cortex-A9 @ 800MHz/852MHz/1GHz/1.2 GHz*

- **Process:** 40nm

- **Package:** 21x21 0.8mm Flip-chip BGA

- **Temp Range (Tj):**

  – Auto -40 to 125C

  – Industrial -40 to 105C

  – Extended Commercial -20 to 105C

- **Qual Tiers:** Commercial, Automotive, Industrial
- **Pin compatible with i.MX 6Quad and i.MX 6Dual**

- Up to 11,520 DMIPS
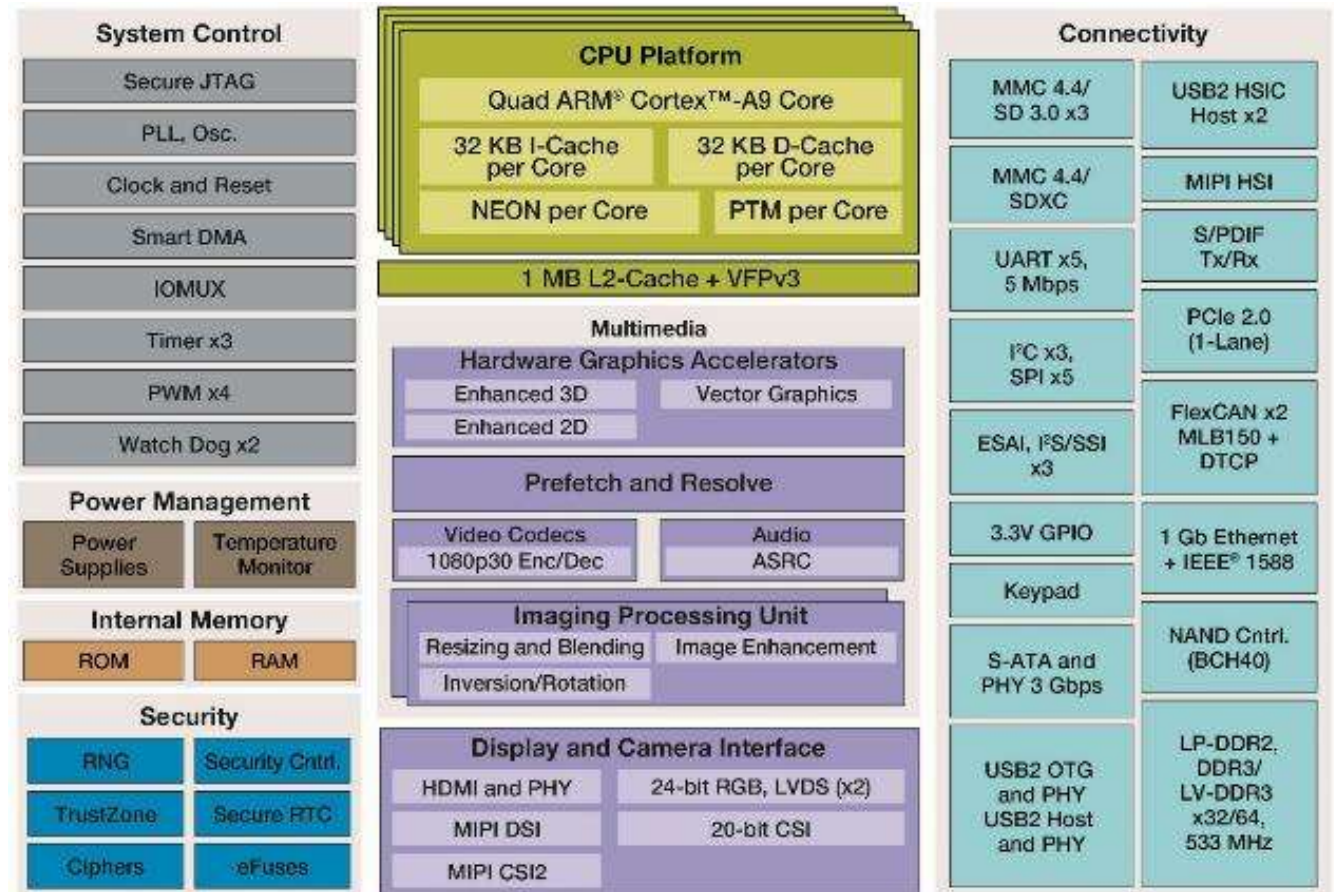
* 1.0 GHz available now. For 1.2 GHz, contact NXP for availability

i.MX 6DualPlus/i.MX 6QuadPlus Target Applications

Automotive

- Infotainment
- Instrument Clusters

Smart Devices

- Aerospace / Defense
- Digital Signage
- Health Care – patient monitoring, fitness equipment
- Factory, process and building automation (gateways, surveillance, HMI)
- Home entertainment, appliances
- Media Streaming
- Transportation - industrial vehicle with control & HMI, e.g. tractor, train, ship, heavy equipment

REFERENCE BOARD AND BSP

SABRE Platform for Auto Infotainment (AI)

CPU Card Details

Power and Memory
- NXP PF-Series PMIC
- 2 GB DDR3 memory (i.MX 6Dual/Quad/DualPlus/QuadPlus)
- 1GB DDR3 memory (i.MX 6Solo)
- 32GB Parallel NOR Flash
- NAND Socket

Display
- LVDS connector
  – Compatible with MCIMX-LVDS1
- Parallel RGB display interface
- HDMI output connector

Debug
- JTAG connector
- Debug UART connector

Connectivity and Expansion
- SD Card Slot
- High Speed USB OTG
- Ethernet
- SATA
- MIPI CSI
- PCIe
- MLB150 INIC connector
- 281-pin MXM card edge connector for main board expansion

SABRE AI boards will only be supported at automotive customers

Part Numbers

Base Board: MCIMXABASEV1 ($699)
CPU Cards: MCIMX6DLAICPU2 ($799)
MCIMX6QAICPU2 ($799)
MCIMX6QPAICPU3 ($799)
Display: MCIMX-LVDS1 ($499)

Base Board Details

Connectivity and Expansion
- SD card slot (WiFi module or SD)
- Bluetooth or Bluetooth+WiFi header
- AM/FM tuner header
- Sirius XM Module header (de-pop''d)
- GPS (UART) module connector
- 2x CAN
- Dual High Speed USB Host connectors
- MLB 25/50 INIC connector
- SPI NOR flash

Display I/O
- LVDS connector
  – Compatible with MCIMX-LVDS1
- Analog Video Input
- LVDS Input

Audio
- Cirrus multichannel audio codec
  – Up to 8 outputs
  – Dual microphone inputs
  – Stereo Line Level Input
- SPDIF receiver

OS Support
- Linux, Android (internal)
- Others: future support by 3rd parties

i.MX6 Single Board Computers

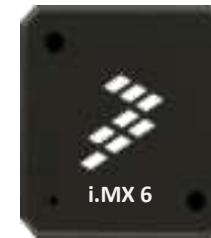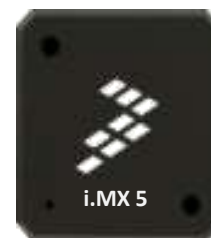- There are many choices to use i.MX based SBC, with development environments

Leadership Software - i.MX Linux Enablement

- **Silver Member of Linux Foundation**
- **AGL Working Group Bronze Member**

THE LINUX FOUNDATION
Silver Member

yocto PROJECT
PARTICIPANT

GENIVI

Over the past 15 years shipping i.MX application processors...

i.MX 2   i.MX 3   i.MX 5   i.MX 6

39,000+ Linux Downloads

Multiple i.MX 6 Series customer engagements are using GENIVI Solutions

Freescale has more compliant platforms than ANY semiconductor vendor

Reference: http://www.genivi.org/compliant-products

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BUILDING AGL BSP

Download the NXP BSP source

- I use "imx-3.14.38-6QP_ga" tags for build.
  - With this release, BSP uses weston 1.8.0 and less compatibility issues.

```
$: mkdir fsl-arm-yocto-agl
$: cd fsl-arm-yocto-agl
$: repo init -u git://git.freescale.com/imx/fsl-arm-yocto-bsp.git -b imx-3.14.38-6QP_ga
$: repo sync
```

- Checkout meta-agl layers under sources directory

```
$: cd sources/
$: git clone -b albacore https://git.automotivelinux.org/gerrit/AGL/meta-agl
$: git clone -b albacore https://git.automotivelinux.org/gerrit/AGL/meta-agl-demo
```

  - To minimize compatibility issue, I use "albacore" branch when checking out
  - Some bbappend would cause issue while bitbake, and need to rename/remove these files

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Set up directory and configuration files

- To set up directory and configuration files for SABREAICPU3(i.MX 6QP) board
  - To use wayland, add "-e wayland" to use wayland backend for frame buffers

```
$: MACHINE=imx6qpsabreauto source ./fsl-setup-release.sh -b build-agl-wayland -e wayland
```

Fixing missing layers

- Need to add meta-agl layers besides NXP's layers
  - Modify "bblayers.conf" under conf directory as below

```
--- bblayers.conf.org      2016-02-16 11:42:43.867306944 +0900
+++ bblayers.conf          2016-02-03 19:03:48.996044538 +0900
@@ -25,3 +25,9 @@
 BBLAYERS += " ${BSPDIR}/sources/meta-openembedded/meta-ruby "
 BBLAYERS += " ${BSPDIR}/sources/meta-openembedded/meta-filesystems "
 BBLAYERS += " ${BSPDIR}/sources/meta-qt5 "
+##AGL layers
+BBLAYERS += " ${BSPDIR}/sources/meta-agl/meta-agl "
+BBLAYERS += " ${BSPDIR}/sources/meta-agl/meta-agl-bsp "
+BBLAYERS += " ${BSPDIR}/sources/meta-agl/meta-ivi-common "
+BBLAYERS += " ${BSPDIR}/sources/meta-agl-demo "
```

Tuning configuration for AGL build

- Need to add some configuration at local.conf

  - Add necessary information from meta-agl/meta-agl/conf/distro/poky-agl.conf to local.conf (under investigation, not fully verified)

```
+# To use systemd as init mamanger
+PREFERRED_PROVIDER_udev ?= "systemd"
+PREFFERED_PROVIDER_udev-utils ?= "systemd"
+VIRTUAL-RUNTIME_init_manager = "systemd"
+VIRTUAL-RUNTIME_initscripts = ""
+# Need to add to fix parse error while bitbake. Need to investigate right settings
+export systemd_system_unitdir = "${nonarch_base_libdir}/systemd/system"
+export nonarch_libdir = "${exec_prefix}/lib"
+export systemd_user_unitdir = "${nonarch_libdir}/systemd/user"
+# Override these in poky based distros
+AGL_DEFAULT_DISTRO_FEATURES = "systemd opengl wayland pam bluetooth bluez5"
+AGL_DEFAULT_EXTRA_RDEPENDS = "packagegroup-core-boot"
+AGL_DEFAULT_EXTRA_RRECOMMENDS = "kernel-module-af-packet"
+DISTRO_FEATURES ?= "${DISTRO_FEATURES_DEFAULT} ${DISTRO_FEATURES_LIBC} ${AGL_DEFAULT_DISTRO_FEATURES}"
+DISTRO_FEATURES_remove = "x11"
+DISTRO_FEATURES_BACKFILL_CONSIDERED = "sysvinit"
+DISTRO_EXTRA_RDEPENDS += " ${AGL_DEFAULT_EXTRA_RDEPENDS}"
+DISTRO_EXTRA_RRECOMMENDS += " ${AGL_DEFAULT_EXTRA_RRECOMMENDS}"
+# To fix missing files under rootfs
+IMAGE_INSTALL_append = " weston-init weston-ivi-shell-config"
+# set the perferred version to GST1.4
+PREFERRED_VERSION_gstreamer1.0 ?= "1.4.%"
+PREFERRED_VERSION_gstreamer1.0-plugins-bad ?= "1.4.%"
+PREFERRED_VERSION_gstreamer1.0-plugins-base ?= "1.4.%"
+PREFERRED_VERSION_gstreamer1.0-plugins-good ?= "1.4.%"
+PREFERRED_VERSION_gstreamer1.0-plugins-ugly ?= "1.4.%"
+PREFERRED_VERSION_gstreamer1.0-libav ?= "1.4.%"
+PREFERRED_VERSION_gstreamer1.0-omx ?= "1.2.%"
```

To fix error while bitbake

- Need to rename/remove or BBMASK in conf below files to avoid error with AA AGL layer
  - meta-agl/meta-agl/recipes-graphics/wayland/weston_1.5.0.bbappend
  - meta-agl/meta-ivi-common/recipes-graphics/wayland/weston_1.5.0.bbappend
  - meta-agl-demo/recipes-graphics/wayland/weston_1.5.0.bbappend
  - meta-agl-demo/recipes-qt/qt5/qtwayland_%.bbappend(Need to regenerate patch)
  - meta-agl-demo/recipes-connectivity/bluez5/bluez5_%.bbappend

- Need to modify header files to avoid error while wayland-ivi-extension compilation
  - Need to add -DLINUX -DEGL_API_FB -DWL_EGL_PLATFORM to fix unrecognized platform error while compilation
  - Currently manually modified while do_compile, but need to create patch for bb file

bitbake! and flashing images to SD card

- Building AGL images

  ```
  $: bitbake agl-image-minimal
  $: bitbake agl-image-ivi
  $: bitbake agl-image-weston
  $: bitbake agl-demo-platform
  ```

- Flashing an SD card image resides in <build dir>/tmp/deploy/images

  ```
  $: dd if=<image name>.sdcard of=/dev/sd<partition> bs=1M && sync
  ```

Current status and observations at this point

- Qt3D(QML), and wayland/weston with 3D GPU works fine.
  - CES2016 demo works well without any modification with desktop-shell
- Multimedia functions has not been fully checked. (lightmediascanner, rygel, etc)
- "systemd" has not fully verified with current NXP BSP?
  - serial-getty doesn't run after boot (due to recent systemd libudev-monitor.c changes?)
- Most of issues are around Wayland/Weston, and ivi-shell
  - Compilation error at ivi-shell-integration of qtwayland (under investigation, currently masked)
  - Compilation error while compile ivi-shell examples (Need to add patch to cmake configuration, and also manually patched to some files, due to vivante egl header files specific requirements)
  - Ivi-shell and its demos works, but need to investigate further for running CES demo on ivi-shell
  - I used to use AGL master branch, but currently to use albacore branch to minimize these issues.

Demo movies

- Boot console (asciinema1 as of end of Dec 2015/asciinema2 as of mid of Feb 2016)

- CES2016 AGL demo (on i.MX 6QP, 1080x1920 portrait screen)
- IVI shell and example applications (on i.MX6 QP, 1920x1080 landscape screen)
- 3D IVI demo (on i.MX 6QP, 1920x1080, Wayland backend w/OpenGLES+2D GPU)
  - 3D IVI application preview, designing with authoring tool which supports wayland
- 3D graphic cluster demo (on i.MX 6QP, 1920x1080, frame buffer backend w/OpenGLES)
  - 3D graphic cluster application preview, designing with authoring tool

- AGL boot on (on i.MX 6SoloX, 1024x768)
  - Built AGL with same BSP for low-end device, GPU shader performance is 1/8 of 6QP. Running same application with low resolution, low frame rate

Conclusion and future support plan for AGL

- NXP start to investigate AGL on i.MX 6 series and continue to work
  - NXP already provided Yocto based BSP to all i.MX processors
  - NXP provides reference boards for automotive customers, also many SBCs with i.MX processors
  - We can support AGL on i.MX processors with relatively small effort, but…
    - Currently, NXP BSP uses Yocto 1.8(fido), but AGL expects Yocto 1.7(dizzy), and it would cause some issues.

- NXP are discussing how to broaden AGL involvement for next generation i.MX
  - Both NXP and AGL layers will move to Yocto 2.0(Jethro)
  - This would make easy to support AGL with NXP BSP