

# Tinker board

IoT를 위한 최선의 엣지 단말기



MAKER SPACE  
**G·CAMP**

# Contents

- MIPI
- 카메라
- LTE
- SoftAP

# MIPI

Mobile Industry Processor Interface(MIPI)의 약자

-> 모바일 산업에서 활용되는 시스템

인텔, ARM, 노키아, 삼성, STM, TI가 2003년에 모여서 MIPI(Mobile Industry Processor Interface) 얼라이언스를 설립

기능: 저전력 설계로 표준화를 만들고 이를 통해 제품 복잡성을 낮추고 제품의 호환성도 높이기 위해 준비된 기술

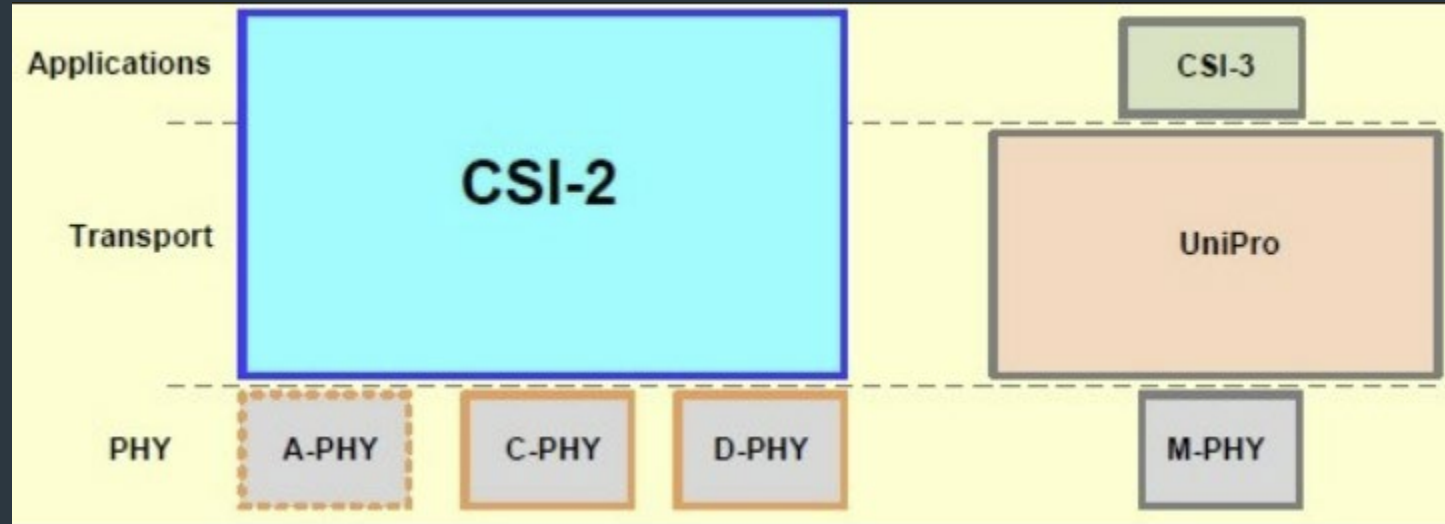
MIPI에서 만든 대표적인 인터페이스가 DSI와 CSI

DSI(Display Serial Interface)는 AP와 LCD와 같은 디스플레이를 연결하는 인터페이스에 관한 표준이고

CSI(Camera Serial interface)는 AP와 카메라를 연결하는 인터페이스에 관한 표준

MIPI는 레인이란 개념으로 레인 개수로 속도가 나뉨

# MIPI



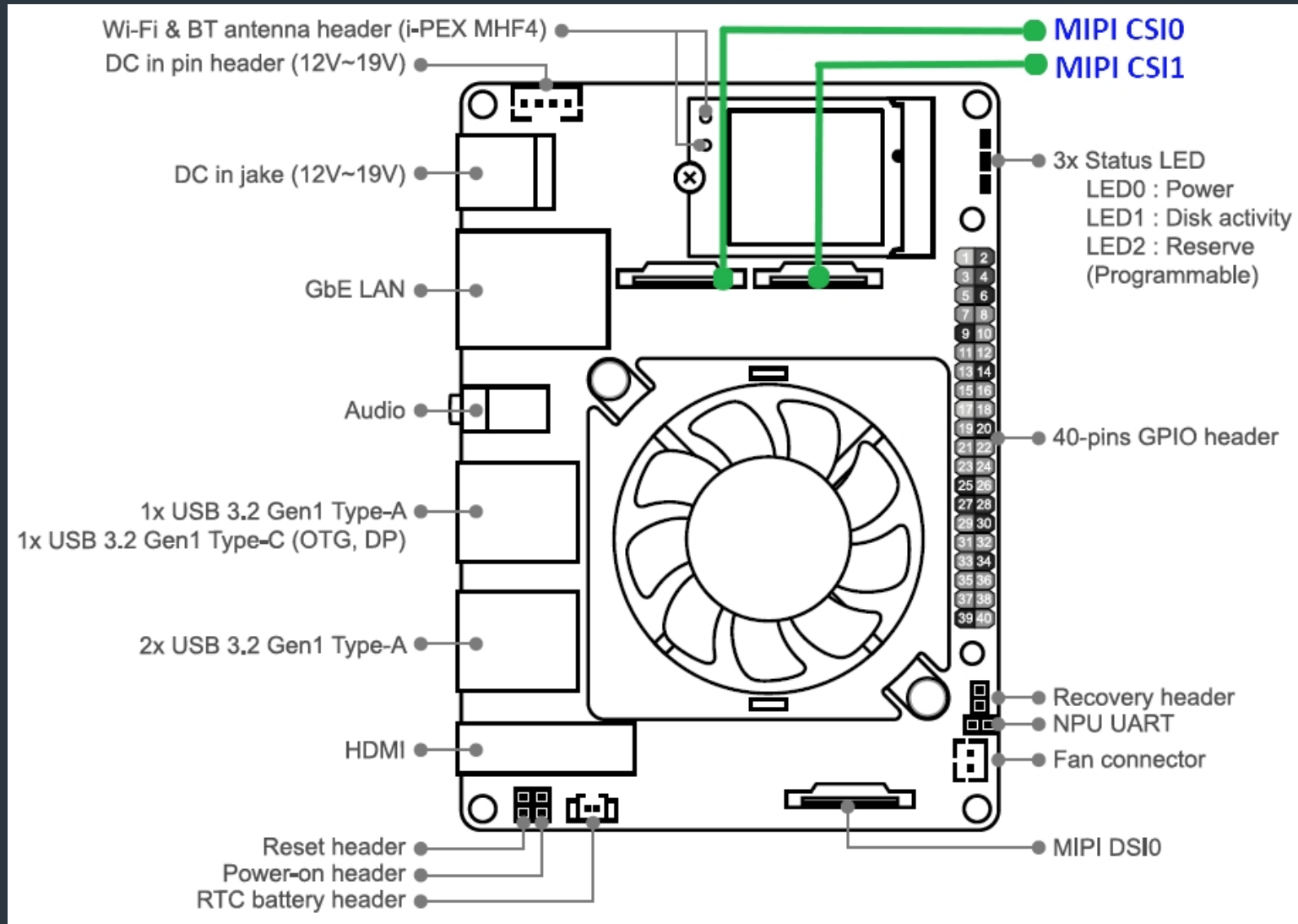
MIPI는 OSI 7 layer 중 MIPI는 전체 7 Layer를 다 사용  
물리계층 -> C-PHY와 D-PHY, M-PHY  
프로토콜 계층 -> CSI, DSI

2009년에 D-PHY란 카메라와 디스플레이간 물리 인터페이스 정의  
2009년에 M-PHY는 RF모듈, 스토리지, 멀티미디어 데이터 관련 부품들간 물리 인터페이스 정의  
2009년에 C-PHY는 카메라와 디스플레이간 인터페이스를 D-PHY를 개선하여 만듦

MIPI는 최대 4개까지의 데이터 레인으로 구성 가능

최근 MIPI는 C-PHY를 주로 사용하며,  
C-PHY는 전송속도를 클럭이 아닌 초당 심볼수로 나타내는데 심볼당 데이터는 2.28비트  
레인당 2.5Gsym/s가 가능하므로  $2.5 \times 2.28 = 5.7\text{Gbps}$ 가 되어 4개 레인이면 22.8Gbps의 속도를 지원

# MIPI



# MIPI

	RASPBERRY PI CAMERA V1.3	RASPBERRY PI CAMERA V2.1
Image Sensor :	<a href="#">OmniVision OV5647</a>	<a href="#">Sony IMX219</a>
Resolution :	2592 × 1944 pixels (5 megapixel)	3280 × 2464 (8 megapixel)
Sensor Image Area:	3.76 × 2.74 mm	3.69 × 2.81 mm
Pixel Size:	1.4 μm × 1.4 μm	1.12 μm × 1.12 μm
Video :	1920 × 1080 (1080p)30p	1920 × 1080 (1080p)30p

- MIPI CSI0 은 OV5647 센서가 디폴트 세팅
- MIPI CSI1 은 IMX219 센서가 디폴트 세팅

# MIPI

```
File Edit Tabs Help
GNU nano 3.2 /boot/config.txt

# There are two CSI interface for camera, CSI0 and CSI1. CSI1 can switch to DSI$
# The default state is OV5647 connect CSI0, IMX219 connect CSI1.
# If you want to change OV5647 connect CSI1, please modify the overlay as follo$
# overlay=CSI1-OV5647
# If you want to change IMX219 connect CSI0, please modify the overlay as follo$
# overlay=CSI0-IMX219
# If you want to connect two mipi-dsi panel, you need switch CSI1 to DSI1, pleas$
# overlay=panel-asus-DSI1-overlay
#
overlay=CSI1-OV5647
```

```
linaro@linaro-alip:~$ sudo -i
root@linaro-alip:~# overlay=CSI0-IMX219
root@linaro-alip:~#
```

- /boot/config.txt 에서 세팅을 변경하거나  
Shell에서 변경 가능
- Tinker Edge R의 CSI1 포트는 DSI1 포트와  
공용으로  
overlay=panel-asus-DSI1-  
overlay  
으로 DSI 포트로 변경 가능

# MIPI

```
linaro@linaro-alip: ~  
File Edit Tabs Help  
GNU nano 3.2 /boot/config.txt  
  
#intf:i2c7=off  
#intf:i2s0=off  
#intf:spdif=off  
#intf:spi1=off  
#intf:spi5=off  
#intf:pwm0=off  
#intf:pwm1=off  
#intf:pwm3a=off  
  
##### Driver Config #####  
  
## Note: auto_ums: Auto enable ums mode while power on with USB connected. ##  
  
conf:eth_wakeup=on  
conf:auto_ums=on  
  
##### Tinker Power Management #####  
  
cpu_governor=ondemand  
  
^G Get Help ^O Write Out ^W Where Is ^K Cut Text ^J Justify ^C Cur Pos  
^X Exit ^R Read File ^\ Replace ^U Uncut Text ^T To Spell ^_ Go To Line
```

- /boot/config.txt 에서 세팅 변경 후 재부팅 필수
- USB Type-C DP도 해당 세팅 변경으로 사용 가능  
overlay=DP\_VOPB
- 추가적으로 I2S, I2C, GPIO 기본 in, Out, auto UMS, CPU 클럭 세팅 가능



# V4L2

- V4L2는 V4L Version 2, 즉 V4L의 두 번째 버전이란 뜻으로 V4L의 오류 등을 수정한 버전
- V4L은 Video4Linux의 줄임말로 리눅스에서 비디오를 처리하기 위한 드라이버

# Camera

```
linaro@linaro-alip:~$ dmesg | grep video
[ 1.109146] Linux video capture interface: v2.00
[ 3.985833] usbcore: registered new interface driver uvcvideo
linaro@linaro-alip:~$
```

- dmesg | grep video  
카메라 모듈 확인

# V4L2

```
linaro@linaro-alip: ~  
File Edit Tabs Help  
linaro@linaro-alip:~$ v4l2-ctl -h  
General/Common options:  
--all          display all information available  
-C, --get-ctrl <ctrl>[,<ctrl>...]  get the value of the controls [VIDIOC_G_EXT_CTRLs]  
-c, --set-ctrl <ctrl>=<val>[,<ctrl>=<val>...]  set the value of the controls [VIDIOC_S_EXT_CTRLs]  
-D, --info      show driver info [VIDIOC_QUERYCAP]  
-d, --device <dev> use device <dev> instead of /dev/video0  
                  if <dev> starts with a digit, then /dev/video<dev> is used  
-e, --out-device <dev> use device <dev> for output streams instead of the  
                  default device as set with --device  
                  if <dev> starts with a digit, then /dev/video<dev> is used  
-h, --help      display this help message  
--help-all     all options  
--help-io       input/output options  
--help-meta     metadata format options  
--help-misc     miscellaneous options  
--help-overlay  overlay format options  
--help-sdr      SDR format options  
--help-selection crop/selection options  
--help-stds     standards and other video timings options  
--help-streaming streaming options
```

- Tinker Edge R에는 기본적으로 V4L2 가 설치되어 있음
- v4l2-ctl -h로 설치 여부 및 명령어 확인

# V4L2

```
linaro@linaro-alip: ~  
File Edit Tabs Help  
linaro@linaro-alip:~$ v4l2-ctl --all  
Driver Info:  
  Driver name      : rkisp1_v0  
  Card type        : rkisp1_mainpath  
  Bus info         : platform:ff910000.rkisp1  
  Driver version    : 4.4.194  
  Capabilities     : 0x84201000  
    Video Capture Multiplanar  
    Streaming  
    Extended Pix Format  
    Device Capabilities  
  Device Caps      : 0x04201000  
    Video Capture Multiplanar  
    Streaming  
    Extended Pix Format  
Media Driver Info:  
  Driver name      : rkisp1  
  Model            : rkisp1  
  Serial           :  
  Bus info         :  
  Media version     : 0.1.0  
  Hardware revision: 0x00000000 (0)  
  Driver version    : 0.0.0  
Entity Info:
```

- v4l2-ctl --all  
명령어로 현재 설치된 카메라  
정보 확인
- 기본적으로 첫 번째 장치에 관한  
정보
- 2개 이상의 카메라를 사용  
중이시다면 디바이스 번호를 지정  
필요

# V4L2

```
linaro@linaro-alip:~$ ls /dev/video*
/dev/video-dec0  /dev/video1  /dev/video4  /dev/video7
/dev/video-enc0  /dev/video2  /dev/video5  /dev/video8
/dev/video0      /dev/video3  /dev/video6  /dev/video9
linaro@linaro-alip:~$ sudo v4l2-ctl --all -d 0
Driver Info:
    Driver name      : rkisp1_v0
    Card type        : rkisp1_mainpath
    Bus info         : platform:ff910000.rkisp1
    Driver version    : 4.4.194
    Capabilities     : 0x84201000
                        Video Capture Multiplanar
                        Streaming
                        Extended Pix Format
                        Device Capabilities
    Device Caps      : 0x04201000
                        Video Capture Multiplanar
                        Streaming
                        Extended Pix Format
Media Driver Info:
    Driver name      : rkisp1
    Model            : rkisp1
```

- ls /dev/video\*
- v4l2-ctl --all -d [Device 번호]
- ls /dev/video\* 명령어로 확인한 video 뒤의 숫자가 바로 디바이스 번호
- 이렇게 특정 디바이스를 지정해서 장치 정보를 확인

# V4L2

```
linaro@linaro-alip:~$ sudo v4l2-ctl -V
Format Video Capture Multiplanar:
    Width/Height      : 0/0
    Pixel Format       : ''
    Field             : Any
    Number of planes   : 0
    Flags              :
    Colospace          : Default
    Transfer Function  : Default
    YCbCr/HSV Encoding: Default
    Quantization       : Default

linaro@linaro-alip:~$ media-ctl -p
Media controller API version 0.1.0

Media device information
-----
driver      rkisp1
model       rkisp1
serial
bus info
hw revision 0x0
driver version 0.0.0
```

- Sudo v4l2-ctl -V
- media-ctl -p
- 카메라 모듈 정보 확인

# V4L2

```
linaro@linaro-alip:~$ ls -l /sys/class/video4linux/
total 0
lrwxrwxrwx 1 root root 0 Aug 20 23:29 v4l-subdev0 -> ../../devices/platform/ff910000.rkisp1/video4linux/v4l-subdev0
lrwxrwxrwx 1 root root 0 Aug 20 23:29 v4l-subdev1 -> ../../devices/platform/ff910000.rkisp1/video4linux/v4l-subdev1
lrwxrwxrwx 1 root root 0 Aug 20 23:29 v4l-subdev2 -> ../../devices/platform/ff920000.rkisp1/video4linux/v4l-subdev2
lrwxrwxrwx 1 root root 0 Aug 20 23:29 v4l-subdev3 -> ../../devices/platform/ff920000.rkisp1/video4linux/v4l-subdev3
lrwxrwxrwx 1 root root 0 Aug 20 23:29 video0 -> ../../devices/platform/ff910000.rkisp1/video4linux/video0
lrwxrwxrwx 1 root root 0 Aug 20 23:29 video1 -> ../../devices/platform/ff910000.rkisp1/video4linux/video1
lrwxrwxrwx 1 root root 0 Aug 20 23:29 video2 -> ../../devices/platform/ff910000.rkisp1/video4linux/video2
lrwxrwxrwx 1 root root 0 Aug 20 23:29 video3 -> ../../devices/platform/ff910000.rkisp1/video4linux/video3
lrwxrwxrwx 1 root root 0 Aug 20 23:29 video4 -> ../../devices/platform/ff910000.rkisp1/video4linux/video4
lrwxrwxrwx 1 root root 0 Aug 20 23:29 video5 -> ../../devices/platform/ff920000.rkisp1/video4linux/video5
```

- `ls -l /sys/class/video4linux/`
- Image sensors at the i2c ports 1 & 2
- 이미지 센서가 어떤 GPIO 포트를 점유하는지 확인

# Gstreamer



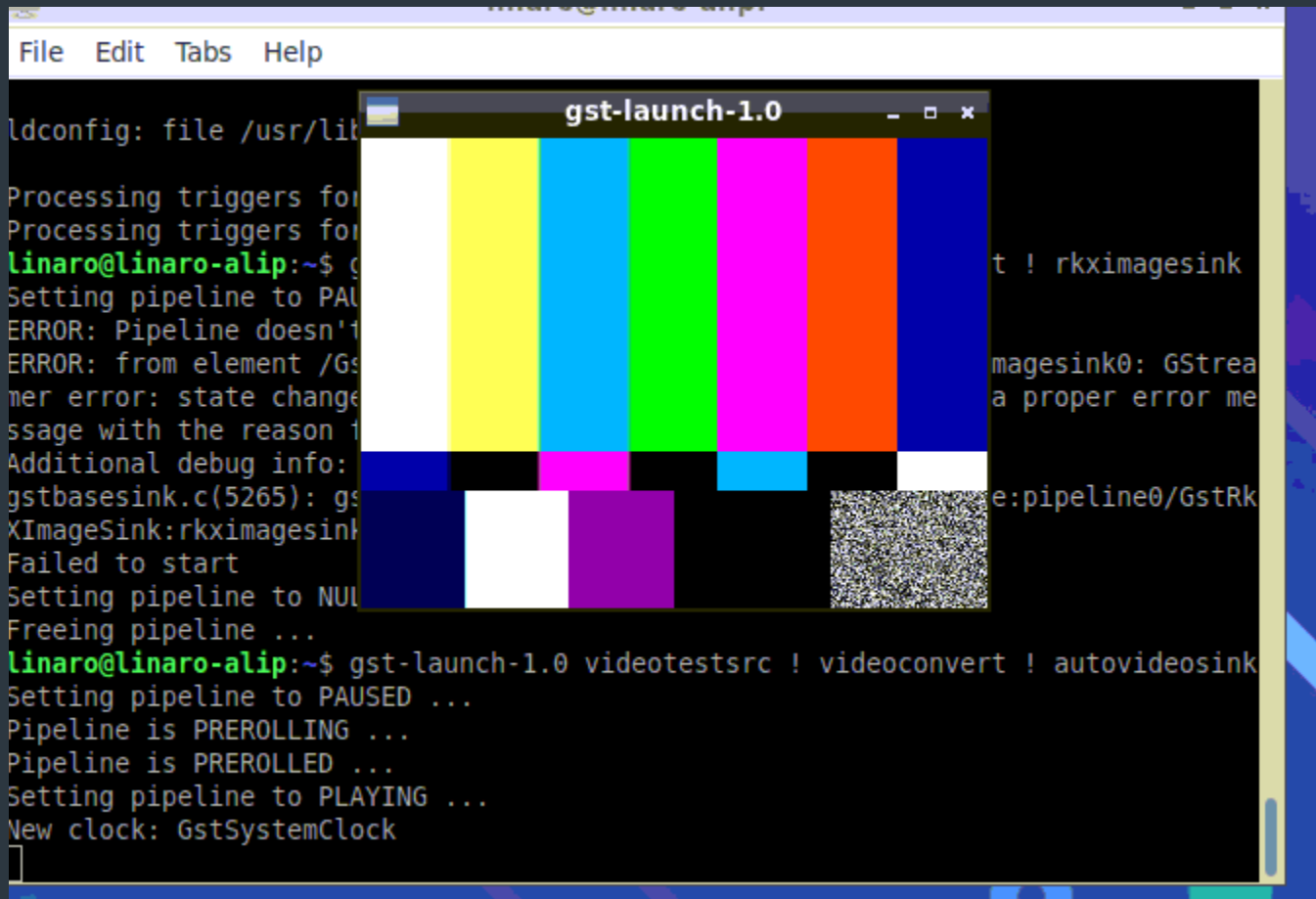
- Gstreamer는 여러 데이터들을 스트림 될 수 있도록 도와주는 프레임워크
- 비디오 또는 오디오 스트리밍에서 주로 사용



# Gstreamer

- Tinker Edge R에는 이미 설치되어 있지만 몇몇 구성 요소가 빠져있음
- `sudo apt install libgstreamer1.0-0 gstreamer1.0-plugins-base gstreamer1.0-plugins-good gstreamer1.0-plugins-bad gstreamer1.0-plugins-ugly gstreamer1.0-libav gstreamer1.0-doc gstreamer1.0-tools gstreamer1.0-x gstreamer1.0-alsa gstreamer1.0-gi gstreamer1.0-gtk3 gstreamer1.0-pulseaudio`  
로 설치

# Gstreamer



The screenshot shows a terminal window with a menu bar (File, Edit, Tabs, Help) and a title bar (linaro@linaro-alip). The terminal output includes error messages from a previous command and the successful execution of a new Gstreamer pipeline. A small window titled 'gst-launch-1.0' is overlaid on the terminal, displaying a video test pattern consisting of a grid of colored squares (white, yellow, cyan, magenta, red, blue, black, and a noisy pattern).

```
ldconfig: file /usr/lib/...
Processing triggers for ...
Processing triggers for ...
linaro@linaro-alip:~$ gst-launch-1.0 videotestsrc ! rkximagesink
Setting pipeline to PAUSED ...
ERROR: Pipeline doesn't have element /GstRkxImageSink
ERROR: from element /GstRkxImageSink: GStreamer error: state change failed: no such element or mapping
Additional debug info:
gstbasesink.c(5265): gst_base_sink_set_state: /GstRkxImageSink: Failed to start
Setting pipeline to NULL ...
Freeing pipeline ...
linaro@linaro-alip:~$ gst-launch-1.0 videotestsrc ! videoconvert ! autovideosink
Setting pipeline to PAUSED ...
Pipeline is PREROLLING ...
Pipeline is PREROLLED ...
Setting pipeline to PLAYING ...
New clock: GstSystemClock
```

- `gst-launch-1.0 videotestsrc ! videoconvert ! autovideosink`
- Gstreamer 스트리밍 테스트 확인

# Gstreamer



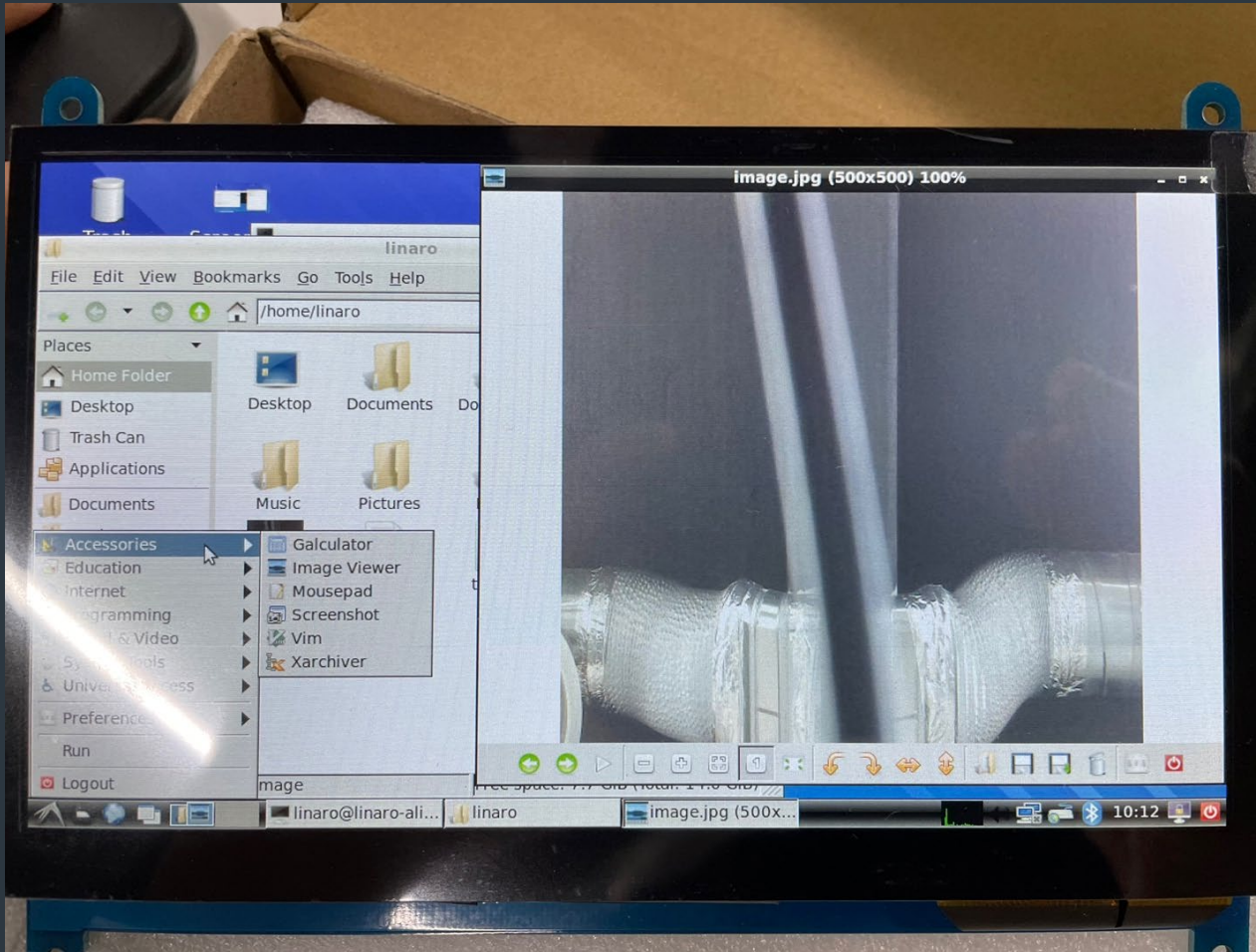
- `sudo gst-launch-1.0 v4l2src device! videoconvert ! Autovideosink`
- 카메라를 이용한 테스트 영상 출력

# Gstreamer



- `sudo gst-launch-1.0 v4l2src ! videoscale ! video/x-raw,width=500, height=400 ! videoconvert ! autovideosink`
- width와 height 값을 조정하여 원하는 해상도로 변경

# Gstreamer



- `sudo gst-launch-1.0 v4l2src num-buffers=10 ! video/x-raw,format=NV12,width=640,height=480 ! jpegenc ! multifilesink location=image.jpg`
- 버퍼 및 컬러 포맷, width와 height 값을 조정하여 카메라를 원하는 해상도의 jpg 파일로 캡처해 저장

# cheese

```
linaro@linaro-alip:~$ sudo apt-get install cheese
Reading package lists... Done
Building dependency tree
Reading state information... Done
cheese is already the newest version (3.31.90-1).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
linaro@linaro-alip:~$ Sudo apt-get install guvcview
bash: Sudo: command not found
linaro@linaro-alip:~$ sudo apt-get install guvcview
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following additional packages will be installed:
  libgsl23 libgslcblas0 libguvcview-2.0-2 libportaudio2
Suggested packages:
  gsl-ref-psdoc | gsl-doc-pdf | gsl-doc-info | gsl-ref-html
```

- Cheese는 GUI로 간단하게 카메라를 캡처할 수 있는 APP
- Tinker Edge R에는 이미 설치되어 있지만 몇몇 구성 요소가 빠져있음
- `sudo apt-get install guvcview`

# LTE

```
linaro@linaro-alip:~$ sudo apt-get install modemmanager libqmi-utils libmbim-util  
ls ppp  
Reading package lists... Done  
Building dependency tree  
Reading state information... Done  
ppp is already the newest version (2.4.7-2+4.1+deb10u1).  
modemmanager is already the newest version (1.14.12-0.2).  
The following NEW packages will be installed:  
  libmbim-utils libqmi-utils  
0 upgraded, 2 newly installed, 0 to remove and 0 not upgraded.  
Need to get 232 kB of archives.  
After this operation, 778 kB of additional disk space will be used.  
Do you want to continue? [Y/n] y  
Get:1 http://cdn-fastly.deb.debian.org/debian buster/main arm64 libmbim-utils ar  
m64 1.18.0-1 [96.7 kB]  
Get:2 http://cdn-fastly.deb.debian.org/debian buster/main arm64 libqmi-utils arm  
64 1.22.0-1.2 [135 kB]  
Fetched 232 kB in 5s (44.2 kB/s)
```

- Debian의 경우 LTE 모듈을 컨트롤하는 modemmanager 설치 필요
- `echo "deb http://http.debian.net/debian/  
buster main contrib non-free" >>  
/etc/apt/sources.list  
sudo apt-get update  
sudo apt-get install modemmanager  
libqmi-utils libmbim-utils ppp`

# LTE

A terminal window titled 'linaro@linaro-alip: ~' with a menu bar (File, Edit, Tabs, Help). The prompt is 'linaro@linaro-alip:~\$'. The user enters 'sudo -i', changing the prompt to 'root@linaro-alip:~#'. Then, the user enters 'nmcli c add type gsm ifname '\*' con-name Cellular apn <KT>'. The terminal shows an error: '-bash: syntax error near unexpected token `newline''.

```
linaro@linaro-alip:~$ sudo -i
root@linaro-alip:~# nmcli c add type gsm ifname '*' con-name Cellular apn <KT>
-bash: syntax error near unexpected token `newline'
```

- Apn list 내려받기
- `sed -i '/buster/'d /etc/apt/sources.list`
- `apt-get update`
- Reboot
- `nmcli c add type gsm ifname '*' con-name Cellular apn <your_apn>`  
로 apn 세팅



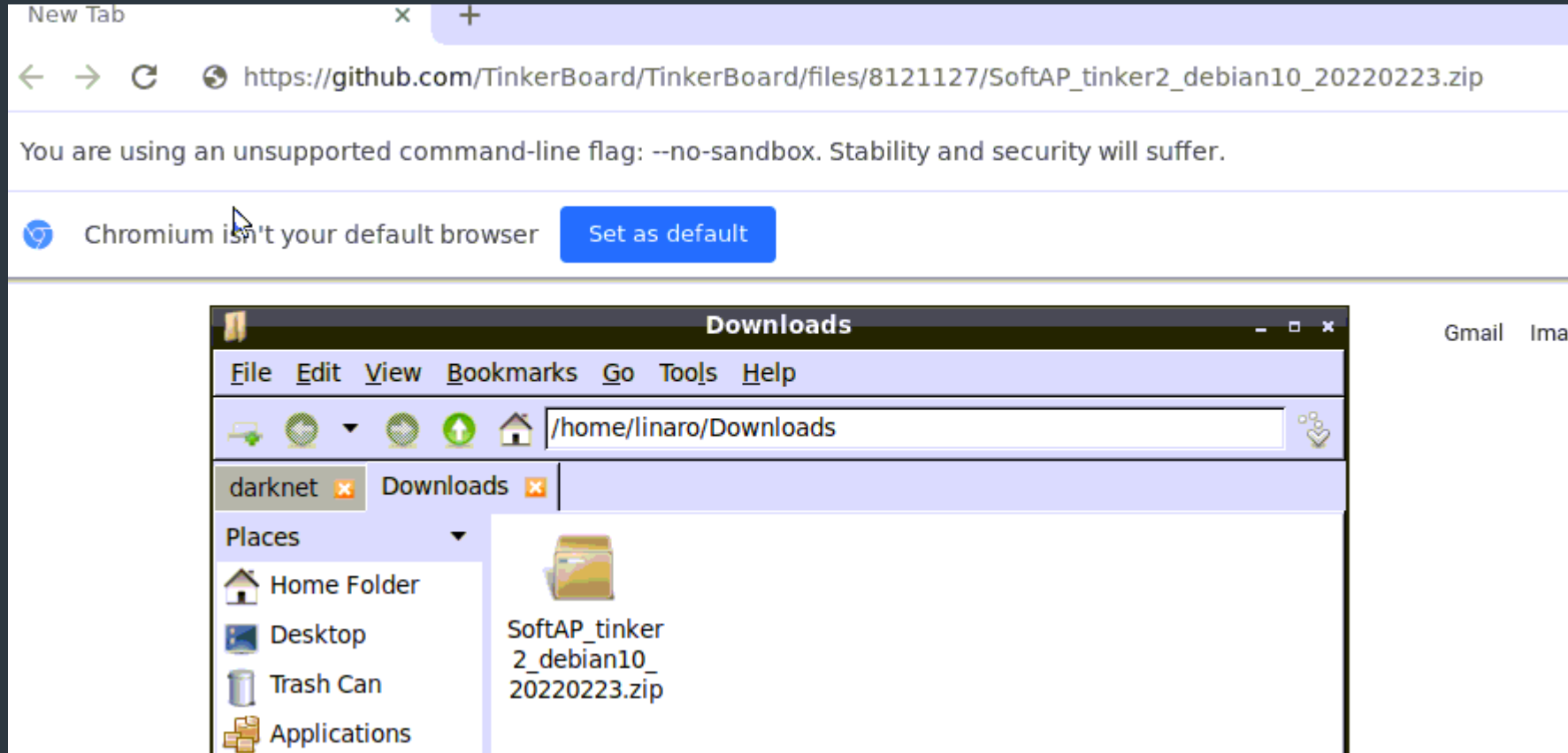
# SoftAP

```
linaro@linaro-alip:~/darknet$ sudo apt install dnsmasq hostapd
Reading package lists... Done
Building dependency tree
Reading state information... Done
Package dnsmasq is not available, but is referred to by another package.
This may mean that the package is missing, has been obsoleted, or
is only available from another source
However the following packages replace it:
  dnsmasq-base

E: Package 'dnsmasq' has no installation candidate
linaro@linaro-alip:~/darknet$ sudo apt install dnsmasq-base hostapd
Reading package lists... Done
Building dependency tree
Reading state information... Done
dnsmasq-base is already the newest version (2.80-1+deb10u1).
hostapd is already the newest version (2:2.7+git20190128+0cle29f-6+deb10u3).
0 upgraded, 0 newly installed, 0 to remove and 0 not upgraded.
linaro@linaro-alip:~/darknet$
```

- LTE나 LAN으로 데이터를 수신하고 Wifi를 통해 네트워크를 공유하는 사설 공유기, AP를 만들 수 있음
- 전반적인 인터넷을 관리하는 dnsmasq, hostapd를 활용
- 이미 Tinker Edge R에서는 dnsmasq-base 바이너리로 설치되어 있음

# SoftAP



- [https://github.com/TinkerBoard/TinkerBoard/files/8121127/SoftAP\\_tinker2\\_debian10\\_20220223.zip](https://github.com/TinkerBoard/TinkerBoard/files/8121127/SoftAP_tinker2_debian10_20220223.zip)  
SoftAP를 위한 바이너리 다운

# SoftAP

```
linaro@linaro-alip:~/Downloads$ cd /home/linaro/Downloads/SoftAP_tinker2_debian10_20220223
linaro@linaro-alip:~/Downloads/SoftAP_tinker2_debian10_20220223$ chmod 755 Enable_SoftAP.sh Disable_SoftAP.sh
linaro@linaro-alip:~/Downloads/SoftAP_tinker2_debian10_20220223$
```

- 바이너리 압축 해제 후
- `chmod 755 Enable_SoftAP.sh Disable_SoftAP.sh`  
로 sh에 권한 획득

# SoftAP

- `./Enable_SoftAP.sh`  
로 AP 모드 활성화
  - `./Disable_SoftAP.sh`  
로 AP 모드 비활성화
  - AP모드 시 Wifi 사용 불가
- default SSID =  
TinkerSoftAP
  - default Password =  
87654321

# SoftAP

- `sudo nano`  
`/etc/hostapd/hostapd.conf`
- SSID, PW 수정 가능
- Channel 및 Mac address  
기반 차단 기능 설정 가능  
`accept_mac_file=/etc/hostapd/hostapd.accept`  
`deny_mac_file=/etc/hostapd/hostapd.deny`