**Layer 4 - Inputs and Outputs**

Inputs

We are going to split this Layer in two big sections. In the first one we are going to see what inputs are terminals have, the devices that will give the visual and audio. The next section will be the input from the Information flow Layer.

SECTION 1

-TV/SMART TV

### HDMI (High-Definition Multimedia Interface)

This is your go-to input for your high definition sources and every HD video device manufactured now will sport an HDMI output. Amongst the many reasons it is favoured by the industry is that offers better protection against copying than analogue inputs.

### HDMI Version 1.4

You don’t really need to worry too much about which revision of the HDMI standard your TV has but it’s worth pointing out that HDMI 1.4 brought with it the opportunity to carry HD 3D video signals. If your TV is 3D capable, it will be HDMI 1.4 equipped and any 3D sources available will carry corresponding outputs so, for example, just hook up your 3D Blu-ray Player to your 3D TV and away you go.

### Do I need a special HDMI V 1.4 cable?

Well, HDMI cables don't have version numbers, they should be labelled as either high speed or standard. If you want 3D images and the likes of HDMI ARC (see below), you will need High Speed cables.

### What is HDMI ARC?

The 1.4 revision also saw the introduction of the Audio Return Channel (ARC) functionality. You will usually find that a TV only has one ARC capable HDMI port so it’s important you get this one right. ARC is a very specific feature and, as the long name would suggest, it carries audio signals between the TV and connected AV receivers, soundbars or other audio equipment.

The beauty of ARC is that it allows the audio signal of any sources connected to the TV to be taken out of it by a single cable. For example, in this instance HDMI 2 is our ARC capable port on the TV and it is connected to a soundbar. We can then have our Blu-ray player connected to HDMI 1, our games console through HDMI 3 and a HD set top box in to HDMI 4 and we can play the audio of each through the soundbar. Connecting thus will also allow you to use your TV’s remote to control the volume of the soundbar, thanks to HDMI CEC (see below).

Be warned that sometimes (quite often actually), the implementation of ARC varies between manufacturers and you may get issues with TVs and audio equipment ‘talking to each other’, which can necessitate pulling cables in and out and rebooting. It’s great when it does work, however, but be sure you have an HDMI cable certified as High Speed. It doesn’t have to be anything expensive.

### What is HDMI CEC?

HDMI Consumer Electronics Control (CEC) is a feature designed to allow the user to command and control other CEC-enabled devices connected to the TV. So, for example, we could have a Blu-ray player connected to the TV but be able to use the transport and menu keys on the television’s remote control to operate it. Like ARC, we sometimes see some inter-manufacturer compatibility issues with CEC so you may need to use the dedicated controller if you can’t get things working properly and it’s often only available via one input – so check for CEC/EC labelling.

### What is HDMI 2.0?

This latest revision of the HDMI spec is really mostly about 4K Ultra HD and we’d recommend when looking at 4K TVs that you check for 2.0 compatibility, at least via one of the HDMI ports. Whilst HDMI 1.4 is capable of carrying a resolution of 3840 x 2160 pixels, it can only do so at low frame rates, so it might not be future-proofed against advances in Ultra HD delivery technology. There are some other benefits but you’re not going to have to worry about them in the foreseeable future.

### What is HDCP 2.2 and do I need to worry about it?

The very latest version of High-bandwidth Digital Content Protection (HDCP) is 2.2 and you should get compatibility via any HDMI 2.0 labelled input; meaning when 4K Blu-ray players and other UHD video sources start to become available, this will be your go-to connection. For connected devices with older HDCP compliance (just about every HDMI device currently available), that are connected to HDMI 2.0 inputs, you might need to change a setting in the user menus concerning HDCP version, to ensure everything works as expected – check your owner’s manual for details.

### What is HDMI MHL and how do you use it?

MHL stands for Mobile High-Definition Link and, as the name might suggest, it allows you to connect your phone or tablet to the TV to share its screen in larger proportions. It works using a special cable that connects the micro USB port of your mobile device and the MHL labelled HDMI input on your TV – again, you usually only get one, if any, on a TV. Older revisions of MHL allow for uncompressed video in 1080p and up to 8 channels of audio, while MHL 3.0 is all geared up for 4K with support for formats all the way up to a 3840 × 2160 resolution at 30Hz.

### DVI

If your equipment is even remotely up-to-date, you don’t really need to worry about this one but, in the infancy of High Definition TVs, sometimes a Digital Visual Interface connection was your only option. In most cases, the connection looks and acts like HDMI, only it doesn’t carry an audio signal, so you need to make separate provision for that using a corresponding audio input – it’s usually a 3.5mm stereo jack located somewhere near the DVI input and is labelled accordingly. About the only current use-case scenario we can conjure up for this, is when connecting your TV to a computer with an older graphics card and no HDMI support.

### VGA connection

There aren’t many new TVs that have a VGA (Video Graphics Array) input being produced, it’s all HDMI now. A VGA port might be useful if you want to hook up an older PC or perhaps an Xbox 360 to your TV but we really can’t think that many people actually currently still do this. Again, there is no audio signal taken over a VGA connection so separate provision for that will be needed.

### USB

Certain Smart TV features and accessories can only be used via designated USB ports. The most common examples are for video camera/microphone attachments and USB hard drives used for Personal Video Recorder functions. In almost all cases these specified functions will be labelled next to the relevant USB input but your owner’s manual will also have the details. A good rule of thumb would be, that when using PVR functions with a connected hard drive, you will need the input to be a minimum if USB 2.0, and USB 3.0 if dual tuners are involved.

### SD Card

There aren’t too many televisions with SD Card slots but they are really useful for getting photos and videos from your camera to the TV, without the need to have your PC in the middle of the process. Of course, many people now share photos and video in lots of other ways but there’s something reassuringly fuss free and reliable about using a card.

### LAN

A Local Area Connection is the absolute bare minimum for a Smart TV to have and most these days will have built-in WiFi capability, or at least a bundled USB dongle for wireless internet. Even some TVs without ‘connected’ features have a wired LAN port which can be used for software updates, so it’s worth connecting it up to your router, now and then, to see if your television is up to date.

-Tablet

If the think freedom device is going to be connected to a tablet there two ways to make that happen. One is via bluetooth and the other via HDMI mini port and the bluetooth. This needs an adaptor. In both cases we need the help of the software to make it work.

-PC

To make it work on a PC, the incoming signal must be recognized from the pc as a HID device, like a mouse click or a keyboard key stroke. To make this work we need from previous Layers to alter the signal.

SECTION 2

Actually the inputs here are the outputs of Layer 3. The ways the signals are going to come here are:

-CABLE

As we mentioned before the most useful cables we are going to use are the HDMI and the USB cable. The HDMI cable we mentioned above how it works and what we should be careful with before using it.

If we are going to use a USB cable the input signal must follow the specs of the USB protocol. The USB is mentioned in a previous Layer.

-Bluetooth

The specs for this way of communication has been said to previous Layers. In general there has to be a bluetooth adaptor to receive the signal from the control unit the via a small logical circuit it should form the signal to match the output device (TV/smart TV/tablet/PC).

-Zigbee

The specs for this way of communication has been said to previous Layers. In general the zigbee is used in home automation. The way zigbee works and it protocols are the best solution for the Think Freedom device.

-Internet(Wifi/Ethernet)

This way the output Layer must work like a server. This way the signal(bitstream) will be transmitted there and it will processed. This way gives the Think Freedom device more universall access to every one.