Evaluation of active and passive POE systems

LiveLink Technology

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1 Passive POE

Passive POE, or POE mode B, utilises the unused pins in a CAT5e/6/6A cable to send power to the device.

Pin number	T568A Colour	T568B Colour	Mode B 10/100	Gigabit mode B
1	White/green	White/orange	Rx +	TxRx A +
2	Green	Orange	Rx -	TxRx A -
3	White/orange	White/green	Tx +	TxRx B +
4	Blue	Blue	DC+	TxRx C + / DC +
5	White/blue	White/blue	DC+	TxRx C - / DC +
6	Orange	Green	Tx -	TxRx B -
7	White/brown	White/brown	DC -	TxRx D + / DC -
8	Brown	Brown	DC -	TxRx D - / DC -

Figure 1: Wire usage in POE mode B

From looking at the table you can see that there are no unused wires when in Gigabit mode, so mode B operates in a similar way to mode A when using gigabit Ethernet. Passive POE has an advantage when using speeds lower than gigabit, as it means that the data doesn't have to go through additional circuit to separate the power and signal. This reduces the chance of noise and packet loss, resulting in a more reliable connection.

However if by mistake the cable is plugged straight into an Ethernet port, this could damage the port due to the high voltage.

1.1 Implementation

Passive POE would be the simplest to implement if gigabit Ethernet was not used. It would not require active circuit to manage the phantom power, only some wiring to route the power out of the cable. We could also protect the PD's[1] Ethernet port by not connecting the high voltage[2] power wires to the port.

The voltage would have to be stepped down to 5V in order to power the Raspberry Pi. Raspberry Pi takes a maximum of 1A, so using $P = IV$, at a maximum 48W would be transferred to the Pi. Stepping this down to 5V would require a high efficiency DC to DC converter.

2 Active POE

Active POE or POE mode A utilises data wires in CAT5e/6/6A cable to send power and data on the same wires to the PD. It does this using **phantom power**, where the data's AC signal rides on top of the DC power. This means that power is not restricted to unused pins, so gigabit Ethernet can be used.

[1] Powered device

[2] Usually 48V

Pin number	T568A Colour	T568B Colour	Mode A 10/100	Gigabit mode A
1	White/green	White/orange	Rx + / DC +	TxRx A + / DC +
2	Green	Orange	Rx - / DC +	TxRx A - / DC +
3	White/orange	White/green	Tx + / DC -	TxRx B + / DC -
4	Blue	Blue	Unused	TxRx C +
5	White/blue	White/blue	Unused	TxRx C -
6	Orange	Green	Tx - / DC -	TxRx B - / DC -
7	White/brown	White/brown	Unused	TxRx D +
8	Brown	Brown	Unused	TxRx D -

Figure 2: Wire usage in POE mode A

From looking at the table, it is clear that POE mode A has no advantage over mode B when using 10/100 Mbit Ethernet. It requires additional smart circuitry, and leaves unused pins which is a waste.

Mode A is essentially the same as mode B when using gigabit Ethernet, they both use phantom power. Phantom power requires circuitry that can take the data + power wire and separate the two, and also step the data signal down to ¡ 5V.

2.1 4 Pair

4 Pair is similar to mode A, expect it uses the C and D pairs also. This allows for greater power to be transferred to the PD.

2.2 Implementation

Active POE can be implemented in two ways, *endspan* and *midspan*.

2.2.1 Endspan

Endspan is where the power is injected at the same time as the data is, so this in most cases is implemented in the switch. This is used mostly in new installations, as switches can be very expensive, so retrofitting all the switches to include POE injection is not financially viable.

2.2.2 Midspan

Midspan is where the power is injected anywhere along the cable. This is good when Ethernet infrastructure has already been installed, and POE is to be added at a later date. Small POE injection modules can be very cost effective.

Active POE also requires the complex circuitry to deal with the phantom power / data wires. While this modules aren't expensive, if it is wanted to be implemented without using 'off the shelve' hardware then this could become quite complex.

3 IEEE standards

The IEEE has standardised POE in its different forms. The most modern is '802.3bt Type 4' which only supports 4 pair mode. It also allows up to 71W to be delivered to the PD. The other modern standard '802.3bt Type 3 "4PPoE"' offers all of the modes (A, B, 4 pair) and up to 51W at the PD.

3.1 PD protection

When using this protocol both the PD and PSE[3] must follow a protocol to allow power to be transferred. The PD must be checked to be standards-compliant and this is done by placing a 25KΩ resistor across the two powered pairs on the PD. The PSE then supplies a voltage to the PD, between 3 and 10V, and checks the resistance value is correct. This resistance value can be changed to specify the power level that the PD can handle. If the PD doesn't have a resistor which is around 25KΩ then power will not be sent to the device.

This is a useful safety feature. It would help protect against accidental connection of a CAT5 cable to a device that cannot withstand the high voltage. However, if strict protocols and procedures are listed for installation of the system, this is less useful. This protection is not useful when the system has already been installed.

4 Recommendation

For use in powering the embedded hardware that controls the door locks at LLMCH, POE is a good way of doing this. I don't think that Active POE is necessary, as gigabit Ethernet should not be required by the Pi's. They should only need to communicate with the central database to recache the tag database, and to allow web control, all of which do not require connection speeds greater than 100Mbit.

The advantage of having a passive system is that this could be easily implemented 'inhouse' removing the dependency on competitors. The basic hardware required could be easily designed onto a PCB. The PCB themselves will be very cheap to manufacture, less than 3-5 per PCB depending on the size of the PCB. For the components, these should come to less than 5 per board also. The most expensive component would be the

[3]Power sourcing equipment

DC to DC converter, so depending on how efficient it is required to be will determine the price.

Range is determined by voltage drop, so the higher the voltage we feed in the greater the range. Also getting higher quality CAT cables would give a lower voltage drop. We are limited by the range of the Ethernet data signal, which is 100 meters as detailed in the specification.

The downside to this approach is that if our devices are required to be compliant with the IEEE standards this would require much more work, having to obtain the standards which could be expensive, and rigorous testing to obtain the certification.