Power-Over-Ethernet (POE) and Intelligent Power Management (IPM)

Introduction – Power over Ethernet (PoE)

Over the last decade, as wireless has proliferated across the enterprise, Power Over Ethernet was developed to provide power to the devices over the ethernet cable from the switch in order to remove the need to run dedicated power to each device. There are some terms to be aware of, and there have been a few standards over the years to be aware of, relevant to the value of IPM

- **PD** = Powered Device (access point, camera, etc)
- **PSE** = Power Sourcing Equipment (PoE switch, midspan power injector, etc)
- **802.3af** (commonly referred to as 'POE') – An IEEE standard that provides up to 15.4W at 44V minimum to the PD (usually 48V at the PSE).
- **802.3at** – An IEEE standard that provides up to 30W at a the PSE (25.5W at the PD) with a minimum of 50V minimum at the PD (usually 54V at the PSE). 802.3at PSE devices are backward compatible with 802.3af
    - **Note:** POE+ is **NOT** the same as 802.3at. 'POE+' is a non-standard nomenclature used by Cisco and Microsemi that is basically a 30W version of 802.3af, specifically the same voltage of 48V. However, a device requiring 803.at power @ 54V and will not get enough voltage and may not operate (if the device requires 802.3at for minimum operation).
- **802.3bt** – An IEEE standard that can deliver up to 60W at the PSE (and could go up to 90-100W), with anywhere from 51-60W at the PD, at 50V minimum at the PD (usually 54V at the PSE). 802.3bt should be backward compatible with 802.3at and 802.3af.
    - **Note**: Cisco's UPOE is a Cisco-proprietary 60W solution (similar to their 'POE+ moniker previously) and is NOT a standard solution. Cisco switches supporting UPOE MAY NOT ALWAYS be convertible to 802.3bt, which would mean a hardware forklift upgrade.
- **LLDP** – Generally required for most 802.3at/802.3bt PDs, and should be supplied by a PoE Switch. Midspan power injectors would not require LLDP support, but as a best practices, the uplink switches should support LLDP.

Introduction – Intelligent Power Management (IPM)

Because many of the new Aruba APs require 802.3at or 802.3bt power for full feature support, Aruba acknowledged that there are instances where the switches supporting the APs via POE may not always have the ability to support 802.3at/bt. Additionally, while some APs have a 'fall back' support for the lowered power of 802.3af, those auto fall back adjustments may result in adjustments that are not ideal within the customer environment.

With the introduction of Intelligent Power Management (IPM), starting in ArubaOS and Instant 6.5.2 on certain AP platforms, Aruba now gives the user the ability to define, as part of the IPM policy, which features would be disabled to save power, allowing for the APs to operate at a lower power consumption but maintaining the features desired by the customer.

IPM Option Settings

The following options are available within the IPM config:

Setting	Description	Performance Impact	Power Savings*
'cpu_throttle_25'	Reduce CPU frequency to 25% of normal	Major	~0.6W
'cpu_throttle_50'	Reduce CPU frequency to 50% of normal	Moderate	~0.4W
'cpu_throttle_75'	Reduce CPU frequency to 75% of normal	Minor	~0.2W
'disable_alt_eth'	Disable 2nd Ethernet port	Usually Minor, leave enabled if required	~0.3W for 1G ~1.3W for SR
'disable_pse'	Disable PSE	Usually Minor, leave enabled if required	Up to 15W if used for PSE (AP-303H only)
'disable_usb'	Disable USB	Usually Minor, leave enabled if required	Up to ~5W if used
'radio_2ghz_chain_1x1'	Reduce 2GHz chains to 1x1	Major	~0.75W per reduction from max chains supported
'radio_2ghz_chain_2x2'	Reduce 2GHz chains to 2x2	Moderate	~0.75W per reduction from max chains supported
'radio_2ghz_chain_3x3'	Reduce 2GHz chains to 3x3	Minimal	~0.75W per reduction from max chains supported
'radio_2ghz_power_3dB'	Reduce 2GHz radio power by 3dB from maximum	Moderate	~0.5W (N/A if power is already set 3dB below max)
'radio_2ghz_power_6dB'	Reduce 2GHz radio power by 6dB from maximum	Major	~1W (N/A if power is already set 6dB below max)
'radio_5ghz_chain_1x1'	Reduce 5GHz chains to 1x1	Major	~0.75W per reduction from max chains supported
'radio_5ghz_chain_2x2'	Reduce 5GHz chains to 2x2	Major (Major for AP-555 in 8x8 Mode)	~0.75W per reduction from max chains supported
'radio_5ghz_chain_3x3'	Reduce 5GHz chains to 3x3	Moderate (Major for AP-555 in 8x8 Mode)	~0.75W per reduction from max chains supported
'radio_5ghz_chain_4x4'	Reduce 5GHz chains to 4x4	Major (for AP-555 Only)	~0.75W per reduction from max chains supported
'radio_5ghz_chain_5x5'	Reduce 5GHz chains to 5x5	*Reserved for future platforms*	~0.75W per reduction from max chains supported
'radio_5ghz_chain_6x6'	Reduce 5GHz chains to 6x6	*Reserved for future platforms*	~0.75W per reduction from max chains supported
'radio_5ghz_chain_7x7'	Reduce 5GHz chains to 7x7	*Reserved for future platforms*	~0.75W per reduction from max chains supported
'radio_5ghz_power_3dB'	Reduce 5GHz radio power by 3dB from maximum	Moderate	~0.5W (N/A if power is already set 3dB below max)
'radio_5ghz_power_6dB'	Reduce 5GHz radio power by 6dB from maximum	Major	~1W (N/A if power is already set 6dB below max)

** power savings are not fixed from platform to platform and are somewhat variable depending on AP model, load, etc. Values are approximations*

Table 1 -

Regarding the 'chain' reductions, it is approximately 0.75W per chain reduction. That means reducing the AP-555 5Ghz (8x8) to 4x4 can save up to 3W (0.75*4 steps). Reducing the AP-335 5Ghz (4x4) to 2x2, saving 1.5W (0.75W*2 steps). The amount saved will vary depending on the AP model and chains supported compared to the number of steps that are reduced.

The IPM policy, when applied to the AP, is based on IPM priorities, where the IPM policy can be crafted to disable or reduce certain features in a specific sequence and in a manner to apply the minimum reduction necessary to reduce the AP power consumption below the power budget. For example, when using CPU throttling as an IPM setting to reduce AP power, the 'cpu_throttle_25' should have a lower priority than 'cpu_throttle_75' at a higher priority, so that the least impactful settings are applied first.

Note that IPM priority is inversely related to the notion of the enablement priority. IPM applies higher priority settings (corresponding to lower integer values) first, over lower priority settings (corresponding to a higher integer value) which are applied last. Therefore the lower priority IPM settings correspond to those settings that may never be applied and are therefore those settings that have the highest probability of remaining enabled.

IPM priority settings are given integer values, where the lower values have the highest priority and will be implemented first. In essence, the 'integer value' assigned to the setting defines the position of the setting to be applied within the sequence. The sequence of power reductions is applied in in increasing order, starting with '1', then '2', then '3', etc. An IPM priority policy with a value of '1' would be the highest priority and would be implemented first, then the next IPM policy with a value of '2' would be implemented next (if needed), and so on. See Table 2 for an example of a 6-item IPM policy, the order the IPM settings are applied, and the impact on overall AP performance.

"IPM_Step_Priority" Value	Order Implemented	Performance Impact
1 (highest priority)	First	Minimal
2 (...)	Second	Minimal
3 (...)	Third	Moderate
4 (...)	Fourth	Moderate
5 (...)	Fifth	Major
6 (lowest priority)	Sixth	Major

Table 2

IPM Policy Strategy

There are no limits or controls on the IPM policy that is created, and the admin can choose to implement whatever policy controls are desired, depending on the expected reduction required. For example, the policy can just jump to 'cpu_throttle_50' if created that way. The APs will implement the policy that is configured and applied, even if it's not ordered correctly or in accordance with best practices. Just note that implementing severe power reductions first can result in impaired performance or have unintended results.

Additionally, on settings that apply to the same feature (CPU, radio chains, etc), they should be prioritized accordingly so that the lower-impact setting are applied before the higher impact setting. For example, regarding CPU throttling, if the 'cpu_throttle_75' should have an IPM policy of '1', then if the next setting is 'cpu_throttle_50', it should have a priority of '2'. If this was reversed, where 'cpu_throttle_25' was given a policy value of '1', and 'cpu_throttle_50' was given a policy value of '2', the more impactful (and more detrimental) policy of reducing CPU to 25% would be applied first,

which is not desired. See Table 2 for examples of an incorrect policy compared to a correct policy for an indoor AP-535 that is used for WLAN client access, with no connection on Eth1 and no access to the USB port.

Incorrect IPM Policy	
"IPM Priority"	Value
cpu_throttle_25	1
cpu_throttle_50	2
disable_usb	3
disable_alt_eth	4

Correct IPM Policy	
"IPM Priority"	Value
disable_alt_eth	1
disable_usb	2
cpu_throttle_50	3
cpu_throttle_25	4

Table 2

In the incorrect policy above, the most impactful reduction of reducing CPU by 25% is first, while the USB and Eth1, which are not in use, are disabled last. The correct IPM policy properly disables the USB and Eth1 ports (which are not in use) first, then gradually throttles the CPU as needed.

Customers should match the AP with the required PSE power to unleash the AP's full potential. For circumstances where this is not possible, enable IPM.

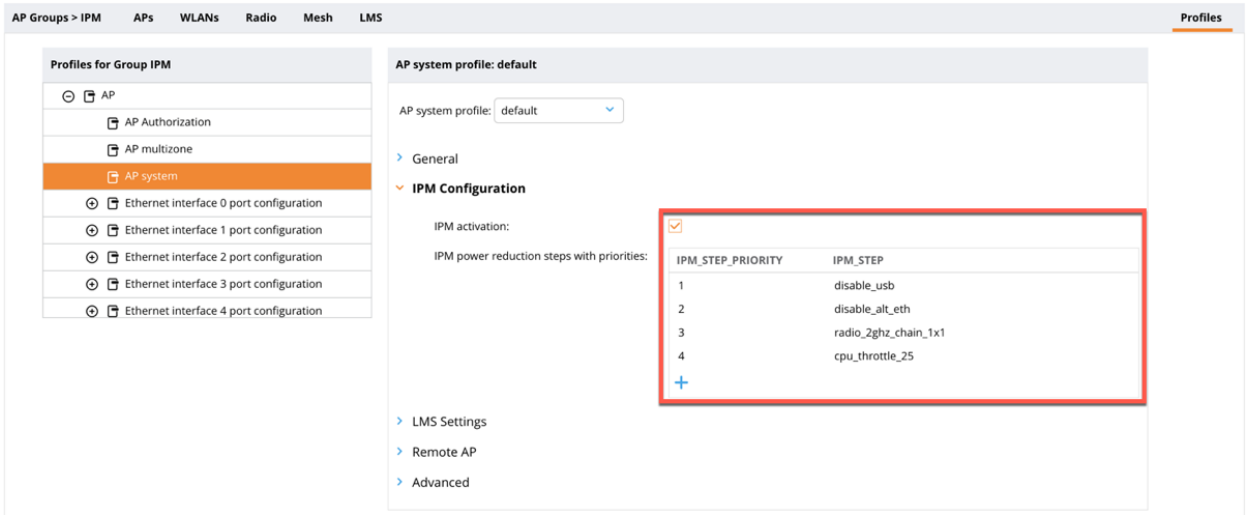
Conclusion

The primary goal of IPM is that, when customers need to run APs that may require 802.3at/bt but only have 802.3af/at switches or PSEs, if the default power-save settings outlined on the data sheet are not acceptable, then a custom IPM policy can be defined, which can allow those APs to run on 802.3af/at power in a configuration that is required per the config, and gives the admin more granular control over how the IPM policies impact overall performance.

A secondary benefit of IPM is that it allows for the creation of policies that maximize performance to use as much of the available power from the PSE as possible, by constantly monitoring the AP power consumption and adjusting the power saving IPM features within the power budget, instead of assuming a worst-case power utilization scenario.

Configuration Examples

ArubaOS 8.x GUI:



ArubaOS CLI

```
ap system-profile "default"
    ipm-power-reduction-step-prio ipm-step disable_usb priority 1
    ipm-power-reduction-step-prio ipm-step disable_alt_eth priority 2
    ipm-power-reduction-step-prio ipm-step radio_2ghz_chain_1x1 priority 3
    ipm-power-reduction-step-prio ipm-step cpu_throttle_75 priority 4
    ipm-power-reduction-step-prio ipm-step cpu_throttle_25 priority 5
```

InstantOS CLI

```
Portal-d0:6a (config) # ipm
Portal-d0:6a (ipm)
    ipm-power-reduction-step-prio ipm-step disable_usb priority 1
    ipm-power-reduction-step-prio ipm-step disable_alt_eth priority 2
    ipm-power-reduction-step-prio ipm-step radio_2ghz_chain_1x1 priority 3
    ipm-power-reduction-step-prio ipm-step cpu_throttle_75 priority 4
    ipm-power-reduction-step-prio ipm-step cpu_throttle_25 priority 5
```