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Towards energy efficient data intensive computing using IEEE 802.3az

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Network energy saving in distributed computing systems

- Available approaches in Energy Efficient Ethernet
  - Power down unused switch ports
  - Adjust the cable length
  - Turn inactive ports to sleep when no traffic

The 802.3az protocol

- Control port status based on network traffic
- Final standard released in 9/2010
- Products available later 2011

1) Huawei S1728GWR-4P 2) Cisco SG300-28

Motivation

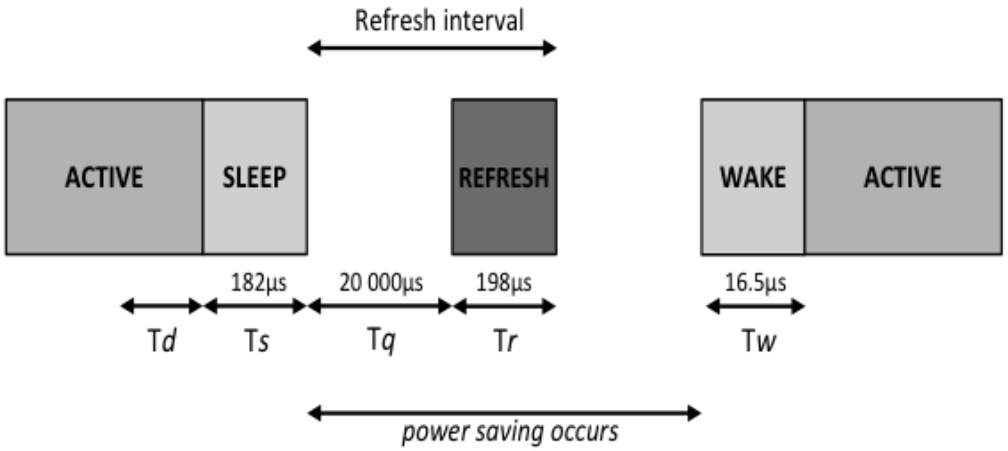
- Can we make use of 802.3az in optimizing the energy efficiency of an application in cluster environments?

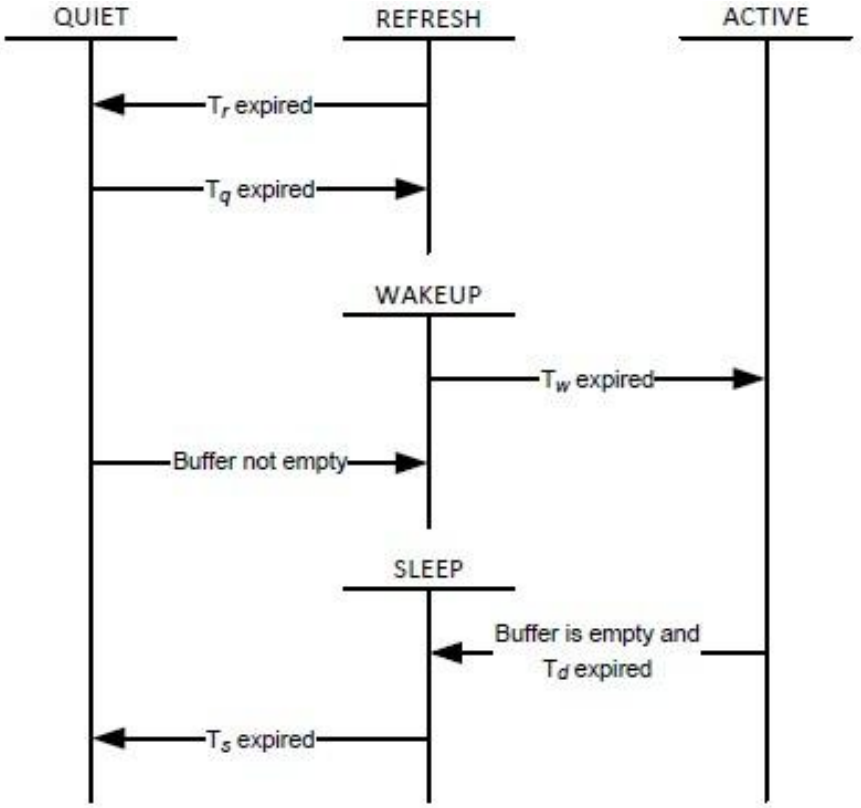
Contents

- How does IEEE802.3az work?
- How to use IEEE 802.3az?
  - Energy behavior of IEEE 802.3az in practice
  - Proposed system
- Experimental study
- Conclusions
- Future work

Basic idea of IEEE 802.3az

- The IEEE 802.3az protocol turns inactive links to a low power model based on the traffic condition on those links; it refreshes in a interval to detect coming traffic and wakes up.





Our approach

- Profile the energy behavior of IEEE 802.3az devices
  - Dependencies on communication patterns
  - Check the difference between simulation study [1] and actual implementations
- Estimate the energy consumption for an application in a specific network
  - Schedule applications based on the communication patterns

[1] P. Reviriego, J.A. Hernandez, D. Larrabeiti, and J.A. Maestro. Performance Evaluation of Energy Efficient Ethernet. 2009.

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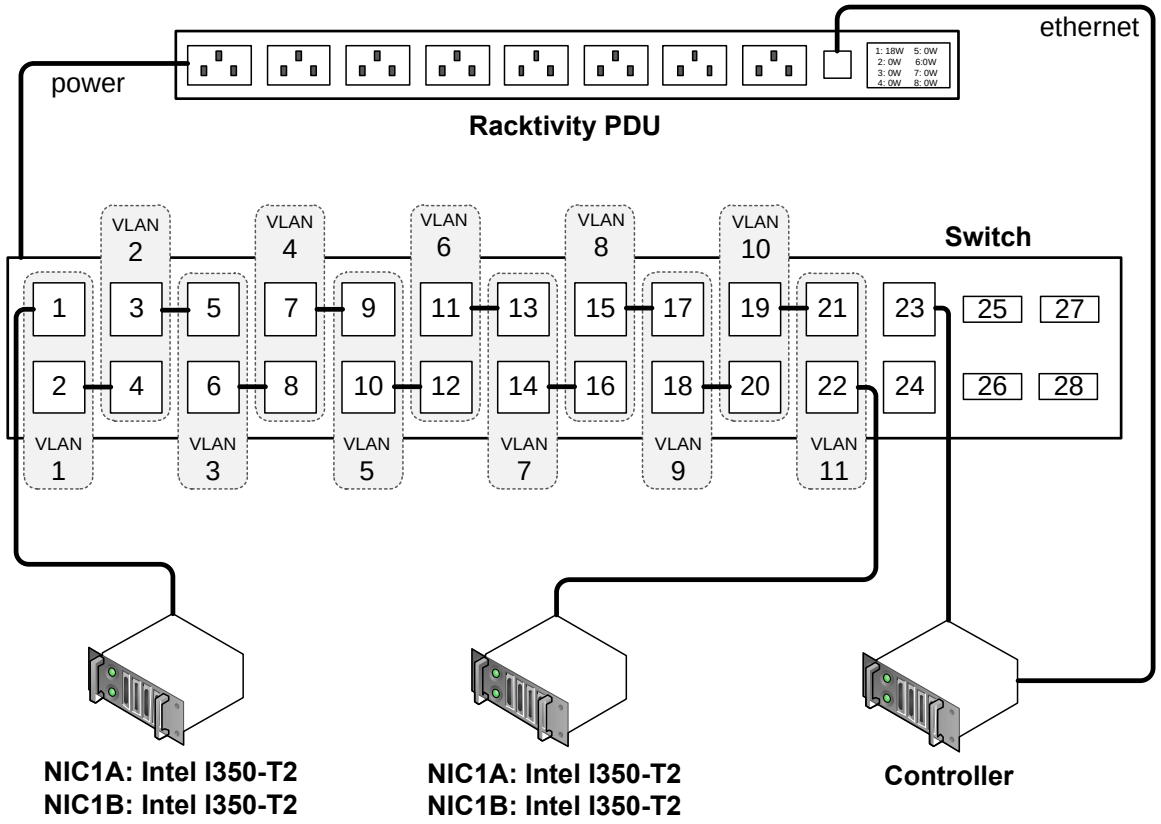
Experiment setup



Two devices tried:
Huawei S1728GWR-4P vs. Cisco SG300-28
PDU: Racktivity ES6024-16

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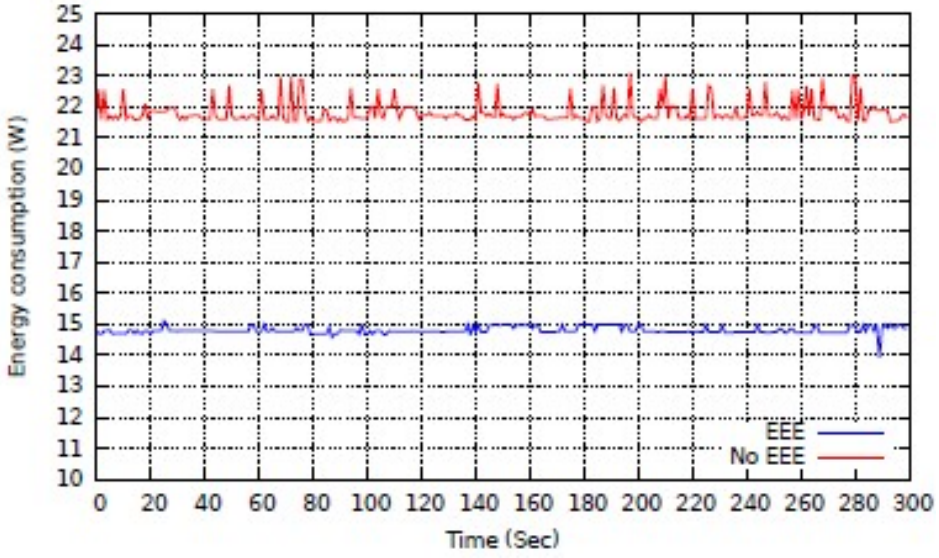
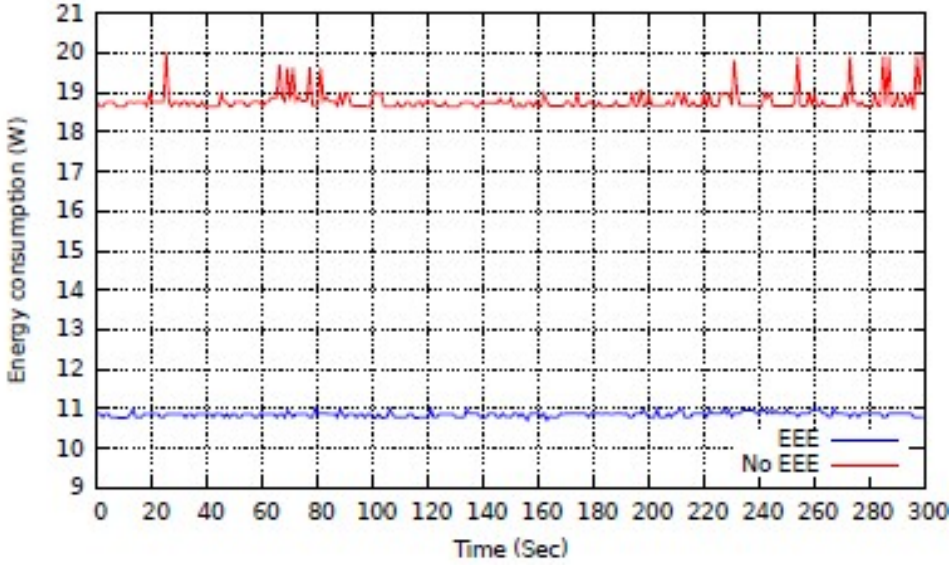
Max and Min energy consumption



A) Huawei (37% saving)



B) Cisco (40% saving)

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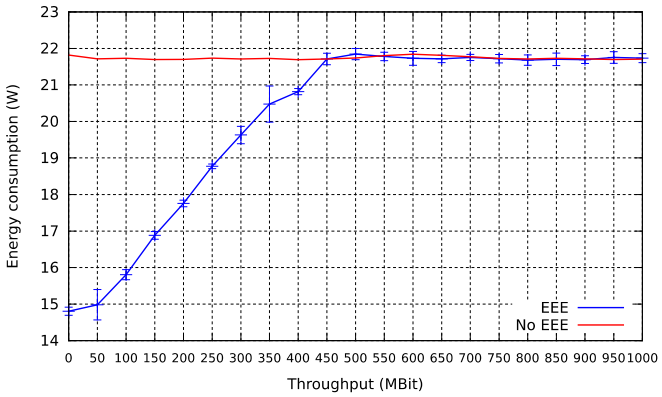
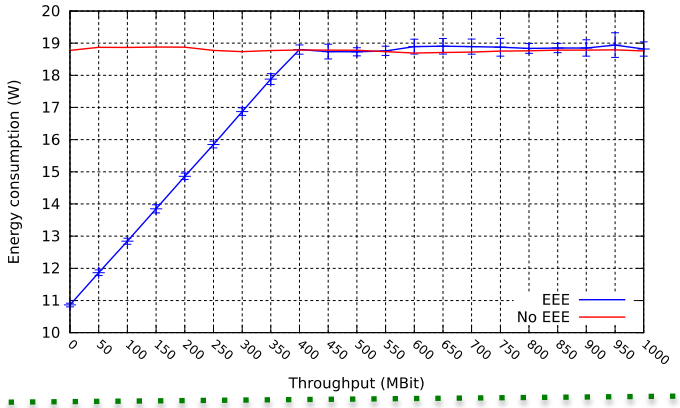
Energy vs. Throughput (1000BASE-T)

Huawei

Cisco

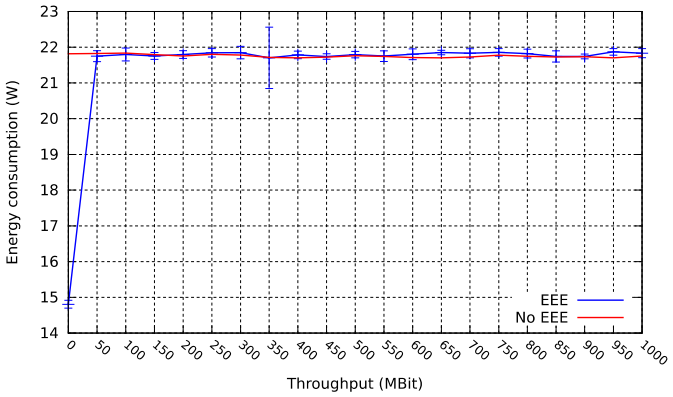
TCP

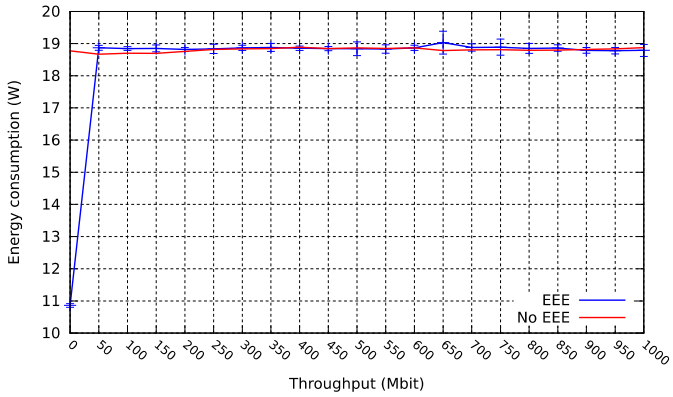




Both EEEs show a linear increase in power consumption

UDP





Both EEEs always consume maximum energy, regardless of throughput.

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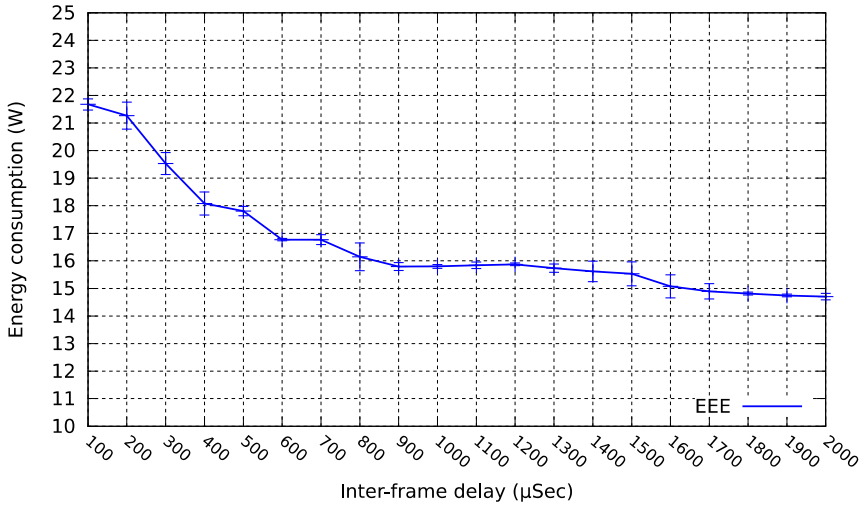
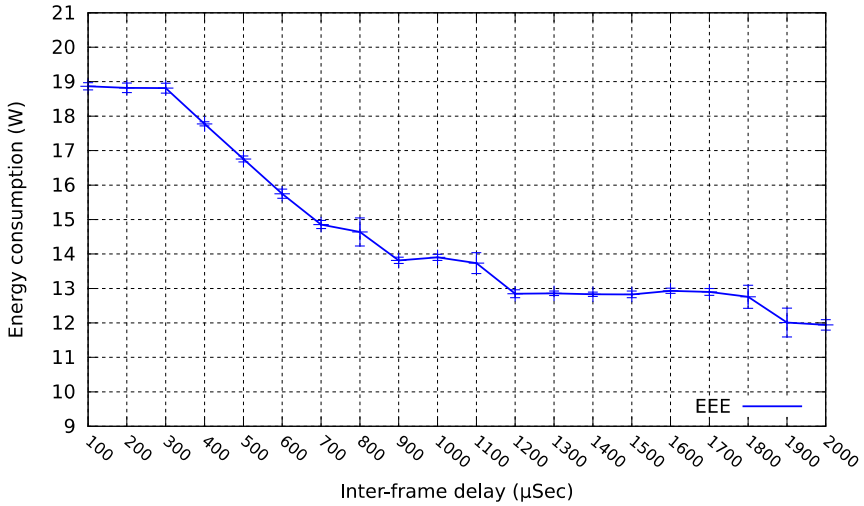
Energy vs. Inter-frame delay(TCP, 1000BASE-T)

Huawei



Cisco



The Huawei device starts saving energy at smaller inter-frame delay values than the Cisco device.

What did we learn?

- 802.3az is effective in reducing the energy consumption of TCP traffic. The amount of energy saved varies depending on vendor.
- The inter-frame time interval influences the energy consumption of running the data intensive application.
- Energy saving :
  - Set a suitable and stable interval.
  - Buffer application requests to increase idle time.

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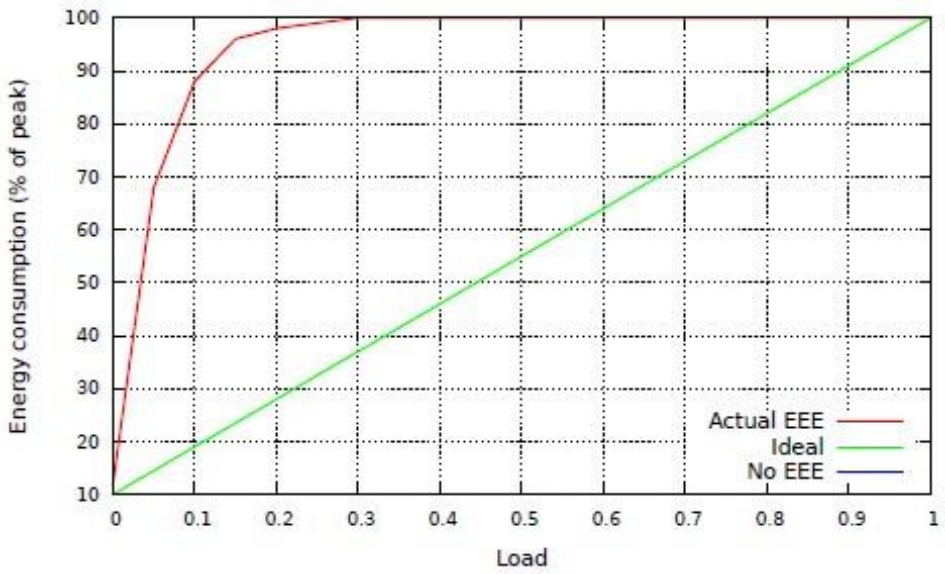
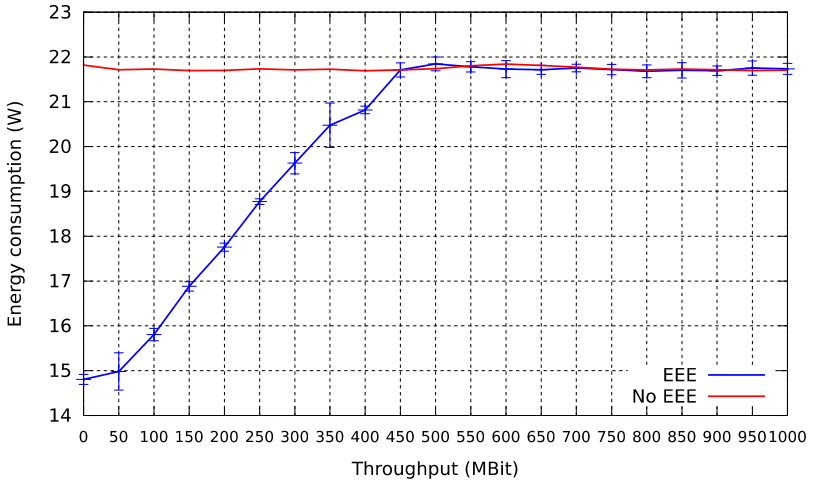
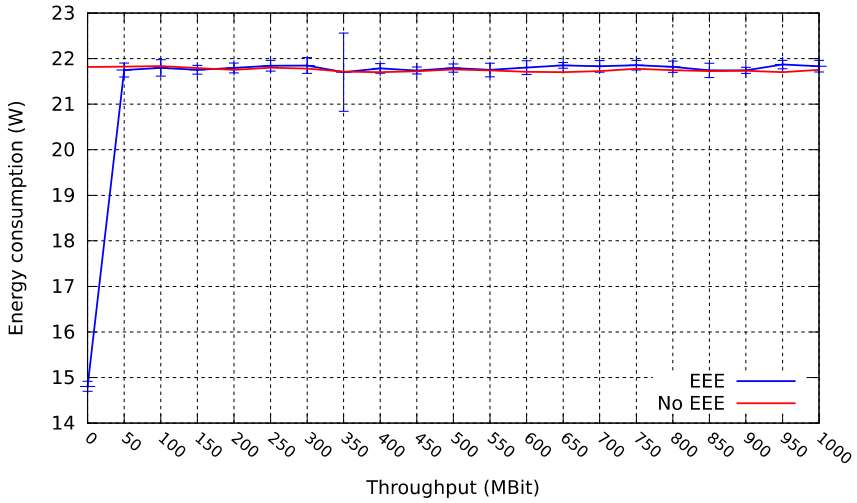
Cont.







Simulation made in [1]

[1] P. Reviriego, J.A. Hernandez, D. Larrabeiti, and J.A. Maestro. Performance Evaluation of Energy Efficient Ethernet. 2009.

Power Budget Calculator

- The goal of modeling is to:
  - Estimate the energy consumption generated by the data transmission.
  - Understand the impact of changes to the scenarios: e.g. adding new nodes.
  - Optimize based on scenario: e.g. determine best number of used nodes or reduce the transmission speed.
- The model derives from parameters of data-intensive tasks and the energy profiling in the EEE environment.
- Components: Task-based Estimate and Data-based Estimate.

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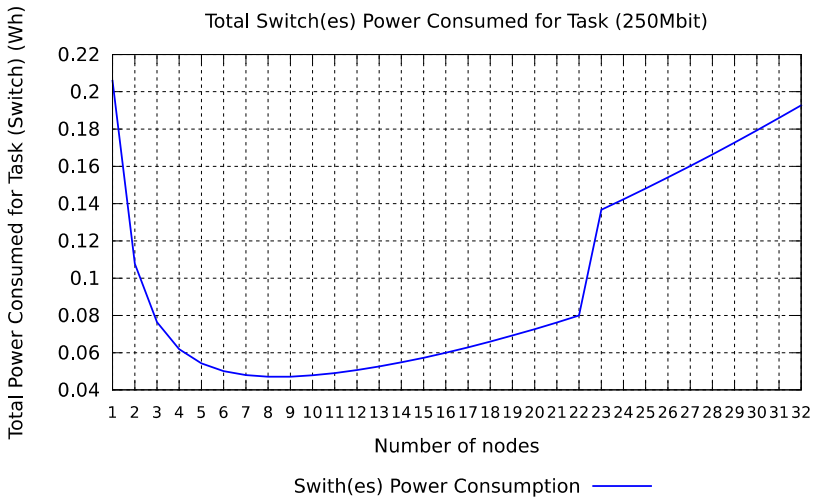
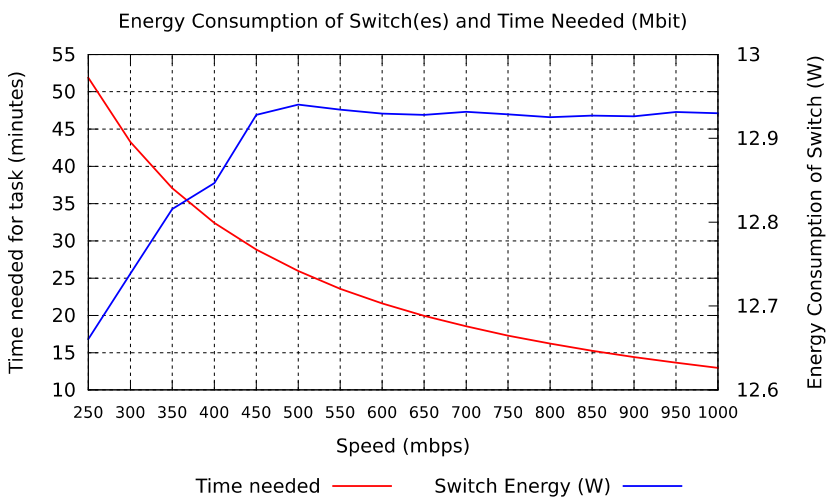
Use cases of the Calculator

Optimize the scenarios: calculate the energy usage in different conditions and determine optimal execution parameters





Energy=((Ptp-Pb)/Np)*N*((Ts/n)+(n-1)*C).

Energy = ((Ptp-Pb)/Np)*N*(Dsize/Throughput)

Conclusions

- 802.3az is effective in reducing the energy consumption of device.
  - The amount of energy saved varies depending on vendor.
- Power Budget Calculator
  - An energy model of transmission in network.
  - Applied to energy optimization.

Future work

- The future version of the Calculator will be free of unrealistic assumptions and incorporated into our scheduler.
- The Calculator will be included in the ongoing energy knowledge base system, which exposes measurement data and supports prediction of energy characteristics.

Reference

- Acknowledgement

- URL of Power Budget Calculator
  - https://github.com/zupper/cluster-efficiency