IBM appreciates the opportunity to provide comments to ENERGY STAR® Large Network Equipment (LNE) Discussion Document and ENERGY STAR Preliminary Approach for Testing Large Network Equipment. IBM manufactures and markets data center access and aggregation switches and therefore has an interest in ensuring that the final LNE requirements energy efficiency and testing requirements are both technically and economically feasible for manufacturers while furthering the mission of ENERGY STAR to recognize and promote the sale of energy efficient products.

Switch and Router Categorization: IBM recommends that EPA evaluate network equipment from a different viewpoint, in addition to the four types of network devices identified in the discussion documents. Network equipment can be segregated into two groups that establish connectivity to the internet based on where they are used:

1. Enterprise class: These are the network devices that connect individual users (IP phones, workstations, laptops, etc.) to the network. They will be found in office buildings, factory environments, and other environments where individual devices are present and in use. Note that in this case the use of the term Enterprise is distinct and different from its use in describing Enterprise storage or server systems – it represents system outside of the data center. These network devices historically have had side to side airflow as they are located in individual setting or small closets.
2. Data Center class: These are the network devices that route traffic from the individual data center components – servers and storage systems – to the internet or broader network. These are Ethernet switches. These switches typically have air flow through the switch to conform to the "hot aisle – cold isle" configuration typical for data center installations.

Both classes of network devices can be configured into three layers.

a. Access Layer: This is type of switch collects network traffic from individual devices – servers and storage systems in the data center or workstations, laptops, and controllers in the enterprise setting – and routes the traffic to internet switches and routers. These systems typically support a large number of "user" ports and a smaller number of "network" ports. Access system network equipment is generally a fixed switch, but can be modular in some models. At this layer, if IP telephony is used, management of PoE is important.
b. Aggregation Layer: This is a type of router that collects network traffic from the access switches, aggregates the traffic and sends it to core routers, which may be inside or outside a corporate firewall. Aggregation layer routers can be modular or fixed and managed switch to router traffic.
c. Core Layer: These are the routers that move traffic around the internet. They manage router to router traffic. These routers are primarily modular systems.

These three layers are the basis for the categories in the ATIS Standard "Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products". Detailed classifications are

provided in Tables A-1 and A.2 of the ATIS Standard. IBM believes that use of these categories, or some subset of these categories, offers the best general approach for classifying routers and switches under the LNE requirements. Further dialogue and exploration with industry stakeholders will be needed to better define the categories of LNE that make the most sense for inclusion in Version 1 of the LNE requirements.

Power Over Ethernet (POE) Switches: One specific switch type that EPA should also consider are Power Over Ethernet switches, which specific to the access layer in the Enterprise Class and are used to power the devices that are connected to the switch. Because these switches overlay the data packets with power for the device, the switches use significant amounts of power. IBM recommends that requirements be established for POE switches.

This hierarchy of network switches and routers is focused on the Ethernet network. IBM recommends that EPA focus on these six categories of Ethernet switches and routers in developing the LNE requirements. As noted above, the three layers of switches consist of both fixed and modular systems. It should be noted that fixed systems can be stacked, particularly in the Enterprise space, and as such a group of fixed switches can become similar to a group of modules in a modular switch. IBM encourages EPA to explore the possible configurations and compare the performance and characteristics of stacked, fixed switches and modular switches before deciding to exclude modular switches from the requirements.

Exclusions: IBM recommends that the following types of networking equipment be excluded from the LNE requirements.

Storage Area Networks: The network hierarchy described above does not consider storage area networks that are based on fibre channel technology. Storage Area Networks are largely confined to the data center supporting communications between servers and storage systems and operating on fibre channel technology. The fibre channel switches have different metrics than Ethernet switches and would not fit easily into categorization of Ethernet switches. There are two types of switches that exist in this space, both of which IBM proposes be excluded from the Large Network Equipment category.

a. Fibre Channel switches: These switches manage communications between servers and storage systems inside the data center space.
b. Converged switches: These switches integrate fibre channel and internet connectivity to create a more versatile switch for managing data center connectivity between systems and to the network. The converged switches are also a relatively small part of the market.

IBM recommends that these switches be considered as a separate category for a future ENERGY STAR requirements document.

Embedded Blade and Server switches: The I/O connectivity for blade or server systems are provided by modular systems which are “embedded” in the server or blade chassis

hardware. These systems are typically "modular" in nature (*i.e.* you can install one to some defined number of switches in a given blade chassis or server depending on the workload and requirements of the applications being run on the server). These switches can connect to an access switch or they can serve as a server level access switch which connects to a data center aggregation layer router. Given the diversity of embedded switches across the range of server products, IBM recommends that EPA not include embedded blade or server switches in this product category, as they are implicitly managed with the requirements of the server requirements.

Security Appliances: IBM has evaluated the security appliance category and recommends that EPA exclude security appliances from the Large Network Equipment requirements development process. This recommendation is based on the following analysis:

1. Security appliances come in two primary configurations: In-line appliances which are 'bump-in-the-wire' topology which inspect and/or analyze (and in certain cases, block) network traffic as it moves through critical network junctures; and appliances that 'tap' the network traffic, sampling (but do not impede or interdict) data traffic. As such, each type of security appliance has very different metrics, both of which are different than the metrics that would be used for network switches and routers. In the case of in-line deep packet inspection security appliances, the throughput is dependent on the level of inspection (certain customers prefer to block or restrict throughput to ensure 100% security inspection; others prefer 100% network uptime over security). As such, security appliances do not fit well within the performance/power metrics for LNE.
2. By the nature of their task, security appliances have a limited opportunity for power management or dynamically adjusting power to match utilization. The systems must be able to respond quickly to changes in network traffic, limiting the latency that can be tolerated from power management capabilities.
3. Approximately 1% of IBM's currently available security systems have more than 11 ports, meaning that most would be exempt from the LNE requirements.
4. Security appliances represent a very small portion of the large network equipment market. Based on IDC data, security appliances revenue of $532 M[1] represents approximately 0.4 percent of the 2011 service provider network market revenue of $135 B[2]. In terms of number of products introduced into the market, security appliances are a miniscule percentage of the marketplace. IBM security appliance sales are a similar percentage of its network equipment sales.
5. While network systems encompass tens to thousands of network devices as you move from the access layer to the core layer, security appliances are only located at critical systems junctions. This is the technical reason that security appliance volumes are a very small percentage of network system volumes.

[1] http://idc-cema.com/eng/about-idc/press-center/49334-security-appliance-market-shows-healthy-growth-across-cema-region-idc-study-reveals
[2] http://itcandor.net/2012/04/25/networks-q212%EF%BB%BF%EF%BB%BF/

The bulk of the opportunity for reducing energy use in Ethernet networks resides in the routers and switchers used in the Data Center or the Enterprise. The different nature of and metrics associated with security appliances offers no synergies or benefits for evaluating security appliances under the LNE requirements. IBM recommends that EPA exclude network appliances from the LNE requirements.

Network Equipment Energy Efficiency Features:

1. **Ability to manage the power consumption of switches and routers and their ports:** The technology that enables ports/switches/routers to be turned on and off to reflect their use status is currently evolving between two levels of capability.
    a. Older, and some current, technologies can turn off individual ports or switches in a fixed or modular framework if they are not being used. However, whole fixed unit or module has to be reset in order to enable ports or switches that have been turned off, briefly making the fixed unit or module "unavailable" to manage traffic. This affects the serviceability of the unit.
    b. Newer technologies allow individual ports or switches to be idled, but not managed remotely.
    c. Wake on LAN capability is useful in the enterprise space where user communications can be intermittent, less useful in the data center space where data traffic patterns are more consistent.

In general, switch and router technology is developing the ability to idle individual ports or a fixed or modular switch when no traffic is present, but the power cannot be turned off. EPA needs to investigate what types of switches and routers can put a fixed or modular switch into a low power state and which categories have the capability to idle specific ports. This information will be important to determine the power management requirements for different switch and router categories.

2. **Use of Variable Speed fans:** Network switches and routers have variable speed fans for cooling.

3. **Designs that dynamically scale power use with system utilization**: Switches and routers are being designed with switches that can power down certain parts of the switch when activity is minimal. The capabilities are dependent on the design of the chips on the switch. If devices are not custom made, they typically will have power management available as discussed in item (1) above.
4. **Reporting of equipment energy use to the network**: For the most part, network equipment does not have the ability to report actual power use and temperature to the network. This capability will have to be incorporated into new systems or Intelligent PDUs will need to be included as options for network equipment power supplies. IBM recommends that EPA perform a survey of the manufacturers of LNE to determine the availability of power use and inlet temperature report on currently available equipment.

5. **Ability to operate to ASHRAE A2 (27oC/80oF) or A3 (35oC/95oF):** Due to their characteristics and construction, network switches and routers are more tolerant of higher operating temperatures. Most LNE can operate at ASHRAE A3 conditions.

Power Supply Efficiency: As with servers and storage systems, power supply efficiency is an appropriate requirement for Version 1 of the LNE requirements. IBM recommends that EPA perform a survey of the manufacturers of LNE to determine the current power supply efficiency and power factor characteristics to set the appropriate 80 plus power supply efficiency requirements for LNE.

Equipment Metrics:

IBM agrees that the ATIS Standard "Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products" is the appropriate Standard for measuring LNE equipment performance/power efficiency. The IMIX traffic profile is the correct profile to test network systems. Network test equipment from the two main suppliers has IMIX as a standard offering. There are several additional requirements that should be considered during the requirements development process:

1. As most of these switches are Ethernet based, the minimum packet size should be 64 bytes (lines 137-138, 157-173). Anything smaller is likely to be dropped by the test.
2. Testing protocols need to include 10 GB and 40 GB ports. These port speeds are prevalent in aggregation and core switches in both the Enterprise and the Data Center. As server connectivity moves from 1G to 10G to 40G in next couple of years, its is important to include these speeds.

As EPA is at the initial stages of investigating what subset of the 2 classes and 6 layers would be appropriate to include in the LNE specification. IBM recommends that EPA gain a further understanding of the market, equipment volumes, and power use profiles to determine the included equipment universe for Version 1 of the LNE specification. As discussed earlier, further dialogue and exploration with industry stakeholders will be needed to better define the categories of LNE and the appropriate testing requirements and considerations that make the most sense for inclusion in Version 1 of the LNE requirements.